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New York State Energy Research
and Development Authority

Draft Environmental Impact Statement
for
Completion of the West Valley Demonstration Project
and
Closure or Long-Term Management of Facilities at the Western New York Nuclear Service Center

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COVER SHEET

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ABSTRACT: The purpose of the agency action is compliance by DOE with the statutory requirements of the West Valley Demonstration Project Act by completing the West Valley Demonstration Project and management by NYSERDA of the balance of the site by closing it or bringing it to a condition that reduces the amount of long-term maintenance that will be required. The expected environmental consequences over the implementation phase (about 30 years) and post-implementation phase (about 1,000 years) are evaluated, including analysis of transporting, stabilizing, storing and disposing of wastes generated by decontamination and decommissioning of the West Valley Demonstration Project and by closure or long-term management of facilities at the Western New York Nuclear Service Center. The document analyzes alternatives of no action (monitoring and maintenance), complete removal and off-site disposal, complete removal and storage on premises, in-place stabilization and on-premises disposal, and discontinue operations. Neither DOE nor NYSERDA have identified a preferred alternative.

PUBLIC COMMENTS: Public meetings on the Draft Environmental Impact Statement, will be announced in February 1996; oral comments will be accepted at these meetings. Written comments on the Draft Environmental Impact Statement will be accepted until September 1996 (see Notice of Availability for exact date) at the New York address at West Valley provided above. The U.S. Department of Energy and the New York State Energy Research and Development Authority will consider these public comments in preparing the Final Environmental Impact Statement.

SUMMARY

The Western New York Nuclear Service Center (Center) is a 1,352-ha (3,340-acre) site located 48 km (30 mi) southeast of Buffalo, New York. The New York State Energy Research and Development Authority (NYSERDA) holds title to and manages the Center on behalf of the people of the State of New York. The Center contains a reprocessing facility that operated from 1966 to 1972 and produced approximately 2.3 million L (600,000 gal) of liquid high-level [radioactive] waste. The Center also contains two radioactive waste disposal areas: (1) a 6-ha (15-acre) New York State-licensed disposal area that operated as a commercial low-level [radioactive] waste facility from 1963 to 1975, and (2) a 2-ha (5-acre) U.S. Nuclear Regulatory Commission-licensed disposal area that received radioactive wastes from the reprocessing plant and associated facilities from 1966 through 1986. In addition to the nuclear fuel reprocessing plant and the disposal areas, the Center has a high-level [radioactive] waste tank farm, waste lagoons, aboveground radioactive waste storage areas, and some soil and groundwater contamination in areas near these facilities.

In 1980, Congress enacted the West Valley Demonstration Project (WVDP) Act that required the U.S. Department of Energy (DOE) to demonstrate the safe solidification of liquid high-level [radioactive] waste and transportation of this solidified waste to a geologic repository for permanent disposal. Under this Act, DOE assumed exclusive possession of the 80-ha (200-acre) portion of the Center, referred to as the Project Premises, which includes the former reprocessing facility, the U.S. Nuclear Regulatory Commission-licensed disposal area, the high-level [radioactive] waste tanks, waste lagoons, and aboveground waste storage areas. NYSERDA retained responsibility for the balance of the Center, which includes the New York State-licensed disposal area. DOE and NYSERDA are evaluating alternatives for completing the WVDP and closure beginning in the year 2000 or long-term management of facilities at the Center near West Valley, New York.

This draft Environmental Impact Statement (EIS) discusses alternatives and potential impacts for both off site (the area outside the Center boundary) and on site (the area within the Center boundary). For purposes of analysis, the on-site area is divided into two areas. One of these areas includes the Project Premises [the 80-ha (200-acre) area controlled by DOE] and the New York State-licensed disposal area. The other on-site area is the balance of the site (the area within the Center, excluding the Project Premises and New York State-licensed disposal area).

This EIS evaluates alternatives for integrated sitewide actions to complete DOE decontamination and decommissioning activities and provide for NYSERDA's closure or long-term management of facilities at the Center. The EIS is prepared in accordance with the National Environmental Policy Act and the New York State Environmental Quality Review Act. This joint EIS supports the selection of the site management strategy and gives environmental input for NYSERDA and DOE decisions for future site closure or management activities. DOE and NYSERDA will identify the selected strategy in a Record of Decision and in New York State Environmental Quality Review Act Findings, respectively. If necessary, additional National Environmental Policy Act or New York State

Environmental Quality Review Act documents will be prepared for DOE and NYSERDA actions not specifically addressed in this document.

PURPOSE AND NEED FOR AGENCY ACTION

The purpose of the agency action is compliance by DOE with the statutory requirements of the WVDP Act by completing the WVDP and management by NYSERDA of the balance of the site by closing it or bringing it to a condition that reduces the amount of long-term maintenance that will be required.

ALTERNATIVES CONSIDERED

Five alternatives for WVDP completion and closure or long-term management of the facilities at the Center are analyzed in this EIS. These five alternatives were identified after considering comments received on the Notice of Intent. The five alternatives are

1. Alternative I: Removal and Release to Allow Unrestricted Use

2. Alternative II: Removal, On-Premises Waste Storage, and Partial Release to Allow Unrestricted Use

3. Alternative III: In-Place Stabilization and On-Premises Low-Level Waste Disposal

4. Alternative IV: No Action: Monitoring and Maintenance

5. Alternative V: Discontinue Operations.

Figure S-1 summarizes the alternatives. Alternative II (On-Premises Storage) was identified at public meetings as an alternative for consideration in the EIS. Alternative IV (No Action: Monitoring and Maintenance) is required by National Environmental Policy Act and New York State Environmental Quality Review Act regulations as a benchmark for comparison with the environmental effects of the alternative actions. Alternative V (Discontinue Operations) was also identified at public meetings as an alternative for evaluation in the EIS. Although Alternative V is not considered a reasonable alternative by either agency, it provides an environmental baseline for evaluating impacts. The long-term performance assessment (an analysis of the effects that contaminated facilities would have on human health and the environment over the long term) of Alternative V gives an understanding of the long-term public hazard and contribution of natural processes such as surface water flow or erosion to that hazard.

Table S-1 summarizes the actions for each alternative, including the disposition of newly generated and stored waste.

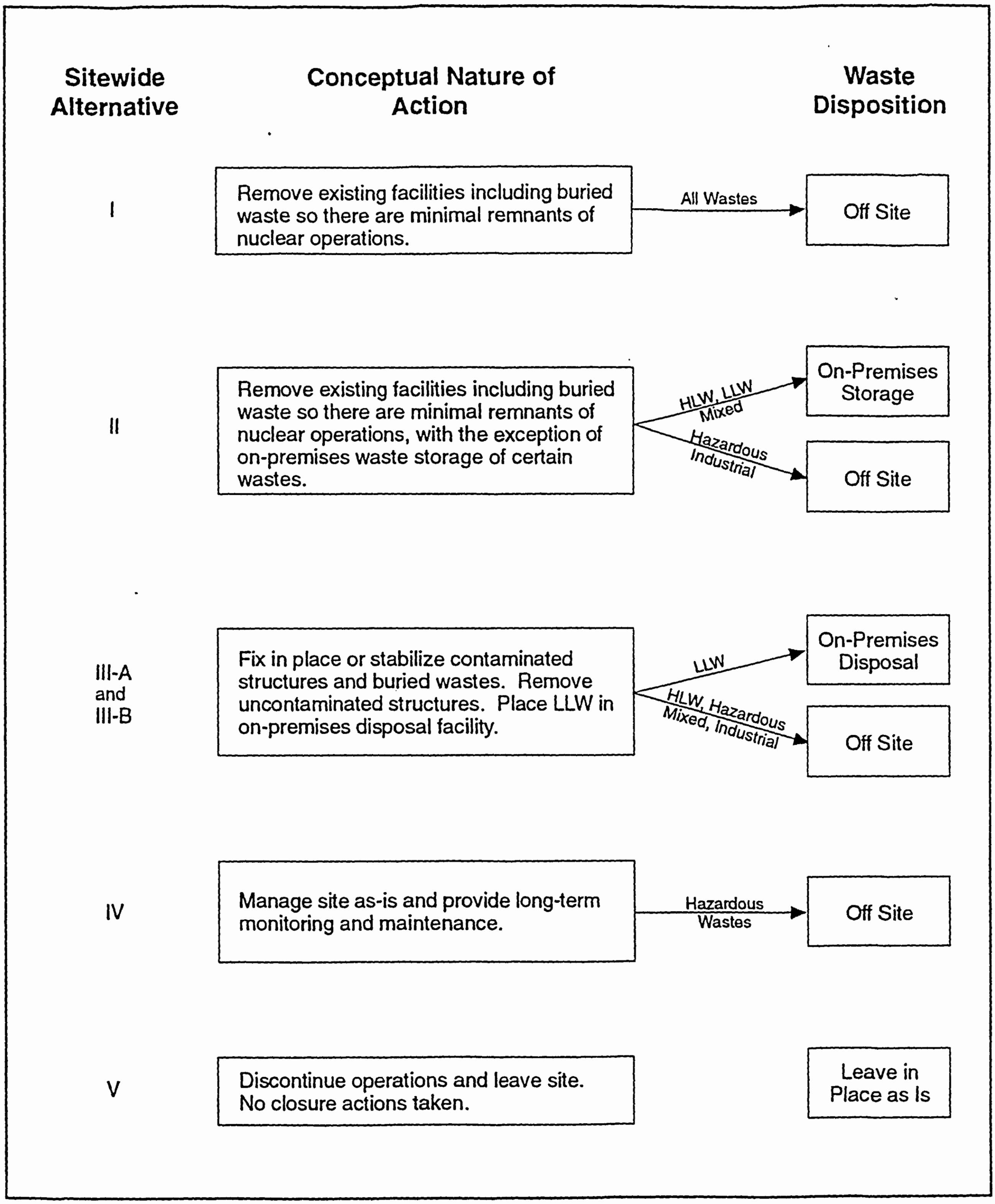

Figure S-1. **Alternatives for Completing the West Valley Demonstration Project and Closure or Long-Term Management of Facilities at the Western New York Nuclear Service Center.**

Table S-1. Summary of Actions for Alternatives I through V

Alternative I Removal	Alternative II On-Premises Storage	Alternative IIIA In-Place Stabilization (Backfill)	Alternative IIIB In-Place Stabilization (Rubble)	Alternative IV No Action: Monitoring and Maintenance	Alternative V Discontinue Operations
Dismantle buildings	Dismantle buildings	Dismantle buildings except process building and vitrification facility. Backfill process building and vitrification facility with concrete.	Dismantle and remove buildings except process building and vitrification facility. Dismantle abovegrade portions of process building and vitrification facility and install cap on belowgrade portions of these buildings and the building rubble.	Install locks and security systems on buildings. Weld exterior access doors shut.	Shut down facilities' active systems, lock buildings, and leave waste as-is
Remove stored waste and dismantle waste storage facilities	Remove stored waste and dismantle waste storage facilities except RTS drum cell	Remove stored waste and dismantle waste storage facilities except RTS drum cell. Convert RTS drum cell into tumulus.	Remove stored waste and dismantle waste storage facilities except RTS drum cell. Convert RTS drum cell into tumulus.	Not applicable	Not applicable
Pump leachate from disposal areas and exhume buried waste	Pump leachate from disposal areas and exhume buried waste	Pump leachate from NDA and SDA and grout SDA trenches. Install circumferential slurry wall around NDA and SDA and cap them both.	Pump leachate from NDA and SDA and grout SDA trenches. Install circumferential slurry wall around NDA and SDA and cap them both.	Not applicable	Not applicable
Remove in-ground structures	Remove in-ground structures	Backfill HLW tanks with concrete. Cap LLWTF lagoons and SDA filled lagoons. Backfill or remove other in-ground structures.	Backfill HLW tanks with concrete. Cap LLWTF lagoons and SDA filled lagoons. Backfill or remove other in-ground structures.	Excavate sediments from sludge ponds and backfill. Store generated waste on premises. Leave other waste as-is.	Not applicable
Remove remaining facilities, including draining the reservoirs	Remove majority of remaining facilities, including draining the reservoirs	Remove majority of remaining facilities	Remove majority of remaining facilities	Not applicable	Not applicable
Excavate contaminated soil from the Project Premises, SDA, and the balance of the site	Excavate contaminated soil from the Project Premises, SDA, and the balance of the site	Not applicable	Not applicable	Not applicable	Not applicable

Table S-1. Summary of Actions for Alternatives I through V (Continued)

Alternative I Removal	Alternative II On-Premises Storage	Alternative IIIA In-Place Stabilization (Backfill)	Alternative IIIB In-Place Stabilization (Rubble)	Alternative IV No Action: Monitoring and Maintenance	Alternative V Discontinue Operations
Treat contaminated waste, soil, and wastewater in new on-premises container management area. Dismantle container management area after implementation phase.	Treat contaminated waste, soil, and wastewater in new on-premises container management area. Dismantle container management area after implementation phase. Construct new retrievable storage areas.	Treat contaminated wastewater in new wastewater treatment area. Dismantle wastewater treatment area after implementation phase.	Treat contaminated wastewater in new wastewater treatment area. Dismantle wastewater treatment area after implementation phase. Construct new LLW disposal facility.	Not applicable	Not applicable
Stabilize LLWTF lagoon 3 embankment	Stabilize LLWTF lagoon 3 embankment. Stabilize the stream banks along Erdman Brook and Franks Creek.	Either install several localized erosion control structures or implement extensive, sitewide erosion control measures including large-scale stream bed filling	Either install several localized erosion control structures or implement extensive, sitewide erosion control measures including large-scale stream bed filling	Install localized erosion control structures. Stabilize the stream banks along Erdman Brook and Franks Creek.	Not applicable
Dispose of waste off site	Store all radioactive and mixed waste on-premises in new retrievable storage areas. Dispose of industrial waste off site. (RTS drum cell remains.)	Dispose of generated and stored radioactive waste in process building or vitrification facility. Dispose of spent fuel fines and vitrified, mixed, hazardous, and industrial waste off site.	Dispose of generated and stored radioactive waste in new on-premises LLW disposal facility. Dispose of spent fuel fines and vitrified, mixed, hazardous, and industrial waste off site.	Not applicable	Not applicable
Release the Center for unrestricted use	Monitor and maintain the retrievable storage areas, RTS drum cell, Erdman Brook stream banks, and the Franks Creek stream banks south of the RTS drum cell and east of the SDA	Monitor and maintain the remaining facilities and erosion control measures on Erdman Brook, Franks Creek, and Quarry Creek (local erosion control strategy only)	Monitor and maintain the remaining facilities and erosion control measures on Erdman Brook, Franks Creek, and Quarry Creek (local erosion control strategy only)	Inspect, monitor, and maintain all areas of the Center	Personnel leave the Center

HLW = high-level [radioactive] waste
LLW = low-level [radioactive] waste.
LLWTF = low-level waste treatment facility
NDA = Nuclear Regulatory Commission-licensed disposal area
RTS = radwaste treatment system
SDA = New York State-licensed disposal area

The evaluations of impacts of alternatives cover two periods of time: an implementation phase and a post-implementation phase. The implementation phase refers to the period of time it takes to remove or stabilize facilities and the post-implementation phase refers to the subsequent period, which includes long-term monitoring and maintenance for Alternatives II (On-Premises Storage), III (In-Place Stabilization), and IV (No Action: Monitoring and Maintenance). Table S-2 shows the duration of the implementation phase, whether there is a long-term post-implementation monitoring and maintenance period, and new facilities that would be constructed. The labor requirements and waste volumes to be managed, which indicate the effort in implementing the alternatives, are also shown in Table S-2.

As shown in Table S-2, Alternatives I (Removal) and II (On-Premises Storage) involve the greatest effort because the buried waste would be exhumed, the stored waste would be removed, facilities would be decontaminated and demolished, and soil contaminated above assumed contaminant cleanup levels would be excavated. A new facility, the container management area, would be constructed to treat waste, soil and wastewater and to package the stored and newly generated waste. The major difference between these two high-effort alternatives is the disposition of the waste. Under Alternative I (Removal), waste would be disposed of off site, while under Alternative II (On-Premises Storage), the radioactive and mixed waste would be placed into new retrievable storage areas on the Project Premises.

The in-place stabilization alternatives [Alternatives IIIA (Backfill) and IIIB (Rubble)] involve stabilizing the waste, controlling contamination, and managing facilities in-place, and these alternatives would require less effort than Alternatives I (Removal) and II (On-Premises Storage). A new wastewater treatment area would be constructed under both alternatives to treat contaminated liquids. The distinguishing difference between these in-place stabilization alternatives is the treatment of the process building, vitrification facility, and the stored waste in the lag storage building, lag storage additions, and chemical process cell waste storage area. Under Alternative IIIA [In-Place Stabilization (Backfill)], the stored waste would be placed in either the process building or the vitrification facility, which would be backfilled with concrete to convert the building and the waste into a monolith. Under Alternative IIIB [In-Place Stabilization (Rubble)], stored waste would be placed in a new on-premises LLW disposal facility while the process building and the vitrification facility would be demolished within a single, newly-constructed confinement structure. The result of Alternative IIIB would be a grouted pile of building rubble covered by an engineered cap to minimize water infiltration.

Alternative IV (No Action: Monitoring and Maintenance) would involve minimal initial effort to prepare for long-term monitoring and maintenance of the facilities and of the buried and stored wastes. Alternative V (Discontinue Operations) would involve no effort. Facilities would be shut down and personnel would abandon the site.

Alternatives II, IIIA, IIIB, and IV implement erosion controls. Under Alternative III (In-Place Stabilization), either several localized erosion control structures could be installed (e.g., diversion dikes and water control structures) or extensive sitewide, global erosion

Table S-2. Summary of Resource Requirements and Waste Volumes

	Alternative I Removal	Alternative II On-Premises Storage	Alternative IIIA In-Place Stabilization (Backfill)	Alternative IIIB In-Place Stabilization (Rubble)	Alternative IV No Action: Monitoring and Maintenance	Alternative V Discontinue Operations
Implementation Phase Duration (years)	26	28	10[a] or 14[b]	26	5	0[c]
Post-Implementation Phase Monitoring and Maintenance	No	Yes	Yes	Yes	Yes	No
New Facilities	Volume reduction, soil treatment and wastewater treatment (all in container management area)	Volume reduction, soil treatment and wastewater treatment (all in container management area) and waste storage facilities (retrievable storage areas)	Wastewater treatment	Wastewater treatment, LLW disposal facility, and confinement structure for dismantling process building and vitrification facility	Wastewater treatment	None
Labor for Implementation Phase (worker-years)	14,433	18,864[a]	2,071[a] or 2,627[b]	5,634[a] or 6,190[b]	131	0
Direct Employment Levels						
• Peak for Implementation	850	1,026	327	504	24	0
• Level During Monitoring and Maintenance	0	30	50	50	200	0
Waste Volumes Managed During Implementation Phase (ft^3)						
• LLW: A, B, C	4,820,000	4,610,000	510,000	555,000	15,200	0
• LLW: Greater-Than-Class C	272,000	272,000	15,100	15,100	0	0
• HLW[d]	10,600	10,600	9,420	9,420	0	0
• Hazardous	5	2	2	2	1	0
• Mixed	1,810	1,810	2,220	2,220	0	0
• Contaminated Soil	4,230,000[e]	4,230,000[e]	0	0	0	0
• Industrial[f]	5,130,000	4,080,000	1,440,000[a] or 2,410,000[b]	1,420,000[a] or 2,400,000[b]	212,000	0
Total Cost ($1996, thousands)						
Implementation Phase	8,300,000	3,700,000	400,000[a] or 510,000[b]	990,000[a] or 1,100,000[b]	17,000	0
Post-Implementation Phase ($1996 thousands/year)	0	2,800	11,000	11,000	30,000	0

HLW = high-level [radioactive] waste
LLW = low-level [radioactive] waste
a. Assumes local erosion controls would be used.
b. Assumes global, sitewide erosion controls would be used.
c. There would be on-site personnel completing WVDP HLW solidification until the year 2004. No initiatives for completing the WVDP or closing facilities on the Center would be taken.
d. Volumes include the spent fuel fines in the process building. Although the classification of the spent fuel fines is not yet known, for purposes of analysis it was assumed that it would be HLW.
e. Estimated as 25 percent of the original volume of contaminated soil (20 percent that could not be successfully treated and 5 percent that would be contaminated sludge from soil treatment operations).
f. For purposes of analysis, this EIS assumes that this uncharacterized waste would be industrial waste. However, if all of this waste was found to be contaminated during closure activities instead of uncontaminated (as assumed in this table), there would be no industrial waste and these volumes would be Class A waste.

control measures could be implemented, including constructing a new diversion channel and filling stream beds. As shown in Table S-2, the labor requirements would increase if a global erosion control strategy were selected where the drainage pattern of the Project Premises and New York State-licensed disposal area is modified. Erosion control would not be implemented either under Alternative I (Removal), because the waste would be removed from the Center, or under Alternative V (Discontinue Operations), because for analysis purposes, it was assumed that the Center is abandoned.

At this time, neither DOE nor NYSERDA have identified a preferred alternative for completing the WVDP or for closure or long-term management of facilities at the Center, but a preferred alternative will be identified in the final EIS after comments on the draft EIS are considered.

Table S-2 also summarizes the estimated waste volumes that would be managed under each alternative. The waste volumes are dominated by the low-level radioactive, contaminated soil, and the industrial waste categories. The sources for most of the waste volumes are the large buildings (process building and vitrification facility), the disposal areas (New York State-licensed disposal area and U.S. Nuclear Regulatory Commission-licensed disposal area), and the waste storage facilities (lag storage building and additions and chemical process cell waste storage area). Under Alternatives I (Removal) and II (On-Premises Storage), the waste volumes could increase if soil treatment is not as effective as estimated in the conceptual engineering designs. No bench test or pilot scale evaluations have been performed for site-specific soil treatability. The disposition of these waste volumes under the same alternatives could be affected depending on whether off-site facilities would accept industrial waste generated by the demolition of decontaminated facilities. For Alternatives III (In-Place Stabilization), IV (No Action: Monitoring and Maintenance), and V (Discontinue Operations), the waste volumes to be managed are less than the volumes for Alternatives I and II, either because the facilities are stabilized in place, managed as is, or no action is taken at all.

COMPARISON OF IMPACTS

Direct environmental impacts occur during the implementation phase and vary depending on the alternative. The resources required to implement an alternative; the impacts to the public and workers from routine actions, accidents, and transportation; and impacts to air, water, biotic resources, wetlands and floodplains, cultural resources, and land use are evaluated. The costs and socioeconomic impacts are also evaluated. All impact areas are summarized in Section 3.8 of Chapter 3. The impacts that differentiate among the alternatives are summarized here.

Potential accidents were postulated and evaluated for each of the alternatives. The dose to the maximally exposed off-site individual and to the general population were calculated together with the annual probability of the postulated accident. At least one accident was identified for each alternative that resulted in a dose of 25 rem (25,000 mrem) to a member of the public, although more than half of the postulated accidents would result in a dose of less than 5 rem (5,000 mrem). All of these accidents have an estimated annual probability of occurring that ranges from one in ten thousand to one in 100 million (10^{-4} to 10^{-8}). These are considered to be bounding estimates of severity and frequency. The range of potential worker doses were also estimated but could not be precisely defined because of the lack of definitive information on facility design and occupancy patterns. The accident analysis is presented in Appendix G and the results are summarized in Chapter 5. The results are not summarized here because they did not discriminate among alternatives.

Implementation of the alternatives could result in fatalities because of radiation exposure (latent cancer fatality) or transportation accidents. Estimates of these fatalities are presented in Table S-3. Fatalities are greater for Alternatives I and II than the other alternatives because the buried waste would be exhumed and buildings would be demolished, which creates the potential for accidents and for more radioactive material being released to the environment.

As shown in Table S-3, Alternative I (Removal) requires off-site disposal of a large volume of radioactive waste. Approximately 21,000 truck shipments or 13,300 rail shipments to an off-site radioactive waste disposal site would be needed. Adverse nonradiological and radiological impacts would result from both the shipping and waste disposal activities. Shipping would result in increased traffic congestion, the potential for nonradiological injuries and fatalities because of traffic accidents, and radiological exposure and the corresponding risk of latent cancer to both the shipping personnel and the public along the shipping routes. Alternatives II (On-Premises Storage) and III (In-Place Stabilization) would ship industrial waste off site, but it would be shipped in smaller volumes than for Alternative I.

As shown in Table S-3, Alternatives I (Removal) and II (On-Premises Storage) result in the largest implementation phase impact on air, biotic resources, and wetlands from disturbing a larger area by demolishing buildings, exhuming buried waste, or removing contaminated soil. Some specimens of a State-Endangered plant species, Rose Pinks, could be destroyed if Alternative I or Alternative II were implemented. Likewise, more forested areas on the balance of the site would be uprooted from implementing Alternative I or Alternative II. However, there are no critical habitats located on the Project Premises and New York State-licensed disposal area, the industrial area where most of the action would be occurring; therefore, impacts to biotic resources in this area would be minimal.

The total disturbed area also depends on the type of erosion control strategy implemented. More land, biotic resources, cultural resources, and wetlands would be disturbed or destroyed if a global erosion strategy were selected.

Implementing Alternative I or Alternative II would destroy or disturb 8.8 ha (21.9 acres) of wetlands. These wetlands are small, generally less than 0.6 ha (1 acre) in size, and do not support critical habitat. DOE and NYSERDA would work with the U.S. Army Corps of Engineers and the New York State Department of Environmental Conservation as appropriate to mitigate impacts to wetlands.

Table S-3. Summary of Impacts During the Implementation Phase

Impact	Alternative I Removal	Alternative II On-Premises Storage	Alternative IIIA In-Place Stabilization (Backfill)	Alternative IIIB In-Place Stabilization (Rubble)	Alternative IV No Action: Monitoring and Maintenance	Alternative V Discontinue Operations
Maximally Exposed Off-Site Individual						
• Annual risk of Latent Cancer Fatality	2.2×10^{-9}	2.2×10^{-9}	1.6×10^{-6}	1.6×10^{-6}	2.9×10^{-7}	No implementation
Fatalities from Site Operations						
• Because of Occupational Industrial Accidents	0.25	0.31	0.13	0.25	0.0035	0
• Latent Cancer Fatality—Occupational	0.5	0.5	0.05	0.05	0.005	No Implementation
• Latent Cancer Fatality—Public	0.06	0.06	0.02	0.02	0.001	No Implementation
Fatalities from Transportation (Hanford for LLW)						
• Truck Accidents	3.55	0.28	0.22	0.22	0.016	No Implementation
• Rail Accidents	3.24	0.26	0.20	0.20	0.006	No Implementation
• Occupational Latent Cancer Fatalities—Truck	0.56	0	0.028	0.028	0	No Implementation
• Occupational Latent Cancer Fatalities—Rail	0.14	0	0.006	0.006	0	No Implementation
• Public Latent Cancer Fatalities—Truck	5.9	0	0.38	0.38	0	No Implementation
• Public Latent Cancer Fatalities—Rail	0.69	0	0.029	0.29	0	No Implementation
Total Latent Cancer Fatalities (Site Operations and Transportation)					0	
Truck	7.02	0.56	0.48	0.48	0.006	No Implementation
Rail	1.39	0.56	0.10	0.10	0.006	No Implementation
Number of Waste Shipments (Off Site)						
• Radioactive Waste (Truck)	21,000	0	340	340	0	0
• Radioactive Waste (Rail)	13,300	0	180	180	0	0
• Industrial Waste (Truck)	10,000	8,200	5,000	5,000	500	0
• Industrial Waste (Rail)	7,000	5,700	3,500	3,500	340	0
Area Required at Off-Site Disposal Facilities (acres)	23	0	Negligible	Negligible	0	0
Total Disturbed Area [hectares (acres)]	81 (200)	83[a] (205)	39[a] to 57[b] (97 to 142)	39[a] to 57[b] (97 to 142)	32[a]	0
Wetlands, Disturbed or Destroyed [hectares (acres)]	8.8 (21.9)	8.8[a] (21.9)	1.9[a] or 6.4[b] (4.7 or 20.7)	1.9[a] or 6.4[b] (4.7 or 20.7)	0.6[a] (1.4)	0
Cultural Resources						
• Historic	No impact	No impact	No impact	No impact	No impact	No impact
• Archaeological [hectares (acres)]	3.8 (9.5)	3.8[a] (9.5)	3.8[a,c] (9.5)	3.8[a,c] (9.5)	No impact[a]	No impact
Dedicated Area [hectares (acres)]	0	340 (830)	350 (860)	350 (860)	1,350 (3,340)	47 (115)
Socioeconomic Impact in the Region of Influence from combination of implementing the alternative and decline in employment from WVDP HLW solidification operations	Gradual decrease in direct site employment from current level of 950 to 850 in 2011 and then decrease to zero in 2026. Decrease would occur over 15 years and would cause loss of about 57 direct jobs/year.	Increase in direct site employment from current level of 950 to 1,026 in 2011 and then gradually decrease to stable level of 30 in 2026. Decrease would occur over 15 years and would cause loss of about 67 direct jobs/year.	Decrease in direct site employment from current level of 950 to stable level of 50 in 2011. Decrease would occur over 11 years and would cause loss of 82 direct jobs/year.	Decrease in direct site employment from current level of 950 to stable level of 50 in 2027. Decrease would occur over 27 years and would cause loss of 33 direct jobs/year.	Decrease in direct site employment from current level of 950 to stable level of 187 by 2004. Decrease would occur over 4 years and would cause loss of 190 direct jobs/year.	Decrease in direct site employment from current level of 950 to zero by 2004 from completion of HLW solidification. Decrease would occur over 4 years and would cause loss of 237 direct jobs/year.

HLW = high-level [radioactive] waste
LLW = low-level [radioactive] waste
WVDP = West Valley Demonstration Project
a. Assumes local erosion controls would be used.
b. Assumes global, sitewide erosion controls would be used.
c. More area may be disturbed if global erosion controls were used.

No historic structures are located on the Project Premises, New York State-licensed disposal area, or balance of the site; therefore, there would be no impact to historic cultural resources in these areas. No known archaeological resources are located in areas to be disturbed on the Project Premises and New York State-licensed disposal area; therefore, there would be no impact. Areas with the potential for prehistoric archaeological sites could be disturbed on the balance of the site.

The dedicated land area resulting from implementing the alternatives would range from 0 to a maximum of 1,352 ha (3,340 acres) depending on the alternative. Under Alternative I (Removal), the Center would be released to allow unrestricted use. Under Alternative IV (No Action: Monitoring and Maintenance), the Center is monitored and maintained. Under Alternatives II (On-Premises Storage) and III (In-Place Stabilization), about one fourth [340 — 350 ha (830 — 860 acres)] of the acreage on the Center would be restricted to accommodate buffer zones and erosion control measures.

The WVDP currently accounts for about 6 percent of the employment in a 20-km (12-mi) radius from the Center, and all alternatives would ultimately eliminate most, if not all, of these jobs. The elimination of jobs would occur slowly over an extended period of time with the exception of Alternative V (Discontinue Operations). Alternative I or Alternative II defers this job reduction for about 20 years. The in-place stabilization alternatives (Alternatives IIIA and IIIB) defer this reduction for 10 or 26 years depending on the selected technology. Under Alternative IV (No Action: Monitoring and Maintenance), a maintenance and monitoring staff would remain. No noticeable influx of personnel would result from implementing any of the alternatives. The current site employees would be expected to fill most of the jobs associated with the alternatives.

Impacts to the population are measured in latent cancer fatalities that could result from radiation exposure. Two populations were evaluated in this EIS: those people residing within a 80-km (50 mi) radius of the site and those people along the transportation routes as summarized in Table S-3. All alternatives would result in less than one additional latent cancer fatality to the general population from site operations during the implementation phase.

The results of the transportation analysis shows that if all of the waste were shipped off site (Alternative I, Removal), the latent cancer fatalities could potentially be about 6 (5.9 on Table S-3) if the waste were shipped by truck. The number of latent cancer fatalities would be about 15 times less (0.38) if the waste were shipped by rail instead. The number of latent cancer fatalities from shipping radioactive waste under Alternatives II (On-Premises Storage), III (In-Place Stabilization), and IV (No Action: Monitoring and Maintenance) would be zero or less than one either because no radioactive waste would be shipped (Alternatives II and IV) or a much smaller volume of radioactive waste would be shipped (Alternative III).

Even though DOE expects little or no adverse health impacts from any of the alternatives assuming institutional control is maintained, it analyzed whether or not there would be "disproportionately high and adverse human health or environmental effects on minority populations or low-income populations" (Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations"). To estimate health impacts to the Seneca Nation, the EIS includes in Section 5.8.2.4 an analysis based on fish consumption rates from the Mohawk Indians and Environmental Protection Agency guidance. DOE does not have information on Seneca Nation fish consumption, but is consulting with the Seneca Nation on this issue. The final EIS will include results of that consultation and any conclusion that DOE has reached based on the Seneca Nation-specific information.

The impact assessment shows the implementation phase environmental impacts are largest for Alternatives I and II because more area would be disturbed to remove contamination. The extent of these impacts is indicated by the acres disturbed, the labor requirements, the number of shipments, and the required area for new storage facilities. The implementation phase impacts are less for Alternatives IIIA and IIIB, depending on the selected erosion control strategy. The streams on the Project Premises are drastically changed if the global erosion control strategy is implemented. The least implementation phase impacts are from Alternative IV (No Action: Monitoring and Maintenance), where minimal area is disturbed and minimal labor is required to implement the alternative.

Table S-4 summarizes the results of the long-term radiological performance assessment, an analysis of the effects that contaminated facilities would have on human health and the environment over the long term. The results from three cases are presented: the expected case that assumes institutional control is maintained (for 100 years), a loss of institutional control case assuming only a Buttermilk Creek intruder, and loss of institutional control assuming there is an intruder on either the Project Premises or the New York State-licensed disposal area. The dominant pathway (i.e., groundwater, surface water, or erosion) along with the expected radiation dose in the peak year of maximum impact is shown on Table S-4.

The dose estimates, including those for the expected case, are biased high. They are based on conservative radionuclide release and transport estimates and on air, water, and soil use assumptions that overestimate the results. For any one pathway (e.g., air, water, or soil) 10 to 20 factors may be evaluated to determine a potential dose (including water infiltration rate, radionuclide solubility, radionuclide adsorption onto soil, groundwater velocity, dilution by ground and surface waters, source of drinking water, and source of irrigation water, source of and amount of food consumed). The cumulative effect of these conservative biases could overestimate the dose by factors ranging from 2 or 3 to factors greater than 10. The cumulative biases are even greater for the scenarios evaluated for loss of institutional control where there is the increased potential for groundwater releases or erosional collapse into streams. Given these conservative biases, the analytical results from long-term performance are most useful for comparing the alternatives and for identifying the potential sources (e.g., high-level [radioactive] waste tanks or low-level waste treatment facility) or pathways (e.g., groundwater or erosion) that contribute to the dose. The conservative biases make it difficult to accurately predict if a particular dose standard (e.g., 25 mrem/yr) would be exceeded. If, however, the analysis indicates the dose would be less than a particular standard, there is high likelihood the standard would not be exceeded.

Table S-4. Summary of Post-Implementation Phase (Long-Term) Peak Doses[a]

Receptor	Alternative I Removal (mrem)	Alternative II On-Premises Storage (mrem)	Alternative IIIA In-Place Stabilization (Backfill) (mrem)	Alternative IIIB In-Place Stabilization (Rubble) (mrem)	Alternative IV No Action: Monitoring and Maintenance (mrem)	Alternative V Discontinue Operations (mrem)
Maintenance of Institutional Control[b]						
Off-Site Resident (Cattaraugus Creek)	<<15	<<15	72 (HLW tanks)	72 (HLW tanks)	1.2 (LLWTF)	5,600 from groundwater flow from HLW tanks through sand and gravel layer; 560 to 41,000 from erosion-induced releases from NDA and SDA to surface water
Off-Site Person of the Seneca Nation [24 km (15 mi) Downstream on Cattaraugus Creek at the Cattaraugus Reservation][c]	<<15	<<15	126 (HLW tanks)	126 (HLW tanks)	2.2 (LLWTF)	9,800 from groundwater flow from HLW tanks; 980 to 72,000 from erosion-induced releases from NDA and SDA to surface water
Loss of Institutional Control						
Intruder Buttermilk Creek	<<15	652 (RSAs degradation) 4,500 (RTS drum cell)	541 (HLW tank failure); 4,500 to 280,000 from erosion-induced releases from RTS drum cell, NDA, and SDA	541 (HLW tank failure); 4,500 to 280,000 from erosion-induced releases from RTS drum cell, NDA, and SDA	4,700 (HLW tank failure); 4,500 to 280,000 from erosion-induced releases from RTS drum cell, NDA, and SDA	45,000 (HLW tank failure); 4,500 to 330,000 from erosion-induced releases from RTS drum cell, NDA, and SDA
Intruder to Project Premises and SDA	<15	130,000,000 (RSAs)	89,000,000 (HLW tanks)	89,000,000 (HLW tanks)	1,100,000,000 (HLW tanks)	9,200,000,000 (HLW tanks)

< = less than
<< = much less than
HLW = high-level [radioactive] waste
LLWTF = low-level waste treatment facility
SDA = New York State-licensed disposal area
NDA = Nuclear Regulatory Commission-licensed disposal area
RTS = radwaste treatment system
RSAs = retrievable storage areas

a. Impacts are from surface water and groundwater pathways.
b. Referred to as the "expected conditions" case in Volumes I and II of the EIS.
c. Dose calculations for Seneca Indians assumes consumption of, and crop irrigation with, Cattaraugus Creek water and a high rate of consumption of Cattaraugus Creek fish.

Long-term performance analysis under expected conditions shows that for Alternatives II (On-Premises Storage) and IV (No Action: Monitoring and Maintenance) the dose to the maximally exposed off-site individual would be less than 25 mrem/yr. The off-site dose to the maximally exposed individual under expected conditions would be greater than 25 mrem/yr under Alternatives IIIA [In-Place Stabilization (Backfill)] and IIIB [In-Place Stabilization (Rubble)] because of potential releases from the high-level [radioactive] waste tanks. The high-level [radioactive] waste tanks contribute to this higher dose because of the tank inventory and the waste form (a concrete-sludge mixture). The conceptual engineering design for the inventory and waste form was developed before the long-term performance assessment was completed. Modifying the conceptual engineering design under this alternative could reduce the waste inventory, improve the waste form, or provide for selective removal of the high-level [radioactive] waste tanks. For Alternative IV (No Action: Monitoring and Maintenance), the high-level [radioactive] waste tanks perform better than Alternative III (In-Place Stabilization) because they would be maintained.

The long-term radiological performance assessment also evaluated the impact of potential intruders that could enter the site if there was loss of site control and loss of maintenance of creek banks next to the facilities (loss of institutional control). This analysis showed doses for the Buttermilk Creek intruder that exceed 25 mrem/yr. The peak doses are expected to occur 60 to 70 years after loss of institutional control for potential releases from facilities on the Project Premises and New York State-licensed disposal area that are not eroded. For potential releases from facilities on the Project Premises and New York State-licensed disposal area that are eroded, the peak doses occur 200 to 300 years after loss of institutional control if a local erosion control strategy is implemented and after 1,000 years if a global erosion control strategy is implemented. Alternative II (On-Premises Storage) would be less susceptible to erosion than Alternatives IIIA, IIIB, and IV if the retrievable storage areas were located in areas less likely to erode or if the facility was specifically designed to withstand the effects of the till erosion. Alternatives IIIA, IIIB, and IV appear to have comparable impacts from erosion because the material that can be eroded is in the same place. The potential impact can be reduced by implementing the erosion control strategies.

Finally, the long-term radiological performance assessment examined the impact of potential intruders on the Project Premises and the New York State-licensed disposal area following loss of institutional control. This analysis showed large doses (greater than 500 mrem) for most of the remaining waste management areas under Alternatives II through V. The large doses result from managing the waste in a concentrated form and are not specific to the waste or the Center. All alternatives are susceptible to intrusion, and there is no basis for concluding that any alternative is less prone to intrusion than another. The results of the analysis demonstrate the necessity of institutional control to limit site access under Alternatives II through IV.

The maximum long-term radiological impact after implementation of Alternative I (Removal) to a potential reuser of the Project Premises and New York State-licensed disposal area would be 15 mrem/yr. This level has been proposed as a radiological cleanup criteria in draft regulations prepared by the U.S. Nuclear Regulatory Commission and the U.S. Environmental Protection Agency.

The expected long-term impacts of disposing of the waste off site [Alternative I (Removal)] would likely be less than those presented for the on-premises disposal alternatives because more favorable water and soil conditions at the disposal site would enhance isolation of the waste from the environment. The long-term impacts from loss of institutional control and site maintenance at the selected disposal site would also be expected to be less than those presented for alternatives where waste would remain at the Center. The reduced dose would result from improved soil and water conditions, a more stable site, and engineered features of the disposal facility to limit migration from and intrusion into the waste.

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1. INTRODUCTION

The U.S. Department of Energy (DOE) and the New York State Energy Research and Development Authority (NYSERDA) are evaluating alternatives for completing the West Valley Demonstration Project (WVDP) and closure or long-term management of facilities at the Western New York Nuclear Service Center (Center) near West Valley, New York, beginning in about the year 2000. This Environmental Impact Statement (EIS) was prepared to assist DOE and NYSERDA in their decisionmaking roles.

This EIS discusses actions and impacts both off site (defined as the area outside of the Center boundary) and on site (defined as the area within the Center boundary). For purposes of analysis, the on-site area is divided into two areas. One of these areas includes the Project Premises [defined as the 80-ha (200-acre) area controlled by DOE] and the New York State-licensed disposal area (SDA). The other on-site area is the balance of the site (defined as the area within the Center, excluding the Project Premises and the SDA). The Center boundary and the Project Premises and SDA within the Center boundary are shown on Figure 1-1.

In 1980, Congress enacted the WVDP Act (42 U.S.C. 2021a). This law requires DOE to demonstrate that the liquid high-level (radioactive) waste (HLW) from reprocessing spent nuclear fuel can be safely managed by solidifying it at the Center and transporting it to a geologic repository for permanent disposal. Under this Act, DOE took possession of the 80-ha (200-acre) Project Premises to implement the WVDP as discussed in Section 1.1.2. NYSERDA retains ownership for the entire site and management responsibility for the SDA and the balance of the site.

The Center, comprising 1,352 ha (3,340 acres) approximately 50 km (30 mi) southeast of Buffalo, New York, is the site of the only commercial nuclear fuel reprocessing facility that has operated in the United States. NYSERDA holds title to and manages the Center on behalf of the people of the State of New York. The nuclear fuel reprocessing facility, located in the Project Premises, operated from 1966 to 1972 and produced approximately 2.3 million L (600,000 gal) of liquid HLW which is now stored in belowground tanks. The volume of the HLW in tanks has been reduced by processing and solidification of the waste is estimated to begin in January 1996.

Two radioactive disposal areas are located at the Center. The SDA is a 6-ha (15-acre) area that was operated by Nuclear Fuel Services, Inc. (NFS) as a commercial low-level (radioactive) waste (LLW) facility from 1963 to 1975, when waste disposal operations ended. The 2-ha (5-acre) U.S. Nuclear Regulatory Commission (NRC)-licensed disposal area (NDA), located on the Project Premises, was licensed as part of the reprocessing facility. The NDA received radioactive wastes from 1966 through 1986 from operation and decontamination activities at the reprocessing facility.

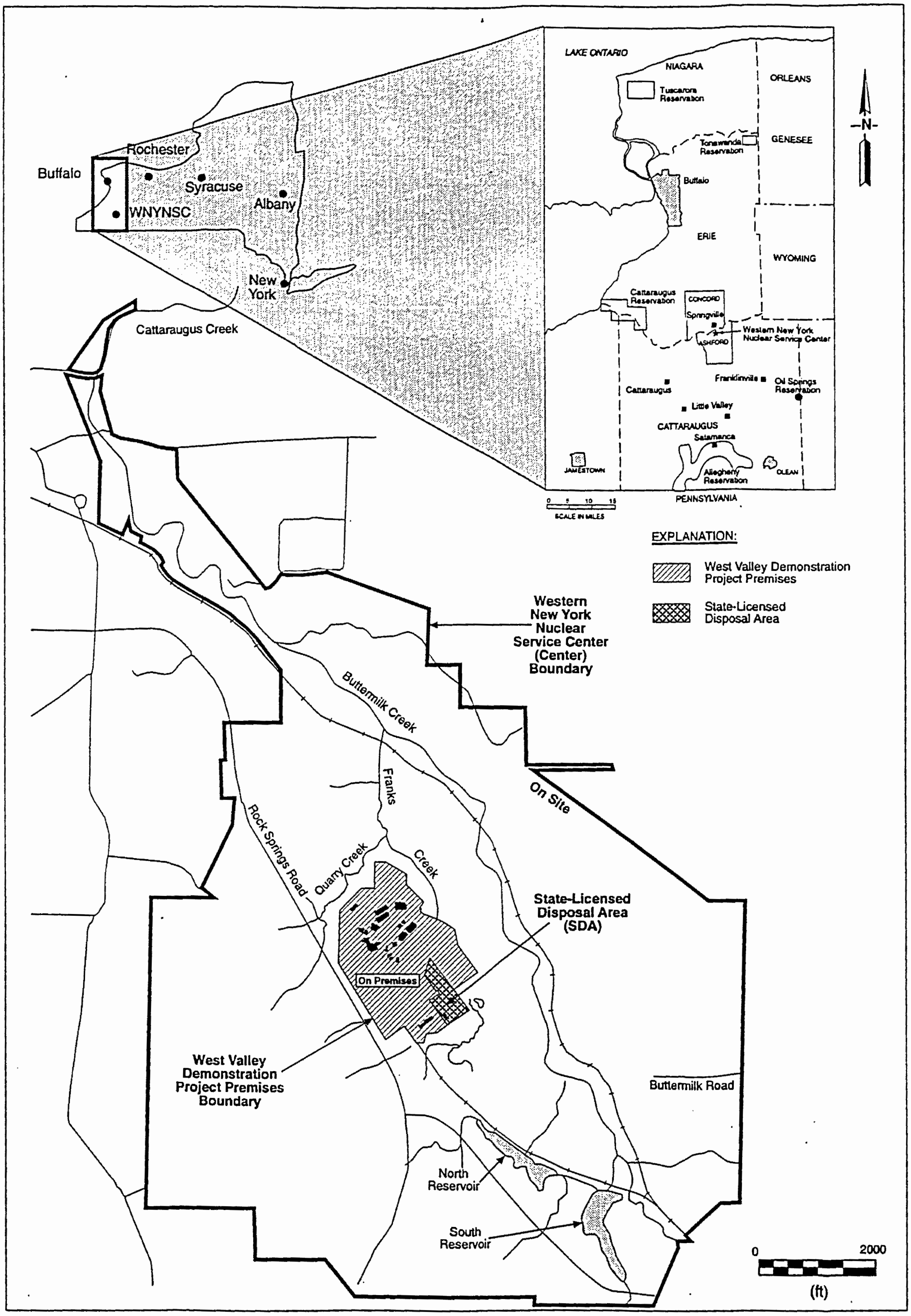

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Figure 1-1. The Western New York Nuclear Service Center, the West Valley Demonstration Project Premises, and the State-Licensed Disposal Area.

In addition to the nuclear fuel reprocessing facility and the disposal areas, numerous other support facilities located on the Project Premises include a spent nuclear fuel receiving and storage area containing 25.6 metric tons (28.2 tons) of spent fuel (DOE 1995a), a HLW tank farm, waste lagoons, and aboveground radioactive waste storage facilities. Past reprocessing and disposal operations resulted in some soil and groundwater contamination in areas near these facilities. Efforts to characterize this contamination and mitigate its impacts are ongoing.

1.1 BACKGROUND

1.1.1 Regulatory Background

The nuclear fuel reprocessing facility (including the NDA) was licensed by the NRC and operated by NFS. The SDA is managed under a New York State Department of Environmental Conservation (NYSDEC) 6 New York Code of Rules and Regulations (NYCRR) Part 380 ("Rules and Regulations for Prevention and Control of Environmental Pollution by Radioactive Materials") land burial permit. In addition, the Department of Labor issued NFS a Radioactive Material License for the SDA, which is now held by NYSERDA.

The WVDP Act authorized the DOE to demonstrate that liquid HLW from the reprocessing of spent nuclear fuel could be safely managed. A "Cooperative Agreement between the United States Department of Energy and New York State Energy Research and Development Authority on the Western New York Nuclear Service Center at West Valley, New York" (referred to as the Cooperative Agreement) became effective October 1, 1980 (DOE and NYSERDA 1981). This agreement includes but is not limited to the use of the facilities by DOE for the WVDP; the financial responsibilities of DOE and New York State for the WVDP; the guarantee of technical assistance from DOE in securing license amendments; and a guarantee of joint submittal of an NRC license amendment providing DOE with exclusive possession of the 80-ha (200-acre) Project Premises and the facilities and buildings on the Project Premises necessary to conduct the WVDP. Additional facilities used to conduct the WVDP include the north and south reservoirs, railroad spur, old schoolhouse, environmental monitoring facilities, and firing range, which are outside of the Project Premises boundary on the balance of the site.

In 1981, the facility license was amended to give DOE exclusive possession of the Project Premises, including buildings and facilities, and to suspend the operating license and operational responsibilities of the two licensees, NYSERDA and NFS, until the WVDP was completed. A second amendment in 1982 terminated the license authority and responsibility of NFS. DOE assumed operational control of the Project Premises and facilities in February 1982. Processing of the HLW began in 1988, and solidifying the HLW will begin in January 1996.

The NRC also has specific responsibilities under the WVDP Act, which are specified in the Act and in a Memorandum of Understanding between DOE and NRC [46 FR 233 (FR 1981)]. The Memorandum of Understanding, which became effective in September 1981, established procedures for review of and consultation on Center activities by the NRC.

The West Valley Nuclear Services Company, Inc. (a wholly owned subsidiary of Westinghouse Electric Corporation) was selected by DOE to operate the facilities on the Project Premises. NYSERDA continues to manage the SDA and the balance of the site.

1.1.2 Statutory Authority

The WVDP Act was signed into law on October 1, 1980, by the President to authorize DOE to carry out a liquid HLW management demonstration project at the Center. The Act directs the Secretary of Energy to

1. Solidify HLW in a form suitable for transportation and disposal

2. Develop containers suitable for the permanent disposal of the HLW solidified at the Center

3. As soon as feasible, transport, in accordance with applicable provisions of law, the waste solidified at the Center to an appropriate geologic repository for permanent disposal

4. Dispose of the LLW and transuranic (TRU) waste produced by solidifying the HLW

5. Decontaminate and decommission the tanks and other facilities that stored HLW solidified during the WVDP, the facilities used to solidify the waste, and material and hardware used during the WVDP in accordance with requirements prescribed by the NRC.

DOE is solidifying HLW (requirements 1 and 2), and this EIS evaluates alternatives for fulfilling requirements 3 through 5.

1.1.3 Stipulation of Compromise Settlement

DOE agreed to a Stipulation of Compromise Settlement (referred to as the stipulation agreement) with the Coalition on West Valley Nuclear Wastes and the Radioactive Waste Campaign, resulting from litigation relating to the on-site disposal of LLW generated by implementing the WVDP and classifying radioactive wastes being proposed for on-site disposal (U.S. District Court, Western District of New York, May 27, 1987). Section 1.5.2 describes the agreements set forth in the stipulation agreement that relate to the scope of the EIS.

1.1.4 National Environmental Policy Act and New York State Environmental Quality Review Act Requirements

A key element of DOE and NYSERDA decisionmaking is a thorough understanding of the environmental impacts that may occur from implementing the alternatives. The National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. 4321 et seq.), and the New York State Environmental Quality Review Act (SEQRA) provide federal and New York State decisionmakers with a process to consider potential environmental consequences of the alternatives before they make decisions. These laws are described below.

1.1.4.1 National Environmental Policy Act of 1969

The NEPA of 1969 established environmental protection as a mandate for Federal agencies. NEPA created the Council on Environmental Quality, which formulated Federal regulations (40 CFR Parts 1500 through 1508) for implementation and ensured environmental concerns were incorporated into federal agency decisionmaking by requiring a detailed statement for every "major federal action significantly affecting the quality of the human environment." The completion of the WVDP by DOE is such an action. This EIS is written to comply with DOE NEPA implementing regulations in 10 CFR Part 1021 ("Compliance with the National Environmental Policy Act").

1.1.4.2 New York State Environmental Quality Review Act

SEQRA contains the State of New York's requirements for State actions (New York State Environmental Conservation Law, Article 8). The statute is implemented in regulations promulgated by NYSDEC [6 NYCRR Part 617 ("State Environmental Quality Review")]. SEQRA requires "that all agencies determine whether the actions they directly undertake, fund, or approve may have a significant effect on the environment, and if it is determined that the action may have a significant effect on the environment, prepare or request an environmental impact statement" (6 NYCRR Part 617.1). NYSERDA holds title to the Center on behalf of the people of New York State, and NYSERDA closure or long-term management activities are subject to SEQRA.

1.1.5 Lead and Cooperating Agency Designations

DOE and NYSERDA are joint lead agencies for preparing the EIS. DOE is responsible for completing the WVDP, which includes decontaminating and decommissioning WVDP facilities. NYSERDA is responsible for managing the remainder of the facilities on the SDA and the balance of the site. NRC has specific obligations under the WVDP Act to prescribe decontamination and decommissioning requirements for the WVDP and, therefore, is a cooperating agency in the EIS.

1.2 AREAS OF ENVIRONMENTAL IMPACT

This section describes the geographic areas referred to in the EIS: off site, on site, Project Premises, the SDA, and balance of the site. The description of alternatives and analysis of impacts focus on these areas.

1.2.1 Off-site Areas

Off-site areas are outside the boundary of the 1,352-ha (3,340-acre) Center shown on Figure 1-1. Off-site areas of known contamination and relevance to this EIS includes a portion of the cesium prong, located northwest of the Center, and portions of Buttermilk and Cattaraugus Creeks downstream of the site, which drain to Lake Erie about 63 km (39 mi) northwest of the Center.

1.2.2 On-site Areas

On-site areas are within the boundary of the 1,352-ha (3,340-acre) Center. Sections 1.2.2.1 and 1.2.2.2 briefly describe the two on-site areas referred to throughout this EIS: (1) the Project Premises and SDA and (2) the balance of the site. These two areas have been divided into 12 geographic units called waste management areas (WMAs). For analysis, a WMA consists of facilities (defined as man-made structures, like ponds, storage tanks, and buildings) and the surrounding grounds, including soil, piping, tanks, stored or buried waste, other underlying materials, and associated soil or groundwater contamination within a geographical boundary. The following sections discuss the WMAs, and Chapter 3 and Appendix C describe the WMAs in greater detail.

1.2.2.1 Project Premises and the State-Licensed Disposal Area (Waste Management Areas 1 through 10)

The Project Premises and the SDA together comprise approximately 80 ha (200 acres) of land in the middle of the Center (Figure 1-1). This area is industrialized and includes the former reprocessing facility and the associated structures, office complexes, and two disposal areas (NDA and SDA). The industrialized area is maintained regularly. A few forest areas are located on the northern and eastern edge of the Project Premises and the SDA. The Project Premises and the SDA are on a flat-topped plateau bounded on the north and east by a deeply eroded stream channel valley. The area is drained by one creek and two perennial tributaries that have associated wetlands. There are 25 discrete natural wetland areas within the Project Premises and the SDA (WVNS 1994). Twenty-two of the wetland areas are less than 0.4 ha (1 acre) in area. The largest wetland mapped in this area is 0.6 ha (1.6 acres). The majority of the activities evaluated in the EIS will take place on the Project Premises and the SDA, in accordance with 10 CFR Part 1022 ("Compliance with Floodplain/Wetlands Environmental Review Requirements").

The numerous facilities and other structures used by NFS for former reprocessing operations and now being used by DOE for WVDP activities are located primarily on the Project Premises. Figure 1-2 shows the nine WMAs located on the Project Premises

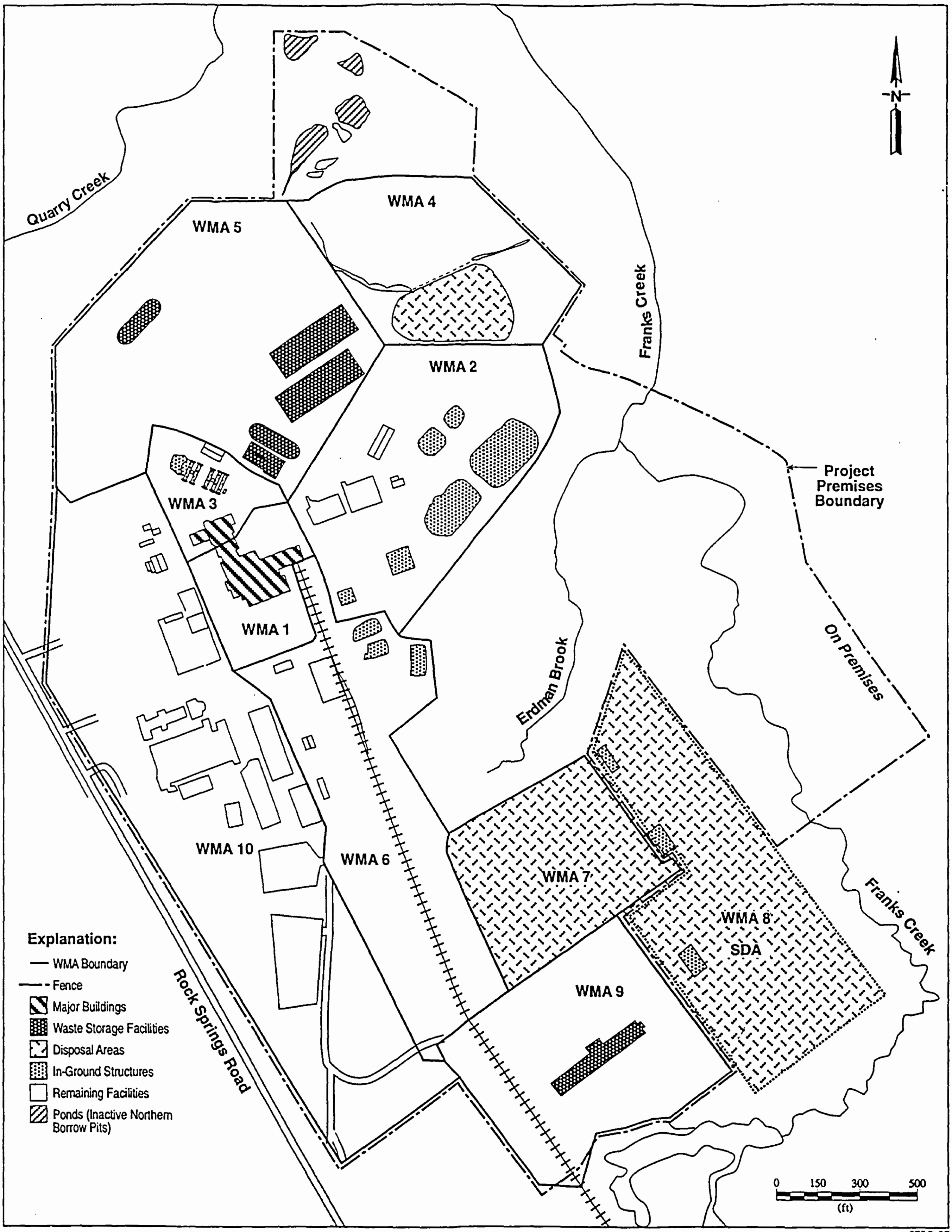

Figure 1-2. Waste Management Areas on the Project Premises and the State-Licensed Disposal Area.

(WMA 1 through WMA 7, WMA 9, and WMA 10) and other areas on the Project Premises that include the former borrow pits and environmental contamination in the creeks within the Project Premises boundary. WMA 8, the SDA, is adjacent to the Project Premises. The 10 WMAs on the Project Premises and the SDA are listed below:

1. WMA 1: Process Building Area
2. WMA 2: Low-Level Waste Treatment Facility (LLWTF) Area
3. WMA 3: High-Level Waste Storage and Vitrification Facility Area
4. WMA 4: Construction and Demolition Debris Landfill
5. WMA 5: Waste Storage Area
6. WMA 6: Central Project Premises
7. WMA 7: NDA and Associated Facilities
8. WMA 8: SDA and Associated Facilities
9. WMA 9: Radwaste Treatment System (RTS) Drum Cell
10. WMA 10: Support and Services Area.

1.2.2.2 Balance of the Site (Waste Management Areas 11 and 12)

The balance of the site refers to the 1,256-ha (3,140-acre) on-site area outside of the Project Premises and the SDA. The balance of the site is largely undisturbed and consists of open areas, forests, and abandoned agricultural areas reverting to forests. The topography is rolling and irregular and is incised by several streams. The elevation on the balance of the site ranges from 366 to 579 m (1,200 to 1,900 ft) above sea level. Small wetlands exist on parts of the balance of the site (WVNS 1994).

Two WMAs are located on the balance of the site outside of the Project Premises and the SDA:

1. WMA 11: Bulk Storage Warehouse and Hydrofracture Test Well Area
2. WMA 12: Balance of Site.

WMA 11 refers to facilities on the southeast portion of the Center. The bulk storage warehouse is used and maintained by DOE by a lease from NYSERDA. The hydrofracture test well area is maintained by NYSERDA. WMA 12 refers to other miscellaneous man-made structures and environmental contamination located on the balance of the site, outside of the Project Premises boundary and the SDA as shown in Figure 1-3.

1.2.3 Classification of Site Facilities and Wastes

Appendix C describes each facility, its location in a WMA, and waste inventories expected to be present at the time of closure. Section 4.10 discusses the nature and extent of contamination in the soil or groundwater at each WMA.

The facilities and structures within a WMA have been classified by their primary function or characteristics as follows:

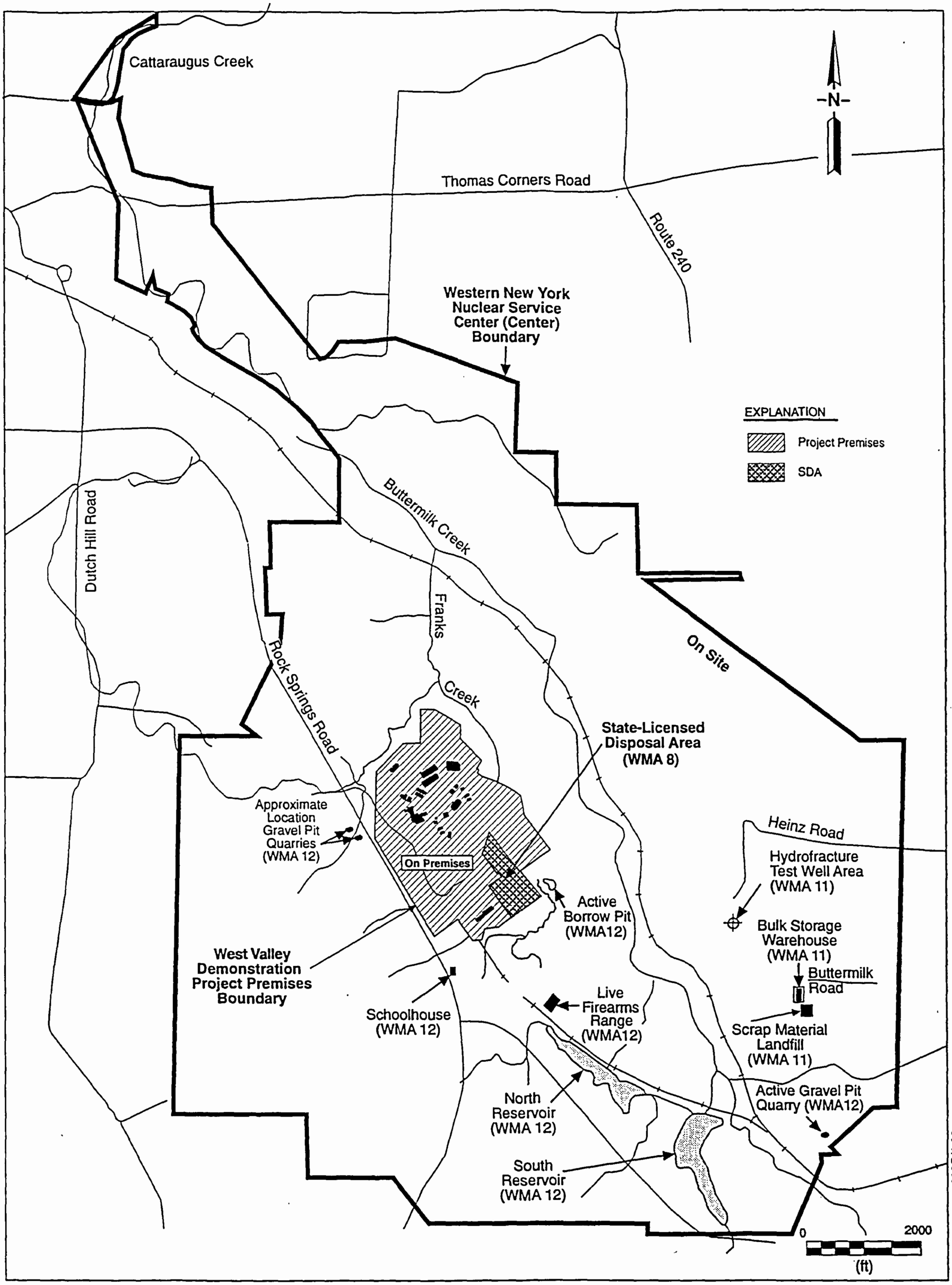

Figure 1-3. Waste Management Areas 11 and 12 Located Outside of the Project Premises and the State-Licensed Disposal Area.

- Buildings
- Waste storage facilities
- Disposal areas
- In-ground structures (e.g., lagoons, pits, and tanks)
- Remaining facilities
- Environmental contamination (soil or groundwater) outside the facilities and structures.

Table 1-1 uses this classification to show the types of buildings or facilities and the environmental contamination in the 12 WMAs.

Discussions in the EIS are organized either by WMA or facility classification. For example, geographical or environmental characteristics, doses and health effects, and environmental impacts are discussed by WMA. The building or facility classification is used when the similarity of structures is important, for example, when describing either the technology options for the alternatives or similar decontamination, dismantlement, removal, and waste processes for one type of structure.

A variety of wastes would be managed as part of implementing the alternatives for closure or long-term management of the facilities at the Center. The wastes would be characterized and then potentially treated, stored, and disposed of to meet applicable regulations. The primary regulations for waste management are those of the NRC, EPA, and NYSDEC. Table 1-2 presents the types of wastes defined and regulated by these authorities and West Valley-specific examples of these waste types. The waste classification examples presented in Table 1-2 are based on the current understanding of waste characteristics, and these classifications are used to estimate impacts presented in Chapter 5. Characterizing waste after generation could cause some waste to be reclassified. Table 1-2 also identifies industrial waste, a category of waste that does not contain radioactive or hazardous constituents and, therefore, is not regulated by NRC or the NYSDEC hazardous waste program.

1.3 FEDERAL AND STATE REQUIREMENTS

Radioactive, mixed, and hazardous waste would have to be managed as part of site closure or long-term management. Federal and New York State laws and environmental requirements for managing these wastes govern site activities and apply to the alternatives for completing the WVDP and closure or long-term management of the Center. This section discusses the requirements general to site operations, including statutory requirements and interagency agreements. Appendix B discusses requirements specific to the alternatives that

Table 1-1. Waste Management Areas and Building and Facility Classification at the Western New York Nuclear Service Center[a]

Waste Management Area/Facility	Major Buildings	Waste Storage Facilities	Disposal Areas	In-ground Structures	Remaining Facilities	Environmental Contamination
1—Process Building Area	Process Building 01/14 Building	—[b]	—	—	Utility Room Laundry Room Plant Office Building Electrical Substations	Soil and Groundwater
2—Low-Level Waste Treatment Facility Area	02 Building	—	—	Lagoons 1-5 Old Interceptor Maintenance Shop Leach Field North and South Interceptors Solvent Dike Neutralization Pit	Maintenance Shop Test and Storage Building	Soil and Groundwater
3—High-Level Waste (HLW) Storage and Vitrification Facility Area	Vitrification Facility	—	—	HLW Storage Tanks and Vaults	Equipment Shelter Cold Chemical Building Con-Ed Building Permanent Ventilation System Building	Soil
4—Construction and Demolition Debris Landfill (CDDL)	—	—	CDDL	—	—	Soil and Groundwater
5—Waste Storage Area	—	Chemical Process Cell Waste Storage Area Lag Storage Building Lag Storage Additions 1, 3, and 4	—	—	"Old" Hardstand Area Lag Storage Addition 2 Foundation Hazardous Waste Storage Lockers	Soil and Groundwater
6—Central Project Premises	—	Proposed Contaminated Soil Consolidation Area	—	North and South Sludge Ponds Effluent Mixing Equalization Basin	Incinerator Sewage Treatment Plant Rail Spur Cooling Tower	Soil
7—U.S. Nuclear Regulatory Commission-Licensed Disposal Area (NDA) and Associated Facilities	—	NDA Interim Waste Storage Facility	NDA (including the NDA former lagoon)	NDA Trench Interceptor Project NDA Trench Interceptor Project Liquid Pretreatment System	NDA Hardstand	Soil and Localized Areas of Groundwater
8—New York State-Licensed Disposal Area (SDA) and Associated Facilities	—	SDA Waste Storage Facility	SDA	SDA Northern Filled Lagoon SDA Southern Filled Lagoon SDA Inactive Filled Lagoon	—	Soil and Localized Areas of Groundwater

Table 1-1. Waste Management Areas and Building and Facility Classification at the Western New York Nuclear Service Center (Continued)

Waste Management Area/Facility	Major Buildings	Waste Storage Facilities	Disposal Areas	In-ground Structures	Remaining Facilities	Environmental Contamination
9—Radwaste Treatment System (RTS) Drum Cell	——	RTS Drum Cell	——	——	——	——
10—Support and Services Area	——	——	——	——	New Warehouse OB-1 Office Building Administration Building and Office Trailers Parking Lots Meteorological Towers Expanded Laboratory Security Gate Houses	——
Other Areas on the Project Premises				Inactive Northern Borrow Pits		Sediments
11—Bulk Storage Warehouse and Hydrofracture Test Well Area	——	——	——	——	Bulk Storage Warehouse Scrap Material Landfill Hydrofracture Test Well	——
12—Balance of Site	——	——	——	——	Schoolhouse Live Firearms Range Earthen Dams and Reservoirs Active Borrow Pit Inactive Gravel Pit Quarries Active Gravel Pit Quarry (leased to Ashford)	Soil

a. Refer to figures in Appendix C for a detailed illustration of buildings and facilities in a waste management area. Not all in-ground structures and remaining facilities are shown on the maps in Appendix C.
b. ——— = No facility of that classification or environmental contamination in the waste management area.

Table 1-2. Wastes that May Require Management During Closure or Long-Term Management of the Center

Waste Category	Definition	Examples at Western New York Nuclear Service Center
High-Level [Radioactive] Waste (HLW)[a]	HLW is defined by NRC in 10 CFR Part 60.2 as "(1) irradiated reactor fuel, (2) liquid wastes resulting from the operation of the first cycle solvent extraction system, or equivalent, and the concentrated waste from subsequent extraction cycles, or equivalent in a facility for reprocessing irradiated reactor fuel, and (3) solids into which such liquid wastes have been converted."	42 buried spent fuel elements, if retrieved from the NDA 350 borosilicate glass canisters
Low-Level [Radioactive] Waste (LLW)	Waste that contains radioactivity and is not classified as HLW, transuranic waste, or spent nuclear fuel. There are four classes of LLW (A, B, C, and greater-than-Class C) defined in 10 CFR Part 61.55. Classes A, B, and C are generally acceptable for near-surface disposal. Greater-than-Class C waste is not generally acceptable for near surface disposal.	Waste in these categories will be analyzed for radionuclide concentrations and classified as Class A, B, C, or greater-than-Class C. Examples of the expected waste matrices include: <u>Class A, B, C</u> Materials disposed of in the disposal areas (e.g., air filters, water filters, failed equipment, plastic, clothing from plant operations, etc.) Materials stored on site (e.g., compacted filters, plastic, failed equipment, etc.) Concrete waste forms stored in the radwaste treatment system drum cell <u>Greater-than-Class C</u> Boxes of waste from the chemical process cell stored in the chemical process cell waste storage area Drums of West Valley Demonstration Project-generated waste stored in the lag storage building and lag storage additions
Transuranic Waste (TRU)[b]	U.S. Environmental Protection Agency standards (40 CFR Part 191.02) define transuranic waste as waste containing more than 100 nanocuries of alpha-emitting isotopes, with half-lives greater than 20 years, per gram of waste. Disposal of this waste must meet the requirements of 40 CFR Part 191, Subpart B.	If the disposal areas were exhumed, some waste could be characterized as TRU.

a. In other contexts DOE does not refer to its own irradiated fuel as HLW but rather as spent nuclear fuel {definition in the Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environnmental Restoration and Waste Management Programs EIS, DOE/EIS-0203, [60 FR 105 (FR 1995)]} because the DOE has not determined the ultimate disposition of its irradiated fuel.

b. The West Valley Demonstration Project Act defines [transuranic] waste for the Project as "material contaminated with [transuranic] elements...in concentrations of 10 ηCi/g or in such other concentrations as the Commission may prescribe."

In the event that an alternative which includes on-premises disposal of this waste is ultimately selected, DOE expects to use analytical results like those presented in Appendix D, Section D.3 as the technical basis for requesting a determination from NRC that the material in the RTS drum cell can be classified as LLW suitable for on-premises disposal.

Table 1-2. Wastes that May Require Management During Closure or Long-Term Management of the Center (Continued)

Waste Category	Definition	Examples at Western New York Nuclear Service Center
Mixed Waste	Mixed wastes are hazardous wastes and radioactive wastes that are commingled. The management of mixed wastes is governed under Subtitle C of RCRA (see 40 CFR Part 264) and 6 New York Code of Rules and Regulations (NYCRR) 370 through 376 and the Atomic Energy Act.	Waste, soil, and leachate if removed from the disposal areas Three percent residual sludge in the HLW storage tanks Stored waste (e.g., contaminated hazardous material like lead, paint wastes, polychlorinated biphenyl-contaminated capacitors, batteries, analytical wastes, TURCO products, zinc bromide, petroleum products, residues from spills, photographic wastes, groundwater sampling wastes, etc.)
Hazardous Waste	Hazardous wastes are defined in 40 CFR Part 261.3 and 6 NYCRR Part 371.1. A solid waste is a hazardous waste if it (1) exhibits one of the characteristics of hazardous waste and in 6 NYCRR Part 371.3, i.e., ignitability, corrosivity, reactivity, or toxicity, (2) if it is listed in 40 CFR Parts 261.31 through 261.33 and 6 NYCRR Part 371.4, or (3) if it is a mixture of a solid waste and a listed hazardous waste.	Polychlorinated biphenyl-contaminated transformers, capacitors, fluorescent light fixtures in buildings, etc.
Industrial Waste	As used in this EIS, industrial waste is solid or semisolid material resulting from site cleanup activities. These industrial wastes do not contain hazardous constituents regulated under the Resource Conservation and Recovery Act and do not contain source, special nuclear, by-product material, as defined by the Atomic Energy Act of 1954.	Demolition debris such as scrap metal, concrete, asphalt, piping, electrical wiring, etc.

provide a basis for comparing or determining the significance of environmental impacts. Figure 1-4 shows the statutes and regulations applicable to site operations or the alternatives. This section summarizes the applicable statutes and regulations.

The Center has an NRC license for the on-site area except for the SDA, which has a state-issued permit. Section 2 of the WVDP Act requires that DOE conduct decontamination and decommissioning activities in accordance with NRC prescribed standards. DOE issues Orders under the Atomic Energy Act (AEA) (42 U.S.C. 2011 et seq.) to regulate its own activities. Worker and public radiation protection Orders and environment, safety, and health Orders would be applicable to DOE activities during the implementation phase of Alternative I (Removal), II (On-Premises Storage), III (In-Place Stabilization), and IV (No Action: Monitoring and Maintenance).

Both the facility license and the SDA permit have been amended under regulations enacted pursuant to the AEA by NRC and NYSDEC, respectively, as described in Section 1.3.1. Sections 1.3.1.1 and 1.3.1.2 describe the NRC license and State permit for the SDA. Section 1.3.2 discusses the Resource Conservation and Recovery Act (RCRA), which regulates the activities at facilities that handle hazardous and mixed waste and some ongoing investigations.

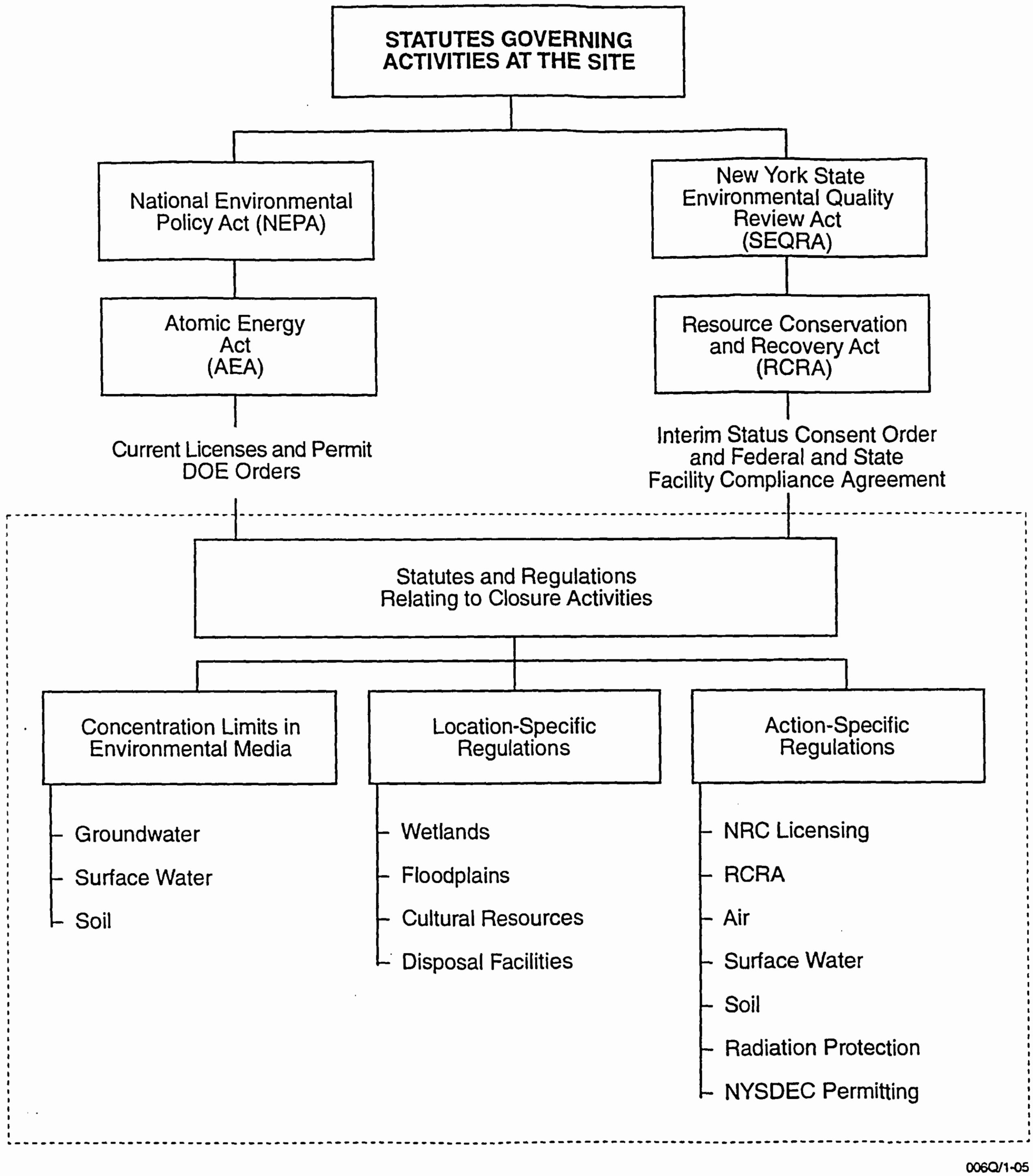

Figure 1-4. Summary of Statutes and Regulations Applicable to the Western New York Nuclear Service Center (Statutes and regulations in the dashed box are described in Appendix B).

1.3.1 Atomic Energy Act of 1954, As Amended

The AEA of 1954 addresses developing and controlling atomic energy in military and peaceful applications, and it gives the NRC and DOE the responsibility to protect public health and safety in the use and handling of radioactive material. Under this statute, the NRC has the responsibility for licensing and regulating commercial uses of atomic energy through a system of licensee requirements promulgated in 10 CFR Parts 0 through 199.

The AEA was amended in 1960 to allow states to enter into agreements with the NRC whereby the state is granted authority to license most uses of radioactive material. These states are referred to as Agreement States. New York State became an Agreement State in 1962. The authority to regulate radioactive materials is divided among the New York State Departments of Conservation, Labor, and Health and the New York City Department of Health. The Department of Labor issues licenses for commercial and industrial uses of radioactive materials. The Department of Health and New York City Department of Health have authority for medical, academic, and research uses. NYSDEC regulates most disposal and environmental releases of radioactive materials for facilities regulated under the Agreement State program.

1.3.1.1 Nuclear Regulatory Commission License

NRC licensed the Center fuel reprocessing facility in 1966 (Operating License CSF-1, Docket No. 50-201). The license recognized NYSERDA as the owner of the Center and granted NFS authority to operate the reprocessing facility and NDA under the provisions of 10 CFR Parts 20, 30, 40, 50, and 70. After passage of the WVDP Act in 1980, the operating license was amended twice. The first amendment granted DOE exclusive possession of the Project Premises so it could fulfill its obligation under the WVDP Act and suspended the operating license and operational responsibilities of the two licensees, NYSERDA and NFS, until the WVDP was completed (Amendment 31). The second amendment terminated the authority and responsibility of NFS under the license (Amendment 32). As a former reprocessing facility, this license remains under direct NRC, rather than Agreement State, regulation.

1.3.1.2 New York State Permit and License for the State-Licensed Disposal Area

Facilities regulated under the Agreement State program in New York State must obtain a permit if they discharge or dispose of radioactive materials to the environment. When the New York State Department of Health originally licensed NFS in 1963, it granted an exemption from the requirements of the New York State Sanitary Code, Part 16, Section 8, to allow burial of radioactive materials in the SDA. This license was assigned number COL No. 670. Through a series of amendments, the license was expanded to accommodate a variety of wastes, including limited amounts of unpackaged radioactive wastes having surface dose rates exceeding 200 R/hr, uranium-contaminated building material, and radioactive liquid wastes. Regulatory authority of the SDA was transferred to NYSDEC in 1974, and the Part 16 exemption became the 6 NYCRR Part 380 Land Burial Permit (Permit No. 9-04522-00011/00003-0). In addition, the New York State Department of Labor issued NFS a Radioactive Materials License for the SDA (RML No. 382-1139); this license transferred to NYSERDA in 1983. This license addresses worker safety issues.

1.3.2 Resource Conservation and Recovery Act of 1976, as Amended by the Hazardous and Solid Waste Amendments of 1984

The RCRA (42 U.S.C. 9601 et seq.) establishes a national program to control hazardous waste from its generation to final disposition. The federal regulations for implementing the RCRA-mandated hazardous waste program are codified at 40 CFR Parts 260 through 271. The U.S. Environmental Protection Agency (EPA) has given New York State final authorization for implementing certain portions of the RCRA program. In New York, the RCRA program is codified in ECL, Article 27, Title 9, the Industrial Hazardous Waste Management Act. NYSDEC administers the Industrial Hazardous Waste Management Act regulations, which are implemented in 6 NYCRR Parts 370 through 376. These regulations give a system of standards for hazardous waste generators, as well as for owners and operators of hazardous waste treatment, storage, and disposal facilities.

The Hazardous and Solid Waste Act Amendments of 1984 (P.L. 98-616) required EPA to promulgate additional requirements for hazardous wastes. These requirements prohibit land disposal of hazardous waste not meeting required treatment standards, set new minimum technological requirements for land disposal units, order corrective action for releases of hazardous wastes or constituents from solid waste management units at a RCRA-permitted facility, and mandate an accelerated schedule for permit application submittals. Pursuant to RCRA as amended by the Hazardous and Solid Waste Act, DOE and NYSERDA notified EPA of hazardous waste activities and were issued EPA Hazardous Waste Identification numbers.

In June 1990, DOE and NYSERDA submitted RCRA Part A applications to store and treat mixed radioactive/hazardous wastes at the WVDP and the Center, respectively, and thereby received interim status [pursuant to Section 3005[e] of RCRA and Title 6, Part 373-1.3 of the NYCRR ("Hazardous Waste Treatment, Storage and Disposal Facility Permitting Requirements")] to operate those facilities. Interim status allows existing treatment, storage, or disposal facilities to remain in operation until a site-specific permit is issued by NYSDEC. Chapter 3 identifies facilities that have interim status. These interim-status facilities operate in accordance with applicable laws and regulations and a Federal and State Facility Compliance Agreement (EPA 1992a). The RCRA was amended in October 1992, through enactment of the Federal Facilities Compliance Act, which requires the DOE to develop its plans for treating mixed waste inventories. Treatment can be either on site or off site at another DOE facility or at a commercial facility. The WVDP has prepared a Proposed Site Treatment Plan for the mixed waste inventory as of September 1, 1994 and projects the mixed waste inventory from 1994-1999 (WVNS 1995). This EIS evaluates the mixed waste inventory that will exist or be generated by WVDP decontamination and decommissioning by DOE and site closure or long-term management by NYSERDA after the year 2000.

Section 3008(h) of RCRA authorizes EPA to issue an order requiring corrective action or other response measures as the administrator deems necessary to protect human health and the environment whenever it has been determined that there has been a release of hazardous waste (including mixed radioactive/hazardous waste) into the environment from an interim status facility. Similarly, New York State ECL 71-2727 authorizes NYSDEC to issue an order requiring corrective action at certain facilities. Because hazardous constituents have been identified in solid waste management units at the Center, the EPA, NYSDEC, DOE and NYSERDA negotiated a joint Consent Order (Docket No. II RCRA-3008[h]-92-0202) in 1991 (EPA 1992b). The Consent Order requires that DOE and NYSERDA monitor the environment and perform specific tasks, including a RCRA Facility Investigation (RFI) to fully determine the nature and extent of hazardous wastes or hazardous constituents released from the facility into the environment (EPA 1992b). A corrective measures study would be required if releases documented in the RFI exceed EPA action levels under applicable law and guidance or as agreed to by DOE, EPA, NYSDEC, and NYSERDA. The Order also requires interim measures (e.g., cleanup) if needed, to mitigate environmental problems that pose a threat to human health and the environment.

The EIS is being prepared concurrently with the performance of the RFI. The RFIs required under the Consent Order are in progress to determine the nature and extent of hazardous wastes present or hazardous constituents released from the facilities into the environment. The SDA RFI is final and has been approved by NYSDEC and EPA. The RFI reports will be reviewed by NYSDEC who will determine if further action, additional assessment, or corrective action is required. DOE's and NYSERDA's intention is to coordinate and integrate the RFI and EIS programs to the extent possible, thereby minimizing duplicate efforts between the programs while remaining consistent with applicable regulations and the protection of human health and the environment. Information obtained during the RFI on the presence of hazardous wastes and constituents will be incorporated into the EIS, and the RFI sampling programs were designed to provide information on radionuclides for the EIS. The Consent Order does not identify final corrective action requirements to avoid prejudicing the NEPA process or fragmenting the overall decision-making for completing the WVDP and for NYSERDA site closure or long-term management of facilities at the Center.

1.4 RELATIONSHIP WITH OTHER NATIONAL ENVIRONMENTAL POLICY ACT DOCUMENTS

There is site-specific NEPA documentation and other EISs that are relevant to this EIS. These documents and the programs are discussed in this section. Office of Environmental Management *Waste Management Programmatic Environmental Impact Statement*, DOE/EIS-0200-D (Waste Management PEIS) addresses a broad, systematic approach for addressing waste management practices for the entire DOE complex. Waste processing technologies as well as the management of HLW, LLW, TRU waste, mixed waste, and hazardous waste at DOE facilities are addressed (DOE 1995b). NEPA review of DOE waste management activities during decontamination and decommissioning of facilities used by the WVDP will be tiered in accordance with 40 CFR Part 1502.2 ("Tiering") from the strategy presented in the PEIS, as appropriate.

The HLW solidifying and container development activities listed in Section 1.1.2 (items 1 and 2) were evaluated in the *Final Environmental Impact Statement, Long-Term Management of Liquid High-Level Radioactive Wastes Stored at the Western New York Nuclear Service Center, West Valley* (DOE 1982). Since the Record of Decision on this EIS was issued, certain modifications have been made to improve operations and mitigate potential environmental impacts from HLW solidification. These actions are evaluated in *Supplement Analysis of Environmental Impacts Resulting from Modifications in the West Valley Demonstration Project* (DOE 1993a). Based on this supplement analysis, DOE determined that no supplement to the 1982 EIS was required (DOE 1993b). DOE prepared an Environmental Assessment for the disposal of the LLW produced from the treatment of the liquid HLW in an aboveground tumulus-type disposal facility and also evaluated the continued shallow land disposal of LLW produced by the WVDP in the NDA (DOE 1986). The April 1986 Finding of No Significant Impact in this Environmental Assessment was the subject of legal challenge resulting in the Stipulation of Compromise Settlement, signed May 1987, described in Sections 1.1.3 and 1.5.2 of the EIS.

The final disposition for the 125 spent fuel assemblies at West Valley is included in the Record of Decision for the *Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs EIS* issued on June 1, 1995 [60 FR 105 (FR 1995)]. The Record of Decision states that the 125 spent fuel assemblies in storage at West Valley will be shipped to the Idaho National Engineering Laboratory. The spent fuel removal is a near-term waste management activity that is independent from WVDP completion activities being evaluated in this EIS.

Various on-site construction projects conducted since inception of the WVDP have excavated contaminated low activity soil, some of which is now temporarily stored in steel containers near the NDA and some of which is stored in the lag storage building in WMA 5, which was designed to accommodate LLW rather than low activity soil. To free up storage space in the lag storage building, DOE is considering management alternatives for this low activity soil. These alternatives are being evaluated in an *Environmental Assessment for the Construction and Operation of a Contaminated Soil Consolidation Area at the West Valley Demonstration Project*, DOE/EA-1072 (DOE 1995c). The proposed action is to design, construct, operate, and decommission a covered soil consolidation area for temporary storage of radiologically contaminated soil. The contaminated soil in interim storage was evaluated in this EIS since it would be on the Project Premises at the start of closure or long-term management.

DOE is also evaluating near-term LLW management alternatives for the WVDP Class A LLW storage facilities, which are estimated to fill to capacity in 1996. Alternatives for the period from 1996 to 2001 are being evaluated in an Environmental Assessment, *Treatment of Class A Low-Level Radioactive Waste and Mixed Low-Level Waste Generated by the West Valley Demonstration Project*, DOE/EA-1071 (DOE 1995d). The proposed action is to sort, repack, and load waste at the WVDP; transport the waste for commercial treatment; and return the residual waste to the WVDP for interim storage. Near-term waste management activities are independent from completion and closure activities (i.e., long-term LLW management after about the year 2000) being evaluated in this EIS. The impacts of long-term LLW management are bounded by the analysis presented in this EIS. Neither the proposed action nor any of the alternatives analyzed in the Environmental Assessment would prejudice the choice of alternatives in this EIS.

1.5 SCOPE OF THE EIS

This EIS evaluates the environmental impact from implementing different engineering technologies for the alternatives considered for completing the WVDP and closure or long-term management of facilities at the Center. Section 1.5.1 discusses the history of the EIS scope and scoping activities, Section 1.5.2 describes the agreements set forth in the Stipulation of Compromise Settlement, and Section 1.5.3 discusses the organization of the EIS.

1.5.1 History of the EIS Scope

The DOE published a Notice of Intent to prepare a draft EIS in the *Federal Register* on December 30, 1988, and to solicit comments and suggestions for consideration in the preparation of the statement [53 FR 53052 (FR 1988)]. NYSERDA published a similar notice in the *State Environmental Notice Bulletin* on January 11, 1989. At the time the NOI was published, additional data were needed for decisionmaking. These data have been developed since publication of the Notice of Intent, and environmental characterization data collected in 1992 and 1993 facilitate decisionmaking for completing the WVDP and selecting a closure or long-term management strategy for facilities on the Center. The WVDP has an active public information and involvement program that was "formalized" as part of the stipulation agreement discussed in Section 1.1.3. The WVDP Quarterly Public Meeting group meets quarterly for topical briefings from WVDP personnel to review WVDP progress and to solicit input into the EIS.

In response to the Notice of Intent, 34 letters were received, and 23 individuals made oral presentations at the two public scoping meetings held on February 9, 1989. Analysis of the letters and statements identified 138 substantive comments. These comments are summarized in the EIS Implementation Plan (DOE 1995b). This EIS addresses those issues identified by DOE, NYSERDA, NRC, and the public during the scoping process.

1.5.2 Stipulation of Compromise

As discussed in Section 1.1.3, the DOE and the Coalition on West Valley Nuclear Wastes and the Radioactive Waste Campaign agreed to a settlement agreement that stipulates items within the scope of the EIS as described in this section.

Stipulation item 3 requires evaluation of the impacts of disposing of Class A and Class B/C wastes generated by DOE activities at the WVDP.

This joint EIS being prepared by DOE and NYSERDA evaluates the impacts of managing all categories of waste that are either currently stored on site or will be generated from site closure activities. All of the Class A and Class B/C wastes that have been or will be generated by the WVDP are a subset of the total volume of waste considered in the EIS. Chapter 3 presents the waste volumes to be managed under the alternatives, and Chapter 5 presents the impacts from waste management alternatives.

Stipulation item 7 requires evaluation of erosion impacts and erosion control impacts and the need for erosion control measures for consideration of any on-site disposal.

Appendix L of the EIS describes the erosion processes active at the site or expected to occur under various site use scenarios. Appendix L shows that erosional processes of stream bank widening and gully advancement are important for predicting radiological impacts to the public. Predicting bank widening rates is uncertain; therefore, both expected and worst case estimates are presented in Appendix L and used in the analysis of long-term performance described in Appendix D. The precise location for gully advancement cannot be predicted, but the rate of gully growth is estimated for use in the long-term performance assessment. Chapter 3 describes proposed erosion control measures and Chapter 5 describes the impacts from erosion control measures.

Stipulation item 8 requires a good-faith effort to evaluate the site and the design(s) relative to the provisions of 10 CFR Parts 61.50 ("Disposal site suitability requirements for land disposal") and 61.51 ("Disposal site design for land disposal"). It also states that if the Class B/C waste form does not satisfy or meet otherwise applicable NRC regulations and guidelines at the time of the EIS, DOE will evaluate reasonable additional site suitability and disposal facility design safeguards to provide reasonable assurance that exposures to humans are within NRC regulatory limits and guidelines.

Section 3.9 of the EIS evaluates the site against the provisions of 10 CFR Parts 61.50 and 61.51. The evaluation is specific for the Project Premises and the SDA because this area has been characterized during site development, environmental monitoring, and site-specific investigations over the last 30 years. Section 3.9 also evaluates the design of facilities under consideration for on-site storage or disposal of radioactive waste. This evaluation reflects available conceptual design-specific characterization information and is not a regulatory determination by NRC.

The EIS does not evaluate additional site suitability or disposal facility design safeguards for the Class B/C waste because DOE believes this waste form meets the applicable NRC regulations and guidelines. DOE has developed and tested recipes for cement solidification of the wastes in the RTS drum cell. The NRC has reviewed these recipes and concluded that solidified waste produced in accordance with the recipes would satisfy the requirements of 10 CFR Part 61 ("Licensing Requirements for Land Disposal of Radioactive Wastes") and the guidance in the NRC's Branch Technical Position on Waste Form (NRC 1991). There are 200 to 300 drums which do not meet the recommended immersed sample compression strength required in the Branch Technical Position, but DOE does not consider this immersion test applicable to the RTS drum cell because it is specifically designed to prevent the accumulation of water which could immerse the waste.

Stipulation item 11 requires DOE to seek a determination from the NRC as to whether WVDP waste containing material with atomic number greater than 92 in concentrations greater than 10 ηCi/g is TRU waste within the meaning of the WVDP Act.

The RTS drum cell contains waste having concentrations of TRU elements (elements with atomic number greater than 92) greater than 10 ηCi/g. Appendix D presents the long-term performance assessment of this material, where the RTS drum cell is converted to a tumulus. In the event that an alternative which includes on-premises disposal of this waste is ultimately selected, DOE expects to use analytical results like those presented in Appendix D, Section D.3, as the technical basis for requesting a determination from NRC that the material in the RTS drum cell can be classified as LLW suitable for on-premises disposal.

1.5.3 Organization of Document

This EIS is presented in three volumes. Volume I presents Chapters 1 through 6. Volume II includes the technical appendices. The Summary is included as a separate volume. Volume I, Chapter 1, describes the site background, site areas, laws governing activities, related NEPA documents and scope of the EIS. Chapter 2 discusses the purpose and need for agency action. The range of reasonable alternatives including a comparison of alternatives is presented in Chapter 3. Chapter 4 describes the affected environment including the nature and extent of contamination. A detailed analysis of the impacts that would result from implementing the alternatives is presented in Chapter 5, and Chapter 6 identifies the list of contributors to this EIS. Chapter 7 is an index. The sixteen technical appendices in Volume II support the impact analysis in this EIS.

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DOE, 1995b. *Draft Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste*, DOE/EIS-0200-D, August.

DOE, 1995c. *Environmental Assessment for the Construction and Operation of a Contaminated Soil Consolidation Area at the West Valley Demonstration Project*, DOE/EA-1072, July.

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[1]DOE, 1995e. *Implementation Plan for the Environmental Impact Statement for Completion of the West Valley Demonstration Project by the U.S. Department of Energy and Closure of the Western New York Nuclear Service Center by the New York State Energy Research and Development Authority*, Rev. 7, March.

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1 Document available in the public reading room.

DOE and NYSERDA (New York State Energy Research and Development Authority), 1981. "Cooperative Agreement between United States Department of Energy and New York State Energy Research and Development Authority on the Western New York Nuclear Service Center at West Valley, New York," effective October 1, 1980, as amended September 18.

[1]EPA (U.S. Environmental Protection Agency), 1992a. "Federal and State Facility Compliance Agreement to U.S. Department of Energy, West Valley Nuclear Services Company, Inc. and New York State Energy Research and Development Authority, Docket No. II RCRA-92-007."

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[1]FR (Federal Register), 1981. 46 FR 223, "Memorandum of Understanding between the U.S. Nuclear Regulatory Commission and the Department of Energy; Implementation of the West Valley Demonstration Project Act of 1980," U.S. Department of Energy and U.S. Nuclear Regulatory Commission, November 19.

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[1] Document available in the public reading room.

2. PURPOSE AND NEED FOR AGENCY ACTION

The purpose of the agency action is compliance by DOE with the statutory requirements of the Act by completing the WVDP and management by NYSERDA of the balance of the site by closing it or bringing it to a condition that reduces the amount of long-term maintenance that will be required. The expected environmental consequences over the implementation phase (about 30 years) and post-implementation phase (about 1,000 years) are evaluated including analyzes of transporting, stabilizing, storing and disposing of these wastes. The document analyses alternatives of no action, complete removal and off-site disposal, complete removal and storage on premises, in-place stabilization and on-premises disposal, and discontinue operations.

DOE WVDP activities since 1982 to solidify the liquid HLW for geologic repository disposal will generate vitrified HLW, TRU waste, mixed waste, LLW, and hazardous waste that will be managed or disposed of on site or off site. Past spent fuel reprocessing and radioactive waste disposal operations by Nuclear Fuel Services, Inc., generated waste that would now be classified as greater-than-Class-C, LLW, HLW, and TRU waste; unprocessed spent fuel debris; hazardous waste; and mixed waste. These operations have also resulted in contaminated buildings, soil, and groundwater on portions of the Project Premises, the SDA, and the balance of the site. These wastes and contamination will be removed or managed as a part of closure or long-term management of facilities at the Center. Fulfilling the WVDP Act mandates and proper closure or long-term management of the Center will permit, more passive stewardship of the site and also ensure the protection of public health and safety.

DOE is currently preparing for solidification of the liquid HLW at the Center and developing containers suitable for permanent disposal of the solidified HLW (requirements 1 and 2 in Section 1.1.2). Vitrification, a method used to solidify waste, is scheduled to begin in January 1996. DOE reviewed these two actions in an earlier EIS (DOE 1982). Options for the remaining actions required under the WVDP Act (requirements 3, 4, and 5 in Section 1.1.2) are evaluated in the alternatives in this EIS.

This EIS supports the selection of the closure strategy and provides environmental input for facility- or WVDP-specific decisions on proceeding with future closure activities. DOE and NYSERDA will later identify the selected strategy in a Record of Decision and in New York State Environmental Quality Review Act (SEQRA) Findings, respectively. If necessary, additional NEPA or SEQRA documents will be prepared to support facility or WVDP activities not specifically addressed in this EIS or supply information not currently available to support a decision. After the Record of Decision and SEQRA Findings are published, detailed plans will be prepared and submitted to regulators to meet regulatory requirements. For example, detailed decommissioning plans will be prepared for facilities (e.g., the process building) licensed by the U.S. Nuclear Regulatory Commission. Corrective measures studies will be submitted to NYSDEC, if required, for facilities subject to closure under the RCRA Corrective Action process.

REFERENCES

[1]DOE (U.S. Department of Energy), 1982. *Final Environmental Impact Statement Long-Term Management of Liquid High-Level Radioactive Wastes Stored at the Western New York Nuclear Service Center, West Valley*, DOE/EIS-0081, June.

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1 Document is in the public reading room.

3. ALTERNATIVES

This chapter presents the alternatives for DOE's WVDP completion and NYSERDA's closure or long-term management of the facilities at the Center and compares the environmental impacts of the alternatives. Section 3.1 presents an overview of alternatives evaluated in the EIS, discusses representative implementation actions for each alternative, and identifies alternatives considered but not analyzed in detail. Section 3.2 describes the engineering evaluations and conceptual designs developed to identify representative actions necessary to implement the alternatives and their use in estimating the environmental impacts of the alternatives. Section 3.2 also identifies the facilities evaluated, assumptions about conceptual designs, hazardous waste management, radioactive waste management, and waste disposal, which are important factors in estimating environmental impacts. Sections 3.3 through 3.7 describe the five alternatives evaluated in this EIS. These descriptions are based on the conceptual design and the waste disposition assumptions. The analysis of the environmental impacts of the alternatives is developed in Chapter 5. Section 3.8 compares the alternatives to each other, and includes a summary of the environmental impacts presented in Chapter 5. Section 3.9 evaluates the site and conceptual engineering designs against NRC regulations in 10 CFR Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste."

3.1 OVERVIEW OF ALTERNATIVES

This EIS evaluates five alternatives for WVDP completion and closure or long-term management of facilities at the Center based on the Notice of Intent and scoping comments received on the Notice of Intent. These five alternatives are:

1. Alternative I: Removal and Release to Allow Unrestricted Use

2. Alternative II: Removal, On-Premises Waste Storage, and Partial Release to Allow Unrestricted Use

3. Alternative III: In-Place Stabilization and On-Premises Low-Level Waste Disposal

4. Alternative IV: No Action: Monitoring and Maintenance

5. Alternative V: Discontinue Operations.

Alternative II (On-Premises Storage) was identified at public meetings in 1990 as an alternative for consideration in the EIS. Alternative IV (No Action: Monitoring and Maintenance) is required by NEPA and SEQRA regulations as a benchmark for comparison with the environmental effects of the alternative actions. Alternative V (Discontinue Operations) was also identified at public meetings as an alternative for evaluation in the EIS. Although Alternative V is not considered a reasonable alternative by either agency, it provides an environmental baseline for evaluating impacts. The long-term performance assessment (an analysis of the effects that contaminated facilities would have on human health and the environment over the long term) of Alternative V gives an understanding of the long-term public hazard and the contribution of natural processes such as surface water flow or erosion to that hazard.

Figure 3-1 summarizes the alternatives for completion of the WVDP and closure or long-term management of the facilities at the Center. Section 3.1.1 describes the facility-specific actions that would be performed under each alternative. Section 3.1.2 summarizes other alternatives considered for evaluation but eliminated from detailed analysis.

This EIS does not present a preferred alternative for DOE's WVDP completion actions and NYSERDA's actions for closure or long-term management of facilities at the Center. A preferred alternative will be identified in the final EIS. The preferred alternative is expected to be similar to one of the five alternatives, but it may include selected features from some or all of the alternatives considered. Major considerations in selecting the preferred alternative could include but are not limited to:

- Short-term and long-term protection of workers and public health and safety
- Potential environmental impacts
- Technical implementability
- Administrative implementability
- Public concerns expressed as comments on the draft EIS
- Cost effectiveness
- WVDP mission requirements
- Institutional uncertainties (such as availability of off-site disposal).

3.1.1 Implementation Actions

Table 3-1 shows the features in each WMA together with the actions that could occur as part of an alternative being evaluated in the EIS. As is evident from Table 3-1, each facility in a WMA could be managed or closed using different strategies, and the strategies could be combined to create a preferred alternative. Table 3-1 also identifies the types of waste that would be generated by the actions.

Alternative I (Removal) and Alternative II (On-Premises Storage) are presented together on the table because the actions taken for existing facilities would be the same except for the RTS drum cell (WMA 9) and the OB-1 office building (WMA 10). The primary difference between these two alternatives is the disposition of the waste. Alternative I disposes of all the waste off site while Alternative II stores the radioactive waste on premises in new storage facilities. For Alternatives I and II, the general strategy for facilities is to decontaminate, if necessary, and then dismantle using conventional techniques. For waste disposal areas, lagoons, and structures that are set in the ground (such as concrete pits), the general strategy is exhumation. Structures containing stored waste would be removed after the stored waste has been removed. Contaminated soil and groundwater would be removed. Groundwater would be treated and released; soil would be

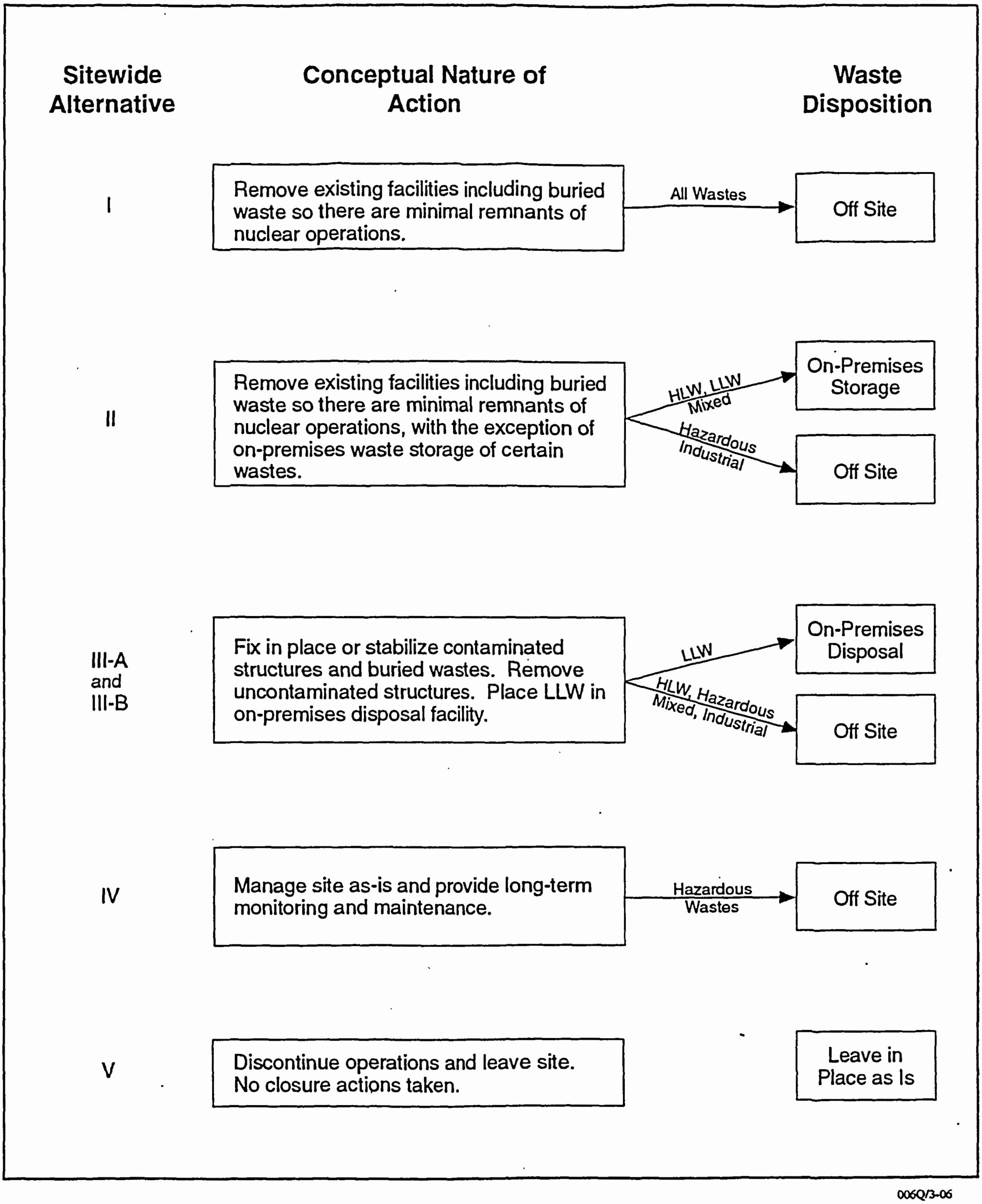


Figure 3-1. Alternatives for Completing the West Valley Demonstration Project and Closure or Long-Term Management of Facilities at the Western New York Nuclear Service Center.

Table 3-1. Facility-Specific Actions Taken and Types of Waste Generated for Each Alternative[a]

WMA	Site Feature[b,c]	Alternative: I/II[d] Removal/On-Premises Storage	Alternative: IIIA In-Place Stabilization (Backfill)	Alternative: IIIB In-Place Stabilization (Rubble)	Alternative: IV No Action: Monitoring and Maintenance	Alternative: V Discontinue Operations
1	Process Building	Decontaminate and dismantle. Radioactive (including HLW), mixed, and industrial waste would be generated.	Remove HLW. Place radioactively-contaminated waste generated from dismantlement activities occurring across the WNYNSC in the building and backfill with concrete.	Remove HLW. Backfill below-grade portion with rubble/grout; dismantle above-grade portions and cap rubble with concrete.	Flush liquid waste treatment system (LWTS). Remove ventilation stack; install security system; lock main door and weld all other doors shut.	Leave in place as-is. Building's active systems (e.g., ventilation, fire protection, etc.) would be shut down and the building locked.
	01-14 Building, Utility Room, Laundry Room	Decontaminate and dismantle. Radioactive, mixed, and industrial waste would be generated.	Same as for Alternatives I/II.	Same as for Alternatives I/II.	For 01-14 building, flush cement solidification system, install security system, lock main door, and weld all other doors shut; PCB waste would be removed. For other buildings, manage as is, monitor, and maintain.	
	Plant Office Building	Dismantle. Industrial waste would be generated.	Same as for Alternatives I/II.	Same as for Alternatives I/II.	Manage as is, monitor, and maintain.	
	Electrical Substation	Dismantle. Industrial waste and PCB waste would be generated.	Leave in place as is.	Leave in place as is.	Leave in place as is.	
2	02 Building	Decontaminate and dismantle. Radioactive, mixed, and industrial waste would be generated.	Same as for Alternatives I/II.	Same as for Alternatives I/II.	Flush LWTS; install security system; lock main door and weld all other doors shut; PCB waste would be removed.	
	LLWTF Lagoons 1 through 5	Excavate waste and contaminated sediments. Radioactive waste would be generated.	Backfill with soil, then install engineered cap.	Same as for Alternative IIIA.	Same as for Alternative IIIA.	
	Neutralization Pit, Old Interceptor, New Interceptors	Remove waste, decontaminate, and dismantle structures. Radioactive waste would be generated.	Backfill with concrete and cap with soil.	Same as for Alternative IIIA.	Manage as is, monitor, and maintain.	
	Solvent Dike	Excavate waste, dismantle structure, and excavate contaminated soil. Radioactive waste would be generated.	Same as for Alternatives I/II.	Same as for Alternatives I/II.	Manage as is, monitor, and maintain.	
	Test and Storage Building	Dismantle. Industrial waste and PCB waste would be generated.	Same as for Alternatives I/II.	Same as for Alternatives I/II.	Manage as is, monitor, and maintain.	
	Maintenance Shop	Dismantle. Industrial waste would be generated.	Leave in place as is.	Leave in place as is.	Manage as is, monitor, and maintain.	
	Maintenance Shop Sanitary Waste Leach Field	Excavate septic system and contaminated soil. Radioactive and industrial waste would be generated.	Same as for Alternatives I/II.	Same as for Alternatives I/II.	Manage as is, monitor, and maintain.	

Table 3-1. Facility-Specific Actions Taken and Types of Waste Generated for Each Alternative[a] (Continued)

		Alternative				
WMA	Site Feature[b,c]	I/II[d] Removal/On-Premises Storage	IIIA In-Place Stabilization (Backfill)	IIIB In-Place Stabilization (Rubble)	IV No Action: Monitoring and Maintenance	V Discontinue Operations
3	High-Level Waste Storage Tanks and Vaults	Decontaminate and dismantle. Radioactive (including HLW), mixed, and industrial waste would be generated.	Backfill with concrete.	Backfill with concrete.	Install security system in the HLW storage area. Manage as is, monitor, and maintain.	Leave in place as is. Buildings' active systems (e.g., ventilation, fire protection, etc.) would be shut down and the buildings locked.
	Vitrification Facility	Decontaminate and dismantle. Radioactive, industrial and PCB waste would be generated.	Place radioactive waste generated from dismantlement activities occurring across the WNYNSC into building and backfill with concrete.	Backfill below-grade portion with rubble/grout; dismantle above-grade portions and cap rubble with concrete.	Remove ventilation stack, install security system, lock main door, and weld all other doors shut.	
	Permanent Ventilation System Building, Equipment Shelter, Con-Ed Building, Cold Chemical Building, Supernatant Treatment System Support Building	Decontaminate and dismantle. Radioactive and industrial waste would be generated.	Same as for Alternatives I/II, except below-grade portions of supernatant treatment system support building which would be backfilled with concrete.	Same as for Alternative IIIA.	Manage as is, monitor, and maintain.	
4	Construction and Demolition Debris Landfill	Excavate waste and contaminated soil. Radioactive and potential mixed waste would be generated.	Leave in place as is. (It has been capped and closed.)	Leave in place as is. (It has been capped and closed.)	Leave in place as is. (It has been capped and closed.)	
5	Lag Storage Building, Lag Storage Additions 1, 3, and 4, Chemical Process Cell Waste Storage Area	Remove stored waste and soil. Decontaminate and dismantle structures. Radioactive, mixed, and industrial waste would be generated.	Same as for Alternatives I/II.	Same as for Alternatives I/II.	Manage as is, monitor, and maintain.	
	Dismantled Lag Storage Addition 2 Foundation, "Old" Hardstand Area	Remove/excavate waste and contaminated soil. Radioactive waste would be generated.	Same as for Alternatives I/II.	Same as for Alternatives I/II.	Leave in place as is.	
	Hazardous Waste Storage Lockers	Dismantle. Industrial waste would be generated.	Same as for Alternatives I/II.	Same as for Alternatives I/II.	Manage as is, monitor, and maintain.	
6	Sludge Ponds, Effluent Mixing Equalization Basin	Pump out stored wastewater.[e] Remove/excavate structure and excavate contaminated soil. Radioactive and industrial waste would be generated.	Same as for Alternatives I/II.	Same as for Alternatives I/II.	Same as for Alternatives I/II for sludge ponds. Manage effluent equalization basin as is, monitor, and maintain.	

Table 3-1. Facility-Specific Actions Taken and Types of Waste Generated for Each Alternative[a] (Continued)

WMA	Site Feature[b,c]	Alternative				
		I/II[d] Removal/On-Premises Storage	IIIA In-Place Stabilization (Backfill)	IIIB In-Place Stabilization (Rubble)	IV No Action: Monitoring and Maintenance	V Discontinue Operations
6 (cont.)	Sewage Treatment Plant, Old Warehouse, Incinerator, Cooling Tower, Rail Spur	Decontaminate sewage treatment plant. Dismantle/remove all structures. Excavate contaminated soil at the cooling tower and along rail spur. Radioactive, industrial, and PCB waste would be generated.	Same as for Alternatives I/II.	Same as for Alternatives I/II.	Leave all facilities as is. Manage, monitor, and maintain old warehouse and sewage treatment plant.	Leave in place as is. Building's active systems (e.g., ventilation, fire protection, etc.) would be shut down and the building locked.
	Proposed Contaminated Soil Consolidation Area	Remove stored soil and liner. Radioactive waste would be generated.	Same as for Alternatives I/II.	Same as for Alternatives I/II.	Manage as is, monitor, and maintain.	
7	NDA Disposal Areas	Pump out leachate from disposal holes. Excavate waste and contaminated soil.[f] Radioactive (including HLW) and mixed waste would be generated.	Pump out leachate from disposal holes. Install circumferential slurry wall and cover entire area with engineered cap.	Same as for Alternative IIIA.	Manage as is, monitor, and maintain.	
	Interim Waste Storage Facility	Decontaminate and dismantle. Remove stored waste. Mixed and industrial waste would be generated.	Same as for Alternatives I/II.	Same as for Alternatives I/II.	Manage as is, monitor, and maintain.	
	NDA Trench Interceptor Project, Inactive Plant Water Line, Inactive Leachate Transfer Line, NDA Hardstand, NDA Former Lagoon	Dismantle the liquid pretreatment system. Remove/excavate structures and contaminated soil. Radioactive and industrial waste would be generated.	Same as for Alternatives I/II.	Same as for Alternatives I/II.	Leave in place as is. Manage trench interceptor project as is, monitor, and maintain.	
8	SDA Disposal Trenches	Pump out leachate from disposal trenches. Excavate waste and contaminated soil. Radioactive and mixed waste would be generated.	Pump out leachate from disposal trenches. Install circumferential slurry wall, grout waste in trenches, and cover entire area with engineered cap.	Same as for Alternative IIIA.	Manage as is, monitor, and maintain. Periodically pump out leachate from disposal trenches.	
	SDA North, South, and Inactive Filled Lagoons	Excavate waste and contaminated soil. Radioactive waste would be generated.	Cover with engineered cap (the same cap that would be installed over the SDA disposal trenches).	Same as for Alternative IIIA.	Manage as is, monitor, and maintain.	
	Trench 14 Leachate Treatment System	Decontaminate and dismantle. Radioactive and industrial waste would be generated.	Same as for Alternatives I/II.	Same as for Alternatives I/II.	Manage as is, monitor, and maintain.	
	Slurry Wall	Remains in place.	Leave in place as is.	Leave in place as is.	Leave in place as is.	

Table 3-1. Facility-Specific Actions Taken and Types of Waste Generated for Each Alternative[a] (Continued)

WMA	Site Feature[b,c]	Alternative				
		I/II[d] Removal/On-Premises Storage	IIIA In-Place Stabilization (Backfill)	IIIB In-Place Stabilization (Rubble)	IV No Action: Monitoring and Maintenance	V Discontinue Operations
9	Radwaste Treatment System Drum Cell	Under Alternative I, decontaminate and dismantle. Remove stored waste. Radioactive and industrial waste would be generated. Under Alternative II, manage as is, monitor, and maintain.	Convert into a tumulus.	Same as for Alternative IIIA.	Manage as is, monitor, and maintain.	*Leave in* place as is. Buildings' active systems (e.g., ventilation, fire protection, etc.) would be shut down and the buildings locked.
10	Administrative Building and Office Trailers, Expanded Laboratory, Meteorological Towers, Parking Lots	Dismantle structures. Under Alternative I, excavate parking lots; under Alternative II, leave 10 percent of parking lots, which would be required for security, inspection, monitoring and maintenance of the retrievable storage areas. Industrial waste would be generated.	Same as for Alternative II.	Same as for Alternative II.	Leave in place as is. Monitor and maintain administrative building, office trailers, and expanded laboratory.	
	OB-1 Office Building, New Warehouse, Security Gate Houses	Under Alternative I, dismantle structures. Under Alternative II, dismantle OB-1 office building, but leave new warehouses and security gate houses as is. Industrial waste and PCB waste (under Alternative I only) would be generated.	Leave in place as is.	Leave in place as is.	Manage as is, monitor, and maintain.	
11	Bulk Storage Warehouse, Scrap Material Landfill	Dismantle warehouse. Excavate waste from landfill. Industrial and PCB waste would be generated.	Same as for Alternatives I/II.	Same as for Alternatives I/II.	Leave in place as is. Monitor and maintain bulk storage warehouse.	
	Hydrofracture Test Well Area	Remove casings from injection wells and grout the wells.	Same as for Alternatives I/II.	Same as for Alternatives I/II.	Leave in place as is.	
12	Schoolhouse, Live Firearms Range	Dismantle. Industrial and PCB waste would be generated.	Same as for Alternatives I/II.	Same as for Alternatives I/II.	Leave in place as is. Monitor and maintain the schoolhouse.	
	Gravel Pit Quarries	Leave in place as is.	Leave in place as is.	Leave in place as is.	Leave in place as is.	
	Earthen Dams and Reservoirs	Remove dams and pump out water from reservoirs.	Leave in place as is.	Leave in place as is.	Manage as is, monitor, and maintain.	
Other Areas on the Project Premises	Inactive Northern Borrow Pits	Leave in place as is.	Leave in place as is.	Leave in place as is.	Leave in place as is.	Leave in place as is.
	Contaminated Stream Sediment Along Erdman Brook and Franks Creek	Excavate contaminated stream sediments. Radioactive waste would be generated.	Leave in place as is.	Leave in place as is.	Leave in place as is.	Leave in place as is.

Table 3-1. Facility-Specific Actions Taken and Types of Waste Generated for Each Alternative[a] (Continued)

WMA	Site Feature[b,c]	Alternative: I/II[d] Removal/On-Premises Storage	Alternative: IIIA In-Place Stabilization (Backfill)	Alternative: IIIB In-Place Stabilization (Rubble)	Alternative: IV No Action: Monitoring and Maintenance	Alternative: V Discontinue Operations
1, 2, 4, and 5	Contaminated Soil and Groundwater Associated with the Contaminated Groundwater Plume on the North Plateau and Other Areas of Contaminated Soil	Excavate contaminated soil. Radioactive waste would be generated.	Excavate areas of contaminated soil at structures that are being dismantled, excavated, or removed. Continue to treat groundwater using mitigative measures; monitor and maintain as necessary.	Same as for Alternative IIIA.	Continue to treat groundwater using mitigative measures; monitor and maintain as necessary.	Leave in place as is.
3, 4, 5, and 12	Contaminated Surface Soil Associated with the Cesium Prong and Other Areas of Contaminated Soil	Excavate contaminated soil. Radioactive waste would be generated.	Leave in place as is.	Leave in place as is.	Leave in place as is.	Leave in place as is.
Various	Erosion Control Structures	Under Alternatives I/II, stabilize LLWTF lagoon 3 embankment. Under Alternative II, also install stormwater collection system and maintain Franks Creek stream banks south of WMA 9.	Stabilize LLWTF lagoon 3 embankment; install localized erosion control structures[g] or perform site-wide, global erosion control measures.[h]	Stabilize LLWTF lagoon 3 embankment; install localized erosion control structures[g] or perform site-wide, global erosion control measures.[h]	Stabilize LLWTF lagoon 3 embankment; install localized erosion control structures[g]	None
Various	New Facilities	Under Alternatives I/II, construct a container management area[i] with three parts: a volume reduction area to reduce the waste volume and treat RCRA hazardous waste, a soil treatment area, and a wastewater treatment area. The volume reduction area would be required for partial implementation of Alternatives I/II that involve generating large volumes of low-level or mixed low-level waste. The soil treatment area would be needed for partial implementation of Alternatives I/II that involve handling large volumes of contaminated soil. The wastewater treatment area would be needed for partial implementation of Alternatives I/II that involve generating large volumes of contaminated wastewater, if existing wastewater treatment systems (liquid waste treatment system and LLWTF) could not be used, or were unavailable.	Construct a wastewater treatment area to process wastewater generated during implementation. Partial implementation of Alternative IIIA would require a scaled version of this facility to process wastewater if existing wastewater treatment systems (liquid waste treatment system and LLWTF) were either unavailable or could not treat the wastewater from decontaminating facilities to be demolished and leachate pumped from the SDA and NDA.	Construct a wastewater treatment area to process wastewater generated during implementation. Partial implementation of Alternative IIIA would require a scaled version of this facility to process wastewater if existing wastewater treatment systems (liquid waste treatment system and LLWTF) were either unavailable or could not treat the wastewater from decontaminating facilities to be demolished and leachate pumped from the SDA and NDA. Construct LLW disposal facility modules[k] for disposal of stored and generated waste. The number of LLW disposal facility modules would vary depending on how much waste would be disposed of.	Construct a wastewater treatment area to process wastewater for the foreseeable future. Partial implementation of Alternative IV would require scaled versions of this facility to process wastewater from pumping leachate out of the SDA and NDA.	None

Table 3-1. Facility-Specific Actions Taken and Types of Waste Generated for Each Alternative[a] (Continued)

WMA	Site Feature[b,c]	Alternative: I/II[d.] Removal/On-Premises Storage	IIIA In-Place Stabilization (Backfill)	IIIB In-Place Stabilization (Rubble)	IV No Action: Monitoring and Maintenance	V Discontinue Operations
Various (cont.)	New Facilities (cont.)	Alternative II would also require construction, filling, and monitoring and maintenance of retrievable storage areas[j]. Partial implementation of Alternative II would require construction of retrievable storage areas consistent with the amount and type of waste generated.				

Note: Abbreviation definitions: WMA (waste management area); HLW [high-level (radioactive) waste]; LLWTF (low-level waste treatment facility); NDA (Nuclear Regulatory Commission-Licensed Disposal Area); and SDA (New York State-Licensed Disposal Area).

a. Refer to Table 3-2 for the disposition of the different classes of waste under each alternative. Under Alternatives I/II, treated soil would be returned to the site to be used as fill.
b. Refer to Figure 1-2 for the location of these site features, classified as major buildings, waste storage facilities, disposal areas, in-ground structures, or remaining facilities.
c. Each area that is excavated will be backfilled with soil, regraded, and seeded with native plants.
d. The facility specific actions and the types of waste generated under Alternatives I and II are the same. The only difference between these alternatives is that under Alternative I, all generated and treated waste would be disposed of off site, while under Alternative II, the waste would be stored on site in newly built retrievable storage areas.
e. The sanitary wastewater would be treated by the existing sewage treatment plant.
f. The containerized waste in the four caissons would be removed, the caissons would be left in place, backfilled, and the concrete caps would be replaced.
g. Would consist of installing a stormwater collection system, installing water control structures at major gullies, constructing interceptor channel along Franks Creek, constructing diversion dikes along tops of creek slopes, installing drop structures in stream beds, and maintaining Franks Creek stream banks south of WMA 9 and Erdman Brook stream banks.
h. Would consist of large-scale filling of stream beds, constructing a diversion channel, and installing grade stabilization structures at the end of newly filled or excavated areas.
i. The container management area would consist of a volume reduction area, soil treatment area, and a wastewater treatment area.
j. The retrievable storage areas would consist of a shielded retrievable storage area and four contact retrievable storage areas.
k. The LLW disposal facility modules would consist of three in-ground disposal facilities, each of which would be converted into a tumulus.

treated and the fraction below free release limits would be used for backfill in the excavated areas (i.e., used as free release fill). All excavated areas would be restored to near-original contours and would be regraded and revegetated with native plants for erosion control.

Alternative III (In-Place Stabilization) includes a combination of actions and contains two subalternatives, IIIA [In-Place Stabilization (Backfill)] and IIIB [In-Place Stabilization (Rubble)]. The common actions for Alternatives IIIA and IIIB would include backfilling with soil, and capping and backfilling with concrete and capping the lagoons and concrete pits (e.g., interceptors) respectively, associated with the LLWTF; converting the RTS drum cell to a tumulus (i.e., make into an artificial hill by covering the concrete, soil, and an engineered cap); pumping leachate from the holes in the NDA and trenches in the SDA and capping the areas, after grouting the trenches in the SDA; and backfilling the HLW tanks and vaults and the belowgrade portions of the supernatant treatment system. For small facilities or facilities with minimal or no contamination (see definition in subsection 3.2.1.), the common actions would be either to leave them in place or remove them as described for Alternatives I and II.

The distinguishing features between Alternatives IIIA and IIIB are the disposition of the process building, the vitrification facility, and the stored waste in the lag storage building and its additions and in the chemical process cell (CPC) waste storage area. For Alternative IIIA, the stored waste would be placed in the process building and the vitrification facility and then these buildings would be backfilled with concrete. Alternative IIIB would place the stored waste in a new LLW disposal facility. Alternative IIIB would remove the abovegrade portions of the process building and vitrification facility and use the removed material as fill for the belowgrade portions of the buildings. The void space between the fill would be grouted and the filled belowgrade structure would be covered with an engineered cap.

Alternative IV (No Action: Monitoring and Maintenance) actions would monitor and maintain the facilities in the condition they will be in after completion of HLW solidification. Minor modifications would be made to seal entries and to remove stacks that are no longer needed and that would require maintenance. The liquid waste treatment system and the cement solidification systems would be flushed. Wastewater would be pumped out of the sludge ponds. The disposal areas would be managed in place. Leachate would periodically be pumped out of the SDA disposal trenches. The embankment at lagoon 3 would be stabilized. Local erosion control structures would be installed and maintained.

Alternative V (Discontinue Operations) would involve no actions other than shutting down active systems (such as ventilation and fire protection systems), locking doors, and leaving the Center.

3.1.2 Alternatives Eliminated from Detailed Analysis

Several other alternatives identified in public comments were considered for analysis in this EIS but were subsequently eliminated from further consideration. One alternative considered early in the evaluation was delaying decontamination and decommissioning activities for 100 years, to allow further decay of the radionuclides in the waste and environmental contamination and to benefit from advances in cleanup technologies. This alternative has been considered at nuclear power plants and would reduce occupational exposure. Although there are short-lived radionuclides (e.g., cesium and strontium) in waste that would decay over 100 years, there are also long-lived radionuclides (e.g., plutonium) that have half-lives on the order of a thousand years which would not substantially decay over a 100-year period. There is also groundwater contamination on the Project Premises that will migrate off premises with time. Delaying closure or stabilization to allow for radioactive decay would not be responsive to mitigating this environmental contamination. Likewise, the facilities on site would deteriorate with time increasing the potential for environmental contamination. For the reasons described above, this alternative was dismissed from further evaluation.

Another alternative considered but not evaluated in detail involved reusing existing facilities. Detailed analysis was not performed because no realistic reuse scenario was identified for the facilities. By the time the existing buildings would be available for reuse, they would be long past their useful life. NYSERDA, the site owner, has no plans for reusing the site at this time. If necessary, additional NEPA or SEQRA documents will be prepared for DOE or NYSERDA actions not specifically addressed in this document.

One alternative identified during the scoping process was use of the cesium-137 and strontium-90 stored in the waste tanks for irradiating and preserving fruit. This alternative is not practical for the WVDP because the cesium-137 and strontium-90 are mixed in with the HLW in the tanks and cannot be readily separated without a major processing effort. At the Hanford Site, for example, these isotopes were separated at the time of initial spent fuel processing and are hence readily available for other purposes.

A commenter to the Notice of Intent suggested to prepare a draft EIS alternative using cesium-137 and strontium-90 stored in the HLW tanks for irradiating and preserving fruit. While this concept was pursued at another DOE site, it was not viewed as practical for the WVDP because cesium-137 and strontium-90 cannot readily be separated without a major processing effort.

Another alternative identified during the scoping process was reprocessing the spent nuclear fuel. The storage of the 125 spent fuel assemblies currently on the Project Premises is the subject of separate NEPA documents (see Section 1.4) and they will be shipped off site for storage or processing before completion of the WVDP. Therefore, the reprocessing alternative is not within the scope of this EIS.

3.2 CONCEPTUAL ENGINEERING DESIGNS

The environmental impacts of WVDP completion and closure or long-term management of facilities at the Center result from actions taken to implement an alternative including the amount of construction, the areas disturbed, the amount of material moved, the amount of contamination released to the environment, and the residual contamination levels. For example, the short-term impacts (approximately 25 to 30 years) for Alternatives I and II would be much greater than for Alternatives IV and V because Alternatives I and II include large-scale waste retrieval and building decontamination and demolition, while facilities would remain in place under Alternatives IV and V.

To estimate the environmental impacts of the alternatives identified in Section 3.1, a series of conceptual engineering designs were developed for each alternative. The closure engineering reports identified the conceptual designs and representative technologies, actions and facilities required to implement the alternatives. An effort was made to identify actions unique to one alternative.

The specific implementing actions addressed in the conceptual designs vary with alternative and the facility being addressed. The actions include remote and contact decontamination of buildings, exhumation of buried waste forms with different types and levels of contamination, excavation of contaminated soils, and earthmoving to control erosion. The new facilities required also vary by alternative. The new facilities include a new processing facility for solid waste, liquid waste, and contaminated soil; waste storage facilities; or waste disposal facilities. The closure engineering reports estimate the resources (labor, energy, materials, and costs) required to implement the actions and to build and operate new facilities and environmental release rates. They also estimated the area required for new processing, storage, or disposal facilities and for erosion control measures. These resource and area estimates are the basis for evaluating the environmental impacts of the five alternatives.

The level of detail developed for the conceptual designs and presented in this EIS varies with the proposed actions (e.g., decontamination and earthmoving) or the proposed facilities (e.g., waste processing facility and waste storage facility). The level of design detail developed was that considered necessary to estimate the resources and facility footprints (floor area). A greater level of detail was required for the new waste processing facilities than for the new waste storage facilities. Less engineering detail was required to estimate earthmoving activities for erosion control than for dismantling or constructing facilities.

Details of the completion and closure strategy selected in the Record of Decision and Findings may be modified in the final design based on future engineering studies for the preferred alternative. These studies could identify the need for design changes such as the inclusion of clay layers in building foundations or engineered caps to improve long-term performance. The modifications could also lead to better integration of the selected actions (e.g., the use of industrial waste as fill for erosion control) to reduce the cost and environmental impact of the proposed action. The final design might have changes from the representative technologies identified in the current conceptual designs, but if any needed changes lead to impacts outside the range of conditions assessed in this EIS, supplemental assessments could be required. This EIS contains sufficient detail, however, for DOE and NYSERDA to decide their final completion and closure strategy.

3.2.1 Facilities Included in Engineering Evaluations

The closure engineering reports focused on (a) existing facilities that were large [at least 9 x 9 m (30 x 30 ft)], would have more than 5 Ci of radioactivity at the start of closure, or have RCRA interim status, (b) new facilities required to implement the alternatives, and (c) erosion control features. The conceptual designs for closure focused on the following existing facilities on the Project Premises and SDA:

- The process building located in WMA 1—large [82 x 40-m (270 x 130-ft)] concrete structure with high levels of interior radioactive contamination (up to 3,000 Ci of strontium-90 and 3,300 Ci of cesium-137) from former fuel reprocessing activities. The liquid waste treatment system, a portion of which is in the process building, has RCRA interim status.

- The 01/14 building (WMA 1)—smaller [12 x 10-m (41 x 33-ft)] concrete building than the process building with low levels of contamination compared to the process building (less than 200 mCi). The cement solidification system, a portion of which is in the 01-14 building, has RCRA interim status.

- The LLWTF and lagoons 1 through 5 (WMA 2)—includes a small [8.2 x 12-m (27 x 39-ft)] process building (the 02 building) where wastewater is treated and the lagoons, which are classified as in-ground structures. The 02 building has less than 10 Ci of radioactive contamination, and nearly all of the radioactivity in the lagoons is in lagoon 1 (up to 700 Ci of cesium-137).

- HLW storage area (WMA 3)—includes the HLW tanks, the vitrification facility, and the supernatant treatment system. The HLW tanks are located in underground vaults, the supernatant treatment system includes aboveground and belowground structures, and the vitrification facility is a large [10 x 20-m (34 x 65-ft)] reinforced concrete structure. These are waste storage and processing facilities with high levels of radioactive contamination (up to 206,000 Ci of strontium-90 and 408,000 Ci of cesium-137). The tanks, facility, and system have RCRA interim status.

- Waste storage facilities (WMA 5)—includes the lag storage building, three lag storage additions, and the CPC waste storage area, all of which have RCRA interim status. The RTS drum cell is in WMA 9. These facilities are classified as major waste storage facilities (1,500 Ci of strontium-90 and 1,600 Ci of cesium-137 in the lag storage building and additions; 200 Ci of cesium-137, 200 Ci strontium-90, and 200 Ci of plutonium in the CPC waste storage area; and up to 4,000 Ci of technicium-99 and 3,000 Ci of plutonium-241 in the RTS drum cell).

- CDDL (WMA 4)—an unlined landfill [covering 0.6 ha (1.5 acres)] that contains nonradioactive waste, but it may contain hazardous constituents (e.g., lead, chromium, or mercury). It may be radiologically contaminated from infiltration of radioactively contaminated groundwater.

- NDA (WMA 7)—major waste disposal area that contains radioactive waste (with 10,000 to 50,000 Ci of tritium, cobalt-60, strontium-90, cesium-137, and plutonium-241). The interim waste storage facility (IWSF) and trench interceptor project in WMA 7 have RCRA interim status.

- SDA (WMA 8)—major disposal area adjacent to the Project Premises that was used to dispose of commercial LLW (containing 30,000 to 40,000 Ci of strontium-90, cesium-137, plutonium-238, and plutonium-241). The disposal trenches are known to contain leachate with RCRA hazardous constituents. The associated waste storage facilities have RCRA interim status.

The four new facilities addressed in the conceptual engineering designs are as follows:

- A container management area—a facility used to process the radioactive, hazardous, and mixed waste that would be generated by decontamination if facilities were removed and buried waste exhumed (Alternatives I and II). The facility would perform volume reduction and hazardous waste stabilization, soil treatment to produce treated soil that can be used for backfill on site and a fraction of contaminated soil with a higher concentration of radionuclides that would have to be managed as waste, and a wastewater treatment area for wastewater (e.g., leachate or liquids generated by decontamination) containing hazardous chemicals and radionuclides.

- Retrievable storage areas—a facility used for on-premises storage of retrieved and processed radioactive waste under Alternative II. There would be separate storage for contact-handled waste and remote-handled waste.

- A wastewater treatment area—a facility used to process wastewater containing radionuclides and hazardous constituents that would be generated by decontamination of buildings and removal of leachate from disposal areas. This facility would be required under Alternatives III and IV.

- A low-level waste disposal facility—used for on-premises disposal of LLW under Alternative IIIB.

Sections 3.3 through 3.7 present a detailed discussion of these proposed new facilities.

The conceptual engineering designs also addressed erosion control features. The erosion control strategies involve two options. The first option is "local" erosion control that uses dikes and drop structures along stream banks and water flow control structures. The second option is "global" erosion control that reroutes the local stream flow for longer term erosion control. Maintenance of erosion control measures would be necessary to protect facilities that would remain on the Center during the post-implementation phase (i.e., as part of institutional control after implementation phase actions have been completed). The erosion control strategies were developed to estimate the resource and area requirements. It is expected that the representative engineering designs would be modified if selected for implementation, but the design changes would implement the same basic strategy. The magnitude of the environmental impacts would not likely change because of the design change. A discussion of erosion control measures is presented in Section 3.3.2.3.

3.2.2 Conceptual Design Assumptions

This section identifies general assumptions and assumptions made about hazardous and radioactive waste management used to develop the conceptual designs. Hazardous and radioactive waste management assumptions were made to develop the conceptual engineering designs because of uncertainty regarding (a) the acceptable residual contamination level, (b) the results from some of the RFIs, and (c) the disposition of the various waste types that would be generated during implementation of an alternative. These assumptions are discussed in the sections below.

3.2.2.1 General Assumptions

Assumptions made for the conceptual engineering designs include the following:

- Alternatives II, III, and IV would require continued on-premises presence for site access control, environmental monitoring, and maintenance of the facilities to isolate the waste from the environment.

- Estimates were made on the classification and volumes of waste that would be generated during implementation of an alternative. All waste and contaminated soil could be sorted and sampled before determining the actual contaminated volume and classification. When excavating buried waste, waste could be sorted by radiation level, labels on waste packages, and physical characteristics. Similarly, if soil or stream sediments are excavated, field screening could be conducted to determine contamination levels and identify the specific areas requiring excavation. Waste and contaminated soil sent to the container management area would be sorted into similar waste categories after sampling and analyzing to determine the concentration of hazardous constituents and radionuclides and, therefore, the waste classification.

- Facilities for processing radioactive waste would be designed to be consistent with NRC licensing requirements and would have a design life of at least 50 years. Facilities designed for treating or storing potentially hazardous waste would also have to be designed to meet permit requirements under RCRA and NYSDEC regulatory requirements. Radioactive waste storage facilities would be designed to be consistent with NRC licensing requirements and would have a design life of at least 100 years. Radioactive waste disposal facilities would be designed to be consistent with applicable federal and state regulatory requirements.

- Designs would minimize waste generation to the maximum extent practical.

3.2.2.2 Hazardous Waste Management Assumptions

The hazardous waste that would be generated by implementing the alternatives would be regulated by NYSDEC. The conceptual engineering designs use NYSDEC regulations to identify hazardous waste that would have to be managed under the alternatives.

Under Alternatives I through III, the conceptual designs assumed that the 14 facilities that have RCRA interim status would have to be closed under RCRA, and this would be accomplished by flushing equipment with decontamination solutions followed by physical decontamination of building surfaces as necessary to remove hazardous waste or constituents before dismantlement.

It was assumed that the facilities with RCRA interim status that are not used for processing HLW (i.e., liquid waste treatment system, cement solidification system, neutralization pit, SDA interim waste storage facilities, and NDA trench interceptor project) could be flushed to remove hazardous constituents and waste generated by dismantlement would be managed as radioactive waste. It was also assumed that the packaged low-level mixed waste stored in the facilities with RCRA interim status (i.e., lag storage building and additions, CPC waste storage area, hazardous waste storage lockers, interim waste storage facility, and RTS drum cell) would be treated in the container management area under Alternative I. Equipment in facilities with RCRA interim status that contain either HLW or material derived from HLW (i.e., supernatant treatment system, vitrification facility, and HLW tanks) would either have the waste removed and be managed as HLW or would be closed in place to meet RCRA closure requirements.

In addition to the RCRA interim status facilities, the RFIs required under the Consent Order are being conducted to determine the nature and extent of hazardous wastes or hazardous constituents released from site facilities into the environment. The RFI reports will be reviewed by the State regulatory authority (NYSDEC) and the U.S. Environmental Protection Agency (EPA), who will determine if further action, additional assessment, or corrective action is required. The NYSERDA RFI has been completed and approved. NYSDEC and EPA have determined that hazardous constituents have not been released from any of the solid waste management units at the SDA (WMA 8) based on the RFI data (NYSDEC 1994). Determinations that no further action will be required under the Consent Order were made by NYSDEC and EPA for the RTS drum cell (WMA 9) and the hazardous waste storage lockers (WMA 5) during negotiations of the RFI Work Plan. Determinations for the remaining units are not expected to be made for several years and required actions are not expected to fundamentally change the baseline assumptions for this EIS.

Existing environmental monitoring data and data from the RFIs do not indicate environmental contamination with hazardous constituents. If removed from the disposal trenches, leachate in the SDA would be considered a characteristic hazardous waste which would be managed according to RCRA. NYSDEC and EPA are requiring additional infiltration control measures at the SDA as an interim measure under the Consent Order to minimize the potential for leachate migration. The EIS assumes this leachate will be a characteristic mixed waste that would be pumped out of the SDA and treated under four of the five alternatives. On the basis of available data, the conceptual engineering designs assumed that no RCRA corrective actions would be required at other facilities.

3.2.2.3 Radioactive Waste Management Assumptions

Under the WVDP Act, DOE is to propose and the NRC is to prescribe decontamination and decommissioning requirements for facilities and portions of the site used for the WVDP. Radioactive waste generated by implementing the alternatives would be categorized using NRC regulations. The conceptual engineering designs use the waste categories and definitions presented in Table 1-2.

The NRC does not currently have generic cleanup criteria for radiologically contaminated sites, but it has developed proposed standards for site decommissioning. These proposed standards indicate that sites to be released for unrestricted use should be cleaned to the point where the expected dose to the average member of the critical group does not exceed 15 mrem/yr (NRC 1994). This proposed standard was used in conjunction with radiation transport models discussed in Appendix E to estimate acceptable levels of residual contamination.

The conceptual engineering designs conducted in support of the EIS relied upon a conservative radiation transport scenario in the RESRAD computer code to identify radionuclide concentrations that would result in 15 mrem/yr committed total effective dose equivalent to the critical exposed individual. These numerical values are presented in Appendix C. The conceptual engineering designs assumed that areas to be released for unrestricted use would have radionuclide concentrations less than those presented in Appendix C. For hazardous constituents in soil, areas to be released for unrestricted use would have concentrations above background but less than that which would result in an incremental cancer risk of 1×10^{-4}/yr to an off-site receptor. This level is at the upper end of the target range for acceptable risk in present EPA guidance (EPA 1991) and in 40 CFR Part 300, "National Oil and Hazardous Substances Pollution Contingency Plan," 1985, and was selected to be consistent with the radiological risk. The areas to be excavated and the volume of soil to be processed were estimated to meet these limits.

These estimated free release concentrations could be more restrictive than actual regulatory requirements; therefore, scoping calculations as described in Section 5.12 were performed to estimate engineering requirements and impacts of less restrictive concentration limits.

3.2.3 Waste Disposal Assumptions

This section identifies the assumptions used for disposition of the waste that would be generated by WVDP completion and closure or long-term management of facilities at the Center. These wastes would be disposed of after the year 2000. Disposition of radioactive, hazardous, mixed, and industrial waste is described in Sections 3.2.3.1, 3.2.3.2, 3.2.3.3, and 3.2.3.4, respectively.

3.2.3.1 Radioactive Waste

The availability of sites for disposition of the radioactive wastes is currently uncertain. For the types of radioactive wastes that would be transported off site, DOE is currently preparing the *Waste Management Programmatic Environmental Impact Statement (PEIS)* to evaluate alternative configurations of waste management facilities around the country to treat, store, and dispose of DOE waste. Alternatives being considered in the Waste Management PEIS range from centralizing waste activities by waste type at a single site to decentralizing waste management activities to a number of facilities around the country. The actual site that would receive Center radioactive waste will not be known before the Record of Decision (ROD) for the Waste Management PEIS is issued, and perhaps not until the closure period.

The national program for selecting and developing a geologic repository for HLW is in progress. Although the Yucca Mountain site in Nevada is being closely examined, selection of this site has not been finalized. The HLW being managed during completion of the WVDP will eventually be disposed of off site. Alternatives being considered in the Waste Management PEIS assume storage of the WVDP canisters of vitrified HLW at the Center or at a DOE site until a geologic repository becomes available.

During implementation of an alternative, it is expected that spent fuel fines will be found in a few cells of the process building. However, the quantities and concentrations of spent fuel fines that could be retrieved are uncertain. Due to these uncertainties, the classification of spent fuel fines is also uncertain. The retrieved spent fuel fines could be classified as LLW or HLW (because it is irradiated fuel per 10 CFR Part 60.2, "Definitions"). For the purposes of analysis in this EIS, these materials will be considered residues and handled in a manner consistent with HLW. In this EIS, for purposes of analysis it was assumed that the canisters of vitrified HLW would be stored on the Project Premises under Alternatives II, IV, and V. The vitrified HLW would be transported off site under Alternatives I and III. For estimating the impacts of disposing of the HLW canisters, it was assumed they would be transported a distance of 4,000 km (2,500 mi) from the site, which approximates the distance from the Center to several DOE sites (including sites in Nevada and in Washington), consistent with the approach in the Waste Management PEIS.

LLW might go to commercial or DOE facilities. For commercial disposal, the Low-Level Waste Policy Act provided for states to enter into associations (compacts) to cooperatively develop and operate facilities to manage the commercial LLW generated within the states included in the compact boundary. The compacts could exclude waste generated outside the compact from being managed in their facilities. The State of New York is not a member of a compact; therefore, it is responsible for providing for the disposal of non-federal LLW generated within New York State boundaries. Currently, there is no location within New York State to receive the LLW, and New York generators ship their waste to the disposal facility in Barnwell, South Carolina. LLW currently generated at the Center is stored on-premises pending the ROD from this EIS. An Environmental Assessment that evaluates near-term management of Class A LLW and mixed waste is currently in progress as described in Section 1.4.

Disposal of LLW generated by the WVDP would be the responsibility of DOE in accordance with applicable regulations. Long-term programmatic decisions by DOE on managing and disposing of LLW being generated across the DOE complex are being addressed in the Waste Management PEIS. Alternatives under consideration by the DOE range from No Action at the individual sites to centralization of LLW management and disposal activities at a selected site.

The combination of no LLW disposal site within the State of New York and no ROD on the DOE long-term LLW management strategy creates uncertainty as to where either newly generated or currently stored or buried LLW at the Center would be shipped, if off-site disposal were selected. Therefore, specific disposal facilities that might be available during the time frame under consideration were not identified. For this EIS, an attempt was made to estimate and bound the potential transportation impacts of off-site shipment of LLW packages, by assuming that the wastes would be shipped to disposal sites approximately 4,000 km (2,500 mi) from the site. Distances to either DOE or commercial LLW disposal facilities could be shorter. Estimated impacts from incident-free transportation as well as accident risks would be proportional to the distance traveled. The estimated transportation impacts could, therefore, be made for shipments to a closer site by scaling the impact and risk to the distance traveled.

There is also uncertainty for disposing of GTCC waste. DOE has responsibility for the management of both DOE- and NRC-licensee-generated GTCC waste. No site has been selected for the disposal of GTCC waste. The EIS assumes there will be a GTCC storage or disposal facility located 4,000 km (2,500 mi) from the Center at DOE sites as far away as Richland, Washington, and Nevada to evaluate transportation impacts.

3.2.3.2 Hazardous Waste

RCRA-regulated hazardous wastes are currently generated in small quantities at the site and are shipped off site for treatment and disposal. The annual volume of hazardous waste currently shipped off site varies, but in 1994 was approximately 4.0 m^3 (140 ft^3). Because of the limited amount of hazardous waste that is expected to be generated by implementing the alternatives and the established practice of shipping hazardous waste off site, the conceptual engineering designs and the EIS assume that this practice would continue and that the hazardous waste treatment and disposal facilities are approximately 800 km (500 mi) from the site. This is consistent with the current site disposal practices (Lozier 1993a) and with the preferred alternative identified in the Waste Management PEIS.

3.2.3.3 Mixed Waste

Few DOE or commercial sites can currently treat, store, or dispose of mixed waste. DOE is evaluating plans for treating mixed wastes in the Waste Management PEIS and in the DOE Site Treatment Plans required by the Federal Facility Compliance Act. Currently, no active permitted waste disposal facilities are operated by DOE for disposal of mixed waste. However, two commercial facilities in Tennessee are currently permitted to treat mixed wastes. The shipment of mixed waste to a commercial waste management facility at the site-wide level is consistent with the approach in the Waste Management PEIS. The EIS analyses assume a transportation distance to a site 1,600 km (1,000 mi) from the Center, which conservatively estimates the distance to the commercial facilities in Tennessee.

3.2.3.4 Industrial Waste

Many sites can handle industrial waste. Industrial waste described in this EIS is predominantly construction and demolition debris. There are at least 12 landfills in western New York that are currently accepting construction and demolition debris waste. Approximately 27 m^3 (940 ft^3) of industrial waste is currently shipped off site annually for disposal. The EIS assumes that industrial waste is disposed of 640 km (400 mi) from the Center. This assumption is consistent with current industrial waste disposal practices, where the waste is disposed of at sites less than 580 km (360 mi) from the Center (Lozier 1993a, 1993b).

3.2.4 <u>Description of Alternatives</u>

Sections 3.3 through 3.7 describe the five alternatives analyzed. The discussion for each alternative includes the alternative objective; general strategy for implementing the alternative; implementation phase actions, including a description of existing facilities, new facilities, and erosion control measures; waste volumes to be managed; schedule of implementation phase actions; and post-implementation phase actions, including monitoring and maintenance.

As discussed earlier in this section, the level of detail developed for the conceptual design and presented in this EIS varies among alternatives. The detail presented in the alternative descriptions reflects the level of detail in the conceptual design.

Using the information provided in the engineering reports, the alternative descriptions present representative actions, technologies, and designs. The actions are based on an understanding of facility conditions and site contamination levels at the end of WVDP HLW solidification, which is detailed in Appendix C. Appendix C also contains the layout of each WMA, which shows the following features: major buildings; waste storage facilities; disposal areas; in-ground structures (e.g., lagoons and pits); remaining facilities; contaminated soil and stream sediments; and contaminated leachate and groundwater.

Since preparation of the EIS began, the closure engineering reports that provided input for assessing the environmental impacts have evolved because of engineering and project management reviews. The evaluation presented in the Draft EIS is based on the Fall 1994 draft closure engineering reports. Because of this, the numbers in the Draft EIS (e.g., waste volumes, occupational exposure estimates, costs) may not be the same as those in later versions of the closure engineering reports. In most cases, the changes in numbers are from rounding-off, refinement in the calculations, and numerical corrections. These changes are within the realm of uncertainty in the conceptual designs and the assumptions used to develop the closure engineering reports. In those cases where the numbers in the 1995 closure engineering reports either increased or decreased by 50 percent, this has been noted. The conceptual designs based on the Fall 1994 draft closure engineering reports are sufficiently reliable to give the public an accurate picture of the impacts of the alternatives. The Final EIS will use numbers in the updated closure engineering reports.

3.3 ALTERNATIVE I: REMOVAL AND RELEASE TO ALLOW UNRESTRICTED USE

The objective of Alternative I (Removal) is to allow release of the Center for unrestricted use. Release for unrestricted use means that, after cleanup, no further site monitoring or security would be required and that future land use would not be constrained because of residual contamination. Structures on the Center and environmental contamination on the Project Premises and balance of the site would be removed.

Release for unrestricted use is considered acceptable when

- Facilities and equipment meet the NRC Division of Fuel Cycle Safety and Safeguards' guidance in *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material* (NRC 1993). The allowable contamination levels identified in this guideline are expressed in terms of disintegrations per minute per cm^2 (dpm/cm^2) for specific nuclides. These contamination levels are not tied to specific human exposure estimates.

- Residual contaminant concentrations in soil would result in a radiological dose to a potential site user that is as low as reasonably achievable, but not more than 15 mrem total effective dose equivalent per year [59 FR 43200-43232 (FR 1994)][1], and concentrations of hazardous contaminants are less than the proposed RCRA action levels given in 55 FR 30865-30867 (FR 1990) or are less than three times

[1] The preamble to the proposed NRC decontamination and decommissioning dose limit cited states that, until the final limit is promulgated, NRC will determine decommissioning criteria on a case-by-case basis. This position is also consistent with the NRC's role under the WVDP Act. In the absence of site-specific decommissioning criteria, this EIS uses the proposed limit for purposes of analysis.

site background concentrations, whichever is higher (see rationale in Section C.3.1 of Appendix C).

- Actual or potentially usable groundwater sources do not exceed NYSDEC groundwater standards, which are generally applicable to sites released for unrestricted use. These regulations present limits for individual nuclides and limit the total exposure to 4 mrem/yr when multiple nuclides are involved (6 NYCRR Part 703).

3.3.1 General Strategy for Alternative I

The general strategy for implementing Alternative I is to allow release of the Center for unrestricted use. The current wastes on site would be exhumed or removed and sent off site for disposal along with any newly generated wastes. The entire Center would then be eligible for unrestricted use. Figure 3-2 illustrates this general strategy. Buildings would be decontaminated to minimize producing radioactive waste and maximize producing uncontaminated industrial waste and rubble. The nuclear processing facilities (e.g., the process building, the supernatant treatment system support building, and the vitrification facility) would be decontaminated using remote and contact methods. Remote decontamination and dismantlement would be conducted when dose rates are greater than 50 mrem/hr. Remote techniques use robots and equipment that allow operators to control operations from a distance or from behind shielded walls to reduce occupational exposure. Support facilities (e.g., the laundry building and test and storage building) have small amounts of contamination (less than 10 Ci) that would be removed by localized, contact methods. Because occupational exposure would not be as much of a concern for the support facilities, workers could manually operate hand-held equipment to remove selected areas of contamination.

Industrial waste generated by the demolition of decontaminated, clean structures would be disposed of in an off-site sanitary landfill. All contaminated waste and soil would be sent to a new, on-premises container management area that would be used for characterization, treatment, and packaging before transportation off site for disposal. Two buildings would be located at the container management area: (1) one building housing a volume reduction area and a wastewater treatment area and (2) the other building housing a soil treatment area. (See Section 3.3.2.2 for a detailed description of the container management area.)

The waste in the storage facilities (i.e., lag storage building, lag storage additions, RTS drum cell, CPC waste storage area, IWSF, and the proposed contaminated soil consolidation area) would be removed and transported to the container management area described in subsection 3.3.2.2. Necessary decontamination would be performed and the structures would be dismantled and demolished.

Leachate from buried SDA and NDA waste would be pumped to the container management area. The buried waste and associated soil in the CDDL, SDA, and NDA would be exhumed, packaged, and transported to the container management area using

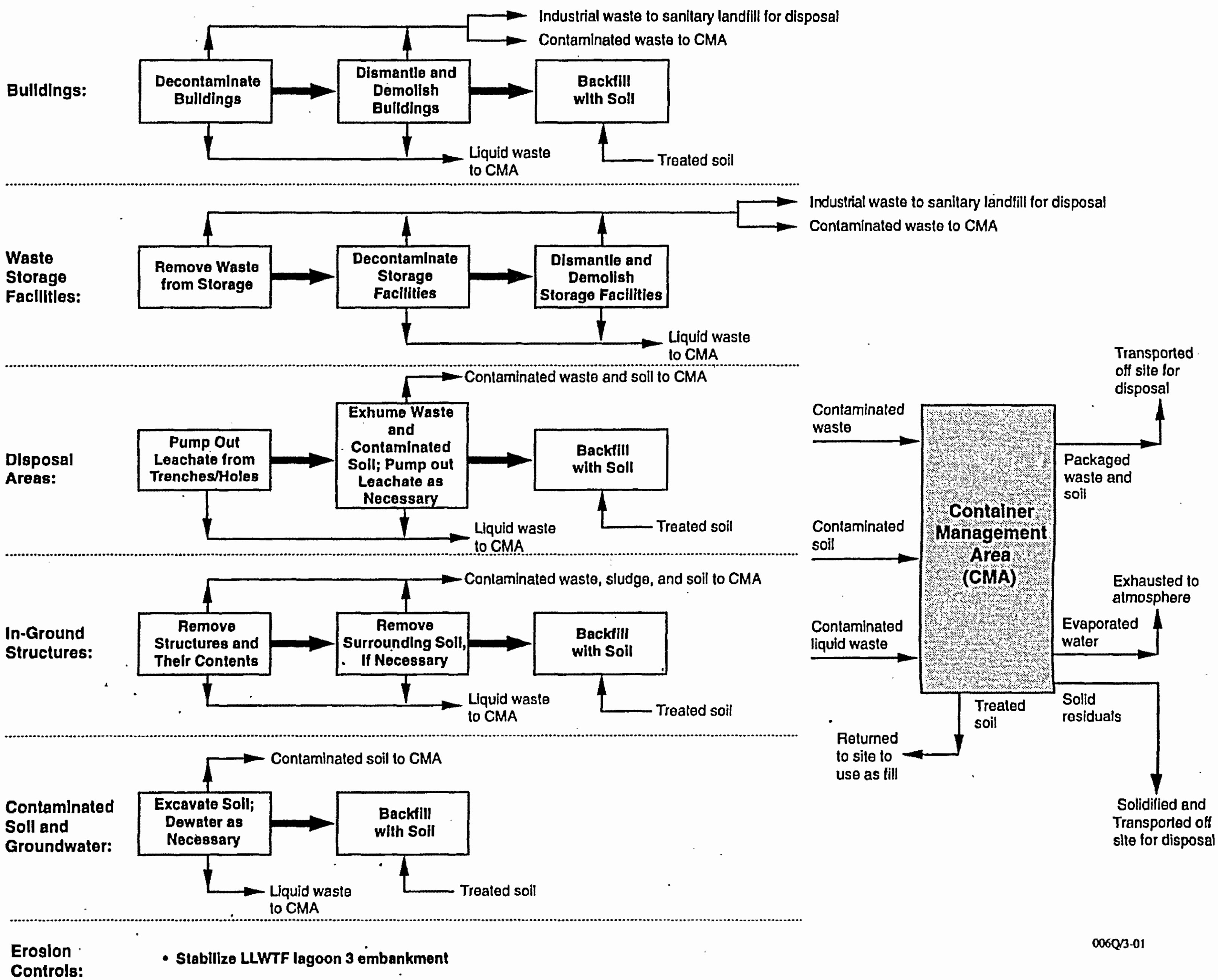


Figure 3-2. General Strategy for Implementing Alternative I (Removal).

systems to keep radiation exposures within applicable standards. After the waste was removed, the former disposal areas would be backfilled with clean soil.

In-ground structures (e.g., HLW storage tanks, interceptors, pits, and lagoons) and their contents would be removed and transported to the container management area. The excavations would be backfilled with clean soil.

Areas of contaminated soil, including on-site portions of the cesium prong, and stream sediments on site would be excavated and treated in the container management area. The cesium prong extends from WMAs 3, 4, and 5 northwest and includes land on the balance of the site (in WMA 12) and off site. Contaminated water (e.g., leachate from the SDA and NDA, and liquid waste generated by decontamination) would also be treated in the container management area. Soils released for unrestricted use would be used as fill. Post-treatment contaminated soils would be packaged for off-site disposal. Contaminated water would be treated and then evaporated. Solid residuals or sludge that remains would be solidified and disposed of off site as described in Section 3.2.2.

Confirmatory surveys to ensure that residual contaminant levels are not above free release limits would be made throughout the implementation phase actions.

Institutional controls during the implementation phase of Alternative I would minimize negative impacts. The institutional controls would include: (a) site security to restrict access to contamination and ongoing operations, (b) effluent monitoring to prevent unplanned releases of contamination to the environment, (c) environmental monitoring (e.g., groundwater monitoring) to evaluate the potential movement of contaminants through the environment, (d) erosion monitoring and control for areas near contaminated facilities or buried waste, and (e) monitoring and maintenance of the facilities, structures, waste storage facilities, and disposal areas.

3.3.2 Alternative I Implementation Phase Actions

This section describes the actions that would be performed for existing facilities, structures, and environmental contamination; new facilities; and erosion control measures during the implementation phase of Alternative I.

3.3.2.1 Existing Facilities, Structures, and Environmental Contamination

This section discusses Alternative I engineering actions for existing buildings, waste storage facilities, disposal areas, in-ground structures, remaining facilities, and environmental contamination.

3.3.2.1.1 Buildings—Specific Actions

The major buildings at the Center include the process building, vitrification facility, 01/14 building, and 02 building.

Process Building. The process building was designed and used to reprocess spent nuclear fuel. Spent fuel was chopped, dissolved, and processed by a solvent extraction system to recover uranium and plutonium. Because of the associated radiation, these operations were conducted in thick-walled rooms called cells. The fuel receiving and storage area in the east side of the process building contains a cask unloading pool and fuel storage pool. The building contains approximately 70 rooms, cells, and other areas, including the fuel receiving and storage area, laboratories, the liquid waste treatment system evaporators, and mechanical cranes. The process building has high levels of radiological contamination (up to 3,000 Ci of strontium-90 and 3,400 Ci of cesium-137) in several of the process cells. Vitrified waste produced during HLW solidification will be stored in the chemical process cell in the process building.

The spent fuel fines and canisters of vitrified HLW waste present in the process building would be disposed of off site, and the building would be decontaminated and dismantled. To prepare for decontamination, confinement and access barriers would be constructed around the selected areas. The confinement barriers would have airlocks, temporary shielding, and a temporary heating, ventilation, and air conditioning system.

The first decontamination step for the process building areas would be to remove loose material and pieces of contaminated equipment and place them into containers for transport to the container management area where they would be characterized, treated, as needed, and packaged. After the loose contamination is removed, contamination attached to equipment and cell or room surfaces would be removed using physical and chemical methods. Physical methods, such as grinding or scabbling, are preferable for accessible surfaces (e.g., those with flat or smooth curvatures). Chemical methods are most useful when surfaces are less accessible (e.g., complex surfaces and internal surfaces) and are generally not porous. Solid waste from physical decontamination methods would be placed in packages and transported to the container management area. Liquid waste from chemical decontamination of the process building would be sent to the wastewater treatment area of the container management area or could be sent to an existing treatment facility, such as the liquid waste treatment system or the LLWTF. These decontamination operations would be performed remotely when radiation levels are greater than 50 mrem/hr. The liquid waste treatment system would have been flushed before implementation of the alternative to ensure that no hazardous material remained. An ultrasonic or mechanical procedure would be used to confirm the absence of liquids in pipes and vessels, and any liquids present would be drained. The floor, wall, ceiling, equipment, and piping surfaces within an area or room would be wiped down (using scrub brushes, if necessary) to remove loose contamination.

Dismantlement would begin after decontamination. Electrical and mechanical equipment would be removed and transported to the container management area where piping would be cut and packaged into containers. The stainless-steel liners on the walls and floors of the shielded cells would be cut into plates, pried loose, and packaged for transport to the container management area. Concrete surfaces (floors, walls, and ceilings) would be scabbled to remove radioactive contamination in the concrete. The depth of scabbling would depend on the depth of contamination, but this evaluation assumed that two 0.64-cm (0.25-in.) passes with a scabbling tool would be required for areas of general contamination and hot spots would have an additional 5 cm (2 in.) of concrete removed (WVNS 1994a). Waste material from surfaces covered with lead-based paint would be sampled to determine if it was mixed waste. After scabbling the surfaces and removing the waste, the area would be vacuumed to remove residual dust and washed by high-pressure water sprays. The liquid wastewater generated would either be collected in an existing sump, in a diked pool, or in a sump in a temporary enclosure. Liquids would be pumped to a tank or container before being treated at the wastewater treatment area of the container management area or at the existing liquid waste treatment system or LLWTF.

Clean or fully decontaminated portions of the process building, including its foundation, would be demolished by conventional methods. Contaminated penetrations and a portion of the wall would be removed by a high-pressure water jet cutter. A water cleanup system would be installed to remove the cutting residue. Rubble (building materials and decontaminated equipment assumed to be uncontaminated industrial waste) generated by demolition would be disposed of off site in a sanitary landfill. The removed belowgrade structures and the in-ground cavity would be backfilled and the area regraded and revegetated with native plants for erosion control.

Vitrification Facility. The vitrification facility is located next to the process building. The major equipment in this building includes the melter, melter feed tankage, a turntable, and the in-cell off-gas treatment equipment that has a submerged bed scrubber, high-efficiency mist eliminators, and prefilters. The vitrification facility will have processed the original inventory in the HLW tanks except some waste that was solidified and stored in the RTS drum cell and the residual sludge in the HLW tanks. The original HLW inventory includes the high-activity plutonium uranium extraction (PUREX) waste sludge, the cesium-loaded zeolite, and thorium extraction (THOREX) wastes. During HLW solidification, these wastes will have been combined with glassmaking additives to produce borosilicate glass canisters. Most of the residual radioactivity is expected to be in the melter and the submerged bed scrubber (WVNS 1994b).

The vitrification facility would be decontaminated, dismantled, and demolished (including removing the foundation) in a manner similar to the process building. Vacuuming and chemical decontamination would be performed, pipes would be drained, and equipment would be removed. The melter superstructure would be decontaminated by chemical wash. The melter would be removed within a localized bubble-type confinement barrier. A crane would place the melter in a shielded box, move it to the staging area, and lift it through the open hatch into the confinement barrier (WVNS 1994b).

Contaminated rubble generated by demolition would be sent to the container management area and then disposed of off site. The removed belowgrade structures and the in-ground cavity would be backfilled and the area regraded and revegetated with native plants for erosion control.

01/14 Building. The 01/14 building houses the cement solidification system and ex-cell vitrification off-gas system. The cement solidification system includes equipment (e.g., tanks, piping, mixers, and container handling equipment) used to mix liquid radioactive waste into a cement matrix. The ex-cell vitrification off-gas system is part of the vitrification melter off-gas treatment system and includes catalytic converters, high-efficiency particulate air filters, and fans. Little contamination is expected to be present in this building.

The 01/14 building would be decontaminated, dismantled, and demolished in ways similar to those for the other buildings. Hazardous materials [e.g., polychlorinated biphenyl (PCB)-contaminated capacitors] would be removed before demolition. Because most of the radioactive contamination is in or on the equipment and not the structure itself (i.e., floors, walls, and ceilings), minimal effort would be required to decontaminate the building walls or structure. The cement solidification system would be flushed to ensure that no hazardous materials remain in the system, and the liquids would be collected in tanks or containers. Then the exteriors of the equipment would be chemically decontaminated, and piping would be checked for liquids. Liquid wastewater would be treated at the wastewater treatment area at the container management area (WVNS 1994c).

Similar to the other buildings, equipment would be removed, valves would be cut from the pipes, and pipes would be cut into pieces and packaged. Conventional means would be used to dismantle and demolish the building. Equipment pieces would be sent to the container management area, and the industrial waste generated by demolition would be disposed of off site in a sanitary landfill. The area would be backfilled, regraded, and revegetated with native plants for erosion control.

02 Building. The 02 building is part of the LLWTF. It houses equipment to treat wastewater from the process building, the liquid waste treatment system, the fuel receiving and storage pool in the process building, and the NDA interceptor trench. The wastewater is processed in the 02 building by flocculation (if needed), clarification, and ion exchange operations to remove radionuclides. The 02 building sections and equipment are assumed to have low levels of radioactive contamination (less than 10 Ci).

The 02 building would be decontaminated, dismantled, and demolished using methods similar to those for the other buildings. Hazardous materials (e.g., PCB-contaminated capacitors) would be removed before demolition. The equipment would be removed, and the interior surfaces of the building would be decontaminated (WVNS 1994d).

The building would be dismantled by draining pipes, removing equipment, cutting valves from piping, and cutting and packaging piping. Conventional methods would be used to demolish the decontaminated 02 building, with contaminated waste sent to the container management area and uncontaminated industrial waste disposed of off site in a sanitary landfill. After demolition, the area would be regraded and revegetated with native plants for erosion control.

3.3.2.1.2 Waste Storage Facilities—Specific Actions

The waste storage facilities include the lag storage building, three lag storage additions (1, 3, and 4), the CPC waste storage area, the RTS drum cell, the IWSF, and a proposed contaminated soil consolidation area.

Lag Storage Building and Lag Storage Additions. The lag storage building is a prefabricated metal building with a concrete floor. Lag storage addition 1 is a metal frame and fabric enclosure that has a base of compacted gravel. Lag storage additions 3 and 4 are preengineered metal frame and fabric structures with concrete floors. Each of these buildings stores radioactive wastes (including metal pipes and hardware, clothing, cloth, paper, wood, soil, and concrete-stabilized wastes) from various site activities and small volumes of known or potential mixed wastes [estimated to be 99 m^3 (3,500 ft^3) at the end of HLW solidification].

All waste (and soil) in storage would be sent to the container management area, where it would be characterized, treated as necessary, and either repackaged or overpacked. Mixed waste containing RCRA hazardous waste component(s) would be treated to meet the appropriate standards for those hazardous waste (see definitions of hazardous and mixed waste in Section 1.3). Mixed wastes that could not be successfully treated in the container management area (see Sections 3.3.2.2 for a discussion of treatment) to achieve the appropriate standards would be treated in off-site facilities and the treated waste returned to the Center as LLW.

After waste removal, the lag storage building, lag storage additions, concrete and gravel bases, associated hardstand, and miscellaneous equipment would be surveyed for hazardous and radiological contamination and decontaminated as necessary. Only minimal and localized decontamination is expected to be required (WVNS 1994e). The structures would then be dismantled and demolished by conventional methods. All waste generated would be disposed of off site; industrial waste would be sent to a sanitary landfill. The excavated areas would be backfilled, regraded, and revegetated with native plants for erosion control.

Chemical Process Cell Waste Storage Area. The CPC waste storage area is a metal and fabric tent structure, resting on a compacted gravel pad with a tar and chip surface. It is used to store LLW (e.g., vessels, pipes, and other materials) and small volumes of mixed waste [less than 1.2 m^3 (44 ft^3)] generated when equipment was removed from the CPC.

The CPC waste storage area would be managed in the same way as the lag storage building and lag storage additions. Wastes would be removed (containers with higher activity would be removed remotely) and sent to the container management area; the small volumes of mixed waste would also be sent to the container management area. The structure would be decontaminated as necessary, dismantled, demolished, and the area would be backfilled, regraded, and revegetated with native plants. Only minimal and localized decontamination is expected to be required. All waste generated would be disposed of off site; industrial waste would be sent to a sanitary landfill (WVNS 1994f).

Radwaste Treatment System Drum Cell. The RTS drum cell is used for curing and storing cement-solidified waste produced by the cement solidification system. It consists of a base pad, concrete shield walls, and temporary weather structure (a metal building). The drums of waste would be removed from the RTS drum cell remotely using the existing crane. The drums would be inspected, wiped down, and overpacked as necessary for transporting off site. The wastes would then be sent to the container management area. The structure would be surveyed and decontaminated as necessary.

For dismantlement, the waste handling equipment (e.g., crane) would be removed followed by the interior walls. The temporary weather structure would be removed last so it could offer weather protection and confinement during dismantlement. Finally, the gravel base pad and concrete footings would be removed, and the area would be backfilled, regraded, and revegetated with native plants for erosion control (WVNS 1994g).

Interim Waste Storage Facility. The IWSF is a metal building with a concrete floor. The building currently is used for temporary storage of both known and potential radioactive, hazardous, and mixed wastes.

The containers of waste would be removed from the IWSF; sent to the container management area for characterization, treatment, and packaging; and then disposed of off site. The IWSF would be demolished, and the industrial waste generated would be disposed of off site in a sanitary landfill (WVNS 1994h).

Proposed Contaminated Soil Consolidation Area. The proposed contaminated soil consolidation area would consist of a lined pad with a leachate collection system. Radioactively contaminated soil would be stored on the pad and covered with a tarp [DOE (in preparation)]. The liner was assumed to have residual contamination.

The stored soil would be removed and sent to the soil treatment area at the container management area for characterization and treatment as described in subsection 3.3.2.2. After treatment it would either be returned to the site as clean fill or disposed of off site. The lined pad and associated materials would be removed, sent to the container management area, and disposed of off site.

3.3.2.1.3 Disposal Areas—Specific Actions

The disposal areas, the CDDL, SDA, and NDA contain three kinds of waste: buried waste, soil intermixed with the waste, and leachate from the waste. Contaminated soil and groundwater outside the disposal area (i.e., beyond the waste/soil interfaces) are addressed in Section 3.3.2.1.6.

Construction and Demolition Debris Landfill. The CDDL covers about 0.6 ha (1.5 acres), averages between 3 to 4.6 m (10 to 15 ft) in depth, and is excavated into the sand and gravel layer on the north plateau. The CDDL was used for disposal of nonradioactive solid waste (including office, machine shop, janitorial, and construction and demolition waste) and incinerator ash. A radioactively contaminated groundwater plume on the north plateau originating near the process building has migrated to the CDDL area. Groundwater monitoring wells in the area indicate that the southwestern portion of the CDDL has become radioactively contaminated from contact with this groundwater (see characterization of the groundwater plume in Section C.3.2 of Appendix C). For purposes of analysis, it was assumed that both the buried waste and the soil intermixed with the buried waste in the CDDL, will be radioactively contaminated because of infiltration of radiologically contaminated groundwater.

Under Alternative I, the waste and soil in the CDDL would be excavated, and the excavated material would be sent to the container management area. There could be localized areas in the CDDL containing hazardous waste because paint cans and batteries were buried there. Waste would be characterized and treated, and soil would be monitored and treated as necessary in the container management area as described in Section 3.3.2.2. Contaminated waste and soil would be disposed of off site. The excavated area would be backfilled with clean fill, graded to the surrounding contours, and revegetated with native plants for erosion control (WVNS 1994i).

State-Licensed Disposal Area. The SDA covers approximately 6 ha (15 acres) and is principally comprised of 14 trenches containing buried LLW. The LLW originated from the process building and from off-site hospitals, laboratories, industrial facilities, and nuclear facilities. Wastes were containerized in drums and boxes made of cardboard, wood, steel, or concrete. It is estimated that approximately one-half of the buried waste could be mixed waste, i.e., contaminated with hazardous constituents above the RCRA Toxicity Characteristic Leaching Procedure (TCLP) concentrations (see Section C.2.8.1 of Appendix C for discussion of estimation methods). In addition, the soil intermixed with the buried wastes and the leachate from the wastes would be radioactively contaminated, and one-half of the soil and leachate is also estimated to be contaminated with hazardous constituents above the RCRA TCLP concentrations.

The SDA would be divided into four areas to implement Alternative I: the north SDA (trenches 1-5), the south SDA (trenches 8-14), a disposal hole trench (trench 6), a shallow trench containing wastes placed on a concrete pad and encased in concrete (trench 7), and the filled lagoons and leachate treatment area (see Figure C-10 in Appendix C for the trench layout). Conceptually, the 12 main SDA disposal trenches (not including trenches 6 and 7) would be exhumed in the following order: trench 14, trench 13, trench 12, trenches 11 and 5, trenches 10 and 4, trenches 9 and 3, and trenches 8, 1, and 2. Trench 14 would be exhumed first so that it could be used to intercept groundwater flowing toward the other trenches (WVNS 1994j).

Each SDA disposal trench would be dewatered and then the cap and top layer of low radioactivity soil would be removed by conventional earth-moving equipment. The excavation would continue to a depth [between 0.9 and 3.0 m (3 and 10 ft)] where minimum shielding is required to protect the workers. When the cap excavation reaches a depth where additional shielding would be required, the exhumation operation would change from using conventional equipment to using remote-controlled operation. A rail system would be laid down along each side of the trench for the mobile remote exhumation unit to ride on, straddling the trench (see Figure 3-3). A confinement structure would be erected to keep rainwater and snow out of the exhumed portion of the trench. Uncontaminated soil would be stored close to the trenches to use for backfilling exhumed trenches.

To create a controlled environment for excavation activities and to minimize the release of airborne radioactivity, a mobile remote exhumation unit enclosed in a confinement structure (see Figure 3-3) would be used to exhume waste and soil from the disposal trenches. Air flow would be controlled by an engineered ventilation system that would draw

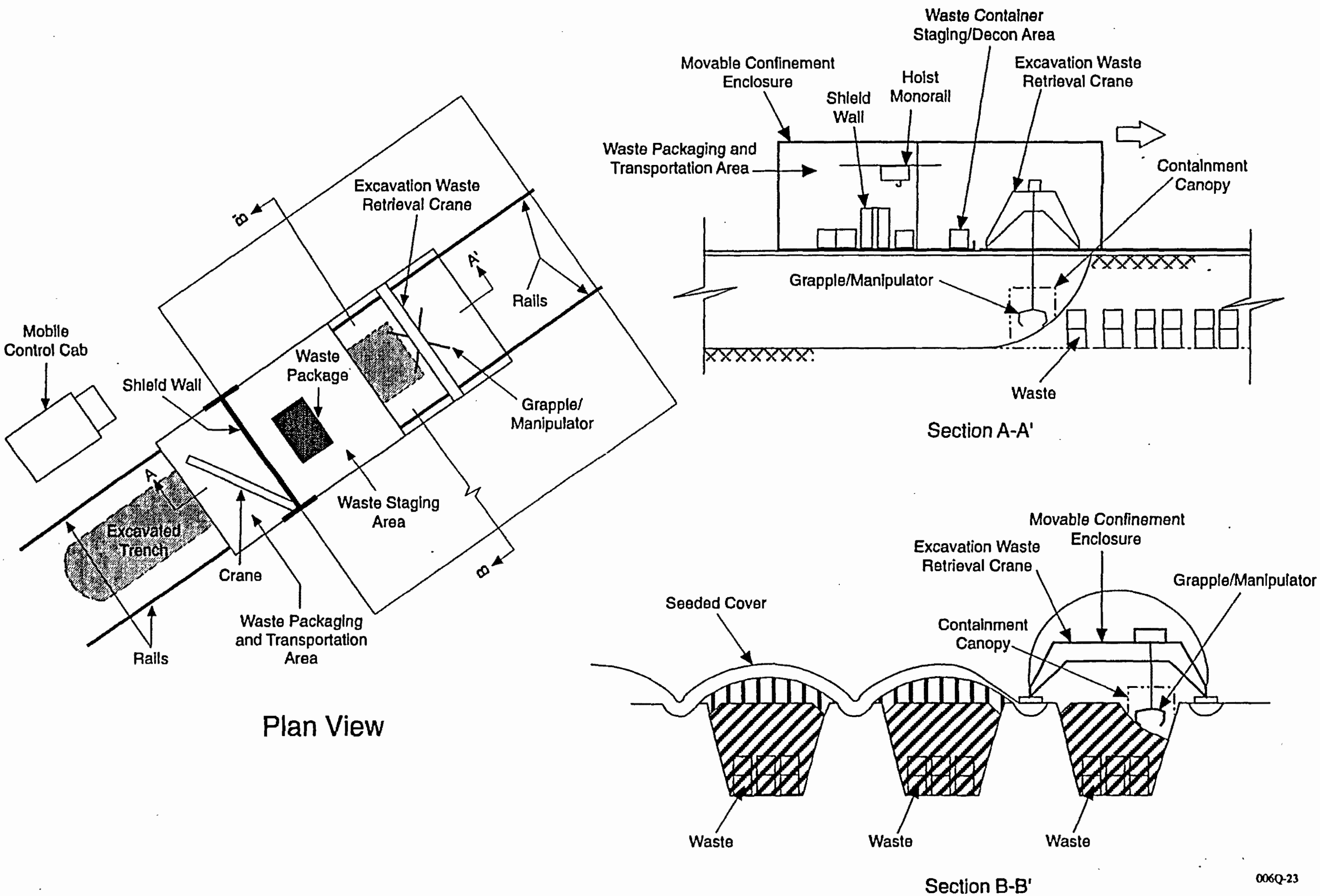


Figure 3-3. Conceptual Design for the Mobile Remote Exhumation Unit for Exhuming Waste from the State-Licensed Disposal Area under Alternative I (modified from WVNS 1994j).

air into the work areas and exhaust it through high-efficiency particulate air filters to control the release of contamination. The mobile remote exhumation unit would have a grapple or manipulator for retrieving waste and soil, and a variety of tools and attachments would be used to handle the different waste forms and packages that could be encountered. The unit would also have facilities for monitoring, packaging, and transportation. The manipulator, attached to a gantry-type crane, would retrieve the waste, and a hoist monorail would move it from the staging and decontamination area to the packaging and transportation area. Exhumation and retrieval operations would be remotely controlled from a mobile control cab using closed circuit television monitors (WVNS 1994j).

Each disposal trench would be dewatered as necessary before and during exhumation, and the collected leachate would be treated at the wastewater treatment area (see Section 3.3.2.2). The mobile remote exhumation unit would excavate contaminated soil and waste packages from the trench. As soil and waste were exhumed, the excavated portion of a trench would be surveyed and backfilled to keep out rainwater and prevent the sides of the trenches from collapsing. Uncontaminated soil excavated from the adjacent trench would be used as backfill for the excavated trench. After one trench had been excavated, the exhumation unit would be pulled to the head of another trench, and the process would be repeated until the 12 main trenches were exhumed. The mobile remote exhumation unit would then be decontaminated and disposed of after trench excavation was completed. The backfill soil could either be treated soil or it could come from off-site borrow pits.

The portions of the SDA that could not use the mobile device (i.e., trenches 6 and 7 and the three filled lagoons) would be excavated by a remote controlled exhumation machine under a dome-shaped, air-supported confinement structure. The portable confinement structure would contain components similar to the mobile remote exhumation unit. Waste packages from disposal holes in trench 6 would be retrieved one location at a time. A crane would be used for excavating soil, picking up waste packages, and loading them onto a truck. For the waste encased in concrete in trench 7, the concrete would be broken into large pieces and transported to the container management area. There, the concrete would be broken into smaller pieces and the waste would be extracted from the concrete. After retrieving the waste, the interior of the disposal holes in trench 6 and excavated area in trench 7 would be surveyed for radioactive contamination, and additional contaminated soil would be scraped off and removed.

The confinement enclosure would be decontaminated, disassembled, and reassembled at one of the filled lagoons after exhumation of trenches 6 and 7. Contaminated waste would be sent to the container management area and industrial waste would be disposed of off site. Finally, the SDA would be backfilled, graded, and revegetated with native plants for erosion control.

Nuclear Regulatory Commission-Licensed Disposal Area. The NDA covers approximately 2 ha (5 acres) and consists of two disposal areas. NFS disposed leached fuel hulls, fuel assembly hardware, spent fuel assemblies, filter media, spent solvents sorbed onto solid wastes, discarded vessels, piping, and other refuse generated by the nuclear fuel reprocessing operations in a U-shaped area at the NDA as shown in Figure 3-4 and in greater

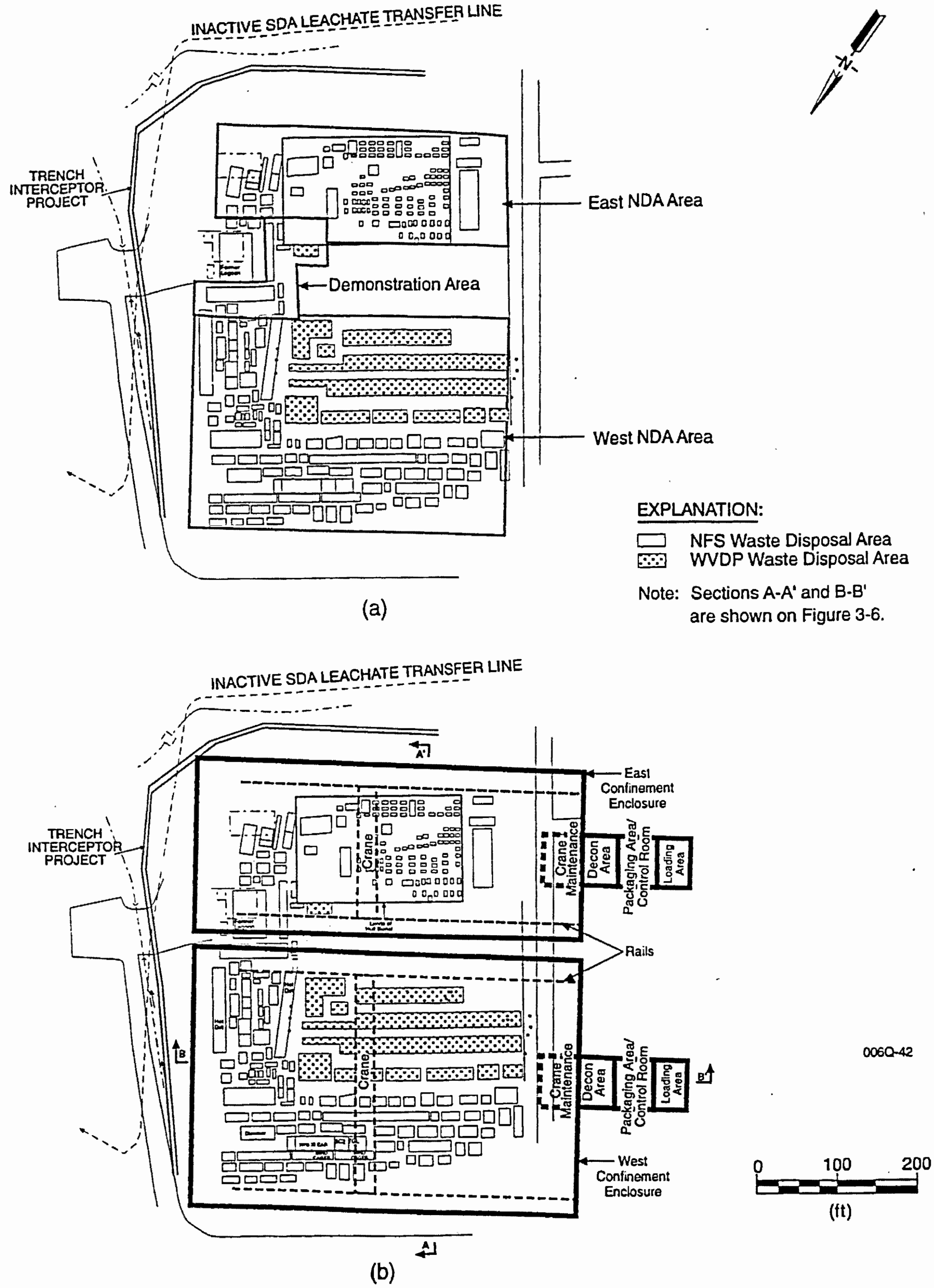


Figure 3-4. Conceptual Design for Remote Exhumation of the Nuclear Regulatory Commission-Licensed Disposal Area under Alternative I (a) Three Areas of the Nuclear Regulatory Commission-Licensed Disposal Area, and (b) East and West Confinement Enclosures (modified from WVNS 1994h).

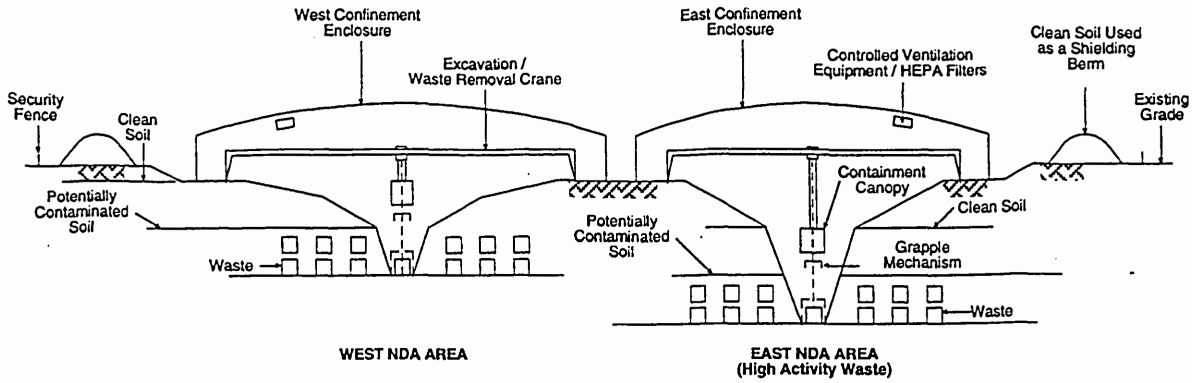
detail in Figure C-9 in Appendix C. The WVDP disposed of miscellaneous waste (including general plant waste, debris, sludges and resins, filters, soils, lead, and analytical wastes) in the parcel of land within the U-shaped area used by NFS. The buried wastes, intermixed soil, and the leachate from the wastes are assumed to be radioactively contaminated. A small percentage (less than 1 percent) of these wastestreams may be contaminated with hazardous constituents as well.

Buried waste and contaminated soil in the NDA disposal areas would be exhumed and sent to the container management area for characterization, treatment, and packaging. The NDA would be divided into three areas for exhumation: the east NDA, the west NDA, and a demonstration area between the two areas (see Figure 3-4). The demonstration area would be exhumed first to validate the design and effectiveness of the excavation and waste removal equipment, to identify modifications to the exhumation process, and to improve efficiency and reliability. A sprung structure (a large tent-like structure made of metal and fabric) would be erected over the demonstration area for radiological confinement, and the area would then be exhumed. The exhumed waste and soil would be sent to the container management area (WVNS 1994h). The sprung structure would be chemically decontaminated, dismantled, and disposed of off site as industrial waste.

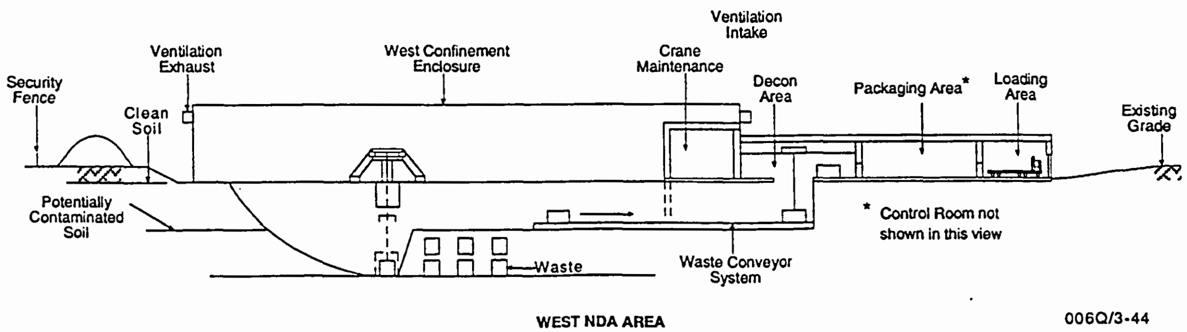
The existing cap and top layer of soil overlying the NDA would be removed by conventional earthmoving equipment in the east and west areas. Uncontaminated soil excavated from the disposal areas would be stored as a berm around the perimeter of the NDA for localized shielding. A sprung structure would be erected over each of the two caisson areas (see Figure C-9 in Appendix C) for radiological confinement during exhumation activities. The four caissons are 18 m (60 ft) deep, 2.1 m (7 ft) diameter, cylindrical steel-lined concrete vaults. Because the caissons contain recently (1982 to 1986) placed waste from WVDP and because all waste in the caissons is in drums, the caissons are not likely to be contaminated. Thus, the waste drums in the caissons would be removed and transferred to the container management area. The caissons would be left in place and backfilled, and the concrete caps would be replaced.

Support structures for the east and west confinement enclosures would house the control room; heating, ventilation, and air conditioning equipment, container decontamination area; and waste loadout area. As shown in Figure 3-5, the enclosures would have an excavation or removal crane, grappling mechanism, and waste conveyance equipment. Like the SDA exhumation equipment, the crane would run on rails inside of the confinement enclosures. The exhumation activities would be remotely controlled and monitored by closed circuit television because of the direct radiation from the buried waste.

Exhumation would begin at the southwest corner of the confinement enclosures to intercept groundwater inleakage in the exhumed area. The excavation system would remove soil from the top of the waste packages while the grappling mechanism would retrieve the waste packages and intermixed soil and place them into a container. After waste removal, the area would be surveyed for contamination. Contaminated soil above the assumed



Section A-A'



Section B-B'

Note: Plan View shown on Figure 3-4.

Figure 3-5. Sections through Nuclear Regulatory Commission-Licensed Disposal Area Showing the Conceptual Design for Confinement Enclosures Including Exhumation Equipment (modified from WVNS 1994h).

contaminant cleanup levels would be removed and sent to the container management area. Leachate would be sent to the wastewater treatment area for treatment. The excavation and waste removal crane would be moved to the next location and the retrieval process repeated.

After exhumation is completed, the excavation and retrieval equipment, the confinement enclosures, and the support structures would be decontaminated, dismantled, and demolished, and the resulting waste would be transported to the container management area. The NDA would then be backfilled, graded, and revegetated with native plants for erosion control.

3.3.2.1.4 In-Ground Structures

The in-ground structures include the HLW storage tanks and vaults, SDA filled lagoons, LLWTF lagoons, old and new interceptors, neutralization pit, NDA trench interceptor project, maintenance shop sanitary waste leach field, solvent dike, effluent equalization mixing basin, and two sludge ponds. Other in-ground structures with no or small amounts of contamination are discussed with the other remaining facilities in Section 3.3.2.1.3.

High-Level Waste Storage Tanks and Vaults. There are four underground HLW storage tanks: tanks 8D-1, 8D-2, 8D-3, and 8D-4. Tanks 8D-1 and 8D-2 are 2,840,000-L (750,000-gal) tanks, each having an internal gridwork of I-beams and support plates on the tank bottom. Tank 8D-2 was used to store HLW generated by PUREX operations. Most of the fission products (except for cesium) have been precipitated into a sludge at the bottom of this tank. The cesium was captured on zeolite ion-exchange columns during supernatant treatment system processing. Tank 8D-1 houses the supernatant treatment system ion exchange columns and was contaminated by condensate from tank 8D-2. Each tank is located in its own concrete vault.

Tanks 8D-3 and 8D-4 are both 51,100-L (13,500-gal) tanks and are collocated in one concrete vault. Tank 8D-4 was used to store THOREX waste (resulting from reprocessing thorium-uranium fuel) and as a storage tank for the vitrification waste header system. Tank 8D-4 also held radiochemistry laboratory liquids that exceeded radioactivity limits for transfer to lagoon 2 and condensate from the PUREX tank off-gas system (WVNS 1992). Tank 8D-3 was used to store decontaminated supernatant and sludge wash water before routing it to the liquid waste treatment system. Tanks 8D-2 and 8D-4 are assumed to have residual sludge with significant contamination (approximately 200,000 Ci of strontium-90 and 200,000 Ci of cesium-137 in tank 8D-2 and 1,000 Ci of cesium-137 in tank 8D-4) and are assumed to be mixed waste. Tank 8D-1 is assumed to have a residual sludge with significant contamination (approximately 200,000 Ci of cesium-137), and residuals in tank 8D-3 are expected to have very little contamination (less than 1 Ci).

A containment building would be constructed over tanks 8D-1 and 8D-2 for decontamination. The building would be equipped with overhead cranes for manipulating decontamination equipment, hoisting equipment and waste from the tanks, and loading the containerized waste. Soil above the tanks would be excavated to gain access to them (WVNS 1994b).

A liquid lance and vacuum-extraction system would be used to remove the sludge from the tank bottoms by hydraulically piercing and loosening residual radioactive material and sucking the loosened debris into a vacuum exhaust system. A robotic arm in the tank would move the hydrolance and suction equipment to the desired locations. Extracted fluid would be pumped through a filter to remove entrained particulate matter, and the filtered fluid would be recycled to the water surge tank. The filter would be backwashed as necessary, and the resulting sludge would be solidified and containerized for off-site disposal. The water would be recycled or sent to the wastewater treatment area.

Figure 3-6 is a cross-section of a HLW tank (tank 8D-1 or 8D-2). The remotely-controlled lance/vacuum extraction system would be used to clean the open areas free of the steel support structures, the I-beams, and support plates on the tank bottoms. Sufficient penetrations would be made to cover the entire inside of the tank. Waste material would be retrieved with a removal bucket at the center of the tank (WVNS 1994b).

An external support structure for the tank roofs would be installed for dismantling the HLW tanks. It would consist of a system of hangers installed like expansion, or toggle, bolts. Each bolt assembly would be pushed through a hole drilled or cored in the concrete vault roof and the tank roof. Tightening action would expand or open the end of the assembly, which would engage the interior of the tank roof.

Conceptually, dismantling tank 8D-2 would begin by mechanically removing the bottom support structure of steel I-beams and plates. Pins would be snipped, and the joints between I-beams and the support plates would be cut. The resulting waste would be retrieved by the removal bucket, and the interior tank surfaces would be washed and vacuumed. Finally, the tank walls and bottom would be cut into pieces and removed.

Tank 8D-1 would be decontaminated and dismantled in the same way as tank 8D-2, including spraying with high-pressure water and removing the supernatant treatment system equipment (ion exchangers, filters, pumps, and associated piping).

After tanks 8D-1 and 8D-2 were removed, the abovegrade containment building would be dismantled and demolished; the rubble would either be sent to the container management area or, if uncontaminated (i.e., industrial waste), directly off site. The concrete tank vaults would be decontaminated as necessary and demolished by conventional techniques. The rubble would either be sent to the container management area or, if uncontaminated, directly off site, and the cavity would be backfilled.

The Con-Ed building would be removed to access tanks 8D-3 and 8D-4. These tank interiors would be flushed to remove contamination with the same lance/vacuum-extraction system used for tanks 8D-1 and 8D-2. The anchor bolts attaching each tank to its foundation would be cut, the tanks would be removed by crane from the vault and transported to the container management area. Because tank 8D-4 has significantly higher contamination, it

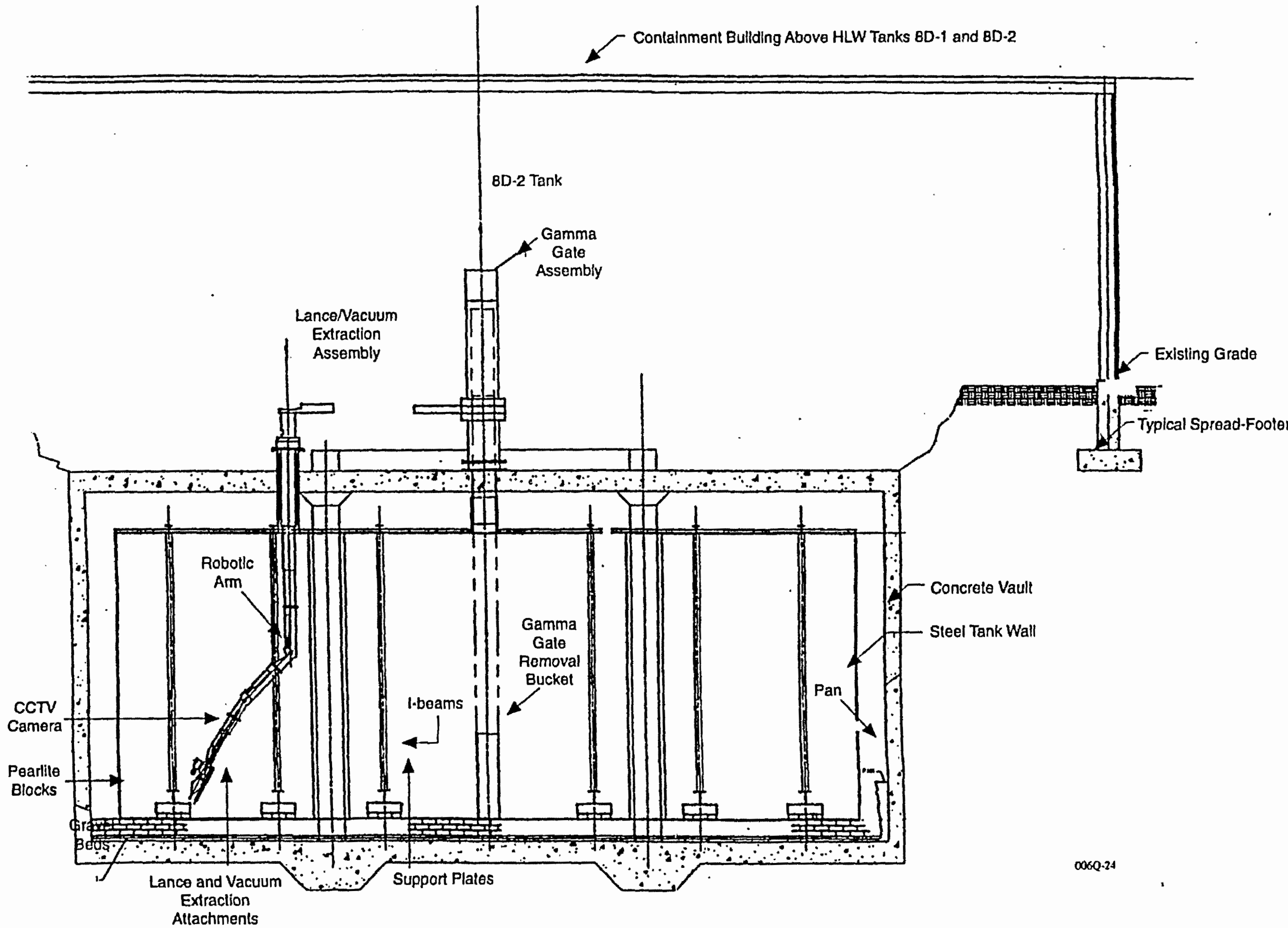


Figure 3-6. Cross-Section of High-Level Waste Tank Showing Conceptual Design for Lance/Vacuum Extraction Removal System under Alternative I (modified from WVNS 1994b).

would be placed into a shielded container for transport to the container management area (WVNS 1994b).

After removal of tanks 8D-3 and 8D-4, the concrete vault would be decontaminated as necessary and demolished using conventional techniques. The rubble would be sent to the container management area or, if uncontaminated, directly off site. The cavity would be backfilled and the area regraded and revegetated with native plants for erosion control.

State-Licensed Disposal Area Filled Lagoons. The SDA northern, southern, and inactive filled lagoons stored leachate pumped out of the SDA trenches. Low levels of radioactive (approximately 25,000 pCi/g) and hazardous contamination (up to 3,050 mg/kg barium) have been detected in the lagoon sediments.

The lagoons would be exhumed with the same procedure described for SDA trenches 6 and 7 in Section 3.3.2.1.3. The equipment and confinement structure would be decontaminated, disassembled, and reassembled at the northern filled lagoon, and the lagoon would be exhumed. The procedure would be repeated for the southern and inactive filled lagoons—decontamination, disassembly, reassembly of the confinement enclosure over each lagoon, and exhumation of the lagoon. Exhumed soil would be packaged and sent to the soil treatment area (WVNS 1994j). Finally, the confinement structure and equipment would be decontaminated in place, disassembled, and sent to the container management area. Soil would be used to backfill the lagoons.

Low-Level Waste Treatment Facility Lagoons 1, 2, 3, 4, and 5. Lagoon 1 is a deactivated lagoon filled with radioactively contaminated soil. Lagoon 2 is an unlined lagoon that stores wastewater before it is treated in the LLWTF. Lagoon 3 is a clay-lined lagoon that stores treated wastewater before discharge. Lagoons 4 and 5 are rubber-lined lagoons that hold wastewater after it is treated in the LLWTF. Except for lagoon 1, which has higher levels of contamination (up to 700 Ci) in the sediment, the lagoons are expected to have low levels (less than 10 Ci) of radioactively contaminated sediment.

Under Alternative I, the contents of the LLWTF lagoons would be exhumed. Sprung structures would be erected over lagoons 1 and 2 for radiological confinement during exhumation. Lagoon sediments would be removed by scraping or pumping and treated at the soil treatment area. The liners in lagoons 3, 4, and 5 would be removed, followed by sediment removal. The sprung structures would be dismantled and disposed of off site as industrial waste (WVNS 1994d). Excavated areas would be backfilled with clean fill or soil, compacted, regraded, and revegetated with native plants for erosion control.

Interceptors and Neutralization Pit. The old interceptor is an in-ground concrete storage tank that collected wastewater from throughout the Project Premises area. The new interceptors are two in-ground steel-lined concrete storage tanks for transferring wastewater into the LLWTF. The neutralization pit is a steel-lined concrete tank for neutralizing wastewater from the process building. The new interceptors and neutralization pit have low levels of radioactive contamination, (approximately 0.01 Ci of predominantly cesium-137 and strontium-90). The old interceptor has higher levels of contamination but exact amounts are not available.

The interior surfaces of all of the interceptors and neutralization pit would be chemically decontaminated. The structures would then be dismantled and excavated by conventional means. A sprung structure erected over the old interceptor would provide radiological confinement. The structure would subsequently be dismantled and disposed of off site as industrial waste. The contaminated steel liners in the new interceptors and neutralization pit would be removed by cutting them into plates and prying them from the floors and walls. The excavated areas would be backfilled, and the area would be regraded and revegetated with native plants for erosion control. The contaminated waste generated would be sent to the container management area and disposed of off site (WVNS 1994i).

Nuclear Regulatory Commission-Licensed Disposal Area Trench Interceptor Project. The NDA trench interceptor project consists of a trench to intercept groundwater or leachate that may be moving away from the NDA and a liquid pretreatment system (includes six tanks for filtration and storage) for treating collected groundwater or leachate. Several of the tanks are covered by a Quonset-style building. No hazardous or radiological contamination has been detected in the trench, and the liquid pretreatment system has never been used.

After the buried waste has been exhumed from the NDA, the liquid pretreatment system would be demolished and the industrial waste disposed of off site (WVNS 1994h). The surface soil in the trench would be surveyed and, if contaminated, would be scraped off and sent to the container management area. The trench would be backfilled, and the area would be regraded and revegetated with native plants for erosion control.

Maintenance Shop Sanitary Waste Leach Field. The septic system formerly used to service the maintenance shop and the test and storage building consists of three septic tanks, a distribution box, and lateral drain tile-pipes that discharge to a 140-m^2 (1,500-ft^2) leach field. The septic tank sludges contain hazardous constituents (including mercury, toluene, and cresol below RCRA action levels).

Under Alternative I, the septic tanks, distribution box, and lateral drains would be removed. The soil beneath the maintenance shop and the test and storage building would be excavated and sent to the container management area for characterization and treatment if necessary. Industrial waste generated would be disposed of off site in a sanitary landfill. The excavated areas would be backfilled, regraded, and revegetated with native plants for erosion control (WVNS 1994i).

Solvent Dike, Effluent Equalization Mixing Basin, and North and South Sludge Ponds. The solvent dike is an unlined seepage basin that received contaminated rainwater runoff from the plant solvent storage terrace. It has low levels of radiological contamination (up to 200 pCi/g of cesium-137), and no hazardous contamination is present. The effluent equalization mixing basin is a surface impoundment constructed with a membrane liner and underdrain system that was used as a settling pond for nonradioactive liquid effluents from the utility room (e.g., clarifier blowdown, clarifier and filter backwash, softener regeneration waste, and boiler blowdown). The basin is not contaminated. The north and south sludge ponds are unlined basins that received liquid effluents from the sanitary sewage treatment plant on the Project Premises and some effluents from the utility room. The sludge ponds have sediments that contain radioactive contaminants (cesium-137).

Under Alternative I, the solvent dike and surrounding soils and the sludge ponds and sediments would be excavated and sent to the container management area. The sanitary effluent in the effluent equalization mixing basin would be pumped out and treated by the existing sewage treatment plant. The membrane liner and underdrain system would be excavated, and the industrial waste would be disposed of off site. The excavated areas would be backfilled with clean fill, regraded, and revegetated with native plants for erosion control (WVNS 1994i).

3.3.2.1.5 Remaining Facilities

Table 3-2 lists the remaining facilities, which are primarily located in WMAs 10, 11, and 12. Most of the facilities are small buildings and office trailers. Other miscellaneous

Table 3-2. Remaining Facilities

Buildings/Trailers	In-Ground Structures	Other/Miscellaneous
1. Plant Office Building	1. Rail Spur	1. Waste Paper Incinerator
2. Cold Chemical Building	2. Foundation of Dismantled Lag Storage Addition 2	2. Meteorological Towers
3. Con-Ed Building	3. Parking Lots	3. Electrical Switching Station
4. Ship-Out Building	4. NDA Driveway	4. Barbed Wire Fencing
5. Supernatant Treatment System Support Building	5. NDA Former Lagoon	5. Electrical Substation
6. Equipment Shelter	6. Scrap Material Landfill	6. Steel Fence
7. Permanent Ventilation System Building	7. Roadways	7. Utility Poles
8. Bulk Storage Warehouse	8. Hydrofracture Test Well Area	8. Aboveground and Underground Storage Tanks
9. Administration Building/Annex Trailers Complex	9. SDA Slurry Wall	9. Electrical Transformers
10. Security Gate Houses	10. Water Supply System (including dams and reservoirs)	10. Cooling Tower
11. Expanded Lab	11. Groundwater Monitoring Wells	11. Live Firearms Range
12. OB-1 Office Building	12. Borrow (Clay) Pit	12. Environmental Sampling Stations
13. Schoolhouse	13. Gravel Pit Quarries	13. Hazardous Waste Storage Lockers
14. Hazardous Waste Satellite Accumulation Areas	14. Hardstand and Pumphouse	14. RTS Drum Cell Monitoring Station
15. Cargo Unit Trailer Body	15. Road Salt and Sand	
16. Trailer City Trailers	16. Additional Gravel Pit	
17. "Z" Series Trailers		
18. New Warehouse		
19. Old Warehouse		
20. Test and Storage Building		
21. Sewage Treatment Plant		
22. Maintenance Shop		
23. Fire Pump House		
24. Laundry Room		
25. Utility Room		
26. Barn		
27. Cargo Unit Trailer Bodies		

facilities include in-ground or aboveground structures and equipment. Only a few of these areas have contamination at them. Under Alternative I, the remaining facilities would be decontaminated as necessary, dismantled, and completely removed.

Buildings would be decontaminated as needed and demolished; the industrial waste generated would be disposed of off site. Contaminated waste and rubble generated would be volume reduced and packaged at the container management area before being disposed of off site, and the areas would be backfilled, regraded, and revegetated with native plants for erosion control. PCB-contaminated fluorescent light fixtures or transformers in the buildings would be removed and disposed of off site in accordance with applicable regulations. The hot side of the laundry room next to the process building has radioactive contamination. Decontamination of this portion of the room would include scabbling a 1.3-cm (0.5-in.) layer off the concrete floor and spraying the walls and floor. The scabbled material would contain lead-based paint and would be tested to determine if it was mixed waste (WVNS 1994k).

Storage tanks (e.g., the process tanks for the sewage treatment plant, water supply system tanks, and the various storage tanks holding fuel oil, diesel fuel, and gasoline) would be removed, cleaned out, decontaminated as necessary, and the uncontaminated material would be disposed of off site as industrial waste. The liquid rinsate would be collected and characterized before disposal. The water supply system would be dismantled by removing the earthen dams, restoring stream channels, and allowing the water to drain out of the two reservoirs. The buried waste in the scrap material landfill would be excavated, and the industrial waste generated would be disposed of off site. All of the other aboveground structures would be removed and disposed of off site. Uncontaminated areas (such as the hydrofracture test well area, the groundwater monitoring wells, the abandoned borrow pit, water wells, and the gravel pit quarries) would be closed in place. Excavated areas would be backfilled, regraded, and revegetated with native plants for erosion control (WVNS 1994k).

3.3.2.1.6 Contaminated Soil and Groundwater

Areas of contaminated soil and contaminated stream sediments would be excavated by conventional methods, sent to the soil treatment area for characterization and treatment, and either returned to the site as clean fill or disposed of off site. Excavated soil would include soil beneath or around buildings; soil beneath or around in-ground structures; soil beneath or around disposal areas; soil in the cesium prong on the Project Premises and the balance of the site (WMAs 3, 4, 5, and 12), soil contaminated by the groundwater plume in the north plateau (WMAs 1, 2, and 4); and contaminated soil at the remaining minor facilities. (For descriptions of areas of radiologically and chemically contaminated soil and groundwater and maps showing their locations, refer to Section C.3 of Appendix C). Excavating soil to the depth of contamination could require excavating soil from above and below the water table. The excavated areas would be backfilled, compacted, and revegetated with native plants for erosion control.

Excavated stream sediments would include areas along Franks Creek and Erdman Brook (refer to Section C.3.4.2 of Appendix C). Excavation would be performed during seasons when the flow in the streams is low or nearly absent and the ground is relatively firm and dry. Small, conventional truck-mounted vehicles (e.g., a backhoe) would be used to excavate the sediments. Because of the steepness of the creek valleys, the vehicles would have to enter the creeks at their headwaters where the slopes are gradual. A crane might be needed to raise boxes of contaminated soil from the stream beds to the top of the stream valley walls.

By removing structures, facilities, and waste and excavating contaminated soil, the source of groundwater contamination would be removed, which would prevent additional contamination from entering the environment. The contaminated groundwater in the south plateau (at the NDA and SDA) would be removed by excavating and dewatering contaminated soil. In the case of the contaminated groundwater plume in the sand and gravel layer on the north plateau, mitigative measures implemented before closure will prevent growth of the contaminated area.

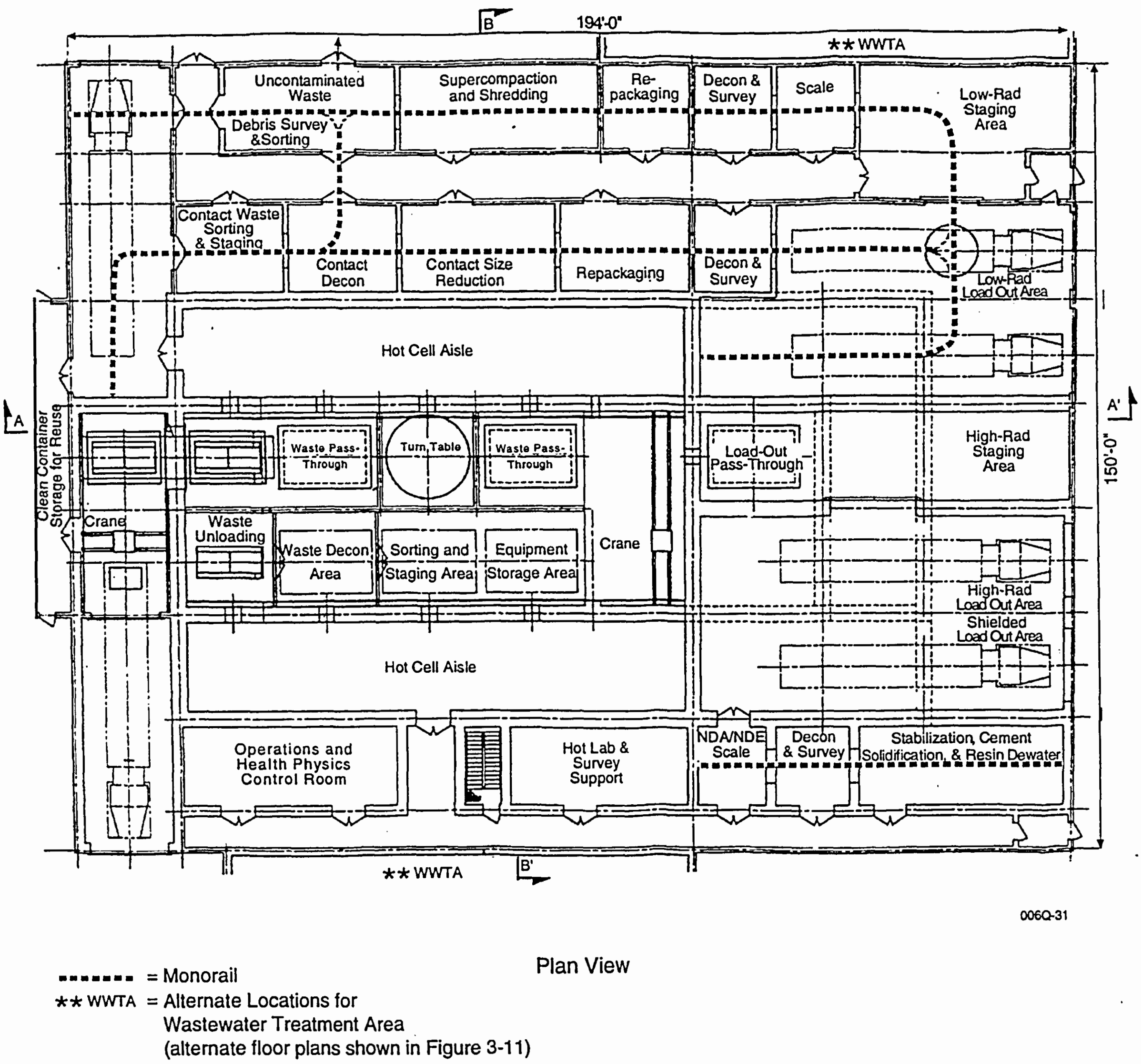
The locations and volumes of contaminated soil, groundwater, and leachate are discussed in Appendix C.

3.3.2.2 New Facilities Required

Under Alternative I, new facilities would be required for volume reduction, characterization, treatment, and repackaging of the various waste forms either currently stored or generated during closure. A container management area would be constructed for reducing the volume, treating, and packaging radioactive and mixed wastes and soils. It would be designed to reduce waste volumes to 33 percent and radioactively-contaminated soil volumes to 25 percent of their original volume (more than three-fourths, or 80 percent, of the soil treated at the container management area would be used as fill at the site) (WVNS 1994l).

The container management area would consist of three contiguous waste handling areas: a volume reduction area, a soil treatment area, and a wastewater treatment area. The volume reduction area, including a washing system for contaminated debris, would be located in one building at the container management area. The wastewater treatment area would be located in a separate area attached to the volume reduction area. The soil treatment area would be housed in a separate building to receive, treat, and package contaminated soil. Each of the three areas would have a ventilation system that exhausts through high-efficiency particulate air filters, with air flow from areas of lower contamination to those of higher contamination.

Volume Reduction Area. The volume reduction area has been conceptualized as an abovegrade and belowgrade, reinforced concrete structure measuring 46 x 61 m (150 x 200 ft) (see Figures 3-7, 3-8, and 3-9) (WVNS 1994m). It would be divided into two sections: one for remote-handled waste and one for contact-handled waste. The belowgrade area would consist of remote-handled operations, equipment and container storage, and two hold-up tanks for spent decontamination water. Auxiliary rooms on the ground floor would have space for operations, health physics, a hot lab, and survey support.



Note: Sections A-A' and B-B' shown on Figure 3-9.

Figure 3-7. Conceptual Design for Volume Reduction Area, Ground Floor (modified from WVNS 1994m).

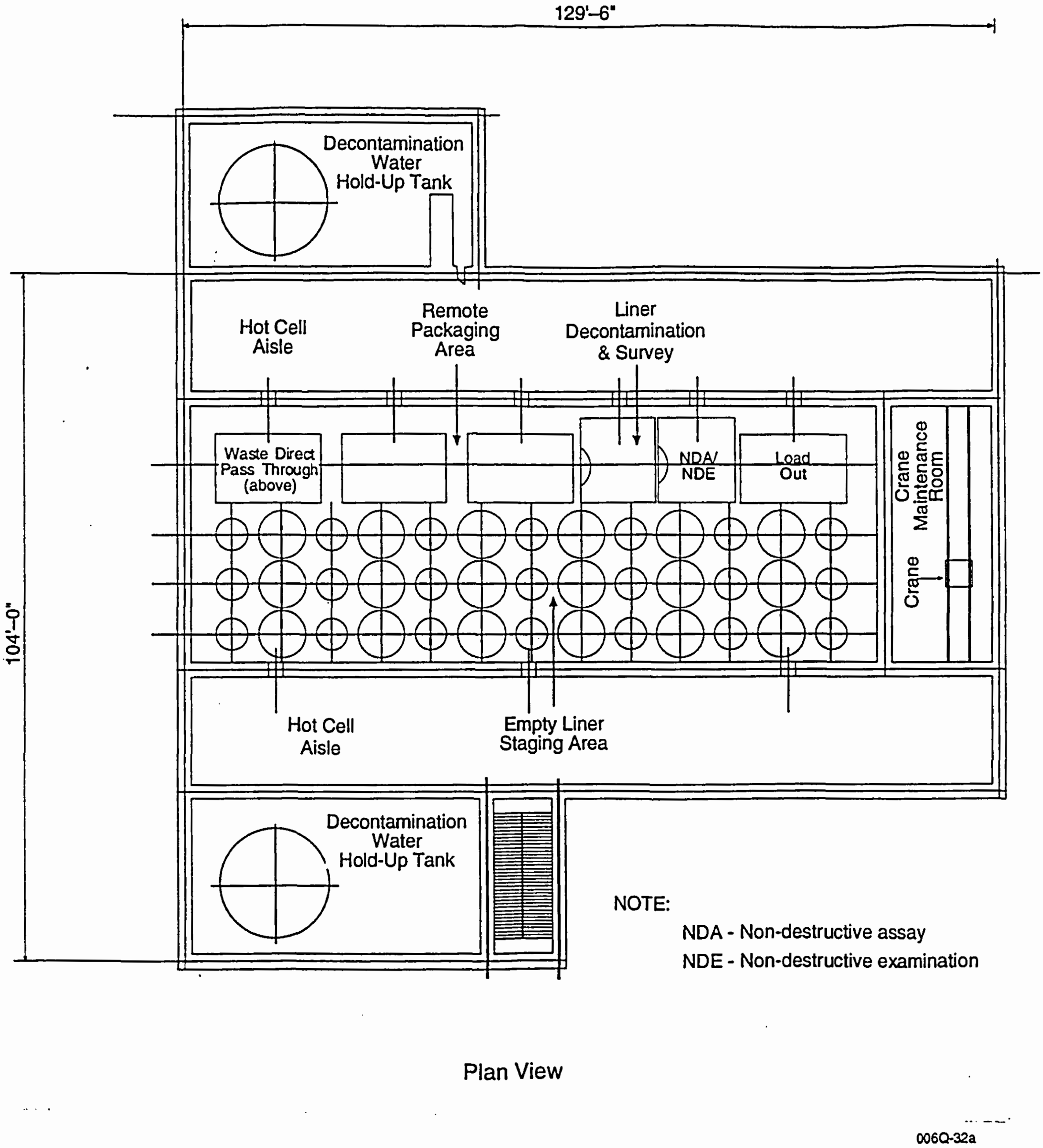
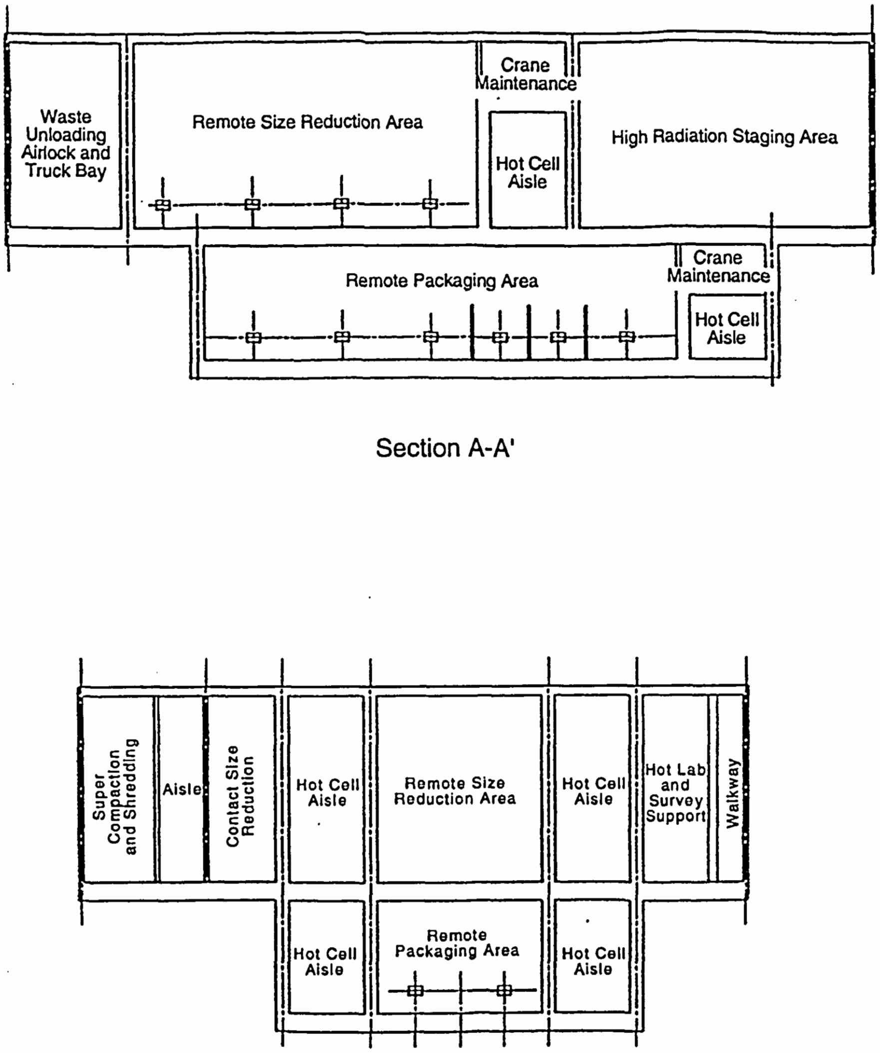


Figure 3-8. Conceptual Design for Volume Reduction Area, Basement Floor (modified from WVNS 1994m).



Note: Plan views shown on Figures 3-7 and 3-8.

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Figure 3-9. Conceptual Design for Volume Reduction Area (a) Section A-A' and (b) Section B-B' (modified from WVNS 1994m).

The major portion of the volume reduction area would consist of the receiving area, unloading areas; waste survey, assay, and examination area; remote-handled waste process enclosure; and contact-handled waste process enclosure, including a debris washing system and waste treatment area (see Figure 3-7). The operations performed in each of these areas would be as follows:

- Receiving area—Area where waste containers would be received and inspected.

- Unloading areas—Enclosures where waste containers would be moved from the transport vehicles by overhead cranes or monorail systems. There would be separate areas for unloading remote-handled and contact-handled waste.

- Waste survey, assay, and examination area—Area where waste would be examined to determine radiation levels, isotopic content, and contamination level. There would be separate examining areas for remote-handled and contact-handled waste. Potential mixed wastes would be characterized.

- Remote-handled waste process enclosure—A shielded cell that would be used for opening waste packages, volume reduction, and repackaging of radioactive waste. Operations would be performed remotely using manipulators and closed circuit television. Waste would be visually inspected and either size reduced (see Figure 3-7) or further characterized. Waste that had been size reduced would be repackaged (see Figure 3-8).

- Contact-handled waste process enclosure—A series of rooms for volume reduction, treatment, and repackaging operations using contact methods. Waste containers would be opened, emptied, surveyed, sampled as necessary, and sorted. Debris and accumulated waste or waste packages potentially containing hazardous material would be sorted and screened for hazardous classification. Waste would be decontaminated and treated as required, reduced, and repackaged. Small volumes of mixed or hazardous waste that could not be treated by the available treatment processes in the container management area (e.g., PCB-contaminated waste from transformers and capacitors) would be treated (mixed waste) or treated and disposed of (hazardous waste) off site.

    - Debris washing system—System to treat debris containing mixed waste by removing surface contamination. Debris would be placed in a spray tank and sprayed with high-pressure steam and water containing detergents and surfactants.

    - Waste treatment area—Area where hazardous and mixed waste and debris would be treated to either remove or stabilize (cement solidification) hazardous constituents. For example, paint waste classified as mixed waste would be solidified so that it passes the TCLP for lead, producing radioactive waste.

Soil Treatment Area. The soil treatment area would measure approximately 39 x 39 m (127 x 127 ft) (see Figure 3-10) (WVNS 1994m) and be located in a separate building adjacent to the volume reduction area. The three primary operations in this area would be initial monitoring and sorting to separate contaminated soil from clean soil, screening of contaminated soil by dry and wet methods to segregate coarse and fine fractions, and chemical treatment of the fine fraction as described below:

- Initial monitoring—Incoming soil would be monitored or sampled for contamination levels and then either treated or stored as a clean soil pile to be used as fill on the site. Field screening would have been conducted before soil was processed at the soil treatment area.

- Screening—Dry and wet screening would be used. Dry screening would use mechanical methods to separate oversized particles and a vacuum system would recover volatile organics. The wet screening method would use vibratory screening, froth flotation, and spiral concentrators to produce a contaminated fine fraction and a coarse fraction (above 30 to 60 microns) with contamination levels that would allow release for unrestricted use. Such screening is a standard soil treatment step and is used because contaminants selectively concentrate in the fine soil fraction that contains silts and clays (Raytheon Engineers & Constructors 1995).

- Contaminant leaching and extraction—The contaminated fine soil fraction would be treated with aqueous leaching solutions like chelating agents or carbonate to solubilize metal contaminants. Metals would be recovered by organic extraction agents. It was assumed that the leaching and extraction process would be specific to the contaminants (primarily cesium and strontium) and to the soil types characteristic at the Center. The conceptual engineering design assumed that the leaching and extraction process would successfully treat soils with concentrations no more than about five times the assumed contaminant cleanup level (Raytheon Engineers & Constructors 1995).

- Dewatering—The treated fine fraction would be rinsed and dewatered. The soil fines would be monitored for radioactivity to determine if it could be used as fill on the site or would have to be managed as radioactive waste.

The overall efficiency of the soil treatment process was estimated based on soil characterization data that included soil type (sand and gravel, weathered till, unweathered till, silt) and contaminant concentration. It was assumed that the coarse fraction (that portion greater than 30 to 60 microns) could be treated and used as fill on the site (Raytheon Engineers & Constructors 1995). It was also assumed that the fine fraction with contamination levels less than five times the assumed contaminant cleanup level could also be treated and used as fill on the site. It was also assumed that the fine fraction with concentrations greater than five times the assumed contaminant cleanup level could not be treated by the chemical treatment step (Raytheon Engineers & Constructors 1995). Finally, it was assumed that treatment produced a radioactive waste sludge that was 5 percent of the

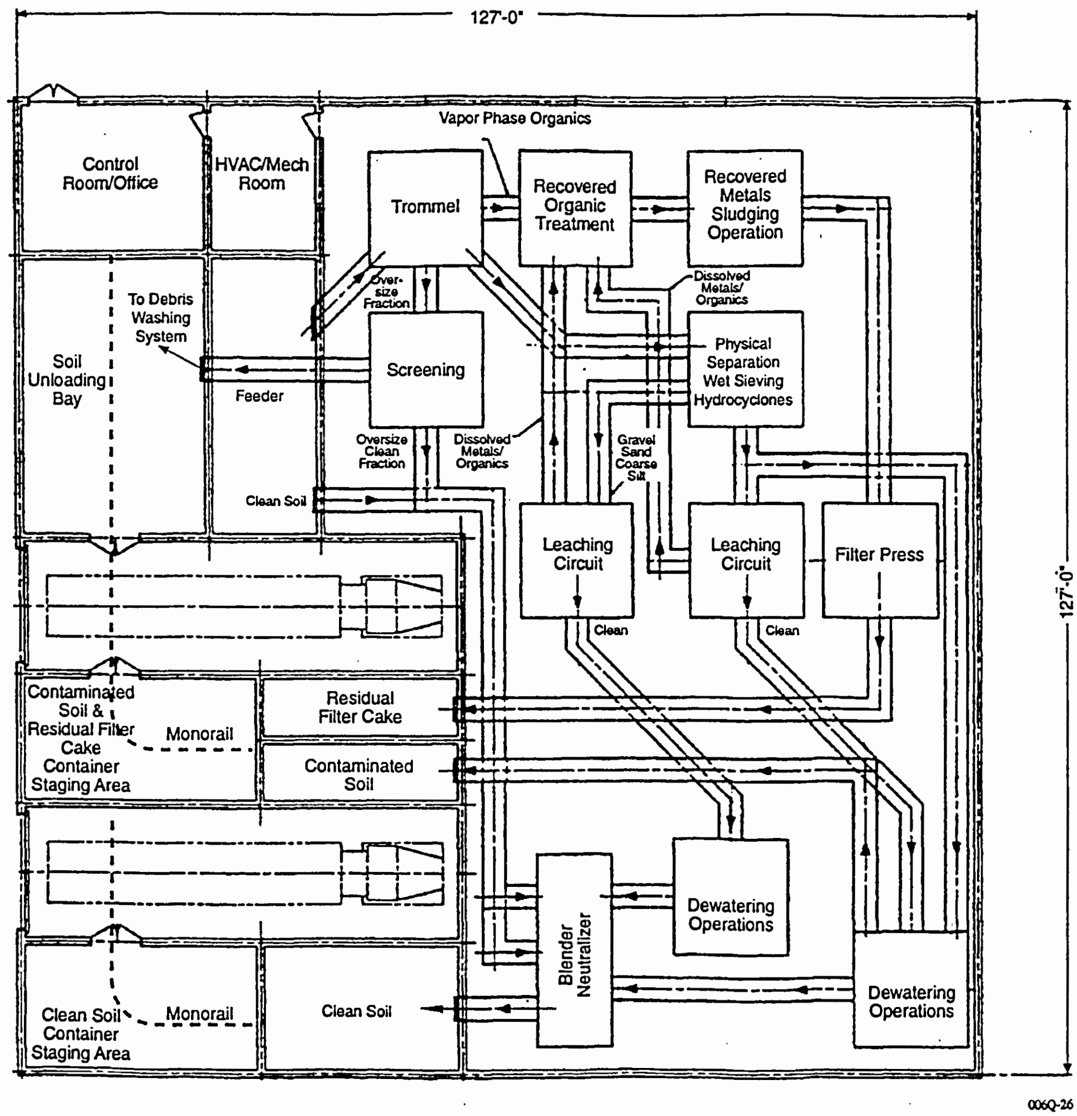


Figure 3-10. Conceptual Design for Soil Treatment Area at the Container Management Area (modified from WVNS 1994m).

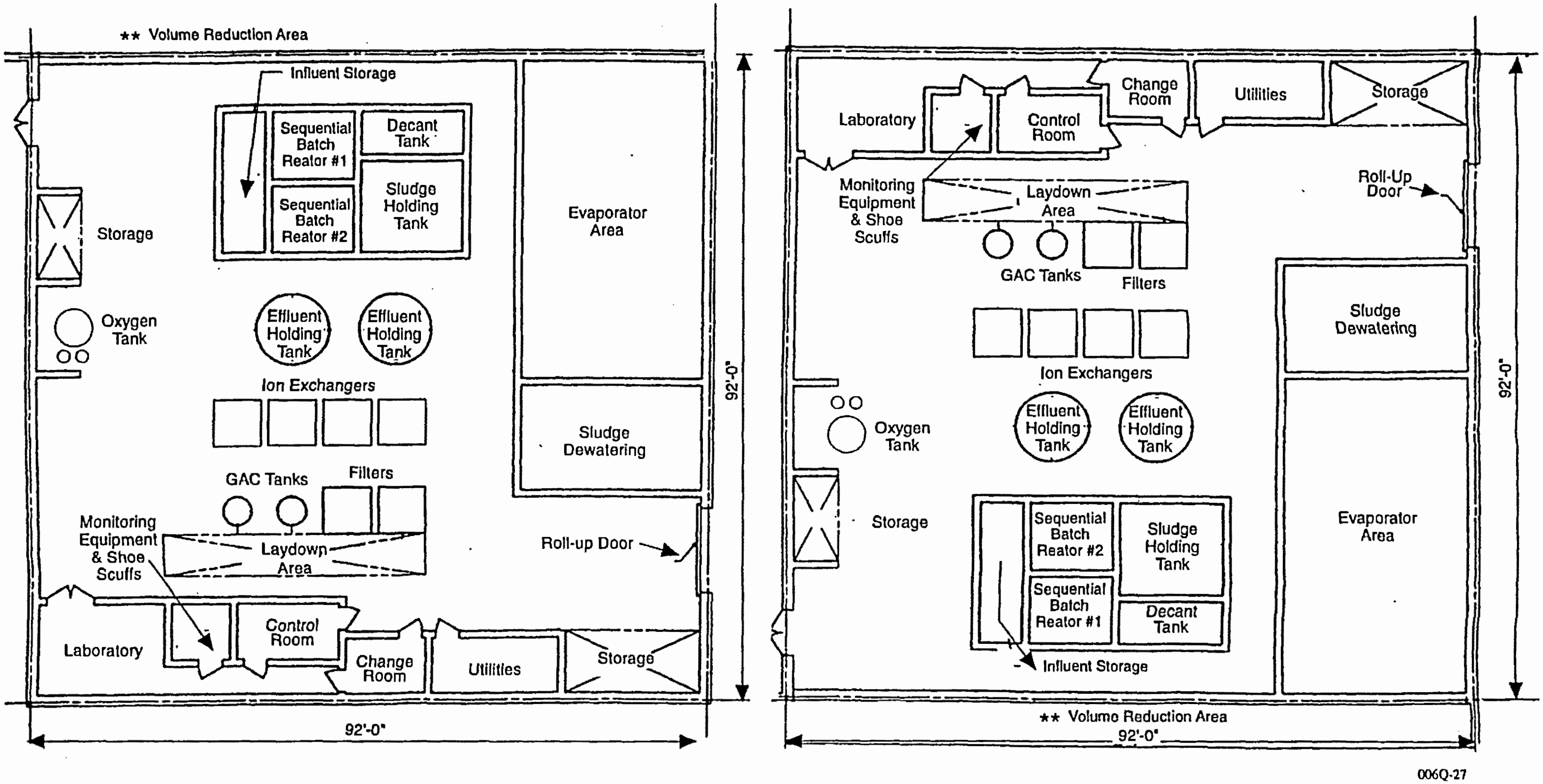
treated soil mass. Using these assumptions, an overall soil treatment efficiency was estimated to be 80 percent (i.e., 80 percent of the estimated volume of contaminated soil would be used for fill on the site). The treatment process would produce radioactive waste equal to 25 percent of the original contaminated soil volume (20 percent would be the fine fraction that could not be successfully treated and 5 percent would be contaminated sludge from the soil treatment operation).

The remote-handled and contact-handled sections of the volume reduction area and the soil treatment area would each have loading and transferring equipment for final survey, temporary storage, overpack loading, and documentation. Each area would have an overhead crane to handle the containers and overpacks. A high-rad staging area would be sized to accommodate the dry-shielding liners containing GTCC waste. This area would be enclosed and shielded to accommodate an 18-m (60-ft) truck and an overhead crane (WVNS 1994m).

Wastewater Treatment Area. A wastewater treatment area would be constructed to treat liquid waste (see Figure 3-7 for alternate locations and Figure 3-11 for alternate floor plans). It would receive contaminated wastewater from facilities undergoing decontamination; from heating, ventilation, and air conditioning condensate drains; from decontamination areas in the volume reduction and soil treatment areas; from the debris washing system; from the soil treatment area dewatering process; and from contaminated leachate. Wastewater would collect in an equalization tank and be processed through two sequential batch reactors for biological treatment of organic constituents. The supernatant would be decanted to another holding tank, filtered for solids, processed through ion exchange beds to remove radioactive constituents, and then sent to an effluent holding tank. The liquid effluent would be evaporated using an evaporator spray dryer. The emissions would exhaust through a baghouse to remove particulates and be released to the atmosphere (WVNS 1994m).

A potential location for the container management area is on the central Project Premises in WMA 6, as shown in Figure 3-12. The factors used to determine available areas and potential locations for the container management area are discussed in detail in Appendix N.

Each area of the container management area would be decontaminated, dismantled, and demolished by conventional methods in ways similar to those used for the other buildings. Only the remote-handled section of the volume reduction area would be expected to have radioactive contamination requiring the installation of confinement and access barriers. Each area would be decontaminated as described for the process building (see Section 3.3.2.1.1). Equipment and vessels would be flushed, decontaminated, and drained. The effluent would be treated by a State Pollutant Discharge Elimination System (SPDES)-permitted mobile wastewater treatment system and discharged to Erdman Brook. Pipes would be size reduced and packaged. The waste generated would be disposed of off site. The area would be backfilled, regraded, and revegetated with native plants for erosion control.



(a) (b)

Notes: GAC = Granulated activated carbon
** Volume Reduction Area = Volume Reduction Area is adjacent (see Figure 3-7).

Figure 3-11. Alternate Plan Views of the Conceptual Design for the Wastewater Treatment Area at the Container Management Area (a) Adjacent to the Low-Rad Staging Area and (b) Adjacent to the Operations and Health Physics Control Room (modified from WVNS 1994m).

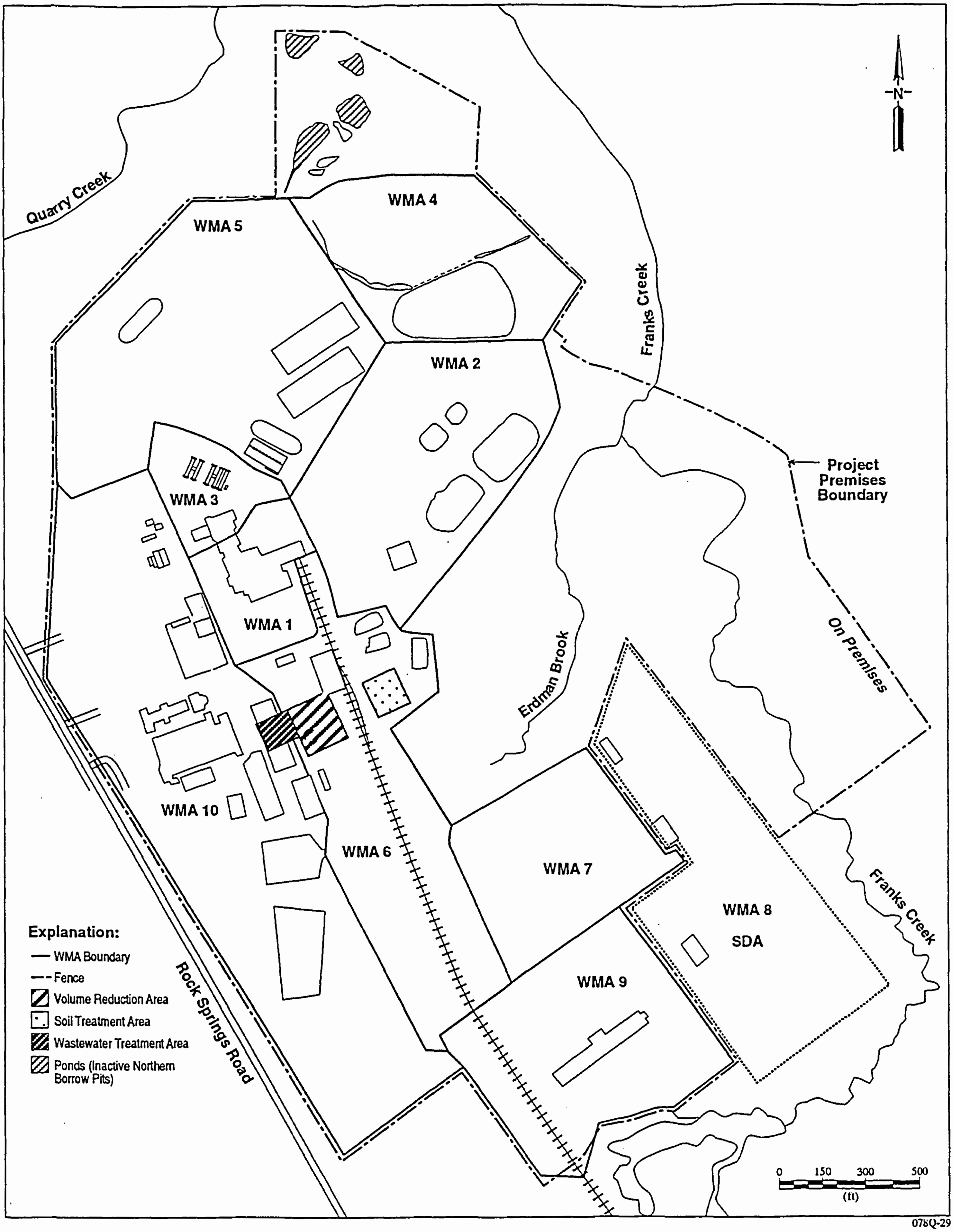


Figure 3-12. Potential Location of Container Management Area under Alternative I.

3.3.2.3 Erosion Control Measures

Under Alternative I, all structures (including the container management area) would be removed, buried waste would be exhumed, and the remaining cavities would be backfilled and graded. The LLWTF lagoon 3 embankment would be stabilized with steel-sheet piling to prevent contaminated soil from washing into Erdman Brook during closure activities. The 18-m (60-ft) high sheet piling, located at the base of the embankment of lagoon 3, would extend 67 m (220 ft) along Erdman Brook embedded 12 m (40 ft) into the ground (WVNS 1994n). The top of the sheet piling would be stabilized by soil or rock anchors.

3.3.3 Volumes of Waste Generated Under Alternative I

Table 3-3 summarizes waste volumes produced from implementing Alternative I that would have to be disposed of off site. Radioactive wastes would be characterized, treated, and packaged at the container management area before being disposed of off site. The largest volumes of radioactive waste would be from the waste storage facilities in WMA 5, process building, SDA, and NDA. Fifty-six percent of the contaminated soil leaving the container management area would be from the SDA and NDA in the south plateau. The mixed waste removed from the waste storage facilities and excavated from the disposal areas was assumed to be treated in the container management area until it no longer contains hazardous waste, but the resulting waste would still be radioactive. However, the stored waste removed from the IWSF (WMA 7) and some of the stored waste from WMA 5 was assumed not to be able to be treated and would remain as mixed waste. The hazardous waste volume shown in Table 3-3 consists primarily of PCB-contaminated capacitors. The uncontaminated industrial waste would be transported directly off site for disposal in a sanitary landfill.

The contaminated soil volumes that would have to be excavated and the remaining portion still considered to be waste after treatment are shown in Table 3-4. Table 3-5 summarizes the total contaminated waste and soil leaving the container management area for off-site disposal. It was assumed that 80 percent of the previously contaminated soil could be used as fill on the site.

Contaminated waste processed through the container management area would be packaged in steel drums, steel boxes, high-integrity containers, and dry-shielded canisters for shipment off site. Descriptions of the specific containers follow.

- Cylindrical steel drums, which measure 61 cm (24 in.) in diameter and 91 cm (36 in.) high and have a capacity of 208 L (55 gal). These drums would be used to transport Class A waste.

Table 3-3. Waste Volumes Leaving the Container Management Area for Alternative I (Removal)[a,b]

WMA/Facility	Class A (ft^3)	Class B (ft^3)	Class C (ft^3)	GTCC (ft^3)	HLW[c] (ft^3)	Mixed (ft^3)	Hazardous (ft^3)	Industrial[d] (ft^3)
1—Process Building	159,000	1,750	8,880	0	420 (935)[e]	0	0	757,000
01/14 Building	792	0	0	0	0	0	1	70,600
2—LLWTF and Lagoons 1-5	31,700	15,500	0	0	0	0	1	42,800
3—HLW Tanks/Vitrification Facility	77,400	500	25,000	0	10,200	0	0	457,000
4—CDDL	849,000	0	0	0	0	0	0	374,000
5—CPC Waste Storage Area	11,000	257	360	15,100	0	0	0	2,760 (4,076)
Lag Storage Building/Additions	333,000	41,100	77,400	0	0	441 (1,664)	0	66,100 (10,409)
7—NDA	240,000	0	0	124,000	12	1,370	0	150,000 (4,040,847)
8—SDA	2,390,000	330,000	0	133,000	0	0	0	6,480
9—RTS Drum Cell	0	0	210,000	0	0	0	0	320,000 (97,308)
Other Facilities (including WMAs 6,10,11,12)	4,700	0	0	0	0	0	3 (79)	2,220,000
Container Management Area	13,200	0	0	0	0	0	0	667,000
Erosion Control	0	0	0	0	0	0	0	432
Total[a]	4,110,000[f]	389,000	322,000	272,000	10,600	1,810	5	5,130,000[f]

a. Does not include contaminated soil volumes (refer to Table 3-4). All volumes rounded to three significant figures. Values in columns may not add up to totals because of rounding.
b. To convert cubic feet to cubic meters, multiply by 0.02832.
c. Consists of canisters of vitrified waste, spent fuel fines, NDA fuel assemblies, and HLW tank sludge. Although the classification of the spent fuel fines is not yet known, for purposes of analysis it was assumed that it would be HLW.
d. Industrial waste would not be processed through the container management area, but would be sent directly off site for disposal.
e. Values in parentheses are those in the 1995 version of the closure engineering reports. The Final EIS will use final versions of the closure engineering reports.
f. For purposes of analysis, this EIS assumes that this uncharacterized waste will be industrial waste. However, if all of this waste was found to be contaminated during closure activities instead of uncontaminated (as assumed in this table), there would be no industrial waste and 9,244,000 ft^3 of Class A waste.

Source: Modified from WVNS (1994a through 1994n)

Table 3-4. Contaminated Soil Volumes Generated from Implementing Alternative I (Removal)[a]

Location[b]	Estimated Contaminated Soil Volume that Would be Excavated[c] (ft^3)	Estimated Contaminated Soil Volume After Treatment in the Container Management Area[d] (ft^3)
North Plateau (excluding cesium prong volume)		
Unsaturated Zone	311,000	77,800
Saturated Zone		
North Plateau Plume	4,000,000	1,000,000
Other	540,000	135,000
South Plateau		
Weathered Till	6,410,000	1,600,000
Unweathered Till	4,710,000	1,180,000
Cesium Prong[e]	904,000	226,000
Stream Sediments[f]	10,000	2,500
Total	16,900,000	4,220,000

a. To convert cubic feet to cubic meters, multiply by 0.02832.
b. See Appendix C for discussion of locations and volumes of contaminated soil.
c. All values rounded to three significant figures.
d. Estimated as 25 percent of the original volume of contaminated soil (20 percent that could not be successfully treated and 5 percent that would be contaminated sludge from soil treatment operations).
e. Volumes are for those areas in the cesium prong with a dose greater than 15 mrem/yr.
f. Estimated volume of contaminated sediments within the Project Premises along Franks Creek and Erdman Brook. Contaminated sediments above the assumed contaminant cleanup level of 15 mrem/yr were not identified along Buttermilk or Cattaraugus Creeks.

- B-96 boxes, which are made of hot-rolled steel. They measure 1.2 m (4 ft) wide x 2.4 m (8 ft) long x 1.2 m (4 ft) high and have a capacity of 2.7 m^3 (96 ft^3) (WVNS 1994l). These boxes would be used to transport Class A waste.

- High-integrity containers, which are cylindrical containers made of concrete or duplex stainless steel. They measure 1.8 m (6 ft) in diameter and 1.8 m (6 ft) high and have a dome-shaped lid (WVNS 1994l). The total capacity of these containers is 3.7 m^3 (130 ft^3); however, common practice is to fill the containers to 90-percent capacity, or 3.3 m^3 (117 ft^3). High-integrity containers would be used to transport Class B and C waste.

- Nutech Horizontal Modular System© (NUHOMS) dry-shielded canisters, which are cylindrical canisters made of 1.6-cm (5/8-in) thick stainless steel. Shield

Table 3-5. Total Waste and Soil Volumes Leaving the Container Management Area for Alternative I (Removal)[a]

Waste Stream	Class A (ft^3)	Class B (ft^3)	Class C (ft^3)	GTCC (ft^3)	HLW (ft^3)	Mixed (ft^3)	Hazardous (ft^3)	Industrial (ft^3)
Waste	4,110,000	389,000	322,000	272,000	10,600[b]	1,810	5	5,130,000
Soil	4,230,000[c]	0	0	0	0	0	0	12,700,000[d]
Total	8,340,000[e]	389,000	322,000	272,000	10,600	1,810	5	5,130,000[e]

a. To convert cubic feet to cubic meters, multiply by 0.02832.
b. Includes spent fuel fines. Although the classification of the spent fuel fines is not yet known, for purposes of analysis it was assumed that it would be HLW.
c. Estimated as 25 percent of the original volume of contaminated soil (20 percent that could not be successfully treated and 5 percent that would be contaminated sludge from soil treatment operations).
d. This volume of treated soil would leave the container management area, but it is assumed that all of this treated soil would be used as free release fill and would not be considered waste.
e. For purposes of analysis, this EIS assumes that this uncharacterized waste will be industrial waste. However, if all of this waste was found to be contaminated during closure activities instead of uncontaminated (as assumed in this table), there would be no industrial waste and 13,500,000 ft^3 of Class A waste.

plugs and cover plates are on each end, and spacers are located inside so the waste can be placed in uniform layers (WVNS 1994l). These canisters are available in capacities of 11, 3.8, and 2.1 m^3 (400, 135, and 75 ft^3); however, a capacity of 3.8 m^3 (135 ft^3) is assumed for this EIS. The NUHOMS canisters would be used to transport GTCC waste.

It is estimated that the volumes of waste generated and transported off site under Alternative I would require a total of 5,990 208-L (55-gal) drums, 62,520 B-96 boxes, 4,280 high-integrity containers, and 2,100 NUHOMS canisters. Table 3-6 shows the numbers of containers needed for transporting waste from each facility. For the RTS drum cell, no waste containers would be required because the stored waste would be shipped in the existing storage containers. Except for Class A waste, which would have to be placed into new containers, the same would be true for containers in the lag storage building, lag storage additions, and CPC waste storage area.

Table 3-6. Estimated Number of Waste Containers Required for Implementing Alternative I (Removal)

WMA/Facility	Drums	B-96 Boxes	High Integrity Containers	NUHOMS Canisters[a]
1—Process Building	0	1,830	91	3
01/14 Building	0	9	0	0
2—LLWTF and Lagoons 1-5	4,170	39	130	0
3—HLW Tank/Vitrification Facility	0	890	220	76
4—CDDL	0	9,800	0	0
5—CPC Waste Storage Area	0	130	5	110
Lag Storage Building/Additions	0	3,840	1,010	0
7—NDA	0	2,780	0	920
8—SDA	40	27,560	2,820	990
9—RTS Drum Cell	0	0	0	0
Other Facilities (including WMAs 6,10,11,12)	0	54	0	0
Container Management Area	1,780	14	0	0
Erosion Control	0	0	0	0
Soil	0	15,570	0	0
Total[b]	5,990	62,520	4,280	2,100

a. NUHOMS = Nutech Horizontal Modular System.
b. Values in columns may not add to totals due to rounding.

Sources: Modified from WVNS (1994a through 1994n)

3.3.4 Schedule for Alternative I Implementation Phase Actions

This section describes the Alternative I actions, including the duration of the implementation phase, the sequencing of the facility-specific actions, labor required for closure, primary construction materials required, and releases to the environment. Information for this section was obtained from WVNS (1994l).

Under Alternative I, facilities and structures at the Center would be demolished, waste and contaminated soil would be excavated, and leachate would be removed. Wastes would require extensive packaging or repackaging for secure transport. Tools and equipment would be similarly decontaminated, demolished if appropriate, and disposed of off site. A new facility, the container management area (described in Section 3.3.2.2), would be used to classify, process, and repackage wastes before disposal off site. Implementation of Alternative I would take approximately 26 years to complete (WVNS 1994l).

The planning for implementation would begin in 1998, and the Center could be available for unrestricted use in 2024, as shown in the schedule in Figure 3-13. No monitoring or maintenance activities would be required after the implementation phase. Implementation activities would require an estimated 14,433 worker-years to complete, with the labor breakdown by WMA shown in Table 3-7. Approximately 7,900 worker-years would be required for decontamination and removal of individual facilities and performing erosion control measures (stabilization of LLWTF lagoon 3 embankment); the remaining 6,500 worker-years would be required for site support operations, including project administration, finances, purchasing, and human resources; engineering, analytical chemistry, and quality assurance; radiation, safety, safeguards, and security; environmental assessment, permitting, and regulatory compliance; and maintenance and modifications (WVNS 1994l). Site support operations were assumed to be distributed proportionally across the facility-specific closure activities.

The container management area would be built before the start of actual site closure work over about 3 years. During the planning phase, appropriate radioactive waste management approvals and a RCRA permit for treating hazardous waste would be obtained. Container management area operations would last throughout the remainder of the implementation phase.

After the container management area had been constructed and lagoon 3 stabilized, exhuming waste from the SDA would begin and was estimated to take 19 years in the conceptual design. Excavation of contaminated soil and stream sediments would be performed during the operation of the container management area.

The stored waste in the lag storage building, lag storage additions, and the CPC waste storage area (WMA 5); the IWSF (WMA 7); and the RTS drum cell (WMA 9) would be removed at the same time the SDA was being exhumed, but would take about 4 years from removal to decontamination and demolition (WVNS 1994l). The simultaneous excavation and backfilling of the CDDL would take approximately 2.5 years.

Table 3-7. Labor Requirements for Implementing Alternative I (Removal)

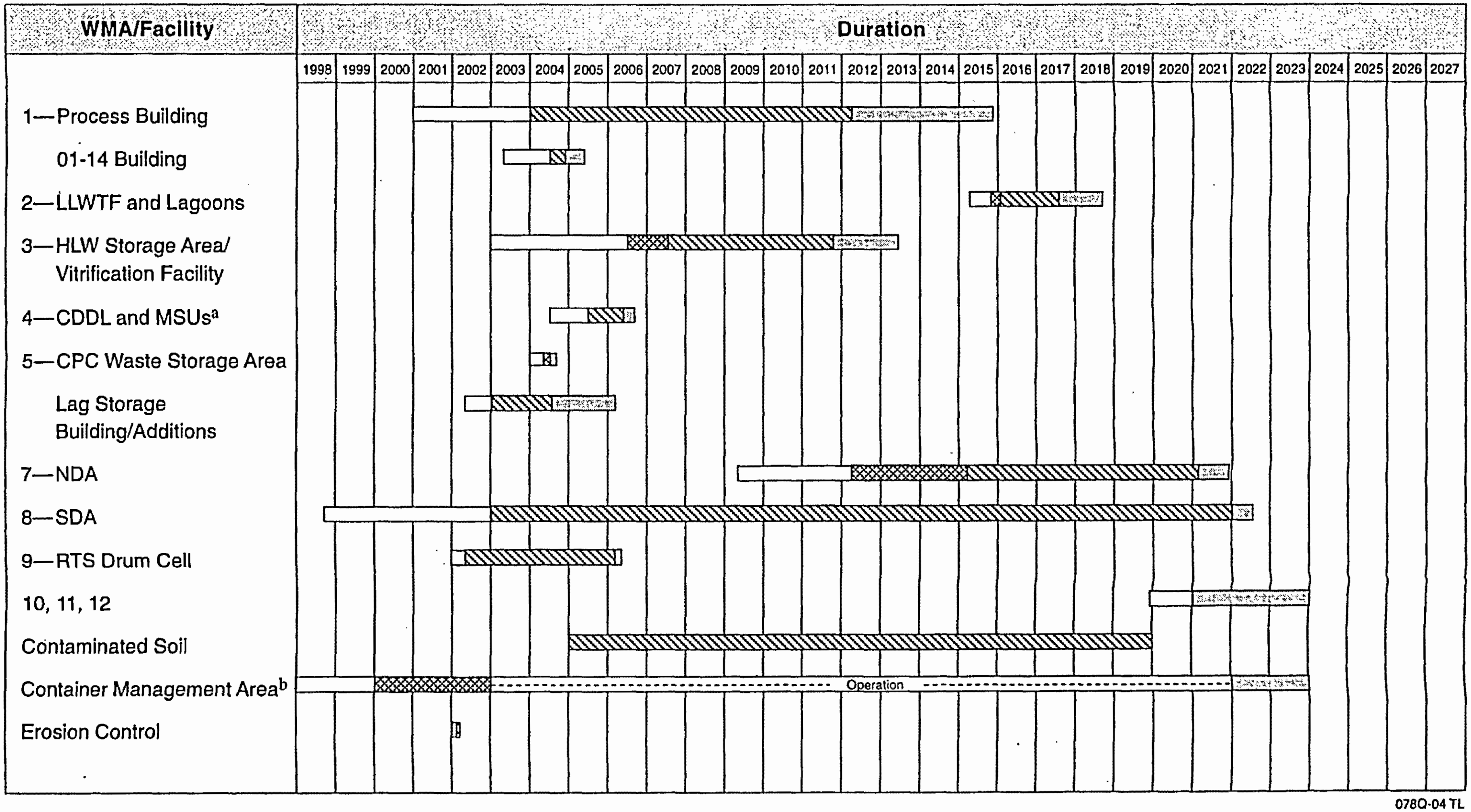
WMA/Facility	Labor (worker years)
1—Process Building	1,410
01/14 Building	26
2—LLWTF and Lagoons 1-5	58
3—HLW Tanks/Vitrification Facility	570
4—CDDL	23
5—CPC Waste Storage Area	4 (10)[a]
Lag Storage Building/Additions	24
7—NDA	1,340 (2,046)
8—SDA	1,350
9—RTS Drum Cell	36
Other Facilities (including WMAs 6,10,11,12)	160
Container Management Area[b]	2,930
Erosion Control	2
Site Support Operations	6,500
Total	14,433

a. The values given in parentheses are those in the 1995 version of the closure engineering reports. The Final EIS will use final versions of the closure engineering reports.
b. Includes operational requirements.

Sources: WVNS (1994a through 1994n)

In the conceptual engineering design, decontamination and dismantlement of large buildings would begin shortly after exhumation began at the SDA. The sequence of decontamination would be the process building, 01/14 building, HLW tanks and support structure, and vitrification facility and associated areas occurring over 10 to 15 years. Decontamination and dismantlement of the 01/14 building would take less than 2 years. During dismantlement of the large buildings, the NDA would be exhumed. Removal of the NDA is expected to take approximately 10 years in the conceptual engineering design and would be completed about the same time as the SDA removal. The SDA activities would take longer than those at the NDA because a single machine would be used to exhume the SDA. Also, the NDA would have two separate areas being exhumed simultaneously, as described in Section 3.3.2.1.3 and shown in Figures 3-4 and 3-5.

The LLWTF would be decontaminated and removed over a 3.5-year period, after the large buildings and during the end of the SDA and NDA exhumation period. The remaining facilities would be removed during the last 4 years of the implementation phase. At the same



a. MSUs = miscellaneous small units. These include the maintenance shop and sanitary waste leach field, waste paper incinerator, solvent dike, effluent equalization mixing basin, and the sludge ponds.
b. During the planning phase, it is assumed that a NRC license and a RCRA permit for treating hazardous waste would be obtained.

Planning | New Construction | Decontamination and Dismantlement (for buildings) or Exhumation (for disposal areas, in-ground structures, and contaminated soil) | Closure

Figure 3-13. Schedule for Implementing Alternative I (Removal) (modified from WVNS 1994l).

time, the container management area would be decontaminated and demolished, taking about 2 years.

The primary construction materials required for implementing Alternative I would be concrete and steel. It is estimated that 31,940 m^3 (1.1 million ft^3) of concrete and 2,240 metric tons (2,460 tons) of steel would be required to implement Alternative I (see Table 3-8). Process enclosures would be constructed to house dismantlement of the HLW tanks and the equipment for exhuming waste from the NDA. Concrete and steel would also be required for constructing the container management area. Additional resources required—electricity, gas, and fuel—are discussed and evaluated in Section 5.2.1.1.

Table 3-8. Major Construction Materials Required for Implementing Alternative I (Removal)

WMA/Facility	Concrete (yd^3)[a]	Steel (tons)[b]
1—Process Building	0	0
01/14 Building	0	0
2—LLWTF and Lagoons 1-5	0	0
3—HLW Tanks/Vitrification Facility	2,470	0
4—CDDL	0	0
5—CPC Waste Storage Area	0	0
Lag Storage Building/Additions	0	0
7—NDA	14,500	2,353
8—SDA	100	15
9—RTS Drum Cell	0	0
Other Facilities (including WMAs 6,10,11,12)	0	0
Container Management Area	24,700	89
Erosion Control	0	0
Total	41,770	2,460

a. To convert cubic yards to cubic meters, multiply by 0.7646.
b. To convert tons to metric tons, multiply by 0.91.

Sources: WVNS (1994a through 1994n)

Implementing Alternative I would result in discharges to air, as shown in Table 3-9. Nonradionuclide releases to air include on-site releases from heavy equipment (tractors, loaders, and trucks) and fugitive dust and off-site releases produced during shipping. Radiological releases to air result from radionuclides entrained in gases vented during waste removal, equipment dismantlement, and demolition. Decontamination liquids and leachate treated in the wastewater treatment area of the container management area would also be

Table 3-9. Releases to the Environment from Implementing Alternative I (Removal)

	Radiological Releases	Nonradiological Releases (tons)[a]		
WMA/Facility	Air (mCi/yr)	Fugitive Dust	Shipping Emissions[b]	Heavy Equipment[c]
1—Process Building	14	137	56	82
01/14 Building	0	0.7	4.2 (1.4)[d]	6
2—LLWTF and Lagoons 1-5	1.9	37	122 (281)	24
3—HLW Tanks/Vitrification Facility	180	288[e]	37	79
4—CDDL	0	75	50	28
5—CPC Waste Storage Area	0	0.6[e]	2.9 (0.02)	0.08
Lag Storage Building/Additions	0	29[e] (14)	73	0.8 (5.3)
7—NDA	7.3	12	267	103
8—SDA	7.1×10^5	445	607	43
9—RTS Drum Cell	0	0.06 (2)	47	10
Other Facilities (including WMAs 6,10,11,12)	0	1,620[e] (45)	60	149
Container Management Area	0[f]	43	NR[g]	623
Erosion	0	0.06	0.02	0.3
Total	7.1×10^5	2,687	1,326	1,148

a. To convert tons to metric tons, multiply by 0.91.
b. Includes hydrocarbons, carbon monoxide, and nitrogen oxides.
c. Includes particulates, carbon monoxide, hydrocarbons, nitrogen oxides, aldehydes, and sulfur oxides.
d. Values given in parenthesis are those in the 1995 version of the closure engineering reports. The Final EIS will use final versions of the closure engineering reports.
e. Original data given in tons per year or tons per month. The integrated schedule in WVNS (1994l) was used to estimate the total amount.
f. Releases from evaporation at the wastewater treatment area in the container management area would occur. They are included in the releases for the source WMAs.
g. NR = not reported in the closure engineering reports.

Sources: WVNS (1994a through 1994n)

evaporated and exhausted to the atmosphere. The largest release would be from evaporating leachate pumped out of the SDA disposal trenches. The largest volume of fugitive dust would result from removing pavement and miscellaneous structures on the Project Premises and excavating soil on the balance of the site. No confinement structures were assumed for actions in these areas. Fugitive dust results from construction, demolition, and exhumation. Control methods, such as watering twice daily, could reduced fugitive dust emissions by up to 50 percent. Shipping emissions were estimated from average exhaust emission rates at low altitude for heavy-duty vehicles. The greatest shipping emissions would result from transporting the waste volumes [96,500 m^3 (3.4 million ft^3)] from the SDA and NDA. The container management area would have the greatest contribution to heavy-duty equipment releases because it must be constructed, operated, and demolished.

3.3.5 Alternative I Post-Implementation Phase Actions

This alternative would result in releasing the Center for other uses. Because no areas would be retained, institutional control of the site would not be needed, and there would be no post-implementation phase after the waste has been removed.

3.4 ALTERNATIVE II: REMOVAL, ON-PREMISES WASTE STORAGE, AND PARTIAL RELEASE TO ALLOW UNRESTRICTED USE

The objective of Alternative II (On-Premises Storage) is to allow release of the Center for unrestricted use, except for creek channels on site and areas on the north and south plateaus that would have waste storage facilities. The waste storage facilities would require a long-term monitoring and maintenance program.

3.4.1 General Strategy for Alternative II

The general strategy for implementing Alternative II is the same as for Alternative I except newly generated radioactive and mixed waste would be stored in new, on-premises storage facilities. The waste would be stored in retrievable storage areas for an indefinite period of time instead of being disposed of off site immediately. A flow diagram representing the general strategy for implementing Alternative II is shown in Figure 3-14. The figure shows contaminated waste and soil generated from dismantlement and exhumation being sent to the container management area for characterization, treatment, and packaging. Soil processed through the container management area soil treatment area and still having low-specific activity would be placed in a bulk soil storage area located within part of the retrievable storage areas. Class A soil would be placed into containers before being placed into the retrievable storage areas.

Institutional controls would be applied during the implementation phase of Alternative II to minimize negative impacts. The institutional controls would be the same as those identified for Alternative I in Section 3.3.1.

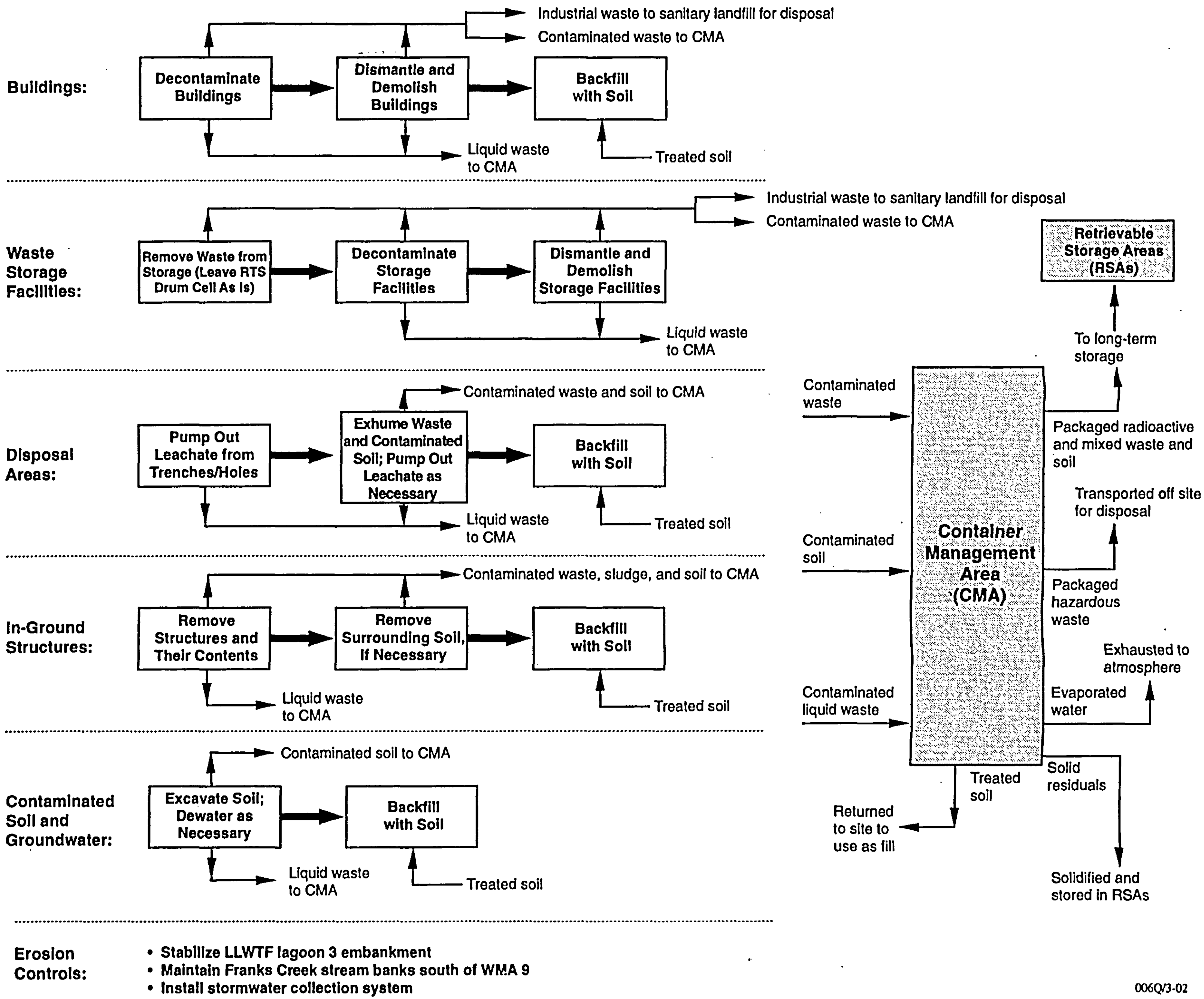


Figure 3-14. General Strategy for Implementing Alternative II (On-Premises Storage).

3.4.2 Alternative II Implementation Phase Actions

This section describes actions for existing facilities, structures, and environmental contamination; new facilities; and erosion control measures during the implementation phase of Alternative II.

3.4.2.1 Existing Facilities, Structures, and Environmental Contamination

The specific actions taken under Alternative II would be identical to those for Alternative I (see Section 3.3.2) except that contaminated waste packaged in the container management area and the canisters of vitrified HLW would be stored on-premises in newly constructed retrievable storage areas. Clean demolition waste would be disposed of off site in a sanitary landfill, and treated soil meeting release criteria would be used as fill on the site. The excavated areas would be backfilled, regraded, and revegetated with native plants for erosion control. Exceptions to these actions include the RTS drum cell and some of the remaining facilities. The RTS drum cell would remain a waste storage facility and have long-term monitoring and maintenance. The temporary weather structure would be inspected regularly and replaced, as necessary (WVNS 1994g).

Under Alternative II, some of the facilities listed in Table 3-3 would remain to support on-premises storage in the retrievable storage areas (WVNS 1994k). These retained facilities would be (a) security gate houses, (b) electrical substation, (c) steel fence, (d) new warehouse, (e) utility poles, (f) parking lots (10 percent of existing parking lots), (g) roadways (50 percent of existing roadways), and (h) RTS drum cell monitoring station. Like Alternative I, the existing earthen dams would be removed, the two reservoirs would be drained, and stream channels would be restored.

3.4.2.2 New Facilities Required

The container management area (see Section 3.3.2.2) would also be required for implementing Alternative II. However, instead of generated wastes being disposed of off site, the wastes repackaged in the container management area would be sent to newly constructed retrievable storage areas for on-premises storage. The retrievable storage areas would be used for currently stored waste and for wastes generated during implementation phase activities except industrial waste. The preconceptual design of the retrievable storage areas includes two separate areas: a contact retrievable storage area and a shielded retrievable storage area. The contact retrievable storage area would consist of individual modules which could be combined to form one building. Figure 3-15 shows the conceptual design of one module of the contact retrievable storage area.

Each module of the contact retrievable storage area would consist of six storage bays, a drive-through truck bay, and secondary support rooms. The initial module has been conceptualized as a concrete structure measuring 114 x 104 m (374 x 342 ft), with each bay 18 x 98 m (60 x 322 ft) in area and 12 m (40 ft) high (WVNS 1994m). Two bays would store Class A waste, two bays would store Class B and Class C waste, one bay would store GTCC waste, and one bay would store miscellaneous waste (e.g., low specific activity

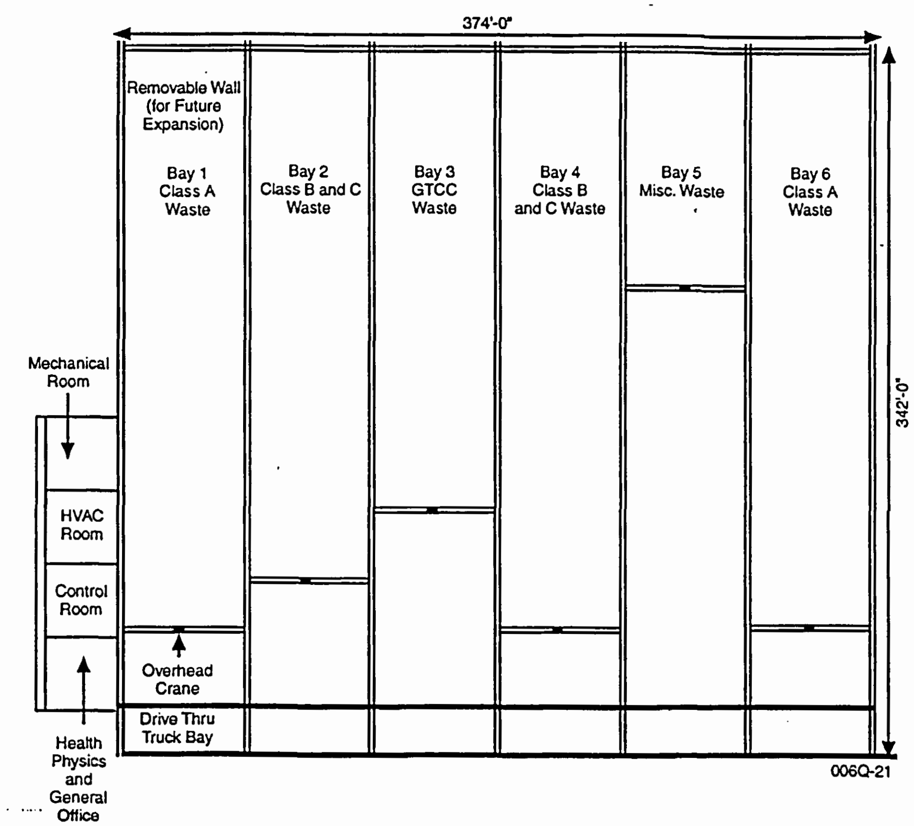


Figure 3-15. Conceptual Design for the Initial Module of the Contact Retrievable Storage Area (modified from WVNS 1994m).

contaminated building equipment and debris, repackaged buried waste, and soil) in shielded and nonshielded drums and high-integrity containers. The bays would be arranged so that the highest radioactive waste would be stored in the center and less radioactive waste would be stored in the outside bays to reduce external exposure rates, as shown in Figure 3-15. Class A soil would be placed in containers before being placed in the bays. The truck bay would be located next to the storage bays and shielded by 0.6-m (2-ft) thick concrete walls. Each bay would contain remote-controlled overhead bridge cranes for unloading and handling waste. Air flow would be from areas of low radioactive contamination to areas of high radioactive contamination. Each bay would have a knockout panel to allow for future expansion. To store all of the LLW generated by implementing Alternative II, four modules would be required.

The shielded retrievable storage area building would measure about 88 x 55 m (290 x 180 ft) (WVNS 1994m). This building would store approximately 350 canisters of vitrified HLW produced during HLW solidification, fuel assembly hardware, fuel fines and equipment contaminated during decontaminating and decommissioning, and other miscellaneous GTCC waste. The shielded retrievable storage area would use an NRC-licensed, dry shielded canister system for use in independent spent fuel storage installations. The conceptual design of the shielded retrievable storage area, shown in Figure 3-16, indicates the approximate number of vaults and the aisle spacing between the vaults to be used. This building would have a transfer trailer with a transfer cask and a hydraulic unloading ram.

Figure 3-17 shows potential locations for the container management area and retrievable storage areas under Alternative II. Factors for determining available areas and potential locations are described in detail in Appendix N.

After contaminated waste has been processed through the container management area, it would be decontaminated, dismantled, and demolished like in Alternative I. Radioactively contaminated demolition waste would be stored in the retrievable storage areas. Industrial waste from demolition would be disposed of off site in a sanitary landfill.

3.4.2.3 Erosion Control Measures

As under Alternative I, it would be necessary to stabilize the LLWTF lagoon 3 embankment to prevent soil from washing into Erdman Brook during implementation phase actions. The embankment would be stabilized with steel sheet piling as described in Section 3.3.2.3.

The only structures left on site would be the retrievable storage areas (the contact retrievable storage area and shielded retrievable storage area) and the RTS drum cell located on the Project Premises. As shown in Figure 3-17, potential locations for the retrievable storage areas are away from the creeks on the Project Premises; therefore, the area the retrievable storage areas are constructed on is less prone to erosion. Erosion could impact the retrievable storage areas after 1,000 to 2,000 years following loss of institutional control. Erosion is not an immediate threat for the RTS drum cell, but is expected to pose a long-

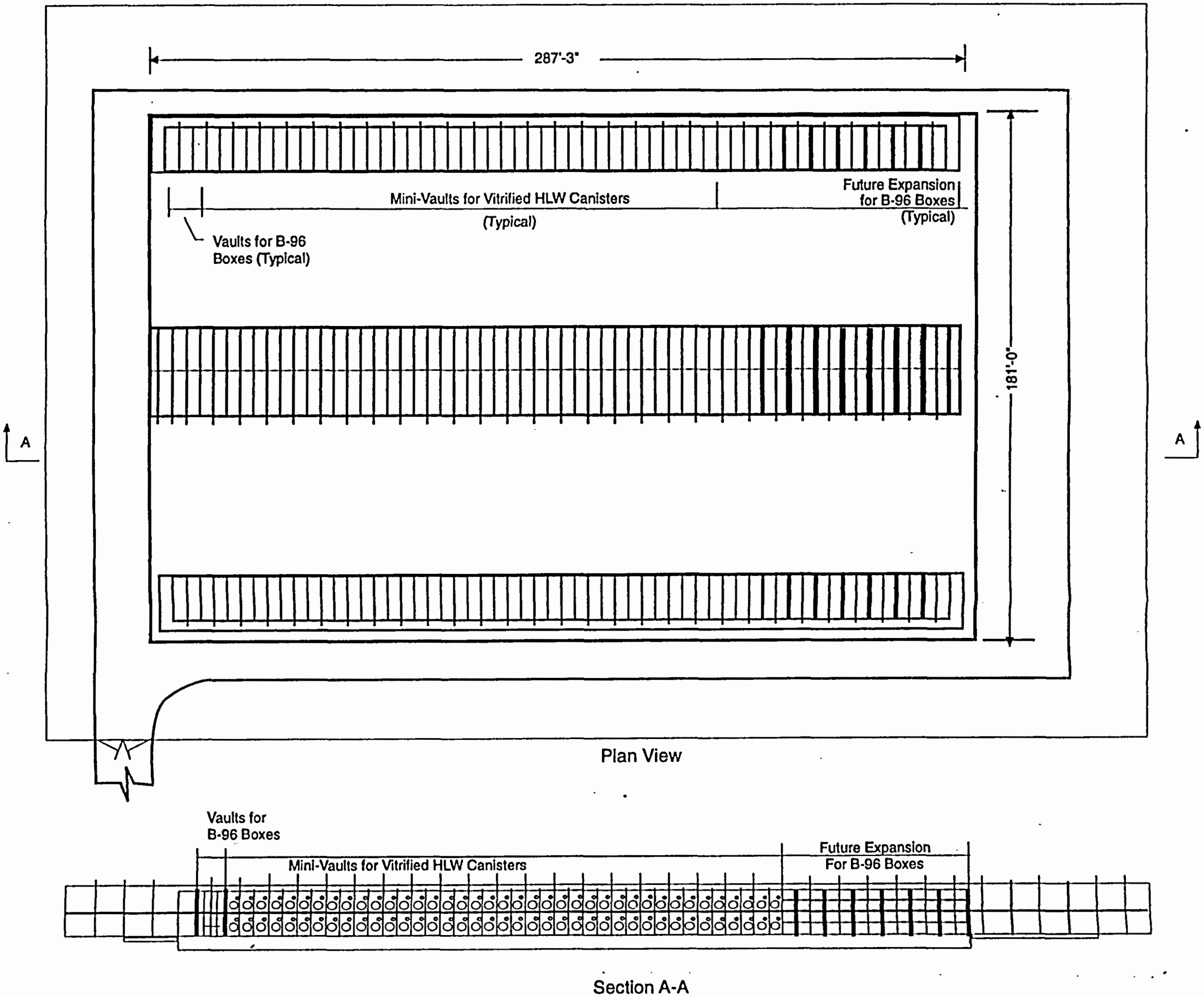


Figure 3-16. Conceptual Design for the Shielded Retrievable Storage Area (modified from WVNS 1994m).

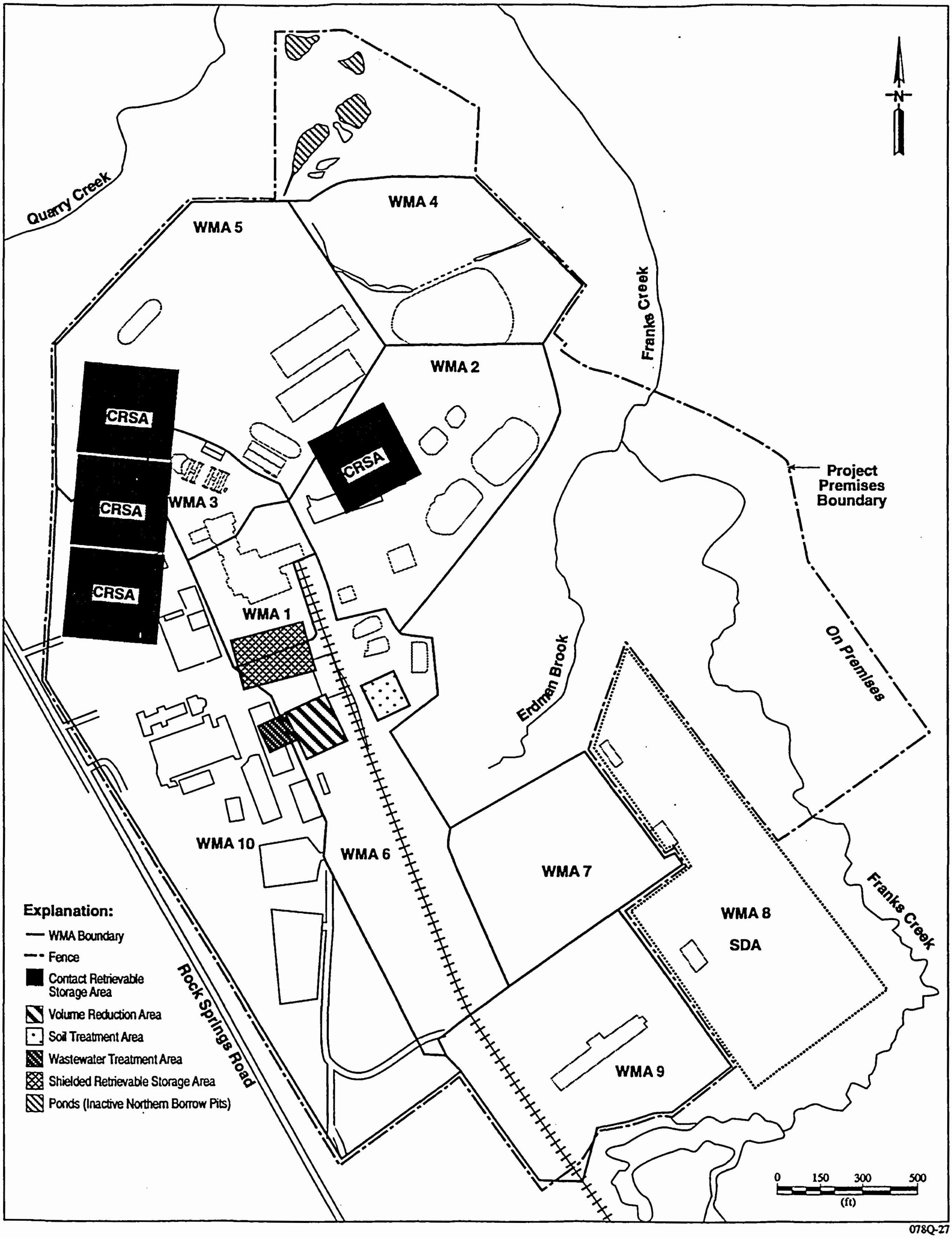


Figure 3-17. Potential Location of Container Management Area and Retrievable Storage Areas under Alternative II.

term hazard. Therefore, the stream banks on Franks Creek and Erdman Brook would be maintained to limit the development and advancement of gullies and the widening of the stream valleys to protect the south and north side of WMA 9, respectively. For example, riprap could be used for slope stabilization.

To prevent stormwater from flowing across open grounds and to direct surface runoff from the paved areas on the Project Premises to selected points for controlled discharge to Erdman Brook, Franks Creek, and Quarry Creek, a stormwater collection system, consisting of paved ditches, surface pavement, site regrading, curb installation, and landscaping, would be installed. The streambanks on Franks Creek and the stormwater collection system would be inspected, maintained, and replaced as necessary.

3.4.3 Volumes of Waste Generated under Alternative II

Table 3-10 gives the estimated volumes of waste that would be processed through the container management area for either on-premises storage in the retrievable storage areas (radioactive and mixed) or off-site disposal (industrial waste). Waste volumes were estimated as described in Section 3.3.3.

Radioactive wastes would be characterized, treated, and packaged at the container management area before being stored. The difference between the waste volumes leaving the container management area for Alternatives I and II is that for Alternative II, the RTS drum cell would remain a waste storage facility and some facilities on the balance of the site would remain standing to support storage operations.

The volumes of contaminated soil excavated from the site and the remaining soil characterized as waste after treatment in the soil treatment area at the container management area are the same as those volumes shown in Table 3-4 for Alternative I. Table 3-11 summarizes the total contaminated waste and soil leaving the container management area under Alternative II.

Contaminated waste processed through the container management area would be packaged in the same type of containers as described in Section 3.3.3. It is estimated that the volume of waste to be stored on the Project Premises or transported off site would require the same number of containers as for Alternative I (see Table 3-6), that is, a total of 5,990 208-L (55-gal) drums, 62,520 B-96 boxes, 4,280 high-integrity containers, and 2,100 NUHOMS canisters.

3.4.4 Schedule for Alternative II Implementation Phase Actions

Implementing Alternative II would have the same schedule as implementing Alternative I, except for the disposition of the wastes. Accordingly, Alternative II would require the same methods of demolition, decontamination, exhumation, and removal as Alternative I, but this alternative would require constructing new retrievable storage areas for waste storage on the Project Premises, in addition to the new container management area.

Table 3-10. Waste Volumes Leaving the Container Management Area for Alternative II (On-Premises Storage)[a,b]

WMA/Facility	Class A (ft^3)	Class B (ft^3)	Class C (ft^3)	GTCC (ft^3)	HLW[c] (ft^3)	Mixed (ft^3)	Hazardous (ft^3)	Industrial[d] (ft^3)
1—Process Building	159,000	1,750	8,880	0	420 (935)[e]	0	0	757,000
01/14 Building	792	0	0	0	0	0	1	70,600
2—LLWTF and Lagoons 1-5	31,700	15,500	0	0	0	0	1	42,800
3—HLW Tanks/Vitrification Facility	77,400	500	25,000	0	10,200	0	0	457,000
4—CDDL	849,000	0	0	0	0	0	0	374,000
5—CPC Waste Storage Area	11,000	257	360	15,100	0	0	0	2,760 (4,076)
Lag Storage Building/Additions	333,000	41,100	77,400	0	0	441 (1,664)	0	66,100 (10,409)
7—NDA	240,000	0	0	124,000	12	1,370	0	150,000 (4,040,847)
8—SDA	2,390,000	330,000	0	133,000	0	0	0	6,480
9—RTS Drum Cell	0	0	0	0	0	0	0	0
Other Facilities (including WMAs 6,10,11,12)	4,700	0	0	0	0	0	0	1,490,000
Container Management Area	13,200	0	0	0	0	0	0	667,000
Retrievable Storage Areas	0	0	0	0	0	0	0	0
Erosion Control	0	0	0	0	0	0	0	432
Total	4,110,000[f]	389,000	112,000	272,000	10,600	1,810	2	4,080,000[f]

a. Does not include contaminated soil volumes (refer to Table 3-5). All volumes rounded to three significant figures. Values in columns may not add up to totals because of rounding.
b. To convert cubic feet to cubic meters, multiply by 0.02832.
c. Consists of vitrified waste canisters, spent fuel fines, NDA fuel assemblies, and HLW tank sludge. Although the classification of the spent fuel fines is not yet known, for purposes of analysis it was assumed that it would be HLW.
d. Industrial waste would not be processed through the container management area but would be sent directly off site for disposal.
e. Values in parenthesis are those in the 1995 versions of the closure engineering reports. The Final EIS will use final versions of the closure engineering reports.
f. For purposes of analysis, this EIS assumes that this uncharacterized waste will be industrial waste. However, if all of this waste was found to be contaminated during closure activities instead of uncontaminated (as assumed in this table), there would be no industrial waste and 8,190,000 ft^3 of Class A waste.

Sources: modified from WVNS (1994a through 1994n)

Table 3-11. Total Waste Volumes Generated from Implementing Alternative II (On-Premises Storage)[a]

Waste Stream	Class A (ft^3)	Class B (ft^3)	Class C (ft^3)	GTCC (ft^3)	HLW (ft^3)	Mixed (ft^3)	Hazardous (ft^3)	Industrial (ft^3)
Waste	4,110,000	389,000	112,000	272,000	10,600[b]	1,810	2	4,080,000
Soil	4,230,000[c]	0	0	0	0	0	0	12,700,000[d]
Total	8,340,000[e]	389,000	112,000	272,000	10,600	1,810	2	4,080,000[e]

a. To convert cubic feet to cubic meters, multiple by 0.02832.
b. Includes spent fuel fines. Although the classification of the spent fuel fines is not yet known, for purposes of analysis it was assumed that it would be HLW.
c. Estimated as 25 percent of the original volume of contaminated soil (20 percent that could not be successfully treated and 5 percent that would be contaminated sludge from soil treatment operations).
d. This volume of treated soil would leave the container management area, but it is assumed that all of this treated soil would be used as backfill at the site and would not be considered waste.
e. For purposes of analysis, this EIS assumes that this uncharacterized waste will be industrial waste. However, if all this waste was found to be contaminated instead of uncontaminated (as assumed in this table), there would be no industrial waste and 12,400,000 ft^3 of Class A waste.

The waste stored in the retrievable storage areas would be packaged to meet on-site storage or off-site transportation regulations (WVNS 1994m).

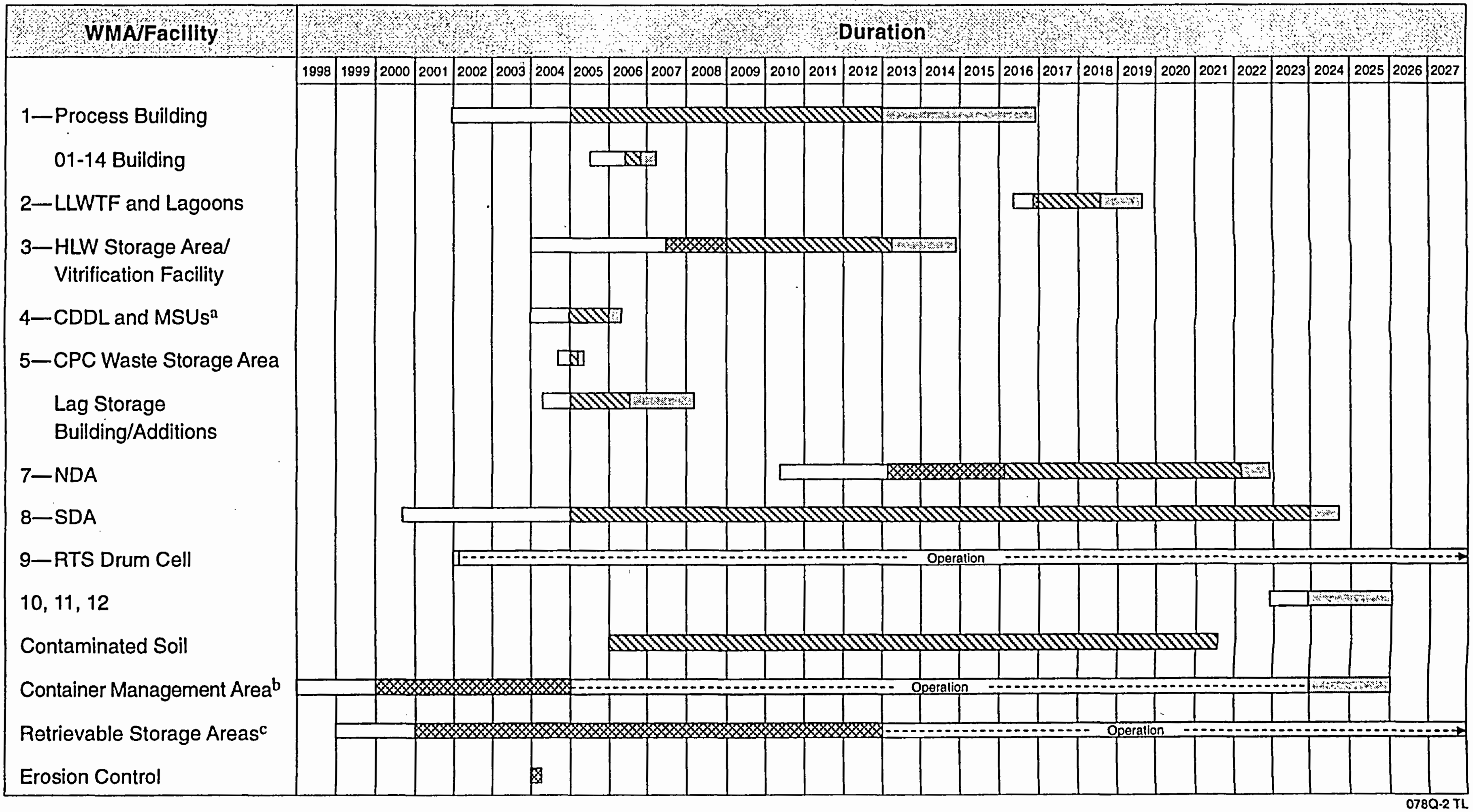
Implementing Alternative II is estimated to take approximately 28 years to complete (WVNS 1994l). The planning for implementation would begin in 1998, and except for parts of the Project Premises, the Center would be available for partial release in 2026, as shown in the schedule for implementation in Figure 3-18. After the implementation phase, a staffing level of about 30 worker-years per year would be needed to monitor and maintain the site during the storage period. Implementation activities would require an estimated 18,800 worker-years to complete. Table 3-12 gives the distribution of labor by WMA/facility that would be required for site closure. Approximately 13,000 worker-years would be required for decontamination and removal of site facilities and performing erosion control measures, and the remaining 5,800 worker-years would be required for site support operations.

Table 3-12. Labor Requirements for Implementing Alternative II (On-Premises Storage)

WMA/Facility	Labor (worker-years)
1—Process Building	1,410
01/14 Building	26
2—LLWTF and Lagoons 1-5	58
3—HLW Tanks/Vitrification Facility	570
4—CDDL	23
5—CPC Waste Storage Area	4 (10)[a]
Lag Storage Building/Additions	24
7—NDA	1,340 (2,046)
8—SDA	1,350
9—RTS Drum Cell	0.6
Other Facilities (including WMAs 6,10,11,12)	126
Container Management Area[b]	2,930
Retrievable Storage Areas[b]	5,200
Erosion Control	2
Site Support Operations	5,800
Total	18,864

a. The values given in parenthesis are those in the 1995 closure engineering reports. The Final EIS will use final versions of the closure engineering reports.
b. Includes operational requirements.

Sources: WVNS (1994a through 1994n)



a. MSUs = miscellaneous small units. These include the maintenance shop and sanitary waste leach field, waste paper incinerator, solvent dike, effluent equalization mixing basin, and the sludge ponds.
b. During the planning phase, it is assumed that a NRC license and a RCRA permit for treating hazardous waste would be obtained.
c. During the planning phase, it is assumed that a NRC license would be obtained as well as a RCRA permit for areas where mixed waste would be stored. Operation of the first retrievable storage areas constructed would occur while the next retrievable storage areas are being constructed.

Planning | New Construction | Decontamination and Dismantlement (for buildings) or Exhumation (for disposal areas, in-ground structures, and contaminated soil) | Closure

Figure 3-18. Schedule for Implementing Alternative II (On-Premises Storage) (modified from WVNS 1994l).

A comparison of Figures 3-13 and 3-18 shows that the sequence of closure activities under Alternatives I and II are similar. The retrievable storage areas and the container management area would be constructed at the beginning of the implementation phase. During the planning phase for the container management area and the retrievable storage areas, appropriate radioactive waste management approvals as well as RCRA permits for treating hazardous waste and storing mixed waste would be obtained. The container management area would operate throughout the implementation phase, and the retrievable storage areas would be maintained indefinitely. The shielded retrievable storage area and one contact retrievable storage area building would be constructed within 4 years and finished at the same time as the container management area. The remaining contact retrievable storage area buildings would be constructed in the following 8-year period. After construction of the container management area, shielded retrievable storage area, and the initial module of the contact retrievable storage area, removal of facilities in the WMAs would begin. The schedule would be longer than for Alternative I because the retrievable storage areas must be constructed.

The sequence of facility removal would be the same as for Alternative I except neither stored waste in the RTS drum cell would be removed nor would the structure be demolished. The RTS drum cell would be prepared for storage and remain on the Project Premises for Alternative II.

The primary construction materials, concrete and steel, required for implementing Alternatives I and II would be the same (see Table 3-8) except additional materials required for constructing the retrievable storage areas: 129,000 m^3 (4.3 million ft^3) of concrete and 236 metric tons (260 tons) of steel. Thus, the total construction materials required for implementing Alternative II is 155,000 m^3 (5.5 million ft^3) of concrete and 2,400 metric tons (2,700 tons) of steel. Additional resources required for implementing Alternative II—electricity, gas, and fuel—are discussed in Section 5.3.1.1.

Implementing Alternative II would result in discharges to air as summarized in Table 3-13. The radiological releases to air from radionuclides entrained in gases vented during waste removal, from equipment dismantlement and demolition, and from evaporating decontamination liquids and leachate in the wastewater treatment area at the container management area would be the same as for Alternative I. The nonradionuclide releases to air include releases from heavy equipment, fugitive dust, and shipping emissions. As in Alternative I, demolishing the balance of site facilities generates the largest amount of fugitive dust. Shipping emissions are greatly reduced because contaminated waste would no longer be transported to an off-site disposal facility. The emissions from heavy duty equipment are higher than Alternative I because of construction of the retrievable storage areas.

3.4.5 Alternative II Post-Implementation Phase Actions

After the implementation phase, institutional control of the Center would be retained indefinitely. The retained areas requiring active management would be limited to portions of the channels on Buttermilk and Franks Creeks (on site), and areas on the Project Premises

Table 3-13. Releases to the Environment from Implementing Alternative II (On-Premises Storage)

WMA/Facility	Radiological Releases: Air (mCi/yr)	Nonradiological Releases (tons)[a]: Fugitive Dust	Shipping Emissions[b]	Heavy Equipment[c]
1—Process Building	14	137	20	82
01/14 Building	0	0.7	3.7 (1.2)[d]	6
2—LLWTF and Lagoons 1-5	1.9	37	64 (8.3)	24
3—HLW Tanks/Vitrification Facility	180	288[e]	0 (14)	79
4—CDDL	0	75	10	28
5—CPC Waste Storage Area	0	0.6[e]	0.005	0.08
Lag Storage Building/Additions	0	29[e] (14)	0 (2)	0.8 (5.3)
7—NDA	7.3[e]	12	1.1 (4.8)	103
8—SDA	7.1×10^5	445	2.1	43
9—RTS Drum Cell	0	0	0	0
Other Facilities (including WMAs 6,10,11,12)	0	1,548[e] (43)	39	108
Container Management Area	0[f]	43	0	623
Retrievable Storage Areas	0	392	0	1,070
Erosion Control	0	0.06	0.02	0.3
Total	7.1×10^5	3,007	140	2,167

a. To convert tons to metric tons, multiply by 0.91.
b. Includes hydrocarbons, carbon monoxide, and nitrogen oxides.
c. Includes particulates, carbon monoxide, hydrocarbons, nitrogen oxides, aldehydes, and sulfur oxides.
d. Values in parentheses are those in the 1995 version of the closure engineering reports. The Final EIS will use final versions of the closure engineering reports.
e. Original data given in tons per year or tons per month. The integrated schedule in WVNS (1994l) was used to estimate the total amount.
f. All releases would be from evaporation at the wastewater treatment area of the container management area, but are shown from the source WMAs.

Sources: WVNS (1994a through 1994n)

where the retrievable storage areas and the RTS drum cell are potentially located [a total of about 336 ha (830 acres)]. About 1,350 ha (3,340 acres) would be available for reuse. The activities that would be conducted during the post-implementation phase would include (a) site security to restrict access to the retrievable storage areas, (b) environmental monitoring to assure that contamination is not being released from the retrievable storage areas to the surrounding environment, (c) monitoring erosion around the retrievable storage areas, and (d) monitoring and maintenance of the retrievable storage areas.

Monitoring and maintenance of the retrievable storage areas would include (a) contamination monitoring and inspecting the waste packages to make sure the waste is being contained (e.g., containers not corroded), (b) monitoring and maintenance of the ventilation system to ensure that backup contamination control capabilities are being provided, (c) monitoring for water infiltration through the roofs (d) monitoring of the leak detection systems, and (e) monitoring the structural stability. Appropriate maintenance actions would be taken that could include repackaging or overpacking waste, repairing or replacing roofs, or replacing ventilation system components. If a building is still required at the end of its design life (100 years), engineering evaluations would determine how to continue providing for waste storage. The evaluations could recommend extending facility life with minimal structural upgrades or constructing a replacement facility and transferring the waste.

Monitoring and maintenance activities would produce minor volumes of radioactive waste. For example, if the waste packages failed and the waste had to be repackaged or overpacked, radioactive waste would be generated. This radioactive waste volume would be small and may be stored on the Project Premises in the retrievable storage areas.

3.5 ALTERNATIVE III: IN-PLACE STABILIZATION AND ON-PREMISES LOW-LEVEL WASTE DISPOSAL

The objective of Alternative III (In-Place Stabilization) is to allow unrestricted use of the Center, except for areas of contaminated soil on the balance of the site (i.e., the cesium prong) and creek channels and portions of the Project Premises and the SDA where contaminants would be immobilized. Alternative III involves removal or in-place stabilization of facilities and in-situ stabilization of buried waste.

3.5.1 General Strategy for Alternative III

The general strategy for implementing Alternative III is that site structures and facilities would either be removed or stabilized in place. On-site environmental contamination would remain and the retained areas would be monitored. Most LLW generated during the implementation phase would be disposed of on the Project Premises, and the remaining radioactive waste, mixed waste, and hazardous waste would be disposed of off site. Two approaches could be taken for the on-premises disposal of LLW: (1) it could be placed in contaminated buildings, which would then be backfilled with concrete

[Alternative IIIA: In-Place Stabilization (Backfill)] or (2) it could be placed in a newly constructed disposal facility [Alternative IIIB: In-Place Stabilization (Rubble)].

Under both approaches, existing capabilities would be used to characterize, treat, and package waste. Existing compactors could be used for volume reduction of most waste types, except for heavy steel components (such as removed equipment), and the cement solidification system could be used to solidify liquid wastes. Flow diagrams representing the general strategy for implementing Alternatives IIIA and IIIB are shown in Figures 3-19 and 3-20, respectively. A detailed description of the proposed LLW disposal facility constructed under Alternative IIIB is given in Section 3.5.2.2.

With the exception of the process building, the supernatant treatment system support building, and the vitrification facility, buildings would be decontaminated, dismantled, and demolished as described for Alternative I. LLW generated by demolition would be disposed of on the Project Premises. Under Alternative IIIA, the process building, the supernatant treatment system support building, and the vitrification facility would be backfilled with concrete. The LLW currently in storage in the lag storage building; lag storage additions 1, 3, and 4; CPC waste storage area; IWSF; and the proposed contaminated soil consolidation area would be disposed of in the backfilled buildings. Stored waste would remain in the RTS drum cell, and the drum cell would be converted into a tumulus. Under Alternative IIIB, these same buildings would be demolished and the pile of rubble would be capped. The LLW would be disposed of in a new disposal facility on the Project Premises. Other types of waste would be disposed of off site.

Leachate would be pumped out of the NDA and SDA and transferred to a new wastewater treatment area. Residual sludge resulting from treatment would be solidified and managed as LLW. The buried waste in the SDA and NDA would be isolated with new covers, and barrier walls would be installed. Waste in the SDA disposal trenches would be grouted.

The in-ground structures (e.g., interceptors, pits, and lagoons) and their contents would be backfilled and capped.

Contaminated soil would be left in place, and groundwater contamination would be mitigated and monitored to ensure that contamination is not migrating off site.

Two erosion control strategies could be used under Alternative III. One strategy would include local erosion control measures that would result in high maintenance (with a service life of 30 to 50 years). Local erosion controls would consist primarily of diversion dikes, water control structures, and concrete drop structures. The second strategy would consist of global, site-wide erosion control measures that would result in a long design life. Global erosion control measures would modify the drainage pattern and consist of filling streambeds and constructing a diversion channel. Either of these strategies or a combination of these strategies could be used under Alternative III.

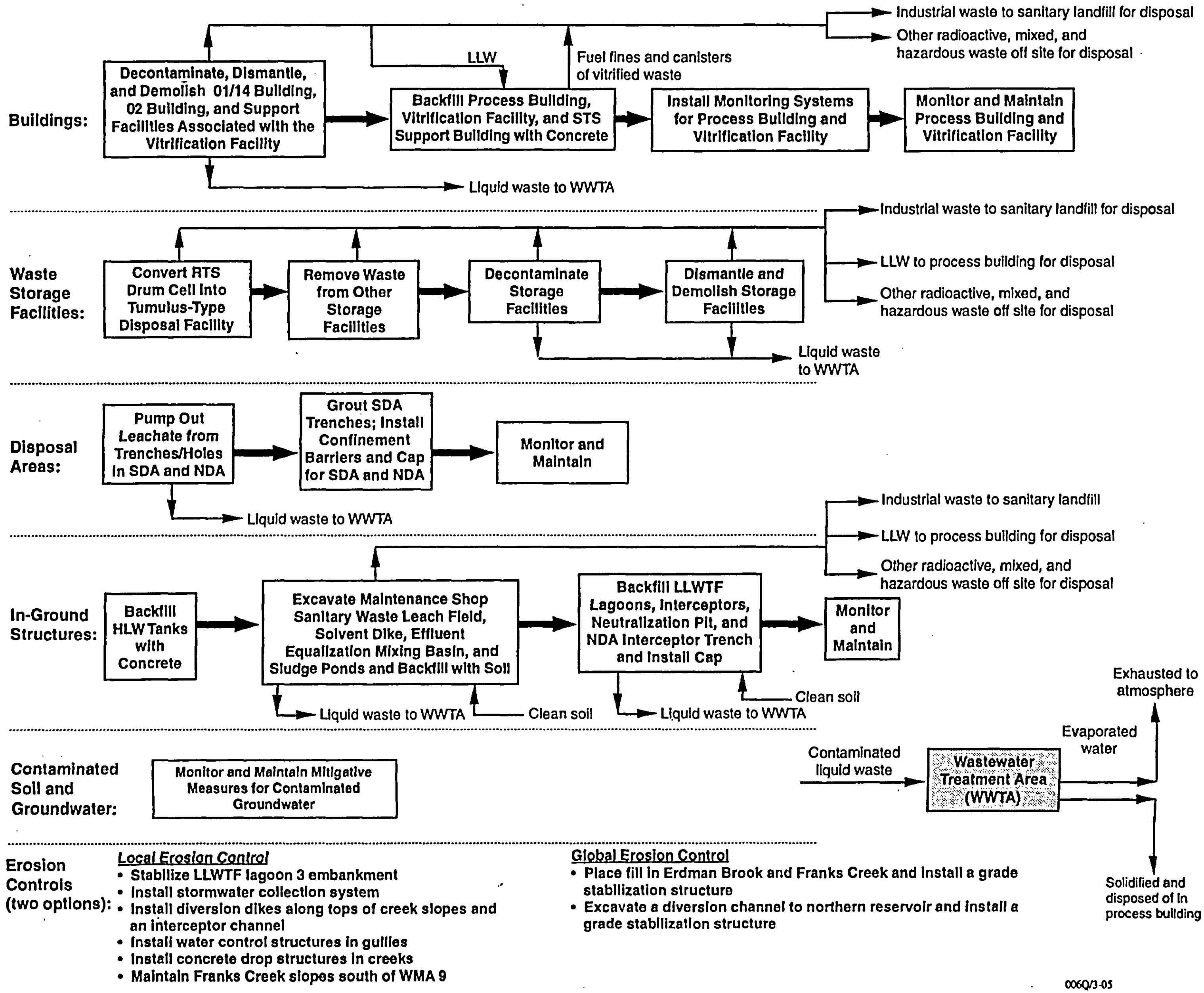


Figure 3-19. General Strategy for Implementing Alternative IIIA [In-Place Stabilization (Backfill)].

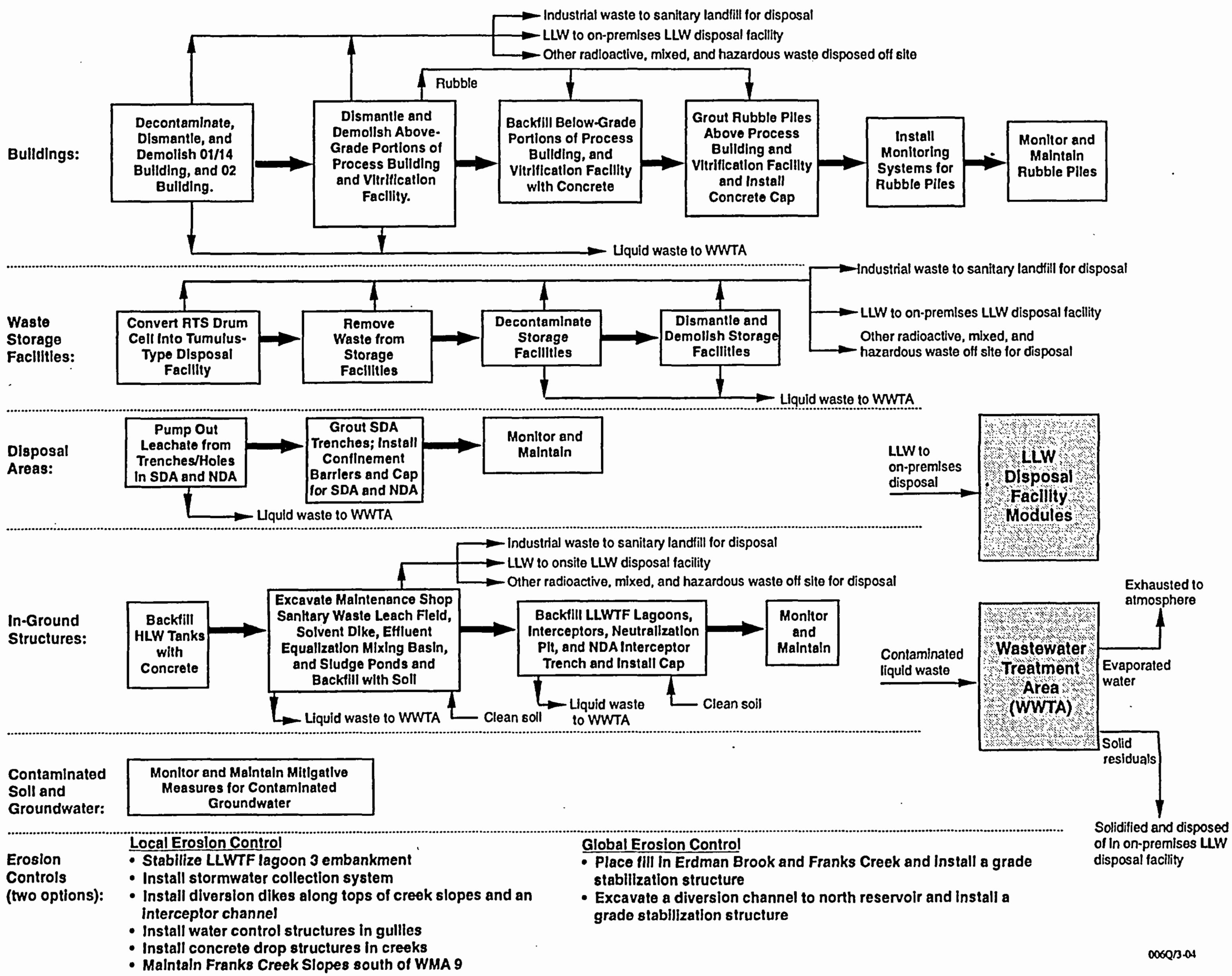


Figure 3-20. General Strategy for Implementing Alternative IIIB [In-Place Stabilization (Rubble)].

The institutional controls applied during the implementation phase of Alternatives IIIA and IIIB would be the same as those identified for Alternative I in Section 3.3.1.

3.5.2 Alternative III Implementation Phase Actions

This section describes the actions for existing facilities, structures, and environmental contamination; new facilities; and erosion control measures during the implementation phase for Alternative III.

3.5.2.1 Existing Facilities, Structures, and Environmental Contamination

This section discusses Alternative III engineering actions for existing buildings, waste storage facilities, disposal areas, in-ground structures, remaining facilities, and contaminated soil and groundwater.

3.5.2.1.1 Buildings—Specific Actions

The process building, the supernatant treatment system support building and the vitrification facility would be backfilled with concrete [Alternative IIIA: In-Place Stabilization (Backfill)] or demolished in place and capped [Alternative IIIB: In-Place Stabilization (Rubble)]. The other buildings would be decontaminated as necessary and dismantled. The contaminated materials and equipment would be disposed of on the Project Premises either in the backfilled buildings (Alternative IIIA) or in a new LLW disposal facility (Alternative IIIB). Building-specific actions under Alternatives IIIA and IIIB are described in the following sections.

Process Building. Alternative III would be implemented in one of two ways for the process building. Under Alternative IIIA, waste would be placed inside the process building, and the entire building would be backfilled with concrete to create a monolith. Under Alternative IIIB, the process building would be dismantled with the rubble used to fill the belowgrade rooms and cells. The rubble pile would then be capped.

Alternative IIIA: Monolith. The process building would not be decontaminated, except for remote vacuuming of spent fuel fines from the rooms with highest radioactive contamination and flushing the liquid waste treatment system to remove hazardous contamination. The HLW would be disposed of off site in a geologic repository. The stack and office building would be dismantled and removed by conventional methods, with the rubble placed in temporary storage on the Project Premises. The cavity occupied by the office building and its foundations would be backfilled with soil, regraded, and revegetated with native plants for erosion control.

In preparation for backfilling the process building, access and confinement barriers would be installed. These barriers would consist of air locks, temporary shielding, temporary heating, ventilation and air conditioning system, and access openings for the backfilling equipment. Stored wastes in the CPC waste storage area, lag storage building, and the lag storage additions and the waste from the stack and office building would be placed inside the process building. The entire building from the bottom level upward would be backfilled with low-density concrete or grouted in layers to uniformly distribute the load. When the backfilling was finished, the building would form a monolithic mass (WVNS 1994a). The monolith would look like the existing building, but the inside would be filled with concrete.

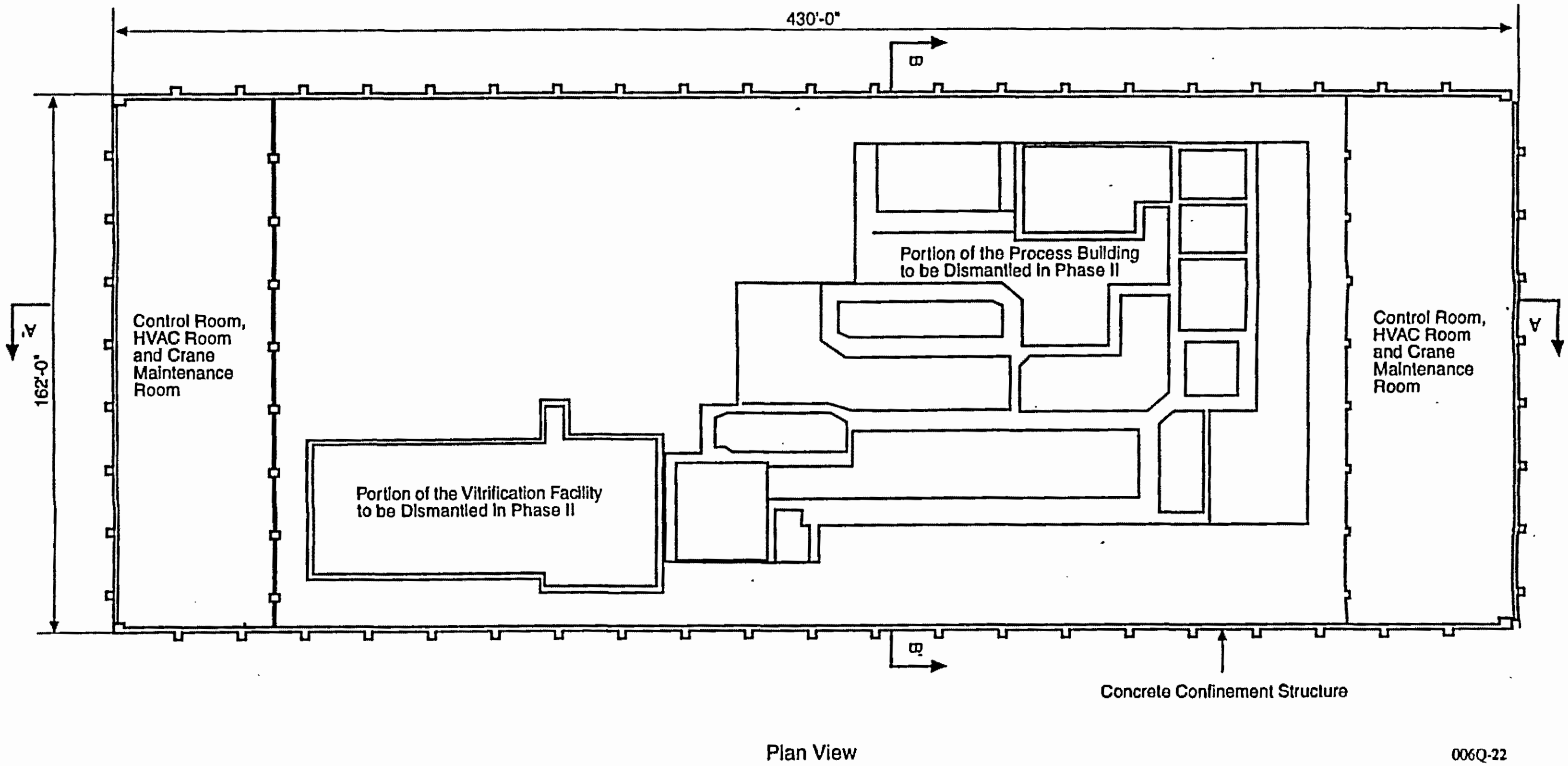
Physical security barriers, intrusion detection and alarm systems, and radiation monitors would be installed. A surveillance program, including a remote readout for the intrusion alarm system, would be installed for long-term monitoring and maintenance.

Alternative IIIB: Capped Rubble Pile. Decontamination operations would consist of remotely vacuuming the floors of the rooms containing spent fuel fines and flushing the liquid waste treatment system as described for Alternative IIIA. The HLW would be disposed of off site in a geologic repository.

The process building would be dismantled in two phases. The abovegrade portions of the building would be dismantled during Phase I where the most accessible rooms and areas with low levels of contamination would be dismantled and removed by conventional methods. A high-pressure water jet cutter could be used to remove contaminated penetrations in the walls. A water cleanup system would remove the cutting residue, and the resulting wastewater would be routed to the wastewater treatment area described in Section 3.5.2.2. The rubble generated would be uncontaminated, industrial waste that would be temporarily stored at some location on the Project Premises. (The industrial waste could be stored in a pile on the ground and would not have to be stored inside a facility.) The rubble (would be returned to the process building location during Phase II of dismantlement (WVNS 1994a).

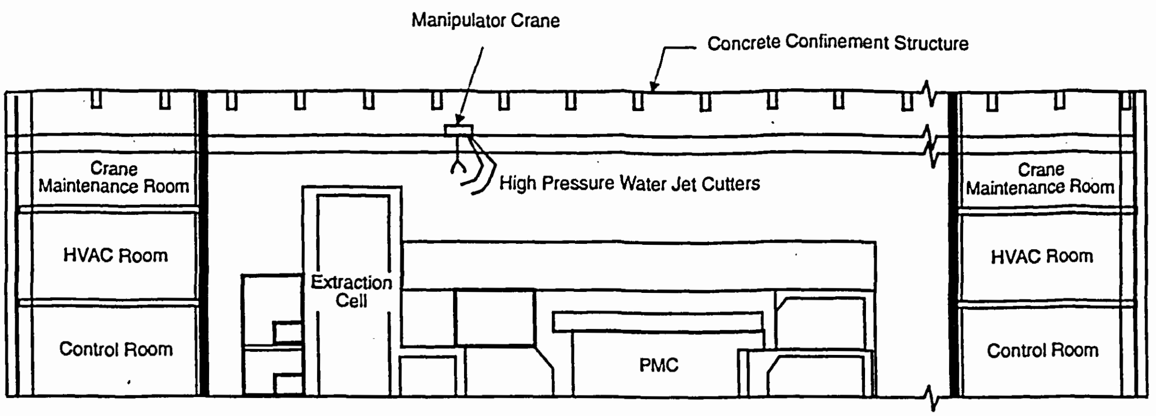
During Phase II of dismantlement, the belowgrade portions of the process building would be backfilled. Access and confinement barriers would be constructed, followed by backfilling the belowgrade rooms with concrete. A concrete confinement structure, conceptualized as shown in Figure 3-21, would be constructed to enclose the remaining process building and the vitrification facility to prevent the spread of radioactive contamination. The process building concrete support structure, including equipment and components, would be dismantled using a remotely operated, overhead bridge crane equipped with hoisting, positioning, grappling, and water jet cutters (WVNS 1994a). The hoisting system would hold the dismantled pieces and lower them to the floor. The crane position in the process building portion of the confinement structure is shown in Figure 3-22, and a schematic diagram of the crane system is shown in Figure 3-23.

Concrete walls and slabs would be cut into blocks of similar weight and shape; equipment and components would be cut into pieces; and the manipulator would stack the blocks, equipment, and components into available space in the process building. Dismantling operations would begin from the roof and progress downward, by first stacking cut blocks and equipment pieces from the ground upward (i.e., from the location of the fuel receiving and storage pool to the process cells and then up to the ground floor of the confinement structure) and then pressure-grouting them in a 0.6-m (2-ft) layer of low-density concrete poured over the pile (WVNS 1994a).

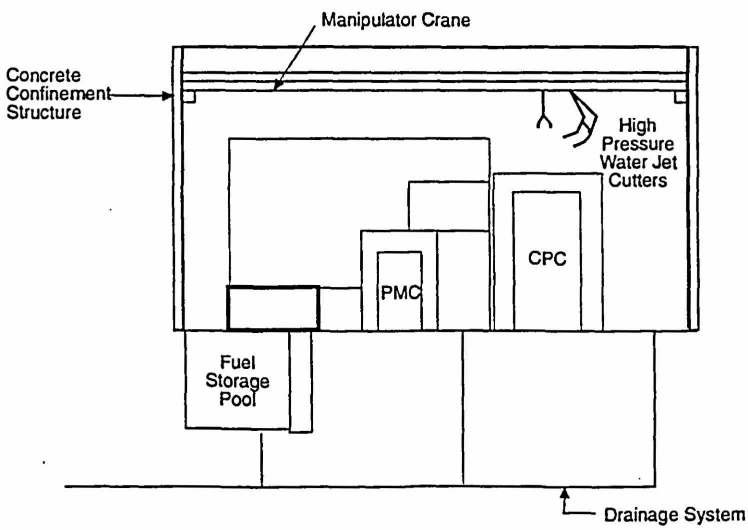


Note: Sections A-A' and B-B' shown on Figure 3-22.

Figure 3-21. Conceptual Design for the Concrete Confinement Structure around the Process Building and Vitrification Facility under Alternative IIIB (modified from WVNS 1994a and l).



Section A-A'



Section B-B'

Notes: Plan view shown on Figure 3-21.
PMC = Process Mechanical Cell
CPC = Chemical Process Cell

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Figure 3-22. Sections through the Process Building Showing the Conceptual Design for the Concrete Confinement Structure under Alternative IIIB (modified from WVNS 1994a).

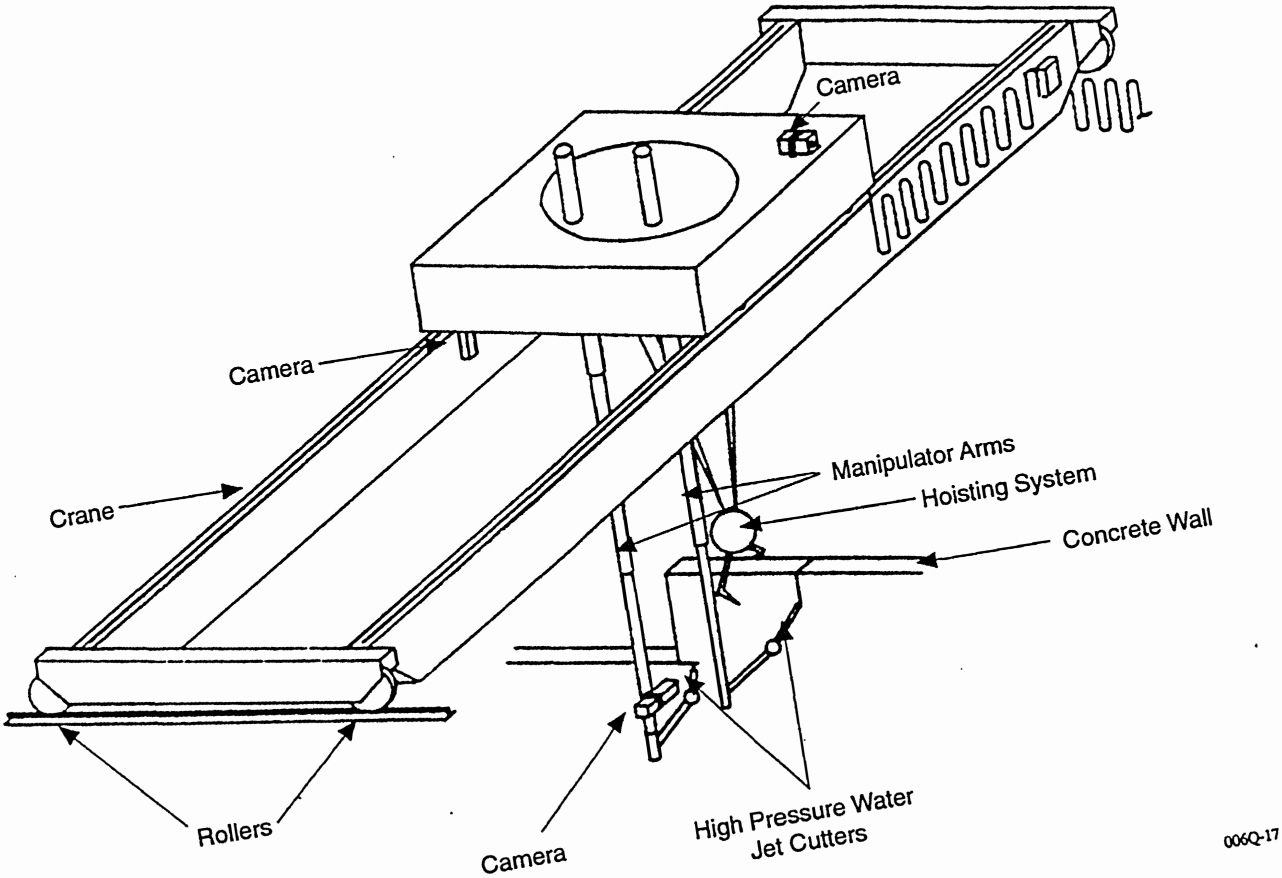


Figure 3-23. Conceptual Design for the Remotely Operated Manipulator Crane Used for Dismantling the Process Building under Alternative IIIB (modified from WVNS 1994a).

After the lower portion of the process building had been backfilled, the equipment and systems would be removed, and the concrete confinement structure would be decontaminated, dismantled, and demolished by conventional means. The rubble generated would be placed on the perimeter of the Phase II grouted rubble pile; the Phase I dismantlement rubble would be added to the pile; and the rubble pile would be shaped as necessary and capped with soil, clay, and mortar, as shown in Figure 3-24. Alarm systems and radiation monitors would be installed, and a surveillance program would be implemented for long-term monitoring and maintenance.

Vitrification Facility.

Alternative IIIA: Monolith. The vitrification facility would not be decontaminated. The steel and siding that forms the operating area around the vitrification cell would be removed. The stack would be removed and disposed of in the vitrification facility. Access and confinement barriers would be constructed, and the vitrification cell (including the melter, in-cell off-gas system, and the water transfer area) would be backfilled with low-density concrete. The resulting monolith would look like the existing building, but the inside would be filled with concrete. Security systems would be installed, and routine surveillance would be performed for long-term maintenance and monitoring.

Alternative IIIB: Capped Rubble Pile. Dismantlement of the vitrification facility would also occur in two phases like the process building. During Phase I of dismantlement, the steel siding surrounding the vitrification cell, the diesel generator room, and a portion of the secondary filter room would be removed by conventional means. Equipment and components would be decontaminated. The rubble generated during Phase I would be uncontaminated, industrial waste, which would be temporarily stored at some location on the Project Premises.

During Phase II of dismantlement, the vitrification cell would be dismantled in conjunction with the process building under a single confinement structure as shown in Figure 3-21. The dismantling equipment would be the same as that used for the process building as shown in Figure 3-23, and it would be used to cut equipment and concrete. Rubble and equipment pieces would be placed at or belowgrade as work progressed. The resulting rubble pile would be pressure-grouted like the process building rubble pile, and a 0.6-m (2-ft) layer of concrete would be placed over the pile. The confinement structure would be decontaminated, dismantled, and demolished. The rubble generated would be placed on the perimeter of the Phase II grouted rubble pile, the Phase I dismantlement rubble would be added (WVNS 1994b), and the rubble pile would be shaped and capped with soil, clay, and mortar, as shown in Figure 3-25. Alarm systems and radiation monitors would be installed, and a surveillance program would be implemented for long-term monitoring and maintenance.

01/14 Building. The cement solidification system in the 01/14 building would be used for solidifying radioactive wastes generated during closure. Because contamination levels are low, the building would be demolished in the same manner as Alternatives I and

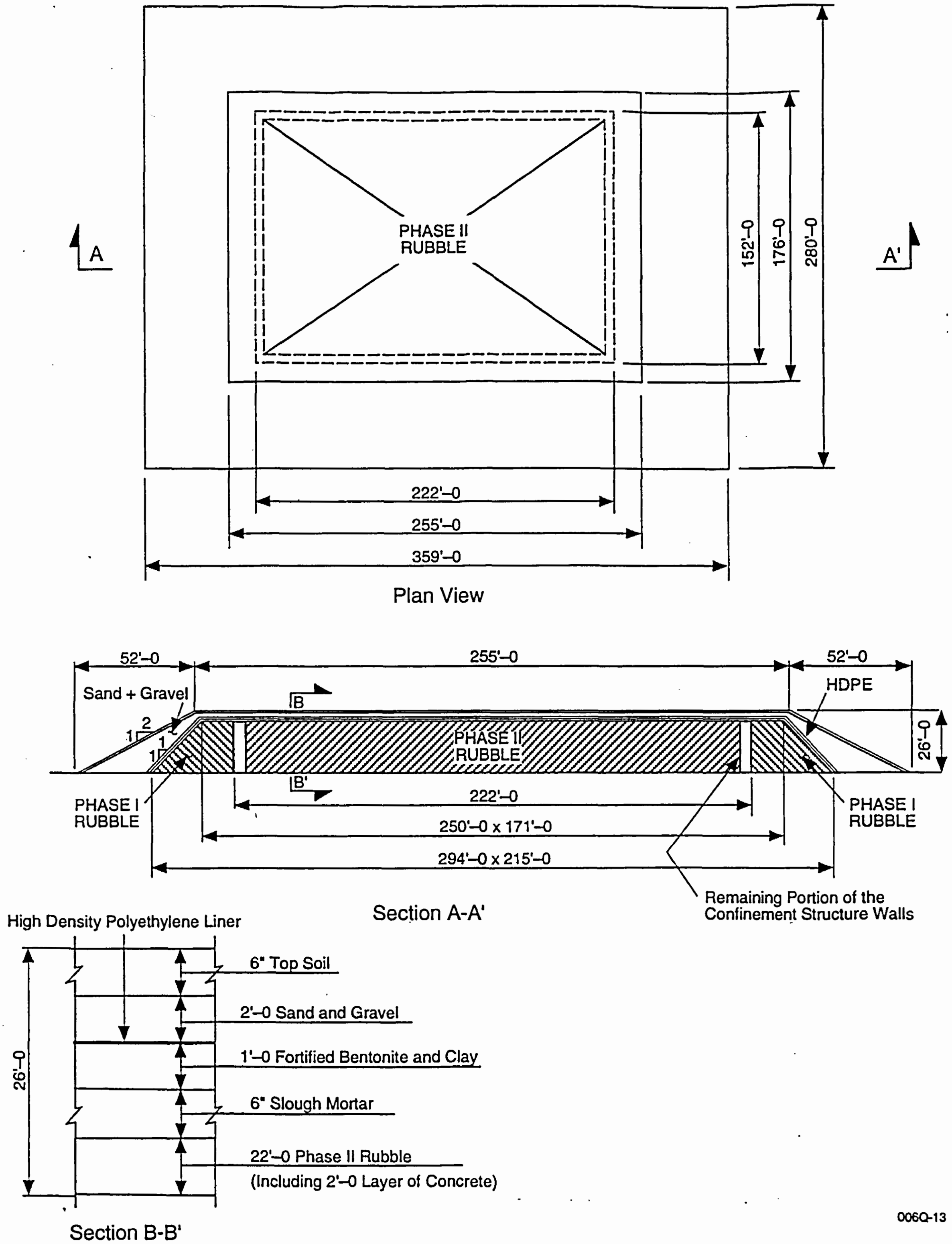


Figure 3-24. Conceptual Design for the Process Building Capped Rubble Pile under Alternative IIIB (modified from WVNS 1994a).

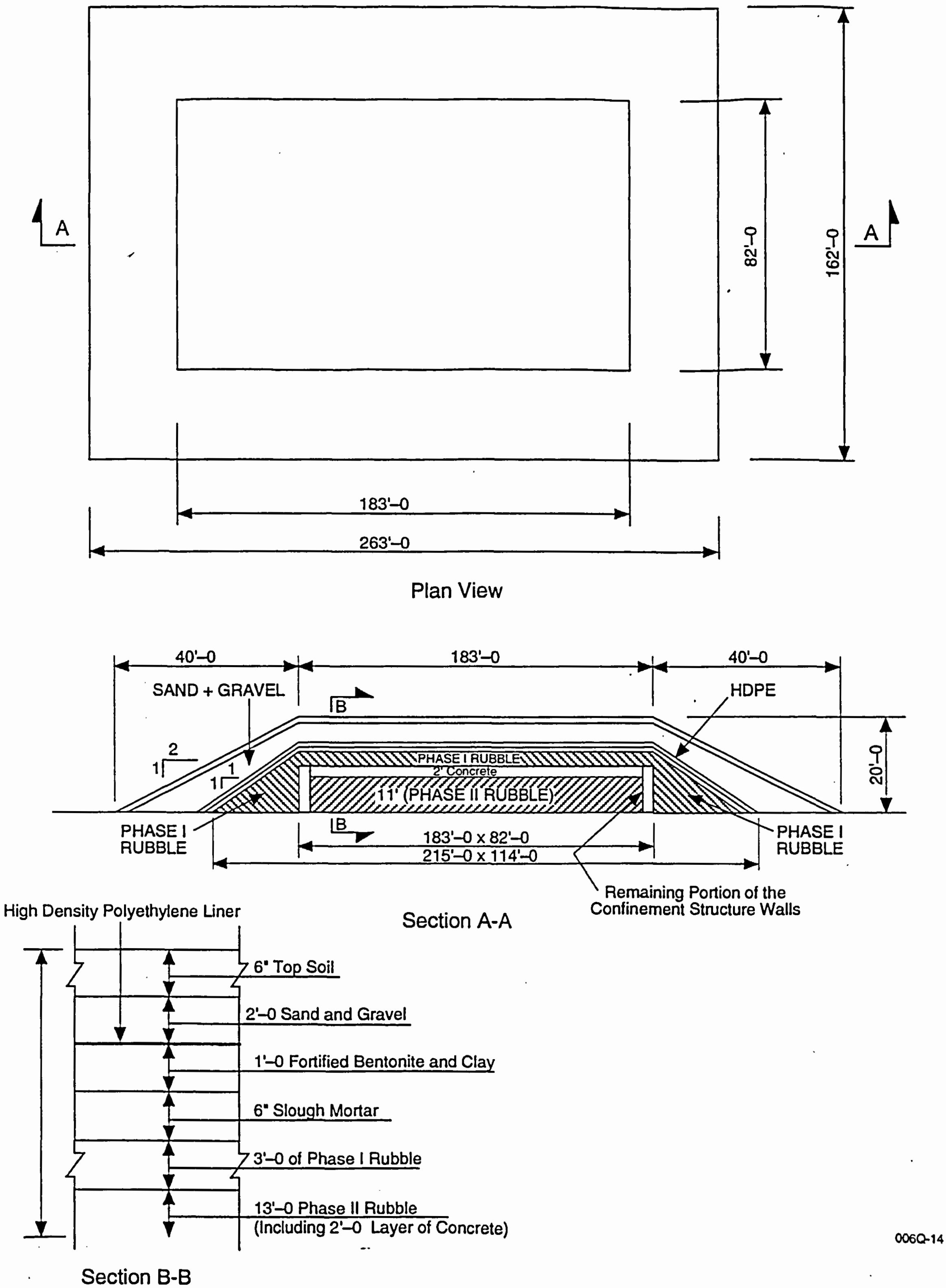


Figure 3-25. Conceptual Design for the Vitrification Facility Capped Rubble Pile under Alternative IIIB (modified from WVNS 1994b).

II. After treatment operations have been completed, the cement solidification system would be flushed, and equipment in the 01/14 building would be decontaminated and dismantled (see Section 3.3.2.1.1). Equipment pieces would be packaged and either disposed of in the process building and vitrification facility under Alternative IIIA or in a new LLW disposal facility under Alternative IIIB (see Section 3.5.2.2). The clean rubble generated from building demolition would be disposed of off site in a sanitary landfill. The area would be backfilled, regraded, and revegetated with native plants for erosion control (WVNS 1994c).

02 Building. The 02 building would be decontaminated and demolished in the same manner as Alternatives I and II. The area would be backfilled, regraded, and revegetated with native plants for erosion control. The waste generated would be disposed either in the process building and vitrification facility under Alternative IIIA or in a new LLW disposal facility under Alternative IIIB.

3.5.2.1.2 Waste Storage Facilities—Specific Actions

Stored waste in the lag storage building, lag storage additions, CPC waste storage area, IWSF, and proposed contaminated soil consolidation area would be characterized. Radioactively contaminated waste would be disposed of on the Project Premises either in the process building (Alternative IIIA) or in a new LLW disposal facility (Alternative IIIB). Clean rubble would be disposed of in an off-site sanitary landfill, and mixed waste would be transported off site for treatment and disposal. The waste storage facilities would be decontaminated as necessary and demolished, and the area would be backfilled, regraded, and revegetated with native plants for erosion control.

No stored waste would be removed from the RTS drum cell. Instead, the RTS drum cell would be converted into a tumulus-type disposal facility. The tumulus would cover an area of approximately 24,100 m^2 (260,000 ft^2) with a maximum height of 13 m (43 ft) abovegrade (WVNS 1994g). The tumulus would be an artificial hillock with side slopes and designed to minimize contact between surface water and the waste. Water contact would be minimized by an overlayer of compacted clay to reduce infiltration and a gravel base pad to permit drainage. Equipment to monitor moisture intrusion and radiation release would be embedded in the tumulus layers. Radiation shielding and access protection would also be provided. A layer of precast dolomite units and stone would be included as a barrier to intruders.

3.5.2.1.3 Disposal Areas—Specific Actions

The disposal areas would be stabilized in place.

Construction and Demolition Debris Landfill. The materials disposed of in the CDDL were uncontaminated when they were landfilled, and the CDDL has been capped and closed under a NYSDEC-approved closure plan (WVNS 1994i). Therefore, the CDDL would be left in place. The contaminated groundwater plume that has migrated to the CDDL would be controlled using mitigative measures put in place before implementation of the alternatives. A long-term monitoring and maintenance program would be implemented.

State-Licensed Disposal Area. The SDA would be stabilized in situ; no soil or waste would be exhumed. Because the degradable waste in the SDA would decompose and form void space, the waste in the disposal trenches would be grouted to provide support for a new engineered cap to prevent slumping. A circumferential slurry wall and an engineered cap would confine and immobilize contaminants.

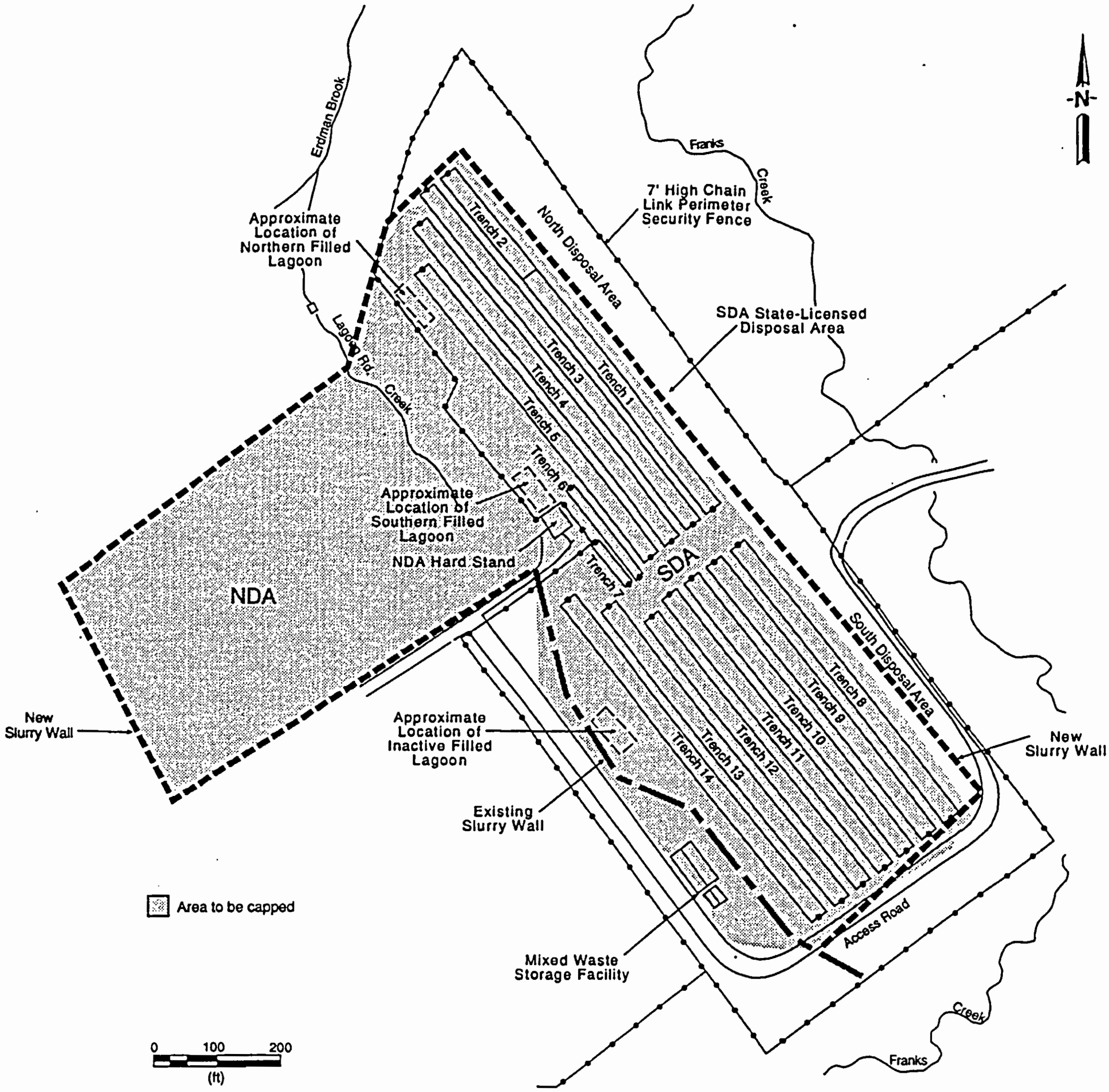
The existing belowgrade slurry wall on the southwestern boundary of the SDA would be extended to merge with the proposed slurry wall for the NDA and extended completely around the SDA. This circumferential slurry wall would prevent groundwater from flowing horizontally into or out of the SDA, thereby minimizing contaminant transport away from the SDA over the long term. Figure 3-26 shows the potential location of the circumferential slurry wall. The slurry wall would be about 9 m (30 ft) deep and extend into the unweathered till (WVNS 1994j).

The existing sumps in the 12 main SDA trenches (trenches 1 through 5 and 8 through 14) would be used to remove leachate which would be pumped to the new wastewater treatment area (see Section 3.5.2.2). The existing hold-up tank enclosure would be demolished, and the industrial waste would be disposed of off site.

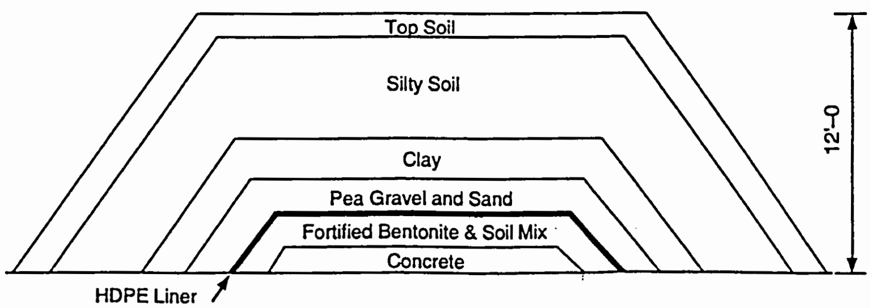
The existing trench caps would be removed, and the buried waste in the trenches would be grouted by pumping concrete into the trenches to support a new, engineered cap. The cap would consist of layers of concrete, clay, fortified bentonite, gravel sand, high-density polyethylene liner, soil, and top soil arranged to provide erosion protection, drainage, and to create an effective infiltration barrier (see Figure 3-26). The cap would be graded and revegetated to protect from erosion. The capped SDA would have a long-term inspection, maintenance, monitoring, and surveillance program.

Nuclear Regulatory Commission-Licensed Disposal Area. The NDA would be stabilized in situ; no waste or soil would be exhumed. Because the waste buried at the NDA contains primarily metals and soil, there would be adequate support for the engineered cap, and the disposal holes would not be grouted. Therefore, the same type of confinement technology used at the SDA would be used for the NDA, except that the disposal holes would not be grouted. A belowgrade slurry wall would be installed to control the horizontal flow of groundwater into the disposal holes. The slurry wall would be about 9 m (30 ft) deep or extend into the unweathered till. The wall would completely surround the NDA, except on the northeast side, where it would merge with the SDA slurry wall, as shown in Figure 3-26 (WVNS 1994h). Leachate in the disposal holes would be pumped to the new wastewater treatment area (see Section 3.5.2.2). Because the trench interceptor project on the north and west sides of the NDA has not indicated contamination, the trench would be left in place (WVNS 1994h).

The same type of multilayered engineered cap installed over the SDA would be installed over the NDA, including a portion of the trench interceptor project to provide one uniform cap over both areas. The cap would provide erosion protection, drainage, and would create an effective infiltration barrier (see Figure 3-26 for the portion of the cap over the NDA). The cap would be graded and revegetated with native plants to control erosion.



(a) Circumferential Slurry Wall and Capped Area



(b) Cross-Section of Engineered Cap for Proposed Use on the SDA and NDA

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Figure 3-26. Conceptual Design for the Circumferential Slurry Wall and Engineered Cap for the State-Licensed Disposal Area and Nuclear Regulatory Commission-Licensed Disposal Area under Alternative III (a) Plan View of Capped Area and (b) Typical Layers of Engineered Cap (modified from WVNS 1994j).

The NDA would have a long-term inspection, maintenance, monitoring, and surveillance program.

3.5.2.1.4 In-Ground Structures—Specific Actions

In-ground structures and associated contaminated material would either be excavated, removed, or stabilized in place (backfilled). Contaminated waste would be disposed of on the Project Premises.

High-Level Waste Storage Tanks and Vaults. The HLW tanks would not be decontaminated, and the sludge inside the tanks would remain in place. Confinement barriers would be constructed, and the tanks and the interior of the tank vaults would be backfilled with low-density concrete applied simultaneously from several access holes in the tanks and vaults to achieve uniform layers. The gravel layers and containment pans beneath the tanks would be backfilled along their perimeters (WVNS 1994b).

State-Licensed Disposal Area Northern, Southern, and Inactive Filled Lagoons. The SDA filled lagoons would be left in place. The new engineered SDA cap would also cover the filled lagoons, as shown in Figure 3-26 (WVNS 1994j). Like the SDA disposal trenches, the filled lagoons would be managed under a long-term maintenance and monitoring program.

Low-Level Waste Treatment Facility Lagoons 1, 2, 3, 4, and 5. The LLWTF lagoons would be stabilized in place. Lagoon 1 has already been backfilled; lagoons 2 through 5 would be backfilled with sand and gravel to grade level. All five of the lagoons would be placed under a multilayered engineered cap to prevent infiltration, and the area would be revegetated with native plants for erosion control. The LLWTF lagoons would be managed under a long-term maintenance and monitoring program (WVNS 1994d).

Old Interceptor, New Interceptors, and Neutralization Pit. The interceptors and neutralization pit would be stabilized in place by backfilling with concrete and capping with soil. The area would be regraded and revegetated with native plants for erosion control and managed under a long-term monitoring and maintenance program (WVNS 1994i).

Nuclear Regulatory Commission-Licensed Disposal Area Trench Interceptor Project. The liquid pretreatment system in the trench interceptor project would be demolished, and LLW would be disposed of on the Project Premises either in the process building (Alternative IIIA) or in the new LLW disposal facility (Alternative IIIB). Industrial waste would be disposed of off site. The trench would be left in place and the eastern portion of the trench would be covered by the new NDA cap.

Maintenance Shop Sanitary Waste Leach Field. The septic system would be removed, and the soil would be excavated to a depth of 1.5 m (5 ft) (WVNS 1994i). The waste is expected to be industrial waste that would be disposed of off site in a sanitary landfill. The excavated area would be backfilled with clean fill, regraded, and revegetated with native plants for erosion control.

Solvent Dike, Effluent Equalization Mixing Basin, and North and South Sludge Ponds. The solvent dike and the north and south sludge ponds would be excavated. The contaminated wastes would be disposed of on the Project Premises either in the process building (Alternative IIIA) or in the new LLW disposal facility (Alternative IIIB). Water in the sanitary effluent equalization mixing basin would be pumped out and treated in the existing sewage treatment plant, and the membrane liner and underdrain system would be excavated. Industrial waste generated would be disposed of off site. Excavated areas would be backfilled with clean fill, regraded, and revegetated with native plants for erosion control.

3.5.2.1.5 Remaining Facilities—Specific Actions

The remaining facilities (see Table 3-3) would be decontaminated as necessary, dismantled, and removed (see Section 3.3.2.1.5). The steel portion of the supernatant treatment system support building that is not contaminated would be removed. The concrete portion of the building, which may have localized areas of contamination, would be backfilled with low-density concrete. Twelve facilities would remain to support the disposal facilities on the Project Premises (WVNS 1994k): (1) security gate houses, (2) OB-1 office building, (3) barbed wire fencing, (4) electrical substation, (5) steel fence, (6) new warehouse, (7) utility poles, (8) parking lots (10 percent of existing parking lots), (9) maintenance shop, (10) roadways, (11) environmental sampling stations, and (12) groundwater monitoring wells. The two earthen dams and reservoirs would remain. The reservoirs would be necessary for instituting a global erosion control strategy.

3.5.2.1.6 Contaminated Soil and Groundwater

Under Alternative III, contaminated soil and stream sediments on the Center and contaminated groundwater would be left as-is, except for the contaminated groundwater plume in the north plateau, which would be controlled using mitigative measures put in place before implementation of the alternatives. In certain cases, the contaminant source would be removed (e.g., some in-ground structures) or managed in place (e.g., at the NDA and SDA disposal areas) to control the spread of contamination.

3.5.2.2 New Facilities Required

Alternative IIIA would require one new facility: a wastewater treatment area for treating both liquid decontamination wastes and leachate from the disposal areas. Alternative IIIB would require two new facilities: a wastewater treatment area and a LLW disposal facility.

Wastewater Treatment Area. The wastewater treatment area required for Alternative III has been conceptualized as being the same as the wastewater treatment area described for the container management area in Alternative I (see Section 3.3.2.2). It would be constructed in a separate building, having a conceptual floor plan as shown in Figure 3-11(b) (WVNS 1994l). The processing equipment in the facility would treat contaminated liquids by using sequential batch biological reactors and evaporating the treated water. Residual sludge would be solidified and disposed of either on the Project Premises or off site. The wastewater treatment area could be located near the process building for Alternative IIIB (see Figure 3-27) or could be located in the northeast corner of WMA 9 near the SDA for Alternative IIIA. Factors for determining available area and potential locations are discussed in detail in Appendix N.

Low-Level Waste Disposal Facility. The disposal of LLW under Alternative IIIB would require a new disposal facility on the Project Premises. A tumulus type disposal system with separate modules would be constructed. Each module would measure 27 m wide x 82 m long x 9 m high (90 ft wide x 270 ft long x 30 ft high) and would hold about 6,700 m^3 (235,000 ft^3) of waste (WVNS 1994o). Each module would consist of reinforced concrete bunkers assembled on a concrete pad at grade with a waste stacking area; a control room; a heating, ventilation and air conditioning equipment room; and a sump room. The first module (and others, if necessary) would have a health physics and records office.

Figure 3-28 shows the conceptual design for a LLW disposal module. Waste would be handled by forklift or gantry crane. Three modules would be required to contain the estimated waste volume to be disposed of.

As each module was filled with waste containers, the areas with waste would be covered by movable roof panels. When the entire module was filled, the roof panels would be removed in sections, void space around the containers would be backfilled with sand and gravel for Class A waste and concrete for Class B and Class C waste, and the roof panels would be replaced. The module would be encapsulated in a tumulus and provided with an impermeable cover (see Figure 3-28). All rollup and other access doors would be removed, the doorways filled with concrete, the support areas (heating, ventilation, and air conditioning; control room; office; and sump room) demolished and removed, and industrial waste generated by demolition would be disposed of off site. The area around each disposal module would be filled with compacted soil to form the base of the tumulus. An engineered cap would cover the entire disposal module to isolate the waste from water. The cap would be multi-layered, consisting of a synthetic liner, clay, bentonite and clay, a drainage layer of sand and gravel, and a vegetative cover of revegetated top soil (WVNS 1994o). Like the other areas on the Project Premises, the capped disposal facility would be managed under a long-term maintenance and monitoring program that would include sampling drainage from the disposal facility.

Potential locations for the three LLW disposal facility modules are shown in Figure 3-27. Factors used to determine available areas and potential locations are described in detail in Appendix N.

3.5.2.3 Erosion Control Measures

Under Alternative III, the process building and vitrification facility disposal facilities (Alternatives IIIA and IIIB); the disposal areas (CDDL, SDA, and NDA); the new LLW disposal facility (Alternative IIIB); and the RTS drum cell tumulus would remain on the Project Premises and would require measures to control erosion and stabilize soil.

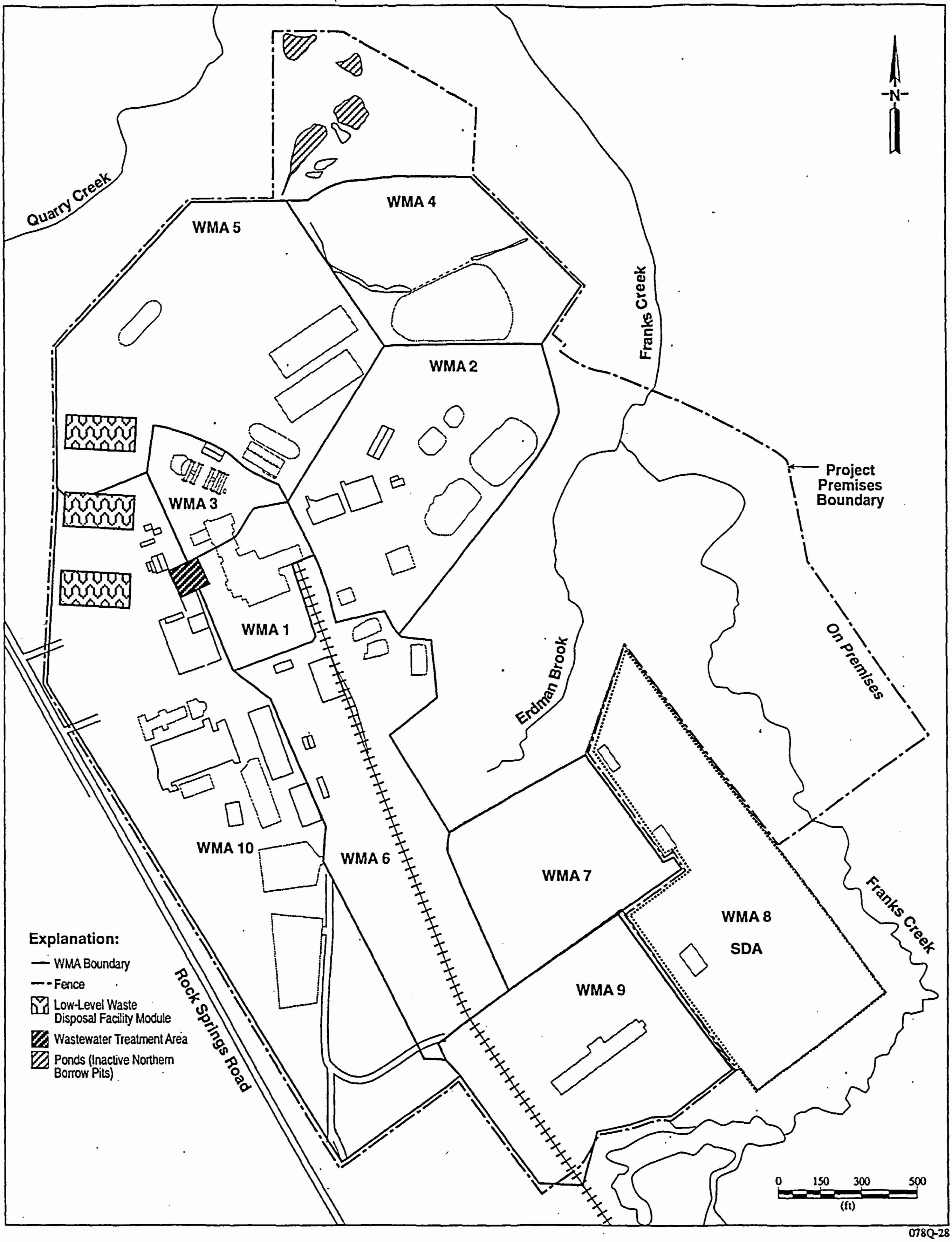
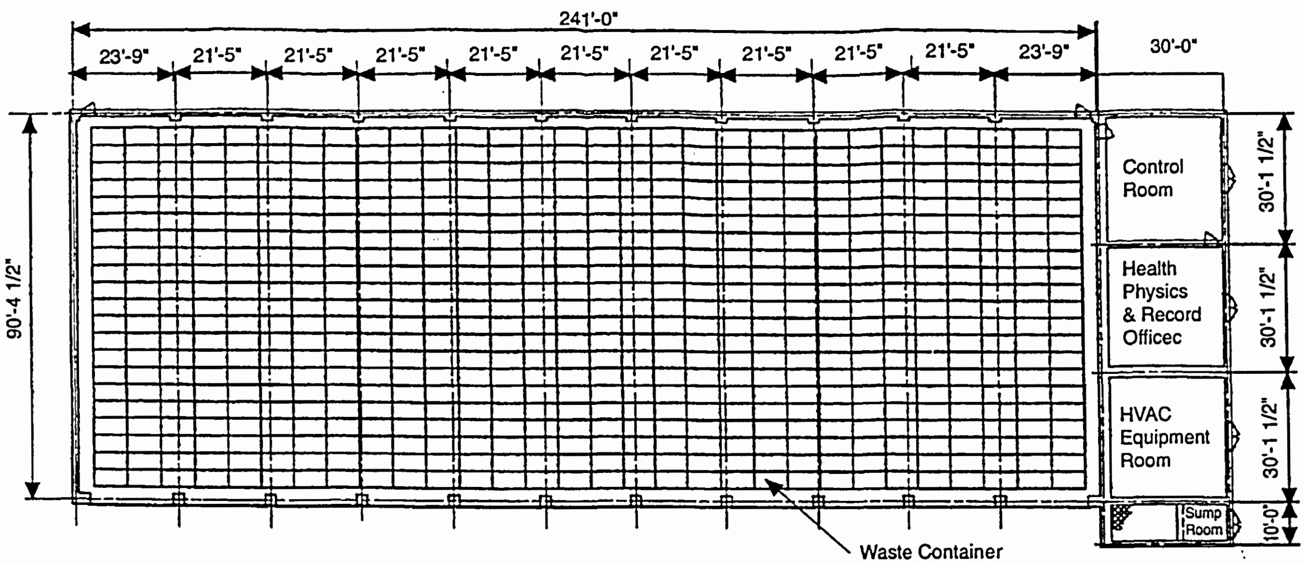
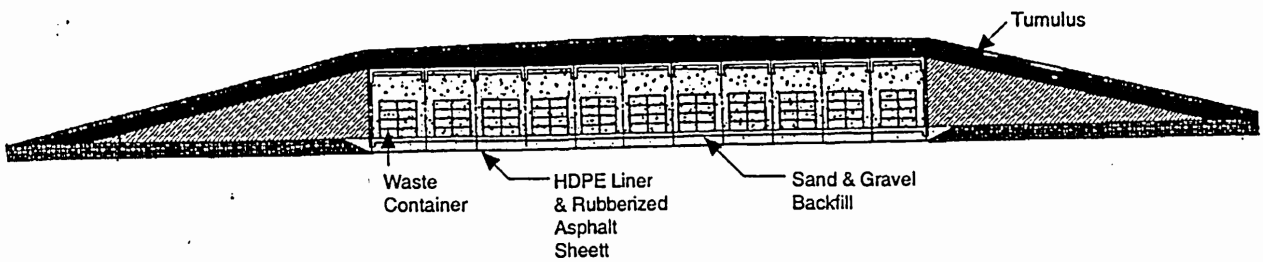


Figure 3-27. Potential Locations of the Wastewater Treatment Area (under Alternatives IIIA and IIIB) and the Low-Level Waste Disposal Facility Modules (under Alternative IIIB only).



(a) Floor Plan of Module



(b) Cross-Section of Tumulus

006Q-28

Figure 3-28. Conceptual Design for the On-Premises Low-Level Waste Disposal Facility Module (a) Floor Plan and (b) Cross-Section after Conversion into a Tumulus (modified from WVNS 1994o).

The embankment of lagoon 3 would be stabilized with sheet piling because lagoon 3 would be backfilled and capped (see Section 3.3.2.3) (WVNS 1994n).

Erosion control measures would be taken to protect the various disposal areas and in-ground structures. Under both Alternatives IIIA and IIIB, either a local or a global erosion control strategy could be used. Many local erosion control structures could be installed with design lives of approximately 30 to 50 years (WVNS 1994n). Long-term solutions could be implemented that would require substantial engineering efforts, including stream diversion in certain areas. In either case, the erosion control measures would require continued inspection, monitoring, maintenance, and replacement as necessary.

3.5.2.3.1 Local Erosion Control Strategy

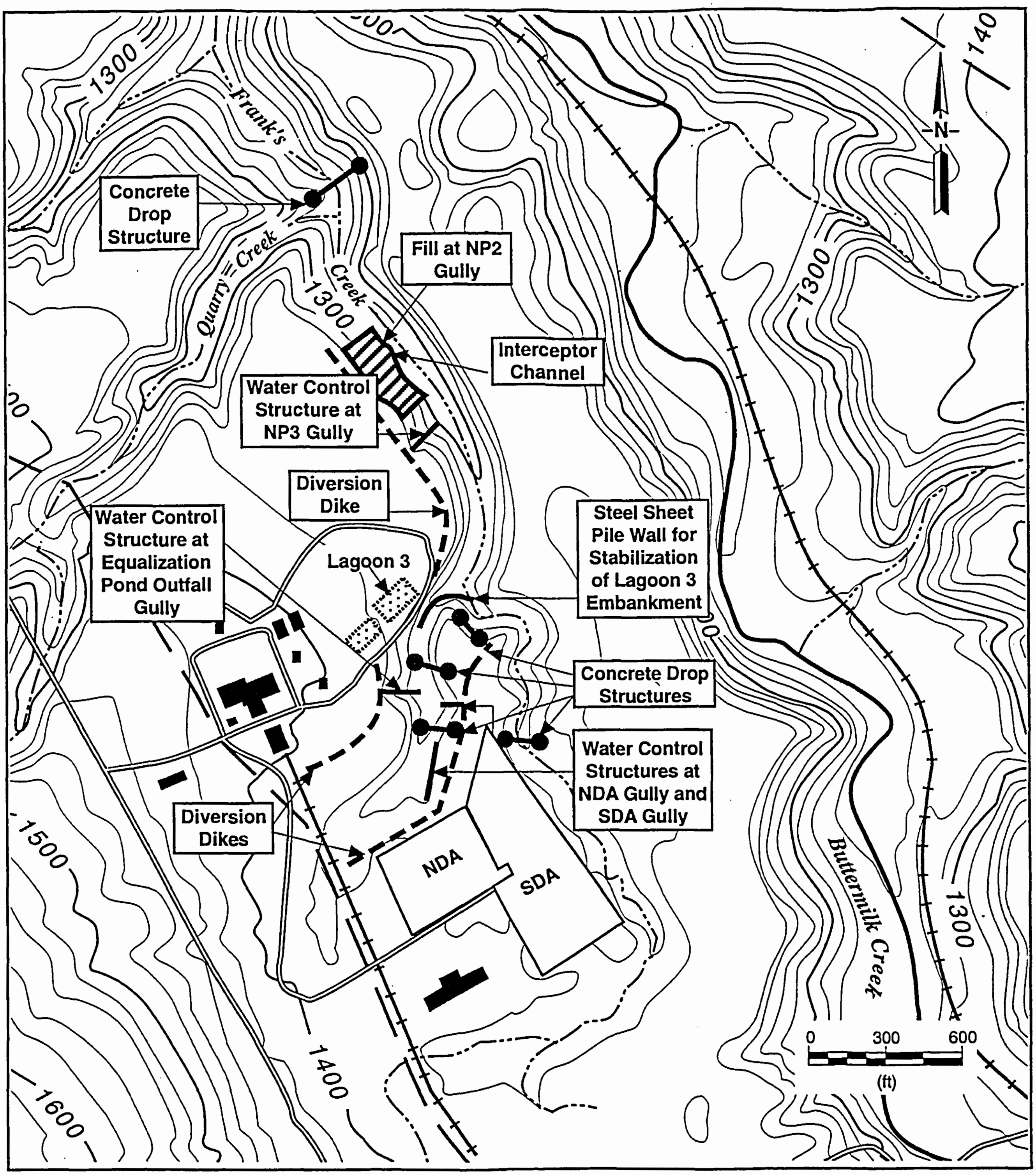
Under Alternatives IIIA or IIIB, local erosion control (consisting of a stormwater collection system, water control structures, diversion dikes, an interceptor channel, and drop structures) could be installed to prevent developing or advancing gullies and widening of stream valleys (WVNS 1994n). Potential locations of the local erosion control structures are shown in Figure 3-29.

A stormwater collection system would be installed on the Project Premises to direct surface runoff from the paved areas to water control structures for discharge to Erdman Brook, Franks Creek, and Quarry Creek (see Section 3.4.2.3).

Water control structures would be installed in four existing gullies (see Figure 3-29): NP3 gully, the effluent equalization mixing basin outlet gully, SDA gully, and NDA gully. The water control structures would minimize erosion by dissipating the erosive energy of the water as it is conveyed from the plant site elevations to the streambeds, thereby, minimizing further advancement of the gullies. Each water control structure would consist of a stormwater inlet, concrete piping, and a riprap outlet. The water control structures located at the NP3 gully and the effluent equalization mixing basin outlet gully would have outlets that drain to a detention pond (see Figure 3-30) to reduce the peak discharge to the stream (Heffernan 1994). Concrete piping would drain water from the detention ponds to the nearby streams below (Heffernan 1994). The outlets to the detention ponds and streams would include riprap for scouring protection.

Three diversion dikes would be installed: one on each side of Erdman Brook and one along the top of the slope along Franks Creek where erosion is active (see Figure 3-29). The dikes would direct overland flow to the water control structures described previously, which would control release to the streams. The diversion dikes would mitigate uncontrolled water flow down the valley slopes and would, therefore, minimize slope erosion. Existing minor gullies would be filled with the material remaining from shaping and grading unstable slopes, and the filled areas would be stabilized using vegetative covers. These actions would enhance local stabilization.

An interceptor channel would be installed across the mid-section of the western slope of Franks Creek as shown on Figure 3-29. The interceptor channel would run parallel to



Note: Much of the plant site would be paved after constructing the storm water collection system. 006Q-36/3-29

Figure 3-29. Conceptual Design for the Local Erosion Control Strategy for Alternative IIIA [In-Place Stabilization (Backfill)] or Alternative IIIB [In-Place Stabilization (Rubble)] (modified from WVNS 1994n).

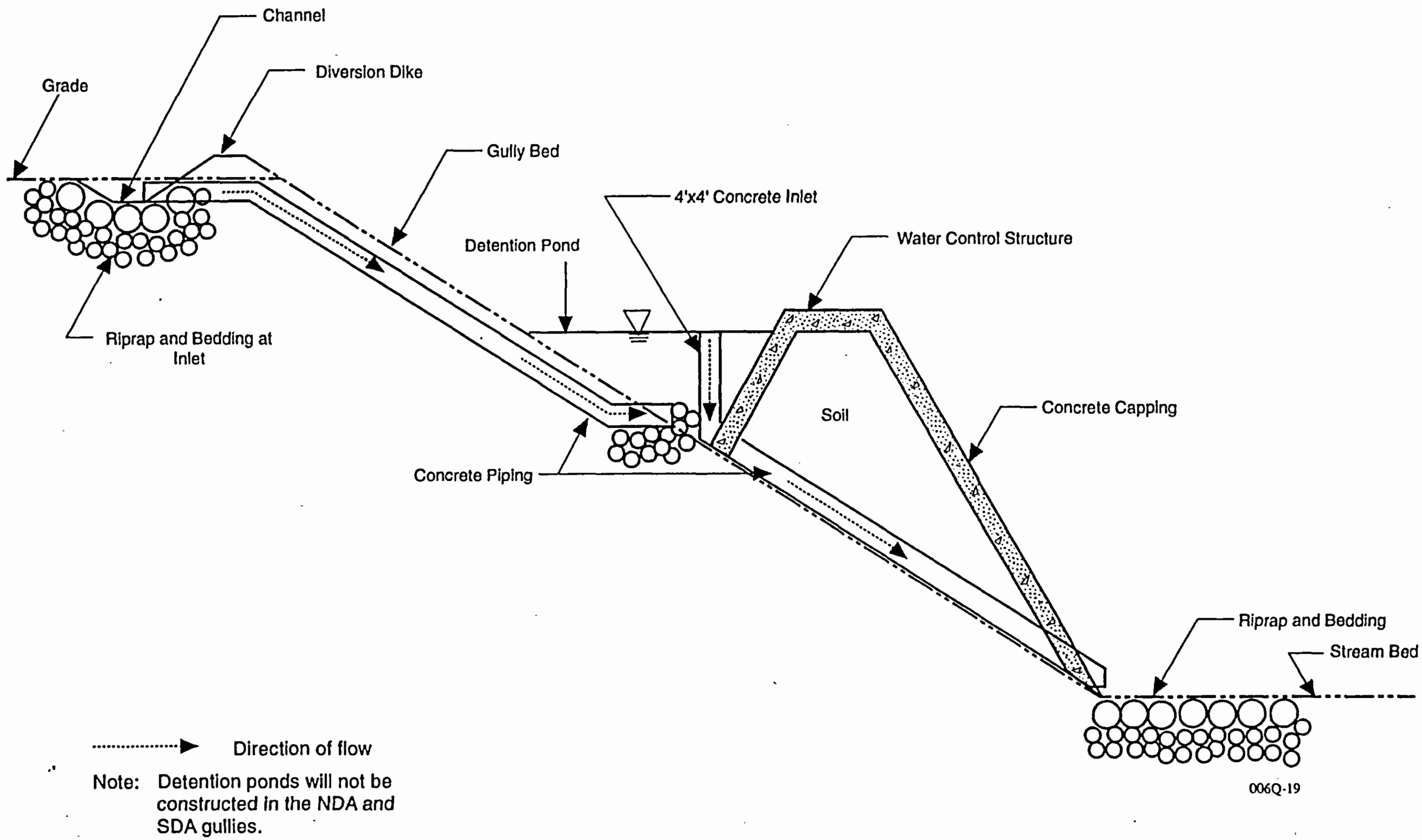


Figure 3-30. Cross Section Showing the Conceptual Design for Typical Water Control Structure at Gullies (modified from WVNS 1994n).

Franks Creek and be located between the top of the slope and the stream bed to increase the stability of the existing slopes by intercepting surface runoff and discharging it into Franks Creek. Gully NP2, which has been inactive, would be filled.

Five concrete drop structures, three in Erdman Brook and two in Franks Creek, would be installed as shown in Figure 3-31. The drop structures would be located at stream sections with high-flow velocities as shown on Figure 3-29. By controlling and reducing the slope of the creek bed, the water velocity in the creek would be reduced and creek valley widening would be slowed. The drop structure would consist of a concrete gravity dam with a riprap outlet channel, and it would create a drop in the creek bed of approximately 1.2 m (4 ft) as shown in Figure 3-31. The stream sections leading into and away from the concrete drop structures would be reshaped and regraded for stabilization and to reduce stream valley widening.

Erosion would be a long-term threat to the RTS drum cell tumulus, NDA, and SDA. Therefore, the Franks Creek stream banks on the south side of WMA 9 and east side of WMA 8 would be maintained and the slopes stabilized to limit developing and advancing of gullies and the eventual widening of Franks Creek.

If these local erosion control structures are not maintained, erosion would continue. Therefore, after the implementation phase, the local erosion control structures would have to be inspected, maintained, and replaced, as necessary.

3.5.2.3.2 Global Erosion Control Strategy

Under either Alternative IIIA or IIIB, extensive global erosion control measures that would alter the site terrain could be implemented to protect remaining facilities. Because buried waste would be left in the ground and newly generated waste would be disposed of aboveground, the main objective of these global erosion controls would be to divert water flow away from the new and existing disposal areas by changing the existing flow directions in the streams. Global erosion control measures have been conceptualized as diversion channel excavation, streambed filling, and construction of grade stabilization structures. These site-wide actions would be able to control 2, 10, and 100-year rainfall events (WVNS 1994n).

A diversion channel would be excavated between Rock Springs Road and the existing railroad embankment, as shown in Figure 3-32, to divert surface water flow from the upper watersheds of Erdman Brook and Franks Creek (away from the NDA and SDA disposal areas) and from the west side of Rock Springs Road, south to the north reservoir. The diversion channel would reduce soil erosion on the slopes adjacent to the NDA and SDA. The width of the diversion channel would be 61 m (200 ft) at the bottom with 1 to 3 side slopes. The channel would slope 0.8 percent from its confluence with Erdman Brook to the northern reservoir (WVNS 1994n).

Fill would be placed in Erdman Brook to slow erosion on the northern side of the NDA and SDA. The southern (upper) portion of Erdman Brook would be filled, with the

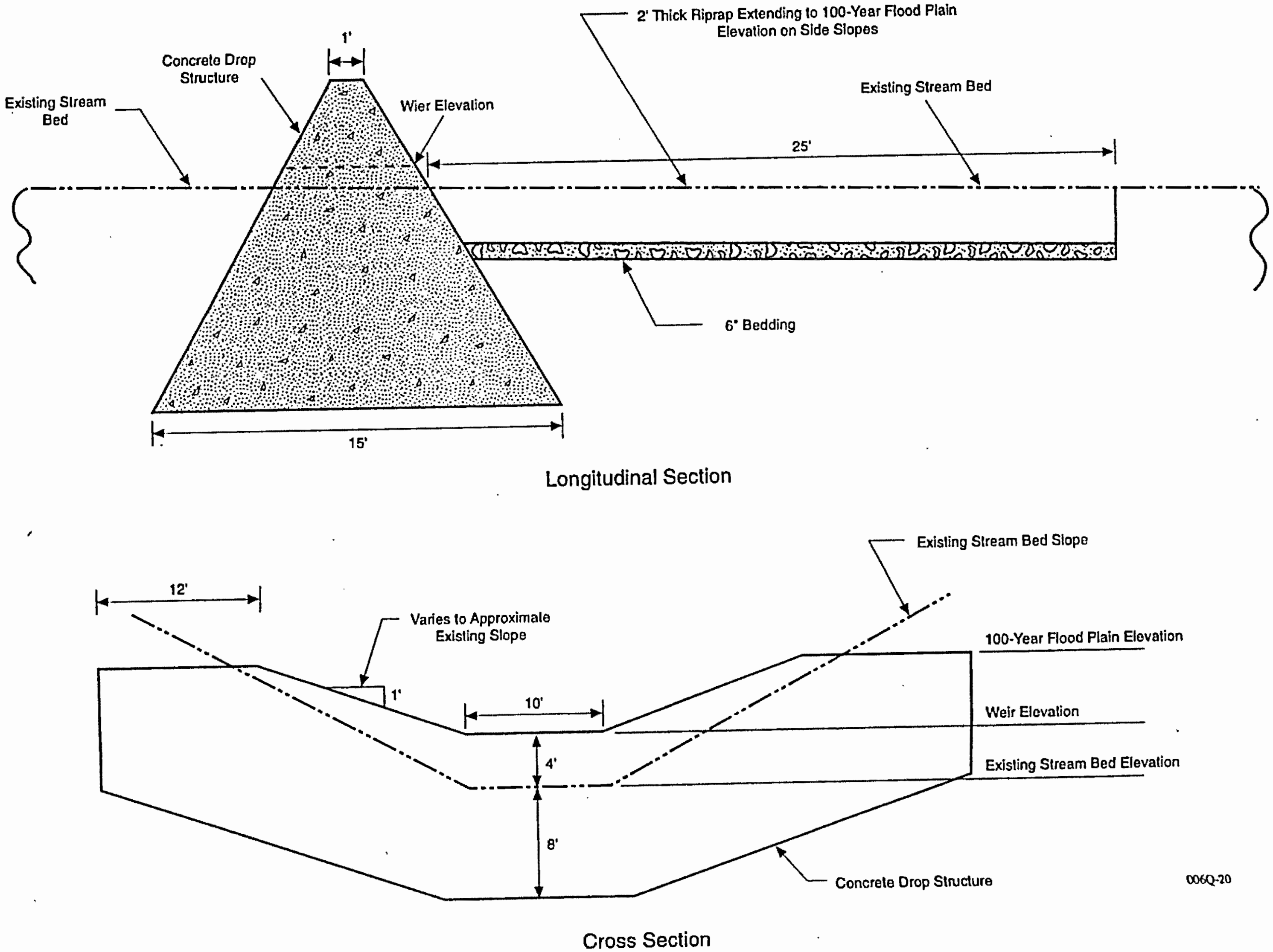


Figure 3-31. Conceptual Design for the Typical Concrete Drop Structure in Streams (modified from WVNS 1994n).

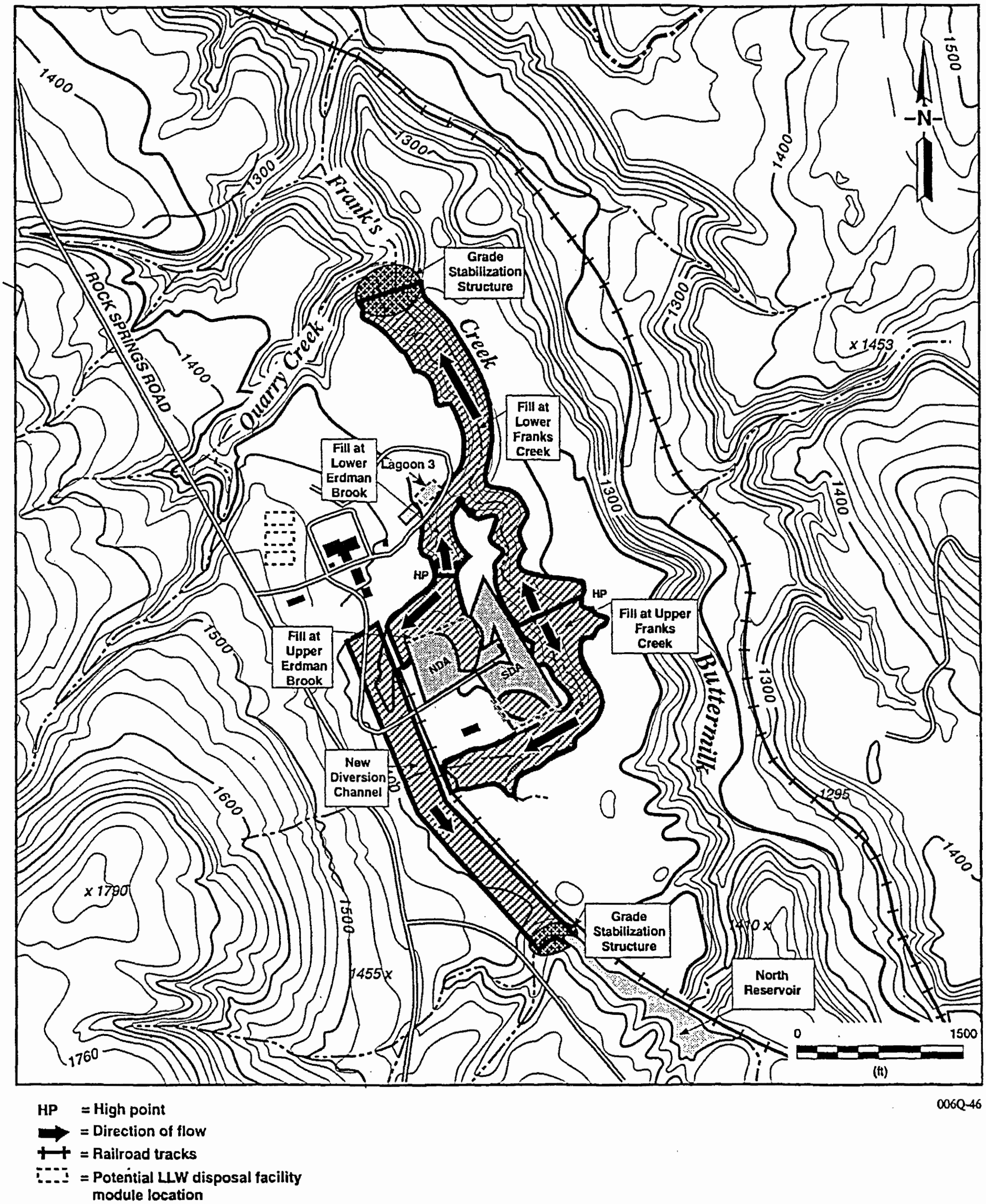


Figure 3-32. Conceptual Design for the Global Erosion Control Strategy for Alternative IIIA [In-Place Stabilization (Backfill)] or Alternative IIIB [In-Place Stabilization (Rubble)] (modified from WVNS 1994n).

high point as shown on Figure 3-32. Approximately 12 m (40 ft) of fill would be placed in the streambed at this location to meet the existing elevation at the top slopes and would be graded to meet the existing railroad bank elevation. A channel on top of the fill would divert flow from the high point toward the new diversion channel, a flow direction that is opposite to the existing flow in Erdman Brook. The channel would be 7.6 m (25 ft) wide and 0.6 m (2 ft) deep, with 1 to 2 side slopes. These erosion control measures would direct surface water flow to the new diversion channel and to the north reservoir instead of to Franks Creek. The NDA and SDA would become the top of the new watershed.

The northern (lower) portion of Erdman Brook would be filled from the new highpoint to the confluence with Franks Creek (see Figure 3-32) and graded to meet the existing elevation at the confluence. As in the upper portion of Erdman Brook, a channel would be established on top of the fill to divert water from the high point to Franks Creek as it currently does.

An underdrain system, consisting of a 1.2-m (4-ft) thick gravel drain in a sand envelope 0.6 m (2 ft) thick, would be constructed along the channel bed of Erdman Brook to maintain existing groundwater levels. The gravel drain would intercept and convey groundwater seepage to a similar gravel drain constructed in the bed of Franks Creek, and the sand envelope would act as a filter to prevent fine-grained soil from migrating into the gravel drain.

Fill would be placed in the southern (upper) portion of Franks Creek to slow erosion on the eastern sides of the NDA and SDA and on the southern side of the RTS drum cell. The upper portion of Franks Creek would be filled with the high point as shown on Figure 3-32. Approximately 12 m (40 ft) of fill would be placed in the streambed at this location to meet the existing elevation at the top of the slopes. The fill would be graded to meet the existing railroad bank elevation and would connect to the new diversion channel. A channel on top of the fill (having the same dimensions as described for Erdman Brook) would divert flow from the high point toward the diversion channel, a flow direction opposite to that of the existing flow in Franks Creek. (The NDA and SDA would become the top of the new watershed.) These erosion control measures would direct surface water flow to the new diversion channel and to the north reservoir instead of to the lower portion of Franks Creek.

The northern (lower) portion of Franks Creek would be filled from the new highpoint to immediately south of its confluence with Quarry Creek (see Figure 3-32) and graded to meet the existing elevation. A channel similar in size to the one in Erdman Brook would be constructed on the fill to direct water flow north as it currently does. The new fill would slow erosion on the eastern side of the disposal areas.

The same type of underdrain system constructed for Erdman Brook would be constructed along the channel bed of Franks Creek to intercept and convey groundwater seepage to the end of the filled section of Franks Creek near its confluence with Quarry Creek.

A grade stabilization structure would be constructed at the outlet of the new diversion channel, where it would empty into the north reservoir (see Figure 3-32) to provide a stable outlet for the water flows and to mitigate erosion of the newly placed fill. As shown on Figure 3-33, the structure has been conceptualized as approximately 61 m (200 ft) wide and 6 m (20 ft) deep and consisting mostly of well-graded rock riprap. Gravel and sand blankets would be placed on the upstream side of the structure to prevent soil migration into the riprap. A 46-m (150-ft) section of each side slope of the new diversion channel upstream of the grade stabilization structure would be protected by 0.9-m (3-ft) thick rock riprap.

A grade stabilization structure would also be constructed in Franks Creek just before its confluence with Quarry Creek (see Figure 3-32) to provide a stable outlet for the water flows and to mitigate erosion of the newly placed fill. As shown in Figure 3-34, this structure would be approximately 27 m (87 ft) high with the base of the structure 6 m (20 ft) belowgrade, and the side slopes would match existing terrain. The structure would be made of rock riprap, and gravel and sand blankets would prevent soil migration into the riprap. The structure would also serve as the outlet for the gravel underdrain systems installed in the stream beds of lower Erdman Brook and lower Franks Creek.

Fill for placement in much of the streambeds would come from the material excavated from the new diversion channel.

After the implementation phase actions, the global erosion control measures would have to be inspected and maintained as necessary.

3.5.3 Volumes of Waste Generated under Alternative III

The estimated volumes of waste generated under Alternatives IIIA and IIIB are given in Table 3-14. Most of the contaminated wastes generated are removed from the waste storage facilities in WMA 5. LLW generated by dismantlement would be disposed of in the process building and vitrification facility (Alternative IIIA) or in the new LLW disposal facility (Alternative IIIB). Industrial waste would be generated by construction of erosion control structures. The waste would be disposed of off site. The small volumes of mixed waste generated from WMA 5 and the NDA [63 m^3 (2,220 ft^3)] would consist of stored waste removed from the lag storage building/additions and the IWSF. Soil used for backfilling and capping would come from on-site and off-site borrow pits.

Radioactively contaminated waste generated during the implementation phase would be packaged in the same kind of containers as described in Section 3.3.3. Table 3-15 gives the estimated number of containers that would be required for disposal of radioactive waste on the Project Premises. (For the RTS drum cell, no waste containers would be required because the stored waste would not be removed.)

3.5.4 Schedule for Alternative III Implementation Phase Actions

Alternative III would involve in-place (in-situ) stabilization of site facilities rather than their removal from the site. Because Alternative III would involve LLW disposal on the

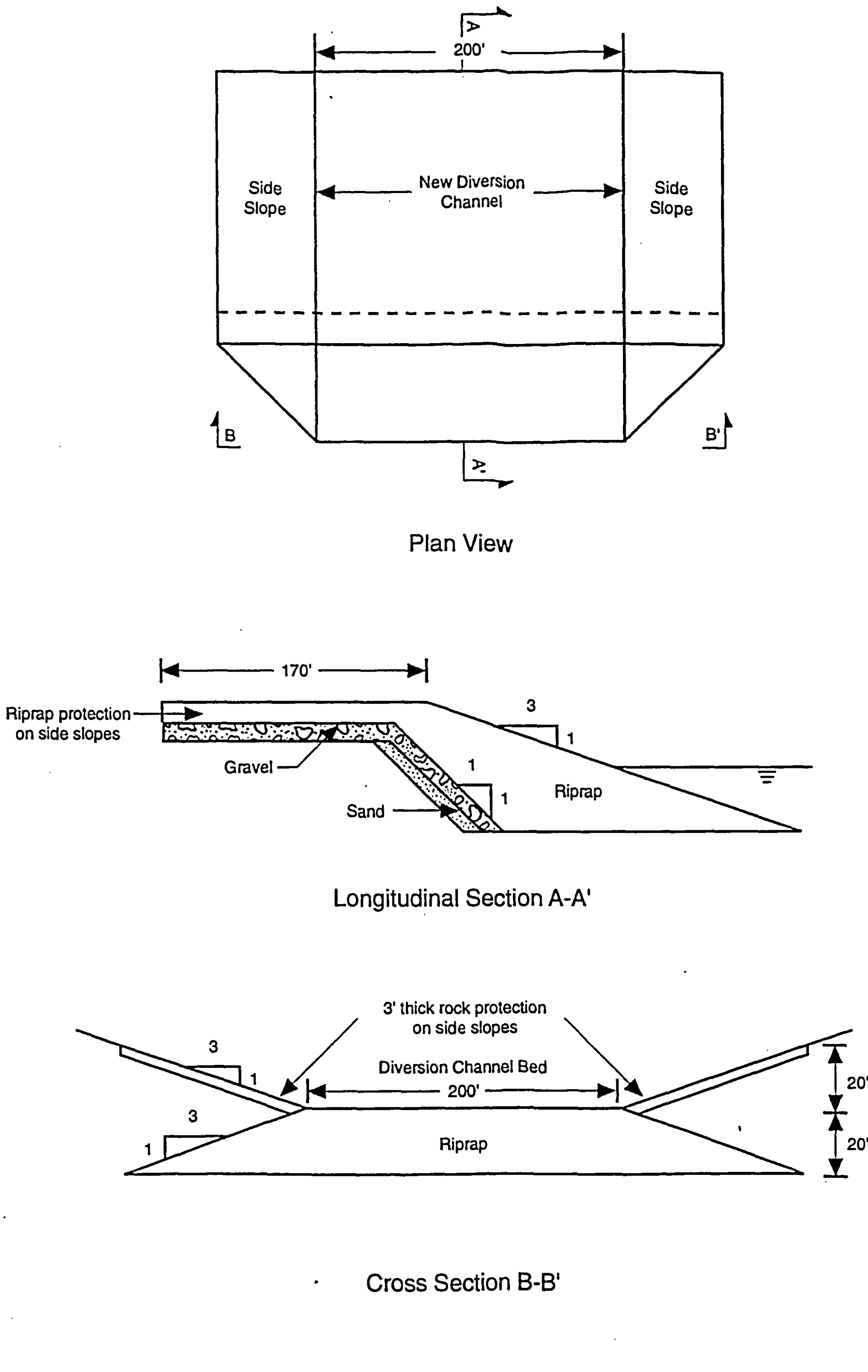


Figure 3-33. Conceptual Design for the Grade Stabilization Structure at the Outlet of the New Diversion Channel (modified from WVNS 1994n).

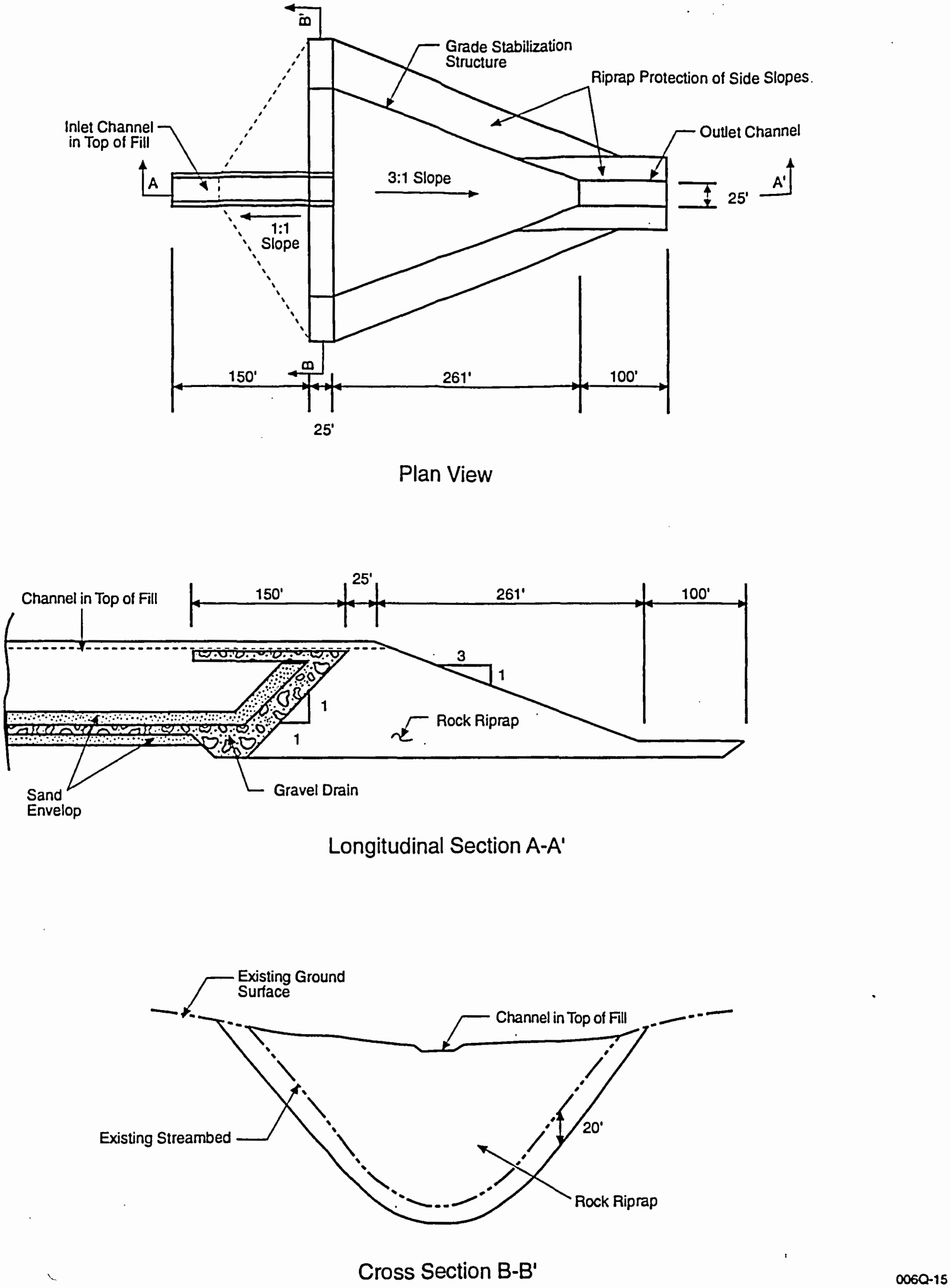


Figure 3-34. Conceptual Design for Grade Stabilization Structure at Franks Creek near the Confluence with Quarry Creek (modified from WVNS 1994n).

Table 3-14. Waste Volumes Generated from Implementing Alternative III (In-Place Stabilization)[a,b]

WMA/Facility	Class A (ft³) IIIA	Class A (ft³) IIIB	Class B (ft³) IIIA	Class B (ft³) IIIB	Class C (ft³) IIIA	Class C (ft³) IIIB	GTCC (ft³) IIIA	GTCC (ft³) IIIB	HLW[c] (ft³) IIIA	HLW[c] (ft³) IIIB	Mixed (ft³) IIIA	Mixed (ft³) IIIB	Hazardous (ft³) IIIA	Hazardous (ft³) IIIB	Industrial (ft³) IIIA	Industrial (ft³) IIIB
1—Process Building	11,900 (0)[d]	47,700 (0)	0	0	0	0	0	0	420 (887)	420 (887)	0	0	0	0	32,200 (0)	0
01/14 Building	900	900	0	0	0	0	0	0	0	0	0	0	1	1	70,600	70,600
2—LLWTF and Lagoons 1-5	6,390	6,390	0	0	0	0	0	0	0	0	0	0	1	1	14,700	14,700
3—HLW Tanks/Vitrification Facility	1,650	1,650	0	0	0	0	0	0	9,000	9,000	0	0	0	0	52,900	73,600 (288,549)
4—CDDL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5—CPC Waste Storage Area	11,000	11,000	257	257	360	360	15,100	15,100	0	0	0	0	0	0	2,760 (4,076)	2,760 (4,076)
Lag Storage Building/Additions	333,000	333,000	41,100	41,100	77,400	77,400	0	0	0	0	772 (1,754)	772 (1,754)	0	0	66,100 (10,409)	66,100 (10,409)
7—NDA	238	238	0	0	0	0	0	0	0	0	1,450	1,450	0	0	20,600 (122,472)	20,600 (122,472)
8—SDA	550	550	0	0	0	0	0	0	0	0	0	0	0	0	6,480	6,480
9—RTS Drum Cell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3,380 (18,980)	3,380 (18,980)
Other Facilities (including WMAs 6,10,11,12)	18,900	18,900	0	0	0	0	0	0	0	0	0	0	0	0	956,000	956,000
Wastewater Treatment Area	5,960	15,600	0	0	0	0	0	0	0	0	0	0	0	0	44,200	44,200
LLW Disposal Facility	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Erosion Control[e]																
Local erosion control strategy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	166,000[f]	166,000[f]
Global erosion control strategy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,140,000[g]	1,140,000[g]
Total	390,000[h]	436,000[i]	41,400	41,400	77,800	77,800	15,100	15,100	9,420	9,420	2,220	2,220	2	2	1,440,000[f,h] or 2,410,000[g,h]	1,420,000[f,i] or 2,400,000[g,i]

a. Does not include contaminated soil volumes (refer to Table 3-16). All volumes rounded to three significant figures. Values in columns may not add up to totals because of rounding.
b. To convert cubic feet to cubic meters, multiply by 0.02832.
c. Consists of canisters of vitrified waste and spent fuel fines from the process building. Although the classification of the spent fuel fines is not yet known, for purposes of analysis it was assumed that it would be HLW.
d. Values in parentheses are those in the 1995 versions of the closure engineering reports. The Final EIS will use final versions of the closure engineering reports.
e. Could consist of either local or global erosion control measures for either Alternative IIIA or Alternative IIIB.
f. Assumes local erosion control strategy is implemented.
g. Assumes global erosion control strategy is implemented.
h. For purposes of analysis, this EIS assumes that this uncharacterized waste will be industrial waste. However, if all of this waste was found to be contaminated during closure activities instead of uncontaminated (as assumed in this table), there would be no industrial waste and 1,830,000 or 2,800,000 ft³ of Class A waste if the local or global erosion control was assumed, respectively.
i. For purposes of analysis, this EIS assumes that this uncharacterized waste will be industrial waste. However, if all of this waste was found to be contaminated during closure activities instead of uncontaminated (as assumed in this table), there would be no industrial waste and 1,860,000 or 2,840,000 ft³ of Class A waste if the local or global erosion control was assumed, respectively.

Sources: Modified from WVNS (1994a through 1994o)

Table 3-15. Estimated Number of Waste Containers Required for Implementing Alternative III (In-Place Stabilization)

WMA/Facility	Drums		B-96 Boxes		High Integrity Containers		NUHOMS Canisters[a]	
	IIIA	IIIB	IIIA	IIIB	IIIA	IIIB	IIIA	IIIB
1—Process Building	1,760	7,070	0	0	0	0	3	3
01/14 Building	0	0	10	10	0	0	0	0
2—LLWTF and Lagoons 1-5	0	0	74	74	0	0	0	0
3—HLW Tanks/Vitrification Facility	240	240	0	0	0	0	67	67
4—CDDL	0	0	0	0	0	0	0	0
5—CPC Waste Storage Area	0	0	0	0	5	5	110	110
Lag Storage Building/Additions	0	0	9	9	1,010	1,010	0	0
7—NDA	0	0	20	20	0	0	0	0
8—SDA	81	81	0	0	0	0	0	0
9—RTS Drum Cell	0	0	0	0	0	0	0	0
Other Facilities (including WMAs 6,10,11,12)	0	0	220	220	0	0	0	0
Wastewater Treatment Area	880	2,310	0	0	0	0	0	0
LLW Disposal Facility	0	0	0	0	0	0	0	0
Erosion Control	0	0	0	0	0	0	0	0
Total[b]	2,960	9,700	330	330	1,020	1,020	180	180

a. NUHOMS = Nutech Horizontal Modular System.
b. Values in columns may not add to totals due to rounding.

Sources: Modified from WVNS (1994a through 1994n)

Project Premises, a LLW disposal facility would be constructed. Under Alternative IIIA, the process building would be used as the disposal facility. Under Alternative IIIB, a new modular LLW disposal facility would be built on the Project Premises.

Implementing Alternative IIIA would take 10 years if the local erosion control strategy was used or 14 years if the global erosion strategy was used. Implementing Alternative IIIB would take 26 years to complete, regardless of which erosion control strategy was selected. Closure activities would begin in 1999. Under Alternative IIIA, site stabilization would be complete in 2009 (if local erosion control) or 2013 (if global erosion control) and under Alternative IIIB, site stabilization would be complete by 2025, as shown in the schedules in Figures 3-35 and 3-36. Table 3-16 presents labor requirements for closure activities. Alternative IIIA would require an estimated 2,071 worker-years (if local erosion control) or 2,627 worker-years (if global erosion control) to complete facility closure including 660 worker-years for site support operations. Alternative IIIB would require more than twice as many, or 5,634 worker-years (if local erosion control) or 6,190 worker-years (if global erosion control) to complete facility closure because of construction of the new LLW disposal facility and extra labor to dismantle the process building and vitrification facility. Implementing Alternative III would be followed by an indefinite period of monitoring and maintenance, requiring approximately 50 worker-years per year.

Implementing Alternative IIIA would begin with the construction of the wastewater treatment area which would take less than 3 years. Wastewater treatment operations would continue throughout the implementation phase. If local erosion control measures (described in Section 3.5.2.3.1) were selected, they would be completed within 3.5 years, soon after the wastewater treatment area was constructed. If global, site-wide erosion control measures (described in Section 3.5.2.3.2) were selected, they would be completed within 13 years. Under Alternative IIIA, stored waste from the lag storage building, lag storage additions, and CPC waste storage area would be placed inside the process building or vitrification facility while the wastewater treatment area was constructed. Then the storage facilities would be demolished. The 01/14 building would be demolished, and radioactive waste generated would also be placed in the process building or vitrification facility. The RTS drum cell would be converted to a tumulus, a process which has been estimated to take less than 2 years.

Removing leachate, grouting waste in the SDA trenches, capping the SDA, and installing the slurry wall would begin after construction of the wastewater treatment area and take approximately 4 years to complete. Closure of the small inground structures (e.g., solvent dike, effluent equalization mixing basin, and sludge ponds) would occur simultaneously with the SDA activities and take 1 year to complete. Capping the NDA and installing the slurry wall would begin after the SDA activities and take about 2.5 years. Small buildings in WMA 3 with little or no contamination would be removed at the same time as the activities at the NDA and SDA.

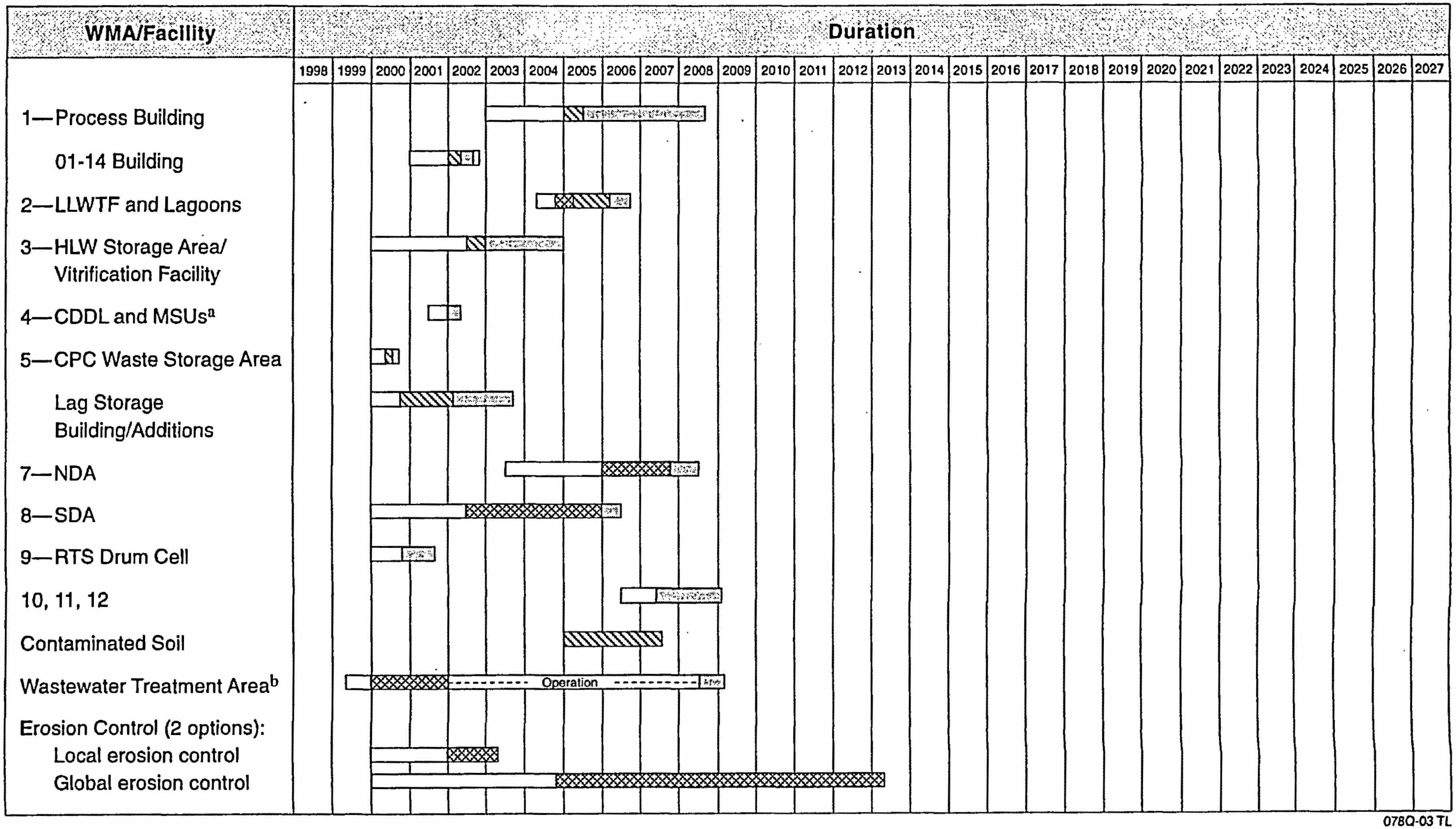
During stabilization of the disposal areas, the HLW tanks, vitrification facility, and process building would be backfilled with low-density concrete. These activities would take approximately 8.5 years. At the same time, the 01/14 building would be decontaminated and

Table 3-16. Labor Requirements for Implementing Alternatives IIIA and IIIB

WMA/Facility	Labor (worker-years) IIIA	IIIB
1—Process Building	200	1,700
01/14 Building	26	26
2—LLWTF and Lagoons 1-5	45	45
3—HLW Tanks/Vitrification Facility	130	430
4—CDDL	0	0
5—CPC Waste Storage Area	4.2 (10)[a]	4.2 (10)
Lag Storage Building/Additions	24	24
7—NDA	220	220
8—SDA	440	440
9—RTS Drum Cell	33	33
Other Facilities (including WMAs 6,10,11,12)	97	97
Wastewater Treatment Area[b]	160	400
LLW Disposal Facility	0	733
Erosion Control[c]		
Local erosion control strategy	32[d]	32[d]
Global erosion control strategy	588[e]	588[e]
Site Support Operations	660	1,450
Total	2,071[d] or 2,627[e]	5,634[d] or 6,190[e]

a. The values in parentheses are those in the 1995 version of the closure engineering reports. The Final EIS will use final versions of the closure engineering reports.
b. Includes operational requirements.
c. A local or global erosion control strategy could be used for either Alternative IIIA or IIIB. The values do not include life cycle labor.
d. Assumes local erosion control strategy is implemented.
e. Assumes global erosion control strategy is implemented.

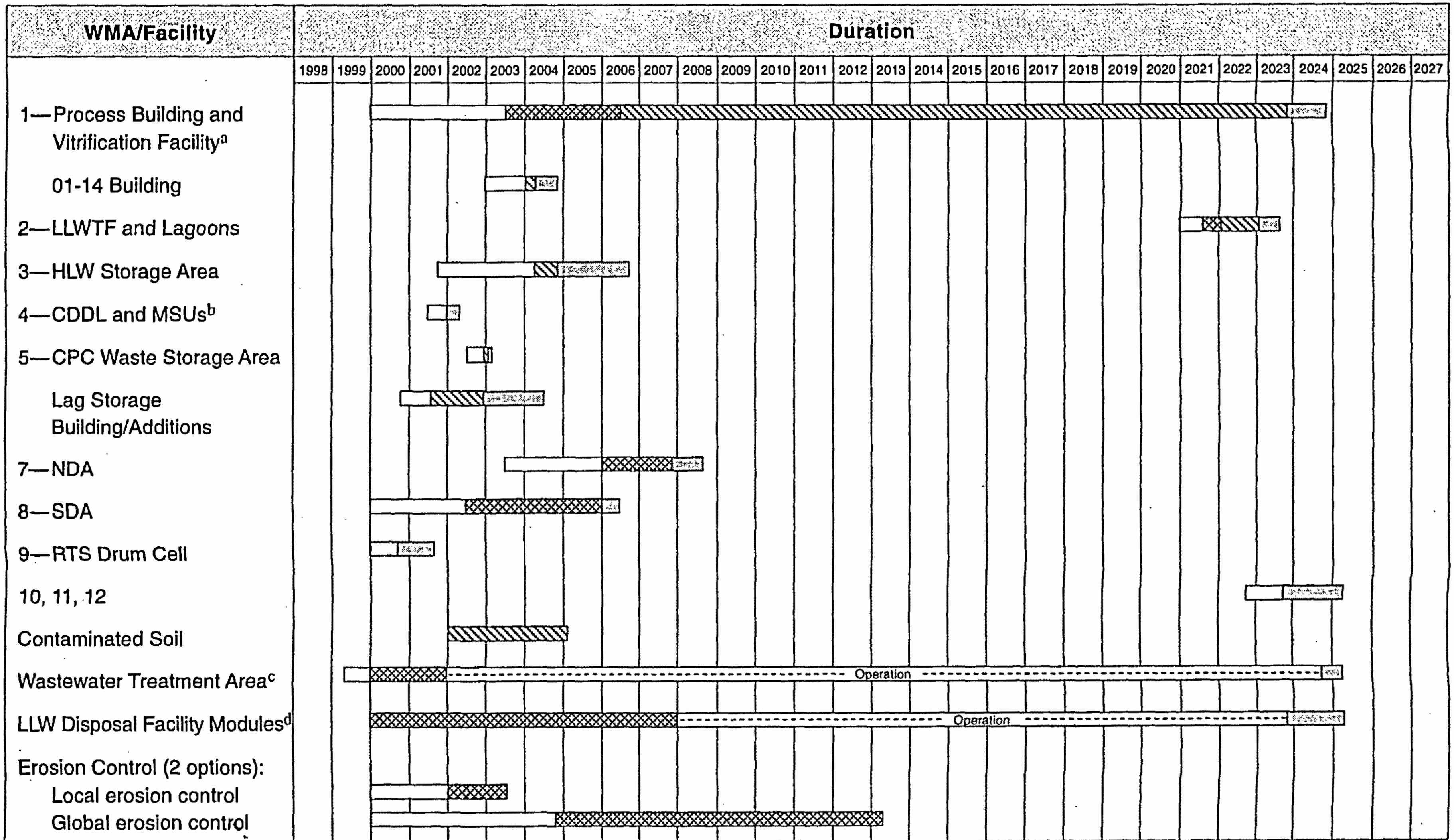
Sources: WVNS (1994a through 1994o)



a. MSUs = miscellaneous small units. These include the maintenance shop and sanitary waste leach field, waste paper incinerator, solvent dike, effluent equalization mixing basin, and the sludge ponds.
b. During the planning phase, it is assumed that a NRC license and a RCRA permit for treating hazardous waste would be obtained.

Planning | New Construction | Decontamination and/or Dismantlement (for buildings) or Exhumation (for in-ground structures and contaminated soil) | Closure

Figure 3-35. Schedule for Implementing Alternative IIIA [In-Place Stabilization (Backfill)] (modified from WVNS 1994l).



a. The processs building and vitrification facility would be dismantled together, under one confinement structure.
b. MSUs = miscellaneous small units. These include the maintenance shop and sanitary waste leach field, waste paper incinerator, solvent dike, effluent equalization mixing basin, and the sludge ponds.
c. During the planning phase, it is assumed that a NRC license and a RCRA permit for treating hazardous waste would be obtained.
d. Because there will be several modules, construction, operation, and closure of the individual modules may occur in several different stages. It is assumed that an NRC license would be obtained.

Planning; New Construction; Decontamination and/or Dismantlement (for buildings) or Exhumation (for in-ground structures and contaminated soil); Closure

Figure 3-36. Schedule for Implementing Alternative IIIB [In-Place Stabilization (Rubble)] (modified from WVNS 1994l).

dismantled (less than 1 year), the 02 building would be decontaminated and demolished, and the LLWTF lagoons would be backfilled and capped.

Finally, the remaining facilities would be dismantled, a process conceptualized as taking approximately 2.5 years. The wastewater treatment area would be closed and dismantled.

Under Alternative IIIB, construction of the new LLW disposal facility modules would occur at the same time the new wastewater treatment area was being constructed and the RTS drum cell was being converted into a tumulus (estimated to take 1.5 years). As with Alternative IIIA, the stored radioactive waste in the lag storage building, lag storage additions, and CPC waste storage area would be removed and placed in the LLW disposal facility, and the storage facilities would be demolished (3.5 years). Likewise, the 01/14 and 02 buildings would be demolished and the waste placed in the LLW disposal facility (1 year). The small, inground structures described above and the LLWTF lagoons would be backfilled (2 years). After these activities have been completed, the LLW disposal modules would be closed.

After the wastewater treatment area has been constructed, leachate would be removed from the SDA, the SDA trenches would be grouted, the SDA would be capped, and a slurry wall would be installed (4 years) followed by the NDA being capped, and the slurry wall completed around it (2.5 years). If local erosion control measures were selected (see Section 3.5.2.3.1), they would be in place within 3.5 years. If global, site-wide erosion control measures were selected (see Section 3.5.2.3.2), they would be in place in approximately 13 years.

After the LLW disposal facility modules were constructed, the HLW tanks would be backfilled with concrete. A confinement structure would be erected around the process building and vitrification facility (3 years), and dismantlement of them would take at least 17 years. The confinement structure would then be dismantled, and the process building and vitrification facility rubble piles would be grouted and capped (1 year).

Finally, the remaining facilities would be decommissioned and the wastewater treatment area would be closed and dismantled.

The primary construction materials required for implementing Alternative III are concrete and steel. Table 3-17 gives the amounts of these materials required for each facility. For both Alternatives IIIA and IIIB, concrete would be required for capping the LLWTF lagoons, the NDA, and the SDA and for grouting the SDA trenches. Large volumes of concrete would be required for backfilling the process building, vitrification facility, and HLW tanks under Alternative IIIA and grouting the process building and vitrification facility rubble piles under Alternative IIIB. Additional concrete and steel would be required for constructing the wastewater treatment area, the concrete drop structures if local erosion control measures were selected, and the LLW disposal facility and the process building confinement structure under Alternative IIIB. Additional resources required for

Table 3-17. Major Construction Materials Required for Implementing Alternative III (In-Place Stabilization)

	Concrete (yd^3)[a]		Steel (tons)[b]	
WMA/Facility	IIIA	IIIB	IIIA	IIIB
1—Process Building	57,100	12,626	0	0
01/14 Building	0	0	0	0
2—LLWTF and Lagoons 1-5	1,560	1,560	0	0
3—HLW Tanks/Vitrification Facility	21,370	26,350	0	0
4—CDDL	0	0	0	0
5—CPC Waste Storage Area	0	0	0	0
Lag Storage Building/Additions	0	0	0	0
7—NDA	9,090	9,090	0	0
8—SDA	25,000	25,000	0	0
9—RTS Drum Cell	0	0	0	0
Other Facilities (including WMAs 6,10,11,12)	0	0	0	0
Wastewater Treatment Area	1,630	1,630	19 (5)[c]	19 (5)
LLW Disposal Facility	0	52,620	0	120
Erosion Control[d]				
Local erosion control strategy	1,330[e]	1,330[e]	0[e]	0[e]
Global erosion control strategy	0[f]	0[f]	0[f]	0[f]
Total	117,080[e] or 115,750[f]	130,206[e] or 128,876[f]	19[e,f]	139[e,f]

a. To convert cubic yards to cubic meters, multiply by 0.7646.
b. To convert tons to metric tons, multiple by 0.91.
c. Values in parentheses are those in the 1995 version of the closure engineering reports. The Final EIS will use final versions of the closure engineering reports.
d. A local or global erosion control strategy could be used for either Alternative IIIA or IIIB.
e. Assumes local erosion control strategy is implemented.
f. Assumes global erosion control strategy is implemented.

Sources: WVNS (1994a through 1994o)

implementing Alternative III—electricity, gas, and fuel—are discussed and evaluated in Section 5.4.1.1.

Implementing Alternative III would result in discharges to air as shown in Table 3-18. More liquids would be generated and evaporated under Alternative IIIB than Alternative IIIA, because the abovegrade portions of the process building and vitrification facility would be dismantled, causing radionuclide emissions to air, and decontaminated, generating wastewater that would have to be evaporated. The demolition of the remaining facilities in WMAs 6, 10, 11, and 12 under Alternative IIIA would generate fugitive dust and shipping emissions because of the number of facilities, and the industrial waste would be disposed of off site. The largest emissions from heavy equipment would be from the NDA and SDA (because of slurry wall and cap construction) and from the wastewater treatment area (because of construction and demolition). Global site-wide erosion controls, if selected, would generate more dust and shipping emissions than local erosion controls because of the extent of the activities.

3.5.5 Alternative III Post-Implementation Phase Actions

After the implementation phase has been completed, institutional control of the Center would be retained indefinitely. The retained areas requiring active management would include portions of the channels in Buttermilk and Franks Creeks and soil contamination (i.e., the cesium prong) on the balance of the site; areas on the Project Premises where the new LLW disposal facility (Alternative IIIB only), and facilities that would have been stabilized would be located, and where contamination had been immobilized [a total of about 360 ha (880 acres)]. The activities that would be conducted during the post-implementation phase would include the following: (a) site security to restrict access, (b) environmental monitoring to assure that contamination is not being released from the disposal facilities (i.e., the process building and vitrification facility under Alternative IIIA, the LLW disposal facility modules under Alternative IIIB), or from the existing disposal areas (i.e., SDA, NDA, and CDDL), (c) erosion monitoring and maintenance, and (d) monitoring and maintenance of both existing and new disposal facilities. About 1,000 ha (2,460 acres) would be available for reuse.

The erosion monitoring and maintenance activities would vary between Alternatives IIIA and IIIB depending on whether a local or global erosion control strategy was selected. The local erosion control strategy would have multiple erosion control features with a 50-year design life. Erosion would be monitored, and eroded areas would be filled and structures would be repaired as necessary. The local erosion control structures would be replaced at the end of their effective life. The global erosion control strategy would entail major changes to the drainage patterns on the Project Premises and SDA. The global erosion control features would have a long design life and routine inspection with required maintenance (e.g., filling and regrading around grade stabilization structures).

Monitoring and maintenance of the new disposal facilities and existing disposal areas would include monitoring contamination levels to determine if radionuclides were being released. Caps and covers would be repaired to prevent water infiltration into the facilities.

Table 3-18. Releases to the Environment from Implementing Alternative III (In-Place Stabilization)

	Radiological Releases		Nonradiological Releases (tons)[a]					
	Air (mCi/yr)		Fugitive Dust		Shipping Emissions[b]		Heavy Equipment[c]	
WMA/Facility	IIIA	IIIB	IIIA	IIIB	IIIA	IIIB	IIIA	IIIB
1—Process Building	5.7	7.4	4.5	714 (130)[d]	0.014 (0.83)	0.056 (0.83)	23	65
01/14 Building	0	0	0.7	0.7	3.7 (1.2)	3.7 (1.2)	6	6
2—LLWTF and Lagoons 1-5	1.8	1.8	48	48	0.98 (0.38)	0.98 (0.38)	19 (6.8)	19 (6.8)
3—HLW Tanks/Vitrification Facility	2.1	19	288[e] (13)	288[e] (13)	8.3 (1.4)	16 (7.5)	10	22
4—CDDL	0	0	0	0	0	0	0	0
5—CPC Waste Storage Area	0	0	0.6[e]	0.6[e]	0.005	0.005	0.08	0.08
Lag Storage Building/ Additions	0	0	29[e] (14)	29[e] (14)	0 (2)	0 (2)	0.8 (5)	0.8 (5)
7—NDA	12	12	15	15	0.21 (17)	0.21 (17)	176	176
8—SDA	2.5×10^6	2.5×10^6	128	128	0.003	0.003	76	76
9—RTS Drum Cell	0	0	0.7 (86)	0.7 (86)	0.085 (0.6)	0.085 (0.6)	31	31
Other Facilities (including WMAs 6,10,11,12)	0	0	522[e] (3)	522[e] (3)	27	27	78 (35)	78 (35)
Wastewater Treatment Area	0[f]	0[f]	3.5	3.5	0	0	41	114
LLW Disposal Facility	0	0	0	424	0	0	0	86
Erosion Control[g]								
Local erosion control strategy	0[h]	0[h]	441[h]	441[h]	4.3[h]	4.3[h]	14[h]	14[h]
Global erosion control strategy	0[i]	0[i]	15,828[i]	15,828[i]	30[i]	30[i]	365[i]	365[i]
Total	2.5×10^6	2.5×10^6	1,481[h] or 16,868[i]	2,191[h] or 17,578[i]	45[h] or 71[i]	52[h] or 78[i]	475[h] or 826[i]	602[h] or 953[i]

a. To convert tons to metric tons, multiply by 0.91.
b. Includes hydrocarbons, carbon monoxide, and nitrogen oxides.
c. Includes particulates, carbon monoxide, hydrocarbons, nitrogen oxides, aldehydes, and sulfur oxides.
d. Values in parentheses are those in the 1995 version of the closure engineering reports. The Final EIS will use final versions of the closure engineering reports.
e. Original data given in tons per year or tons per month. The integrated schedule in WVNS (1994l) was used to estimate the total amount.
f. All releases would be from evaporation at the wastewater treatment area, but are shown from the source WMAs.
g. A local or global erosion control strategy could be used for either Alternative IIIA or IIIB.
h. Assumes local erosion control strategy is implemented.
i. Assumes global erosion control strategy is implemented.

Sources: WVNS (1994a through 1994o)

Appropriate maintenance actions that could include regrading the cover on slopes and reseeding areas where the vegetative cover has degraded would be taken. Monitoring and repairing caps would continue indefinitely.

Monitoring and maintenance activities would produce minimal volumes of radioactive waste generated by environmental monitoring activities and potentially from the cap maintenance activities. The radioactive waste volumes would be small and could either be stored or disposed of in an off-site facility.

3.6 ALTERNATIVE IV: NO ACTION: MONITORING AND MAINTENANCE

The objective of Alternative IV is to monitor and maintain the site and facilities in the state they will be in following completion of HLW solidification, allowing the natural radioactive decay process to occur. Analysis of this alternative is required by NEPA.

3.6.1 General Strategy for Alternative IV

The general strategy for Alternative IV is that minimal actions would be taken to prepare the site for long-term monitoring and maintenance. Institutional controls would be implemented that are similar to those described in Section 3.5.5 for Alternative III.

3.6.2 Alternative IV Implementation Phase Actions

This section describes actions for existing facilities, structures, and environmental contamination; new facilities; and erosion control during the implementation phase of Alternative IV.

3.6.2.1 Existing Facilities, Structures and Environmental Contamination

This section discusses Alternative IV engineering actions for existing buildings, waste storage facilities, disposal areas, in-ground structures, remaining facilities, and contaminated soil and groundwater.

3.6.2.1.1 Buildings—Specific Actions

The processing equipment in the buildings (e.g., the liquid waste treatment system and the cement solidification system) would be flushed to remove hazardous constituents. The vitrification facility stack, the process building stack, and the permanent ventilation system building stack would be removed and disposed of off site. The canisters of vitrified HLW would remain in the process building. PCB-contaminated capacitors in the 01/14 building and 02 building would be removed and disposed of off site.

Alarm systems would be installed to detect intruders, and security locks would be installed on interior doors and the main access door in preparation for long-term monitoring. Exterior access doors would be welded shut. The security systems would be remotely monitored, and periodic radiation surveys would be conducted. Regular inspections, painting, and repairs would be performed as required (WVNS 1994l).

3.6.2.1.2 Waste Storage Facilities—Specific Actions

No waste would be removed from the waste storage facilities (i.e., lag storage building, lag storage additions, CPC waste storage area, RTS drum cell, IWSF, and proposed contaminated soil consolidation area), and no decontamination would be performed. The storage facilities would be managed as-is and a long-term monitoring and maintenance program would be implemented that would include periodic replacement of the fabric in the lag storage additions, the CPC waste storage area and the tarp covering the soil in the proposed contaminated soil consolidation area about once every 10 years (WVNS 1994l).

3.6.2.1.3 Disposal Areas—Specific Actions

Buried waste in the CDDL, SDA, and NDA would remain in place. The disposal areas would be managed as-is. There would be monitoring, inspections, and maintenance. The CDDL has already been closed under NYSDEC authority.

As part of long-term maintenance, a new facility for collecting and treating leachate generated in the SDA trenches would be constructed. This facility would be identical to the wastewater treatment area described for the container management area (WVNS 1994l) (see Section 3.3.2.2), and it could be located in the same area as shown in Figure 3-27.

3.6.2.1.4 In-Ground Structures—Specific Actions

Most of the in-ground structures (the HLW tanks, SDA filled lagoons, interceptors, neutralization pit, trench interceptor project, maintenance shop sanitary waste leach field, solvent dike, and effluent equalization mixing basin) would be managed as-is with long-term monitoring, maintenance, and surveillance. The HLW storage area would be monitored for structural integrity and corrosion. Security measures would also be instituted.

The LLWTF lagoon sediments and the north and south sludge ponds would be closed because contamination is close to the surface and has the potential to disperse. Like for Alternative III, the LLWTF lagoons would be backfilled with sand and gravel to grade level (WVNS 1994d). A multilayer cap would be installed to prevent infiltration and the spread of radiological material, and the areas would be revegetated with native plants for erosion control. Sediment from the sludge ponds would be removed and stored in an existing waste storage facility on the Project Premises (WVNS 1994i). The excavated areas would be backfilled to grade level. Both areas would be monitored and maintained.

3.6.2.1.5 Remaining Facilities—Specific Actions

The remaining facilities would be managed as-is with a long-term monitoring and maintenance program.

3.6.2.1.6 Contaminated Soil and Groundwater

Contaminated soil and stream sediments would be left as-is. The contaminated groundwater plume on the north plateau would continue to be treated using the mitigative measures put in place before implementation of the alternatives.

3.6.2.2 New Facilities Required

One new facility, a wastewater treatment area, would be constructed to treat leachate from the SDA disposal trenches. It would be the same as the wastewater treatment area described for the container management area (see Section 3.3.2.2 and Figure 3-11[b]) and could potentially be located in the northeast corner of WMA 9, near the SDA.

3.6.2.3 Erosion Control Measures

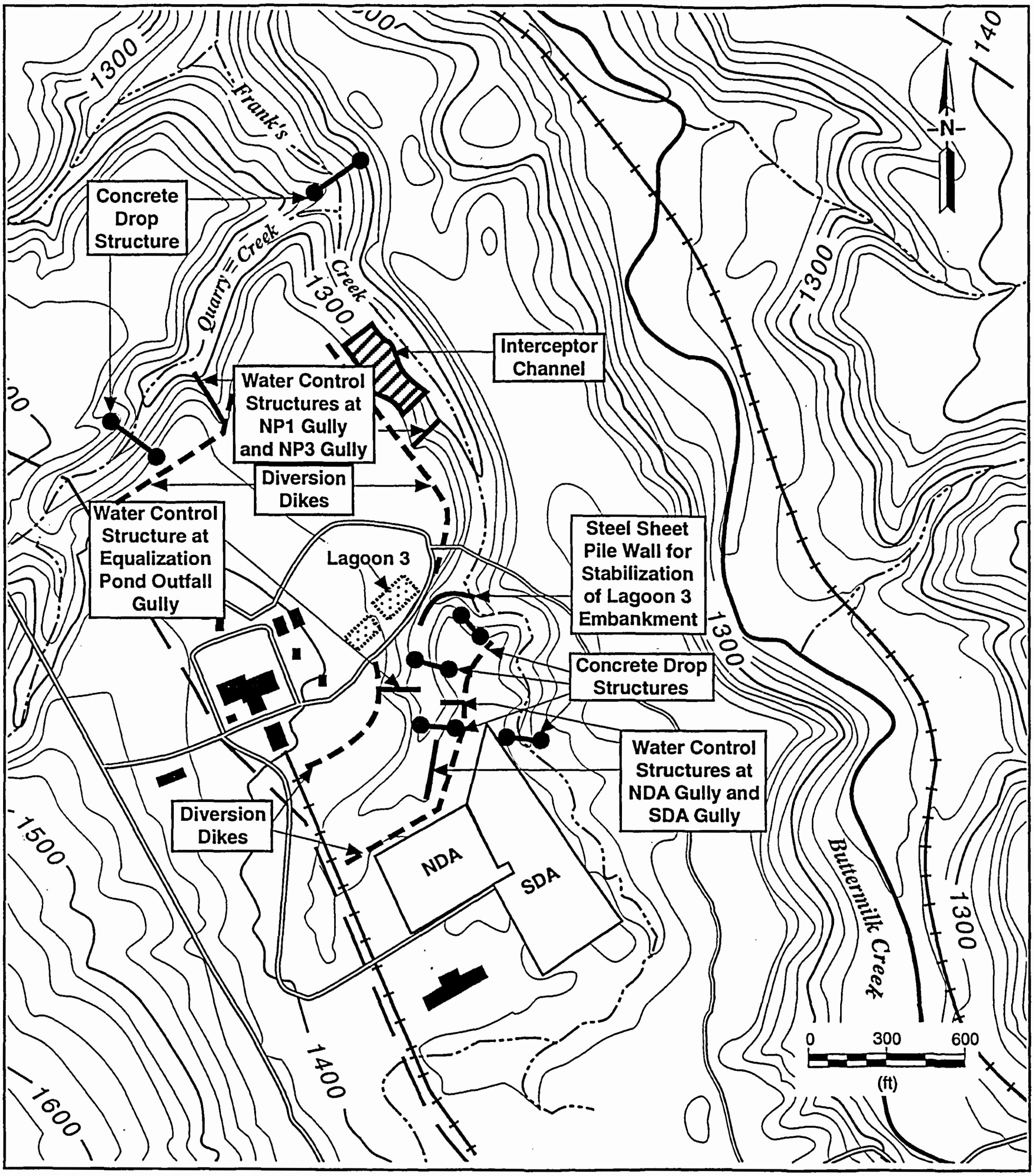
The local erosion control strategy for Alternative III, [maintaining stream banks on Franks Creek on the south side of WMA 9 and east side of WMA 8 and stream banks on Erdman Brook on the north side of WMA 9 (see Section 3.5.2.3.1)] would be implemented under Alternative IV (WVNS 1994n). The following erosion control structures would be installed on Quarry Creek because the buildings in WMA 5 (i.e., the lag storage building, lag storage additions, and the CPC waste storage area) would remain on the Project Premises:

- Water control structure in the NP1 gully
- Diversion dike along the top of the slope along Quarry Creek
- Concrete drop structure in Quarry Creek.

These erosion control measures and the existing facilities that would remain on the Project Premises are shown in Figure 3-37. The erosion control measures would have design lives of 30 to 50 years, and they would be inspected, maintained, and replaced, as necessary after the implementation phase.

3.6.3 Volumes of Waste Generated under Alternative IV

Closure engineering reports of the major facilities give estimates of the waste volumes that would be generated by implementing Alternative IV (WVNS 1994a through 1994n) as summarized in Table 3-19. The radioactive waste volume consists of contaminated sediments or soil excavated from the sludge ponds and miscellaneous waste generated by LLWTF lagoon closure. Miscellaneous trash from decommissioning the LLWTF would be packaged in twenty 208-L (55-gal) drums, and sediments excavated from the sludge ponds would be packaged in 173 B-96 boxes. These wastes would be stored in an existing waste storage facility on the Project Premises. No waste would come from the other facilities.



Note: Much of the plant site would be paved after constructing the storm water collection system.

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Figure 3-37. Conceptual Design for Erosion Control Structures under Alternative IV (modified from WVNS 1994n).

Table 3-19. Waste Volumes Generated from Implementation of Alternative IV (No Action: Monitoring and Maintenance)[a]

WMA/Facility	Class A (ft³)	Class B (ft³)	Class C (ft³)	GTCC (ft³)	HLW (ft³)	Mixed (ft³)	Hazardous (ft³)	Industrial (ft³)
1—Process Building	0	0	0	0	0	0	0	0
01/14 Building	0	0	0	0	0	0	0	0
2—LLWTF and Lagoons 1-5[b]	151	0	0	0	0	0	1	0
3—HLW Tanks/Vitrification Facility	0	0	0	0	0	0	0	0
4—CDDL	0	0	0	0	0	0	0	0
5—CPC Waste Storage Area	0	0	0	0	0	0	0	0
Lag Storage Building/Additions	0	0	0	0	0	0	0	0
7—NDA	0	0	0	0	0	0	0	0
8—SDA	0	0	0	0	0	0	0	0
9—RTS Drum Cell	0	0	0	0	0	0	0	0
Other Facilities (including WMAs 6,10,11,12)[c]	15,000	0	0	0	0	0	0	0
Wastewater Treatment Area	0	0	0	0	0	0	0	0
Erosion Control	0	0	0	0	0	0	0	212,000
Total	15,151	0	0	0	0	0	1	212,000

a. To convert cubit feet to cubic meters, multiply by 0.02832.
b. Waste volume consists of miscellaneous waste generated by closure of lagoons.
c. Waste volume consists of contaminated sediments or soil excavated from the sludge ponds.

Sources: Modified from WVNS (1994a through 1994n)

The only hazardous waste generated would consist of PCB-contaminated capacitors removed from the 02 building.

3.6.4 Schedule for Alternative IV Implementation Phase Actions

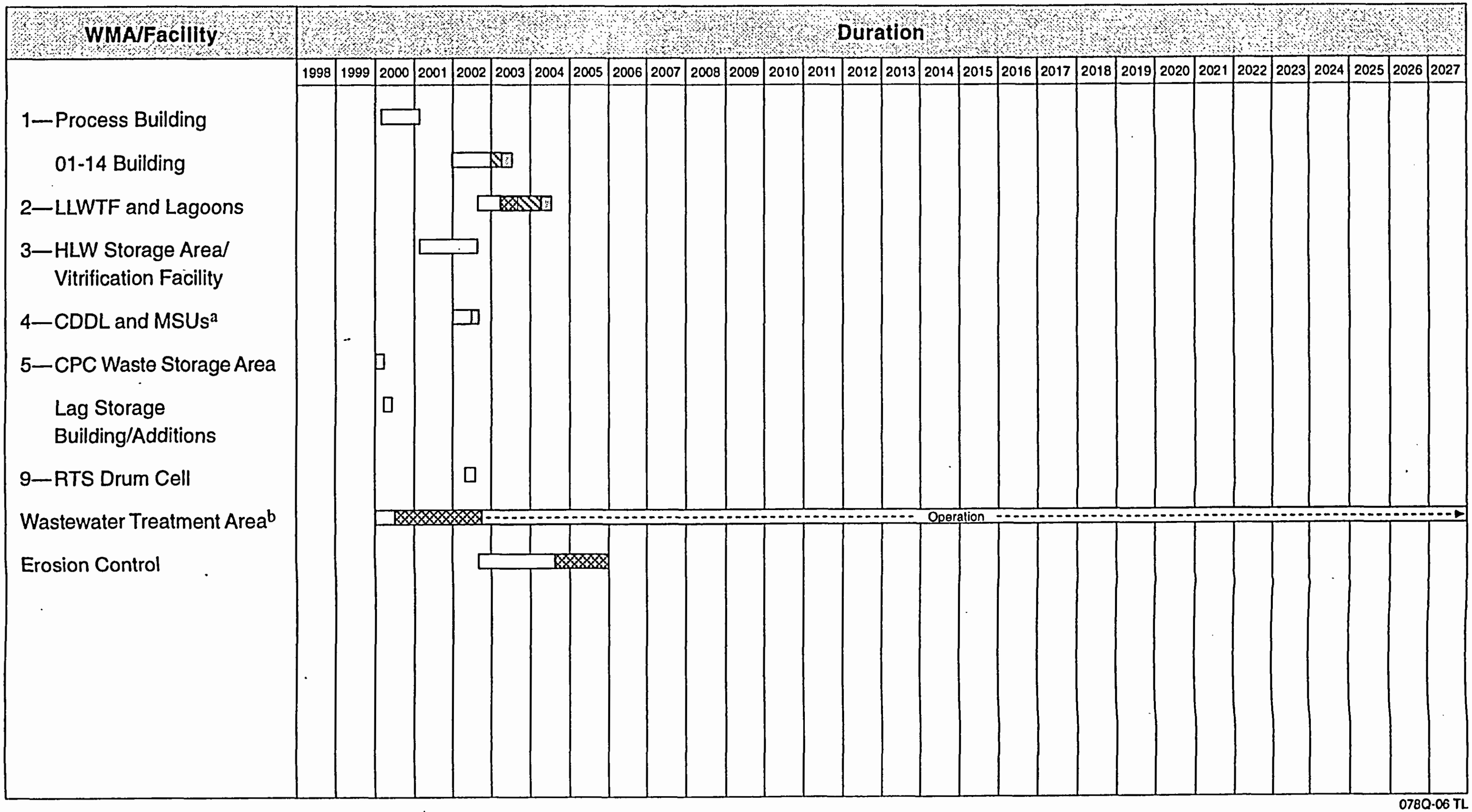
Under Alternative IV, the site would be maintained indefinitely, during which time natural radioactive decay and degradation of wastes would occur. Implementation phase activities would begin in 2000, and preparation for long-term storage or monitoring would be completed in 2005, as shown in the schedule in Figure 3-38. Activities to prepare for long-term monitoring would require approximately 131 worker-years, as shown in Table 3-20. Monitoring and security would be required during the monitoring and maintenance period.

Table 3-20. Labor Requirements for Implementing Alternative IV (No Action: Monitoring and Maintenance)

WMA/Facility	Labor (worker-years)
1—Process Building	16
01/14 Building	3
2—LLWTF and Lagoons 1-5	19
3—HLW Tanks/Vitrification Facility	16
4—CDDL	0
5—CPC Waste Storage Area	0.7
Lag Storage Building/Additions	0.7
7—NDA	0
8—SDA	0
9—RTS Drum Cell	0.6
Other Facilities (including WMAs 10,11,12)	3
Wastewater Treatment Area	32
Erosion Control	40
Total	131

Sources: WVNS (1994a through 1994n)

No actions would be performed for the NDA and SDA. However, a new wastewater treatment area (see Section 3.3.2.2) would be constructed for treating leachate generated in the SDA trenches. Construction of this system would take approximately 2 years, and it would operate throughout the monitoring and maintenance period. The waste storage facilities—that is, the lag storage building and lag storage additions, CPC waste storage area, IWSF, RTS drum cell, and the proposed contaminated soil consolidation area—would be managed as-is. Some demolition of high-maintenance items, such as the process building and vitrification facility stacks, would occur before long-term monitoring and maintenance



a. MSUs = miscellaneous small units. These include the maintenance shop and sanitary waste leach field, waste paper incinerator, solvent dike, effluent equalization mixing basin, and the sludge ponds.
b. During the planning phase, it is assumed that a NRC license and a RCRA permit for treating hazardous waste would be obtained.

Preparation and Planning for the Monitoring and Maintenance Period | New Construction | Decontamination (for buildings) or Exhumation (for in-ground structures) | Closure

Figure 3-38. Schedule for Implementing Alternative IV (No Action: Monitoring and Maintenance) (modified from WVNS 1994l).

because of the difficulty in maintaining these structures indefinitely. The process building, vitrification facility, and 01/14 building would include security systems (2.5 years). No actions would be performed for the CDDL. The LLWTF lagoons would be backfilled and capped (1.5 years). After site facilities or structures were prepared for long-term monitoring, local erosion control measures would be implemented (2 years). Annual maintenance activities, including maintenance of erosion control structures, would require 200 worker-years.

The primary construction materials, concrete and steel, required for implementing Alternative IV are given in Table 3-21. Concrete would be required for capping the LLWTF lagoons and installing concrete drop structures for erosion control. Concrete and steel would also be required for constructing the wastewater treatment area. Additional resources required for implementing Alternative IV—electricity, gas, and fuel—are discussed and evaluated in Section 5.5.1.1.

Table 3-21. Major Construction Materials Required for Implementing Alternative IV (No Action: Monitoring and Maintenance)

WMA/Facility	Concrete (yd^3)[a]	Steel (tons)[b]
1—Process Building	0	0
01/14 Building	0	0
2—LLWTF and Lagoons 1-5	1,040	0
3—HLW Tanks/Vitrification Facility	0	0
4—CDDL	0	0
5—CPC Waste Storage Area	0	0
Lag Storage Building/Additions	0	0
7—NDA	0	0
8—SDA	0	0
9—RTS Drum Cell	0	0
Other Facilities (including WMAs 10,11,12)	0	0
Wastewater Treatment Area	1,600	19 (5)[c]
Erosion Control	2,000	0
Total	4,640	19

a. To convert cubic yards to cubic meters, multiply by 0.7646.
b. To convert tons to metric tons, multiply by 0.91.
c. Value in parenthesis are those in the 1995 version of the closure engineering reports. The Final EIS will use final versions of the closure engineering reports.

Sources: WVNS (1994a through 1994n)

Implementing Alternative IV would result in discharges to air as summarized in Table 3-22. The nonradiological releases to air would include releases from heavy equipment, fugitive dust, and shipping emissions from sludge pond removal, LLWTF lagoon closure, construction and operation of the wastewater treatment area, and erosion control measures. The only radiological releases to air would be from evaporating the SDA leachate [estimated to be generated at 114,000 L (30,000 gal) per year] (WVNS 1994j).

Table 3-22. Releases to the Environment from Implementing Alternative IV (No Action: Monitoring and Maintenance)

	Radiological Releases	Nonradiological Releases (tons)[a]		
WMA/Facility	Air (mCi/yr)	Fugitive Dust	Shipping Emissions[b]	Heavy Equipment[c]
1—Process Building	0	0	0	0
01/14 Building	0	0	0	0
2—LLWTF and Lagoons 1-5	0	19.8	0.02 (0)[d]	17.6 (6)
3—HLW Tanks/Vitrification Facility	0	0	0	0
4—CDDL	0	0	0	0
5—CPC Waste Storage Area	0	0	0	0
Lag Storage Building/ Additions	0	0	0	0
7—NDA	0	0	0	0
8—SDA	14	0	0	0
9—RTS Drum Cell	0	0	0	0
Other Facilities (including WMAs 10,11,12)	0	0	1.8	0.23
Wastewater Treatment Area	0[e]	2.1	0	0.42[f]
Erosion Control	0	473	5.5	17.3
Total	14	495	7.3	35.6

a. To convert tons to metric tons, multiply by 0.91.
b. Includes hydrocarbons, carbon monoxide, and nitrogen oxides.
c. Includes particulates, carbon monoxide, hydrocarbons, nitrogen oxides, aldehydes, and sulfur oxides.
d. Values in parenthesis are those in the 1995 versions of the closure engineering reports. The Final EIS will use final versions of the closure engineering reports.
e. The releases would be from evaporation at the wastewater treatment area, but is shown from the source WMA.
f. The tabulated value is for construction of the wastewater treatment area. Operations will result in release of 4.7 tons/yr.

Sources: WVNS (1994a through 1994n)

3.6.5 Alternative IV Post-Implementation Phase Actions

After the limited actions taken during the implementation phase have been completed, the entire Center would be retained [1,350 ha (3,340 acres)]. Areas requiring active management would include the creek channels on the site and the Project Premises and SDA. The activities that would be conducted during the post-implementation phase would include: (a) site security to restrict access, (b) environmental monitoring to assure that contamination is not being released from the waste storage facilities and disposal areas, (c) erosion monitoring and maintenance, and (d) monitoring and maintenance of the waste storage facilities and disposal areas. No area would be available for reuse.

The erosion monitoring and control activities would involve multiple local erosion control structures as described in Section 3.6.2.3. Erosion would be monitored; eroded areas would be filled and structures would be repaired as necessary. At the end of their effective lives, the local erosion control structures would be replaced.

Monitoring and maintenance of the disposal areas would include monitoring contamination levels to determine if radionuclides were being released from the disposal areas. Caps and covers over disposal areas would be repaired to prevent water from entering the facilities. Areas would be inspected after any major seismic event to assess the capability of the facility to isolate the waste from water. Maintenance actions would be taken, that could include regrading the slope cover and reseeding areas where the vegetative cover has degraded. Monitoring and repairing the disposal area caps would continue indefinitely.

Monitoring and maintenance activities would produce minimal volumes of radioactive waste from some of the environmental monitoring activities and from potential cap maintenance activities. Small waste volumes [approximately 50 m^3 (1,800 ft^3) per year] would also be generated by periodically treating SDA leachate in the wastewater treatment area and solidifying the residuals. The wastewater treatment area would annually generate about 22 m^3 (770 ft^3) of Class A waste that would be packaged in 80 208-L (55-gal) drums. These wastes would be small and could either be stored or disposed of offsite.

3.7 ALTERNATIVE V: DISCONTINUE OPERATIONS

Alternative V is the abandonment alternative where operations would be discontinued. This alternative was suggested in the scoping process and could occur if the federal and State governments were to have severe budget crises. Even though it is inconsistent with current waste management policies, this alternative was analyzed because it establishes a useful baseline for understanding the inherent risks of the site facilities, buried waste, environmental contamination, and site erosion. For purposes of analysis in this EIS, Alternative V was assumed to be implemented in the year 2000.

Under this alternative, buildings' active systems (e.g., ventilation, fire protection, electrical, and water supply systems) would be shut down or removed, and the buildings would be locked. The buried waste in the CDDL, SDA, and NDA would remain as-is.

Stored waste in the waste storage facilities (lag storage building and lag storage additions, RTS drum cell, CPC waste storage area, IWSF, and the proposed contaminated soil consolidation area) would be left in these storage structures. Similarly, the canisters of vitrified HLW would remain in the process building. The in-ground structures (e.g., interceptors, pits, and lagoons) would be left as-is. No effort would be taken to mitigate environmental contamination.

There would be no institutional controls under Alternative V. There would be no site security to restrict access to the site, no effluent monitoring or environmental monitoring, no erosion monitoring and control, and no monitoring and maintenance of facilities, structures, waste storage facilities, or disposal areas.

This alternative involves abandonment of the site. Institutional control of the site would be lost, and there would be no post-implementation phase actions. An estimated 47 ha (115 acres) would remain contaminated from environmental contamination and facilities abandoned on the Project Premises, and represents an irreversible and irretrievable commitment of resources.

3.8 COMPARISON OF ALTERNATIVES

This section compares the characteristics of the site closure or stabilization alternatives, the resources required to implement the alternatives, waste volumes generated, and associated impacts to the environment including those on the regional and national population. Completing the WVDP and closure or stabilization of the facilities at the Center would result in impacts over two periods of time: an implementation phase and a post-implementation phase. During the implementation phase, actions would be taken to remove or stabilize facilities. The post-implementation phase of closure includes the period of institutional control and long-term monitoring and maintenance. This section describes the impacts during these two time periods.

Section 3.8.1 compares the actions identified in the conceptual engineering designs to implement specific alternatives. Section 3.8.2 discusses implementation times and estimated major resources for implementing the actions, and Section 3.8.3 summarizes the impacts of implementing the actions based on the analyses of environmental consequences in Chapter 5. Environmental impacts during the implementation and post-implementation phases are discussed.

3.8.1 Comparison of Actions

Implementing strategies for completing the WVDP and for closure or long-term management of facilities at the Center involve actions to remove and package waste before dispositioning or stabilizing waste and facilities in place. Table 3-23 summarizes the major actions for each alternative, including construction of new facilities, and erosion control. Table 3-24 shows the disposition of newly generated and stored waste with distances that were assumed for off-site disposal facilities.

Table 3-23. Summary of Actions for Alternatives I through V

Alternative I Removal	Alternative II On-Premises Storage	Alternative IIIA In-Place Stabilization (Backfill)	Alternative IIIB In-Place Stabilization (Rubble)	Alternative IV No Action: Monitoring and Maintenance	Alternative V Discontinue Operations
Dismantle buildings	Dismantle buildings	Dismantle buildings except process building and vitrification facility. Backfill process building and vitrification facility with concrete.	Dismantle and remove buildings except process building and vitrification facility. Dismantle abovegrade portions of process building and vitrification facility and install cap on belowgrade portions of these buildings and the building rubble.	Install locks and security systems on buildings. Weld exterior access doors shut.	Shut down facilities' active systems, lock buildings, and leave waste as-is
Remove stored waste and dismantle waste storage facilities	Remove stored waste and dismantle waste storage facilities except RTS drum cell	Remove stored waste and dismantle waste storage facilities except RTS drum cell. Convert RTS drum cell into tumulus.	Remove stored waste and dismantle waste storage facilities except RTS drum cell. Convert RTS drum cell into tumulus.	Not applicable	Not applicable
Pump leachate from disposal areas and exhume buried waste	Pump leachate from disposal areas and exhume buried waste	Pump leachate from NDA and SDA, and grout SDA trenches. Install circumferential slurry wall around NDA and SDA and cap them both.	Pump leachate from NDA and SDA, and grout SDA trenches. Install circumferential slurry wall around NDA and SDA and cap them both.	Not applicable	Not applicable
Remove in-ground structures	Remove in-ground structures	Backfill HLW tanks with concrete. Cap LLWTF lagoons and SDA filled lagoons. Backfill or remove other in-ground structures.	Backfill HLW tanks with concrete. Cap LLWTF lagoons and SDA filled lagoons. Backfill or remove other in-ground structures.	Excavate sediments from sludge ponds and backfill. Store generated waste on premises. Leave other waste as-is.	Not applicable
Remove remaining facilities, including draining the reservoirs	Remove majority of remaining facilities, including draining the reservoirs	Remove majority of remaining facilities	Remove majority of remaining facilities	Not applicable	Not applicable
Excavate contaminated soil from the Project Premises, SDA, and the balance of the site	Excavate contaminated soil from the Project Premises, SDA, and the balance of the site	Not applicable	Not applicable	Not applicable	Not applicable

Table 3-23. Summary of Actions for Alternatives I through V (Continued)

Alternative I Removal	Alternative II On-Premises Storage	Alternative IIIA In-Place Stabilization (Backfill)	Alternative IIIB In-Place Stabilization (Rubble)	Alternative IV No Action: Monitoring and Maintenance	Alternative V Discontinue Operations
Treat contaminated waste, soil, and wastewater in new on-premises container management area. Dismantle container management area after implementation phase.	Treat contaminated waste, soil, and wastewater in new on-premises container management area. Dismantle container management area after implementation phase. Construct new retrievable storage areas.	Treat contaminated wastewater in new wastewater treatment area. Dismantle wastewater treatment area after implementation phase.	Treat contaminated wastewater in new wastewater treatment area. Dismantle wastewater treatment area after implementation phase. Construct new LLW disposal facility.	Not applicable	Not applicable
Stabilize LLWTF lagoon 3 embankment	Stabilize LLWTF lagoon 3 embankment. Stabilize the stream banks along Erdman Brook and Franks Creek.	Either install several localized erosion control structures or implement extensive, sitewide erosion control measures including large-scale stream bed filling	Either install several localized erosion control structures or implement extensive, sitewide erosion control measures including large-scale stream bed filling	Install several localized erosion control structures. Stabilize the stream banks along Erdman Brook and Franks Creek.	Not applicable
Dispose of waste off site	Store all radioactive and mixed waste on-premises in new retrievable storage areas. Dispose of industrial waste off site. (RTS drum cell remains.)	Dispose of generated and stored radioactive waste in process building or vitrification facility. Dispose of spent fuel fines and vitrified, mixed, hazardous, and industrial waste off site.	Dispose of generated and stored radioactive waste in new on-premises LLW disposal facility. Dispose of spent fuel fines and vitrified, mixed, hazardous, and industrial waste off site.	Not applicable	Not applicable
Release the Center for unrestricted use	Monitor and maintain the retrievable storage areas, RTS drum cell, Erdman Brook stream banks, and the Franks Creek stream banks south of the RTS drum cell and east of the SDA	Monitor and maintain the remaining facilities and erosion control measures on Erdman Brook, Franks Creek, and Quarry Creek (local erosion control strategy only)	Monitor and maintain the remaining facilities and erosion control measures on Erdman Brook, Franks Creek, and Quarry Creek (local erosion control strategy only)	Inspect, monitor, and maintain all areas of the Center	Personnel leave the Center

Table 3-24. Comparison of Waste Disposition[a,b]

Category	Alternative I Removal	Alternative II On-Premises Storage	Alternative IIIA In-Place Stabilization (Backfill)	Alternative IIIB In-Place Stabilization (Rubble)	Alternative IV No Action: Monitoring and Maintenance	Alternative V Discontinue Operations
High-Level Waste						
• Vitrified waste	4,000 km	Move to retrievable storage areas	4,000 km	4,000 km	Remain in process building (chemical process cell)	Remain in process building (chemical process cell)
• HLW tank sludge	4,000 km	Move to retrievable storage areas	Remain in place	Remain in place	Remain in place	Remain in place
• Spent fuel fines[c]	4,000 km	Move to retrievable storage areas	4,000 km	4,000 km	Remain in process building	Remain in process building
• Spent fuel assemblies in NDA	4,000 km	Move to retrievable storage areas	Remain in place	Remain in place	Remain in place	Remain in place
Low-Level Waste						
• Stored LLW	4,000 km	Move to retrievable storage areas	Move to process building or vitrification facility	Move to LLW disposal facility	Remain in storage facilities	Remain in storage facilities
• Buried LLW	4,000 km	Move to retrievable storage areas	Remain in SDA and NDA	Remain in SDA and NDA	Remain in SDA and NDA	Remain in SDA and NDA
• Greater-than-Class-C	4,000 km	Move to retrievable storage areas	Move to process building or vitrification facility	Move to LLW disposal facility	Remain in place	Remain in place
Mixed Waste	1,600 km	Move to retrievable storage areas	1,600 km	1,600 km	Remain in place	Remain in place
Hazardous Waste	800 km	Balance of site facilities waste remains in place, 800 km otherwise	Balance of site facilities waste remains in place, 800 km otherwise	Balance of site facilities waste remains in place, 800 km otherwise	800 km for 01/14 and 02 buildings waste, remain in place otherwise	Remain in place
Industrial Waste	640 km	640 km	640 km	640 km	640 km	Remain in place

a. If waste would remain on the Project Premises, the name of the facility is given. If waste would be disposed of off site, the estimated distance to a disposal facility is given.
b. To convert from kilometers to miles, multiply by 0.6214.
c. Although the classification of the spent fuel fines is not yet known, for purposes of analysis it was assumed that it would be HLW.

The removal (Alternative I) and on-premises storage (Alternative II) alternatives would involve the greatest effort because buried waste would be exhumed, stored waste would be removed, facilities would be decontaminated and demolished (except the RTS drum cell under Alternative II), and soil and stream sediments contaminated above the assumed contaminant cleanup levels would be excavated. A new facility, the container management area, would be constructed to treat and package the stored and newly generated wastes. The major difference between these two high-effort alternatives is the disposition of the waste. Under the removal alternative (Alternative I) waste would be disposed of off site. Under Alternative II, the radioactive waste (and mixed waste remaining after treatment in the container management area) would be placed into new retrievable storage areas on the Project Premises.

Alternatives IIIA [In-Place Stabilization (Backfill)] and IIIB [In-Place Stabilization (Rubble)] attempt to achieve waste isolation by stabilizing wastes and facilities in place and would require less effort than Alternatives I and II. A new wastewater treatment area for treating contaminated liquids would be required under Alternatives IIIA and IIIB. The major difference between these in-place stabilization alternatives is the disposition of the large contaminated buildings (i.e., the process building and the vitrification facility) and the stored waste in the lag storage building, lag storage additions, and CPC waste storage area, interim waste storage facility, and proposed contaminated soil consolidation area. Under Alternative IIIA, the stored waste would be placed in either the process building or the vitrification facility and backfilled with concrete to convert the buildings and waste into a monolith. Under Alternative IIIB, stored waste would be placed in a new LLW disposal facility on the Project Premises and the process building and the vitrification facility would be demolished in a controlled manner within a single, newly-constructed confinement structure, resulting in a grouted rubble pile covered by an engineered cap.

Each of the alternatives implements a strategy to control erosion except Alternative V (Discontinue Operations); under Alternative V the Center is abandoned. Under Alternatives I and IV, a limited erosion control strategy could be implemented where embankments are stabilized; for example, stormwater collection systems and water control structures could be built. Under Alternative III (In-Place Stabilization), either local or global erosion control measures could be used to control erosion. The global measures modify the drainage pattern and include such things as constructing a diversion channel and filling the creeks.

3.8.2 Comparison of Implementation Times, Resource Requirements, and Waste Volumes

Implementing the actions requires time and resources. Waste volumes generated by implementing the alternatives would have to be managed. Table 3-25 identifies the time and resources to implement the alternatives. The implementation phases range from 10 to 28 years for Alternatives I through III. Alternative IV has a much shorter implementation phase because less effort is expended to remove facilities. This alternative involves long-term monitoring and maintenance consistent with current practices. Alternative V (Discontinue Operations) involves abandoning the Center and no implementation phase effort

Table 3-25. Comparison of Resource Requirements

Impact Category	Alternative I Removal		Alternative II On-Premises Storage		Alternative IIIA In-Place Stabilization (Backfill)		Alternative IIIB In-Place Stabilization (Rubble)		Alternative IV No Action: Monitoring and Maintenance		Alternative V Discontinue Operations	
Resource	Implementation Phase	Monitoring and Maintenance Phase[a]	Implementation Phase	Monitoring and Maintenance Phase[a]	Implementation Phase	Monitoring and Maintenance Phase[a]	Implementation Phase	Monitoring and Maintenance Phase[a]	Implementation Phase	Monitoring and Maintenance Phase[a]	Implementation Phase	Monitoring and Maintenance Phase[a]
Duration of Implementation Phase (years)	26	0	28	For the foreseeable future	10[c] or 14[d]	For the foreseeable future	26	For the foreseeable future	5	For the foreseeable future	0[b]	0
Total Electrical Power (MW-hr)	65,000	0	1.8×10^5	2,800	7,100	Negligible	99,000	Negligible	0	87	0	0
Estimated Implementation Annual Peak (MW-hr/yr)	4,400	NA	14,000	NA	1,500	NA	6,000	NA	0	NA	0	NA
Current Annual Peak Requirement (MW-hr/yr)	32,000	NA	32,000	NA	32,000	NA	32,000	NA	32,000	NA	32,000	NA
Natural Gas (ft^3)	2.7×10^8	0	8.7×10^8	5.4×10^6	4.7×10^7	Negligible	1.9×10^8	Negligible	0	3.1×10^6	0	0
Estimated Implementation Annual Peak (ft^3/yr)	2.2×10^7	NA	7.1×10^7	NA	6.3×10^6	NA	3.2×10^7	NA	0	NA	0	NA
Current Annual Peak Requirement (ft^3/yr)	8.9×10^7	NA	8.9×10^7	NA	8.9×10^7	NA	8.9×10^7	NA	8.9×10^7	NA	8.9×10^7	NA
Diesel and Gasoline Fuel (gal)	1.9×10^6	0	2.5×10^6	0	1.3×10^6[c] or 3.1×10^6[d]	Negligible	2.1×10^6[c] or 4.1×10^6[d]	Negligible	86,700	5,100	0	0
Estimated Implementation Annual Peak (gal/yr)	7.9×10^4	NA	9.6×10^4	NA	1.4×10^5[c] or 2.4×10^5[d]	NA	84,000[c] or 1.6×10^5[d]	NA	29,000	NA	0	NA
Current Annual Peak Requirement (gal/yr)	24,500	NA	24,500	NA	24,500	NA	24,500	NA	24,500	NA	24,500	NA

Table 3-25. Comparison of Resource Requirements (Continued)

Impact Category	Alternative I Removal		Alternative II On-Premises Storage		Alternative IIIA In-Place Stabilization (Backfill)		Alternative IIIB In-Place Stabilization (Rubble)		Alternative IV No Action: Monitoring and Maintenance		Alternative V Discontinue Operations	
Resource	Implementation Phase	Monitoring and Maintenance Phase[a]	Implementation Phase	Monitoring and Maintenance Phase[a]	Implementation Phase	Monitoring and Maintenance Phase[a]	Implementation Phase	Monitoring and Maintenance Phase[a]	Implementation Phase	Monitoring and Maintenance Phase[a]	Implementation Phase	Monitoring and Maintenance Phase[a]
Concrete (yd^3)	41,770	0	202,000	0	177,080[c]	Negligible	130,206[c] or 128,876[d]	Negligible	4,600	Negligible	0	0
Steel (tons)	2,500	0	2,700	0	19	Negligible	139	Negligible	19	Negligible	0	0
Earth Materials for Fill, Rip-Rap (yd^3)	5.6×10^6	0	5.6×10^6	0	0	0	3.9×10^6	0	0	0	0	0
Drums	5,990	0	5,990	0	2,960	Negligible	9,700	Negligible	20	80	0	0
B-96 Boxes	62,520	0	62,520	0	330	Negligible	330	Negligible	173	0	0	0
High Integrity Containers	4,280	0	4,280	0	1,020	Negligible	1,020	Negligible	0	0	0	0
NUHOMS[b]	2,100	0	2,100	0	180	Negligible	180	Negligible	0	0	0	0
Labor (worker-yr)	14,433	0	18,864	30	2,071[c] or 2,627[d]	50	5,634[c] or 6,190[d]	50	131	200	0	0
Estimated Implementation Annual Peak (workers/year)[e]	850	0	1,030	NA	330	NA	510	NA	24	NA	0	0

Negligible = Estimated to be negligible.
NA = Not applicable.
NUHOMS = Nutech Horizontal Modular System

a. These are annual requirements.
b. Would only take a few days.
c. Assumes local erosion control strategy would be implemented.
d. Assumes global erosion control strategy would be implemented.
e. The current annual peak requirement is 1,000 workers/year.

is required. Table 3-25 indicates that Alternatives I and V are the only two alternatives without a post-implementation phase. Under Alternative I, a post-implementation phase is not necessary because no residual contamination above assumed contaminant cleanup levels would remain. Under Alternative V, no implementation or post-implementation phase would occur according to the definition of the alternative.

Table 3-25 also presents the energy, materials, and labor resources required for the implementation and post-implementation phases.

For the implementation phase, the estimated peak annual use rate for electricity, natural gas, fuel, and labor is presented. For comparison, the estimated current annual peak use for these same resources during HLW solidification for the WVDP is also presented. Comparing the peak use rates shows the alternatives would not consume these resources, except for fuel, at a rate higher than current or projected future consumption.

Alternatives I (Removal) and II (On-Premises Storage) would use the largest amount of natural gas, steel, containers, and labor because of the magnitude of implementation activities. Electricity requirements for Alternative IIIB [In-Place Stabilization (Rubble)] would be higher than Alternative I because of operation of the LLW disposal facility. Alternative II resource requirements are the highest (except containers) because of construction, operation, and storage activities at the retrievable storage areas. The largest amount of fuel would be required under Alternative III if global erosion control measures were implemented. Alternative IIIB would require the largest amount of concrete because three LLW disposal facility modules would be constructed.

Table 3-26 presents the implementation and post-implementation phase costs. Alternative I (Removal) would be the most expensive to implement because of the high cost of disposing of a large volume of waste. Alternative II (On-Premises Storage) would be less expensive (56 percent) because waste is stored on-premises. The largest cost component of Alternative II is the labor from implementing the action and constructing and operating the retrievable storage areas. The costs for implementing either Alternative IIIA [In-Place Stabilization (Backfill)] or Alternative IIIB [In-Place Stabilization (Rubble)] would be 70 to 80 percent less than Alternative II (On-Premises Storage) because they require less labor, the waste volumes are smaller, and waste is disposed of on the Project Premises. Alternative IIIB would cost more than IIIA because the process building and vitrification facility would be demolished and three LLW disposal modules would be constructed. Implementing global, rather than local, erosion control measures under either Alternatives IIIA or IIIB would increase costs. Alternative IV (No Action: Monitoring and Maintenance) would have the highest annual post-implementation costs because minimal action would be taken during the implementation phase to stabilize the facilities and, therefore, post-implementation maintenance costs would be higher.

Table 3-27 summarizes the estimated waste volumes generated by each alternative. The relative demand for waste management is similar to that discussed for labor and cost. Alternatives I and II would generate the most waste. Alternative III would generate

Table 3-26. Comparison of Estimated Costs ($1996, thousands)[a]

WMA/Facility	Alternative I Removal		Alternative II On-Premises Storage		Alternative IIIA In-Place Stabilization (Backfill)		Alternative IIIB In-Place Stabilization (Rubble)		Alternative IV No Action: Monitoring and Maintenance		Alternative V Discontinue Operations	
	Implementation	Post-Implementation (Annual) ($/yr)	Implementation	Post-Implementation (Annual) ($/yr)	Implementation	Post-Implementation (Annual) ($/yr)	Implementation	Post-Implementation (Annual) ($/yr)	Implementation	Post-Implementation (Annual) ($/yr)	Implementation	Post-Implementation (Annual) ($/yr)
1—Process Building	330,000	0	220,000	0	37,000		310,000		1,800		0	0
01/14 Building	4,400	0	3,900	0	3,900		3,900		320		0	0
2—LLWTF	46,000	0	18,000	0	6,100		6,100		3,000		0	0
3—HLW Tanks/Vitrification Facility	240,000	0	130,000	0	47,000		110,000		1,800		0	0
4—CDDL	570,000	0	23,000	0	0		0		0		0	0
5—CPC Waste Storage Area	58,000	0	23,000	0	23,000		23,000		86		0	0
Lag Storage Building/Additions	310,000	0	56,000	0	57,000		57,000		86		0	0
7—NDA	950,000	0	490,000	0	32,000		32,000		0		0	0
8—SDA	3,100,000	0	680,000	0	56,000		56,000		0		0	0
9—RTS Drum Cell	120,000	0	0	0	6,700		6,700		0		0	0
Other Facilities[b]	41,000	0	28,000	0	20,000		20,000		530		0	0
Container Management Area[c]	740,000	0	730,000	0	NA[d]		NA		NA		0	0
Retrievable Storage Areas	0	0	490,000	2,700	0		0		0		0	0
Wastewater Treatment Area	0	0	0	0	43,000		98,000		9,300		0	0
Low-Level Waste Disposal Facility	0	0	0	0	0		110,000		0		0	0
Contaminated Soil	960,000	0	35,000	0	0		0		0		0	0
Erosion Control	450	0	450	133	6,100[e] or 110,000[f]		6,100[e] or 110,000[f]		450		0	0
Site Support Operations	790,000	0	790,000	0	66,000		150,000		0		0	0
Monitoring and Maintenance	0	0	0	0	0		0		0		0	
Total	8,300,000	0	3,700,000	2,800	400,000[e] or 510,000[f]	11,000[g]	990,000[e] or 1,100,000[f]	11,000[g]	17,000	30,000[h]	0	0

a. All costs are rounded to two significant figures.
b. Consists of small support structures.
c. Includes volume reduction area, soil treatment area, and wastewater treatment area.
d. Only the wastewater treatment area is constructed for Alternatives III and IV.
e. Assumes local erosion control strategy would be implemented.
f. Assumes global erosion control strategy would be implemented.
g. Post-implementation costs are not facility-specific and consist of costs to maintain a laboratory, run radiation protection and quality assurance programs, maintain site security, and maintain erosion control structures.
h. Post-implementation costs are generally not facility-specific and consist mainly of costs to maintain the facilities, run programs such as radiation protection and laboratories, and miscellaneous smaller programs such as site security.

Source: Modified from WVNS (1994a through 1994o)

Table 3-27. Comparison of Waste Volumes Generated (ft^3)[a,b]

WMA/Facility	Alternative I[c] Removal	Alternative II[c] On-Premises Storage	Alternative IIIA In-Place Stabilization (Backfill)	Alternative IIIB In-Place Stabilization (Rubble)	Alternative IV No Action: Monitoring and Maintenance	Alternative V Discontinue Operations
Class A, B, and C Waste						
1—Process Building	170,000	170,000	11,900	47,700	0	0
01/14 Building	792	792	900	900	0	0
2—LLWTF and Lagoons 1-5	47,200	47,200	6,390	6,390	0	0
3—HLW Tanks/Vitrification Facility	103,000	103,000	1,650	1,650	0	0
4—CDDL	849,000	849,000	0	0	0	0
5—CPC Waste Storage Area	11,600	11,600	11,600	11,600	0	0
Lag Storage Building/Additions	452,000	452,000	452,000	452,000	0	0
7—NDA	240,000	240,000	238	238	0	0
8—SDA	2,720,000	2,720,000	550	550	0	0
9—RTS Drum Cell	210,000	0	0	0	0	0
Other Facilities (including WMAs 6,10,11,12)	4,700	4,700	18,900	18,900	15,200	0
Container Management Area or Wastewater Treatment Area[d]	13,200	13,200	5,960	15,600	0	NA[e]
Total Class A, B, and C Waste	4,820,000	4,610,000	510,000	555,000	15,200	0
Greater-than-Class C Waste						
5—CPC Waste Storage Area	15,100	15,100	15,100	15,100	0	0
7—NDA	124,000	124,000	0	0	0	0
8—SDA	133,000	133,000	0	0	0	0
Total GTCC Waste	272,000	272,000	15,100	15,100	0	0
High-Level Waste						
1—Process Building[f]	420	420	420	420	0	0
3—HLW Tanks/Vitrification Facility	10,200	10,200	9,000	9,000	0	0
7—NDA	12	12	0	0	0	0
Total HLW	10,600	10,600	9,420	9,420	0	0
Hazardous Waste						
1—01/14 Building	1	1	1	1	0	0
2—LLWTF and Lagoons 1-5	1	1	1	1	1	0
Other Facilities (including WMAs 6,10,11,12)	3	0	0	0	0	0
Total Hazardous Waste	5	2	2	2	1	0

Table 3-27. Comparison of Waste Volumes Generated (ft^3)[a,b] (Continued)

WMA/Facility	Alternative I Removal	Alternative II On-Premises Storage	Alternative IIIA In-Place Stabilization (Backfill)	Alternative IIIB In-Place Stabilization (Rubble)	Alternative IV No Action: Monitoring and Maintenance	Alternative V Discontinue Operations
Mixed Waste						
5—Lag Storage Building/Additions	441	441	772	772	0	0
7—NDA	1,370	1,370	1,450	1,450	0	0
Total Mixed	1,810	1,810	2,220	2,220	0	0
Contaminated Soil[g]	4,230,000[h]	4,230,000[h]	0	0	0	0
Industrial Waste[i]						
1—Process Building	757,000	757,000	32,200	0	0	0
01/4 Building	70,600	70,600	70,600	70,600	0	0
2—LLWTF and Lagoons 1-5	42,800	42,800	14,700	14,700	0	0
3—HLW Tanks/Vitrification Facility	457,000	457,000	52,900	73,600	0	0
4—CDDL	374,000	374,000	0	0	0	0
5—CPC Waste Storage Area	2,760	2,760	2,760	2,760	0	0
Lag Storage Building/Additions	66,100	66,100	66,100	66,100	0	0
7—NDA	150,000	150,000	20,600	20,600	0	0
8—SDA	6,480	6,480	6,480	6,480	0	0
9—RTS Drum Cell	320,000	0	3,380	3,380	0	0
Other Facilities (including WMAs 6,10,11,12)	2,220,000	1,490,000	956,000	956,000	0	0
Container Management Area or Wastewater Treatment Area[d]	667,000	667,000	44,200	44,200	0	NA[e]
Erosion Control	432	432	166,000[j] or 1,140,000[k]	166,000[j] or 1,140,000[k]	212,000	0
Total Industrial Waste	5,130,000	4,080,000	1,440,000[j] or 2,410,000[k]	1,420,000[j] or 2,400,000[k]	212,000	0

a. All volumes have been rounded to three significant figures. Values in columns may not add up to totals due to rounding. To convert from cubic feet to cubic meters, multiply by 0.02832.
b. Only the facilities specifically listed under each waste category would generate that type of waste.
c. For Alternatives I and II, these are waste volumes after processing in the container management area.
d. The container management area would be built for Alternatives I and II, and a wastewater treatment area would be built for Alternatives IIIA, IIIB, and IV.
e. NA = not applicable because neither facility would be built for Alternative V.
f. Consists of spent fuel fines. Although the classification of the spent fuel fines is not yet known, for purposes of analysis it is was assumed that it would be HLW.
g. Includes on-site contaminated stream sediments.
h. Estimated as 25 percent of the original volume of contaminated soil (20 percent that could not be successfully treated and 5 percent that would be contaminated sludge from soil treatment operations).
i. For purposes of analysis, this EIS assumes that this uncharacterized waste would be industrial waste. However, if all of this waste was found to be contaminated during closure activities instead of uncontaminated (as assumed in this table), there would be no industrial waste and these volumes would be Class A waste.
j. Assumes local erosion control strategy would be implemented.
k. Assumes global erosion control strategy would be implemented.

Source: Modified from WVNS (1994a through 1994o) approximately 14 to 22 percent of the waste generated for Alternatives I and II, depending on whether the local or global erosion control strategy was selected.

The waste volumes are dominated by three types of waste: low-level radioactive, contaminated soil, and uncontaminated industrial waste. The sources for most of the waste volume are the large buildings (process building and vitrification facility), the disposal areas (SDA and NDA), and the waste storage facilities (lag storage building, lag storage additions, CPC waste storage area, interim waste storage facility, and proposed contaminated soil consolidation area). The volumes could increase under Alternatives I and II if soil treatment results in more than 25 percent of the contaminated soil volume remaining contaminated or if soil treatment is ineffective.

3.8.3 Comparison of Impacts

This section summarizes and compares the impacts for the implementation and post-implementation phases of closure. A detailed analysis of the impacts is presented in Chapter 5. The implementation phase would range from 0 to 28 years depending on the selected alternative. During this time, actions would be taken to stabilize the facilities. Impacts would result from employment changes, worker accidents, transporting waste, releases of radionuclides to the environment, demolishing buildings, excavating soil, and constructing new facilities.

After the implementation actions are complete, long-term radiological impacts would result from reconfiguring the waste.

Section 3.8.3.1 discusses implementation phase impacts, and post-implementation (long-term) radiological impacts are addressed in Section 3.8.3.2.

3.8.3.1 Implementation Phase Impacts

Table 3-28 compares lost workdays, fatalities, and number of waste shipments. More labor is required and more occupational exposures result from implementing Alternatives I and II because of the greater labor requirement. Occupational injuries are 6 to 8 times higher for Alternatives I and II compared to Alternative III and about 500 times higher than Alternative IV. Off-site impacts from transporting waste would occur during the implementation phase. Transportation impacts for Alternative I are distinguished from the other alternatives because the waste is disposed of off site. Transporting waste results in occupational exposure to the truck drivers or railroad personnel, fatalities from traffic accidents, and radiation exposure to the public along the transportation route.

Table 3-29 summarizes environmental impacts from implementing the alternatives. Groundwater quality would improve under Alternatives I through IV because an effort would be made to either remove the contaminant source (Alternatives I and II) or mitigate the effects (Alternatives III and IV). Under Alternative V, groundwater quality would continue to deteriorate.

Table 3-28. Comparison of Lost Workdays, Fatalities, and Number of Shipments

Impact Category	Alternative I Removal		Alternative II On-Premises Storage		Alternative IIIA In-Place Stabilization (Backfill)		Alternative IIIB In-Place Stabilization (Rubble)		Alternative IV No Action: Monitoring and Maintenance		Alternative V Discontinue Operations	
	Implementation Phase Incidents	Post-Implementation Annual Incidents	Implementation Phase Incidents	Post-Implementation Annual Incidents	Implementation Phase Incidents	Post-Implementation Annual Incidents	Implementation Phase Incidents	Post-Implementation Annual Incidents	Implementation Phase Incidents	Post-Implementation Annual Incidents	Implementation Phase Incidents	Post-Implementation Annual Incidents
Occupational Lost Workdays	273	NA[a]	323	Negligible[b]	126	Negligible	217	Negligible	1.9	306	0	NA
Fatalities Related to Operations												
Occupational	0.25	NA	0.31	Negligible	0.13	Negligible	0.25	Negligible	0.0035	0.007	0	NA
Public	0	NA	0	0	0	0	0	0	0	0	0	NA
Fatalities Related to Transportation												
Truck	5.08		1.28	0	0.87	0	0.87	0	0	0	0	NA
Rail	4.93	NA	1.22	0	0.80	0	0.80	0	0	0	0	NA
Estimated Number of Waste Shipments												
Truck	31,042	NA	8,175	0	5,380	0	5,380	0	0	0	0	NA
Rail	20,269	NA	5,723	0	3,705	0	3,705	0	0	0	0	NA

a. NA = not applicable because there would be no post-implementation phase.
b. Negligible = estimated to be negligible.

Table 3-29. Comparison of Environmental Impacts

Impact Category	Alternative I Removal	Alternative II On-Premises Storage	Alternative IIIA In-Place Stabilization (Backfill)	Alternative IIIB In-Place Stabilization (Rubble)	Alternative IV No Action: Monitoring and Maintenance	Alternative V Discontinue Operations
Disturbed Area [hectares (acres)]	81 (200)	83 (205)	39 to 57 (97 to 142)[a]	39 to 57 (97 to 142)[a]	13 (32)	0
Groundwater and Contaminated Soils	Radioactivity in groundwater would decrease Contaminated soil removed	Same as Alternative I	Radionuclide constituents would exceed applicable standards at multiple locations on-premises. Mitigation measures implemented to control groundwater contamination.			
Reserved Areas [hectares (acres)]						
• Creek Channels	0	240 (600)	240 (600)	240 (600)		
• North Plateau	0	57 (140)	57 (140)	57 (140)		
• South Plateau	0	36 (90)	36 (90)	36 (90)		
• Cesium Prong	0	0	14 (34)	14 (34)		
Total Reserved or Committed	0	340 (830)	350 (860)	350 (860)	1,350 (3,340)	47 (115)[b]
Areas Available for Reuse	1,350 (3,340)	1,020 (2,510)	1,000 (2,480)	1,000 (2,480)	0	NA[c]
Socioeconomic Resources (Direct and secondary employment)	868 total jobs in PIA[d] 1,700 jobs in ROI[e] 847 people directly employed	1,049 total jobs in PIA 1,968 jobs in ROI 1,026 people directly employed	336 total jobs in PIA 683 jobs in ROI 327 people directly employed	515 total jobs in PIA 954 jobs in ROI 504 people directly employed	192 total jobs in PIA 381 jobs in ROI 187 people directly employed	Site employment would be zero in the year 2000
Socioeconomic impact in ROI from combination of implementing the alternative and decline from WVDP HLW solidification operations	Gradual decrease in direct site employment from current level of 950 to 850 in 2011 and then decrease to zero in 2026. Decrease would occur over 15 years and would cause loss of about 57 direct jobs/year.	Increase in direct site employment from current level of 950 to 1,026 in 2011 and then gradual decrease to stable level of 30 in 2026. Decrease would occur over 15 years and would cause loss of about 67 direct jobs/year.	Decrease in direct site employment from current level of 950 to stable level of 52 in 2011. Decrease would occur over 11 years and would cause loss of 82 direct jobs/year.	Decrease in direct site employment from current level of 950 to stable level of 49 in 2027. Decrease would occur over 27 years and would cause loss of 33 direct jobs/year.	Decrease in direct site employment from current level of 950 to stable level of 187 by 2024. Decrease would occur over 4 years and would cause loss of 190 direct jobs/year.	Decrease in direct site employment from current level of 950 to zero by 2004 from completion of HLW solidification. Decrease would occur over 4 years and would cause loss of 237 direct jobs/year.

Table 3-29. Comparison of Environmental Impacts (Continued)

Impact Category	Alternative I Removal	Alternative II On-Premises Storage	Alternative IIIA In-Place Stabilization (Backfill)	Alternative IIIB In-Place Stabilization (Rubble)	Alternative IV No Action: Monitoring and Maintenance	Alternative V Discontinue Operations
Biotic Resources	Plant and animals living on the mowed and maintained portions of the Project Premises and SDA would lose habitat, be disturbed, or be killed. No critical habitat would be disturbed.	Same as Alternative I	Loss of habitat on the Project Premises would be less than for Alternatives I and II. Either a local or global erosion control strategy could be implemented. If a global erosion control strategy were selected, a 18 ha (45 acre) area would be disturbed resulting in loss of terrestrial and aquatic habitat and biota in Franks Creek and Erdman Brook.	Same as Alternative IIIA	Very localized impacts to areas disturbed by localized erosion control measures	Plants and animals would begin repopulating the Project Premises and SDA, assuming human activity decreases
	On the balance of the site, forested areas along the creeks and 14 ha (34 acres) of open field would be uprooted or disrupted. Plants and animals living in the affected areas would lose habitat, be disturbed, or be killed. The reservoirs would be drained and the dams would be removed, resulting in loss of habitat for aquatic species living in the reservoirs and for land animals that use them.	Additional disturbance of animals and habitat would occur by constructing and using the shielded and contact retrievable storage areas	Short-term impact to biota inhabiting mowed and maintained areas on the Project Premises and SDA. No critical habitat would be lost.	Same as Alternative IIIA	Expect increases in contaminant levels in plants and animals on and near the site	Expect increases in contaminant levels in plants and animals on and near the site
		Construction of the retrievable storage areas would disturb about 5.3 ha (13 acres) in areas previously disturbed by implementation actions. These areas would be unavailable for plant or animal habitation.	In forested areas along Franks Creek and on the balance of the site, a 15-ha (37-acre) area would be disturbed if the global erosion control strategy is selected. Loss of open field plant communities and uprooting of some forested areas would occur.		Very localized impacts to biota where local erosion control measures implemented	
					During the post-implementation phase, plant and animal species could be exposed to contamination by consuming vegetation growing in contaminated areas on the Project Premises, the SDA, the balance of the site, and off site	
Wetlands	On the Project Premises, approximately 0.8 ha (2.0 acres) comprising 4 discrete wetlands would possibly be destroyed, and 3.6 ha (9 acres) comprising 15 discrete wetlands would be disturbed. On the balance of the site, 4.4 ha (10.9 acres) of wetlands comprising two wetland areas would be disturbed or destroyed. No critical habitat would be lost.	Same as Alternative I	Approximately 6.4 ha (16 acres) comprising three wetlands could be destroyed, and 1.9 ha (4.7 acres) comprising 17 wetlands could potentially be disturbed. No critical habitat would be lost.	Same as Alternative IIIA	Approximately 0.6 ha (1.4 acres) comprising three wetlands would be disturbed from erosion control measures.	No impact
Threatened and Endangered Species	Loss of state-endangered plant from removing reservoir dam	Same as Alternative I	No impact	No impact	No impact	No impact
Air Quality	Short-term impact on the Project Premises and SDA during implementation. No off-site impact. Concentrations of criteria air pollutants below applicable standards at nearest public access.	Same as Alternative I	Same as Alternative I	Same as Alternative I	No impact	No impact

Table 3-29. Comparison of Environmental Impacts (Continued)

Impact Category	Alternative I Removal	Alternative II On-Premises Storage	Alternative IIIA In-Place Stabilization (Backfill)	Alternative IIIB In-Place Stabilization (Rubble)	Alternative IV No Action: Monitoring and Maintenance	Alternative V Discontinue Operations
Cultural Resources						
• Historic	No impact	No impact	Same as Alternative I	No impact	No impact	No impact
• Archaeologic	Disturbance of 3.8 ha (9.5 acres) with low potential for archaeological sites	Same as Alternative I	Same as Alternative I. If a global erosion control strategy were selected, more potential to disturb possible archaeologic sites.	Same as Alternative IIIA	No impact	No impact
Relationship to Land-Use Plans	Consistent with existing land use plans	Same as Alternative I	Same as Alternative I	Same as Alternative I	Same as Alternative I	Inconsistent—not responsible use
Environmental Justice	No impact	No impact	Because DOE does not have adequate information about the Seneca lifestyle (particularly concerning fish consumption), it cannot be determined that impacts to the Seneca are disproportionately high and adverse	Same as Alternative IIIA	No impact	Same as Alternative III
Off-Site Radioactive Waste Disposal Facilities						
• Number of Truck Shipments	21,000 (mostly LLW)	None	340 (HLW)	Same as Alternative IIIA	None	None
• Additional Disposal Areas	9 ha (23 acres)	None	Small	Same as Alternative IIIA	None	None
• Waste Volume	265,000 m^3 (9.34 million ft^3)	None	341 m^3 (12,000 ft^3)	Same as Alternative IIIA	None	None
Off-Site Industrial Waste Facilities						
• Number of Truck Shipments	10,000	8,200	5,000	Same as Alternative IIIA	500	0
• Waste Volume	145,000 m^3 (5.13 million ft^3)	116,000 m^3 (4.08 million ft^3)	40,800 to 68,300 m^3 (1.44 to 2.41 million ft^3)	Same as Alternative IIIA	5,900 m^3 (0.21 million ft^3)	0

a. Lower number if localized erosion control measures implemented; higher number if global erosion control plan implemented.
b. Land is irreversibly and irretrievably committed from the environmental contamination and contaminated facilities on the Project Premises and the SDA.
c. NA = not applicable.
d. PIA = primary impact area
e. ROI = region of influence.

The retained area is a function of the alternative selected and the need to limit access to the waste storage or disposal facilities and parts of the Project Premises and SDA. For Alternative I, the entire Center would be available for reuse. For Alternative II (On-Premises Storage), the retained areas are expected to be the channel for Cattaraugus Creek that is currently part of the Center, the Buttermilk Creek channel to a point opposite the south plateau, and the channel for Franks Creek. Alternative II would also require retention of both the north and south plateaus, which would contain the retrievable storage areas. Alternatives IIIA [In-Place Stabilization (Backfill)] and IIIB [In-Place Stabilization (Rubble)] would require the same creek channel and north and south plateau areas and additional area for the cesium prong on the balance of the site, north of Quarry Creek. Under Alternative IV (No Action: Monitoring and Maintenance), the entire Center would be retained and none of it would be available for reuse. Under Alternative V, an estimated 47 ha (115 acres) of land contaminated from environmental contamination and contaminated facilities on the Project Premises and SDA would be irreversibly and irretrievably committed.

The WVDP currently accounts for about 6 percent of the employment in a 20-km (12-mi) radius from the Center, and all alternatives would ultimately eliminate most, if not all, of these jobs. The elimination of jobs is not expected to produce a serious impact because employment would decrease over an extended period. Alternatives I and II defer this job reduction for approximately 20 years. The in-place stabilization alternatives (Alternatives IIIA and IIIB) defer this reduction for approximately 11 or 27 years depending on the selected technology. Under Alternative IV, a maintenance and monitoring staff would remain. Table 3-29 shows the peak levels of employment for implementing each of the alternatives and describes the timing and rate of employment decrease. No noticeable influx of personnel would result from implementing any of the alternatives. The current site employees would be expected to fill most of the jobs associated with the alternatives. DOE does not anticipate any disproportionately high and adverse impacts on minority or low-income populations. Because DOE does not have adequate information on the Seneca lifestyle (particularly fish consumption), it cannot be determined whether the impacts to the Seneca are disproportionately high and adverse.

Impacts to biota during the implementation phase would be greatest for the removal (Alternative I), on-premises storage (Alternative II), and in-place stabilization (Alternative III) alternatives because more area would be disturbed. Under Alternatives I and II and if a global erosion strategy were selected under Alternative III, some forested areas would have to be uprooted to remove soil contamination. A State-protected plant species, Rose Pinks, on the balance of the site would be destroyed by implementing Alternatives I and II, if mitigative measures, such as moving the plants, were not implemented. This species has not been proposed for inclusion on the Federal list of protected plants (BNA 1995).

Under 10 CFR 1022, DOE is required to assess the potential impact on wetlands from implementing the proposed action. The most wetlands would be destroyed by the in-place stabilization alternatives if a global erosion control strategy were selected, which significantly modifies surface water flow on the Project Premises and on portions of the balance of the site. Impacts to biota and wetlands during the implementation phase would be least under Alternative V (Discontinue Operations) and Alternative IV (No Action: Monitoring and Maintenance) because less area would be disturbed. Over the long term, plants and animals could be exposed to contamination resulting from consumption of vegetation growing in soils with residual contamination.

Implementation actions would result in localized degradation of air quality on the Project Premises and SDA while the action was occurring, but there would be no post-implementation effect. There would be minimal impact to ambient air quality at the Center site boundary.

There would be no impact to known cultural resources under any of the alternatives.

Off-site facilities would be impacted most by Alternative I. Table 3-29 shows the numbers and volumes associated with truck shipment of both radioactive and industrial waste to off-site facilities.

The environmental impacts from implementing Alternative I (Removal) are greater than the other alternatives in most cases because the labor requirement and the transportation distance results in occupational and public exposure and disturbs most of the area on the Project Premises and SDA. The environmental impact is less for Alternative II (On-Premises Storage) because the transportation requirement is reduced. The environmental impact of Alternative III (In-Place Stabilization) is less than Alternative II; however, if a global erosion control strategy is selected, more biotic habitat and wetlands are potentially lost under Alternative III. Finally, the environmental impact of Alternative IV (No Action: Monitoring and Maintenance) during the implementation phase is the smallest because limited stabilization of facilities occur before long-term monitoring and maintenance.

Impacts to the population are measured in latent cancer fatalities that could result from radiation exposure. Two populations were evaluated in this EIS: those people residing within a 80-km (50 mi) radius of the site and those people along the transportation routes as summarized in Table 3-30. All alternatives would result in less than one additional latent cancer fatality to the general population from site operations during the implementation phase. The site occupational latent cancer fatalities are the greatest for Alternative I (Removal) with about 0.5 latent cancer fatalities. The occupational latent cancer fatalities from the other closure or stabilization alternatives are minor. Occupational exposures during the post-implementation monitoring and maintenance phase are minimal. Alternative IV (No Action: Monitoring and Maintenance) has the highest occupational exposures during monitoring and maintenance. The annual occupational exposure would be expected to gradually decrease from about 30 to about 3 person-rem/yr over time because of radioactive decay. No measurable latent cancer fatalities from monitoring and maintenance are expected under any of the alternatives.

Alternative I would result in an estimated 0.56 latent cancer fatalities to workers from transporting waste and an estimated 5.9 latent cancer fatalities to the general population along the transportation route from transporting the radioactive wastes.

Table 3-30. Comparison of Expected Radiological Impacts

Impact Category	Alternative I Removal		Alternative II On-Premises Storage		Alternative IIIA In-Place Stabilization (Backfill)		Alternative IIIB In-Place Stabilization (Rubble)		Alternative IV No Action: Monitoring and Maintenance		Alternative V Discontinue Operations	
	Implementation (cumulative impact)	Monitor and Maintain (impact/yr)	Implementation (cumulative impact)	Monitor and Maintain (impact/yr)	Implementation (cumulative impact)	Monitor and Maintain (impact/yr)	Implementation (cumulative impact)	Monitor and Maintain (impact/yr)	Implementation (cumulative impact)	Monitor and Maintain (impact/yr)	Implementation (cumulative impact)	Long-Term (impact/yr)
Site Occupational Dose												
Person-rem	1,200	NA[b]	1,300	1	118	10 to 1[c]	118	10 to 1[c]	12	30 to 3[c]	NA	NA
LCF[a]	0.5	NA	0.5	0	0.05	0	0.05	0	0.005	0.012 to 0.001	NA	NA
Transport Occupational Dose												
Person-rem	1,400	NA	0	0	69	0	69	0	0	0	NA	NA
LCF[a]	0.56	NA	0	0	0.028	0	0.028	0	0	0	NA	NA
Regional Public Dose												
Person-rem	113	NA	113	0	45	0	45	0	2.8	0	0	<26,000
LCF[a]	0.06	NA	0.06	0	0.02	0	0.02	0	0.001	0	0	13
Transport Public Dose[d]												
Person-rem	12,000	NA	0	0	760	0	760	0	0	0	0	NA
LCF[a]	5.9	NA	0	0	0.38	0	0.38	0	0	0	0	NA
Total LCFs	7		0.56		0.48		0.48		0.006		0	13

a. LCF = latent cancer fatality.
b. NA = not applicable to the alternative.
c. Dose to the monitoring and maintenance staff is expected to decrease with time because the radioactivity in buried waste would decay.
d. Fatalities are associated with truck shipment of radioactive waste to the Hanford site.

The consequences of selected, bounding, very low probability ($<10^{-4}$ to 10^{-8}/yr) radiological accidents are presented in Table 3-31. These accidents can occur because of operator or equipment failure, natural phenomena, and loss of institutional control. The nature of operational accidents is the failure of an existing system to confine radioactive material allowing source terms that exceed design capacity to be introduced (e.g., fires). The potential for accidents increases with the number and duration of operations. Therefore, Alternatives I and II have a greater potential for operational accidents.

Even though DOE expects little or no adverse health impacts from any of the alternatives assuming institutional control is maintained, it analyzed whether or not there would be "disproportionately high and adverse human health or environmental effects on minority populations or low-income populations" (Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations"). To estimate health impacts to the Seneca Nation, the EIS includes in Section 5.8.2.4 an analysis based on fish consumption rates from the Mohawk Indians and EPA guidance. DOE does not have information on Seneca Nation fish consumption, but is consulting with the Seneca Nation on this issue. The final EIS will include results of that consultation and any conclusion that DOE has reached based on the Seneca Nation-specific information.

3.8.3.2 Comparison of Post-Implementation Phase Impacts

A long-term performance assessment was conducted for each alternative to understand the range of potential environmental impacts. Each WMA was evaluated to obtain a location- and facility-specific assessment of the long-term radiological and chemical hazards.

Concern about long-term radiological hazards has been expressed at public meetings and in comments submitted on previous WVDP NEPA documents. It is difficult to predict long-term hazards because of the uncertainty about future human activities. Therefore, three classes of future scenarios were analyzed. The first class was for expected conditions. For Alternatives II, IIIA, IIIB, and IV, this scenario assumes ongoing monitoring and maintenance to control public access, to maintain the waste storage or disposal facilities, and to control erosion near these facilities. The second class assumes the loss of institutional control (i.e., no maintenance of storage or disposal facilities or erosion control), but no on-premises intruder. The third class assumes the presence of an on-premises intruder. Table 3-32 summarizes the three classes of scenarios and details the timing and location of the receptors.

For Alternatives II, IIIA, IIIB, IV, and V there are four on-premises intruder scenarios: a resident-farmer scenario, a construction scenario, a discovery scenario, and a drilling scenario. These scenarios are discussed in Sections 5.3.2.1, 5.4.2.1, 5.5.2.1, and 5.6.2.1 and are consistent with those used by NRC for long-term performance assessments.

Under Alternative III, scenarios were evaluated for both a local and global erosion control strategy. The local erosion control strategy has a design life of 50 years and was

Table 3-31. Comparison of Latent Cancer Fatalities Among the General Public from Selected Bounding Accidents[a]

Accident	Alternative I Removal	Alternative II On-Premises Storage	Alternative IIIA In-Place Stabilization (Backfill)	Alternative IIIB In-Place Stabilization (Rubble)	Alternative IV No Action: Monitoring and Maintenance	Alternative V Discontinue Operations
Internally Initiated Low Probability Accidents During Implementation[b]						
Vent System Failure	3.5 to 5 (PB,CMA)[c]	3.5 to 5 (PB,CMA)	15 (HLW)	—[a]	—	—
Containment Structure Failure	—	—	0.35 (PB)	350 (PB)	—	—
Excavation Fire/Explosion	45 to 200 (LLWTF,SDA,NDA)	45 to 200 (LLWTF,SDA,NDA)	—	—	—	—
Piping failure during removal of tank 8D-2 sludge	0.5 (HLW)	0.5 (HLW)	—	—	—	—
Drum Drop	0.0004 (LSAs)	0.0004 to 5 (LSAs,RSAs)	0.0004 (LSAs)	0.0004 (LSAs,LLWDF)	—	—
Externally Initiated Accidents						
Design Basis Earthquake (I, M&M)[b]	0.0005 (RTS)	—	0.003[c] (RTS)	0.003[c] (RTS)	—	—
Massive Earthquake (I, M&M)[b]	—	100 to 150 (RTS,RSAs)	13[c] (HLW)	13[c] (HLW)	30 to 500 (HLW,PB)	30 to 500 (HLW,PB)

PB = process building, CMA = container management area, RTS = RTS drum cell, HLW = high-level radioactive waste tanks, RSAs = retrievable storage areas, LSAs = lag storage additions, LLWDF = low-level waste disposal facility, LLWTF = low-level waste treatment facility, SDA = New York State-licensed disposal area, NDA = Nuclear Regulatory Commission-licensed disposal area.

a. Accidents were selected to indicate the bounding off-site impacts. For each category of accident initiations. Dashes in the table entry indicate that the accident is either not bounding or relevant for the particular alternative. All identified accidents are expected to have probabilities of 10^{-4} per year or less. Specific estimated annual probabilities by accident are identified in Appendix G and summarized in Chapter 5.

b. Time periods that the accident risk would exist are indicated by (I) for the implementation phase and (M&M) for the monitoring and maintenance period.

c. The total impacts of these accidents occur over 70 years. The total impacts of the other accidents occur over 1 year or less.

Table 3-32. Comparison of Scenarios for Long-Term Performance Assessment

Scenario	Alternative I Removal	Alternative II On-Premises Storage	Alternative IIIA In-Place Stabilization (Backfill)	Alternative IIIB In-Place Stabilization (Rubble)	Alternative IV No Action: Monitoring and Maintenance	Alternative V Discontinue Operations
Expected Conditions	Resident on the Project Premises and SDA analyzed. RESRAD analysis used to identify soil concentrations resulting in less than 15 mrem/yr for agricultural resident.	Receptor at Cattaraugus Creek; site maintenance of facilities and of erosion control structures	Receptor at Cattaraugus Creek; site maintenance of facilities and of erosion control structures	Receptor at Cattaraugus Creek; site maintenance of facilities and of erosion control structures	Receptor at Cattaraugus Creek; site maintenance of facilities and of erosion control structures	Loss of institutional control; scenarios analyzed
Loss of Institutional Control—Buttermilk Creek Receptor	Resident on the Project Premises and SDA analyzed. RESRAD analysis used to identify soil concentrations resulting in less than 15 mrem/yr for agricultural resident.	Occurs 100 years after implementation phase is complete	Occurs 100 years after implementation phase is complete	Occurs 100 years after implementation phase is complete	Occurs 100 years after implementation phase is complete	Occurs immediately
Loss of Institutional Control—Receptor on the Project Premises and SDA	Resident on the Project Premises and SDA analyzed. RESRAD analysis used to identify soil concentrations resulting in less than 15 mrem/yr for agricultural resident.	Occurs 100 years after implementation phase is complete	Occurs 100 years after implementation phase is complete	Occurs 100 years after implementation phase is complete	Occurs 100 years after implementation phase is complete	Occurs immediately

assumed to fail immediately after loss of institutional control; the global erosion control strategy has a long design life and was assumed to fail after 1,000 years.

These scenarios are conservative. The dose to Buttermilk Creek receptors was estimated using moderately conservative values for input parameters including groundwater velocity, radionuclide solubility, radionuclide diffusion, water consumption and use, contaminant uptake by plants and animals (including fish), and erosion rate. The combination of these factors resulted in a conservative (overstated) dose but not exceptionally conservative doses. The calculations used for estimating the dose to the intruder have conservative factors, but they assume intruder actions that result in the maximum dose. For example, the intruder was assumed to build a house on contaminated soil, eat vegetables raised in a garden planted in contaminated soil, eat game and farm animals that had grazed on forage grown in contaminated soil, and people, gardens, and animals were all assumed to use contaminated water.

An understanding of Alternative V (Discontinue Operations) is needed before comparing the alternatives. Under Alternative V operations are discontinued and the Project Premises and SDA are assumed to be abandoned. The facilities would deteriorate and the site would erode. Specifically, erosion would occur along Franks Creek and Erdman Brook. Estimates in Appendix L show that after 1,000 years there would be moderate erosion of the disposal trenches in the SDA, the disposal holes in the NDA on the south plateau, and at the location of the RTS drum cell. On the north plateau, the LLWTF lagoons would erode. Erosion would also destroy wetlands in upper reaches of Franks Creek and along Quarry Creek, although new wetlands would form as the drainage basin changed.

The facilities would deteriorate without maintenance. The tent structures over the CPC waste storage area and the lag storage additions would be expected to fail first. Metal-sided structures and roofs would last a while longer. The concrete structures, the process building, the vitrification facility, and the HLW tank vaults would last the longest, although they, too, would eventually fail because of concrete deteriorating as described in Appendix O. The reinforced concrete facilities are expected to deteriorate over several hundred years. Water could enter the facility and freeze/thaw cycles would cause further deterioration. Weakened structures could collapse from episodic events such as snow storms, high winds, or seismic events.

Radioactive contamination released to the environment from the processes described above would be transported off site by surface water flowing in the Buttermilk Creek drainage basin.

Table 3-33 summarizes the long-term radiological performance assessment for Alternative V (Discontinue Operations). The analysis shows that an intruder on the Project Premises would receive large, unacceptable doses from many of the WMAs. The dose would occur the first year of intrusion. Doses from the agricultural and construction intruder scenarios are shown because they produced the highest doses.

Table 3-33. **Summary of Long-Term Radiological Performance Assessment for Alternative V (Discontinue Operations)**

		On-Premises or SDA Intruder	Buttermilk Creek Receptor		
WMA/Facility	Was WMA Important for Evaluating and Selecting an Alternative?	Dose Commitment to Receptor with Largest Dose (mrem)	Sand and Gravel Aquifer Pathway (mrem)	Weathered Till Pathway (mrem)	Erosion Pathway (mrem)
1—Process Building	Yes	58,000,000 (A)[a] [2017][b]	670 [2061]	no dose	no dose
1—01/14 Building	No			no dose	no dose
2—LLWTF and Lagoons 1-5	Yes	500,000 (A) [2017] 520,000 (C)[c] [2001]	11 [2050]	no dose	520 [2680]
3—HLW Tanks/Vitrification Facility	Yes	9,200,000,000 (A) [2017]	45,000 [2072]	no dose	no dose
4—CDDL	No		no dose	no dose	no dose
5—CPC Waste Storage Area and Lag Storage Building/Additions	Yes	16,000,000 (A) [2017]	490 [2061]	no dose	no dose
6—Central Project Premises	No	24 (A) [2000]	no dose	no dose	no dose
7—NDA	Yes	570,000,000 (A) [2000]	no dose	0.04 [2068]	47,000 [2290]
8—SDA	Yes	44,000,000 (A) [2016]	no dose	1.0 [2248]	330,000 [2220]
9—RTS Drum Cell	Yes	4,400 (A) [2000]	no dose	6.3 [2125]	4,500 [2100]
10—Support Services Area	No		no dose	no dose	no dose
11—Bulk Storage Warehouse and Hydrofracture Test Well Area	No		no dose	no dose	no dose
12—Balance of Site	No		no dose	no dose	no dose
Cesium Prong	No	88 (A) [2000]			
North Plateau Groundwater Plume	Yes	11,000 (A) [2000]	3.4 [2000]		

a. (A) = agriculture scenario
b. [ ] = peak year of occurrence
c. (C) = construction scenario

The dose to the Buttermilk Creek receptor through the three major contaminant transport pathways is also shown in Table 3-33. The sand and gravel aquifer pathway refers to the sand and gravel layer that underlies the north plateau and is a water pathway that transports large volumes of water with a high groundwater velocity. The groundwater discharges through seeps into Franks Creek, which flows into Buttermilk Creek. The HLW tanks and the process building foundations are either in or are hydraulically connected to the sand and gravel layer. Contamination potentially released from these facilities could be transported off site in the sand and gravel layer. The short travel time is shown in Table 3-33, which indicates that the peak dose year would occur immediately or within a few decades (less than approximately 70 years).

The weathered till pathway refers to a process where water flows below but near the surface through fractures in the weathered till. This process has been documented primarily on the south plateau. Water could enter facilities built on the till (RTS drum cell) or within the till (the SDA and NDA) and flow to the postulated Buttermilk Creek receptor. The travel time for this pathway is a little slower as illustrated in Table 3-33. The peak dose for this pathway occurs between 60 and 248 years.

The third pathway is erosion combined with surface water flow. Facilities such as the LLWTF lagoons 1 and 3, SDA, NDA, and RTS drum cell are in locations subject to erosion. A long-term erosion rate equal to or greater than 90 percent of potential long-term erosion rates was used for this analysis. The largest doses occur through this pathway, although the time until the peak is reached is longer than for the sand and gravel layer or weathered till pathways. Peak doses from the erosion pathway occur between 100 and 680 years depending on the facility.

In addition to identifying the transport pathways that are important for each facility, the analytical results for Alternative V (Discontinue Operations) can be used to determine which facilities represent no or minimal long-term hazard to the public. A dose of 25 mrem/yr from a LLW disposal facility meets the regulatory requirements for a member of the public, according to 10 CFR Part 61.41, "Protection of the General Population from Releases of Radioactivity." An intruder dose of 500 mrem also meets the NRC analytical practice (NRC 1982). Using these thresholds and the fact that selected facilities at the Center contribute the largest doses, other areas and certain remaining facilities on the Center are considered to be minimally important when comparing alternatives. These remaining facilities include the 01/14 building, the construction and demolition debris landfill, the facilities in WMA 6 (e.g., sludge ponds, equalization pond, and incinerator), the facilities in WMA 10 (mostly trailers), the bulk storage warehouse and hydrofracture test well area, and the other remaining facilities on the balance of the site. Soil contamination in the cesium prong is also considered of minimal importance. The comparisons of the long-term performance of the alternatives does not address these remaining facilities or areas because of the low dose that would occur were no management actions taken.

Comparison of Expected Doses. Table 3-34 compares the expected peak doses to an off-site receptor located at Cattaraugus Creek. The peak year dose to the off-site receptor is minimal for all facilities under all alternatives except for the HLW tanks under

Alternatives IIIA [In-Place Stabilization (Backfill)] and IIIB [In-Place Stabilization (Rubble)]. The results are low for the facilities because they would be designed or maintained and repaired to minimize and control water infiltration to avoid contaminated leachate from being transported to the accessible environment and because Center soils effectively retain some of the radionuclides that could potentially be released. Ongoing maintenance would also control erosion. The doses are higher for the HLW tanks because the tanks are assumed to fail under Alternative V (Discontinue Operations) and because a conservative analysis cannot preclude release of soluble, mobile, fission products from the large radionuclide inventory encapsulated in a cement waste form under Alternative III (In-Place Stabilization). For the purpose of the EIS analysis, HLW tanks 8D-1 and 8D-2 were conservatively assumed to contain, appropriately corrected for decay, 3 percent of the total activity originally stored in the tanks. Thus, the leaching characteristics of the waste form and the HLW tanks' location near the sand and gravel layer results in a larger dose to the off-site receptor. Under Alternative IV (No Action: Monitoring and Maintenance), the performance of the HLW tanks looks acceptable because it was assumed that the tank and vault would be monitored and maintained to avoid water infiltration into the waste and that the waste does not leak into the surrounding sand and gravel layer.

Table 3-34. Comparison of Expected Doses for an Off-Site (Cattaraugus Creek) Receptor

	Dose (mrem) to Off-site Individual for Expected Conditions			
WMA/Facility	Alternative II On-Premises Storage (mrem)	Alternative IIIA In-Place Stabilization (Backfill) (mrem)	Alternative IIIB In-Place Stabilization (Rubble) (mrem)	Alternative IV No Action: Monitoring and Maintenance (mrem)
1—Process Building	NP[a]	0.6 (SG)[b]	0.2 (SG)	no dose
2—LLWTF and Lagoons 1-5	NP	1.2 (SG)	1.2 (SG)	1.2 (SG)
3—HLW Tanks/Vitrification Facility	NP	71.9 (SG)	71.9 (SG)	no dose
5—CPC Waste Storage Area Lag Storage Building/Additions	NP			
7—NDA	NP	0.003 (WT)[c]	0.003 (WT)	0.005 (WT)
8—SDA	NP	0.1 (WT)	0.1 (WT)	0.1 (WT)
9—RTS Drum Cell	no dose	0.0003 (WT)	0.0003 (WT)	no dose
North Plateau Groundwater Plume	no dose	no dose	no dose	no dose
Low-Level Waste Disposal Facility	NP	NP	0.01 (SG)	NP
Retrievable Storage Areas	no dose	NP	NP	NP

a. NP = this facility is not present for this alternative.
b. (SG) = sand and gravel aquifer pathway is the dominant pathway.
c. (WT) = weathered till pathway is the dominant pathway.

Except for the HLW tanks, all of the alternatives performed comparably. Potential mitigating measures to improve the long-term performance of the HLW tanks is discussed in Section 5.10.

Comparison of Doses to a Buttermilk Creek Intruder Following Loss of Institutional Control. Table 3-35 compares the doses to a Buttermilk Creek intruder following loss of site access control and site maintenance. Under Alternative V (Discontinue Operations), both hydrologic pathways (the sand and gravel layer and the weathered till) produce peak doses about 60 to 70 years after loss of institutional control. For the erosion pathways, the peak dose occurs 220 to 290 years after loss of institutional control. For the sand and gravel pathway, the dose is slightly over 500 mrem; for the erosion pathways, the peak dose is hundreds or thousands of times greater than 500 mrem.

Under Alternative IV (No Action: Monitoring and Maintenance), the scenarios involve identical systems and failures, but the failures occur 100 years later than in Alternative V (Discontinue Operations). The delay results in lower peak doses by an order of magnitude in the sand and gravel and weathered till hydrologic pathways for the large dose sources such as the process building, the HLW tanks, and the lag storage building and additions. The peak occurs 100 years later than the peak dose for Alternative V (Discontinue Operations), the delay corresponding to the 100 years of institutional control (site maintenance). For purposes of analysis, the peak dose for the erosion pathways occurs 100 years later than Alternative V (Discontinue Operations), but peak dose values are not reduced by the 100-year delay. Therefore, Alternative IV (No Action: Monitoring and Maintenance) has a long-term performance advantage over Alternative V (Discontinue Operations) only for the sand and gravel and weathered till pathways, although the peak dose for the HLW tank still is much greater than 500 mrem.

Under Alternatives IIIA [In-Place Stabilization (Backfill)] and IIIB [In-Place Stabilization (Rubble)], the peak dose values are reduced relative to the peak dose values for Alternatives IV (No Action: Monitoring and Maintenance) and V (Discontinue Operations) because Alternatives IIIA and IIIB use an improved waste form (concrete) to reduce the radionuclide release rate. Alternative III considered two erosion control strategies: a local erosion control strategy with a 50-year design life and a global erosion control strategy that substantially modifies the drainage pattern and had a 1,000-year design life. The performance analysis shows that implementing the local erosion control strategy does not decrease the peak dose. The peak dose does decrease with implementing the global erosion strategy, but the peak year dose is still very high. For the Buttermilk Creek receptor, both Alternatives IIIA and IIIB result in lower peak doses than Alternative IV and much lower peak doses than Alternative V.

Alternative II (On-Premises Storage) performs better than Alternatives IIIA and IIIB because contaminated buildings and facilities would be removed from the sand and gravel layer and from areas subject to erosion. Peak doses from the retrievable storage areas and RTS drum cell occur approximately 30 and 125 years, respectively, after abandonment of the facilities. The time frames for certain processes also influence peak dose amounts. For example, the HLW tanks and the process building can produce a peak dose by water flowing through the sand and gravel layer about 60 to 100 years after loss of institutional control, while the erosion-prone areas such as the SDA and NDA would require several hundreds of years after loss of institutional control to reach the peak dose.

Table 3-35. Comparison of Dose to Buttermilk Creek Intruder Following Loss of Institutional Control and Maintenance

	Dose (mrem) to Buttermilk Creek Intruder				
WMA/Facility	Alternative II On-Premises Storage	Alternative IIIA In-Place Stabilization (Backfill)	Alternative IIIB In-Place Stabilization (Rubble)	Alternative IV No Action: Monitoring and Maintenance	Alternative V Discontinue Operations
1—Process Building	NP[a]	4.8 (SG)[b] [2182][c]	1.1 (SG) [2196]	67 (SG) [2161]	670 (SG) [2061]
2—LLWTF and Lagoons 1-5	NP	0.14 (SG) [2387] 520 (EL)[d] [2788] 100 (EG)[f] [3688]	0.14 (SG) [2387] 520 (EL) [2805] 100 (EG) [3705]	0.18 (SG) [2387] 520 (EL) [2780]	11 (SG) [2050] 520 (E)[e] [2680]
3—HLW Tanks/Vitrification Facility	NP	541 (SG) [2181]	541 (SG) [2198]	4,700 (SG) [2172]	45,000 (SG) [2072]
5—CPC Waste Storage Area Lag Storage Building/Additions	NP	NP	NP	48 (SG) [2161]	490 (SG) [2061]
7—NDA	NP	0.02 (WT)[g] [2141] 47,000 (EL) [2398] 9,400 (EG) [3298]	0.02 (WT) [2141] 47,000 (EL) [2415] 9,400 (EG) [3315]	0.0004 (WT) [2535] 47,000 (EL) [2390]	0.04 (WT) [2068] 47,000 (E) [2290]
8—SDA	NP	0.08 (WT) [2321] 280,000 (EL) [2328] 67,000 (EG) [3228]	0.08 (WT) [2321] 280,000 (EL) [2345] 67,000 (EG) [3245]	1 (WT) [2248] 280,000 (EL) [2320]	1 (WT) [2248] 330,000 (E) [2220]
9—RTS Drum Cell	6.3 (WT) [2250] 4,500 (EL) [2225]	1.7 (WT) [2204] 4,500 (EL) [2208] 900 (EG) [3108]	1.7 (WT) [2204] 4,500 (EL) [2225] 900 (EG) [3125]	6.3 (WT) [2225] 4,500 (EL) [2200]	6.3 (WT) [2125] 4,500 (E) [2100]
North Plateau Groundwater Plume	NP	0.27 [2108]	0.19 [2123]	0.32 (SG) [2100]	3.4 (SG) [2000]
Low-Level Waste Disposal Facility	NP	NP	0.002 (WT) [33823]	NP	NP
Retrievable Storage Areas	652 (SG) [2155]	NP	NP	NP	NP

a. NP = this facility is not present for this alternative.
b. SG = sand and gravel aquifer pathway is the dominant pathway.
c. [ ] = peak year of occurrence.
d. EL = erosional collapse is the dominant pathway, local erosion controls assumed.
e. E = erosional collapse is the dominant pathway, no erosion controls assumed.
f. EG = erosional collapse is the dominant pathway, global erosion controls assumed.
g. WT = weathered till pathway is the dominant pathway.

Comparison of Doses to an Intruder on the Project Premises and SDA Following Loss of Institutional Control. Table 3-36 compares the peak year dose for the Project Premises and SDA intruder for Alternatives II, III, IV, and V. Large doses would occur from many of the facilities under these intruder scenarios. The doses are high because some of the facilities have a concentrated inventory. Intruder doses would be eliminated only if the

Table 3-36. Comparison of Peak Year Doses for the Project Premises and SDA Intruder

	Dose (mrem) to Project Premises and SDA Intruder				
WMA/Facility	Alternative II On-Premises Storage	Alternative IIIA In-Place Stabilization (Backfill)	Alternative IIIB In-Place Stabilization (Rubble)	Alternative IV No Action: Monitoring and Maintenance	Alternative V Discontinue Operations
1—Process Building	NP[a]	3.8×10^5	3.8×10^5	5.8×10^6	5.8×10^7
2—LLWTF and Lagoons 1-5	NP	2.2×10^5	2.2×10^5	2.2×10^5	5.0×10^5
3—HLW Tanks/Vitrification Facility	NP	8.9×10^7	8.9×10^7	1.1×10^9	9.2×10^9
5—CPC Waste Storage Area Lag Storage Building/Additions	NP	NP	NP	1.6×10^6	1.6×10^7
7—NDA	NP	no dose	no dose	6.5×10^6	5.7×10^8
8—SDA	NP	no dose	no dose	3.1×10^5	4.4×10^7
9—RTS Drum Cell	440	36	36	440	4,400
North Plateau Groundwater Plume	15	840	590	1,000	11,000
Low-Level Waste Disposal Facility	NP	NP	25	NP	NP
Retrievable Storage Areas	1.3×10^8	NP	NP	NP	NP

a. NP = This facility is not present for this alternative.

concentrated wastes did not exist. These results show the need for institutional control to limit site access.

Summary of Long-Term Performance Comparison. The results of the long-term performance assessment shows that the facilities with the greatest potential hazard over the next few decades are the HLW tanks. If Alternative IIIA or Alternative IIIB could be modified to improve its long-term performance, a weakness in the alternatives would be eliminated. Alternative II has lower risks because material is moved from the ground and away from areas that are eroding. However, site access control and facility monitoring and maintenance would still be required to prevent intruder doses that are higher than 500 mrem.

3.9 COMPARISON TO 10 CFR PART 61.50 and 10 CFR PART 61.51 PROVISIONS

Item 8 of the Stipulation of Compromise, while in and of itself neither subjects the Department of Energy to formal NRC procedures, nor to actions required by law for licensed activities, does require that DOE make a good faith effort to evaluate the site and design(s) relative to the provisions of 10 CFR Parts 61.50 and 61.51. The Stipulation of Compromise does not state where or how this evaluation should be made, but DOE has included this evaluation in the EIS. This evaluation does not constitute a statement by the DOE of the applicability of 10 CFR Part 61 to the site and designs.

The NRC regulations 10 CFR Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste," were developed in 1982 and were based in part on the lessons learned in the 1960s and 1970s with LLW disposal operations at West Valley, New York; Maxey Flats, Kentucky; Sheffield, Illinois; Beatty, Nevada; Hanford, Washington; and Barnwell, South Carolina. The various parts of 10 CFR Part 61, Subpart D, "Technical Requirements for Land Disposal Facilities," were intended to function in an integrated fashion to ensure isolation of the LLW over the length of the radiological hazard and to ensure stability of the disposal site after closure (Siefken et al. 1982). The site suitability requirements of 10 CFR Part 61.50 and the design requirements of 10 CFR Part 61.51 are two portions of Subpart D. The other portions of Subpart D relate to facility operation and closure, environmental monitoring, waste classification, and waste characteristics. The evaluation of the site against the provisions of 10 CFR Part 61.50 is given in Section 3.9.1, and Section 3.9.2 evaluates the conceptual design of the potential waste disposal facilities against the provisions of 10 CFR Part 61.51. These provisions refer to compliance with the performance objectives of Subpart C of 10 CFR Part 61. This EIS presents performance assessment results in Chapter 5 and they are compared to these Subpart C objectives. Current analysis of the facility designs show compliance with the performance objectives for some but not all of the facilities.

3.9.1 Evaluation of the Site Relative to the Provisions of 10 CFR Part 61.50

The requirements of 10 CFR Part 61.50 identify a variety of site features or characteristics that are either desirable or undesirable for a waste disposal site. Evaluation of the site against these requirements requires characterization information. Only about 80 ha (200 acres) (the Project Premises and the SDA) of the 1,350-ha (3,340-acre) Center has been well characterized because it is the industrialized portion of the Center. The characterization data are from site investigations conducted to support development of the site and environmental monitoring and from characterization investigations to understand the nature and extent of contamination. The availability of characterization data determines the scope of the effort to evaluate the site against these siting requirements.

The evaluation for the Project Premises and SDA is presented in Table 3-37. This evaluation was made using the NRC guidance in Branch Technical Position on Site Suitability (Siefken et al. 1982) and the Standard Format and Content Guide for preparation of Safety Analysis Reports for LLW disposal facilities (NRC 1991). This evaluation indicates that although many of the NRC site suitability requirements are easily met, several are marginally met and two would be difficult to meet for any proposed action that involved on-site disposal. The parts of the standard that are expected to be the hardest to meet are those calling for siting above the water table and avoiding areas susceptible to erosion.

While areas outside of the Project Premises and the SDA on the balance of the site have not been well characterized, it is expected that the balance of site would have characteristics similar to those of the Project Premises because most of the balance of site is

Table 3-37. Comparison of 10 CFR Part 61.50 Disposal Site Suitability Requirements with the Project Premises and the SDA

NRC Disposal Site Suitability Requirement	Project Premises and SDA Site Evaluation
61.50(a)(1): The purpose of this section is to specify the minimum characteristics a disposal site must have to be acceptable for use as a near-surface disposal facility. The primary emphasis in disposal site suitability is given to isolation of wastes, a matter having long-term impacts, and to disposal site features that ensure that the long-term performance objectives of Subpart C of this part are met, as opposed to short-term convenience or benefits.	
61.50(a)(2): The disposal site shall be capable of being characterized, modeled, analyzed and monitored.	The potential location evaluated for on-site disposal in this EIS has been characterized through the drilling of over 105 wells used either to characterize groundwater flow or for environmental monitoring. The shallow stratigraphy on the Project Premises and SDA has been characterized based on this information. The surface deposit on the north plateau is underlain by a sand and gravel layer with a maximum thickness of 13 m (41 ft), and the south plateau is weathered till with a maximum thickness of 5 m (16 ft). The stratigraphy on both the north and south plateau is summarized in Table 4-1. Groundwater flow on both the north and south plateaus has been modeled in three dimensions as described in Appendix J. No widely accepted long-term erosion models have been developed. Available models were used to understand the range of likely long-term erosion consequences. A probabilistic model that evaluated different combinations of storm events over the next 1,000 years was used to estimate the rate of stream valley widening. The models and modeling approach are described in Appendix L.
61.50(a)(3): Within the region or state where the facility is to be located, a disposal site should be selected so that projected population growth and future developments are not likely to affect the ability of the disposal facility to meet the performance objectives of Subpart C of this part.	The Center is located in a rural, low population area. The population within a 20-km (12-mi) radius of the site is 29,723 people. The population has been projected to grow less than 1 percent (0.11 percent) during the implementation phase over the 2000 to 2030 time frame (Table 4-14). Population growth and future developments are not expected to undermine the ability of the potential location to meet 10 CFR Part 61 performance objectives.
61.50(a)(4): Areas must be avoided having known natural resources which, if exploited, would result in failure to meet the performance objectives of Subpart C of this part.	The only important natural resource in the region is limited amounts of gas and oil. Oil and gas production near the Center is from producing horizons located at depths of 610 to 1,219 m (2,000 to 4,000 ft). There are no known features that make the Project Premises and SDA an attractive drilling location for oil and gas prospects.
61.50(a)(5): The disposal site must be generally well drained and free of areas of flooding or frequent ponding. Waste disposal shall not take place in a 100-year floodplain, coastal high-hazard area or wetland, as defined in Executive Order 11988, "Floodplain Management Guidelines."	The Project Premises and SDA are located on a plateau, the area is sloped, well drained and not subject to flooding. As shown in Figure 4-10, the facilities on the Project Premises and SDA are located above the flood levels for a 100-year storm. Local ponding occurs in depressions in till areas because of the limited permeability of the till.

Table 3-37. Comparison of 10 CFR Part 61.50 Disposal Site Suitability Requirements with the Project Premises and the SDA (Continued)

NRC Disposal Site Suitability Requirement	Project Premises and SDA Site Evaluation
61.50(a)(6): Upstream drainage areas must be minimized to decrease the amount of runoff which could erode or inundate waste disposal units.	The Project Premises and SDA are located on a ridge where there is less than 2.6 km^2 (1 mi^2) of drainage area flowing through it. See Section 4.4 for more details.
61.50(a)(7): The disposal site must provide sufficient depth to the water table that ground water intrusion, perennial or otherwise, into the waste will not occur. The Commission will consider an exception to this requirement to allow disposal below the water table if it can be conclusively shown that disposal site characteristics will result in molecular diffusion being the predominant means of radionuclide movement and the rate of movement will result in the performance objectives of Subpart C of this part being met. in no case will waste disposal be permitted in the zone of fluctuation of the water table.	The water table on the north plateau is close to the surface and averages 2.4 m (8 ft) below the surface. On the south plateau, the average depth to groundwater is slightly deeper 3 m (10 ft); however, groundwater occurs as discontinuous lenses. Careful siting and design of a new subsurface disposal facility would be required to prevent groundwater intrusion into the waste. For much of the Project Premises and SDA, subsurface waste disposal systems could not be kept above the water table and, therefore, an exception would have to be requested and justified.
61.50(a)(8): The hydrogeologic unit used for disposal shall not discharge ground water to the surface within the disposal site.	Groundwater discharges from the near surface formations to surface water (i.e., Erdman Brook and Franks Creek). Water discharges at a slower rate from the till on the south plateau than from the sand and gravel layer on the north plateau. A limited portion of the north plateau groundwater discharges on an intermittent basis to surface seeps, which then flow to nearby creeks.
61.50(a)(9): Areas must be avoided where tectonic processes such as faulting, folding, seismic activity, or vulcanism may occur with such frequency and extent to significantly affect the ability of the disposal site to meet the performance objectives of Subpart C of this part, or may preclude defensible modeling and prediction of long-term impacts.	The tectonic processes at the site have been characterized. Of the tectonic processes, earthquakes present the greatest hazard. Projected ground accelerations versus return period have been estimated (see Appendix M) and they were not projected at levels that would pose a disposal facility design problem. The expected ground acceleration could be accommodated in disposal facility designs and would not significantly affect the ability of the disposal site to meet the performance objectives or preclude defensible modeling and prediction of long-term impacts.
61.50(a)(10): Areas must be avoided where surface geologic processes such as mass wasting, erosion, slumping, landsliding or weathering occur with such frequency and extent to significantly affect the ability of the disposal site to meet the performance objectives of Subpart C of this part, or may preclude defensible modeling and prediction of long-term impacts.	The Project Premises and SDA are located on till above bedrock and near creeks that cause erosion. Without engineering controls, this erosion would threaten the ability of this area to meet the performance objectives of Subpart C. See Chapter 5 and Appendix L.
61.50(a)11): The disposal site must not be located where nearby facilities or activities could adversely impact the ability of the disposal site to meet the performance objectives of Subpart C of this part, or significantly mask the environmental monitoring program.	The potential location evaluated for an on-premises disposal location is located hydraulically upgradient of existing facilities on the Project Premises. If an alternative were selected where the LLW disposal facility modules were built near the SDA, NDA, or the RTS drum cell on the south plateau, it is not expected that the existence of these other facilities would affect the performance of the potential new facility. New facilities could be located and monitoring programs designed to meet this requirement.

covered with glacial deposits that would also easily erode. There are several areas on the balance of the site that may have reduced erosion potential because bedrock is either at or close to the surface. These areas include the western side of the Center near Dutch Hill and on the eastern side of the Center near Heinz Road, where the edge of the bedrock valley outcrops. The hydrology in these areas is not adequately characterized to evaluate compliance with 10 CFR Part 61.50(a)(7), which requires sufficient depth to the water table that groundwater intrusion will not occur.

3.9.2 Evaluation of the Design Relative to the Provisions of 10 CFR Part 61.51

The 10 CFR Part 61.51 requirements are intended to ensure that LLW disposal facilities provide reasonable assurance that the long-term performance objectives will be met. These requirements are intended to make sure that the disposal facility is located and designed in a manner to promote waste confinement within the disposal area. The types of waste disposal activities under consideration in this EIS range from traditional shallow land burial of LLW drums to entombment of the process building in a concrete monolith. Conceptually, to meet the long-term performance objectives, the degree of reliance on site design features and engineered containment features could vary considerably with the disposal techniques.

New facilities, such as the LLW disposal facility (Alternative IIIB), would be sited, designed, and constructed with a reliance on site design features to the extent possible and supplemented by engineering features to the extent necessary, to provide reasonable assurance that the long-term performance objectives would be met.

Conversion of the existing facilities, such as the process building, vitrification building, HLW tanks, and RTS drum cell, into long-term disposal facilitates would require a strong reliance on engineering design features taking into consideration their location and site features. Techniques that are being considered include converting the process building and the vitrification facility to either a concrete monolith (Alternative IIIA) or a rubble pile (Alternative IIIB), solidification of the HLW in the HLW tanks in place (Alternatives IIIA and IIIB), and converting the RTS drum cell to a tumulus (Alternative IIIB). The engineering techniques, in conjunction with the existing site features and the proposed site designs, have the potential to provide reasonable assurance that the long-term performance objectives would be met.

Evaluation of these disposal facility options against the requirements of 10 CFR Part 61.51 requires an understanding of the specific disposal facility design, the location options, and the overall site design. Conceptual designs have been developed for each of the disposal facilities and the overall site engineering for each of the major alternatives under consideration in this EIS. These designs are presented in detail in the closure engineering reports (WVNS 1994a through o) and are summarized in Sections 3.3 through 3.7 of this chapter. Because of the nature of the site, particularly features such as the types of soils and the potential for erosion, a strong reliance would be placed on engineering designs and controls to reduce reliance on site characteristics in minimizing off-site impacts and providing reasonable assurance that the long-term performance objectives would be met.

The process building, vitrification facility, and HLW tanks are located between Quarry Creek and Erdman Brook and are not in an area expected to erode for at least 1,000 years based on the analysis presented in Appendix L. The RTS drum cell is located near the upper reach of Franks Creek and is located in an area expected to erode if erosion is not controlled. The site of the LLW disposal facility has not been selected, but it is recognized that it will be difficult to meet the performance objectives of Subpart C unless the facility foundation is on rock or till where the location has been engineered to control erosion.

Table 3-38 summarizes the evaluation of these facilities against the requirements of 10 CFR Part 61.51.

Table 3-38. Comparison of 10 CFR Part 61.51 Design Requirements with Proposed Low-Level Waste Disposal Facility Designs

Requirement	Evaluation of Facilities Against the Requirement
61.51(a)(1): Site design features must be directed toward long-term isolation and avoidance of the need for continuing active maintenance after site closure	Conversion of the existing facilities (such as the process building, vitrification building, HLW tanks, and RTS drum cell) into long-term disposal facilitates would require a strong reliance on engineering design features taking into consideration their location and site features. Techniques that are being considered include converting the process building and the vitrification facility to either a concrete monolith (Alternative IIIA) or a rubble pile (Alternative IIIB), solidification of the HLW in the HLW tanks in-place (Alternative IIIA and IIIB), and converting the RTS drum cell to a tumulus (Alternative IIIB). The engineering techniques, in conjunction with the existing site features and the proposed site designs, have the potential to provide reasonable assurance that the long-term performance objectives would be met. The process building, vitrification facility, and HLW tanks are sited in areas that could be used to isolate the waste without long-term maintenance for periods of time greater than 1,000 years. The RTS drum cell is located in an area that is expected to require active maintenance for long-term isolation of the waste. The site of the LLW disposal facility has not been identified, although there appear to be areas on the north plateau or on bedrock on the balance of site that could isolate wastes without relying on long-term maintenance.

Table 3-38. Comparison of 10 CFR Part 61.51 Design Requirements with Proposed Low-Level Waste Disposal Facility Designs (Continued)

Requirement	Evaluation of Facilities Against the Requirement
61.51(a)(2): Disposal site design and operation must be compatible with the disposal site closure and stabilization plan and lead to disposal site closure that provides reasonable assurance that the performance objectives of Subpart C will be met	Contaminants in the process building and HLW tanks are expected to migrate from the facilities into the groundwater in the sand and gravel layer on the north plateau, discharge to Franks Creek, and then ultimately flow into Buttermilk Creek. The projected results for these units are in excess of the limits in Subpart C. If a decision was made to stabilize these facilities in-place, it is expected that features could be designed along with a site closure and stabilization plan, including erosion control, that would provide reasonable assurance of meeting the objectives of Subpart C for expected conditions. If erosion control measures were to fail, as could occur with loss of institutional control, the performance objectives of Subpart C could be exceeded for some of the conceptual designs evaluated.
61.51(a)(3): The disposal site must be designed to complement and improve, where appropriate, the ability of disposal site's natural characteristics to assure that the performance objectives of Subpart C will be met	The conceptual design for Alternative III has been developed for the on-premises facilities that would be used for disposal, and these have been evaluated against the requirements of 10 CFR Part 61, Subpart C. Grading, capping, and erosion control measures could improve this site's natural characteristics for waste isolation.
61.51(a)(4): Covers must be designed to minimize to the extent practicable water infiltration, to direct percolating or surface water away from the disposed waste, and to resist degradation by surface geologic processes and biotic activity.	The conceptual design for Alternative III includes a cover to minimize the potential for water infiltration. Drainage layers route water away from the waste, and vegetated covers and intruder barriers resist local erosion and biotic intrusion into the waste.
61.51(a)(5): Surface features must direct surface water drainage away from disposal units at velocities and gradients which will not result in erosion that will require ongoing active maintenance	Conceptual designs of facilities for long-term waste management have been developed. If a decision was made to select an alternative that required new disposal facilities, the detailed design of the new facilities would include features to direct surface water drainage away from the facility at velocities and gradients to minimize erosion that could require active maintenance. The conceptual design for Alternative III includes features to promote surface water drainage.
61.51(a)(6): Site must be designed to minimize to the extent practicable the contact of water with waste during storage, the contact of standing water with waste during disposal, and the contact of percolating water with wastes after disposal	Conceptual designs for Alternatives I, II, and III also include features to minimize contact of the waste with surface or groundwater. Temporary and permanent structures cover stored waste, and disposal facility designs route infiltrating water away from the waste.

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4. AFFECTED ENVIRONMENT

This chapter describes the existing conditions at the Center and surrounding area. Characterizing existing conditions establishes a baseline for assessing the environmental and socioeconomic impacts from implementing an alternative. This EIS describes the geology and stratigraphy in Section 4.1, structural geology and seismology in Section 4.2, hydrology in Section 4.3, site geomorphology in Section 4.4, meteorology and air quality in Section 4.5, ecology in Section 4.6, land use in Section 4.7, socioeconomics in Section 4.9, and cultural resources in Section 4.9. This chapter emphasizes environmental attributes, such as groundwater hydrology and erosional processes, that could most significantly affect closure decisions. Section 4.10 summarizes the detailed descriptions of the nature and extent of contamination within site facilities which are contained in Appendix C.

More detailed descriptions of the existing environment at the site and on the Project Premises are given in the set of environmental information documents prepared by West Valley Nuclear Services, Inc. (WVNS) and their contractors to develop this EIS (WVNS 1992a, b, c; WVNS 1993a through i; WVNS 1994a, b, c) and the safety analysis report (WVNS 1993j). Results from the site environmental monitoring are contained in the annual site environmental reports also prepared by WVNS and their contractors (WVNS 1991, WVNS 1992d, WVNS 1993k, WVNS 1994d). For analysis purposes, environmental monitoring data available as of July 1994 were reviewed for the EIS. Groundwater data collected as part of geoprobe investigations in 1994 were also evaluated (WVNS 1995).

4.1 GEOLOGY AND STRATIGRAPHY

The Center is located within the glaciated northern portion of the Appalachian Plateau physiographic province (Figure 4-1). The site is approximately midway between the boundary line delineating the southernmost extension of Wisconsinan glaciation (occurring 38,000 to 14,500 years ago) and a stream-dissected escarpment to the north that marks the boundary between the Appalachian Plateau and the Interior Low Plateau province. The Appalachian Plateau is characterized by hills and valleys of low to moderate relief between the Erie-Ontario Lowlands to the north and the Appalachian Mountains to the south.

The Center is located within a U-shaped, northwest-trending bedrock valley filled with approximately 150 m (500 ft) of Pleistocene glacial deposits that form a till plain. The Project Premises and the SDA are located on the till plain west of Buttermilk Creek at an elevation of 430 m (1,400 ft) above mean sea level adjacent to a northwest trending upland that forms the western boundary of the Buttermilk Creek drainage basin (Figure 4-2). Erdman Brook divides the Project Premises into a north and south plateau.

The surface geology on the Project Premises and the SDA is shown in Figure 4-3. The stratigraphy underlying the north and south plateaus is different, as described in Table 4-1 and shown in the cross sections in Figures 4-4 and 4-5. The north plateau is underlain by the sand and gravel unit, Lavery till, Kent recessional and older glacial deposits, and Devonian age bedrock. In general, the weathered Lavery till is absent or little developed. The south plateau is underlain by Lavery till, Kent recessional and older glacial

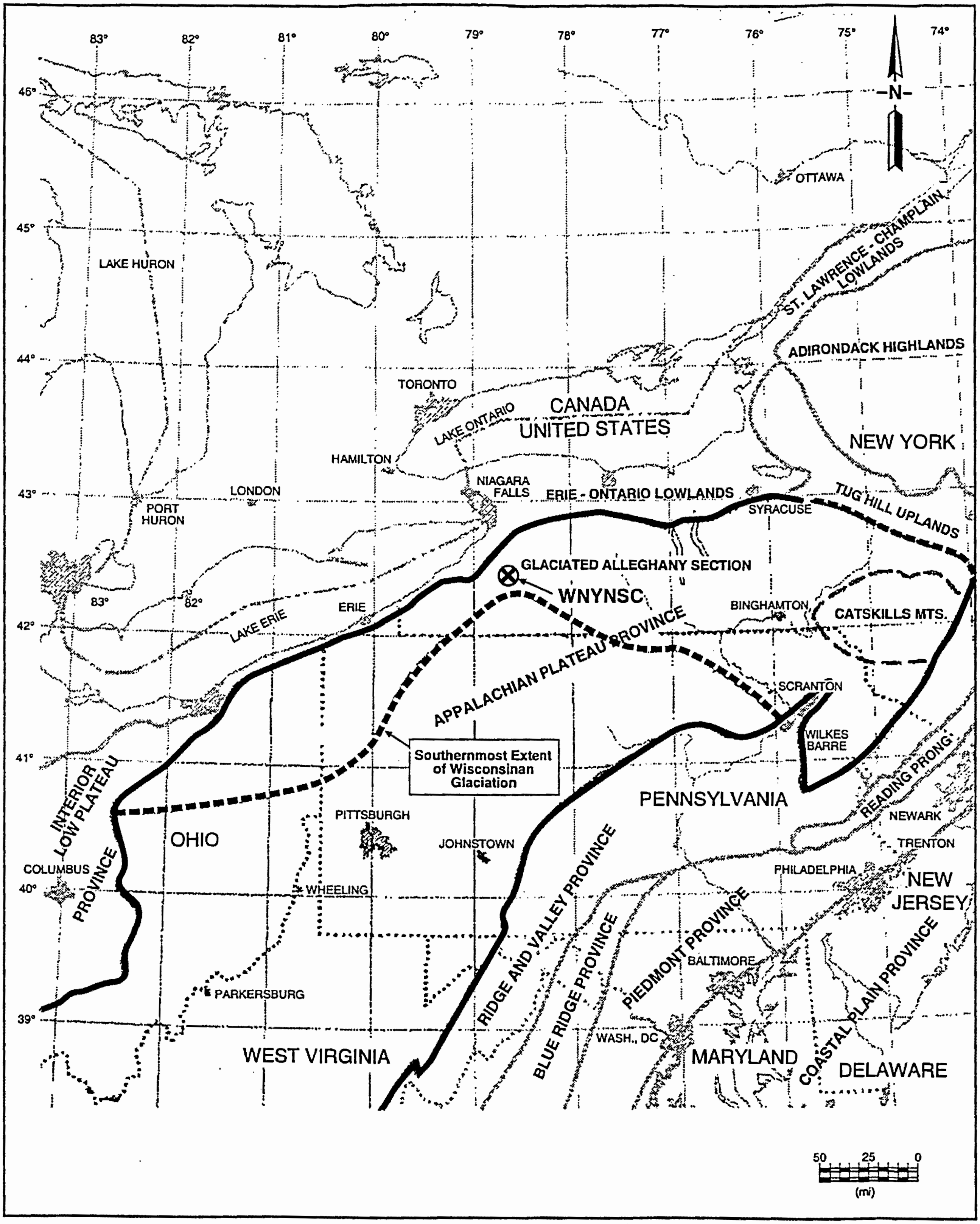

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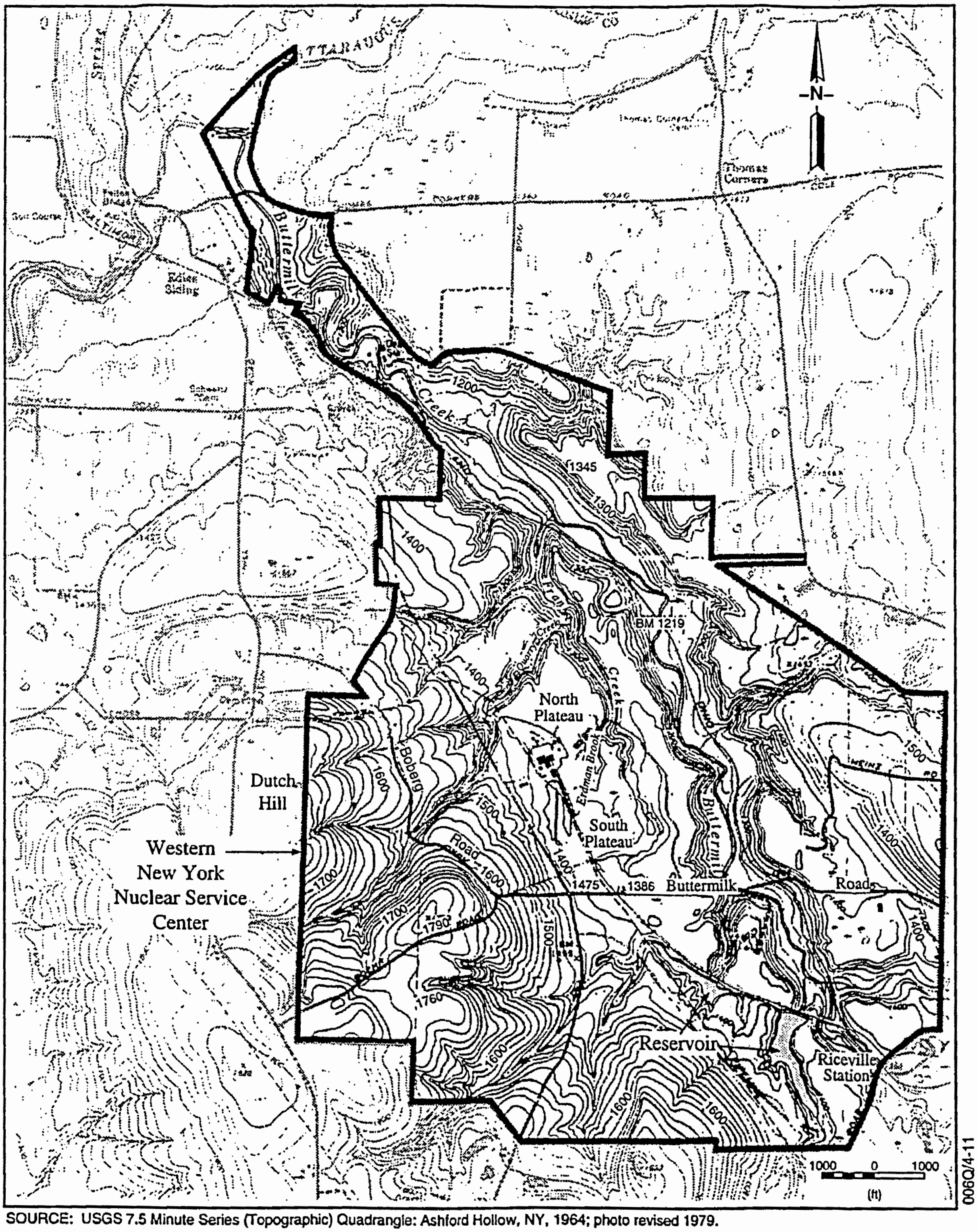
Figure 4-1. Regional Physiographic Map (WVNS 1993h).



SOURCE: USGS 7.5 Minute Series (Topographic) Quadrangle: Ashford Hollow, NY, 1964; photo revised 1979.

Figure 4-2. Topography of the Western New York Nuclear Service Center.

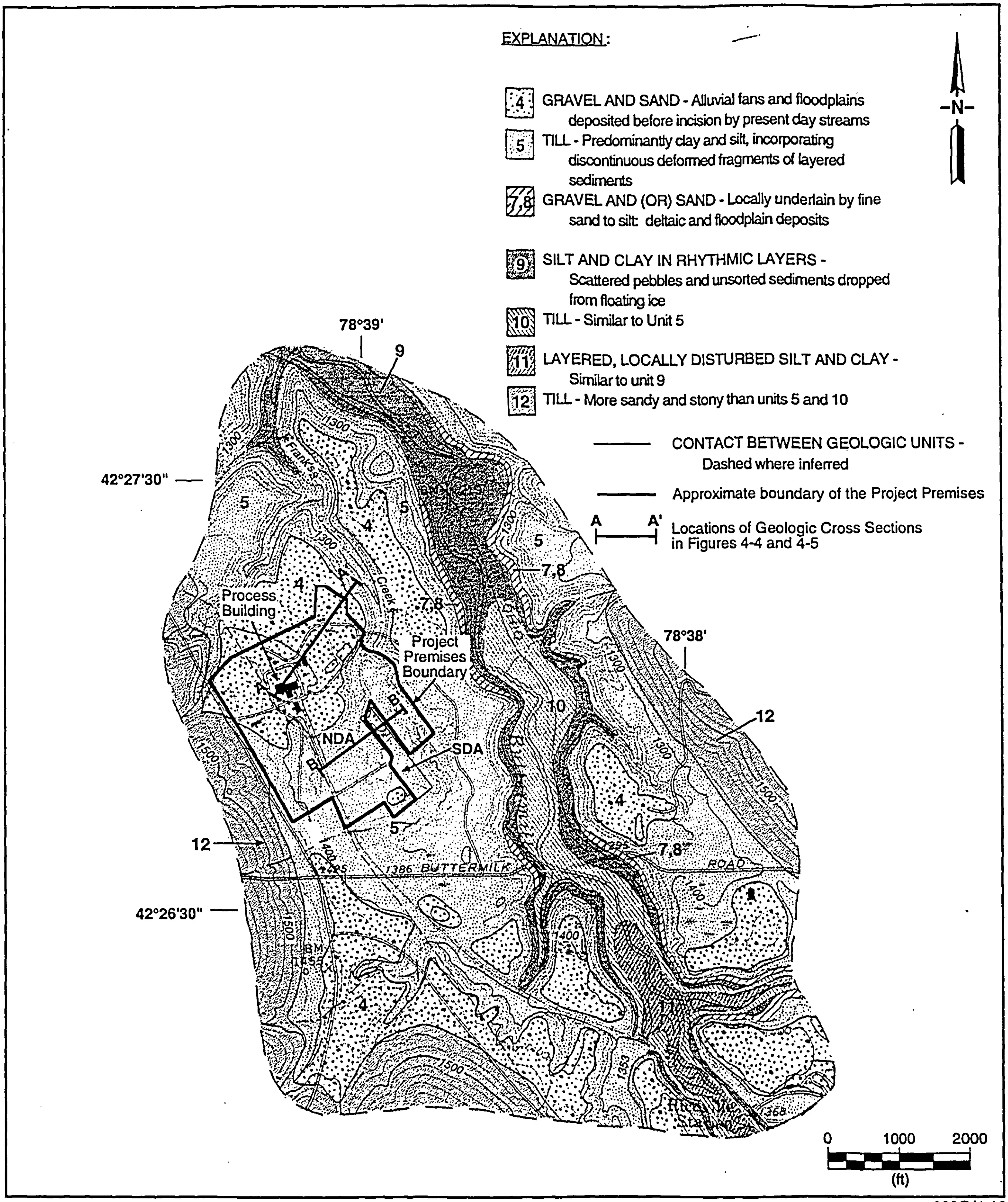


Figure 4-3. Surface Geology on the Project Premises and the State-Licensed Disposal Area (modified from Prudic 1986).

Table 4-1. Stratigraphy of the Project Premises and the State-Licensed Disposal Area[a]

Geologic Unit	Description	Origin	Thickness[b] North Plateau (ft)	Thickness[b] South Plateau (ft)
Colluvium	Soft plastic pebbly silt only on slopes, includes slump blocks several meters thick	Reworked sediments	1—3	1—3
Sand and Gravel Layer	Sand and gravel, moderately silty	Alluvial fan and terrace deposits	0—41	0—5 at well 905;[c] not found at other locations
Slack-water Sequence	Thin-bedded sequence of clays, silts, sands, and fine-grained gravel at base of sand and gravel layer.	Lake deposits	0-15	Not present
Weathered Lavery Till	Fractured and moderately porous till, primarily comprised of clay and silt	Weathered glacial ice deposits	0—9 (commonly absent)	3—16, average = 10
Unweathered Lavery Till	Dense, compact, and slightly porous clayey and silty till with some discontinuous sand lenses	Glacial ice deposits	1—102 Lavery till pinches out west of Project Premises	14-90 Lavery till pinches out west of Project Premises
Till-Sand Member of Lavery Till	Thick and laterally extensive fine to coarse sand within Lavery Till	Possible meltwater or lake deposits	0.3—16	May be present in one well near northeast corner of NDA
Kent Recessional Unit	Gravel, comprised of pebbles, small cobbles, and sand, and clay and clay-silt rhythmic layers overlying the Kent till	Proglacial lake, deltaic, and alluvial stream deposits	0—70	0—44
Kent and Olean Tills	Clayey and silty till similar to Lavery till localized lake and coarse-grained recessional deposits may be present within the tills	Mostly glacial ice deposits	0—300	0—330
Upper Devonian Bedrock	Shale and siltstone, weathered at top	Marine sediments	>1,320	>1,320

a. Source: Geologic unit descriptions and origins from Prudic (1986). Thickness from lithologic logs of borings drilled in 1989, 1990, and 1993 (WVNS 1993l, WVNS 1994c); from well 905 (WVNS 1993g); and from well 834E (WVNS 1993h). Kent and Olean till thickness from difference between bedrock elevation (based on seismic data) and projected base of Kent recessional sequence (WVNS 1993h); upper Devonian bedrock thickness from well 69USGS1-5 located in the southwest section of the Center (WVNS 1993h).

b. To convert feet to meters, multiply by 0.3048.

c. Coarse sandy material was encountered in this well. It is unknown whether this deposit is equivalent to the sand and gravel layer on the north plateau.

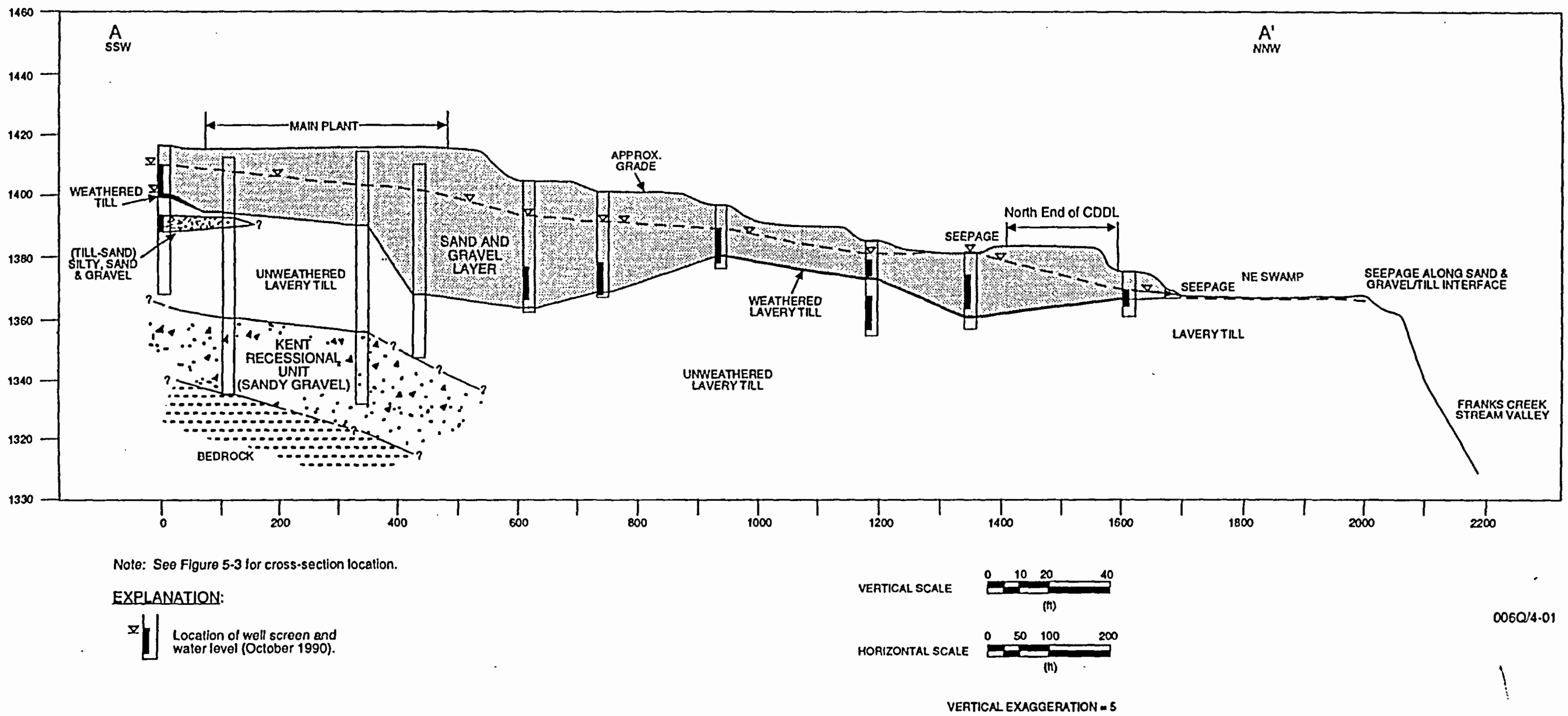


Figure 4-4. Geologic Cross-Section A-A' through the North Plateau (see Figure 4-3 for cross section location) [modified from (WVNS 1993h)].

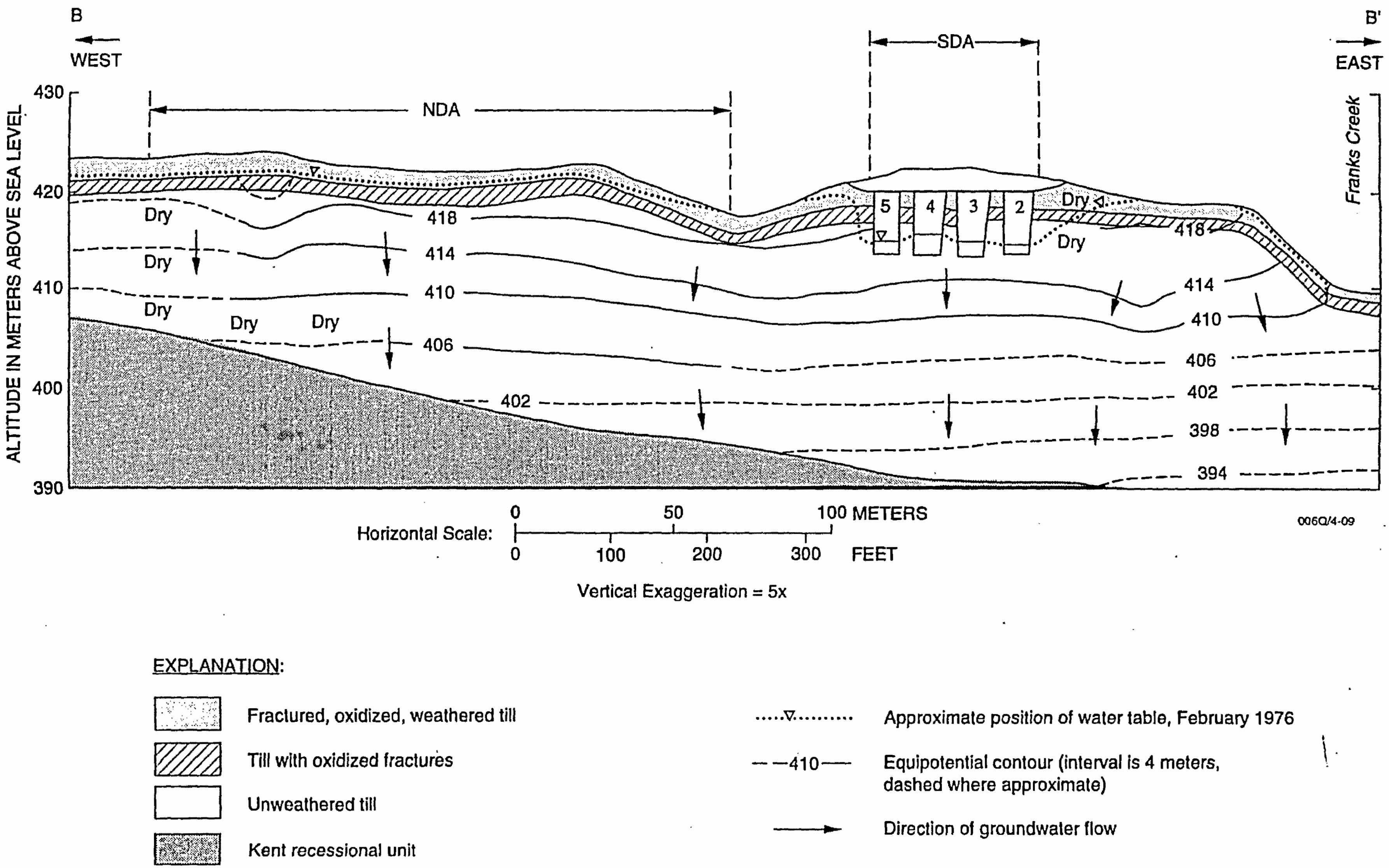


Figure 4-5. **Geologic Cross-Section B-B' through the South Plateau Showing Flow Direction in the Unweathered Lavery Till [see Figure 4-3 for cross-section location modified from (WVNS 1993g)].**

deposits, and Devonian age bedrock. The uppermost Lavery till is fractured and has a higher permeability than deeper portions of the till because of surface weathering processes. The composition of the Kent recessional unit varies across the Project Premises and the SDA from coarse-grained glacial outwash to fine-grained lake deposits.

The bedrock formation in the vicinity of the Project Premises and SDA belongs to the Canadaway Group, which consists of Devonian shale, siltstone, and sandstone and totals more than 400 m (1,300 ft) in thickness (WVNS 1993h). Bedrock outcrops on the shoulder of Rock Springs Road along the western portion of the Project Premises and in Quarry Creek on the north side of the north plateau. The valley fill deposits pinch out to zero thickness where the top of these units contact the bedrock. The upper 1 to 3 m (3 to 10 ft) of bedrock is weathered and fractured. The regional dip is gentle, approximately 0.5 degrees to the south (WVNS 1993h). Recent measurements of the apparent dip of various strata and two marker beds in selected outcrops along Cattaraugus Creek recorded a dip of approximately 0.4 degrees to the west near the northern portion of the Center (CWVNW 1993).

4.1.1 North Plateau

The surface layer on the north plateau consists of up to 12 m (41 ft) of stream-deposited silty sand and gravel (alluvium). The alluvium is thickest in the vicinity of the process building in WMA 1 and the wastewater treatment facility (WMA 2) and thins toward the bounding stream valleys (see Figure 1-2 for WMA locations). Slump deposits are locally present on the plateau slopes near creeks.

The slack-water sequence is at the base of the sand and gravel unit and is shaped like an elongate lens extending from the area of the cooling tower northeast to the Franks Creek valley wall (WVNS 1994c). The sequence is comprised of thin layers containing coarse grain sizes at their base, grading to fine grain sizes at the top. This layering is typical of sediments deposited in still water; in this case, a glacial lake that formed between the front of the glacier and surrounding terrain.

The Lavery till underlies both the north and south plateau; it is a dense clayey and silty till with discontinuous sand lenses. A thick and laterally extensive sand (Till Sand) unit occurs in the Lavery till and underlies WMAs 1, 3, 4, and 6 on the north plateau.

The Lavery till is underlain by the Kent recessional unit, which is interlayered sediments characteristic of glacial margin deposits, including sand and gravel glacial outwash and fine-grained, thinly-bedded lake deposits consisting of silt and clay. The Kent recessional unit consists primarily of coarse-grained sands (WVNS 1993g) and overlies weathered bedrock to the west of the Project Premises and the SDA, where it eventually pinches out (WVNS 1993h). It outcrops along Buttermilk Creek east of the Project Premises. The Kent recessional unit is underlain by the Kent till, which, in turn, is underlain by older glacial deposits extending down to the siltstone and shale bedrock. The entire glacial sequence thickens to the east from the Project Premises to the axis of the buried bedrock valley to a maximum thickness of approximately 150 m (500 ft).

4.1.2 South Plateau

The surface layer on the south plateau is the Lavery till, which is the host formation for the buried waste in the SDA (WMA 8) and the NDA (WMA 7). The upper portion of the Lavery till is weathered and fractured to a depth of approximately 3 m (10 ft). The degree of weathering and fracturing decreases with depth. The weathered Lavery till is characterized by widely spaced vertical fractures oriented N40°W, N40°E, and east-west. These fractures have been logged to depths of 8 m (26 ft) below land surface (WVNS 1993h). The unweathered Lavery till under the south plateau is similar to that under the north plateau except for the general absence of the Till Sand unit. The geologic materials in the Kent recessional unit underlying the south plateau consists primarily of fine-grained, low permeability lake deposits with some coarse-grained sand lenses. Like the north plateau, the Kent till and older glacial deposits underlie the Kent recessional unit.

4.1.3 Fractures

The bedrock is jointed with systematically oriented, or parallel, fractures. Vertical joint sets that trend approximately N68°E to N45°W (Prudic 1986) have been observed on the Center. Glacial till throughout western New York is commonly characterized by systematically oriented fractures. The exact origin of the glacial till fractures is unknown. Dana et al. (1979) (as cited in WVNS 1993h) proposed that the fracture pattern was inherited from the regional joint pattern in the underlying bedrock. However, the till fractures observed in the floors and walls of research trench 1 were predominantly oriented in an east-west direction (WVNS 1993h). The research trench was excavated for fracture orientation studies in the NDA. The origin of these fractures may be from several mechanisms: crustal adjustments related to the present day regional stress field, stress release related to movement on the Clarendon-Linden fault system, and volumetric changes resulting from ion exchange or osmotic processes (WVNS 1993h).

Open, or unfilled, fractures in shallow bedrock and in the weathered Lavery till are pathways for groundwater flow and potential contaminant migration. The fracture spacing in the weathered Lavery till decreases with depth. Calculations indicate that open fractures would not occur at depths of 15 m (50 ft) below ground surface because the till behaves plastically (WVNS 1993h). Fractured till observed in research trenches located on and near the Project Premises were classified as (a) prismatic jointing with horizontal partings in hardpan soils, (b) long, vertical, parallel joints extending the entire thickness of the weathered till into the parent till, (c) small displacements across sand and gravel lenses, and (d) vertical desiccation cracks (WVNS 1993h).

4.2 STRUCTURAL GEOLOGY AND SEISMOLOGY

Seismic events can present near-term hazards to planned operations and can also play a role in determining the long-term hazard of leaving waste material at the Center. This section presents the current understanding of the structural geology and the potential for seismic events and soil liquefaction at the Center, a phenomena which occurs in certain types of soils during seismic events.

4.2.1 Structural Geology

Many studies have been conducted to identify major faults or folds in both the immediate area of the Center and the general region. These studies have involved many techniques including examination of drilling logs, seismic profile mapping, and joint and lineament mapping. The studies provide insight into the geologic structure of the Center region, but they do not always provide exact knowledge on the nature of the underlying structure because of limits in the technical methods or location of individual datum points.

No major faults capable of producing earthquakes have been identified on the Center. East-northeast trending linear fractures (lineaments) can be discerned on high-altitude aerial photographs in the area between Route 219 on the west and Rock Springs Road on the east, but not all lineaments have a structural origin. Stratigraphic offsets of 0.6 m (2 ft) or less have been observed in bedrock in Cattaraugus Creek, but these are not large enough to produce a seismic hazard.

A 97 x 8-km (60 by 5-mi) subsurface gas producing fault zone, the Bass Island trend, extends from the southwest corner of New York State into Erie County, and it is located approximately 8 km (5 mi) north of the Center at its closest point. The Bass Island trend is associated with a detachment along salt beds and, therefore, is not capable of generating earthquakes.

Regional subsurface mapping was conducted in a 348 km^2 (135 mi^2) area surrounding the Center to determine if there were faults underlying the site. Two structure maps showing the elevation of the surface of two geologic formations (the Tichenor Limestone or Tully Equivalent and the underlying Packer Shell) and an isopach map showing the thickness in between these two formations were generated to determine if faulting could be mapped based on available subsurface well data. These two formations were chosen for mapping because they are regionally extensive and structure mapping on the Tichenor Limestone can reflect faults as in the case of the Bass Island Trend described above. Although the Packer Shell is not usually productive of hydrocarbons, it is an easily recognized marker bed for drillers and is a common horizon used for structure mapping in western New York. The Tichenor Limestome occurs at a depth of 678 m (2,225 ft) below the ground surface at the Fault Line Rachic Well No. 1, located about 472 m (1,550 ft) from the western boundary of the Center in the vicinity of Dutch Hill. The Packer Shell occurs at a depth of 1,111 m (3,646 ft) below ground surface at the same well. The hydrofracture test well drilled on the Center was not drilled deep enough to penetrate these formations [total depth of 464 m (1,521 ft)]. Eighty-five wells were reviewed and 62 were used in the mapping exercise. The results of this analysis indicated there was no evidence for faulting based on the regional mapping. Although faulting occurs on the Bass Island Trend discussed above, it is not relevant to the subsurface geology underlying the Center because of both the distance from the site and the geologic factors controlling the Bass Island structure (Gill 1995).

The Center is located in an area that has experienced relatively minor seismic activity. The major structural features capable of generating earthquakes are the St. Lawrence rift valley system, 480 km (298 mi) northeast of the site and capable of producing high magnitude seismicity, and the Clarendon-Linden fault zone, located about 37 km (23 mi) east of the site. While the exact nature and extent of the Clarendon-Linden fault zone is unknown, the various seismic estimates developed for the site have considered it to be the principal source of seismic hazard for the Center (Figure 4-6).

The Clarendon-Linden fault zone trends southward from Lake Ontario through western New York and is currently most active in the vicinity of Attica, New York, located 47 km (29 mi) northeast from the site. From well data, this zone is interpreted as a set of up and down fault block structures (Figure 4-6). The total vertical offset on the structure is about 30 m (100 ft) down to the west (WVNS 1993h). A southwestern trending fault [traceable 10 km (6 mi) southwest of Attica] branches from the western fault of the Clarendon-Linden Fault Zone near Batavia. It has been delineated through epicenters and seismic reflection profiling as far southwest as Varysburg (Figure 4-6), located 37 km (23 mi) from the Center (WVNS 1993j). Well data indicate the Attica splay continues to the southwest, either as a fault or flexure, to Java, 30 km (18 mi) northeast of the Center. Lineaments recognized from aerial photography hint of further southwestern extension of this feature (WVNS 1993h). Soil gas analysis has been interpreted to suggest that the Clarendon-Linden Fault Zone may extend south to the Pennsylvanian border (WVNS 1993h).

The Clarendon-Linden fault zone has been associated with continental-scale gravity and magnetic anomalies, which may link it to major tectonic features. Magnetic and gravity lineaments are coincident with the boundaries of different tectonic terrains. The east-west drainage divide between Lakes Erie and Ontario and the north-south divide between the Great Lakes and the Ohio-Mississippi River Valley are associated with lineaments and also form the eastern and southern margins of the majority of the historical seismicity (Fakundiny et al. 1978). The Amish anomaly, extending from western New York to West Virginia, has been associated with the Clarendon-Linden fault zone (Culotta et al. 1990).

Despite its association with continental-scale features, the offset across the Clarendon-Linden fault zone has been minor. The active portion of the fault zone is small relative to the total extent of the feature. The absence or subtlety of seismically induced features in the valley till and more recent materials indicates that modern seismicity is very mild.

4.2.2 Seismology

Prediction of the seismic hazard for an area is based on the geologic structure of the area described in Section 4.2.1 and on the recognition of the regional earthquake history, described in Section 4.2.2.1. The seismic hazard estimates for the site are described in Section 4.2.2.2.

4.2.2.1 Earthquake History for Western New York State and Vicinity

The earthquake record for western New York and vicinity has been documented for more than 100 years. There have been 118 earthquakes within a 480-km (270-mi) radius of the Center with epicentral intensities of Modified Mercalli Intensity V to VII (WVNS 1993j).

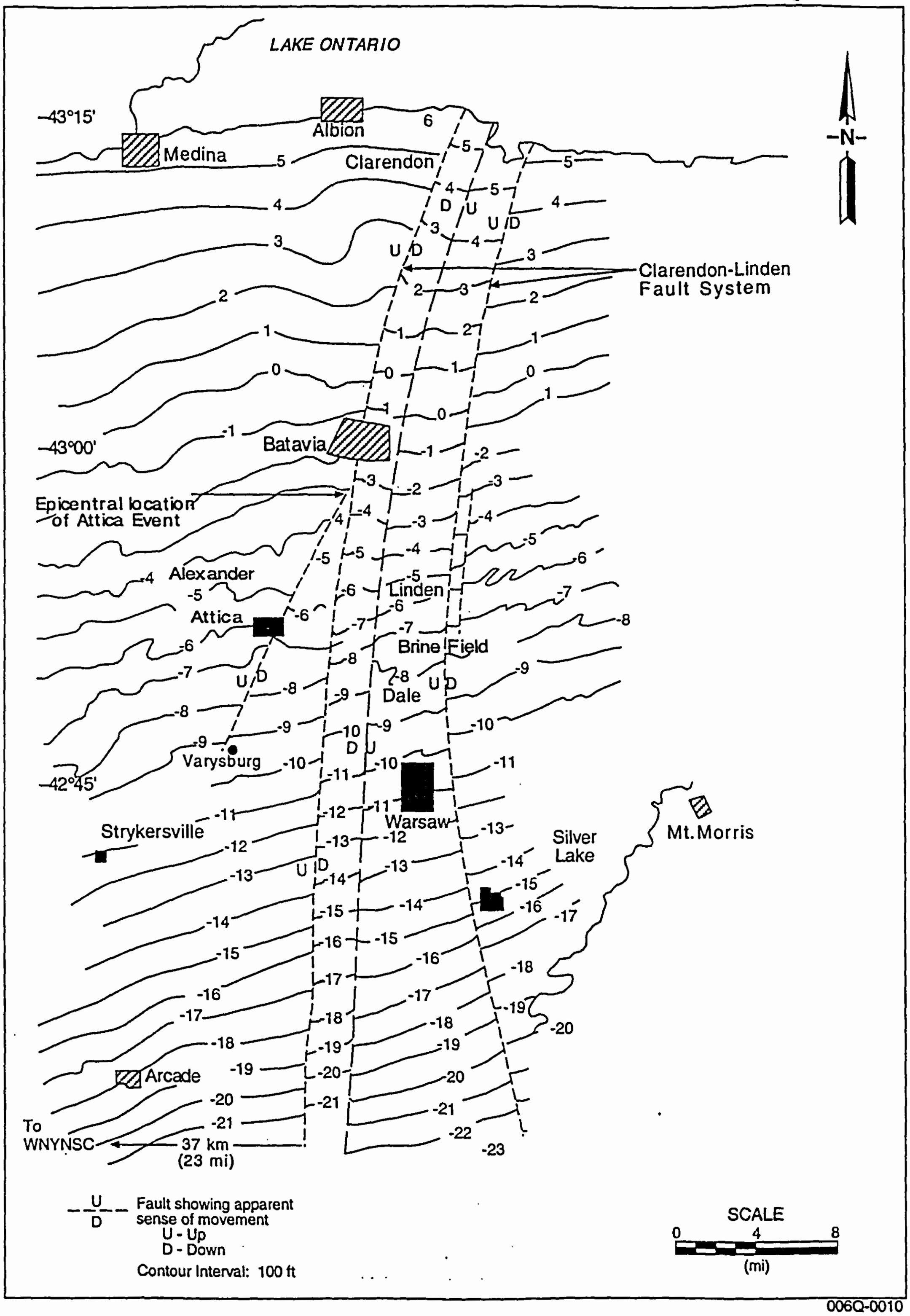


Figure 4-6. Clarendon-Linden Fault Zone Shown by Offsets of the Contours on Top of the Medina Formation (modified from WVNS 1992a).

Table 4-2 summarizes historical earthquakes with a Modified Mercalli Intensity of IV or greater at the Center. Three earthquakes in this century have been estimated to cause a Modified Mercalli Intensity of IV at the Center, which is similar to vibrations from a heavy truck that might be felt by people indoors but do not cause damage. These three earthquakes were near La Malbai, Quebec, in 1925, the 1929 Attica event, and the 1944 Cornwall-Massena earthquake (WVNS 1992a, Heck 1925). Intensities of Modified Mercalli Intensity IV or less correspond to ground accelerations of less than 0.05 g (WVNS 1993j). See Appendices G and O for a discussion of potential damage to selected WVDP structures from earthquakes.

In addition, five large earthquakes, also summarized in Table 4-2, have occurred in the St. Lawrence River Valley, whose epicenter locations are closer to the Center than the 1925 Quebec earthquake (DOC 1973). The June 11, 1638, February 5, 1663, and the September 16, 1732, events may have had an intensity greater than a Modified Mercalli Intensity of IV at the Center because their epicenters were at a distance equal to or less than that of the 1925 event.

The earthquake of 1925 in the St. Lawrence River Valley near La Malbai had an estimated Modified Mercalli Intensity of VIII near the source and was felt over an area of about 5.2 million km^2 (2 million mi^2), including much of the northeastern United States (DOC 1973). However, there is no record of damage in the United States. The Center, at a distance of about 890 km (550 mi) lies between intensity zones IV and V as mapped by Heck (1925).

The Cornwall-Massena earthquake of 1944, with an epicenter located 420 km (260 mi) northeast of the Project Premises, was felt over an area of 452,000 km^2 (175,000 mi^2) and was assigned a Modified Mercalli Intensity of VIII in the epicentral area. Extensive damage was reported in Cornwall, Ontario, and Massena, New York. The intensity at the Center was estimated to be IV.

The Attica event of 1929 was located about 48 km (30 mi) northeast of the Project Premises at the intersection of the Attica splay and the western fault of the Clarendon-Linden fault zone and affected an area of 34,000 km^2 (51,800 mi^2). Damage in the city of Attica included bricks being knocked from chimneys, collapsed chimneys, minor plaster damage to well-constructed buildings, and heavy damage to buildings considered to be poorly constructed. Based on the intensity information, Dames & Moore (1970) assigned an epicentral Modified Mercalli Intensity of VII and a magnitude of 5.2 to this event. The intensity at the Center was estimated to be IV.

4.2.2.2 Tectonic Framework and Seismic Source Zones

The tectonic framework and seismic sources that may influence the earthquake hazard to the Center is defined by the historical earthquake record (Section 4.2.2.1) and tectonic features that may act as potential sources of seismicity (Section 4.2.1). There have been a number of seismic hazard estimates developed for the Center that present both an earthquake severity and likelihood, as shown in Table 4-3. To put the numbers in Table 4-3 in

Table 4-2. Historic Earthquakes with an Estimated Modified Mercalli Intensity Equal to or Greater than III at the Western New York Nuclear Service Center[a,b]

Date	Epicenter Location (City, State, or Province)	Epicenter Intensity (MMI)[a]	Estimated Intensity at the Center (MMI)	Estimated Epicenter Distance from the Project Premises (km)	(mi)
June 11, 1638	Trois Riviere, Quebec	IX	≥IV[c]	660	410
February 5, 1663	Riviere-Ouelle, Quebec	X	≥IV[c]	880	545
September 16, 1732	St. Leonard, Quebec	IX	≥IV[c]	540	335
October 23, 1857	Buffalo, New York - Lockport, New York	VI	III-IV[d]	70	43
October 17, 1860	La Malbaie, Quebec	VIII - IX	≥IV[c]	890	550
October 20, 1870	Baie St. Paul, Quebec	IX	≥IV[c]	860	535
July 6, 1873	West of Niagara, Ontario	VI	III[d]	70	43
August 31, 1886	Charleston, South Carolina	X	III[e].	1,070	665
February 28, 1925	West of La Malbaie, Quebec	VIII	IV[f]	865	535
August 12, 1929	Attica, New York	VII	IV[g]	48	30
September 5, 1944	Cornwall, Ontario - Massena, New York	VIII	IV[g]	420	260
January 1, 1966	Attica, New York	VI	III[d]	53	33
June 3, 1967	Attica, New York	VI	III[d]	55	34

a. MMI = Modified Mercalli Intensity

b. Two additional events, October 9, 1871, near Wilmington, Delaware, and February 23, 1954, at Wilkes-Barre, Pennsylvania, produced local intensities of MMI VII, and occurred close enough to the Center to produce MMI III at the Center according to the eastern United States attenuation curve. However, reported effects outside the epicentral areas make it unlikely that either event would have been perceptible at the Center.

c. Estimated by comparing epicentral intensity with that of 1925 event.

d. Estimated by correcting epicentral intensity by using eastern United States attenuation data.

e. Based on isoseismal map by Heck (1925, 1965).

f. Based on isoseismal map by Heck (1925).

g. From isoseismal maps in WVNS (1993j).

perspective, an acceleration of 0.1 g is commonly accepted by engineers as the threshold for damage to ordinary structures not designed to be resistant to earthquakes.

Table 4-3. Seismic Hazard Estimates[a]

Peak Horizontal Ground Acceleration (including uncertainty) (g)	Return Period (yrs)	Study
0.12	Previous History	Dames & Moore (1970)
0.042	135	EDAC (1975)
0.10 - 0.13	1,000	NRC (1977)
0.14	1,000	TERA (1981)
<0.07	1,000	Dames & Moore (1983)
0.084	1,000	WVNS (1992a)

a. These values include the effect of site amplification because of the soil column on the Project Premises.

Source: Adapted from WVNS (1992a)

WVNS (1992a) applied the Electric Power Research Institute seismic hazard methodology to the Center. The Electric Power Research Institute methodology involved use of expert opinions of six teams of earth scientists and resulted in a range of frequency estimates for specific earthquake severities.

The range of estimates using the methodologies of these six teams are presented in Figure 4-7, which shows the highest and lowest of the six estimates (median values). The figure shows there is less discrepancy among the experts on the likelihood of the less severe earthquake (0.05 g) and more of a difference in expert opinion as the severity of the earthquake increases. The Electric Power Research Institute team did not make estimates of earthquakes more severe than 0.33 g, which would have an even lower likelihood of occurring.

The peak horizontal ground acceleration was determined by combining these six estimates, giving a median value of 0.070 g for a return period of 1,000 years. Current DOE guidelines (DOE-STD-1024-92, "Guidelines for the Use of Probabilistic Seismic Hazard Curves at DOE Sites," 1992) suggest using the Electric Power Research Institute median value multiplied by 1.2, in this case resulting in a peak horizontal ground acceleration of 0.084 g for a return period of 1,000 years (WVNS 1993j).

4.2.3 Liquefaction Potential

Soil liquefaction is a condition where soils that are normally solid can act more like a liquid. Liquefaction can result in large amounts of soil sliding down slopes and in failure of building foundations causing buildings to fall over or tilt severely.

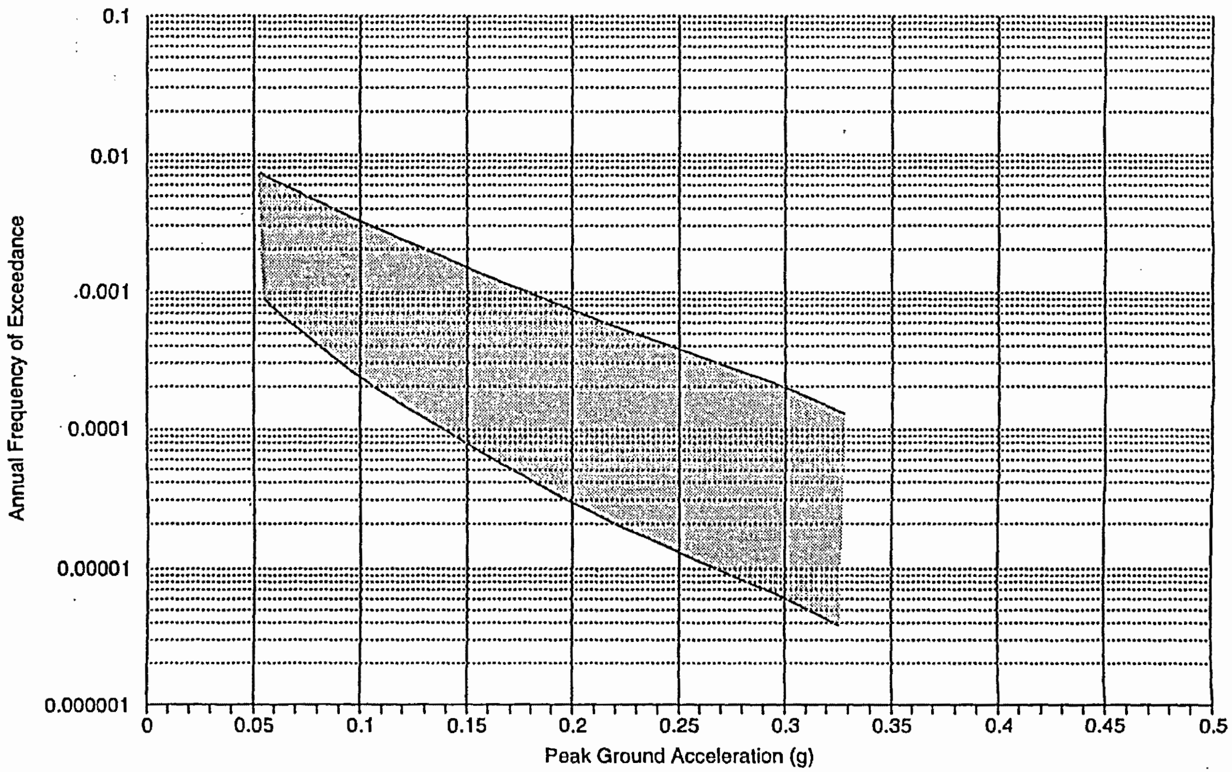


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Figure 4-7. **Frequency for Peak Ground Acceleration Media Fractile Hazard, with Site Amplification, Estimated by the Six Independent Teams (modified from WVNS 1992a).**

Liquefaction typically occurs when an earthquake stresses loose, well-sorted, granular soils in combination with a high water table. The greatest potential occurs when the water table is within 3 m (10 ft) of the surface. Geologically young deposits, such as the sand and gravel layer on the north plateau, are the most likely to liquefy. Generally, older deposits have consolidated to the point where they will not liquefy. Clay-rich deposits of glacial till, such as those found at the site, are generally not liquefied easily.

The standard method for evaluating liquefaction potential for a site uses data from standard penetration tests (WVNS 1992a). These data were analyzed to estimate the probability of liquefaction for a given ground motion at the Center. Magnitude 5.25, the smallest magnitude for which the method has been developed, corresponds to a peak ground acceleration of about 0.15 g with a return period of 3,300 years [in comparison, the largest known earthquake on the Clarendon-Linden fault zone was magnitude 5.2 and occurred about 48 km (30 mi) from the Center]. When this method is applied to the sand and gravel layer on the north plateau, several areas are identified where there is potential for liquefaction, assuming an earthquake of magnitude 5.25 (Modified Mercalli Intensity of VII to VIII). The potential for liquefaction near the CDDL is estimated to be about 20 percent, 30 percent near the old meteorological tower in WMA 10 and less than 1 percent in the area near the CPC waste storage area in WMA 5. There are no foundations and no steep slopes near these locations. There is an increased potential for liquefaction with stronger earthquakes, but the areas with the greatest potential do not contain facilities with large inventories of radioactive material.

The liquefaction potential of the Lavery till and the Kent recessional unit is less than that for the overlying sand and gravel layer. Cohesive, clay-rich glacial tills such as the Lavery till are not easily liquefied (WVNS 1992a). Standard penetration test results from 8 wells completed in the Kent recessional unit under the south plateau indicate that there is less than a 1 percent chance of liquefaction from an earthquake of magnitude 5.25 centered under the site (0.15 g peak horizontal ground acceleration) (WVNS 1993m). None of the wells completed in the Kent recessional unit on the north plateau have yielded water; therefore, they cannot liquefy.

4.3 HYDROLOGY

This section describes the hydrologic (water) cycle and the surface water and groundwater conditions at and near the Project Premises and the SDA. Knowledge of how water moves on and below the ground surface is required to predict where contaminants would migrate and what the potential effect would be on human health and the environment.

4.3.1 Hydrologic Cycle

Water moves on the ground surface as a result of precipitation (i.e., rain and snow) and surface runoff (i.e., overland sheet or stream flow). Surface water can either be released into the atmosphere by evapotranspiration (i.e., evaporation or transpiration from plants) or percolate into the ground and become part of the groundwater system. Water that percolates to depths greater than 2 m (7 ft) at the Project Premises and the SDA discharges into Franks

Creek by means of french drains, seeps into Franks Creek, Quarry Creek and Erdman Brook, and, to a much lesser extent, into Buttermilk Creek by means of flow through the deep glacial strata and fractured bedrock. Figure 4-8 illustrates these processes. More surface runoff and less infiltration occurs on the south plateau than on the north plateau.

4.3.2 Surface Water

As shown in Figure 4-9, the Center is drained by two perennial streams: Cattaraugus Creek and one of its tributaries, Buttermilk Creek. Cattaraugus Creek flows generally west at an average rate of 10 m^3/s (353 ft^3/s) and empties into Lake Erie, about 64 km (40 mi) downstream of the Project Premises. Buttermilk Creek roughly bisects the Center and flows generally north at an average rate of 1.3 m^3/s (46 ft^3/s) to its confluence with Cattaraugus Creek at the northernmost end of the Center boundary (WVNS 1993j). The Center lies entirely within the Buttermilk Creek drainage area of 78 km^2 (30 mi^2).

The Project Premises and SDA are drained by three small streams: Erdman Brook, Quarry Creek, and Franks Creek. Erdman Brook and Quarry Creek are tributaries to Franks Creek, which flows into Buttermilk Creek. Erdman Brook, the smallest of the three streams, receives runoff from the central and largest portion of the Project Premises and the SDA, including the disposal areas (WMAs 7 and 8), the LLWTF and lagoons 1-5 (WMA 2), the process building area (WMA 1), the central Project Premises (WMA 6), and a major part of the parking lots (WMA 10). Quarry Creek receives runoff from the HLW tank farm and vitrification area (WMA 3), the north half of the northern parking lot (WMA 10), and the waste storage area [i.e., the CPC and lag storage additions (WMA 5)]. Franks Creek receives runoff from the east side of the Project Premises and the SDA, including the RTS drum cell (WMA 9), part of the SDA (WMA 8), and the CDDL radwaste treatment system (WMA 4).

Two water-supply reservoirs (WMA 12) located south (upstream) of the Project Premises and the SDA (Figure 4-2) were formed by blocking two tributaries to Buttermilk Creek with earthen dams. The reservoirs drain numerous streams over a 12.9-km^2 (5-mi^2) area. The reservoirs are connected by a short canal; the south reservoir drains to the north reservoir, which discharges into Buttermilk Creek through a sluice gate water-level control structure. The emergency spillway is located on the south reservoir. Overtopping of the emergency spillway was originally designed to occur in the event of a 25-yr storm; however, 21 percent of the available storage in the reservoirs has been lost to sedimentation (WVNS 1993j). Past overtopping has eroded the area around the spillway (Dames & Moore 1986). The dams were not designed to withstand the probable maximum precipitation event or the design basis earthquake and could be expected to fail in either event (WVNS 1993j). If the water in the dams were to overtop, the water would flow from the reservoirs into two creeks that drain into Buttermilk Creek (see Figure 4-2) and the area on the Project Premises and the SDA would be unaffected (WVNS 1993j).

The streams draining the Project Premises and the SDA exhibit wide flow variations. Peak stream flows occur either in spring from a heavy rainfall on snow cover or in summer from heavy thunderstorms with long, soaking rains. Peak flows for the period from 1990 to

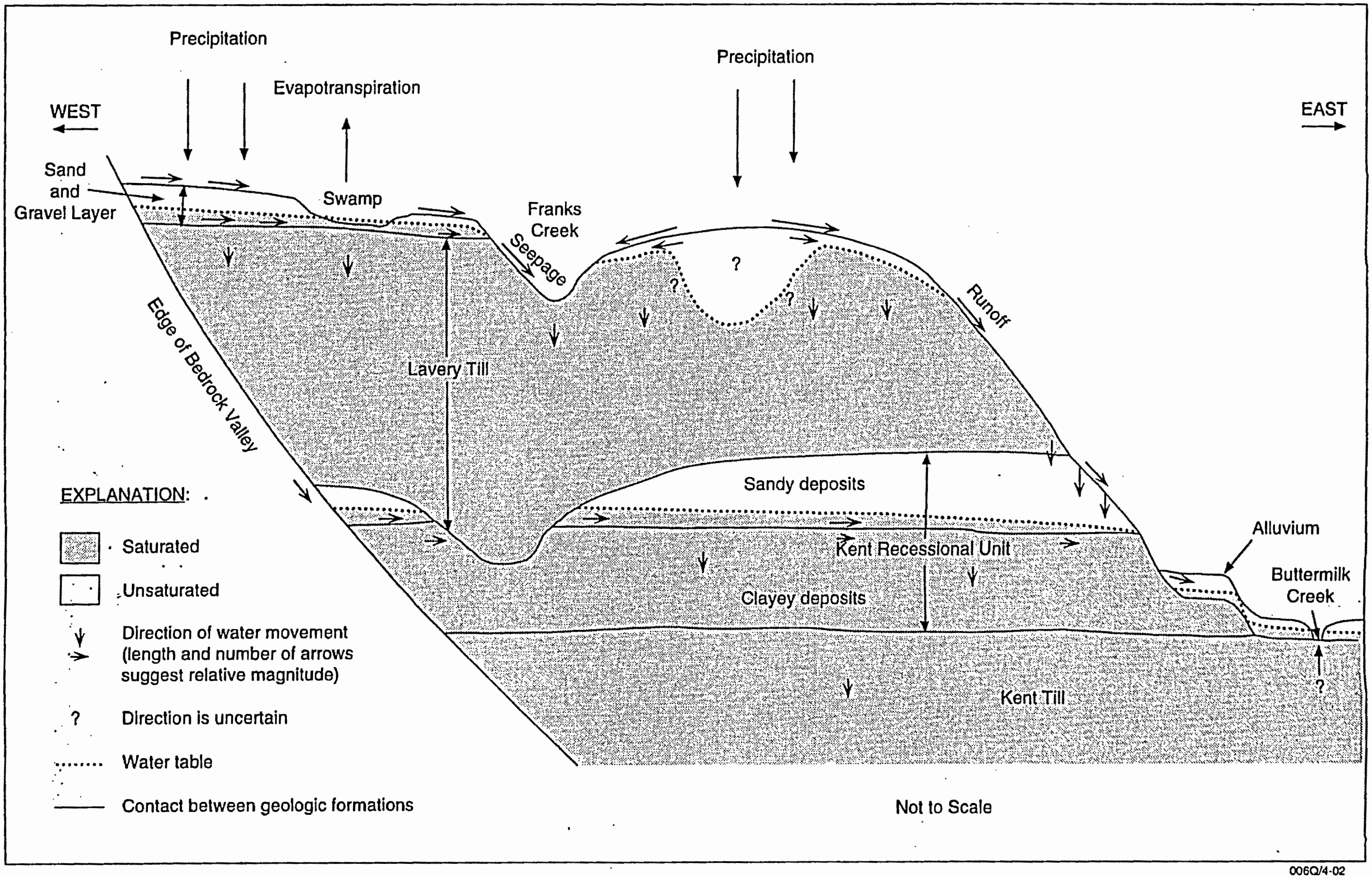


Figure 4-8. Idealized Cross Section Showing Hydrologic Cycle, Distribution of Saturated and Unsaturated Zones, and General Directions of Water Movement (modified from Prudic 1986).

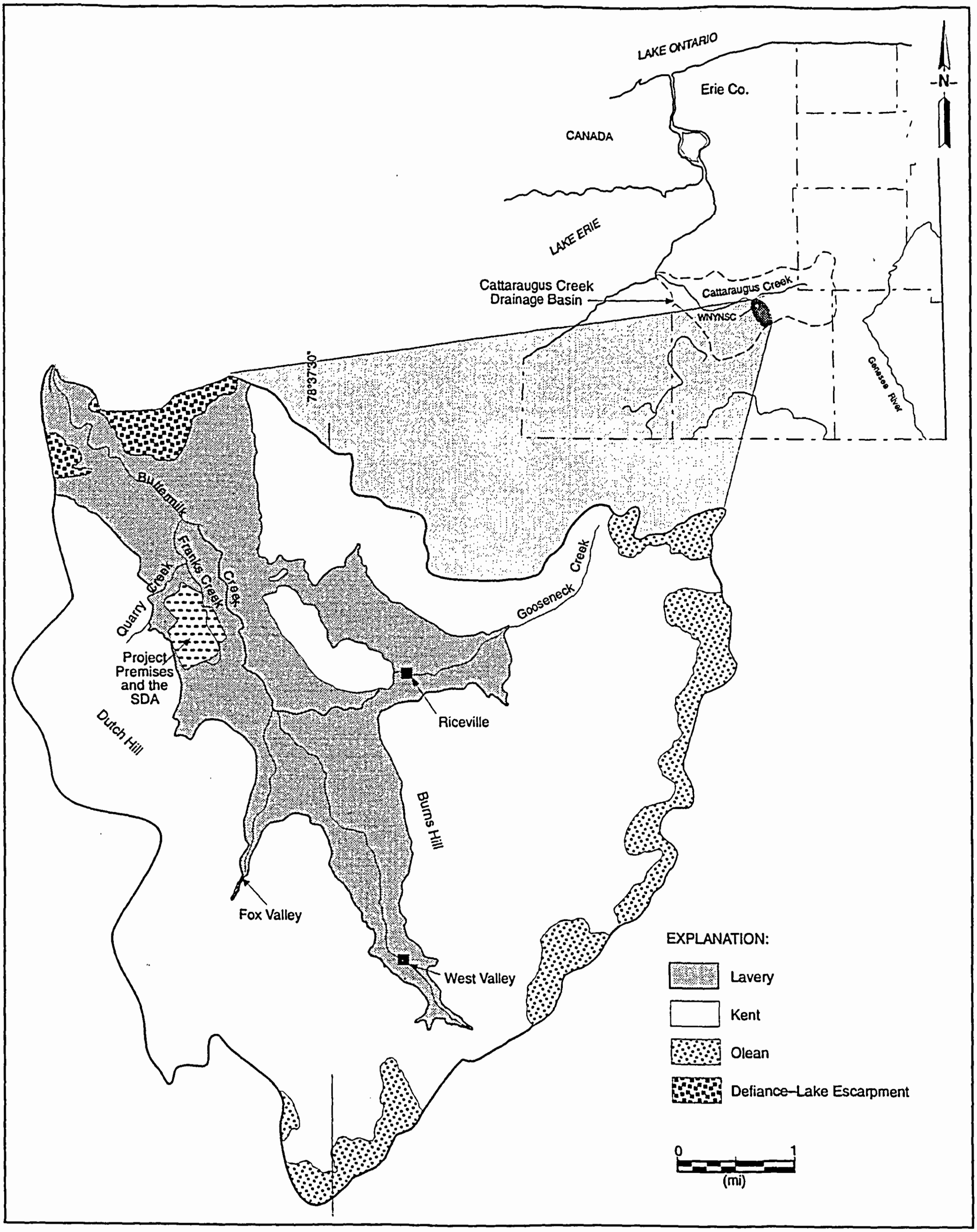


Figure 4-9. Buttermilk Creek Drainage Basin (modified from WVNS 1993h).

1991 were 9.6 m^3/s (340.3 ft^3/s) at the confluence of Quarry Creek and Franks Creek, 4.6 m^3/s (161 ft^3/s) where Franks Creek leaves the Project Premises, and 1.7 m^3/s (60 ft^3/s) in Erdman Brook downstream of the SDA (WVNS 1993j). Peak flow measured at the USGS gauge station at the Bond Road Bridge over Buttermilk Creek (which operated from 1962 to 1968) was 111 m^3/s (3,910 ft^3/s) on September 28, 1967. The historic high-water level of 414 m (1,358.6 ft) above mean sea level in the reservoirs was recorded on the same day (WVNS 1993j).

Flood levels for the 100-year storm, given in Figure 4-10, show that no facilities on the Project Premises or the SDA are in the 100-year floodplain (WVNS 1993a). No 500-year floodplain map is currently available for the creeks bordering the Project Premises and the SDA. If an alternative were selected where a new facility would be sited in this area, the 500-year floodplain would be evaluated in subsequent SEQRA and NEPA review for siting the facility under 10 CFR Part 1022 ("Compliance with Floodplain/Wetlands Environmental Review Requirements"). Computer simulations of the probable maximum flood [based on a hypothetical probable maximum precipitation event of 63.2 cm (24.9 in.) of rainfall in 24 hours] yielded peak flow estimates of 397 m^3/s (14,021 ft^3/s) at the confluence of Franks and Quarry Creeks and 104 m^3/s (3,670 ft^3/s) at the confluence of Franks Creek and Erdman Brook. The most significant impact of large storm events on the Project Premises and the SDA is the turbulent stream velocities that erode several sensitive reaches (WVNS 1993j) and may contribute to slope instability from erosion and saturation of surface soils, as discussed in Section 4.4 and Appendix L.

4.3.3 <u>Unsaturated Zone Hydrology</u>

To understand the movement of water through the subsurface in the unsaturated (vadose) zone, the movement of precipitation through this zone has been closely studied on the north and south plateaus. The unsaturated zone underlying the Project Premises and the SDA is made up of the sand and gravel layer beneath the facilities on the north plateau and of Lavery till on the south plateau. Hydrologic data obtained from 15 on-site monitoring arrays (nested wells, tensiometers, and moisture block arrays) indicates that after rain or snow, moisture that does not run off or is lost by evapotranspiration moves downward in this zone under both the south and north plateaus. These temporary increases in moisture raise the water table and decrease the depth to groundwater. Thus, the thickness of the unsaturated zone varies with the water table fluctuations.

4.3.3.1 North Plateau

The unsaturated zone under the north plateau is within the sand and gravel layer which has a maximum thickness of 12.5 m (41 ft). From 1990 to 1992, the water table fluctuated from 0.34 to 1.55 m (1.1 to 5.1 ft) and averaged about 0.79 m (2.6 ft) (WVNS 1993f). From 1989 to 1992, the depth to groundwater in the sand and gravel layer ranged from 0 to 8.8 m (0 to 29 ft) and averaged 2.4 m (8 ft) below ground surface (WVNS 1993g). The average annual recharge to the sand and gravel unit was estimated at 40 percent of the average annual precipitation, with 60 percent lost to runoff (WVNS 1993f). The water table elevation is shown in Figure 4-11. Groundwater in the sand and gravel layer locally

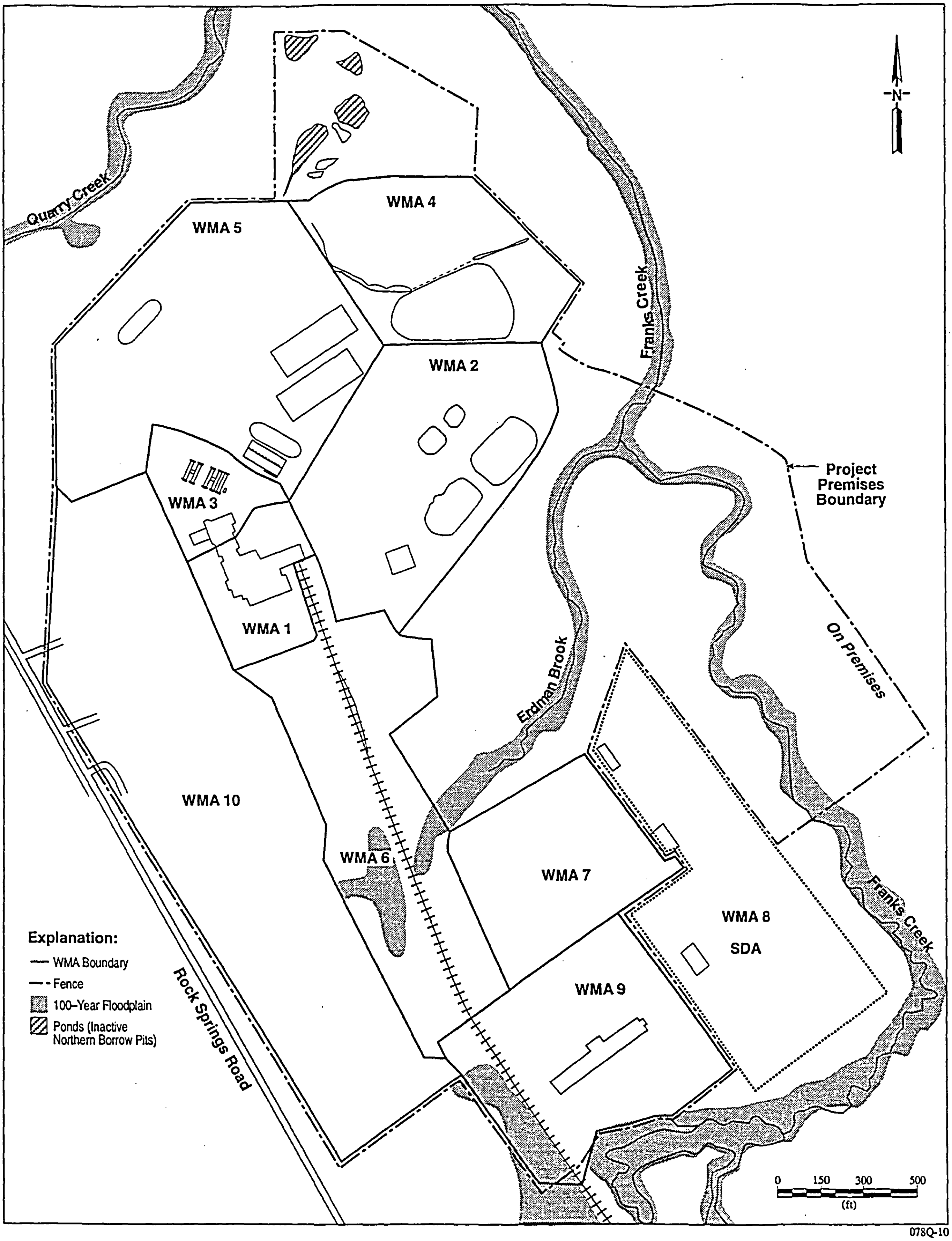


Figure 4-10. 100-Year Floodplain Near the Project Premises (modified from WVNS 1993a).

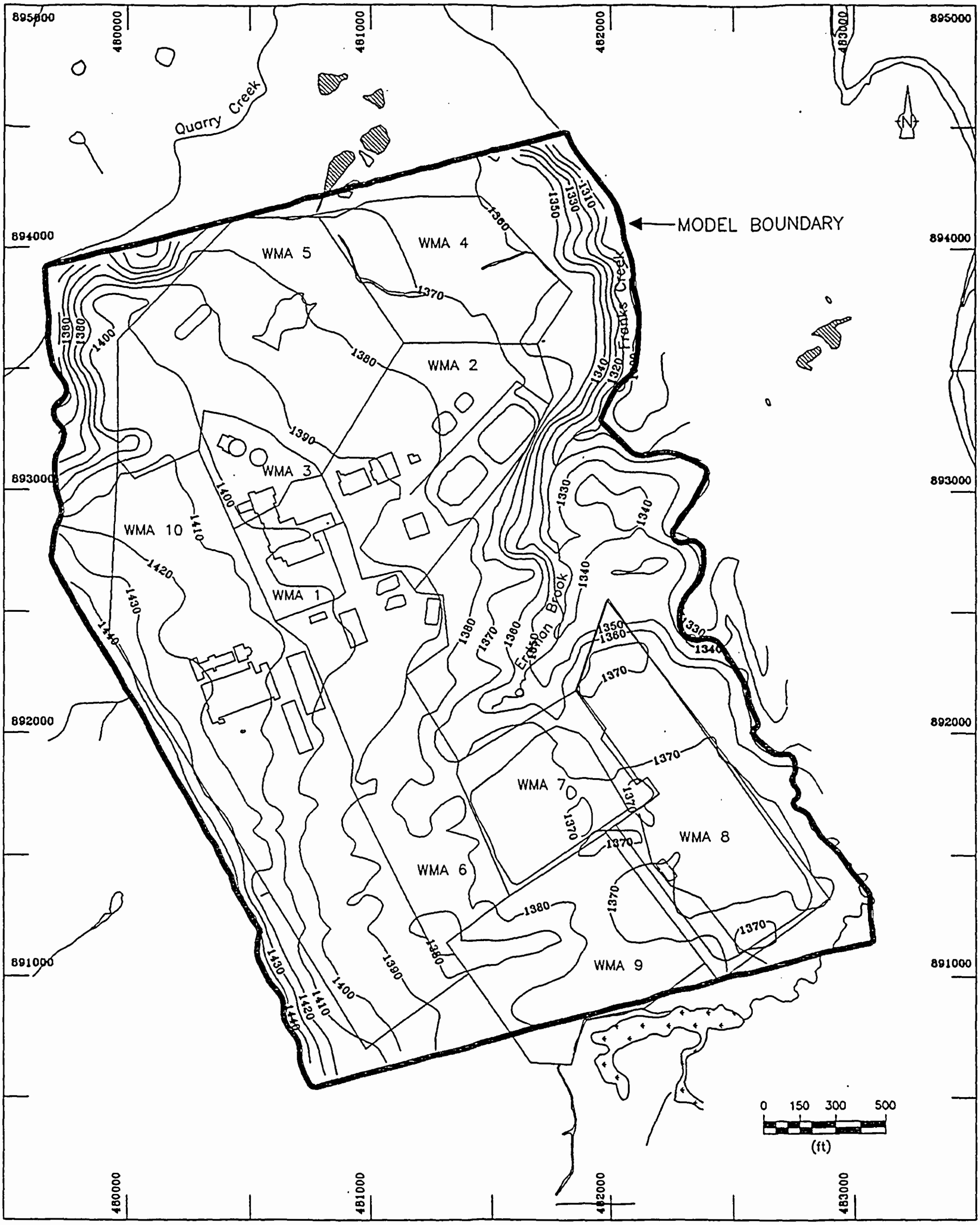


Figure 4-11. Predicted Transient Water Table Elevation Map for 1992 (elevations are contoured in feet above mean sea level).

discharges to the surface creating swamps near the CDDL (WMA 4) and around the edge of the north plateau, creating seeps.

4.3.3.2 South Plateau

The south plateau is immediately underlain by up to 29 m (96 ft) of weathered to unweathered Lavery till. The Lavery till is a silty clay but also contains coarse- to fine-grained sand and gravel lenses occurring irregularly in the upper 15 m (50 ft) of the till. These sand and gravel lenses account for approximately 7 percent of the bulk thickness of the Lavery till (Prudic 1982). The thickness of the unsaturated zone in the weathered till annually fluctuates an average of 3 m (10 ft) (WVNS 1993f). Depth to groundwater ranged from 0.04 to 7.25 m (0.13 to 23.8 ft) and averaged approximately 3 m (10 ft) below ground surface from 1989 to 1992 (WVNS 1993g).

The flow direction within the fine-grained unweathered Lavery till is predominantly downward beneath the Project Premises and the SDA. The saturated hydraulic conductivity ranges from 10^{-8} to 10^{-7} cm/s (3.3×10^{-10} to 3.3×10^{-9} ft/s) while the downward hydraulic gradient ranges from 0.65 to 1.92. Combining the measured hydraulic conductivity and gradients of groundwater yields estimates of downward flow velocities through the unweathered Lavery till ranging from 1.2 to 3.4 cm/yr (0.04 to 0.11 ft/yr). Flow through the top of the weathered Lavery till occurs mostly as evapotranspiration to the atmosphere and storm flow through fractures, mole runs, and root casts. From 1 to 1.5 percent of the total precipitation was estimated to percolate downward to the saturated groundwater system [below a depth of 4 m (13 ft)] with over 80 percent lost to runoff (WVNS 1993f,g).

4.3.4 <u>Saturated Zone Hydrology</u>

The saturated zone underlying the Project Premises and the SDA consists of the sand and gravel layer (north plateau only), the Lavery till, the Kent recessional unit, and bedrock (Table 4-1). The groundwater flow directions and velocities in the sand and gravel layer and the weathered, unweathered, and till-sand units of the Lavery till were calculated by using a three-dimensional steady-state model discussed in Appendix J. The model considered the sand and gravel as a single unit rather than being partially underlain by the slack-water sequence.

4.3.4.1 North Plateau

<u>Sand and Gravel Layer</u>. The sand and gravel layer primarily exists only on the north plateau. The water level in this layer fluctuated between 1.2 and 3.0 m (4 and 10 ft) from 1981 to 1992 (WVNS 1993g). Water levels are typically higher in fall through spring and lower during the summer.

Unconfined groundwater flow in the sand and gravel layer is predominantly to the east-northeast toward Franks Creek and Erdman Brook, as shown in Figure 4-11. Some areas also flow north toward Quarry Creek. Because of the sharp contrast between the hydraulic conductivity of the sand and gravel layer and the underlying Lavery till deposits, flow in the sand and gravel layer is primarily horizontal under an average hydraulic gradient of approximately 0.032 m/m (0.032 ft/ft) (WVNS 1993g). Moreover, the hydraulic conductivity in this layer varies over three orders of magnitude [2.0×10^{-5} to 2.6×10^{-3} cm/s (6.6×10^{-7} to 8.5×10^{-5} ft/s)] because of the variable grain size (WVNS 1993g). Point estimates of the horizontal groundwater flow velocity based on the average hydraulic gradient and the measured hydraulic conductivities range from 0.2 to 26.3 m/yr (0.66 to 86.2 ft/yr). Higher groundwater velocities are expected in the area south and east of the process building because of relatively high conductivity values.

Groundwater discharges from the sand and gravel layer by evapotranspiration, by seepage to the surface at the exposed boundary of the sand and gravel with the underlying Lavery till along the periphery of the north plateau, by drainage to the French drain installed adjacent to lagoons 2 and 3 (WMA 2), by drainage to the HLW tanks drain system (WMA 3), and by downward flow to the underlying Lavery till. Yager (1987) estimated surface springs and seeps accounted for 36 percent of the total annual discharge from the sand and gravel layer, while evapotranspiration (30 percent), drainage to streams and french drains (19 percent), and vertical downward flow to the Lavery till (1 percent) accounted for the remaining discharge from the north plateau (WVNS 1993g). The HLW tanks (WMA 3), the process building (WMA 1), and the French drain in WMA 2 locally influence groundwater flow through the sand and gravel layer. The HLW tanks and some areas of the process building were excavated and constructed through the sand and gravel layer into the underlying till. The excavated areas near the HLW tanks and possibly near the process building were backfilled with lower permeability materials. Water is periodically pumped from the sand and gravel layer near the HLW tanks to maintain a groundwater elevation of about 424 to 425 m (1,391 to 1,393 ft) above mean sea level.

Weathered Lavery Till. Under the north plateau, the weathered Lavery till is thinner, or absent compared to the weathered till underlying the south plateau. Groundwater is not monitored extensively because it is generally less than 0.6 m (2 ft) thick (north and west of WMA 2), and the dominant groundwater pathway is in the more permeable sand and gravel layer.

Unweathered Lavery Till and Till Sand Unit. The till-sand unit is contained within the upper 6.1 m (20 ft) of the unweathered Lavery till under the north plateau. Although isolated lenses of fine- to coarse-sand are common throughout the Lavery till, the till-sand unit is laterally continuous from WMA 1 to the north slope of the Erdman Brook valley and it may have a role in groundwater flow beneath the north plateau. The till-sand unit ranges in thickness from 0.1 to 4.9 m (0.3 to 16 ft) and limited hydrologic testing indicates it has a hydraulic conductivity value of 1.3×10^{-4} cm/s (4.3×10^{-6} ft/s), similar to that observed for the sand and gravel layer (WVNS 1993g). The flow direction in the till-sand is southeast toward Erdman Brook. The absence of significant discharge zones at the surface suggests that the till sand may be encapsulated within the less permeable till and not be exposed at the surface (WVNS 1993g). Groundwater levels in the till sand are generally above the top elevation of the unit, indicating it is under confined conditions. Measured groundwater depths range from 0 to 8.2 m (0 to 27 ft) below ground surface and generally fluctuate less than 1.8 m (6 ft) (WVNS 1993g). Water level fluctuations within the till sand are caused by seasonal variations in recharge and by probable downward and lateral seepage into the surrounding till.

Kent Recessional Unit. The extent of potential groundwater movement from the Kent recessional unit and the deeper till to bedrock is unknown. Groundwater data for the lake-deposited sediments of the Kent recessional unit under the north plateau are limited because four out of five of the monitor wells are consistently dry.

Bedrock Hydrology. Groundwater flow in bedrock is expected to be directed downward in the higher hills, laterally beneath low hillsides, and upwards near major streams (e.g., Buttermilk and Cattaraugus Creeks), as indicated by flowing wells in valleys adjacent to the Buttermilk Creek drainage area (Prudic 1986).

Regional groundwater flow (in the shallow weathered bedrock) is toward the axis of the bedrock valley east of the site. Prudic (1982) estimated the hydraulic conductivity of the weathered bedrock at 10^{-5} cm/s (3.3×10^{-7} ft/s) and 10^{-7} cm/s (3.3×10^{-9} ft/s) for the unweathered bedrock using regional well test data. Borehole 83-4E, located approximately 240 m (800 ft) northeast of the process building, had a yield of 36 L/min (9.5 gal/min) from a 1-m (3-ft) zone of weathered bedrock (Yager 1987). Fractures, joints, and bedding planes enhance lateral and vertical flow and contribute to the variability in the bedrock hydraulic characteristics. Some wells on the Project Premises are completed in bedrock. However, no bedrock wells are monitored.

4.3.4.2 South Plateau

Weathered Lavery Till. Under the south plateau, the groundwater level varies as much as 4.6 m (15 ft) with the largest fluctuations observed in wells located in the SDA. Monitoring wells screened at depth in the weathered till have lower water level elevations, and the water level fluctuates less than wells screened closer to the ground surface.

Groundwater flow on the south plateau is generally controlled by surface topography and flow is eastward under a hydraulic gradient of 0.02 m/m (0.02 ft/ft), (WVNS 1993g). Measurements of hydraulic conductivity of the weathered till range from 2×10^{-8} to 4×10^{-5} cm/s (6.5×10^{-10} to 1.3×10^{-6} ft/s) (WVNS 1993g). The flow velocity through the weathered till has been calculated at 1.3 to 1.34 m/yr (4.3 to 4.4 ft/yr) (WVNS 1993g). Horizontal groundwater flow in the weathered till is influenced by several factors, including groundwater collection in the NDA interceptor trench and groundwater diversion by a slurry wall west of SDA trench 14. Groundwater discharges to marshes and stream valleys that border the NDA and SDA on the south plateau.

Unweathered Lavery Till. Groundwater flow is vertically downward at a very slow rate to the underlying Kent recessional unit (WVNS 1993g). The shallow, unweathered till is responsive to precipitation, as indicated by the variation in water levels. In contrast, the water level at depth in the unweathered till remains constant and is unaffected by precipitation. A cross section showing the vertical gradients in the unweathered Lavery till under the south plateau is presented in Figure 4-5.

Hydraulic conductivity values of the unweathered Lavery till range from 2×10^{-8} to 1×10^{-7} cm/s (6.6×10^{-10} to 3.3×10^{-9} ft/s) as determined by slug tests. The hydraulic conductivity of the silt and fine sand interlayers in Lavery till range from 3×10^{-7} to 2×10^{-5} cm/s (9.8×10^{-9} and 6.6×10^{-7} ft/s) (WVNS 1993g). The average vertical groundwater velocity through the unweathered Lavery till is calculated at 0.06 m/yr (0.2 ft/yr) (WVNS 1993g).

Kent Recessional Unit. The upper portion of the Kent recessional unit beneath the south plateau is unsaturated; however, at depth it is saturated and there may be a horizontal flow pathway for eventual discharge along Buttermilk Creek (Prudic 1986). The unsaturated conditions in the top of the unit result from the low vertical permeability in the overlying unweathered till, which slowly recharges the underlying deposits. Flow in the saturated portion of the unit is to the northeast toward Buttermilk Creek at a gradient of 0.023 m/m. Water levels have varied less than 1.1 m (4 ft) in wells on the south plateau with very slow response to external sources (i.e., precipitation). The range of hydraulic conductivity is estimated at 5.5×10^{-7} to 1.5×10^{-6} cm/s (1.8×10^{-8} to 4.9×10^{-8} ft/s), and hydraulic conductivities derived from particle size data are 8.4×10^{-6} cm/s (2.8×10^{-7} ft/s) for lake-deposited units and 8.4×10^{-5} cm/s (2.8×10^{-6} ft/s) for coarser units. Velocity estimates range from 0.06 m/yr (0.2 ft/yr) to 0.61 m/yr (2.0 ft/yr) (WVNS 1993g).

4.4 SITE GEOMORPHOLOGY

The Center is actively eroding by a number of processes that are described in this section. An understanding of these processes is required to determine the long-term hazard from leaving wastes on site and to determine effective erosion control measures. Geomorphological studies at the Center have focused on the major erosional processes acting on Buttermilk Creek and Franks Creek drainage basins near the Project Premises and the SDA. This section describes these processes—channel incision, slope movement, and gullying—and details where they occur. The erosion rates from these processes have been measured at numerous locations throughout the drainage basins as summarized in Table 4-4 (WVNS 1993e). The methods used to calculate the erosion rates are presented in Appendix L.

4.4.1 Channel Incision

The streams in the vicinity of the Project Premises and the SDA are at a relatively young stage of development. The streams have steep profiles, V-shaped cross sections, and little or no floodplains, which is characteristic of a young developmental stage. During this developmental stage, streams move large quantities of sediment, thereby vigorously eroding their channels, a process referred to as channel incision or stream downcutting. The channel incision process is greatest during high-flow, high-energy rainfalls such as prolonged soaking storms (during spring thaw) and brief, high-intensity thunderstorms in summer.

In addition to downcutting their channels, the streams are actively elongating their stream course or profiles by eroding the upstream end, a process referred to as headward advance. Headward advance starts when the movement of channel sediment is blocked or

Table 4-4. Summary of Erosion Rates at the Center

Location	Erosion Rate (m/yr)	Author and Study Date	Method
Deepening of Buttermilk Creek	0.0015 to 0.0021	La Fleur (1979)	Carbon-14 date of terrace - depth of stream below terrace
Deepening of Buttermilk Creek	0.005	Boothroyd and Timson (1982)	Carbon-14 date of terrace - depth of stream below terrace
Deepening of Quarry Creek, Franks Creek, and Erdman Brook	0.051 to 0.089	Dames & Moore (1992)	Difference from (1980 to 1990 in stream surveys
Slopes on plateaus at WVDP	3 of 8 slopes unstable from earthquake with Modified Mercalli Intensity of VII to IX	Dames & Moore (1992)	Computer model of slope stability
Buttermilk Creek Valley Rim Widening	4.9 to 5.8	Boothroyd and Timson (1979)	Downslope movement of slump block over 2 years
Valley Rim Widening of Buttermilk and Franks Creeks and Erdman Brook	0.05 to 0.13	McKinney (1986)	Extrapolate Boothroyd data for 500 years
Erdman Brook Valley Rim Widening	0.02 to 0.04	Dames & Moore (1992)	Downslope movement of stakes over 9 years
Downcutting of Franks Creek	0.06	Dames & Moore (1992)	Stream profile, knickpoint migration 1955 to 1989
SDA Gully Headward Advancement	0.4	Dames & Moore (1992)	Gully advancement SCS TR-32 method
NP3 Gully Headward Advancement	0.7	Dames & Moore (1992)	Gully advancement SCS TR-32 method
006 Gully Headward Advancement	0.7	Dames & Moore (1992)	Gully advancement SCS TR-32 method

Source: WVNS (1993e)

obstructed by trees or other objects that fall into the channel. The result is an abrupt change (waterfall) in the longitudinal profile of the stream bed, referred to as a knickpoint. The stream erodes the knickpoint area by carrying away the fine-grained sediment downstream and leaving the coarse-grained sediment (gravel and cobbles) at the base of the vertical drop. Stream turbulence from high-energy events agitates the accumulated gravel and cobbles and creates a scour pool (see Figure 4-12). The knickpoint migrates upstream because of the movement of the gravel and cobbles, which erodes the knickpoint at its base. The channel is deepened by abrasion from movement of the gravel and cobbles downstream. As this process continues, the shape of the channel cross section changes from a U-shaped, or flat-bottomed, floodplain with a low erosion rate to a V-shaped channel with a higher erosion rate. Figure 4-13 shows locations where the stream cross sections change from U-shaped to V-shaped channels and the location of known knickpoints. The knickpoint migration rate has

Figure 4-12. Scour Pool on Upper Franks Creek.

been measured at 3.3 m/yr (10.7 ft/yr) along Erdman Brook and 2.3 m/yr (7.5 ft/yr) along Franks Creek (WVNS 1993e).

4.4.2 Slope Movement

The erosion of slopes within the Buttermilk Creek and Franks Creek drainage basin has been dominated by one process: the formation of slump blocks along the stream valley wall (Figure 4-14). The slumps develop when water moves into deep fractures within the stream banks, causes an increase in the soil pore pressures, and reduces the soil strength until the slope slumps or slides down into the stream valley. Also, in locations where the stream channel bends outward against the stream bank (the outside of a meander loop), the increased stream flow velocity undercuts the base of the slope, referred to as the toe, and decreases the slope stability and accelerates the slumping process.

An entire series of slump blocks can form on a slope at the same time, but more typically a single block forms initially. The redistribution of stresses and weight from the movement of the single block adds to the forces already acting at other points on the slope and eventually causes other slump blocks to form.

Three slump blocks have been identified along Franks Creek, one on Erdman Brook, and one on Quarry Creek as shown on Figure 4-13. The blocks vary in length from about 1.5 m to greater than 30 m (5 ft to greater than 100 ft) and tend to be about 1.0 to 1.2 m (3 to 4 ft) in height and width when they initially form (WVNS 1993e). On the basis of data collected from 1982 to 1991, the rate of downslope till movement within the slump blocks on Erdman Brook is reported to range from 0.03 and 0.05 m/yr (0.09 and 0.16 ft/yr), which equates to a stream valley rim widening rate of approximately 0.02 to 0.04 m/yr (0.07 to 0.12 ft/yr) (WVNS 1993c). The most erosion has occurred along a 67-m (220-ft) length of slope along Erdman Brook north of the SDA; however, the rate of movement is not representative of the stream system as a whole because the stream was eroding through uncompacted fill.

4.4.3 Gullying

The steep valley walls of the stream channels within the Buttermilk Creek and Franks Creek drainage basin are susceptible to gullying. The gullies are most likely to form in areas along stream banks where slumps and deep fractures are present, seeps are flowing, and the toe of the slope intersects the outside of the meander loop. The gully propagation process occurs during thaws and after thunderstorms in the areas where a concentrated stream of water flows over the side of a plateau and when groundwater movement, referred to as the hydraulic gradient, becomes great enough for seepage to promote the grain-by-grain entrainment and removal of soil particles from the base of the gully scarp—a process referred to as sapping. Sapping causes small tunnels (referred to as pipes) to form in the soil at the base of the gully, thus, undermining and weakening the scarp until it collapses. Surface water runoff into the gully contributes to gully growth by removing fallen debris at the base of the scarp.

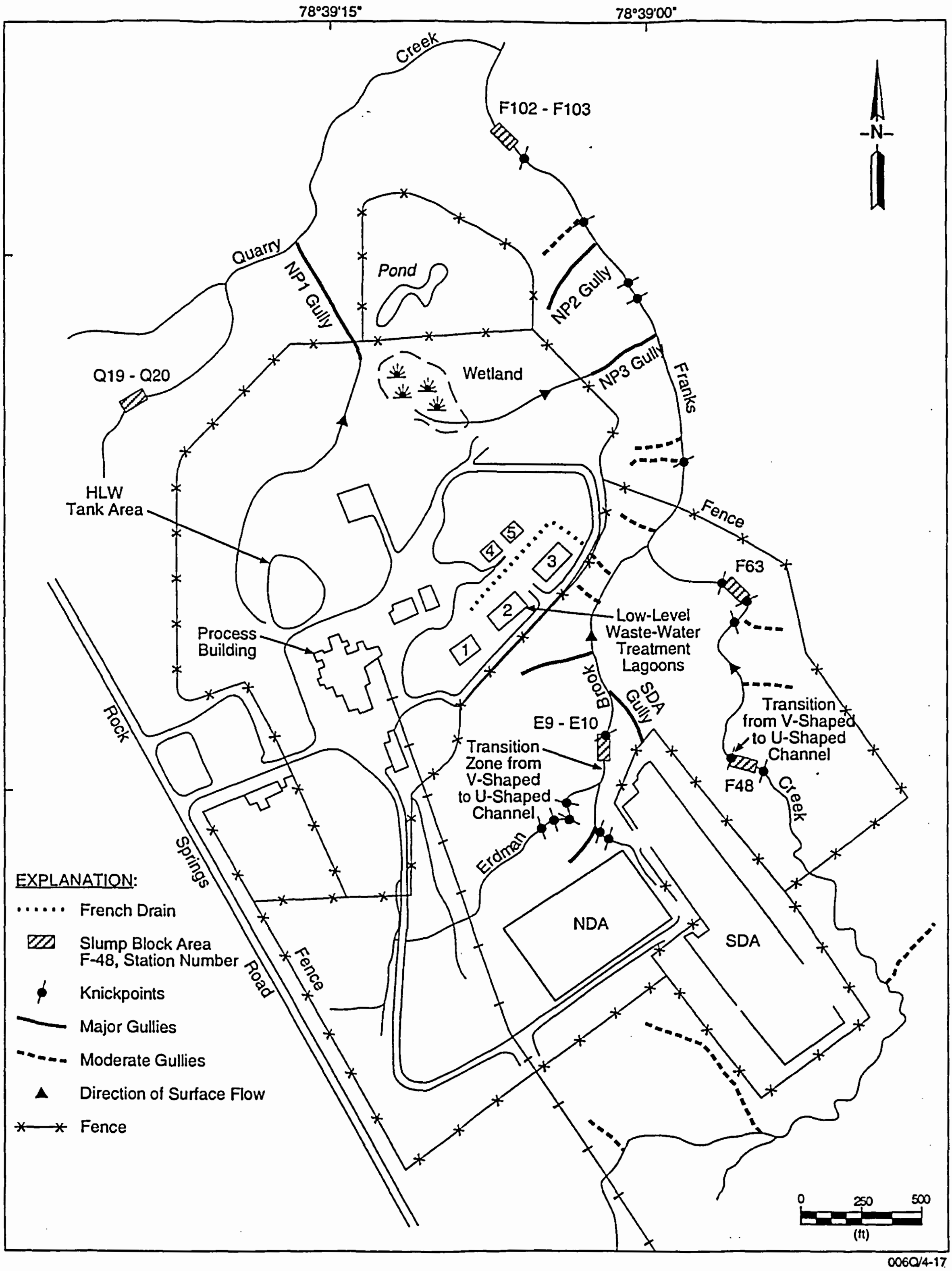


Figure 4-13. Gullies, Major Slump Blocks, Channel Transition, and Knickpoints in the Franks Creek Drainage Basin (adapted from WVNS 1993e).

Figure 4-14. Slump Block on Upper Franks Creek.

More than 20 major and moderate-sized gullies have been identified on the Project Premises and near the SDA, as shown in Figure 4-13. Some of these gullies formed as the result of site activities. For example, runoff from the plant and parking lots directed through ditches to the head of a previously existing gully created a new gully at the upper reaches of the equalization pond outfall. The initiation and growth of these gullies appears to be the quickest mechanism for eroding into the north or south plateau and ultimately disturbing the site facilities. Gully advance was calculated at 0.4 m (1.2 ft) per year near the SDA on the south plateau and at 0.7 m (2.2 ft) per year for two areas on the north plateau (WVNS 1993e).

4.5 METEOROLOGY AND AIR QUALITY

The air resources at the Center and the surrounding region are described in this section. Climate and meteorology are discussed in Section 4.5.1, ambient air quality in Section 4.5.2, and atmospheric dispersion in Section 4.5.3.

4.5.1 Climate and Meteorology

The general climate of the region in which the Center is located is classified as humid continental, which is predominant over the northeastern United States and common for mid-latitudes. Meteorological conditions at the Center, which is 427 m (1,400 ft) above mean sea level, are greatly influenced by the Great Lakes to the west and by the jet stream (polar front), where warm and cold air masses collide. Because the boundary of the jet stream shifts across the site, strong winds occur in the winter and early spring. Precipitation is moderate and evenly distributed throughout the year (WVNS 1993c, NOAA 1981, AMS 1959).

Local and regional topographic features influence the climate at the Center (Figure 4-2). The difference in elevation [400 m (1,310 ft)] between the Lake Erie shoreline and that at the Center affects precipitation, wind direction, and windspeed. Atmospheric dispersion at the site is increased by local mountain (upslope) and valley (downslope) winds.

Climatological data [temperature, windspeed, wind direction, and the standard deviation of the wind direction (sigma theta)] have been collected at the Center since 1983. The climatological baseline is largely based on data from the National Weather Service station in Buffalo, New York, which is located 71 km (44 mi) northwest of the site. These data include regional air flow, upper air flow patterns, and temperature. However, surface air flow data at the site may not be comparable to similar data measured at the Buffalo National Weather Station because of terrain differences between these locations.

4.5.1.1 Winds

The prevailing wind direction is southwesterly, and windspeed averages approximately 5.4 m/s (12 mph). The strongest winds occur from November through March and are generally southwesterly to west-southwesterly. The weakest winds occur from May to October and are generally southwesterly to southerly (WVNS 1993c). Table 4-5 summarizes

Table 4-5. Windspeed and Direction Data at 10 meters (33 feet) for the Period 1984-1989 for the Project Premises[a]

	1984		1985		1986		1987		1988		1989	
Month	WS	WD	WS	WD	WS	WD	WS	WD	WS	WD	WS	WD
January	2.5	247	2.9	260	3.1	257	2.7	251	2.9	220	3.4	229
February	2.9	240	3.1	247	2.7	265	2.4	259	3.0	258	2.6	266
March	3.2	213	3.4	255	3.0	244	2.6	193	2.7	267	2.9	209
April	2.9	179	2.8	251	2.7	245	3.0	133	2.9	283	2.4	266
May	2.7	252	2.5	225	2.5	235	2.6	211	2.2	192	2.3	223
June	2.3	224	2.3	249	2.4	242	2.0	224	2.1	283	2.0	230
July	2.0	232	2.1	216	2.0	248	1.9	226	1.8	230	1.7	200
August	1.8	237	2.0	204	2.1	215	2.0	198	2.0	208	1.9	229
September	2.1	205	2.0	215	2.4	200	1.9	200	2.1	204	2.1	188
October	2.0	206	2.6	196	2.4	212	2.3	226	2.6	234	2.5	222
November	3.0	238	3.2	174	2.8	231	3.3	227	3.3	218	3.2	236
December	3.0	234	2.9	237	2.7	243	3.1	258	2.9	246	3.2	230

a. Windspeed (WS) is reported in meters per second. To convert meters per second to miles per hour, multiply by 2.237. Wind direction (WD) is reported in degrees from True North.

Source: Modified from WVNS (1993c)

the mean windspeed and wind direction data for the Center for the period 1984-1989. Figures 4-15 and 4-16 summarize wind data collected near the Center and at the Project Premises. The winds shown in Figure 4-15 are representative of conditions near the Center in terms of the regional wind climatology. Figure 4-16 shows the effect of complex terrain on the local wind field at the site, which affects atmospheric dispersion.

Severe weather at the Center occurs as straight line winds and tornadoes. The dominant straight line high-wind directions are from the southwest (67 percent) and the west (23 percent) (Fujita 1981). Higher windspeeds because of weather fronts occur in winter and early spring months. Thunderstorms occur in this region approximately 30 days per year, most often in June, July, and August. Severe thunderstorms with winds greater than 22.4 m/s (50 mph) occur in western New York State. Remnants of tropical cyclones occasionally affect the western New York State region, but the impact from these cyclones is usually increased local rainfall and rarely damaging winds (WVNS 1993c). The greatest peak wind gust recorded at 10 m (33 ft) above ground level at the Buffalo National Weather Station was 35 m/s (79 mph). Projections on the return periods for peak gusts exceeding a specified speed are given in Fujita (1981) and summarized in Appendix M.

On average, one tornado per year occurs in the western New York area. On the basis of the methodology described in Fujita (1981) and summarized in Appendix M, the probability of a tornado striking a 2.6 km^2 (1 mi^2) section of the Center was estimated to occur once every 10,000 years. The probability of tornado strikes for the Center is given in Fujita (1981) and summarized in Appendix M. For windspeeds less than or equal to 54 m/s (121 mph) (or a hazard probability level of 2.5×10^{-5}), straight line winds are the more likely; for higher windspeeds, tornadoes are more likely. As shown in Table 4-6, straight-line winds are the dominant form of severe weather at recurrence intervals of less than 100,000 years (McDonald 1981).

4.5.1.2 Temperature and Humidity

The western New York region is subject to extreme seasonal temperature variations because of the shifting boundaries of the jet stream. Average summertime temperatures generally range from 15 to 20°C (59 to 68°F), with temperatures as high as 36°C (97°F) recorded near the site. Average wintertime temperatures at the site range from 0° to -10°C (32 to 14°F), with temperatures as low as -42.8°C (-45°F). Further to the west and closer to the lakes, the mean temperatures are very similar, although disparities in the temperatures between the lake and the Center are a result of differences in the elevation (WVNS 1993c, NOAA 1981). Table 4-7 summarizes the mean temperature at the site and the Buffalo National Weather Station office for the period 1984-1989.

There are diurnal and seasonal variations in relative humidity, according to measurements made at the Buffalo National Weather Station office. Humidity during predawn hours ranges from 35 to 83 percent throughout the year. Afternoon humidity varies from 55 to 60 percent during the summer (June-August) months and from 18 to 25 percent during winter (December-February).

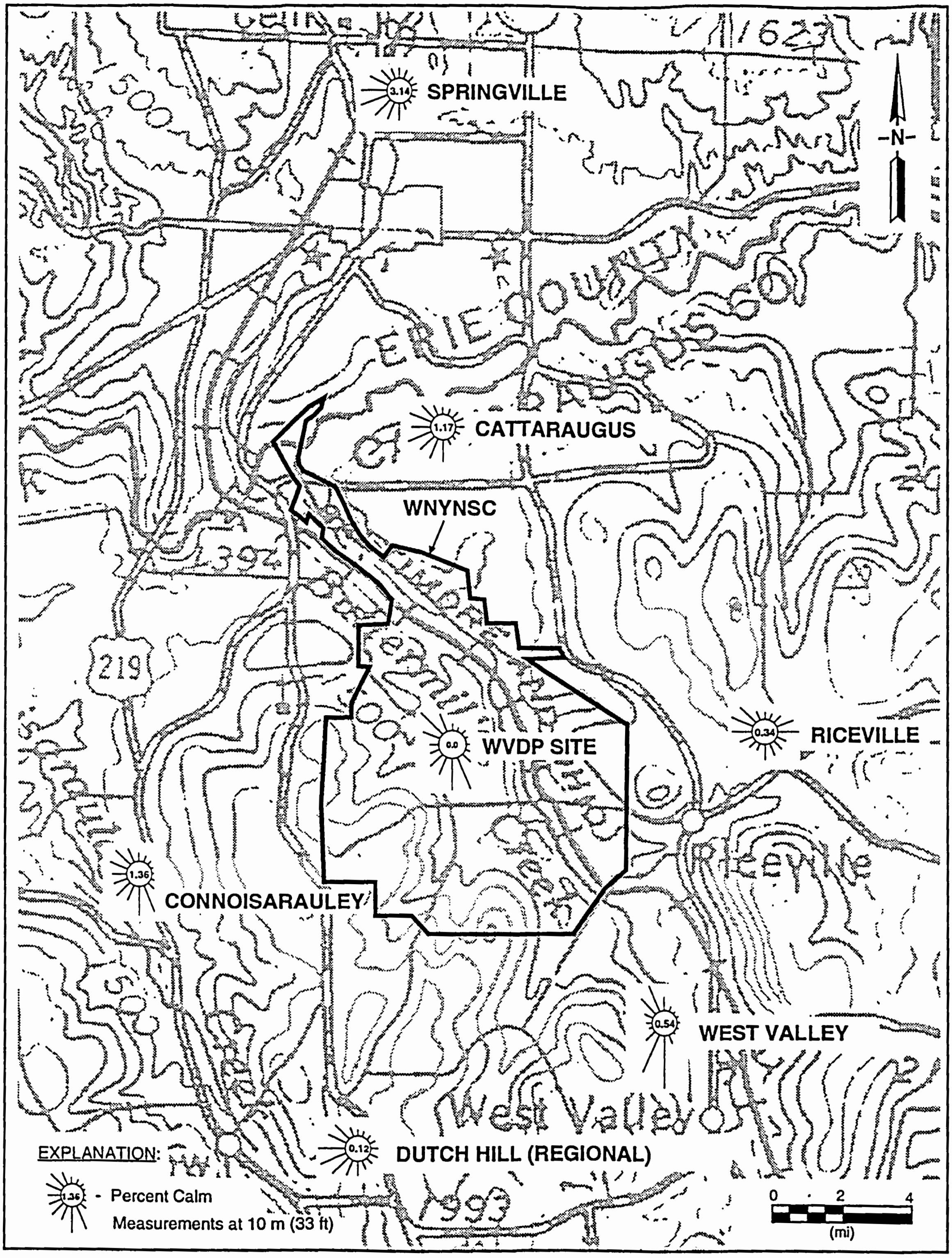


Figure 4-15. Wind Roses for the Western New York Nuclear Service Center, 1983-1984 (the points on each rose represent the directions from which the winds originate).

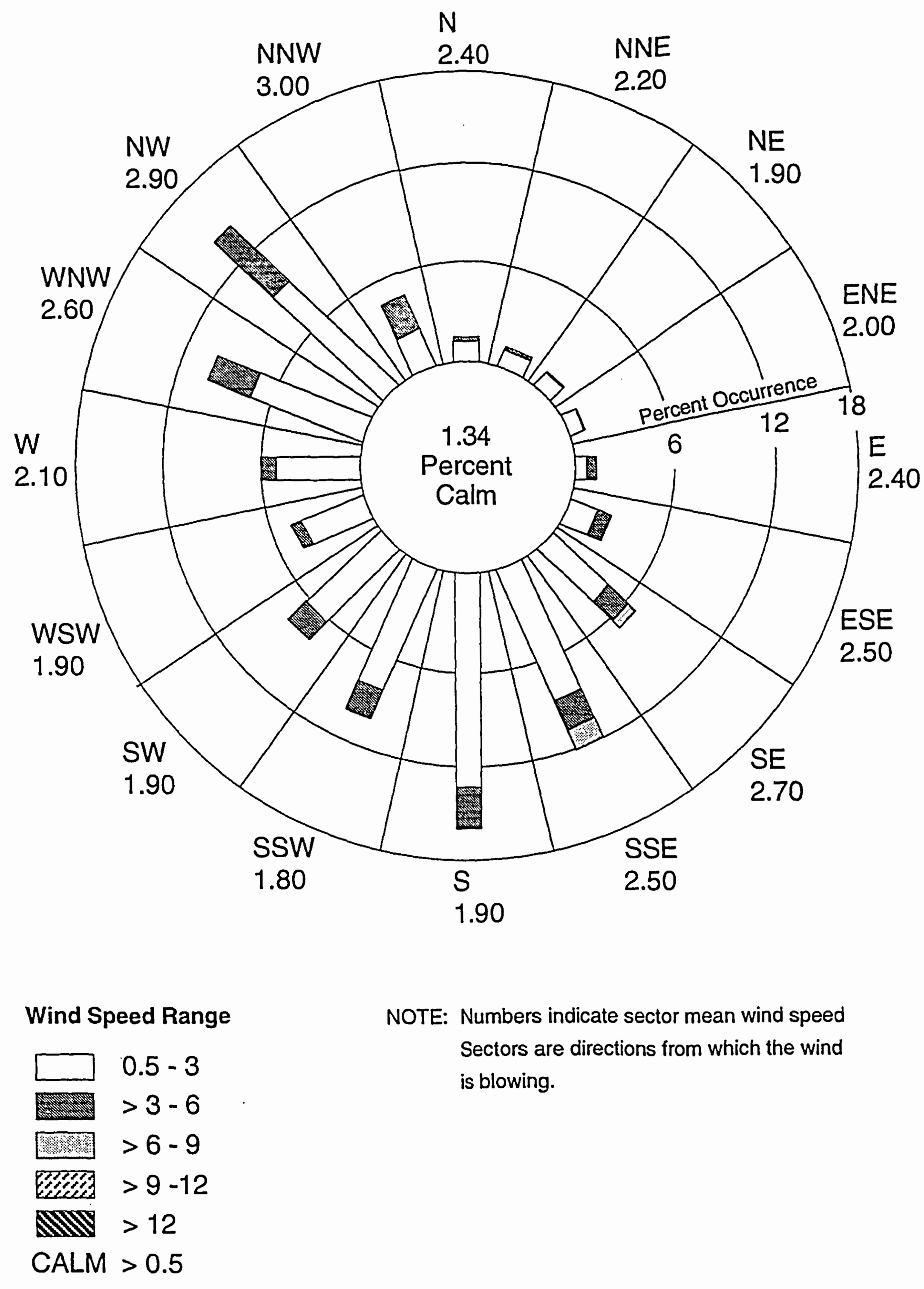


Figure 4-16. Wind Rose for the Project Premises, 10-meter (3-foot) Tower, for 1994.

Table 4-6. Probability of Straight Line Winds and Tornadoes for the Western New York Nuclear Service Center[a]

Return Period (yrs)	Storm Type	Windspeed m/sec	Windspeed mph
10	Straight	29.1	65
100	Straight	34.9	78
1,000	Straight	41.1	92
10,000	Straight	46.9	105
100,000	Straight	53.2	119
1,000,000	Tornado	70.6	158
1×10^7	Tornado	96.6	216

a. Based on the Buffalo, New York, National Weather Service high-wind data (1950-1980) and the DAPPLE Tornado Tape (1916-1980).

Source: Adapted from Fujita (1981)

Relative humidity at the Center is likely to be slightly lower than that reported for Buffalo because the site is located further from Lake Erie and at a higher elevation (WVNS 1993c).

4.5.1.3 Precipitation

Annual precipitation is distributed evenly through the year, with more snow than rain in the winter. The site is not subject to flooding because it is located at a topographic high point within the region. Mean total water equivalent precipitation at the Center probably falls between 94 cm (37 in.) at the Buffalo National Weather Station office to 124 cm (49 in.) at Little Valley, located 14 km (8.4 mi) southwest of the Project Premises. The Center region receives an annual average of 3 m (10 ft) of snowfall, with snow squalls totalling 0.3 to 0.9+ m (1 to 3+ ft) over a 2 to 3-day period not uncommon (WVNS 1993c). Rains resulting from warm fronts are usually light but last for several days; cold fronts often cause heavier rainfall in shorter periods.

4.5.2 Ambient Air Quality

New York State is divided into nine regions for assessing State ambient air quality. The Center is located in Region 9, comprising Niagara, Erie, Wyoming, Chatauqua, Cattaraugus, and Allegany Counties. The EPA has both primary and secondary National Ambient Air Quality Standards for criteria pollutants, which are designed to protect human health and welfare from adverse effects from these pollutants. Currently, there are six criteria pollutants: carbon monoxide, sulfur dioxide, ozone, nitrogen dioxide, particulate matter, and

Table 4-7. **Mean Monthly Temperature Data for the Period 1984-1989 for the Project Premises and the National Weather Service Office at Buffalo International Airport[a]**

	Temperature (°C)											
	1984		1985		1986		1987		1988		1989	
Month	WVDP	NWS	WVDP	NWS	WVDP	NWS	WVDP	NWS	WVDP	NWS	WVDP	NWS
January	-7.4	-6.3	-7.9	-6.1	-4.0	-3.6	-5.0	-3.3	-5.0	-2.9	-1.6	-0.4
February	-0.2	0.9	-4.5	-3.8	-4.7	-4.3	-5.4	-3.8	-5.4	-4.0	-6.1	-5.0
March	-3.9	-2.6	0.9	1.7	2.2	2.4	1.7	3.0	0.4	1.5	0.2	0.2
April	7.0	8.7	9.3	9.5	8.0	8.8	8.3	9.8	5.3	7.3	4.8	5.3
May	10.3	11.5	13.8	15.5	14.2	15.2	14.3	15.7	13.3	15.3	11.8	12.5
June	18.2	20.0	14.9	16.9	16.9	18.0	18.2	20.6	16.0	18.1	17.4	18.7
July	18.7	21.6	18.8	21.1	19.7	21.6	21.0	23.3	21.0	23.6	19.6	21.9
August	19.5	21.2	18.4	20.7	17.1	19.8	18.1	20.5	19.8	22.5	18.2	20.2
September	13.6	14.8	15.9	17.8	16.0	16.6	15.3	17.1	14.3	16.9	14.7	16.0
October	11.9	11.7	10.1	11.5	9.2	10.5	6.7	8.6	6.2	8.0	9.6	10.6
November	2.9	3.9	5.2	5.3	2.2	3.3	4.6	5.8	4.7	6.0	2.3	3.5
December	1.2	2.0	-4.9	-3.7	-1.2	0.2	-0.5	1.2	-2.8	-1.2	-9.1	-8.0

a. To convert degrees Celsius to degrees Fahrenheit, add 17.78 and multiply by 1.80.

Source: Modified from WVNS (1993c)

lead (NYSDEC 1993). The National Ambient Air Quality Standards for each of these pollutants are given in Table 4-8.

Table 4-8. Ambient Air Quality Measurements for Buffalo, New York

Pollutant	1993 Monitoring Data	Primary Standard[a]	Secondary Standard[a]
Carbon Monoxide[b] (ppm)[c]	6.6 - 1 Hour 4.6 - 8 Hour	35 - 1 Hour 9 - 8 Hour	35 - 1 Hour 9 - 8 Hour
Sulfur Dioxide[b] (ppm)	0.036 - 24 Hour 0.009 - Annual	0.140 - 24 Hour 0.03 - Annual	0.5 - 3 Hour
Nitrogen Dioxide[b] (ppm)	0.019 - Annual	0.053 - Annual	0.053 - Annual
Ozone[d] (ppm)	0.088 - 1 Hour	0.120 - 1 Hour	0.120 - 1 Hour
Particulate Matter[e] ($\mu g/m^3$)	72 - 24 Hour 23 - Annual	150 - 24 Hour 50 - Annual	150 - 24 Hour 50 - Annual
Lead[f] ($\mu g/m^3$)	0.05 - Calendar Quarter	1.5 - Calendar Quarter	1.5 - Calendar Quarter

a. National Ambient Air Quality Standards, 40 CFR Part 40; State Ambient Air Quality Standards, 6 NYCRR 257.
b. Monitor 1401-18 (National Air Monitoring Station).
c. ppm = parts per million.
d. Monitor 1451-03 (National Air Monitoring Station).
e. Monitor 1401-32 (National Air Monitoring Station). State standard: 24-hour is 250$\mu g/m^3$; annual is 45 to 75 $\mu g/m^3$ according to level designation.
f. Monitor 1401-29 (National Air Monitoring Station).

Source: NYSDEC (1993)

Ambient concentrations of criteria pollutants for New York State in 1993 (the most recent record) are also shown in Table 4-8. The detected concentrations have either remained the same or decreased from the 1992 results. The closest continuous monitoring location for all six criteria pollutants is located in Buffalo about 48 km (30 mi) from the Center. The data in Table 4-8 indicate that the regional ambient air quality of western New York is in compliance with the federal and state National Ambient Air Quality Standards.

Under 40 CFR Part 93 ("Determining Conformity of Federal Actions to State or Federal Actions to State or Federal Implementation Plans"), the general conformity rules require a Federal action to conform to the applicable State Implementation Plan. The general conformity rules apply to nonattainment areas and to maintenance areas. Because the Center and Cattaraugus County are considered to be "in attainment" or "unclassifiable" with respect to the National Ambient Air Quality Standards for criteria pollutants, these rules do not apply to the Center or to the decontamination and decommissioning of the WVDP or closure or long-term management of facilities at the Center.

The WVDP holds permits for radiological air emissions under the National Emissions Standards for Hazardous Air Pollutants (NESHAPs). Six emission sources are monitored on a continuous basis for radionuclides: the supernatant treatment system, the cement solidification system, the main stack, the supercompactor, the contact size reduction facility, and the portable ventilation units (WVNS 1993n). In 1993, the combined emissions from the six monitored sources were less than one percent of the 10 mrem/year standard for total radionuclides in 1993 (WVNS 1994d).

4.5.3 Atmospheric Dispersion

The transport and diffusion of airborne pollutants is dependent on the horizontal and vertical distribution of temperature, moisture, and wind velocity. Greater amounts of turbulence or mixing in an atmospheric layer lead to greater rates of diffusion. The highest rates of diffusion are found in thermally unstable layers, moderate rates of diffusion are found in neutral layers, and the lowest rates of diffusion are found in thermally stable layers. The variations in windspeed and direction and the subsequent effects of complex terrain on these parameters are discussed in Section 4.5.1.

Favorable atmospheric dispersion conditions exist during periods of moderate to strong winds, unstable conditions, and maximum mixing heights. Holzworth (1972) summarized the mean seasonal morning and afternoon mixing heights for Buffalo, New York. Morning mixing heights vary from 874 m (2,867 ft) during winter to 460 m (1,508 ft) in the summer; afternoon mixing heights are highest during summer [1,625 m (5,333 ft)] and lowest during winter months [862 m (2,828 ft)]. Thus, the most favorable dispersion conditions will occur during nonovercast daytime hours when windspeeds are moderate to strong [i.e., greater than 6 m/s (13 mph)] (EPA 1972).

4.6 ECOLOGY

The Center, a relatively undisturbed area of deciduous forests and farmland that has not been farmed, grazed, or logged since the 1960s, contains numerous plant and animal species adapted to the region's humid climate. The site is mostly undeveloped land with the industrialized area located on the Project Premises and the SDA. The major facilities and activities occupy about 6.6 percent of the total Center land area. Buttermilk Creek, Franks Creek, Quarry Creek, Erdman Brook, and other water bodies on the Center are habitat for aquatic organisms.

Plants and animals that inhabit both the 80-ha (200-acre) Project Premises and the balance of the Center are described in Section 4.6.1. Federal and State Threatened and Endangered Species are discussed in Section 4.6.2. Aquatic ecology and wetlands are discussed in Sections 4.6.3 and 4.6.4, respectively.

4.6.1 Plants and Animals

4.6.1.1 Plants

The Center is within the Eastern Deciduous Forest Floristic Province (Gleason and Cronquist 1963, Braun 1950). Thirteen plant communities have been identified on the site

(Table 4-9), with more than 419 vascular plant species (WVNS 1994b). Much of the area was previously farmed, grazed, or logged until the 1960s. Native vegetation in these areas is becoming reestablished and probably will revert to a climax hardwood community. However, loss of top soil from past agricultural practices, competition with goldenrod (*Solidago* spp.), and grazing by deer has hindered the succession of these old fields to forest communities (McGarry 1993).

Most of the Project Premises and the SDA is industrialized and has little or no remnant vegetation. Plant communities on the Project Premises and SDA shown on Figure 4-17 consist of 18 wetlands totalling 3.7 ha (9.2 acres): five old field vegetation communities (two meadows and three mowed and maintained areas) totalling 21 ha (53 acres); and two forest communities totalling 18 ha (44 acres). The balance of the Project Premises consists of industrialized areas, including office and laboratory space, parking lots, storage areas, and treatment ponds (the lagoons, sludge ponds, and equalization basin). The Project Premises are bounded on the north and east by stands of Beech-Birch-Maple-Hemlock forest.

4.6.1.2 Animals

Animals on the Center are typical of the northeastern United States (Table 4-10). Because of the lack of recent human occupation and restrictions on development, the site is an effective wildlife sanctuary.

<u>Birds</u>. More than 130 species of birds have been recorded on or near the Center (WVNS 1994b). Bird populations and species diversity vary seasonally from migration. Permanent residents at the Center account for 10 percent of the regional bird list; summer residents, 67 percent; migrants, 19 percent; and visitors, which visit but do not breed in the area, 4 percent. Table 4-10 lists permanent resident, summer resident, and migratory birds commonly observed at the Center.

<u>Mammals</u>. Twenty-two mammal species or their signs have been observed (typical mammals at the Center are shown in Table 4-10). NYSDEC delineated a 1,620-ha (4,000-acre) area, including the Center, as a critical habitat because it is a deer wintering ground (WVNS 1994b). The whitetail deer population on site is estimated to be 2 to 2.5 times higher than that of the surrounding area. Public deer hunting occurred on the Center in late 1994 as a population control measure.

<u>Amphibians and Reptiles</u>. Over 35 species of amphibians and reptiles (herptiles) may occur on the site; however, only 10 amphibian and 1 reptile species have been observed. The observed species frequent aquatic or wetland habitats. Although no reptiles other than snapping turtles (*Chelydra serpentina*) have been recorded on the site, several snake species, including rat snakes (*Elaphe* spp.), garter snakes (*Thamnophis* spp.), and kingsnakes (*Lampropeltis* spp.) are likely to be present (McGarry 1993).

Table 4-9. Vegetation Communities Identified on the Western New York Nuclear Service Center[a,b]

Community	Site Acreage	Project Premises and State-Licensed Disposal Area Acreage	Description
Beech-Birch-Maple-Hemlock Forest	1,340 (40%)	0	This is the climatic-climax forest community for most upland sites in northwestern Cattaraugus County. American Beech (*Fagus grandifolia*) and maples (*Acer saccharum and A. rubrum*) are canopy dominants at the higher elevations and remain codominants into the valley bottom lowlands. Eastern hemlock (*Tsuga canadensis*) and yellow birch (*Betula lutea*) are abundant at lower elevations. Other overstory species include basswood (*Tilia americana*), black cherry (*Prunus serotina*), and bitternut hickory (*Carya cordiformis*). Subcanopy species include witchhazel (*Hamemalis virginiania*), ironwood (*Carpnus caroliniana*), hop-hornbeam (*Ostrya virginica*), spicebush (*Lindera benzoin*), and northern arrowood (*Viburnum recognitum*). Common groundcover layer species include mayapple (*Podophyllum peltatum*), sedges (*Carex* spp.), partridgeberry (*Mitchella repens*), and Christmas fern (*Polystichum acrostichoides*). Some protected mesic slopes harbor such species as trillium (*Trillium* sp.), bloodroot (*Sanguinaris canadensis*), and ginseng (*Panax quinquefolia*). Some mesic terraces supporting near-monocultures of hemlock have little or no shrub or herbaceous cover.
Evergreen Forest	5 (0.2%)	0	Conifers planted about 20 to 50 years ago make up this community. White spruce (*Picea glauca*), red pine (*Pinus resinosa*), Scots pine (*Pinus sylvestris*), and white pine (*Pinus strobus*) are the primary species, with the latter two most common. Canopy densities preclude herbaceous ground cover in most of these stands. Hardwood trees have become established and appear to be the next plant successional stage.
Bottomland Forest	150 (4.5%)	0	This community is associated with the flood plains of Cattaraugus Creek, Buttermilk Creek, and the lower reaches of their larger tributaries. Dominant canopy species include sycamore (*Platanus occidentalis*), black willow (*Salix nigra*), cottonwood (*Populus deltoides*), and red maple (*Acer rubrum*). The understory in better drained areas is dominated by coralberry (*Symphlocarpus orbiculatus*) and fly honeysuckle (*Lonicera canadensis*). Cock-spur hawthorne (*Crataegus crusgali*), various apples (*Pyrus* spp.), and northern alder (*Alnus rugosa*) are common. Ground cover dominants in more open sites consist of milkweed (*Asclepias* spp.), Jerusalem artichoke (*Helianthus tuberosa*), coltsfoot (*Tussilago farfara*), and rush (*Juncus* spp.). Relatively pure stands of ostrich fern (*Metteuchia struthiopteris*) or woodreed (*Cinna arundinacea*) are found on the lower stream reaches.

Table 4-9. Vegetation Communities Identified on the Western New York Nuclear Service Center[a,b] (Continued)

Community	Site Acreage	Project Premises and State-Licensed Disposal Area Acreage	Description
Old Field Successional Areas	1,005 (30%)	35 (16%)	This community is found on gentle upper slopes where agricultural activities occurred before site development: Several goldenrod (e.g., *Solidago canadensis and Solidago rugosa)* are dominant. A mix of alien and native species reflect the poor soil conditions. The most important of these are wood mint (*Blephilla hirsuta*), ox-eye daisy (*Chrysanthemum*), tick-trefoil (*Desmodium nudiflorum*), cinquefoil (*Pontnetilla* spp.), sheep sorrel (*Rumex acetocella*), musk mallow (*Malva moschata*), and orange hawkweed (*Hieracium aurantiacum*). A few slightly nutrient richer areas contain farming-remnant species, such as timothy (*Phleum pratense*), various clovers (*Trifolium* spp.), and orchard grass (*Dactylis glomerata*). Shrubs, such as arrowwood (*Viburnum recognitum*), coralberry (*Symphoricanpos orbiculatus*), pin cherry (*Prunus pennsylvanica*), and blackberry (*Rubus* spp.), are occasional as individuals or in isolated clumps.
Forest-Stage Successional Areas	240 (7.2%)	0.6 (0.3%)	A transitional community type between Old Field Successional and Beech-Birch-Maple-Hemlock approximately 5 to 25 years old. Viburnums (*Viburnum triloba, v. acerifolium, v. recognitum*); pin and choke cherries (*Prunus pensylvanica, P. virginiana*); hawthorne (*Crataegus* spp.); and quaking aspen (*Populus tremuloides*) dominate the younger forest areas. Older forest stands include white and green ash (*Fraxinus americana and F. pennsylvanica*) and black locust (*Robinia psuedoacacia*).
Industrial	310 (9.3%)	180 (82%)	
Wet Meadows	60 (1.8%)	2.8 (1.3%)	
Emergent Marshes and Pond Fringes	60 (1.8%)	1.4 (0.6%)	
Lakes and Ponds	160 (4.8%)	0.2 (0.1%)	
Shrub Swamps	3 (0.1%)	0	
Forested Swamps	9 (0.3%)	0	
Fens	4 (0.1%)	0	
Bogs	0.25 (<0.1%)	0	

a. To convert acres to hectares, multiply by 0.4047.
b. Percent acreage may not equal 100 percent because of rounding.

Source: WVNS (1994b)

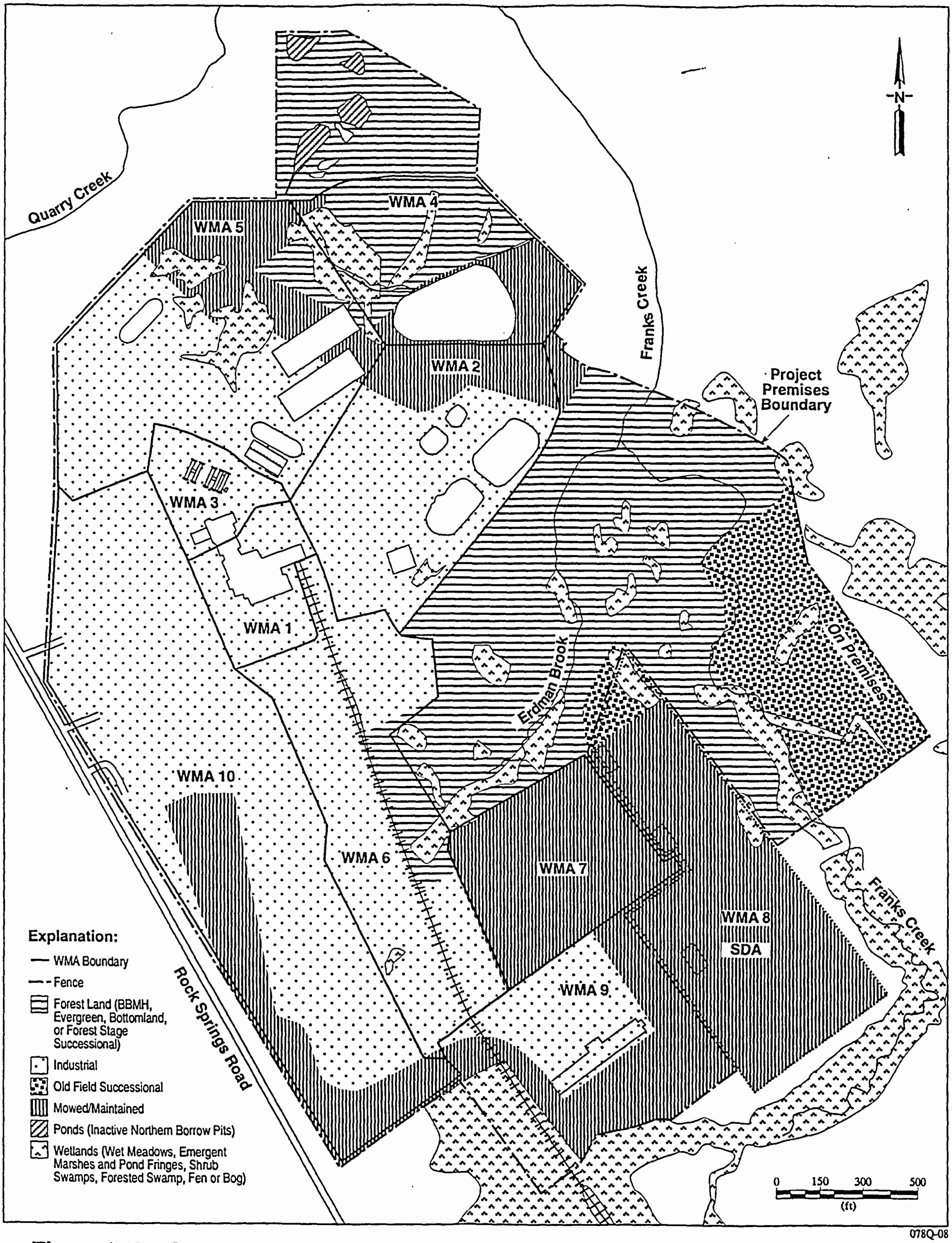


Figure 4-17. General Vegetation Types and Wetland Distribution on the Project Premises and the State-Licensed Disposal Area (modified from Dames & Moore 1993).

Table 4-10. **Common Birds and Mammals at the Western New York Nuclear Service Center**

Common Name	Scientific Name	Residency
	Birds	
American goldfinch	*Carduelis tristis*	summer
American tree sparrow	*Spizella arborea*	migrant
American robin	*Turdus migratorius*	summer
American crow	*Corvus brachyrhynchos*	permanent
Bay-breasted warbler	*Denroica castanea*	migrant
Belted kingfisher	*Megaceryle alcyon*	summer
Black-capped chickadee	*Parus utricapillus*	permanent
Blue jay	*Cyanocitta cristata*	permanent
Canada goose	*Branta canadensis*	migrant
Cedar waxwing	*Bombycilla cedrorum*	summer
Chipping sparrow	*Spizella passerina*	summer
Common grackel	*Quiscalus quiscula*	summer
Common merganser	*Merqus merganser*	migrant
Downy woodpecker	*Picoides pubescens*	permanent
Eastern bluebird	*Sialia sialis*	summer
Eastern phoebe	*Sayornis phoebe*	summer
European starling	*Sturnus vulgaris*	permanent
Fox sparrow	*Passerella iliaca*	migrant
Great horned owl	*Bubo virginianus*	permanent
Great blue heron	*Ardeu herodias*	summer
House wren	*Troglodytes troglodytes*	summer
Killdeer	*Churadrius vociferus*	summer
Least flycatcher	*Empidonax minimus*	summer
Mallard	*Anas platyrhynchos*	migrant
Mourning dove	*Zenaida macroura*	summer
Northern cardinal	*Cardinalis cardinalis*	permanent

Table 4-10. **Common Birds and Mammals at the Western New York Nuclear Service Center (Continued)**

Common Name	Scientific Name	Residency
	Birds (Continued)	
Pine siskin	*Carduelis pinus*	visiting
Red-tailed hawk	*Buteo jamaicensis*	permanent
Rock dove	*Columba livia*	permanent
Ruby-throated hummingbird	*Archilochus colubris*	summer
Ruffled grouse	*Pipilo erythrophthalmus*	permanent
Snow bunting	*Plectorphenax nivalis*	visiting
Song sparrow	*Melospiza melodia*	summer
Tree swallow	*Tridoprocne hicolor*	summer
Tundra swan	*Olor columbianus*	migrant
White-breasted nuthatch	*Sitta carolinesis*	permanent
White-throated sparrow	*Zonotrichia albicollis*	migrant
Wood duck	*Aix sponsa*	migrant
Yellow warbler	*Dendroican petechia*	summer
	Mammals	
Beaver	*Castor canadensis*	permanent
Eastern chipmunk	*Tamias striatus*	permanent
Gray squirrel	*Sciurus carolinensis*	permanent
Groundhog	*Marmota monax*	permanent
Meadow jumping mouse	*Zapus hudsonius*	permanent
Opossum	*Didelphis virginiana*	permanent
Raccoon	*Procyon lotor*	permanent
Red squirrel	*Tamiasciurus hudsonicus*	permanent
Striped skunk	*Mephistis mephitis*	permanent
Whitetail deer	*Odocoileus virginianus*	permanent

Source: WVNS (1994b)

4.6.2 Federal and State Threatened and Endangered Species

No federal threatened, endangered, or candidate species or critical habitat are known to occur on the Center (FWS 1991, 1992, 1994; WVNS 1994b).

One State threatened bird species, the northern harrier (*Circus circus*), has been observed on the Center (WVNS 1994b). Seven bird species listed as species of special concern have been observed on the Center (Table 4-11). Most of these birds are summer residents. Thirteen other State-listed animal species described in WVNS (1994b) may frequent the area because it is within their range; however, they have not been observed at the Center.

Of the plant species, one State Endangered species, one State Threatened species, and four state rare species have been observed (Table 4-11). Over 100 individual Rose Pink plants, a State Endangered species, were found on the east face of the south reservoir dam, which is part of the Project Premises. This plant species has not been proposed for inclusion on the Federal list of threatened and endangered species (BNA 1995). Thirty-one New York State exploitably vulnerable species, which have no legal protection, and three species that may be listed by the State in the future (unprotected species) have also been observed (Table 4-11). One unprotected species (Rafinesque's pondweed) is found on the Project Premises (WVNS 1994b).

4.6.3 Aquatic Ecology

Aquatic biota at the Center are typical of streams in the area (WVNS 1994b). The occurrence and diversity of species on the site depend on the physical environment, such as flow rate, temperature, and sunlight.

Diatoms (Bacillariophyceae) and green algae (Chlorophyceae) are the dominant free-floating algae (phytoplankton) in the streams, ponds, and reservoirs. Diversity is greatest in the streams and lowest in the ponds. Phytoplankton in Franks Creek and Erdman Brook were not estimated, and the water current was too slow to obtain reliable samples in Quarry Creek. Bottom-dweller (benthic) diversity was greatest in the streams and lowest in reservoirs. The most common benthic invertebrates of the streams were larvae of various flies (e.g., mayfly, midge, cranefly, caddisfly, and dragonfly). No invertebrates were observed in the north reservoir and only midge larvae and tubified worms (oligochaetes) were found in the south reservoir. Midge, caddisfly, and dobsonfly larvae were found in small ponds. The distribution and diversity of invertebrates in the streams, ponds, and reservoirs are typical of similar freshwater bodies in western New York State.

Vertebrate species observed in the creeks on the Center include blacknosed dace (*Rhinichthys atratulus*), shiners (*Notropis* spp.), white suckers (*Catostomus commersoni*), creek chub (*Semotilus atromaculatus*), northern hogsuckers (*Hypentelium nigricans*), sunfish (*Lepomis* spp.), and largemouth bass (*Micropterus salmoides*). Three other species, mottled sculpins (*Cottus biardi*), fantail darters (*Etheostoma flabellare*), and brown trout (*Salmo trutta*), have only been observed in Quarry Creek.

Table 4-11. New York State Threatened, Endangered, Rare, Exploitably Vulnerable, and Species of Special Concern—Birds and Plants Observed on the Western New York Nuclear Service Center

Common Name	Scientific Name	Status[a]
	Birds	
Northern harrier	*Circus circus*	Threatened
Cooper's hawk	*Accipiter cooperii*	SSC
Henslow's sparrow	*Ammodramus henslowii*	SSC
Common nighthawk	*Chordeiles minor*	SSC
Northern raven	*Corvus corax*	SSC
Common loon	*Gavia immer*	SSC
Vesper sparrow	*Pooecetes gramineus*	SSC
Eastern bluebird	*Sialia sialis*	SSC
	Plants	
Rose pink	*Sabatia angularis*	Endangered
Round-leaved bittercress	*Cardamine rotundifolia*	Threatened
Houghton's sedge	*Carex houghtonii*	Rare
Meadow horsetail	*Equisetum pratense*	Rare
Small-flowered agrimony	*Agrimonia Parviflora*	Rare
Jack pine	*Pinus banksiana*	Rare
Few-fruited sedge	*Carex eligocarpa*	US
Rafinesque's pondweed	*Potomog eten diversifolius*	US
Black-eyed Susan	*Rudbeckia hirta*	US
N. maidenhair fern	*Adiantum pedatum*	EV
Bradley's spleenwort	*Asplenium bradleyi*	EV
Rattlesnake fern	*Botrychium virginianum*	EV
Crested fern	*Dryopteris cristata*	EV
Oak-fern	*Dryopteris dryopteris*	EV
Goldie's fern	*Dryopteris goldiana*	EV
Shield fern	*Dryopteris simuulata*	EV
Long-bracted orchid	*Habenaria virdis v.bracteata*	EV
Staghorn clubmoss	*Lycopodium clvatum*	EV
Running groundpine	*Lycopodium complanatum*	EV
Tree clubmoss	*Lycopodium obsurum*	EV

Table 4-11. New York State Threatened, Endangered, Rare, Exploitably Vulnerable, and Species of Special Concern—Birds and Plants Observed on the Western New York Nuclear Service Center (Continued)

Common Name	Scientific Name	Status[a]
	Plants (Continued)	
Tree clubmoss	*L. obscurum v.dendroideum*	EV
Ostrich fern	*Matteuccia struthiopteris*	EV
Round-leaved orchid	*Orchis rotundifolia*	EV
Cinnamon fern	*Osmunda cinnamomea*	EV
Interrupted fern	*Osmunda claytoniana*	EV
Ginseng	*Panax quinquefolium*	EV
Virginia rockcap fern	*Polypodium virginianum*	EV
Gray polypody fern	*Polypodium vulgare*	EV
Christmas fern	*Polystichum acrostichoides*	EV
No common name	*Polystichum acrostichoides v. crispa*	EV
Gall-of-the-earth	*Prenanthes trifoliata*	EV
Bloodroot	*Sanguinaria canadensis*	EV
Ladies-tresses orchid	*Spiranthes plantagineum*	EV
Hooded Ladies' tresses	*Spiranthes romanzoffiana*	EV
Linear-leaved tresses	*Spiranthes vernale*	EV
New York fern	*Thelypteris noveboracensis*	EV
Swamp fern	*Theylpteris palustris*	EV
Long beech fern	*Thelypteris phegopteris*	EV
Red trillium	*Trillium erectum*	EV
Common trillium	*Trillium grandiflorum*	EV

a. SSC = species of special concern
US = unprotected species
EV = exploitably vulnerable.

Source: WVNS (1994b)

There is less fish diversity in the ponds and reservoirs, in which sunfish are the most common species, than in the creeks. Largemouth bass, shiners, and sunfish have been seen in the north reservoir; only sunfish have been seen in the south reservoir. Largemouth bass, shiners, and white crappie (*Pomoxis annularis*) live in the ponds.

4.6.4 Wetlands

Wetlands provide several environmental functions. They absorb, store, and slowly release rain and snowmelt water, which minimizes flooding, stabilizes water flow, and retards runoff erosion. Wetlands filter natural and manufactured pollutants by acting as natural biological and chemical oxidation basins. The nutrient byproducts reenter the freshwater food cycle. Wetlands are one of the most productive habitats for feeding, nesting, breeding, spawning, resting, and cover for fish and wildlife.

Wet meadows, emergent marshes and pond fringes, lakes and ponds, forested swamps, shrub swamps, bogs, and fens are plant communities on the Center identified as functional wetlands (WVNS 1994b). A wetland investigation and delineation conducted on 223 ha (550 acres) of the Center, including the 80-ha (200-acre) Project Premises and adjacent parcels to the north, south, and east, identified 51 areas as jurisdictional wetlands (Dames & Moore 1993). These wetlands range in size from 0.01 to more than 3.7 ha (0.3 to more than 9.2 acres). The total wetlands area is approximately 14 ha (35 acres).

The jurisdictional wetlands are palustrine (swamp) systems and meet either broad-leaved, deciduous-forested, emergent, or shrub vegetative life-form classifications. Eighteen wetlands, totalling about 3.7 ha (9.2 acres), were delineated within the 80-ha (200-acre) Project Premises. NYSDEC has determined that eight wetlands encompassing 8.1 ha (20 acres) on the south and east sides of the Project Premises and SDA are linked and meet the criteria for a single wetland (NYSDEC 1994).

Water sources that contribute to wetland formation at the Center include overland flow of precipitation, stream flooding, spring seepage, and stream bottoms. The linked wetland just south of the Project Premises partially results from a beaver dam. Other wetlands have developed on areas of long-term soil saturation caused by past land uses (e.g., ditching, farming, and utility construction) or because of natural geomorphic processes. Common plant species found in the wetlands include common cattail (*Typha* spp.), Canada rush (*Juncus canadensis*), sedges (*Carex* spp.), and willows (*Salix* spp.).

4.7 LAND USE AND VISUAL SETTING

This section describes current and projected land use within a 80-km (50-mi) radius of the Center, the projected land use in Cattaraugus and Erie Counties in the year 2000, and the visual setting of the Center and the WVDP. The Center is a 1,352-ha (3,340-acre) controlled area with limited public access. It was established in 1961 by the New York State Office of Atomic Development in response to the Atomic Energy Commission (AEC) program to encourage private reprocessing of irradiated nuclear fuel as part of its program to commercialize the entire nuclear fuel cycle (DOE 1978).

4.7.1 Current Land Use

Current land uses in the region within the 80-km (50-mi) radius of Center are categorized as agricultural, urban-residential, urban-commercial/industrial, recreational, water, or forest/wetlands/barren lands. The current land use at the site is categorized as commercial-industrial. The land uses at varying distances from the Center are shown in Table 4-12.

Land use in a 0.5-km (0.3-mi) radius surrounding the Center is 64 percent open space (former agricultural and natural lands) and 36 percent industrial. The industrial area is located within the Project Premises. Land within 10 km (6 mi) of the site is primarily agricultural and natural; the towns of Springville and West Valley constitute the urban percentage. Between 10 and 80 km (6 and 50 mi) from the site, land is also predominantly agricultural and natural. The percentage of urban land use increases north toward Buffalo and west along the Lake Erie shoreline. The recreational land use percentage increases to the south toward Allegheny State Park, and the water use percentage increases west toward Lake Erie (WVNS 1992b).

In 1991, approximately 95,100 ha (235,000 acres) of Cattaraugus County and 65,400 ha (164,000 acres) of Erie County were classified as agricultural land, which includes cropland, permanent pasture, woodland on farms, and land in house lots, ponds, and wasteland. Fifty-four percent [51,300 ha (126,700 acres)] of the agricultural land in Cattaraugus County and 75 percent [49,700 ha (122,900 acres)] in Erie County are cropland, with hay and cattle (primarily dairy cattle) being the most abundant crop and livestock in both counties. Corn for silage is the next most abundant crop raised. Table 4-13 summarizes farm animal population and crop estimates within a 5-km (3-mi) radius of the Center.

A total of 20,489 ha (50,629 acres) of federal land is reserved for the Seneca Nation of Indians and 466 ha (1,152 acres) is reserved for the Tuscarora Indians within an 80-km (50-mi) radius of the Center. These reservations are shown on Figure 1-1 in Chapter 1 and in Figure 5-12 in Chapter 5. This land is held in four reservations:

1. Allegheny Reservation—12,330 ha (30,469 acres), approximately 31 km (19 mi) south of the Center, includes Allegheny Reservoir and the City of Salamanca

2. Cattaraugus Reservation—8,055 ha (19,904 acres), approximately 24 km (15 mi) west-northwest of the Center, extends into Chautauqua County

3. Oil Springs Reservation—104 ha (256 acres), approximately 35 km (22 mi) southeast of the Center on the Cattaraugus-Allegany County border

4. Tonawanda Reservation—466 ha (1,152 acres), approximately 66 km (41 mi) north-northeast of the Center on the Erie-Genesee County border.

Table 4-12. Distribution of Current Land Use Surrounding the Western New York Nuclear Service Center[a,b]

Distance		Current Land Use (percentage)						
km	mi	Agricultural (acres)	Urban-Residential (acres)	Urban-Commercial/Industrial (acres)	Recreational (acres)	Water (acres)	Forest/Wetlands/Barren (acres)	Total Acreage (acres)
0 - 0.5	0 - 0.3	17.2	0	35.9	0	0	46.9	192
0.5 - 1	0.3 - 0.6	43.6	0	1.2	0	0	55.2	576
1 - 2	0.6 - 1.2	33.2	0	0	0	0.3	66.5	2,336
2 - 3	1.2 - 1.8	45.2	0	0	0	0.3	54.5	3,888
3 - 4	1.8 - 2.4	53.5	0	0	0	0.5	46.1	5,440
4 - 5	2.4 - 3	41.3	0	0	0	1.0	57.7	6,992
5 - 10	3 - 6	38.3	1.7	0.3	0	0.6	59.1	58,240
10 - 20	6 - 12	44.3	0.4	0.1	0	0.7	54.6	232,960
20 - 30	12 - 18	38.9	1.1	0.1	0	0.4	59.4	388,160
30 - 40	18 - 24	38.0	4.6	0.7	2.9	1.2	52.7	543,520
40 - 50	24 - 30	30.3	4.9	1.7	7.0	14.7	41.5	698,880
50 - 60	30 - 36	26.7	6.4	2.4	2.6	16	45.9	854,080
60 - 80	36 - 50	33	4.0	1.0	1.4	15.1	45.5	2,174,400
Total Acreage		1,649,715	207,687	57,586	116,555	577,094	2,361,027	4,969,664

a. To convert acres to hectares, multiply by 0.4047.
b. Data based on LANDSAT Thermatic Mapper Imagery.

Source: WVNS (1992b)

Table 4-13. Livestock and Crop Estimates within 5 kilometers (3 miles) of the Western New York Nuclear Service Center

	Sector															
	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
Number of Livestock																
Dairy, Beef Cattle	5	30	102	33	7	20	135[a]	0	0	188	100	2	0	130	3	65
Pigs	0	0	6	0	25	0	0	0	0	0	0	3	a	0	5	0
Horses	0	0	6	0	13	0	0	0	0	0	0	0	0	0	0	0
Goats, Sheep, Lambs	0	0	3	0	32	0	0	0	0	0	0	0	a	0	6	0
Chickens, Turkeys, Geese, Ducks	0	60	0	15	84	0	15	0	0	0	20	80	30[a]	23	0	35
Rabbits	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0
Acres of Crops[b]																
Corn	0	0	0	0	0	0	83	0	0	97[c]	0	0	0	152[c]	0	28
Hay & Pasture	0	90	400	50	30	100	330	0	0	116[c]	0	32	0	143[c,d]	0	110
Oats	0	0	0	0	0	0	34	0	0	97[c]	0	0	0	0	0	0
Fruit	e	0	0	0	f	0	0	g	0	0	h	0	0	0	0	0
Commercial Trees	0	0	0	0	0	0	0	0	0	0	100	4	0	0	0	0

a. Precise head count unknown.
b. To convert acres to hectares, multiply by 0.4047.
c. Acreage averaged between different crops.
d. More than the acreage value given.
e. Blueberries.
f. Grapes, blueberries, raspberries, and fruit trees (precise acreage unknown).
g. Apple trees (precise acreage unknown).
h. Grapes, strawberries (precise acreage unknown).

Source: WVNS (1992b)

4.7.2 Projected Land Use in the Year 2000

The planning commissions for Cattaraugus and Erie Counties forecasted their respective land use trends for the year 2000.

4.7.2.1 Cattaraugus County

The Cattaraugus County Land Use Plan (1978, revised 1982) (Cattaraugus County Planning Board 1978) envisions that agricultural land use will increase through reclamation of idle farmland. Growth near the Center is expected to occur in the towns of Yorkshire, Machias, and Ashford. The other towns near the site are expected to remain rural. Residential land use is expected to move outward from the communities of Olean, Allegany, Portville, Salamanca, and Franklinville. Commercial land use is expected to remain in the commercial centers of the county's villages, towns, and cities. New commercial businesses will concentrate in revitalized areas such as the Main Street renovation program in Salamanca. Industrial land use is expected to increase in Yorkshire Township (northeast Cattaraugus County). Recreation on the Allegheny River, approximately 32 km (20 mi) south of the Center, is expected to increase.

4.7.2.2 Erie County

The Erie and Niagara Counties Land Use Plan (Erie and Niagara County Regional Planning Board 1988) for the year 2000 envisions little growth other than that expected to occur within a 32-m (20-mi) radius of Buffalo, New York. Residential land use is expected to increase approximately 23 percent, with the greatest increases expected in the towns of Amherst, Cheektowaga, Grand Island, Hamburg, Orchard Park, and West Seneca. Commercial and public/semipublic land use is expected to increase 20 percent, and industrial land use is expected to increase 12 percent. The increases in residential, commercial, and industrial land use percentages will be absorbed by the expected 5-percent decrease in agricultural land and an expected 7-percent decrease in forested, recreational, and vacant land.

4.7.3 Visual Setting

The Center is located in the northwest-southeast trending valley of Buttermilk Creek and consists mainly of fields, forests, and the ravines of several tributaries to Buttermilk Creek. The Center is in a rural setting surrounded by farms, vacant land, and single homes. From distant northern hilltops, the site appears primarily as hardwood forest and would be indistinguishable from the surrounding countryside if the process building and main stack were not visible. From that distance, the process building resembles a factory building or power plant. Several public roads pass through the Center, including Rock Springs Road, Buttermilk Road, and Thomas Corners Road. The site boundary is marked along the roadsides by a barbed wire fence with regularly-spaced "POSTED" signs. Passers-by mainly see hardwood and hemlock forests, overgrown former farm fields, the southern end of the south reservoir bordered by pine trees and wet low areas. Figure 4-18 shows the

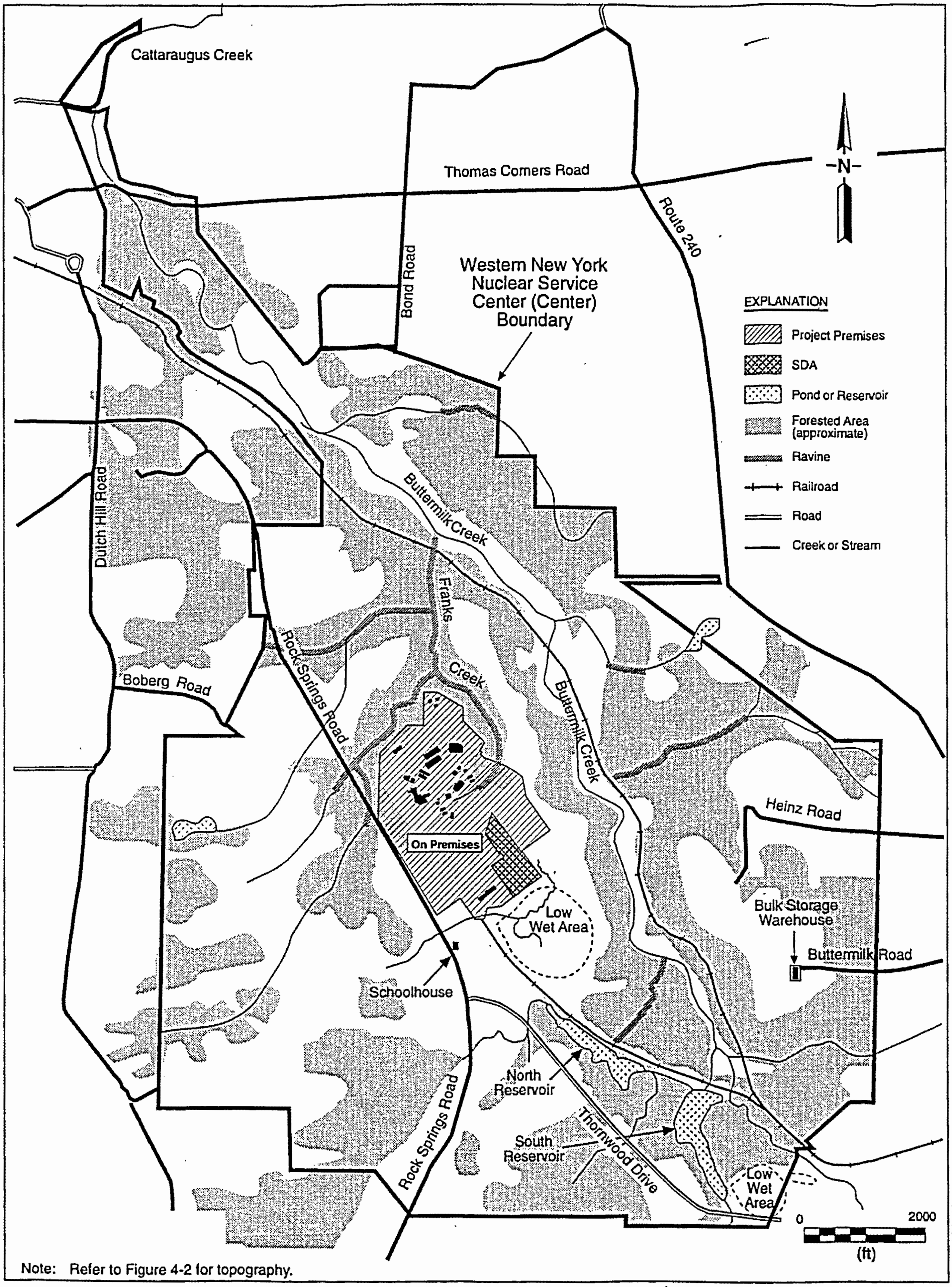


Figure 4-18. Visual Setting near the Western New York Nuclear Service Center.

approximate locations of ravines, forested areas, and low wet areas that can be seen from surrounding roads.

The WVDP is located on relatively flat plateaus located between Dutch Hill and Buttermilk Creek. The surrounding topography and forested areas block views of the WVDP from roadways; however, most of the WVDP on the Project Premises can be seen from hilltops along Route 240 (east of the Center). The WVDP and the north parking lot are temporarily shielded from Rock Springs Road by pine trees, but much of the WVDP can be seen from Rock Springs Road and Thornwood Drive when approaching from the south. The WVDP resembles an industrial complex, with two large paved parking lots outside the barbed wire-topped chain link security fence, the process building and stack, numerous construction trailers, several outdoor storage areas containing scrap material, warehouses, the large white tent-like lag storage areas, and covered roll-offs (large dumpsters). The SDA and the NDA are flat mowed areas, although a black impermeable cover has been installed on several of the SDA trenches. The entire WVDP is brightly lit at night by security lights.

4.8 SOCIOECONOMICS

This section presents the current socioeconomic characteristics of areas surrounding the Center. The characterization focuses on population, employment, earnings and income, housing, taxes, transportation, and public services. It presents recent historical information and projections on population, employment, and earnings. These characteristics are a baseline for the socioeconomic impact analysis presented in Chapter 5. The population information is also used to analyze the impacts from a release of hazardous material, including radionuclides, into the environment.

The Center is located primarily on the northern edge of central Cattaraugus County in western New York. A small portion of the Center is in the southern edge of central Erie County. These two counties are the residence for 95 percent of the WVDP employees. Cattaraugus County covers 3,393 km^2 (1,310 mi^2) and Erie County covers 2,706 km^2 (1,045 mi^2) (DOC 1994a). Buffalo is the major metropolitan center in the region and is located on the western central edge of Erie County, about 48 km (30 mi) from the site. The metropolitan Buffalo area dominates the socioeconomic factors in Erie County. Because of these considerations, the two counties are established as the region of influence (ROI) for this socioeconomic characterization and analysis.

Because most of the anticipated impacts would occur closer to the site rather than throughout the ROI, a primary impact area was also analyzed. The primary impact area is defined as the area within 20 km (12 mi) of the site. The primary impact area is located totally within the two-county ROI.

4.8.1 Population

Population characteristics are used to estimate the impacts of releases of hazardous materials, including radionuclides, to the environment and to estimate the socioeconomic impacts of alternative actions. The radiological impact assessment requires information on the nearest member of the public and the distribution of the population according to direction and distance from the site. The socioeconomic impact assessment only requires information about the total population in the two-county ROI and in the primary impact area.

The Center is located in a rural area and there is a very small population near the site. No members of the public reside within 1 km (0.6 mi) of the Project Premises and SDA. The nearest resident is 1.5 km (0.9 mi) to the north-northwest. The 1990 population in the primary impact area was 26,957. The population distribution is presented by town in Table 4-14 (WVNS 1992b). The table also shows the percent of Cattaraugus and Erie County population by city. The table shows similar total populations for Cattaraugus and Erie Counties in the primary impact area. However, the percent of county population reported in Erie County is smaller because the large population in the Buffalo area is outside the primary impact area. The 1990 population for the two-county ROI was 1,340,443. The distribution of the 1990 population in a 20-km (12-mi) radius from the site is presented in Figure 4-19.

Projected populations for the nation, the State, two-county ROI and the primary impact area are shown in Table 4-15. The projected average annual growth rates from 2000 to 2030 for the ROI and the primary impact area are 0.13 percent and 0.11 percent, respectively. These are slightly lower than the average growth for New York State (0.16 percent). Both of these rates are lower than the projected average annual rate for the United States, which is 0.35 percent over 30 years.

The number of minority residents and percentage of population in the ROI and primary impact area are shown in Table 4-16. The ROI and primary impact area racial composition is predominately white (87 and 98.5 percent, respectively) and the percent minority population is less than that for the State of New York (74.5 percent).

4.8.2 Employment

Employment is an important determinant in socioeconomic conditions and changes in employment will have socioeconomic impact. The WVDP is the largest local employer. As of June 30, 1993, the Center employed 1,054 people, including 881 WVNS employees and 173 other site positions (Dames & Moore, APS security, contract employees, DOE personnel, and NYSERDA). A typical staff breakdown by function for a WVNS staff level of 950 is shown in Table 4-17 (WVNS 1994e). Direct employment at the Center produces indirect employment in the primary impact area and ROI. Based on the analysis presented in Appendix I, the indirect employment from 950 jobs would be approximately 20 jobs in the primary impact area and 20 jobs in the ROI.

Table 4-14. Percent Estimate of Population within the Primary Impact Area, 1990 Population

County/Town	1990 Population	Percent of County Population
Cattaraugus County	84,234	100.0
Ashford	2,162	2.6
Ashford Hollow[a]	500	0.6
Delevan	1,214	1.4
East Otto	1,003	1.2
Lime Lake[a]	500	0.6
Machias	2,338	2.8
Riceville[a]	500	0.6
West Valley	600	0.7
Yorkshire	3,905	4.6
Rural Areas in Primary Impact Area	2,104	2.5
Total Cattaraugus Primary Impact Area	14,826	17.6
Erie County	968,532	100.0
Chaffee[a]	500	0.1
Glenwood[a]	500	0.1
Sardinia	2,667	0.3
Springville	4,310	0.4
Rural Areas in Primary Impact Area	4,154	0.4
Total Erie Primary Impact Area	12,131	1.3
Total Primary Impact Area	26,957	2.6

a. Estimated. Located within 20 km (12 mi) of site according to 1994 Business Traveler's Road Atlas, Rand McNally.

Source: DOC (1992a), WVNS (1992b).

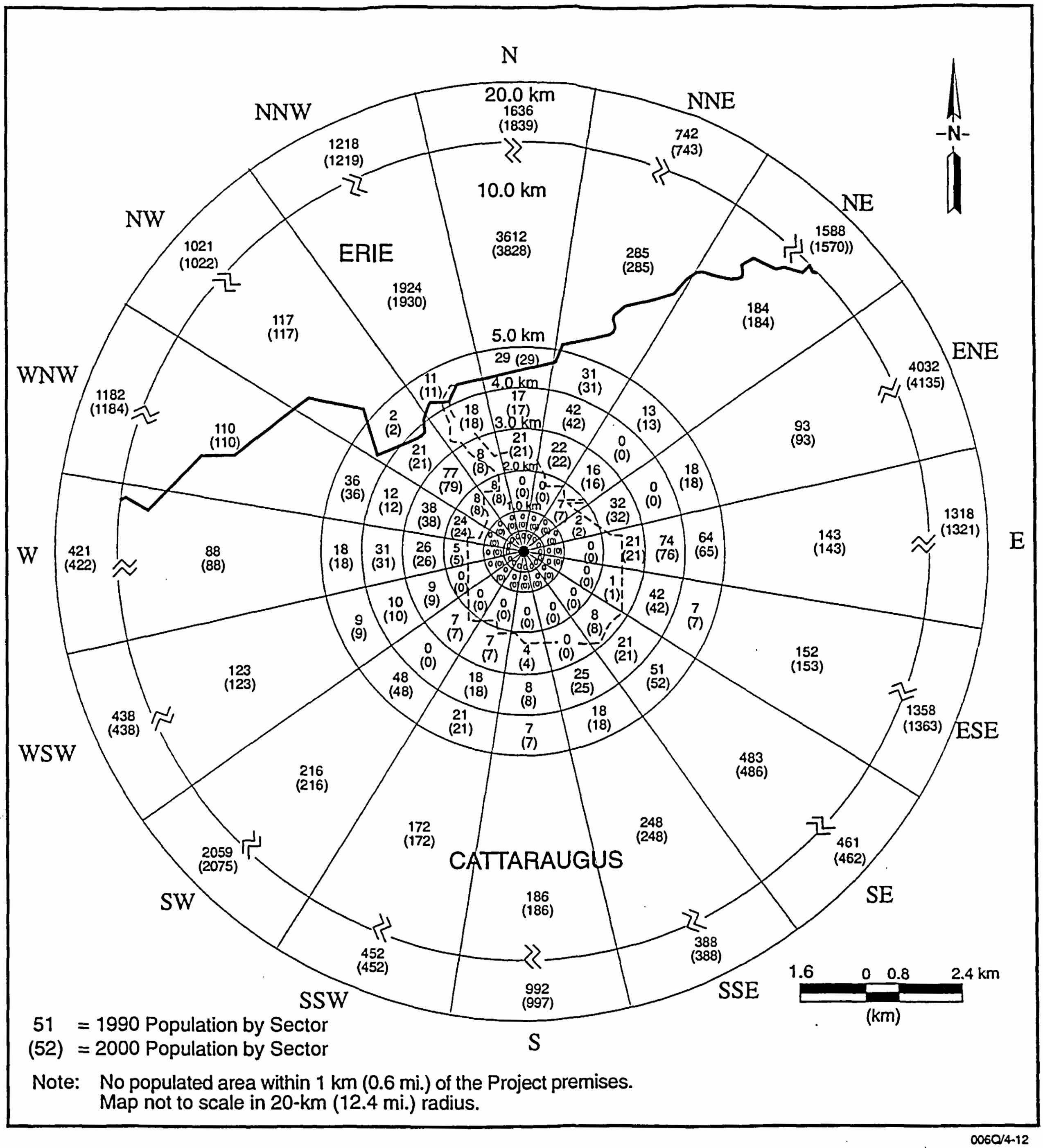


Figure 4-19. 1990 Population and Projected Population (2000) Density by Compass Direction within a 20-kilometer (12-mile) Radius (modified from WVNS 1992b).

Table 4-15. Yearly Projected Economic and Demographic Indicators

Region/Indicator	1992	Projected 1995	2000	2010	2020	2030	Average Annual Growth 1992-2000	2000-2030
UNITED STATES:								
Population	255,077,500	260,836,700	269,024,000	283,437,400	295,312,400	299,037,500	0.67%	0.35%
Employment	139,289,100	144,353,400	151,803,800	158,988,500	156,180,000	153,566,100	1.08%	0.04%
Earnings per Worker (1987$)	21,413	21,938	22,848	24,824	27,016	29,402	0.81%	0.84%
Per Capita Income (1987$)	16,227	16,872	17,892	19,462	20,658	22,297	1.23%	0.74%
NEW YORK:								
Population	18,109,500	18,264,300	18,462,100	18,906,400	19,377,300	19,398,100	0.24%	0.16%
Employment	9,465,985	9,685,967	9,990,705	10,170,190	9,812,635	9,527,717	0.68%	-0.16%
Earnings per Worker (1987$)	27,093	27,697	28,763	31,154	33,851	36,798	0.75%	0.82%
Per Capita Income (1987$)	19,447	20,211	21,365	23,151	24,577	26,525	1.18%	0.72%
CATTARAUGUS COUNTY, NY:								
Population	85,700	86,100	86,500	87,600	89,200	88,900	0.12%	0.09%
Employment	39,468	40,255	41,362	41,865	40,355	39,077	0.59%	-0.19%
Earnings per Worker (1987$)	16,964	17,234	17,776	19,066	20,550	22,282	0.59%	0.76%
Per Capita Income (1987$)	12,060	12,483	13,134	14,131	14,939	16,094	1.07%	0.68%
ERIE COUNTY, NY:								
Population	972,300	981,200	988,300	1,006,500	1,028,100	1,027,800	0.20%	0.13%
Employment	526,898	539,070	556,232	566,648	546,708	530,751	0.68%	-0.16%
Earnings per Worker (1987$)	20,976	21,256	21,831	23,256	25,043	27,104	0.50%	0.72%
Per Capita Income (1987$)	15,979	16,499	17,359	18,676	19,745	21,258	1.04%	0.68%
REGION OF INFLUENCE:								
Population	1,058,000	1,067,300	1,074,800	1,094,100	1,117,300	1,116,700	0.20%	0.13%
Employment	566,366	579,325	597,594	608,513	587,063	569,828	0.67%	-0.16%
Earnings per Worker (1987$)	20,697	20,977	21,550	22,968	24,734	26,773	0.51%	0.73%
Per Capita Income (1987$)	15,662	16,175	17,019	18,312	19,361	20,847	1.04%	0.68%
PRIMARY IMPACT AREA:								
Population	27,723	27,909	28,072	28,502	29,065	29,008	0.16%	0.11%
Employment	13,796	14,093	14,511	14,735	14,210	13,777	0.63%	-0.17%
Earnings per Worker (1987$)	18,956	19,234	19,796	21,160	22,797	24,697	0.54%	0.74%
Per Capita Income (1987$)	13,847	14,319	15,068	16,218	17,149	18,472	1.06%	0.68%

Source: DOC (1992b, 1992c)

Table 4-16. Minority Individuals in the Region of Influence and Primary Impact Area in 1990

	Primary Impact Area	Region of Influence	State of New York
Number of Block Groups Considered	27	1,586	NA[a]
Individuals Residing in Area	29,723	1,573,847	17,990,455
Minority Individuals Residing in Area	451	198,185	6,819,224
Percent Minority Individuals	1.5	13	38

a. NA = not available.

Table 4-17. Current Staffing Levels[a]

Category	1993 Level
Engineering	308
Project Administration	30
Quality Assurance	42
Financial and Purchasing	65
Human Resources	43
Radiation and Safety	57
Safeguards and Security	36
Analytical Chemistry	60
Environmental	97
Maintenance and Modification	45
Operations	167
Total	950

a. As of June 1993, WVNS employed 881 people. This table shows a typical breakdown of employees by function.

Source: WVNS (1994e)

After completing HLW solidification, the staffing level for the WVDP is expected to decrease unless staffing is required to implement a long-term site management alternative. If a long-term site management alternative were not implemented, the staffing at the WVDP is expected to decrease a little before the year 2000, with the major decrease occurring during the years 2000 through 2004. By the year 2005, there would be no direct site employment associated with the WVDP HLW solidification. This staff reduction results from completing HLW solidification, is the baseline for socioeconomic analysis and presented as

Alternative V, Discontinue Operations. Eliminating the WVDP staff would also eliminate the indirect jobs in the primary impact area and ROI.

Recent information on the historical and predicted employment for the nation, the State, Cattaraugus and Erie Counties, the ROI, and the primary impact area are presented in Table 4-15. Employment is projected by the Department of Commerce to grow at an average annual rate of approximately 0.65 percent in both the ROI and primary impact area from 1992 to 2000. Employment is expected to continue to grow until 2010, when it is projected to decline slightly. The table shows minor annual average employment increases (0.6 to 1 percent over the balance of the decade) predicted until the year 2000. The projected increases for the State, the ROI and the primary impact area are about the same and a little less than that projected for the U.S. Small decreases are projected after 2010. The projected annual average decreases are again similar for the State, the ROI and the primary impact area (an annual average decrease of 0.16 percent), which is slightly more than the decrease projected for the U.S.

It is not known whether Department of Commerce estimates for employment specifically include the effects of the end of HLW solidification, which will be completed around the year 2000. Figure 4-20 shows employment in the primary impact area. The top line represents the Department of Commerce estimate of employment and the bottom line shows the effect of employment reductions after HLW solidification, assuming these staff reductions were not considered in the Department of Commerce estimates. The bottom line shows a decrease in employment in the primary impact area of about 2 percent (about 300 jobs lost out of 14,000) per year for 3 years until there is a total reduction of about 950 jobs. This reduction of direct employment resulting from completing HLW solidification is expected to result in a loss of about 7 percent of the jobs in the primary impact area. An estimated 20 indirect jobs in the primary impact area would be lost in the same time frame.

Recent information on the distribution of employment by industry sector for the U.S., New York, Cattaraugus and Erie Counties, the ROI, and the primary impact area is shown in Table 4-18. For all the regions, services employ the largest number of workers (27.78 percent in Cattaraugus to 33.75 percent in New York). In every region except Cattaraugus County, the retail trade employs the second largest number of workers (13.99 percent in New York and 18.92 percent in Erie County). In Cattaraugus County, manufacturing is the second largest employer (19.08 percent), followed by retail trade (17.98 percent), and State and local governments (15.86 percent). It is expected that this distribution of jobs will continue for the foreseeable future.

The trend in unemployment rates in Cattaraugus and Erie Counties is shown in Table 4-19. The table also shows unemployment rates for the Buffalo-Niagara Falls Metropolitan Statistical Area, New York, and the U.S. The Buffalo-Niagara Falls Metropolitan Statistical Area includes Erie and Niagara Counties. Unemployment rates tend to be higher in Cattaraugus County than Erie County, which in turn tends to have higher rates than New York (although this relationship does not always hold). The general pattern of slightly higher regional unemployment is expected to continue.

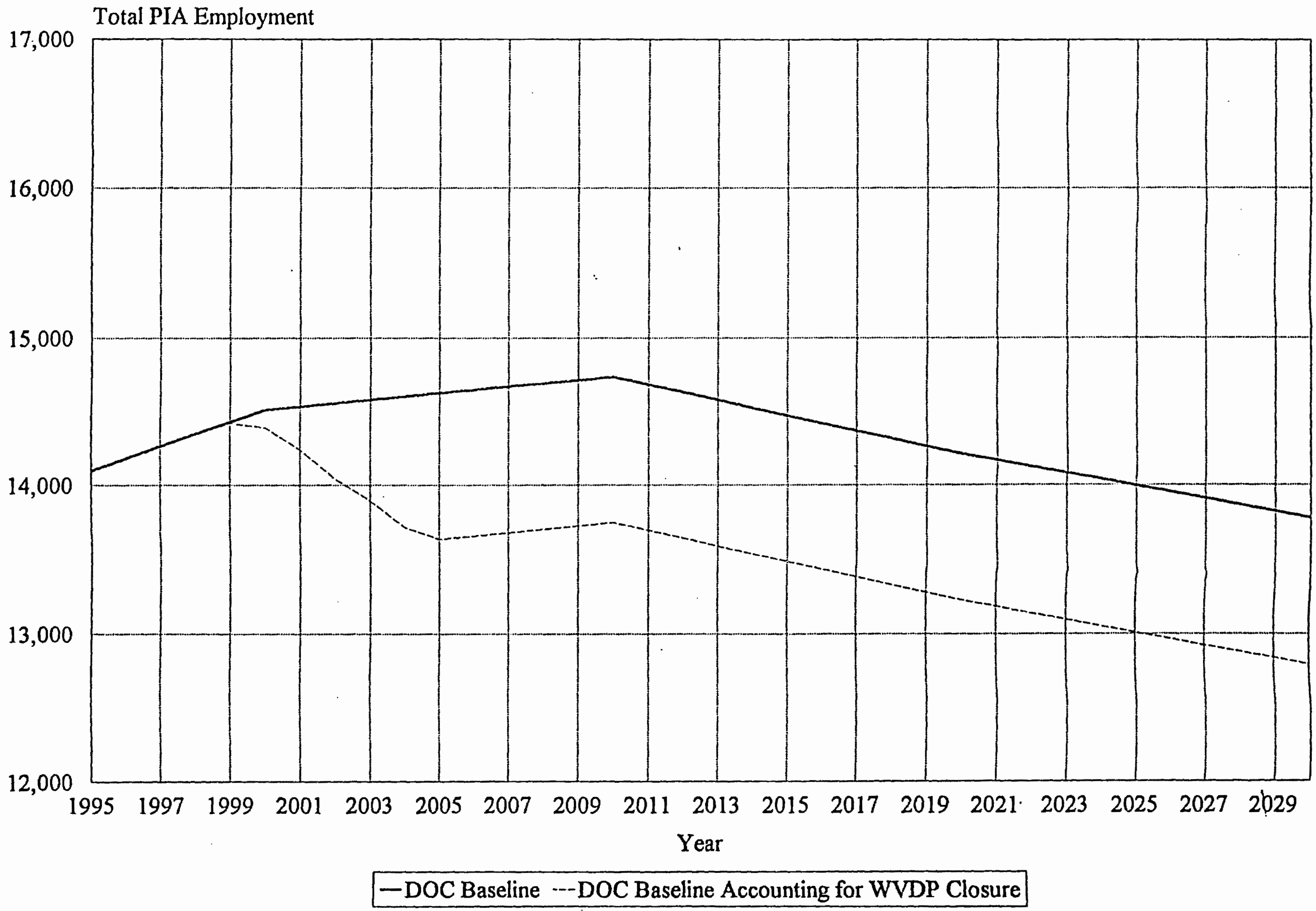


Figure 4-20. Projected Total Employment in the Primary Impact Area.

Table 4-18. 1992 Employment by Industrial Sector

Sector	United States Number Employed	United States Percent of Employment	New York Number Employed	New York Percent of Employment	Cattaraugus County Number Employed	Cattaraugus County Percent of Employment	Erie County Number Employed	Erie County Percent of Employment	Region of Influence Number Employed	Region of Influence Percent of Employment	Primary Impact Area Number Employed	Primary Impact Area Percent of Employment
Farming	3,034,000	2.18	64,163	0.68	1,592	4.04	2,098	0.40	3,690	0.65	307	2.23
Private												
Agricultural Services, Forestry, Fisheries, and Other	1,493,500	1.07	53,405	0.56	292	0.74	2,856	0.54	3,148	0.56	89	0.65
Mining	950,600	0.68	10,123	0.11	266	0.67	587	0.11	853	0.15	54	0.39
Construction	6,612,700	4.75	348,620	3.68	1,276	3.23	21,275	4.04	22,551	3.98	501	3.63
Manufacturing	18,680,200	13.41	1,043,914	11.03	7,531	19.08	72,711	13.80	80,242	14.17	2,271	16.46
Transportation and Public Utilities	6,586,900	4.73	456,954	4.83	1,236	3.13	23,190	4.40	24,426	4.31	519	3.76
Wholesale Trade	6,655,600	4.78	460,998	4.87	1,145	2.90	26,859	5.10	28,004	4.94	551	3.99
Retail Trade	23,014,300	16.52	1,324,595	13.99	7,095	17.98	99,662	18.92	106,757	18.85	2,544	18.44
Finance, Insurance, and Real Estate	10,576,000	7.59	1,034,122	10.93	1,294	3.28	38,423	7.29	39,717	7.01	727	5.27
Services	40,234,300	28.89	3,195,128	33.75	10,964	27.78	163,975	31.12	174,939	30.89	4,061	29.44
Government and Government Enterprises												
Federal Civilian	3,172,000	2.28	156,088	1.65	266	0.67	9,130	1.73	9,396	1.66	166	1.20
Military	2,618,000	1.88	83,498	0.88	253	0.64	3,258	0.62	3,511	0.62	87	0.63
State and Local Governments	15,661,000	11.24	1,234,377	13.04	6,258	15.86	62,874	11.93	69,132	12.21	1,919	13.91
TOTAL PERCENT OF EMPLOYMENT		100.00		100.00		100.00		100.00		100.00		100.00
TOTAL EMPLOYMENT	139,289,100		9,465,985		39,468		526,898		566,366		13,796	

Source: DOC (1994b)

Table 4-19. Unemployment Rates for the United States, New York, Buffalo-Niagara Falls Metropolitan Statistical Area, and Cattaraugus and Erie Counties, 1970-1993

Year	United States (percent)	New York (percent)	Buffalo Niagara Falls Metropolitan Statistical Area (percent)	Cattaraugus County (percent)	Erie County (percent)
1970	4.9	4.5	NA	NA	NA
1975	8.5	9.5	10.8	NA	NA
1980	7.1	7.5	9.7	8.6	9.5
1981	7.6	7.6	9.5	NA	NA
1982	9.7	8.6	12.7	11.0	12.0
1983	9.6	8.6	12.0	NA	NA
1984	7.5	7.2	9.0	NA	NA
1985	7.2	6.5	7.6	NA	NA
1986	7.0	6.3	7.5	8.8	7.2
1987	6.2	4.9	5.8	6.5	5.6
1988	5.5	4.2	NA	NA	NA
1989	5.3	5.1	6.0	7.3	5.8
1990	5.5	6.9	7.0	7.6	7.0
1991	6.7	7.2	6.2	9.2	6.8
1992	7.4	8.5	7.5	9.9	7.3
1993	6.8	7.7	NA	NA	NA

a. NA = Not available

Sources: Nelson A. Rockefeller Institute of Government (1991, 1994), DOC (1983, 1993b, 1994a)

4.8.3 Earnings and Income

The current and projected growth in real per capita income and average annual earnings per worker from 1992 through 2030 are shown in Table 4-15 for the U.S., New York, Cattaraugus and Erie Counties, the ROI, and the primary impact area. Real per capita income (not including inflation) is projected to grow at an average annual rate of more than 1 percent for all regions between 1992 and 2000. Annual earnings per worker are expected to grow only 0.5 percent in the ROI and primary impact area, which is lower than the growth anticipated for New York and the U.S.

The Center contributes to the economic condition of the region through the wages it pays and the goods and services it purchases. In Fiscal Year 1992, the Center paid $29.7 million for base annual salaries. Of this, $7.94 million was paid to employees who live in Cattaraugus County and $21.72 million was paid to employees who live in Erie County (Green 1993). In Fiscal Year 1992, Center also purchased $13.5 million in goods and services from firms in Cattaraugus County ($1.62 million) and firms in Erie County ($11.88 million). These wage expenditures represented less than 0.2 percent of the earnings income for the ROI, and the goods and services expenditures represent less than 0.13 percent of the income of the ROI. The portion of wage expenditure in the primary impact area is expected to be a greater fraction of the earnings than in the ROI. It is estimated that about 5 percent of the primary impact area earnings derive from the WVDP.

The 1992 average annual earnings by industrial sector are shown in Table 4-20 for the U.S., New York, Cattaraugus and Erie Counties, the ROI, and the primary impact area. The highest average earnings in the ROI are in manufacturing ($39,535), followed by federal civilian employment ($38,178), transportation and public utilities ($36,891), and State and local governments ($32,761).

In 1991, the average annual salary at the Center for technical personnel was $31,179. Drafting personnel earned approximately $34,653, and experienced engineering staff earned $51,500. Overall average earnings at WVNS (including base payroll, WVNS employees only, staff of 795) were approximately $39,600 in April 1993 (WVNS 1992b, Green 1993). These salaries are comparable to appropriate averages for similar skill areas in the ROI.

Median family income and numbers of households above and below poverty status in the ROI and the primary impact area for 1993 are given in Table 5-45 in Chapter 5, in the discussion of environmental justice.

4.8.4 Housing

The housing trends for the ROI and primary impact area from 1970 to 1990 are shown in Table 4-21. The housing stock has grown at a faster rate in Cattaraugus County (1.57 percent) than Erie County (0.56 percent) over this period. However, Erie County housing stock accounted for 91.6 percent of the housing in the ROI in 1990. Most of the homes in the ROI are single family units (56.90 percent in 1990), but mobile homes had the fastest growth rate, with an average annual rate of 8.41 percent between 1970 and 1990. In

Table 4-20. Average 1992 Earnings Per Job by Industrial Sector (Dollars)

Sector	United States	New York	Cattaraugus County	Erie County	Region of Influence	Primary Impact Area
Farming	16,485	11,822	12,205	16,005	14,366	12,560
Private						
Agricultural Services, Forestry, Fisheries, and Other	16,114	19,998	11,161	15,618	15,204	12,955
Mining	36,480	26,123	17,989	19,349	18,925	18,333
Construction	29,171	33,770	19,578	30,039	29,447	25,359
Manufacturing	36,923	42,033	29,879	40,535	39,535	34,310
Transportation and Public Utilities	37,270	41,694	28,585	37,334	36,891	33,667
Wholesale Trade	35,379	42,505	23,280	29,550	29,294	27,240
Retail Trade	15,354	17,046	11,808	13,797	13,665	12,823
Finance, Insurance, and Real Estate	25,277	50,573	17,264	25,436	25,170	22,884
Services	24,771	30,408	19,096	21,487	21,337	20,353
Government and Government Enterprises						
Federal Civilian	38,789	40,540	36,891	38,216	38,178	37,729
Military	19,761	13,975	7,874	9,695	9,564	8,747
State and Local Governments	27,517	33,890	26,016	33,433	32,761	29,171
AVERAGE EARNINGS	26,531	33,568	21,019	25,989	25,643	23,487

Source: DOC (1994b, 1994c)

Table 4-21. Household Population and Housing Stock for 1970, 1980, and 1990

Region/Year/Percent Growth Rate	Population	Total Units	Single Family	Multifamily	Mobile Homes	Occupied Units	Vacant Units	Seasonal Units	Vacancy Rates (percent)	Persons Per Unit
UNITED STATES:										
1970	203,798,700	67,656,566	46,941,653	18,864,501	1,850,412	63,449,747	3,446,582	760,237	5.1	3.21
1980	227,255,000	86,758,717	57,182,605	25,160,138	4,415,974	80,389,673	6,369,044	2,614,650	7.3	2.83
1990	249,399,300	102,263,678	65,761,652	27,981,017	8,521,009	91,947,410	10,316,268	3,081,923	10.1	2.71
Annual Change: 1970-80	1.10	2.52	1.99	2.92	9.09	2.39	6.33	13.15	3.72	-1.25
1980-90	0.93	1.66	1.41	1.07	6.79	1.35	4.94	1.66	3.23	-0.43
1970-90	1.01	2.09	1.70	1.99	7.93	1.87	5.63	7.25	3.48	-0.84
NEW YORK:										
1970	18,271,600	6,152,263	2,487,489	3,592,488	72,286	5,913,861	180,216	58,186	2.9	3.09
1980	17,565,300	6,699,084	3,096,438	3,483,229	119,417	6,340,429	311,289	47,366	4.6	2.77
1990	18,001,600	7,226,891	3,231,127	3,693,005	302,759	6,639,322	374,944	212,625	5.2	2.71
Annual Change: 1970-80	-0.39	0.86	2.21	-0.31	5.15	0.70	5.62	-2.04	4.72	-1.09
1980-90	0.25	0.76	0.43	0.59	9.75	0.46	1.88	16.20	1.11	-0.22
1970-90	-0.07	0.81	1.32	0.14	7.42	0.58	3.73	6.69	2.90	-0.65
CATTARAUGUS COUNTY:										
1970	82,200	26,970	19,868	5,724	1,378	24,878	724	1,368	2.7	3.30
1980	85,800	31,678	22,890	6,129	2,659	29,280	1,917	481	6.1	2.93
1990	84,400	36,839	24,636	6,435	5,768	30,456	2,413	3,970	6.6	2.77
Annual Change: 1970-80	0.43	1.62	1.43	0.69	6.79	1.64	10.23	-9.92	8.47	-1.18
1980-90	-0.16	1.52	0.74	0.49	8.05	0.39	2.33	23.50	0.79	-0.56
1970-90	0.13	1.57	1.08	0.59	7.42	1.02	6.20	5.47	4.56	-0.87
ERIE COUNTY:										
1970	1,115,800	359,384	186,812	170,689	1,883	346,374	7,548	5,462	2.1	3.22
1980	1,014,000	387,296	218,782	165,628	2,886	365,217	21,028	1,051	5.4	2.78
1990	968,900	402,131	225,152	166,360	10,619	376,994	23,449	1,688	5.8	2.57
Annual Change: 1970-80	-0.95	0.75	1.59	-0.30	4.36	0.53	10.79	-15.19	9.96	-1.46
1980-90	-0.45	0.38	0.29	0.04	13.91	0.32	1.10	4.85	0.72	-0.78
1970-90	-0.70	0.56	0.94	-0.13	9.03	0.42	5.83	-5.70	5.24	-1.12
REGION OF INFLUENCE:										
1970	1,198,000	386,354	206,680	176,413	3,261	371,252	8,272	6,830	2.1	3.23
1980	1,099,800	418,974	241,672	171,757	5,545	394,497	22,945	1,532	5.5	2.79
1990	1,053,300	438,970	249,788	172,795	16,387	407,450	25,862	5,658	5.9	2.59
Annual Change: 1970-80	-0.85	0.81	1.58	-0.27	5.45	0.61	10.74	-13.88	9.85	-1.45
1980-90	-0.43	0.47	0.33	0.06	11.44	0.32	1.20	13.96	0.73	-0.74
1970-90	-0.64	0.64	0.95	-0.10	8.41	0.47	5.87	-0.94	5.19	-1.10
PRIMARY IMPACT AREA:										
1970	28,973	9,419	5,925	3,226	267	8,881	226	312	2.4	3.26
1980	28,283	10,610	6,873	3,232	506	9,901	611	98	5.8	2.86
1990	27,450	11,711	7,263	3,295	1,153	10,261	730	721	6.2	2.68
Annual Change: 1970-80	-0.24	1.20	1.50	0.02	6.60	1.09	10.46	-10.93	9.15	-1.30
1980-90	-0.30	0.99	0.55	0.19	8.58	0.36	1.80	22.09	0.80	-0.65
1970-90	-0.27	1.09	1.02	0.11	7.59	0.72	6.04	4.28	4.89	-0.97

Source: DOC (1972), (1982), (1993a)

1990, the estimated vacancy rate was 5.9 percent, excluding the 1.29 percent of the seasonally vacant units. Average household size has been declining in the ROI, from 3.23 persons per household in 1970 to 2.59 persons per household in 1990. This trend is similar to those shown for New York and the U.S (Table 4-21).

In the last few years, housing construction increased at a much higher rate than population in the towns near the Ellicottville ski areas, with 44.2 percent of the homes in the towns of Ellicottville, Mansfield, and Great Valley classified by the U.S. 1990 census as seasonal, recreational, or occasional use (WVNS 1992b). This trend is likely to continue.

Housing prices in the ROI and primary impact area fluctuated because of national and regional economics, interest rates, and tax law changes. The early 1980s were a period of recession for the northeast and western New York, with high mortgage interest rates and slow general economic growth. Mortgage interest rates decreased in 1984 and 1985, and housing prices increased to meet excess demand. After 1986, tax laws changed so real estate investors could no longer write off losses, and fewer investors found it cost effective to participate in the real estate market. In the late 1980s and early 1990s, employment growth slowed in the northeast, and most areas, including western New York, no longer have excess housing demand.

4.8.5 Taxes and Payments in Lieu of Taxes

The towns in the study area obtain 54 percent to 70 percent of their operating revenues from real property taxes and 11 percent to 18 percent from intergovernmental revenues (WVNS 1992b). The Center is State-owned property that is exempt from taxation. The State of New York provides payments in lieu of taxes to various local municipalities and agencies. These payments in lieu of taxes have amounted to $157,900 each year since 1980 and are projected to remain at the same sum through 2000. The sum is apportioned as follows: $44,592 for Ashford, $5,466 for the West Valley Fire District, $20,000 for Cattaraugus County, and $87,932 for the West Valley Central School District (WVNS 1992b). In 1992, the State payment in lieu of taxes was 11 percent of the total taxes paid to Cattaraugus County and the town of Ashford and 10 percent of the total taxes paid to West Valley Central School District (WVNS 1992b). The payments represent about 8.5 percent of West Valley Fire District revenues (Nelson A. Rockefeller Institute of Government 1994). These payments compensate local governments for revenues that could be earned if the Center was not publicly owned, and would be replaced by property taxes if the land was privately owned.

4.8.6 Transportation

The major transportation resources in the area include highways, railroad connections, and airports (Figure 4-21). There is no public transportation available in the vicinity of the Center (Seltzer 1993).

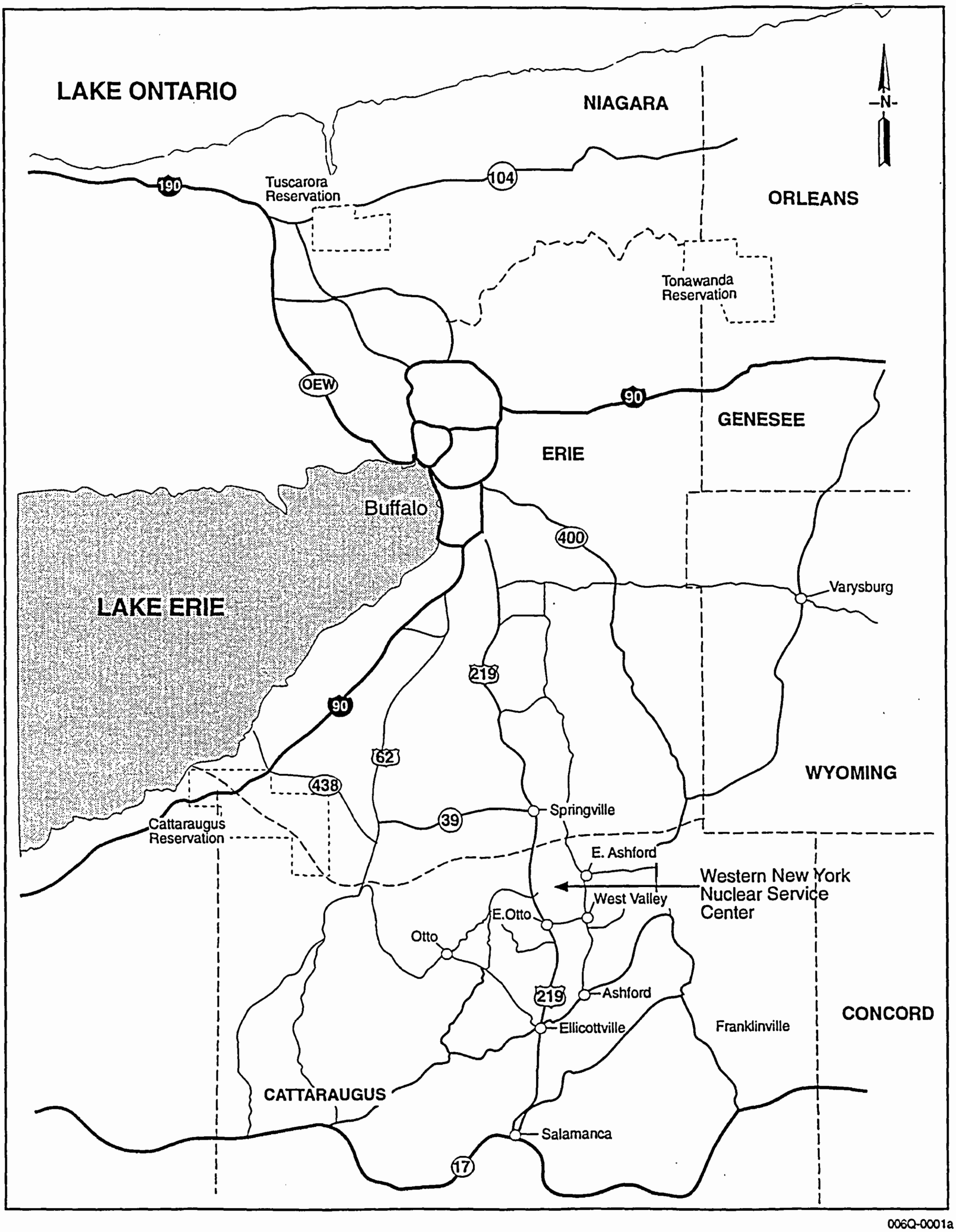


Figure 4-21. Transportation Routes near the Western New York Nuclear Service Center.

4.8.6.1 Roads

Transportation in Cattaraugus County is primarily conducted by road. Access to the Center is through County Roads 85, 86-1, 32, and 12. The highest loads were found on County Roads 85 (Schwartz and Rock Springs Roads), 32 (Rt. 240), and 86-1 (Thornwood Drive) with 2,000, 1,300 and 1,200 vehicles per day, respectively (WVNS 1992b). Other principal roads include State Highway 240, U.S. Highway 219, and State Highway 39, all within 10 km (6.2 mi) of the site. The average annual daily levels of service for these three roads are 3,460 vehicles on State Highway 240, 8,900 vehicles on U.S. Highway 219, and 7,460 vehicles on State Highway 39. Site employees who do not live in communities surrounding the Center generally use Route 219 to County Road 85 to commute to work. The nearest interstate highway, Interstate-90, runs southwest from Buffalo and is 31.1 km (19.3 mi) northwest of the nearest Center boundary (WVNS 1992b). Interstate 90 runs parallel to Lake Erie in western New York. Major interstates and roads leading to the Center are shown in Figure 4-21.

4.8.6.2 Railroads

The Buffalo & Pittsburgh Railroad is the principal railroad serving the West Valley area. The track originates in Buffalo and passes through the Center, coming within approximately 400 m (1,300 ft) of the Project Premises. Erie County has four systems: two Conrail lines one running north to south and one east to west; a Norfolk line running east to west, and a Southern line, also running east to west (WVNS 1992b).

4.8.6.3 Air

The nearest major airport is in Buffalo, New York, about 50 km (30 mi) from the WVDP site. The only other facility is the Olean Municipal Airport, which is 30 km (18 mi) southeast of the site and has no regularly scheduled commercial air service.

4.8.7 Public Services

This section summarizes public safety, public health, recreation, utilities, and education in the area surrounding the Center.

4.8.7.1 Public Safety

There is no local police force; instead, the New York State Police and the Cattaraugus County Sheriff Department have overlapping jurisdictions over the Center and West Valley community (WVNS 1992b). The nearest police substation is about 21 km (13.2 mi) north of the site in Erie County. Another police substation is located in Springville, about 5 km (3 mi) away, although it usually does not provide service to the West Valley community (Seltzer 1993). The Center has its own fire brigade for limited emergency response and is within the jurisdiction of the West Valley Volunteer Fire Department.

4.8.7.2 Public Health

Four medical facilities and several private practices service the area around the Center. The Bertrand Chaffee Hospital in Springville supports Center through its Internal & External Disaster Plan. This facility has 27 doctors, 54 nurses, and 41 beds (Ford 1993) and will likely remain the primary health services supplier in the area into the next century.

4.8.7.3 Recreation

Recreation in Cattaraugus and Erie Counties, and surrounding New York counties includes skiing, camping, fishing, and boating. In Cattaraugus County, the two largest attractions are Allegheny State Park near Salamanca and Holiday Valley ski resort in Ellicottville [about 20 km (12 mi) south of the site]. The largest attraction in Erie County is the Erie County Park System, which has more than 1.3 million visitors annually (WVNS 1992b). Fishing along Cattaraugus Creek occurs primarily near the mouth where the creek discharges to Lake Erie and to a lesser extent at the Springville Dam (WVNS 1993j). People boat along Cattaraugus Creek within 2.9 km (1.8 mi) of the mouth of the creek and canoe at Zoar Valley west of the site depending on the water depths (WVNS 1993j).

4.8.7.4 Utilities

Natural Gas and Fuel. The National Fuel Company provides natural gas to the site and for home use. Fiscal Year 1994 site use was approximately 3,600 million m^3 (127,000 million ft^3) (Kawski 1995). Maximum demand at the site has been 2.8 million m^3 (100 million ft^3) per hour (Werchowski 1995), which is still within National Fuel's capacity to supply. Griffith Oil supplies the site with diesel fuel and gasoline. In Fiscal Year 1994, 13,290 L (3,510 gal) of diesel fuel and 79,500 L (21,000 gal) of gasoline were used by the site (Kawski 1995). There are gasoline key pumps in West Valley. The nearest gasoline service and refilling station is in Springville, 5 km (3 mi) from the Center (Seltzer 1993).

Electric. The Niagara Mohawk Company supplies power to the Center and surrounding communities (Seltzer 1993). Fiscal Year 1994 site use was approximately 19,000 megawatt-hours (WVNS 1995a). Maximum demand at the site has been 0.35 megawatts in a 15-minute period (Werchowski 1995). The substations on the Project Premises have a combined capacity of 12 megawatts.

Water. The WVDP has its own water supply reservoirs (see Section 4.3.2) and treatment system for drinking water. The hamlet of West Valley's water supply comes exclusively from a spring that is piped into a 121,100-L (32,000-gal) tank. The hamlets of Ashford Hollow and Riceville, as well as homes in the vicinity of the Center, rely on private groundwater wells (WVNS 1992b). The village of Springville uses three water supply wells located on the north side of Cattaraugus Creek. The Center is located in the Cattaraugus Creek Basin aquifer, an 842-km^2 (325-mi^2) area that is federally-designated as a sole source of drinking water (see Appendix B). Federally-funded projects constructed in the designated area are subject to EPA review to ensure protection of this water source. No public water supplies are from Cattaraugus Creek (WVNS 1993j). There are groundwater wells used for drinking water in the Cattaraugus Creek Basin aquifer. However, since the area designated as the sole source aquifer is a drainage basin comprising many unconnected water-bearing zones in the sands and gravels in glacial till, water table drawdown or groundwater contamination on the Project Premises is not expected to affect other separate sand and gravel layers in the drainage basin.

Erdman Brook is designated as a Class C stream in the site's current State Pollution Discharge Elimination System (SPDES) permit. According to 6 NYCRR Part 701.8, (Water Quality Regulations, "Class C Fresh Surface Waters") Class C fresh surface waters are best used for fishing. They are suitable for primary and secondary contact recreation (for example, wading and canoeing), although other factors, such as accessibility, may limit their use for these purposes.

4.8.7.5 Education

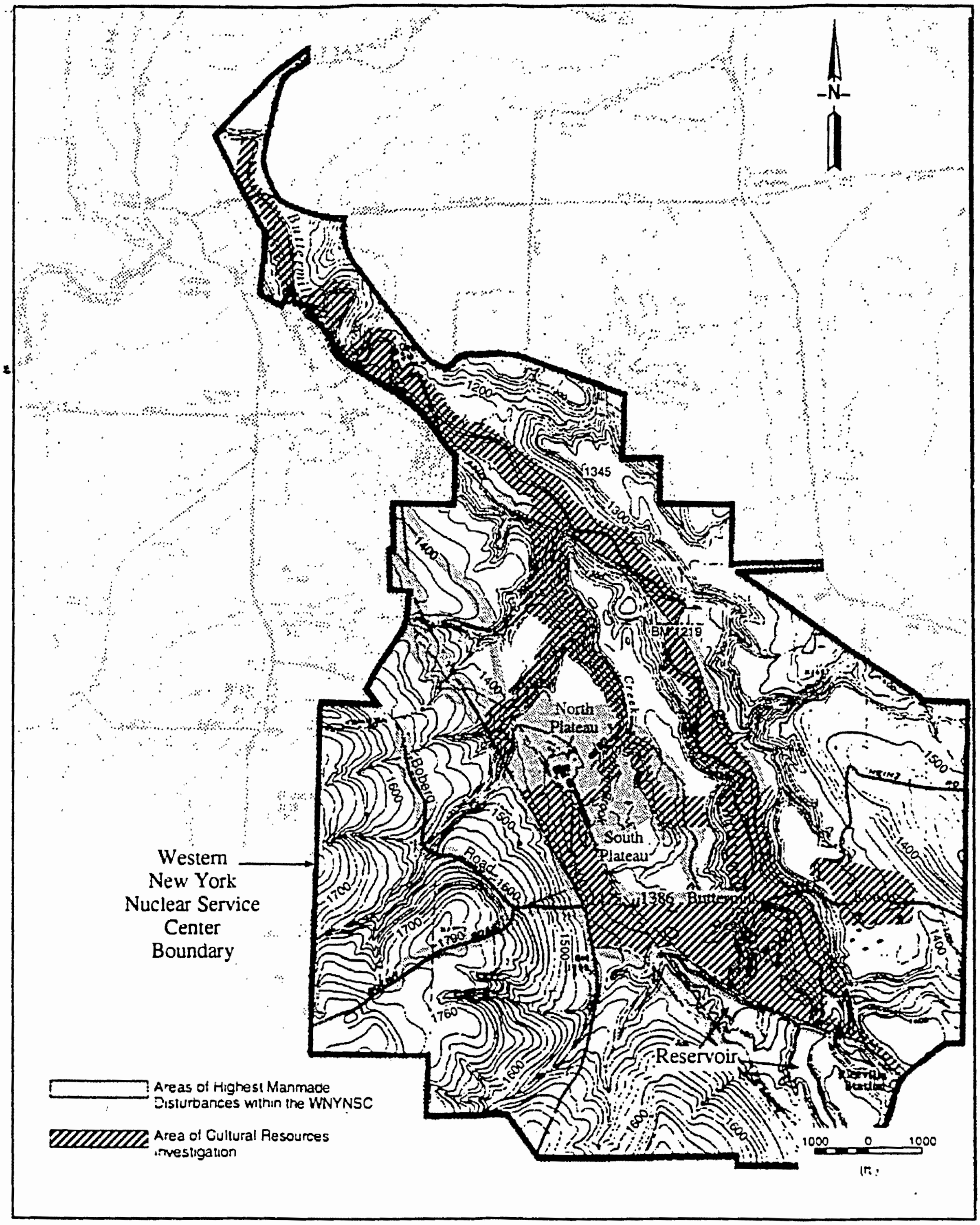
There are 15 school districts in Cattaraugus County and 29 school districts in Erie County. These districts provide preschool through high school education. In 1991, there were 17,483 students enrolled in public schools in Cattaraugus County and 131,404 enrolled in public schools in Erie County. Both counties have a student teacher ratio of about 14 students per teacher. Total enrollment at the four schools within 10 km (6 mi) of the site was 2,808 during 1991 for first through twelfth grade (WVNS 1992b).

4.9 CULTURAL RESOURCES

Several cultural resource studies have been carried out as part of the ongoing management of the Center. The first was a literature review in 1980 (Henderson et al. 1980). Walkover reconnaissance and shovel testing were undertaken in 1990 as part of a Stage IA cultural resources investigation (Pierce 1990); Stage IB inventory was undertaken in 1991 (Pierce 1991). An archaeological predictive model was developed in 1994 (WVNS 1994f). The predictive model uses existing information, survey results, historic maps and photographs, and aerial photographs to identify areas of high potential for cultural resource sites.

The 1990 reconnaissance survey of approximately 146 ha (360 acres) identified one prehistoric and eight historic sites in the surveyed area. The reconnaissance survey focused on those areas most likely to be affected by closure activities: sections of land paralleling Buttermilk Creek, areas adjacent to the Project Premises and SDA, and a land parcel at the bulk storage warehouse (see Figure 4-22) (WVNS 1994a). The rest of the site has not been surveyed. No properties on the Center have been listed on the *National Register of Historic Places* or the *New York State Register of Historic Places*. No archaeological sites were recorded before the 1990 survey (WVNS 1994a). A survey for historic and archaeologic sites was conducted within the Center in 1990. Background research indicated that there were no previously recorded sites (WVNS 1994a).

Cultural resources are defined as a prehistoric or historic district, site, building, structure, or object considered to be important to a culture, subculture, or community for



SOURCE: USGS 7.5 Minute Series (Topographic) Quadrangle: Ashford Hollow, NY, 1964; photo revised 1979.

Figure 4-22. Cultural Resources Investigation Area.

scientific, traditional, religious, or other reason. These are usually divided into three major categories: prehistoric and historic archaeological resources, architectural resources, and traditional cultural resources. Significant cultural resources are those that have retained their integrity and meet at least one of the four criteria of significance for listing on the National Register of Historic Places (36 CFR Part 60.4, Department of the Interior, "Criteria for Evaluation").

Within the Center, areas within 152 m (500 ft) of rivers, streams, or marshes are considered to have potential for containing prehistoric archaeological sites. Historic sites are likely to be found along roadways and near streams. A predictive model for the site was used to assess the potential for impacting potential prehistoric archaeologic sites during implementation of closure actions at the Center. Specific areas would have to be surveyed and effects to significant resources mitigated before clearing, excavation, or other disturbance.

4.9.1 Existing Conditions

The cultural history of the region suggests the potential for identifying a variety of prehistoric and historic cultural resources from the area's temporal-developmental periods: Paleo-Indian (pre-8000 B.C.), Archaic (8000-1000 B.C.), and Woodland (1000 B.C.- A.D. 1600). Major changes through time consist of a gradual diversification in subsistence strategies, from reliance on hunting during the Paleo-Indian, to greater reliance on fishing and food gathering during the Archaic period, and the development of horticulture and complex political, religious, and social systems during the later Woodland period. Researchers suggest that, within the northeastern U.S., the development of ethnographically known cultures occurred from approximately A.D. 1000 until historic contact with Europeans (Fitting 1978).

The Ethnohistoric period began at approximately A.D. 1600. At this time, the Iroquois dominated the region, having displaced the Erie and Neutral nations that previously occupied this portion of western New York. The Seneca, one of the five tribes of the Iroquois Confederacy, incorporated western New York into their hunting territories and controlled the area until the latter part of the eighteenth century. A treaty in 1784 gave the Iroquois much of the surrounding area, including most of Cattaraugas County. Indian claims to land were extinguished in 1797, and the area was opened for Euroamerican settlement (WVNS 1994a).

Although Euroamerican settlement began in the early 1800s, occupation of the study area was not well established until the 1860s. Historical maps show the presence of farmsteads and mills in the town of Ashford, within the present boundaries of the Center. By the 1920s, the area contained a schoolhouse, roads, a railroad, and additional farmsteads. The Center was established in 1961. During the construction of the reprocessing plant, waste storage, and support facilities from 1963 to 1966, many of the original farming structures were demolished (WVNS 1994a).

4.9.2 Archaeological Resources

One prehistoric site and eight historic sites have been identified within the area surveyed in 1990.

At Area E Site, a scraping tool was found on a ridge overlooking an intermittent drainage. Fourteen additional shovel test pits were excavated in the vicinity, and no other cultural material was recovered. This isolated artifact is not considered to be a significant resource (Pierce 1991).

Eight artifacts, two ceramic whiteware shards, a metal plate, pitchfork fragments, and a metal staple were recovered in five shovel test pits excavated in the vicinity of the historical location of the Goodemote/Spittler farmstead. The farmstead was demolished in the early 1960s and no structural evidence of the buildings remains. Because of severe disturbances created during the construction of the former reprocessing facility, this site has lost its integrity and, therefore, is not considered to be significant (Pierce 1991).

The Frank Farmstead Site originally contained a residence, a barn, and an outbuilding, which were demolished in the 1960s. Subsurface testing at this site recovered a concentration of ceramics (some possibly dating to the nineteenth century) and construction materials (bricks, nails, glass, and roofing material). Some mixing and burning of materials was apparent, which was consistent with the information on the demolition procedures used following condemnation of the farmstead in the 1960s. If the selected alternative would disturb this site, additional investigations would be needed to determine the significance of this resource.

The Fleckenstein Farmstead Site is located on the first and second terraces of Buttermilk Creek. It consists of foundation remains and ornamental shrubbery. Two of the foundations are comprised of fieldstone and concrete, while the remains of the barn are made of cobbles. Shovel test pits excavated at this site produced construction materials and some ceramics. Field investigations did not recover datable cultural materials; therefore, this site is not considered to be significant (Pierce 1991).

The Hoyt's Siding Site consists of the remains of a railroad stop constructed sometime between 1869 and 1920. Artifacts include railroad debris, a rectangular concrete slab, and railroad tracks. No shovel test pits were excavated at this site. If the selected alternative would disturb this site, additional investigations would be needed to determine the significance of this resource.

The Capron Farmstead Site is located in the floodplain of Buttermilk Creek and appears on the earliest maps of the area dating to 1869. The surface remains include a house foundation, a bridge, a USGS gauging station, a concrete foundation, and a barn or mill foundation. The bridge probably dates to 1949, when it replaced an earlier structure. Shovel testing at this site produced ceramics, metal fragments, milk cans, bricks, and fragments of mechanical items. None of the materials dated to the earlier occupation; however, the area near the possible residence was not tested. If the selected alternative would disturb this site, additional investigations would be needed to determine the significance of this resource.

Three historic sites may be affected by site closure actions, but preliminary evaluations suggest that they are not significant. The remains of a modern hunting structure were located on a low terrace adjacent to Buttermilk Creek. It was a small, square building with an associated concrete structure. Because of the recent age of the materials, no excavations were conducted at this site and it is not considered to be significant (Pierce 1991).

The Rider/Harvey/Whiteman Silo/Barn Site consists of the remains of a concrete and fieldstone silo pad with a barn foundation. The structures were demolished during the construction of the reprocessing plant. Because of severe disturbances, this site is not considered to be significant (Pierce 1991).

The Erdman/Gentner Trash Midden is located on a ridge above Quarry Creek. It represents a late 1950s to early 1960s residential and agricultural trash deposit. It contained metal pails, probably from the Erdman/Gentner dairy farm. Other artifacts include other metal objects (lawn chairs, nails, and bedsprings); bottles; glass fragments; and ceramics. Because this site is less than 50 years old and is not associated with historical periods or important events, this resource is not considered to be significant (Pierce 1991).

4.9.3 Historic Architectural Resources

Two historic architectural resources located in the study area may be affected by site closure actions. The Buttermilk School is a one and a half story, frame structure located at the northeast corner of Rock Springs and Buttermilk Hill Roads. It appears on historic maps of the area dating to 1920. It may have been moved to its present location before 1920, but it was used as a schoolhouse in the area until 1938. The structure has undergone some modernization. Because of its lack of architectural uniqueness, integrity, and lack of datable cultural material, this resource is not considered to be significant (Pierce 1991).

The Project Premises and surrounding area contain 114 buildings and structures associated with the reprocessing plant. The New York SHPO has determined that facilities on the Project Premises are not eligible for inclusion in the *National Register of Historic Places* (SHPO 1995).

In addition to these resources, a twentieth century hunting camp was found at the north side of the north reservoir. It consists of a 6 x 7.6 m (20 x 25 ft), one story, frame structure with plywood and packing crate walls. The interior has a concrete fireplace and a kitchen with a gas stove and refrigerator. Because of its recent age and lack of association with historic periods or events, this resource is not considered to be significant.

4.9.4 Traditional Cultural Resources

Although Native American archaeological materials are limited at the Center, other traditional use areas may be present. The Center is approximately 24 km (15 mi) upstream from the Cattaraugus Indian Reservation, land reserved for the Seneca Nation of Indians. Consultations with the Seneca Nation are in progress. Concerns expressed by the Seneca Nation of Indians include the potential for contamination of traditional fishing areas downstream from the facility on Cattaraugus Creek (Seneca Nation of Indians 1993).

4.10 NATURE AND EXTENT OF CONTAMINATION

Radioactive materials handling, treatment, and disposal practices on the Project Premises and SDA since the 1960s have resulted in contamination of soil, stream sediments, surface water, and groundwater. The contamination is primarily radiological and the dominant radionuclides are tritium and mixed fission products such as cesium-137 and strontium-90. The transuranic elements plutonium, americium, and uranium have elevated concentrations in the buried waste and lagoon 1 sediment and have not migrated in the environment as far as the mixed fission products. From 1966 to 1972, spent nuclear fuel reprocessing activities occurred on the north plateau in the process building. Burial of radioactive waste in the Lavery till formation occurred on the south plateau in both the NDA (active from 1966 to 1986) and SDA (active from 1963 to 1975).

The nature and extent of radiological and nonradiological (or chemical) contamination at the Center are summarized in this section. The characterization of contamination is based on measurements of radiological and nonradiological constituents in groundwater, soil, and sediment and focuses on cesium-137 and strontium-90 because these are the primary radionuclides that have been released to the environment. Radionuclides with longer half-lives that dominate long-term risks are evaluated in the performance assessment in Appendix D. A description of the volumes of environmental contamination that could have to be managed as part of Center closure is provided in Appendix C.

4.10.1 Background Characterization

Certain radionuclides and metals occur naturally in the environment. Background concentrations of naturally occurring radionuclides and metals must be known to determine if the environment is contaminated. Background soil and subsurface soil samples have been collected on the Project Premises and the SDA, on the balance of the site and off site (E&E 1994; WVNS 1990, 1994c). Tables 4-22 and 4-23 give the background concentrations for radionuclides and metals, respectively. Soils with concentrations above background indicate contamination; and concentrations in soil above an assumed contaminant cleanup level would have to be managed as part of the closure alternatives.

For radionuclides, the assumed contaminant cleanup levels in soil and sediment are based on NRC's proposed 15 mrem/yr total effective dose equivalent to an average member of the public (see Appendix C). Table 4-22 shows the assumed contaminant cleanup levels for radionuclides in only the soil pathway, and radionuclides in soil and in the water

Table 4-22. Background Radionuclide Concentrations in Soil and Assumed Contaminant Cleanup Levels Resulting in a 15 mrem/yr Total Effective Dose Equivalent

		Background (pCi/g)	Concentration in Soil (pCi/g) Resulting in Dose of 15 mrem/yr	
Radionuclide	Number of Analyses[a]	Range	All Pathways Considered[b]	All Pathways Except Water Pathways Considered[b]
Americium-241	24	<0.00773 - 0.388	27.0	27.0
Cobalt-60	11	--[c] - <0.045	1.5	1.5
Cesium-137	24	0.013 - 1.55	6.9	6.9
Tritium	3	-- - <0.3	118	1×10^7
Iodine-129	3	-- - <7.0	0.17	16
Plutonium-238	12	<0.003 - 0.075	31	31
Plutonium-239/240	24	<0.00486 - 0.098	28	28
Plutonium-241	9	<0.88 - 5.2	900	900
Radium-226	114	0.927 - 3.9	0.35	0.35
Radium-228	8	0.98 - 1.3	2.6	2.6
Strontium-90	24	<0.027 - 1.86	6.1	6.1
Uranium-234	15	0.091 - 0.32[d]	7.2	73
Uranium-235	15	<0.00431 - 0.011/<0.07[e,f]	6.0	73
Uranium-238	17	0.056 - 1.3	6.6	76
Technetium-99	3	<0.7 - 0.88	5.0	390
Gross alpha	14	3.8 - 17.1/<20[e]	NA[g]	NA
Gross beta	14	8.6 - 61	NA	NA

a. Background samples from seven locations on the Project premises and the SDA and 10 off-site locations (WVNS 1994f, 1994c, 1990; E&E 1994). The total effective dose equivalent measures the damage to a person's body from radiation exposure. It is used to estimate the risk of health effects.
b. Determined using the RESRAD computer code.
c. -- = Background sample concentration was less than the lower limit of detection or analytical uncertainty.
d. The concentration of uranium-234 may contain a small contribution from uranium-233.
e. Uranium-235 results for isotopic analysis are summarized, gamma spectroscopy values are not used.
f. The detection limit is shown for samples where analytical resolution could not be achieved, as well as the upper value that was quantified in other samples.
g. NA = not applicable because concentrations include a variety of radionuclides.

Table 4-23. Assumed Contaminant Cleanup Levels and Background Levels for Metals in Soil and Sediment

Metal	Proposed RCRA Subpart S Action Level[a] (mg/kg)	Site Background Concentrations[b] (mg/kg)	Assumed Contaminant Cleanup Level[c] (mg/kg)
Antimony	30	ND[d] - 5.09	30
Arsenic	80	2.44 - 15.5	80
Barium	4,000[e]	53.2 - 144	4,000
Beryllium	0.2	ND - 1.1	3.3
Cadmium	40	ND - 1.6	40
Chromium	400[f]	12.1 - 20.4	400
Cobalt	none listed	8.45 - 14	42
Copper	none listed	5.72 - 27.1	81
Lead	none listed	11.2 - 27.3	82
Mercury	20	ND - 0.065	20
Nickel	2,000	13 - 35.3	2,000
Selenium	none listed	ND - 0.178	0.53
Silver	200	<0.50	200
Thallium	6[g]	<0.170	6
Vanadium	700[h]	13.8 - 24.5	700
Zinc	none listed	45.4 - 345	1,035

a. Source: 55 FR 30865-30873 (FR 1990).
b. Range of background concentrations from the SDA (E&E 1994); WVDP RFI samples at BH-39, SS-7, ST-18, ST-26, and ST-6 (WVNS 1994c), and off-site background samples (WVNS 1990).
c. The assumed contaminant cleanup level is the proposed RCRA Subpart S soil cleanup objective or 3 times the maximum site background concentration, whichever is higher.
d. ND = not detected.
e. Proposed action level for ionic barium.
f. Proposed action level for hexavalent chromium.
g. Proposed action level for thallic oxide.
h. Proposed action level for vanadium pentoxide.

pathway. Only radium-226 has been found in background samples at more than 10 percent of the assumed contaminant cleanup level. Radium-226 background concentrations exceed the assumed contaminant cleanup level given in Table 4-22, because naturally-occurring radium in soil in this area is very high. Radium-226 values greater than 3.9 pCi/g (maximum background) were considered contaminated for purposes of analysis.

The assumed hazardous contaminant cleanup levels for soil are either the proposed RCRA Subpart S action levels [55 FR 30865-30873 (FR 1990)] or three times the maximum site background concentrations, whichever is higher. For groundwater, the assumed contaminant cleanup levels are the same as the EPA Drinking Water Standards [40 CFR Part 141, "National Primary Drinking Water Regulations")]. This approach is consistent with that taken in the RFIs.

This section describes the nature and extent of contamination above background and identifies those locations where the assumed contaminant cleanup levels have been exceeded. However, the discussion of soil waste volumes that could be generated if the selected alternative included exhuming contaminated soil is described in Appendix C.

4.10.2 Surface Water and Stream Sediment Contamination

Surface water quality downstream of the Project Premises and the SDA has been impacted by past fuel reprocessing operations, primarily from previous permitted lagoon 3 discharges from 1966 to 1972. During this time, a yearly average of 0.7 Ci of alpha emitters, 65 Ci of beta emitters, and 3,500 Ci of tritium were released from lagoon 3 to Erdman Brook. By 1967, these discharges increased tritium, strontium-90, and gross beta activities by a factor of 100 in Buttermilk Creek [4 km (2.5 mi) downstream of the Project Premises] and by a factor of 10 to 100 in Cattaraugus Creek at Lake Erie [64 km (40 mi) downstream of the Project Premises] (WVNS 1992c). Quarterly surface water monitoring data indicate that NFS effluent discharges from 1966 to 1972, as measured in Cattaraugus Creek near the Center boundary, did not exceed 50 percent of the permit limits (E. R. Johnson Associates 1980).

Radioactive discharges to surface water from lagoon 3 after 1972 were related to treatment of SDA leachate (in 1975-76 and 1980-81) and from facility decontamination (1974 and 1984-85) (WVNS 1992c). Since 1985, the yearly releases from lagoon 3 have generally decreased and have been less than 10 Ci tritium, 0.1 Ci cesium-137 and other gross beta emitters, and less than 0.01 Ci for strontium-90 and gross alpha emitters. The 1993 average annual concentrations in surface water, where Franks Creek leaves the WVDP security fence, were 1,330 pCi/L tritium, 800 pCi/L cesium-137, 92 pCi/L gross beta emitters, 27 pCi/L strontium-90, and 1.9 pCi/mL gross alpha emitters (WVNS 1994d). The effective dose to an off-site individual drinking creek water would be 0.01 mrem. The concentrations were a factor of 10 lower downstream on Buttermilk Creek at Thomas Corners bridge and were comparable to background concentrations. This location is approximately 5.3 km (3.3 mi) downstream of the WVDP security fence.

Several of the discharged radionuclides, particularly cobalt-60, strontium-90, cesium-134, and cesium-137, have an affinity to attach to silt, which can accumulate in the stream beds. For this reason, the nature and extent of contamination in surface water from past discharges is best understood by analyzing sediment samples. Sediment samples from the bottom of the pool behind the Springville Dam [about 4 km (2.5 mi) downstream of the confluence of Buttermilk and Cattaraugus Creek] contained elevated activities of cesium-134 (up to 12 pCi/g), cesium-137 (up to 71 pCi/g), and rubidium/ruthenium-106 (up to

186 pCi/g) in 1971 (NYSDEC 1972). The current concentrations of these radionuclides at this location are expected to be much lower because site discharge levels have decreased, one cesium-137 half-life has nearly elapsed, cesium-134 has a half-life measured in hours, and rubidium/ruthenium-106 has a half-life that is measured in days. Since 1987, the average off-site sediment concentration of cesium-137 has been below 2 pCi/g; the maximum off-site concentration of cesium-137 detected in sediments was 7.56 pCi/g, measured in 1986 in Cattaraugus Creek at Felton Bridge, approximately 6 km (3.8 mi) downstream of the WVDP security fence (WVNS 1994d).

The 50-year committed dose equivalent from ingesting fish or stream sediment and drinking creek water was calculated for the radionuclides listed in Table 4-24 based on the concentrations reported in the WVNS Site Environmental Report for 1991 (WVNS 1992d).

Table 4-24. Analytes Routinely Monitored at Locations of Interest

Location	Radionuclides Sampled (1991)
Buttermilk Creek Effluent at Thomas Corners Road Bridge	Carbon-14, strontium-90, cesium-137, iodine-129, uranium-234, uranium-235, uranium-236, plutonium-238, plutonium-239, plutonium-240, americium-241
Buttermilk Creek Sediment at Thomas Corners Road Bridge	Cobalt-60, strontium-90, cesium-137, iodine-129, uranium-234, uranium-235, uranium-236, plutonium-238, plutonium-239, plutonium-240, americium-241
Cattaraugus Creek Fish Upstream of Springville Dam	Strontium-90, cesium-134, cesium-137

Source: WVNS (1992d)

Table 4-25 shows the results of the dose calculations for stream effluent, sediment, and ingestion of fish caught in the streams upstream of the Springville dam. Based on the results of the calculations, the maximally exposed off-site individual could receive 1.3×10^{-4} rem (0.13 mrem) committed dose equivalent for each year of eating fish, ingesting sediment, and drinking creek water at or upstream of the Springville dam. This committed dose equivalent is well below the 15 mrem assumed contaminant cleanup level.

Table 4-25. 50-Year Committed Dose Equivalent for Undisturbed Streams - Off Site

Pathway	50-Year Committed Dose Equivalent (rem)
Stream Effluent	3.5×10^{-8}
Stream Sediment	9.5×10^{-6}
Fish Ingestion	1.3×10^{-4}
Total	1.3×10^{-4}

The RFI program included on-premises and SDA stream sediment sampling. The SDA RFI was conducted in 1992 and 1993 and included two sediment and three surface water samples (E&E 1994). The WVDP RFI for the Project Premises was conducted in 1993 and included 36 sediment samples from WMAs 2, 4, 5, 6, 7, and 12. The sediment sample results are summarized below. The sampling locations are shown in Figure 4-23.

Waste Management Area 2. One sediment sample was collected in a wet area approximately 7.6 m (25 ft) east of the solvent dike. The radionuclides detected above background at this location were americium-241, cesium-137, cobalt-60, plutonium-238, plutonium-239, strontium-90, and uranium-233/234. Cesium-137 exceeded the assumed contaminant cleanup level. Metals were detected at background levels. Organic compounds were not analyzed at this location.

Another sediment sample was collected from a septic tank on the north side of the treatment and storage building. Only cesium-137 was above background levels. Several semivolatile and volatile organic compounds were detected, including n-dodecane, undecane, benzene, carbon disulfide, ethylbenzene, toluene, and xylene. Cadmium, chromium, copper, zinc and mercury were measured at above background concentrations. Cooper was above the assumed contaminant cleanup level.

Waste Management Area 4. Four sediment samples were collected from the drainages around the construction and demolition debris landfill. All four samples contained above background concentrations of cesium-137, strontium-90, and gross beta emitters. The concentration of strontium-90 exceeded the assumed contaminant cleanup level. The assumed contaminant cleanup level for cesium-137 and radium-226 was exceeded at ST-31 and at ST-29, respectively. Other radionuclides detected above background either on the east side of WMA 4 (ST-29) or at locations on the northwest-draining ditch (ST-30, ST-31, and ST-38) included cesium-137 (ST-29, ST-30, ST-38); gross alpha emitters (ST-29, ST-30, ST-31, and ST-38); cobalt-60 (ST-30, ST-31, and ST-38); and uranium-233/234 (ST-38).

Several metals were detected above background; antimony, barium, and mercury at all four locations; arsenic (ST-29); chromium (ST-31 and ST-38); copper (ST-29 and ST-31); nickel at ST-38; and zinc at ST-29 and ST-38. Zinc (ST-29), arsenic (ST-30), copper (ST-38) and lead (ST-38) were above assumed contaminant cleanup levels. Carbon disulfide was detected at ST-30.

Waste Management Area 5. One sediment sample was collected in WMA 5 from a ditch on the northwest side of lag storage addition no. 1 at location ST-37. Strontium-90, cesium-137, and radium-226 concentrations exceeded the assumed contaminant cleanup levels at this location. Selenium, chromium, mercury, and zinc were detected above background, but below assumed contaminant cleanup level. Several semivolatile organic compounds (phthalates, fluoranthenes, and chrysene) were detected above background.

Waste Management Area 7. One sediment sample was collected in a drainage way between the NDA and the SDA. Cesium-137, uranium-233/234, gross alpha emitters, and

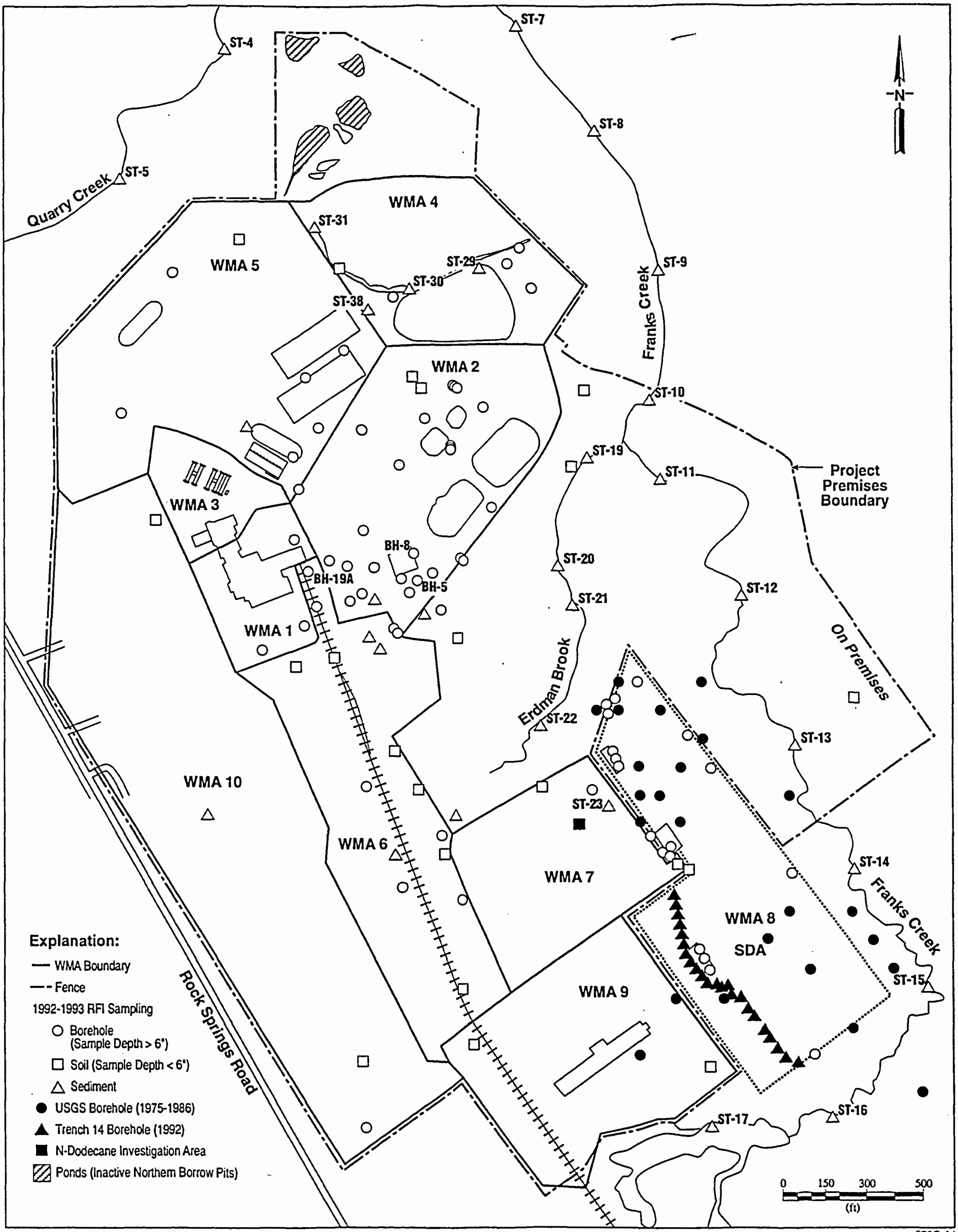


Figure 4-23. Resource Conservation and Recovery Act Facility Investigation Sample Locations on the Project Premises, the State-Licensed Disposal Area, in Streams on the Project Premises, and on the Balance of the Site.

gross beta emitters were detected at levels above background. No metals were detected above background. Organic compounds were not analyzed at this location.

Waste Management Area 8. Two sediment samples were collected within 7.6 m (25 ft) of each other in a marshy area on the northeast corner of the SDA. Cesium-137 was above background at one location and not detected at the other. Beryllium was detected above background, but below the assumed contaminant cleanup levels at both locations. Organic compounds were not detected. The concentrations of metals, radionuclides, and volatile and semivolatile organic compounds measured in three surface water samples from the same area were at background.

Other Areas on the Project Premises (Creek Beds). Seventeen sediment samples were collected from Franks Creek and Erdman Brook, three from Quarry Creek, two samples from Buttermilk Creek, and one from Cattaraugus Creek (Figure 4-23). Cesium-137 was detected above the assumed contaminant cleanup level at all sample locations between ST-19 in Erdman Brook on the Project Premises downstream to ST-7 in Franks Creek on the balance of the site (Figure 4-23). The contamination appears to have originated at one or more of the lagoon outfalls, become entrained in stream sediment, and is migrating downstream. The concentrations increased from an above background concentration of 5.5 pCi/g at ST-21 on the Project Premises to a maximum of 100 pCi/g at ST-10 at the WVDP security fence, decreased to 25 pCi/g at ST-7, and were detected above background at ST-2 on Buttermilk Creek. Cesium-137 concentrations on Franks Creek at sample locations upstream of the Erdman Brook confluence were at or below background except at ST-14, which is located on the balance of the site near an old roadbed that carries runoff from the SDA to Franks Creek. Cesium-137 at this location was above background.

The strontium-90 concentrations in sediment from Erdman Brook and Franks Creek were above background at three locations and exceeded the assumed contaminant cleanup level at sample location ST-8 on the balance of the site (Figure 4-23). Assuming both radionuclides were released to the environment at the same time, strontium-90 appears to be moving downstream more quickly than cesium-137, which has a greater tendency to bind to clay particles. The strontium-90 concentrations increased from 2.6 pCi/g at ST-10 to 11 pCi/g at ST-8 downstream of ST-10. At ST-7, the strontium-90 concentration decreased to 4.3 pCi/g. Strontium-90 was detected at background at the Buttermilk Creek and Cattaraugus Creek sample locations.

Cobalt-60 was detected above background from ST-19 on Erdman Brook downstream to ST-9 on Franks Creek. Plutonium-238 was above background at ST-21 and ST-20. Radium-226 exceeded the assumed contaminant cleanup level at ST-19 and ST-9.

The stream sediment samples were also analyzed for metals. Arsenic was above background at most of the Franks Creek sample locations and exceeded the assumed contaminant cleanup level at five locations. Chromium was above background at ST-13, ST-14, ST-15, and ST-16; antimony at ST-16 and ST-17; copper at ST-14; and nickel at ST-13. At locations ST-13, ST-14, and ST-15 on Franks Creek, barium, cobalt, nickel, selenium, and vanadium were detected above background. On Quarry Creek, selenium and arsenic were detected above background at two sample locations. On Erdman Brook, arsenic was above background at ST-19 and ST-20, and selenium was detected above background at ST-21. Most of the following metals were detected above background at the Cattaraugus Creek and Buttermilk Creek sample points: cadmium, cobalt, copper, mercury, nickel, antimony, selenium, vanadium, and zinc. Organic compounds were not detected or were present but below quantitation limits in the sediment samples.

4.10.3 North Plateau

On the north plateau, radioactively contaminated soil, shallow groundwater, or seeps have been identified in WMAs 1, 2, 3, 4, 5, and 6. Most of the groundwater contamination is confined to the sand and gravel layer, which is the uppermost geologic unit on the north plateau. Releases of radioactive materials have contaminated soil over portions of the north plateau. The ventilation system of the process building failed several times in the late 1960s and contaminated soil on the north plateau (see Section 4.10.5). LLWTF lagoon sediment and soils within the contaminated groundwater plume contain higher cesium-137 and strontium-90 concentrations as well as other radionuclides. The following sections discuss groundwater and soil contamination on the north plateau.

4.10.3.1 Groundwater Contamination

The sources of groundwater contamination appear to be located near the process building (WMA 1) and the LLWTF (WMA 2) based on the mapping of constituents in groundwater.

Groundwater in the sand and gravel monitor wells downgradient of the process building had maximum gross beta and strontium-90 concentrations of 374,000 and 160,000 pCi/L, respectively in 1993 (WVNS 1994d). Geoprobe® studies conducted during 1994 indicated an area or plume near the process building where the gross beta concentration exceeded 3 million pCi/L and strontium-90 concentration was over 1 million pCi/L (WVNS 1995b). The plume is over 244 m (800 ft) long and discharges to drainage ditches near the CDDL. Downgradient of the LLWTF interceptor and lagoon 1, gross beta and strontium-90 have been identified at concentrations of up to 44,200 and 11,000 pCi/L, respectively (WVNS 1993k, 1994d). Groundwater collected from the HLW tank underdrain has contained strontium-90 and cesium-137 in concentrations up to 74.8 and 24.6 pCi/L, respectively, and tritium and technetium in concentrations up to 1,690 and 7,120 pCi/L, respectively (WVNS 1993b). Facilities that are potential sources of groundwater contamination include the acid recovery cell in the process building, the demineralizer sludge ponds, and the former solvent dike.

In 1994, investigations were conducted on the north plateau to characterize potential sources of groundwater contamination (WVNS 1995). In the investigation, 80 locations were sampled, including 6 locations in the process building and 1 location in the fuel receiving and storage area building (Figure 4-24). Groundwater samples were collected at depths ranging from 1.2 to 11 m (4 to 35 ft) and analyzed for gross beta, strontium-90, gross alpha, and

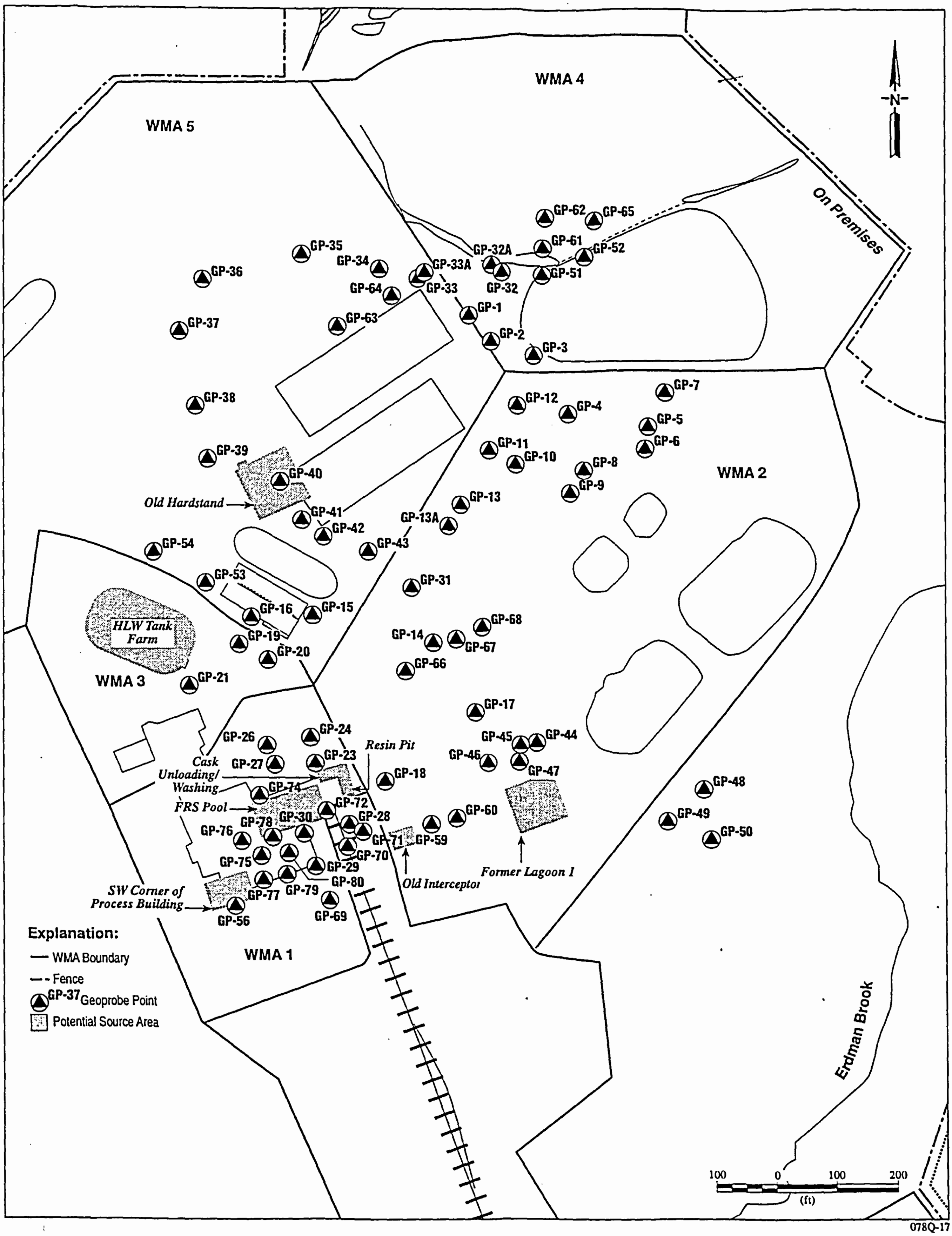


Figure 4-24. Geoprobe Sample Locations and Potential Radiological Source Areas for Groundwater Contamination on the North Plateau (WVNS 1995).

tritium. Several samples underwent an expanded analysis for alpha and beta emitting radionuclides.

Examination of the Geoprobe data indicates that the highest concentrations of strontium-90 were found at a point just south of the fuel receiving and storage area building and east of the process building at GP-30, where the measured values were 3.6 million pCi/L gross beta and 1.2 million pCi/L strontium-90. Other locations sampled near this point also exhibited concentrations exceeding 100,000 pCi/L, suggesting that the principal source of strontium-90 is from the process building area. It is believed that the strontium-90 plume originated from releases in the southwest corner of the process building where a liquid transfer line leaked into an off-gas cell then through an expansion joint in the floor to contaminate groundwater and soil.

The highest gross alpha levels were found at GP-46 (between lagoon 1 and the maintenance building), where readings of 1,170 pCi/L were recorded. Concentrations between 100 and 200 pCi/L were found at GP-18, GP-29, and GP-70. GP-26 and GP-70 are in the process building and GP-18 is approximately 23 m (75 ft) east of the process building. The high readings at GP-18, GP-29, and GP-70 most likely migrated from the process building; the high reading at GP-46 is most likely from the migration of alpha emitters from former lagoon 1. The concentrations between 10 and 100 pCi/L at GP-14, GP-45, GP-66, and GP-69 support the theory that contamination from the process building or transfer line is migrating along a preferential pathway, the slack water sequence deposits described in Section 4.1. These locations are shown on Figure 4-24.

The tritium data show concentrations exceeding 20,000 pCi/L at GP-43, GP-46, and GP-47 and concentrations between 10,000 and 20,000 pCi/L at GP-13A, GP-16, GP-18, and GP-29. This suggests multiple sources of tritium. GP-16, GP-43, and GP-13A may be from a spill that occurred near the old hardstand. These locations are arrayed to the south and southeast of the old hardstand. GP-46 and GP-47, approximately 15 m (50 ft) northwest of lagoon 1, may reflect contaminated soil, asphalt, and vegetation used to fill former lagoon 1.

Trace concentrations (<50 μg/L) of volatile organic compounds (1,1,1-trichloroethane, 1,1-dichloroethane, and dichlorodifluoromethane) were identified in one seep and two wells near the northern and eastern edges of the CDDL and in one well north of the process building (WVNS 1992d). In 1993, similar concentrations of 1,1-dichloroethane and dichlorodifluoromethane were detected in two wells on the eastern edge of the CDDL. Tributyl phosphate (290 μg/L) was detected in a well on the eastern edge of former lagoon 1 (WVNS 1994d).

Groundwater monitoring in 1993 indicated metal concentrations above the NYSDEC maximum contaminant levels (MCLs), primarily in wells developed in the sand and gravel layer on the north plateau (WVNS 1994d). Lead exceeded the MCL in wells 602, 86-04, 116, 105, and 106 located downgradient of the process building in an area between lag storage addition 4, lagoons 4 and 5, and the CDDL (Figure 4-25). In this same area, chromium exceeded the MCL in wells 502 and 116, and arsenic exceeded the MCL at well 105. Chromium and lead exceeded the MCL at well 601 (near a road between the perimeter fence and lag storage addition 3), and chromium exceeded the MCL at well 405 [near a road intersection approximately 60 m (200 ft) northwest of the HLW tank farm]. The above concentrations could primarily be due to runoff and infiltration of contaminated water from roadways or outside storage areas. Lead exceeded the MCL in wells 803 and 804, which are downgradient of the CDDL. Copper exceeded the MCL in well 205, which is downgradient of the north sludge pond.

Analysis of the 1993 general groundwater quality data indicated localized areas of groundwater contamination that may have been affected by the plant waste handling and wastewater treatment activities (WVNS 1994d). Elevated sodium, chloride, pH, and specific conductivity were identified at well 103 (located between the maintenance shop and former lagoon 1), reflecting a localized 1984 sodium hydroxide spill. Elevated specific conductivity, sulfate, and chloride in groundwater near lagoons 1-5, demineralizer sludge ponds, CDDL, and surrounding the process building suggest that infiltration of nonhazardous wastewaters, salts, and sulfate compounds from these sources may have affected groundwater quality.

A review of the monitoring data from 1987 through July 1994 for monitoring wells and seeps indicates that for many locations gross beta concentrations have increased. Tritium generally showed no trend, although short-duration variations in concentrations were noted. Cesium-137 and potassium-40 concentrations decreased over the same period. Because potassium-40 is naturally occurring, has a long half-life, and is found in clays, it is a good indicator of sampling and analytical variation. The decreases in potassium-40 and cesium-137 most likely reflect decreases in suspended clay in the sampled water because cesium-137 is known to adsorb to clay.

Table 4-26 indicates the trends for three parameters (gross alpha, gross beta, and tritium) for 48 monitoring wells and seeps on the north plateau and identifies wells with concentrations approaching or exceeding the MCLs. Gross alpha, gross beta, and tritium were selected for the trend analysis because they are the three parameters that have been monitored the longest. Trends could not be identified for gross alpha data because the low concentrations were accompanied by high uncertainties in the measurements. Gross beta is the best indicator of groundwater contamination from site activities. Tritium is mobile in groundwater and is a good indicator of the leading edge of groundwater contamination. Much of the gross beta increases can be correlated with the gross beta plume (e.g., wells 115, 408, 501, 502, and 801). Other wells showing gross beta increases are located downgradient of former lagoon 1 (wells 111 and 86-06); downgradient of the CDDL (seep locations, wells 804 and 86-12); the lag storage areas (wells 405, 605, and 703); and the LLWTF (wells 106, 107 and 109). Figure 4-25 shows the location of the monitoring wells cited in Table 4-26.

4.10.3.2 Soil Contamination

The nature of soil contamination on the Project Premises and SDA has been determined from samples collected during the RFIs and from other location-specific sampling events. Metals, volatiles, pesticides, semi-volatiles, and specific radionuclides were analyzed as part of the ongoing RFI investigations. Sediment and soil contamination at various

Table 4-26. Trends in Selected North Plateau Wells from 1987 through July 1994

Well	Depth (ft)[a]	Contaminant[b]		
		Gross Alpha[c]	Gross Beta	Tritium
W106	14.5	A	I	I?
W107	28		I	C
W108	33		D	C
W109	33		I	I
W110	33		D	I
W111	11	A	I-E	D
W114	29		D	C?
W115	28		D	I
W116	11		I	D
W201	20		C	C
W202	38		I	C
W203	18		D	C
W204	43		C	C
W205	11		I	C
W206	38		I	C
W207	11		I	C
W208	23		C	C
W301	16		D	C
W302	28		I	C
W305	31		I	C
W307	16	A	I	C
W401	16	A	I-A	C
W402	29	A	I	I
W403	13	A	I	C
W404	36.5		C	C
W405	12.5	A	I-A	D
W406	17		C	D
W408	38	E	I-E	C
W409	55		C	C
W501	33		I-E	C
W502	18		I-E	C?
W601	6		D-E	C
W602	13	A	C	C
W605	11		C-E?	C
W701	28		C	C
W703	21		I	C
W704	15.5	A	D-A	C
W705	21		C	C
W801	17.5		I-E	D
W804	9		I-E	C
GSEEP	(Seep)		I?	D
DMPNE	(Seep)		I-E	D
SWAMP	(Seep)		I	I?
B-86-05	12	E	I-E[d]	D
B-86-06	12	A	I	C
B-86-12	18		I	D

a. To convert feet to meters, multiply by 0.3048.

b. I = Increasing concentration trend; A = Near MCL
D = Decreasing concentration trend; E = Exceeding MCL
C = Constant (no trend); ? = Trend cannot be clearly defined because of variability of the data.

c. Overall, gross alpha concentrations are low with high data uncertainties that prevent identifying trends. A blank space denotes that the gross alpha concentration is neither approaching or exceeding the MCL at that well.

d. Long-term trend increased until 1992 and has been decreasing since then.

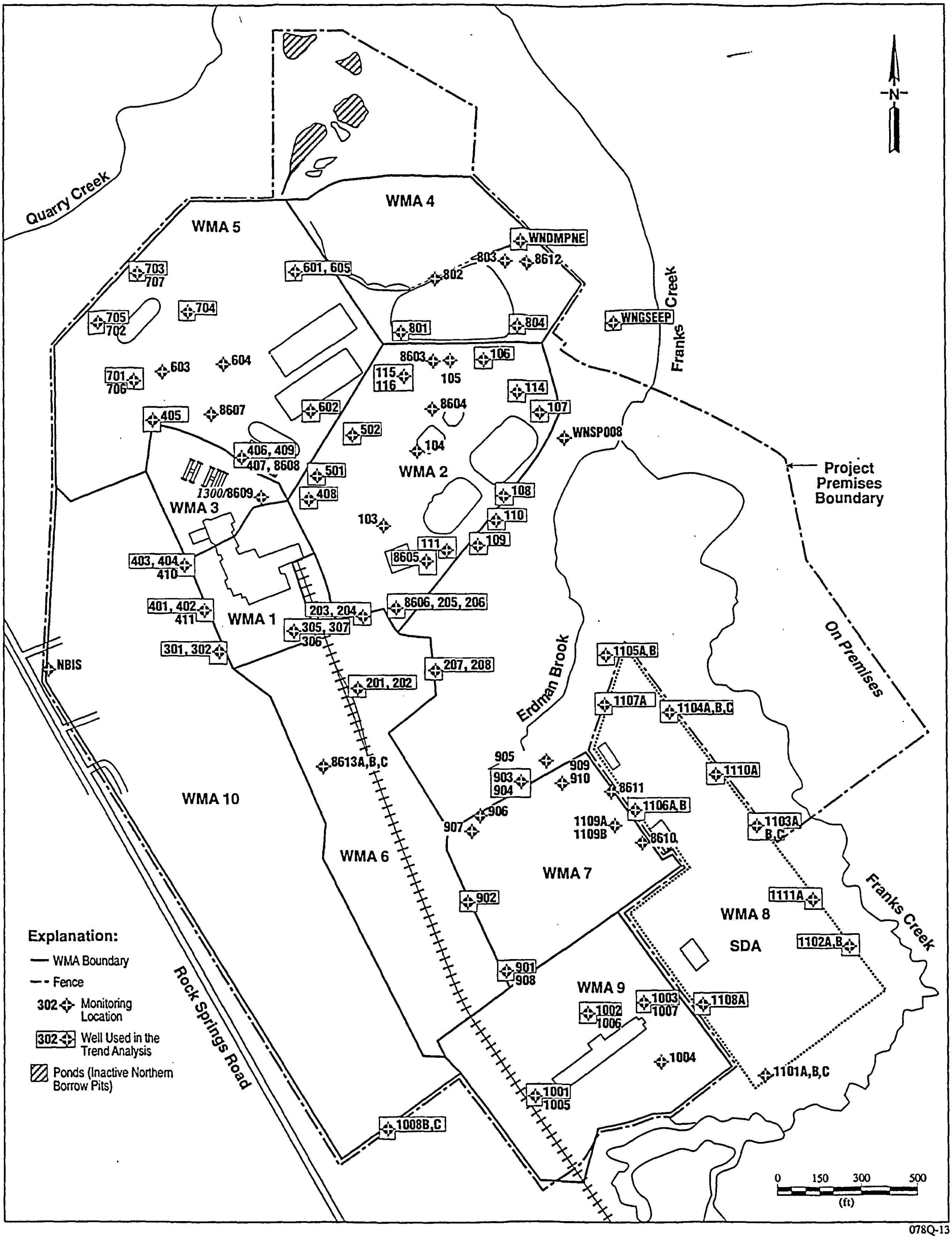


Figure 4-25. Groundwater Monitoring Wells on the North and South Plateaus.

facilities on the north plateau are discussed in Appendix C. This section summarizes the sampling results by WMA and reports whether the concentrations were above background or above the assumed contaminant cleanup levels. The RFI sample locations on the Project Premises and SDA are shown on Figure 4-23. Areas with soil contaminated above the assumed radionuclide contaminant cleanup levels that could require management during closure depending on the selected alternative, are shown in Figures 4-26 and 4-27.

Metal results typically were at or below background levels or at the detection limit of the analytical method. Antimony, arsenic, chromium, copper, lead, and mercury were detected above background primarily in the sand and gravel layer on the north plateau. Volatile and semi-volatile organic compounds were detected in boreholes and surface samples in the parts-per-billion range, but they were not detected above the assumed contaminant cleanup levels except near lagoon 1 (discussed below). Pesticides were not detected in the soil samples.

Waste Management Area 1. About 8 percent of the total area of WMA 1 has soil contamination. Three boreholes sampled during the RFI program detected above-background concentrations of gross beta emitters and strontium-90. On the north side of the fuel receiving facility at the process building, strontium-90 was detected at concentrations above the assumed contaminant cleanup level at depths greater than 5.5 m (18 ft), peaking at 9 to 9.6 m (30 to 32 ft). The total borehole depth was 12 m (38 ft). A borehole located south of the 01-14 building contained strontium-90 above the assumed contaminant cleanup level at 3.6 to 6 m (12 to 20 ft). Soil samples were collected from four Geoprobe sample points located in the process building (GP-75, GP-77, GP-78, and GP-80 on Figure 4-24) at depths ranging from 6 to 12 m (19 to 39 ft) were analyzed for gross alpha, gross beta, and expanded beta emitters (WVNS 1995). Strontium-90 was above the assumed contaminant cleanup level at all four locations, with the highest concentrations occurring at a depth from 6 to 8 m (19 to 25 ft). Other contaminated areas in this WMA are near the acid recovery cells, the utility room and courtyard, the condensate tanks, the south side of the fuel receiving and storage building, and the nitric acid and sodium hydroxide storage tanks.

Waste Management Area 2. About 16 percent of the total area in WMA 2 has soil contamination (see Appendix C for details). Data from 17 boreholes sampled as part of the RFI program detected above-background concentrations of strontium-90, plutonium-239, radium-226, uranium-232/233, uranium-238, americium-241, cobalt-60, cesium-137, or plutonium-238 at 14 locations in four areas that included the old interceptor and lagoon 1, the solvent dike, lagoon 2, and lagoon 3 sediment. The predominant radionuclide contamination in WMA 2 is strontium-90, which was typically detected at depths ranging from 1.2 to 3 m (4 to 10 ft). Boreholes near the interceptor and the solvent dike area had cesium-137, cobalt-60, strontium-90, radium-226, americium-241, plutonium-238, plutonium-239, and uranium-233/234 contamination in concentrations above the assumed contaminant cleanup level. This contamination occurred mainly in the top 1.2 m (4 ft) and in the 2.4 to 3.6-m (8 to 12-ft) range.

Four boreholes clustered between lagoon 1 and lagoon 2 detected radionuclides above the assumed contaminant cleanup level. Boreholes 5 and 8 were the most contaminated in

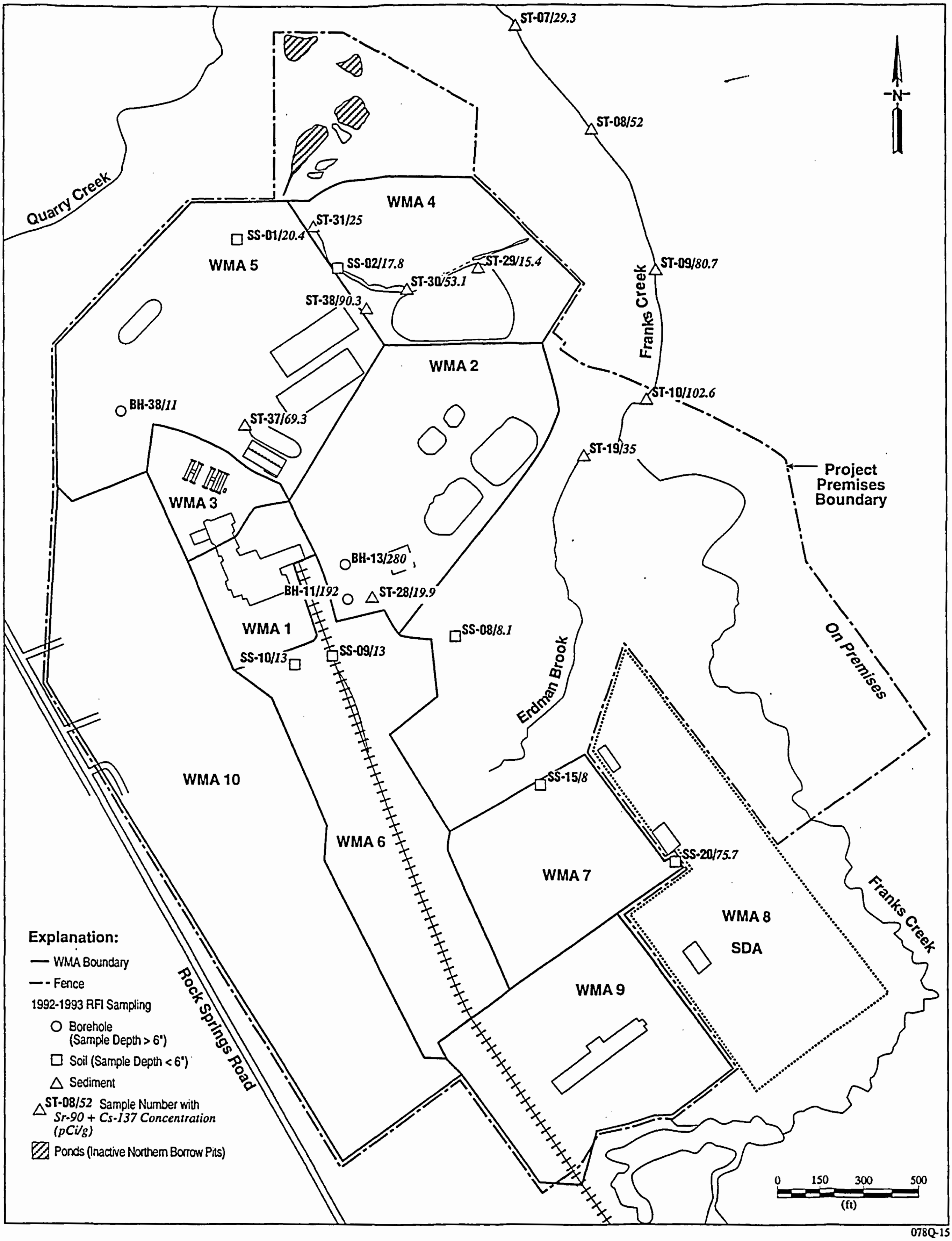


Figure 4-26. Locations where Strontium-90 plus Cesium-137 Concentrations Exceed 15 millirem/year at Depths Less than 1.2 meters (4 feet).

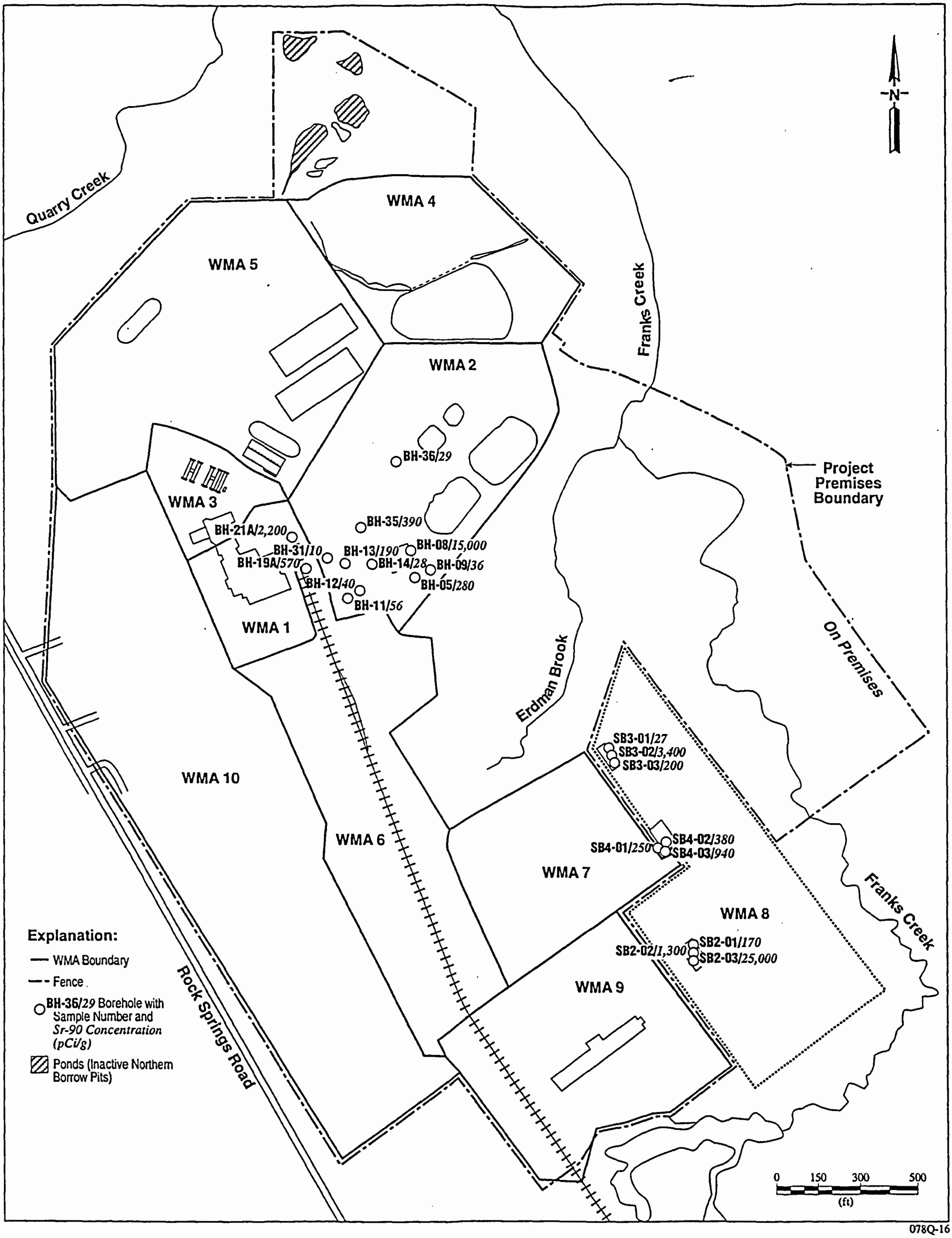


Figure 4-27. Locations Where Strontium-90 Concentrations Exceed 15 millirem/year at Depths Greater than 1.2 meters (4 feet).

WMA 2; the contaminated depth ranged from 1.2 to 3.6 m (4 to 12 ft) (Figure 4-23). Selenium was detected above background at depths ranging from 3 to 5.5 m (10 to 18 ft) in the vicinity of lagoon 1 and downgradient of the process building. Lagoon 1 metal concentrations exceeded background levels, but were below the assumed contaminant cleanup level. One volatile organic compound (toluene) and fourteen semivolatile organic compounds were detected, although their concentrations had to be estimated. The estimated concentrations of chrysene, di-n-butyl phthalate, and benzo[a]-anthracene exceeded the assumed contaminant cleanup level.

Waste Management Area 3. No soil contamination was found at the single location sampled as part of the RFI program; however, a historical surface soil sample contained cesium-137 and uranium-235 above background (WVNS 1994c). The cesium-137 contamination is assumed to be part of the cesium prong described in Section 4.10.5.

Waste Management Area 4. Four boreholes sampled to a depth of 5.4 m (18 ft) did not detect radionuclides above background in any of the sampled intervals. Metals (arsenic, copper, and lead) above background were detected in boreholes on the east side of WMA 4. One surface soil sample contained above-background levels of barium, chromium, mercury, lead, and vanadium.

Waste Management Area 5. About 2 percent of the total area of WMA 5 has radiological soil contamination. Elevated gross alpha and gross beta emitter readings in shallow soil [depths to 1.2 m (4 ft)] were detected in a historical sampling program at the old hardstand (WVNS 1990). A borehole sampled as part of the RFI had strontium-90 above background at this location, but below the assumed contaminant cleanup level. Shallow cesium-137 contamination was detected at two soil sample locations at concentrations above the assumed contaminant cleanup level. The cesium-137 contamination is assumed to be part of the cesium prong contamination described in Section 4.10.5. Above-background concentrations of strontium-90 and plutonium-239 were also detected in the 0 to 1.2-m (0 to 4-ft) depth; a surface soil location contained radium-226 above the assumed contaminant cleanup level.

Two areas in WMA 5 have nonradiological soil contamination. Arsenic, lead, and copper are above background at a borehole on the south side of the lag storage building, and at a borehole north of the CPC waste storage area. This contamination is assumed to be localized.

Waste Management Area 6. Six of the twelve soil sample locations in WMA 6 had above-background concentrations of strontium-90, americium-241, cesium-137, plutonium-238, plutonium-239, cobalt-60, and gross beta. Borehole 19A (Figure 4-25) contained strontium-90 above the assumed contaminant cleanup level at depths of 3.6 to 4.3 m (12 to 14 ft) and 5.4 to 6 m (18 to 20 ft). This borehole is located close to the process building and is within the north plateau groundwater plume described in Section 4.10.3.1. A surface soil sample located between the cooling tower and the warehouse contained concentrations of cesium-137, cobalt-60, strontium-90 and several metals at or above background. Localized areas along the railroad spur, at the old incinerator, and near the sewage treatment trench may also be contaminated, as discussed in Appendix C.

4.10.4 South Plateau

On the south plateau, radioactively contaminated groundwater, soil, and sediment in filled lagoons has resulted from waste disposal and management activities at the NDA (WMA 7) and SDA (WMA 8). At both the NDA and SDA, radioactive waste was disposed of in trenches and holes within the Lavery till formation. Primary contaminants of concern in soil and groundwater near the SDA and NDA include tritium, strontium-90, and cesium-137. In addition, n-dodecane solvent disposed of in the NDA has transported plutonium, americium-241, cobalt-60, and iodine-129 to an area about 27 m (90 ft) away from the original disposal hole. Three hazardous constituents (barium, benzene, and 1,2-dichloroethane) were detected above the RCRA hazardous waste criteria in leachate from some of the SDA disposal trenches. Groundwater and soil contamination in WMAs 7 and 8 are discussed below.

4.10.4.1 Groundwater Contamination

The accumulation of leachate within disposal trenches and holes has contributed to the migration of contaminants in the weathered Lavery till. Leachate is a liquid that forms when groundwater contacts waste and dissolves hazardous and radioactive constituents. The potential for lateral migration of contaminants in the weathered till increases when the fluid level in the disposal trenches or holes accumulates and rises to the top of the trenches. Some groundwater monitoring wells screened in the weathered till have contained concentrations of tritium or strontium-90 above the EPA MCL for drinking water. Groundwater quality in the SDA and NDA varies by location because of the very low permeability of the till and because most groundwater flow is limited to fractures or coarser zones in the till (E&E 1994). Contaminant migration is limited by the size and extent of the fractures and coarser zones. No off-site groundwater contamination from either the NDA or SDA has been documented.

Because till has low permeability, contaminant concentrations can vary several orders of magnitude over short distances. For example, strontium-90 concentrations below the SDA inactive filled lagoon decrease from about 1,000 to 16 pCi/g over a distance of 2.4 m (8 ft) (Dames & Moore 1992). Based on 1977 data, tritium concentrations in soil moisture below SDA disposal trenches 5 and 8 decreased from about 1,000,000 to 10 pCi/mL over a distance of approximately 3 m (10 ft) (Prudic 1986).

High gross alpha (up to 8.20×10^7 pCi/L), gross beta (up to 1.02×10^8 pCi/L), and tritium (up to 4.27×10^9 pCi/L) activities have been identified in leachate within some SDA and NDA disposal trenches (Prudic 1986, Blickwedehl et al. 1989). Tritium has migrated vertically downward from the base of the SDA trenches in unweathered till up to 3 m (10 ft), over a period of 7 to 11 years, and generally less than 2.5 m (8 ft) horizontally in the weathered till. Carbon-14 was observed up to 1 m (3 ft) below the disposal trench floors, while other radionuclides (plutonium-238, cobalt-60, cesium-137 and strontium-90) migrated less than 1 m (3 ft) below the disposal trench floors (Prudic 1986). Maintenance of the disposal trench covers, fluid level monitoring, and dewatering in the SDA have been performed to control contaminant migration.

A review of 1987 through July 1994 monitoring well data indicates that the gross beta readings have increased in downgradient wells 904, 1105A, and 1106B in the vicinity of the NDA and SDA. These wells are 6.4 to 9.4 m (21 to 31 ft) deep. Tritium has increased in downgradient wells 1102A, 1111A, 1103A, 1105A, and 1106A, but it has remained constant in upgradient wells. The tritium is increasing in monitor wells that are 4.9 to 6.4 m (16 to 21 ft) deep. The trends for 23 wells on the south plateau, as identified on Figure 4-25, are shown in Table 4-27.

With the exception of acetone, a common analytical residual sometimes detected in the ten parts per billion range, organic compounds have not been identified at elevated concentrations in the groundwater monitoring wells, except an SDA piezometer on the west side of trench 14 and piezometers in the NDA n-dodecane release area. The SDA slurry and cut off wall and NDA interceptor trench were installed to prevent water from entering the SDA and contaminants from leaving the NDA.

4.10.4.2 Soil Contamination

Waste Management Area 7. Soil samples were collected at five locations in the NDA, and all had above-background concentrations of cesium-137, plutonium-238, strontium-90, cobalt-60, radium-226, and gross beta (Figure 4-23). Surface soil sample SS-20 contained cesium-137, radium-226, and strontium-90 in levels above the assumed contaminant cleanup level. The volume of contaminated soil that would have to be managed if the NDA were exhumed is described in Appendix C.

Waste Management Area 8. During the SDA RFI sampling program, soil samples were collected at seven borings located around the SDA trenches and eight borings located in and downgradient of each of the filled lagoons. The unweathered till beneath the filled lagoons was contaminated with either strontium-90, uranium-233/234, or radium-226 above the assumed contaminant cleanup level and tritium above background (E&E 1994). The background tritium concentration was determined to be 0.2 pCi/g for the SDA (E&E 1994). Soil near the disposal trenches at the north end of the SDA is primarily contaminated with tritium (Prudic 1986). Boreholes were located near well 1107A at the north end of the SDA as part of the RFI. The highest tritium concentration was 6.3 pCi/g at a depth of 3.7 to 4.3 m (12 to 14 ft) in weathered till. Metals and organic compounds in soil have not been detected above the assumed contaminant cleanup level. The volume of soil that would have to be managed if the SDA were exhumed is described in Appendix C.

Waste Management Area 9. Two surface soil samples were collected during the RFI program. Neither sample contained radiological, metallic, or organic constituents above background levels.

Table 4-27. Trends in Selected South Plateau Wells from 1987 to July 1994

Well	Depth (ft)[a]	Contaminant[b] Gross Alpha[c]	Gross Beta	Tritium
901	136		D-I[d]	C
902	128		I?	C
903	133		D	C
904	26		I?	C
1001	116		D	C
1002	113		I?	C
1003	138		D-I[e]	C
1008B	51		D	C
1008C	18		I?	C
1102A	17		D	I
1102B	31		D	C
1103A	16		D	I
1103B	26		D	C
1103C	111		D	C
1104A	19	A	C	C
1104B	36		D	C
1104C	114		D	C
1105A	21		I	I
1105B	36		D	C
1106A	16		D	I
1106B	31		I	C
1107A	19	A	D	D[h]
1108A	16	A	I-D[g]	C
1110A	20	A	D	C
1111A	21	A	C	D-I[f]

a. To convert feet to meters, multiply by 0.3048.
b. A = Near MCL
C = Constant (no trend)
D = Decreasing concentration trend
E = Exceeding MCL
I = Increasing concentration trend.
? = Trend cannot be clearly defined because of variability of the data.
c. Overall, gross alpha concentrations are low with high data uncertainties that prevent identifying trends. Wells with gross alpha concentrations approaching or exceeding the MCL are indicated. A blank space denotes that the gross alpha concentration is neither approaching nor exceeding the MCL at that well.
d. Gross beta concentration decreased until October 1992, then began to increase.
e. Gross beta concentrations decreased until March 1993, then began to increase.
f. Tritium concentrations decreased until December 1992, then began to increase.
g. Gross beta concentrations increased until November 1992, then began to decrease.
h. Tritium concentrations were highest in December 1990 and have fluctuated between 19,000 and 23,000 pCi/L since then. The overall trend is decreasing.

4.10.5 Cesium Prong

The cesium prong area is divided into three sections: (1) the area on the Project Premises (in WMAs 3, 4, and 5), (2) the area on the balance of the site (also referred to as the area north of Quarry Creek), and (3) the off-site area (the area off of the Center). This contamination was caused when high-efficiency particulate air filters in the process building ventilation system failed several times in the late 1960s during fuel reprocessing operations. Decontamination of a lawn area near the process building offices was documented in 1968 after a release from the plant stack (E. R. Johnson Associates 1980). Elevated cesium-137 and strontium-90 activities (generally 3 to 5 times over background) were noted in the top 0.6 m (2 ft) of soil at the maintenance shop leach field, the incinerator, and near WMA 3 (WVNS 1993b).

The extent of the cesium prong is based on the results of an aerial survey conducted in 1984 (EG&G 1991) and recent off-site field surveys. The contaminant of concern is cesium-137, which occurs above the assumed contaminant cleanup level within the top 10 cm (4 in.) of soil in localized areas, based on the results from the 1994 off-site survey (Dames & Moore 1995). Based on process knowledge at the time, the short half-lives of other radionuclides that were released, and laboratory analysis of recent samples, no other radiological or nonradiological contaminants are in the cesium prong. The estimated contaminated areas cover 116,000 m^2 (1,240,000 ft^2) on the Project Premises, 139,000 m^2 (1,500,000 ft^2) on the balance of the site, and 5,560 m^2 (60,000 ft^2) off site.

4.10.6 1993 Air and Direct Radiation Monitoring Results

The ventilation stack from the process building is the largest source of airborne radioactivity on the Project Premises. Other sources of permitted radioactive emissions include the cement solidification system, supernatant treatment system, contact size reduction facility, LLWTF, laundry room, and the supercompactor volume reduction ventilation systems. All of these sources are monitored for gross alpha and gross beta activity.

Between 1987 and 1993 the releases from the process building's main ventilation stack have shown a downward trend of approximately one order of magnitude in both gross alpha and beta activity. In 1993, releases from this source were less than 3.68 x 10^{-7} Ci of gross alpha, 2.01 x 10^{-5} Ci of gross beta, and 5.53 x 10^{-2} Ci of tritium, which is more than an order of magnitude greater than that released by the other WVDP permitted sources. Strontium-90, cesium-137, and iodine-129 account for most of the beta activity (excluding tritium), and americium-241 was the most common alpha radioisotope. The 1993 radioactive emissions from the Project Premises were well below National Emissions Standards for Hazardous Air Pollutants (WVNS 1994d).

Since 1985, direct environmental radiation monitoring has indicated that the exposure to gamma radiation at the perimeter of the Center is about 10 μR/hr or less. This exposure is comparable to the 9.4 μR/hr average measured in 1993 at the six background monitoring stations located 6 to 55 km (4 to 34 mi) from the Center. The CPC waste storage area is the largest source of direct gamma radiation on the Project Premises. A monitoring station located about 46-m (150-ft) north of the CPC waste storage area had an average exposure of 496 μR/hr, which is less than that measured in 1992 (520 μR/hr), 1991 (570 μR/hr), and 1990 (630 μR/hr) (WVNS 1994d). The 1990-1991 overland gamma survey showed higher gamma radiation near the HLW tanks, the process building, lagoons 2 and 3, the southwest portion of the NDA, and the RTS drum cell (WVNS 1993b).

4.10.7 1993 Food Chain Monitoring

Food samples are collected regularly from locations on and off of the Center and from control locations not influenced by the site. Food samples include fish from Cattaraugus Creek upstream and downstream of Springville dam; beef, milk, fruit, and vegetables (beans, apples, sweet corn, and hay) from nearby farms; and venison (WVNS 1994d).

The average radionuclide concentrations from fish samples downstream of the site were found to be statistically indistinguishable from average background concentrations. Concentrations in beef and venison samples were similar to background except strontium-90 values in beef tended to be higher than one of the control samples, resulting in a 0.02 mrem dose to an individual who drinks 310 L (82 gal) of milk (WVNS 1994d). Fruit and vegetable concentrations were below detection or similar to background (WVNS 1994d).

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5. ENVIRONMENTAL CONSEQUENCES

This chapter describes the environmental impacts that would result from implementing the alternatives for WVDP completion and closure or long-term management of facilities at the Center that are described in Chapter 3. The five alternatives evaluated for the site involve combinations of technology options, constructing new storage or disposal facilities, and in-place stabilization. This EIS evaluates the following alternatives:

1. Alternative I: Removal and Release to Allow Unrestricted Use

2. Alternative II: Removal, On-Premises Waste Storage, and Partial Release to Allow Unrestricted Use

3. Alternative III: In-Place Stabilization and On-Premises Low-Level Waste Disposal

4. Alternative IV: No Action: Monitoring and Maintenance

5. Alternative V: Discontinue Operations.

Section 5.1 describes radiation exposure and its consequences. Sections 5.2 through 5.6 discuss the environmental consequences of implementing Alternatives I, II, III, IV, and V. Cumulative impacts are provided in Section 5.7, and Section 5.8 discusses environmental justice. Section 5.9 describes irreversible and irretrievable commitment of resources, and Section 5.10 presents unavoidable adverse impacts and mitigative measures. The relationship between short-term use and long-term productivity is described in Section 5.11, and Section 5.12 assesses incomplete and unavailable information.

The environmental consequences of closure or stabilization were evaluated for the implementation and post-implementation phases of closure. The implementation phase is the time period during which actions are taken to modify the site to either release it to allow unrestricted use or to prepare for long-term monitoring and maintenance. The post-implementation phase includes the period of institutional control and long-term monitoring and maintenance. Alternative V, Discontinue Operations, is the only alternative that does not have an implementation phase.

Implementation phase impact discussions present effects resulting from normal or expected conditions and potential accidents. Normal or expected condition impact analysis includes resource requirements, radiological impacts to the local population and to on-site workers as a result of actions on the Project Premises and the SDA, and radiological impacts to the public and transportation workers as a result of radioactive waste shipments. The discussion of normal impacts also addresses nonradiological impacts including occupational injuries, nonradiological transportation emissions, air quality, water quality, biotic resources, socioeconomics, cultural resources, and land use. Finally, the impacts of disposing of waste off site are also discussed.

The implementation phase impacts also analyze radiological impacts from potential accidents. This analysis presents the potential consequences of unlikely accidents involving radiological material.

The EIS also evaluates the long-term impacts that could occur during the post-implementation phase. These long-term impacts are reported for the 1,000 years after completing the implementation actions for the alternatives. The post-implementation impacts discussions present the expected impacts followed by impacts from less likely events. The expected post-implementation condition for Alternative I (Removal) is free release of the Center. The expected post-implementation condition for Alternatives II (On-Premises Storage), III (In-Place Stabilization), and IV (No Action: Monitoring and Maintenance) assumes institutional control with ongoing monitoring and maintenance to (a) restrict access to the Project Premises and the SDA, (b) monitor the environment, (c) maintain the facilities, and (d) monitor erosion and take corrective action to prevent loss of facilities. Therefore, the expected post-implementation impacts for Alternatives II, III, and IV assume active monitoring and maintenance of the Project Premises and the SDA. The expected post-implementation condition for Alternative V (Discontinue Operations) does not include active monitoring and maintenance; therefore, monitoring and maintenance were not assumed for the impact analysis.

Over the long term, it is possible that planned long-term actions may cease. In particular, institutional controls could fail and active monitoring and maintenance could stop for Alternatives II, III, and IV. If this were to occur, facilities would deteriorate and the area would erode without mitigation. The post-implementation phase long-term performance assessments evaluate these potential conditions for Alternatives II, III, and IV to evaluate the need for ongoing monitoring and maintenance. Some calculations for the long-term performance assessment are carried out as far as 10,000 years to establish the potential contribution of long-lived, relatively mobile radionuclides. The performance assessment uses conservative parameters in the analysis.

For Alternatives II, III, and IV, ongoing institutional controls to limit site access are planned to reduce the possibility of intrusion. Under Alternative V, there would be no site control to reduce this possibility. The long-term performance assessment analyzes the impacts to human health of conservative intrusion scenarios. The intrusion is postulated to occur 100 years after the implementation phase ends for Alternatives II, III, and IV and immediately for Alternative V (Discontinue Operations). Assuming 100 years pass before intrusion occurs is consistent with NRC regulations and provides what is considered to be worst-case consequences from potential intrusion.

There are uncertainties with the implementation-phase impact analyses because of uncertainty about the performance of particular design features or future regulatory decisions. The discussion of each alternative presents the major sources of uncertainty for the implementation-phase impact analyses and the consequences for the long-term assessment. The long-term performance assessment has biases and uncertainties because of assumptions that were required to conduct the analysis. These biases and uncertainties are discussed for each alternative. The methods used to quantify the impacts for this chapter are detailed in the appendices listed below:

- Appendix C — Description of Waste Management Areas, Projected Waste Inventories, and Environmental Contamination
- Appendix D — Risk Assessment Methods
- Appendix E — Release Models and Source Terms
- Appendix F — Method for Calculating Nonradiological Injuries, Illnesses, and Fatalities
- Appendix G — Method for Calculating Radiation Doses to the Public from Accidents
- Appendix H — Analysis of Transportation Impacts
- Appendix I — Method of Socioeconomic Impact Analysis
- Appendix J — Hydrogeologic Models Used to Calculate Groundwater Flow and Transport
- Appendix K — Method for Estimating Nonradiological Air Quality Impacts
- Appendix L — Erosion Studies
- Appendix M — Evaluation of Natural Phenomena
- Appendix N — Potential Locations for New Facilities
- Appendix O — Long-Term Structural Performance of Selected Reinforced Concrete Structures at the Western New York Nuclear Service Center

Key facilities in the analysis of environmental impacts include the process building in WMA 1, the LLWTF and associated lagoons in WMA 2, the HLW tanks and vitrification facility in WMA 3, the NDA in WMA 7, the SDA in WMA 8, and the RTS drum cell in WMA 9. These facilities are most likely to constrain the choice of closure alternatives based on their contribution to the site inventory of radionuclides as identified in Appendix C.

5.1 RADIATION EFFECTS

This section explains basic concepts used in the evaluation of radiation effects as background for discussion of impacts in Sections 5.2 through 5.6.

5.1.1 Human Health Effects

The effects on people of radiation that is emitted during disintegration (decay) of a radioactive substance depends on the kind of radiation (alpha and beta particles, and gamma and x-rays) and the total amount of radiation energy absorbed by the body. The total energy absorbed per unit quantity of tissue is referred to as absorbed dose. The absorbed dose, when multiplied by certain quality factors and factors that take into account different sensitivities of various tissues, is referred to as effective dose equivalent, or where the context is clear, simply dose. The common unit of effective dose equivalent is the rem [1 rem equals 1,000 millirem (mrem)].

An individual may be exposed to ionizing radiation externally, from a radioactive source outside the body, and/or internally, from ingesting or inhaling radioactive material. The external dose is different from the internal dose. An external dose is delivered only during the actual time of exposure to the external radiation source. An internal dose, however, continues to be delivered as long as the radioactive material remains in the body, although both radioactive decay and elimination of the radionuclide by ordinary metabolic processes decrease the dose rate with the passage of time. The dose from internal exposure is calculated over 50 years following the initial exposure.

The maximum annual allowable radiation dose to an individual of the public from licensed nuclear facilities is 0.1 rem (100 mrem) per year as defined in 10 CFR Part 20, "Standards for Protection Against Radiation." It is estimated that the average individual in the U.S. receives a dose of about 0.3 rem (300 mrem) per year from natural sources of radiation. A person must receive an acute (short-term) dose of approximately 600 rem (600,000 mrem) before there is a high probability of near-term death (NAS/NRC 1990).

Radiation can cause a variety of ill-health effects in people including the induction of latent cancer fatalities. This effect is referred to as latent cancer fatalities because the cancer may take many years to develop and for death to occur.

The collective (or population) dose to an exposed population is calculated by summing the estimated doses received by each member of the exposed population. This total dose received by the exposed population is measured in person-rem. For example, if the 1,350,000 people living in an 80-km (50-mi) radius of the Center each received a dose of 0.001 rem (1 mrem), the collective dose is 1,350,000 persons x 0.001 rem (1 mrem) = 1,350 person-rem.

The dose-to-risk conversion factors presented below and used in this EIS to relate radiation exposures to latent cancer fatalities are based on the "1990 Recommendations of the International Commission on Radiation Protection" (ICRP 1991). These conversion factors are consistent with those used by the NRC [56 FR 23363 (FR 1991a)]. The factor that this EIS uses to relate a dose to its effect is 0.0004 latent cancer fatalities per person-rem for workers and 0.0005 latent cancer fatalities per person-rem for individuals among the general population. The latter factor is slightly higher because there are individuals in the general public that may be more sensitive to radiation than workers (e.g., infants).

These conversion factors represent the best-available estimates for relating a dose to its effect; most other conversion factors fall within the range of uncertainty associated with the conversion factors that are discussed in NAS/NRC (1990).

These concepts are applied to estimate the effects of exposing a population to radiation. For example, in the population of 1,350,000 people within an 80-km (50-mi) radius of the Center exposed only to background radiation [0.3 rem (300 mrem) per year], 203 latent cancer fatalities per year would be inferred to be caused by the radiation [1,350,000 persons x 0.3 rem (300 mrem) per year x 0.0005 latent cancer fatalities per person-rem = 203 latent cancer fatalities per year].

For acute doses greater than 20 rem (20,000 mrem), the conversion factors used to relate radiation doses to latent cancer fatalities are doubled. The accident analyses in Sections 5.2 through 5.6 present maximum individual doses greater than 20 rem. The amount of material that would be released following an accident, the limited population in the immediate vicinity of the Center, and the nature of atmospheric dispersion, result in most of the population dose from accidents being associated with individuals located further from the Center where the individual doses are less than 20 rem (20,000 mrem). The estimate of the total latent cancer fatalities in the off-site population is dominated by the latent cancer fatalities that could occur in the large population receiving individual doses of less than 20 rem (20,000 mrem). Even though the risk of a latent cancer fatality is a factor of two higher for the population that receives the large individual doses [i.e., greater than 20 rem (20,000 mrem)], the total dose to this small portion of the population is much less than that to the balance of the larger population. An example from Appendix G illustrates this point. The population dose for the worst-case accident described in Appendix G predicts the largest off-site individual dose as 100 rem (100,000 mrem). In this instance, 99.7 percent of the total population dose is associated with individual doses of less than 20 rem (20,000 mrem). Therefore, over 99 percent of the total latent cancer fatalities are associated with the large population which receives individual doses of less than 20 rem (20,000 mrem).

Calculations of the number of latent cancer fatalities associated with radiation exposure often do not yield whole numbers, and the number may be less than 1.0. For example, if a population of 1,350,000 were exposed as above, but to an average dose of only 0.001 rem (1 mrem) per person, the collective dose would be 1,350 person-rem, and the corresponding estimated number of latent cancer fatalities would be 0.7 (1,350,000 persons x 0.001 rem x 0.0005 latent cancer fatalities/person-rem = 0.7 latent fatal cancers). This value of 0.7 is the average number of latent cancer deaths that would occur if the same radiation exposures were applied to many different groups of 1,350,000 people. Most groups of this size and this radiation exposure would experience 1 latent cancer fatality but several groups would experience none. The average would be 0.7.

The same concepts apply to estimating the effects of radiation exposure on a single individual. For example, the effects of exposure of a single individual to background radiation over a lifetime are calculated below. The "number of latent cancer fatalities" corresponding to a single individual's exposure over a (presumed) 72-year lifetime to 0.3 rem (300 mrem) per year is the following:

1 person x 0.3 rem (300 mrem)/year x 72 years x 0.0005 latent cancer fatalities/person-rem = 0.011 latent cancer fatalities.

In addition to latent cancer fatalities, other health effects could result from environmental and occupational exposures to radiation. These effects include nonfatal cancers among the exposed population and genetic effects in subsequent generations. Table 5-1 shows the dose-to-effect factors for these potential effects, as well as for latent cancer fatalities. For clarity and to allow ready comparison with health impacts from other sources, such as those from chemical carcinogens, this EIS presents estimated effects of radiation only in terms of latent cancer fatalities. Estimates of the total detriment (fatal cancers, nonfatal cancers, and genetic effects) due to radiation exposure may be obtained from the estimates of latent cancer fatalities presented in this EIS by multiplying by 1.4 for workers and by 1.46 for the general public.

Table 5-1. Risk of Latent Cancer Fatalities and Other Health Effects from Exposure to Radiation[a]

Population[b]	Latent Cancer Fatality	Nonfatal Cancer	Genetic Effects	Total Detriment
Workers	0.0004	0.00008	0.00008	0.00056
General Population	0.0005	0.0001	0.00013	0.00073

a. When applied to an individual, units are lifetime probability of latent cancer fatalities per rem (or 1,000 mrem) of radiation dose. When applied to a population of individuals, units are excess number of cancers per person-rem of radiation dose. Genetic effects as used here apply to populations, not individuals.

b. The difference between the worker risk and the general public risk is attributable to the fact that the general population includes more individuals in sensitive age groups (that is, less than 18 years of age and over 65 years of age).

Source: ICRP (1991)

5.1.2 Risk

Another concept important to the presentation of results in this EIS is the concept of risk. Risk is most important when presenting accident analysis results. The chance that an accident might occur during the conduct of an operation is called the probability of occurrence. An event that is certain to occur has a probability of 1 (as in 100 percent certainty). The probability of occurrence of an accident is less than one because accidents, by definition, are not certain to occur. If an accident is expected to happen once every 5 years, the frequency (and probability) of occurrence is 0.2 per year (1 occurrence ÷ 5 years = 0.2 occurrences per year).

Once the frequency (occurrences per year) and the consequences (for radiation effects, measured in terms of the number of latent cancer fatalities caused by the radiation exposure) of an accident are known, the risk can be determined. The risk per year is the product of the annual frequency of occurrence times the number of latent cancer fatalities. This annual risk expresses the expected number of latent cancer fatalities per year, taking account of both the annual chance that an accident might occur and the estimated consequences if it does occur.

For example, if the frequency of an accident were 0.2 occurrences per year and the number of latent cancer fatalities resulting from the accident were 0.05, the risk would be 0.01 latent cancer fatalities per year (0.2 occurrences per year x 0.05 latent cancer fatalities per occurrence = 0.01 latent cancer fatalities per year). Another way to express this risk (0.01 latent cancer fatalities per year) is to note that if the operation subject to the accident continued for 100 years, one latent cancer fatality would be likely to occur because of accidents during that period. This is equivalent to 1 chance in 100 that a single latent cancer fatality would be caused by the accident source for each year of operation.

A frame of reference for the risks from accidents associated with the alternatives can be developed in the same way. For an average resident in the vicinity of the Center, the risk of a latent cancer fatality caused by the breach of radioactive waste drums in the RTS drum cell after a large earthquake would be approximately 5×10^{-8} per year or lower.

5.1.3 Evaluation of Long-Term Impacts

Potential long-term impacts of abandoning the Center include gradual transport of contaminants off site through the air or water and possible occupation of the Project Premises and SDA area by individuals unaware of the danger of intruding into the disposed waste.

Four broad categories of hypothetical scenarios were evaluated to determine the range of potential long-term radiological impacts from abandoning the Center. The likelihood of these scenarios ranges from unlikely to probably incredible (chance of 1 in 10,000 to 1 in 1 million) but they give the range of "what ifs" and an understanding of the risks with this alternative. The four categories considered are impact to individuals (1) residing on the Project Premises and SDA, who drink water from a well located within the contaminated groundwater plume on the north plateau, (2) intruding on the Project Premises and SDA who come into direct contact with contaminated sediments and stored and buried wastes, (3) drinking water from Buttermilk Creek, and (4) drinking water from Buttermilk Creek after erosion has caused collapse of waste into the stream and high concentrations of radionuclides in the creek.

The magnitude of the potential impact would be a function of the year intrusion occurred. Over the first few hundred years after abandonment, the radionuclides of most concern would be strontium-90 and cesium-137, which decay rapidly (with 27.4 and 30.1 year half-lives, respectively). To establish an upper limit on the potential impacts, loss of institutional controls was assumed to occur at abandonment, and the impacts were evaluated for the year 2000.

In the first category of hypothetical scenarios, individuals were assumed to reside on the Project Premises and SDA, drill wells near the disposal areas, and locate the wells in the most contaminated portion of the north plateau groundwater plume. This scenario is viewed as highly unlikely because it requires the loss of institutional control, loss of knowledge that this area contains buried nuclear waste, drilling a water well in the north plateau groundwater plume, and using well water for an extended period without testing.

The second category of hypothetical scenarios involves individuals intruding on the Project Premises and SDA and coming into direct contact with contaminated sediments, stored wastes, and buried wastes. The scenarios evaluated included an individual entering and exploring the abandoned buildings and coming into direct contact with the waste through construction and drilling. These scenarios are also viewed as highly unlikely because they also require loss of institutional control and loss of knowledge that the area contains buried nuclear waste.

The third category of hypothetical scenarios involves individuals drinking water from Buttermilk Creek. A number of potential scenarios were examined to determine the potential radiological impacts to the public off site. The highest potential doses are from a very unlikely sequence of events: ground or surface water becomes contaminated by contact with the buried waste, the contaminated water migrates off site, the contaminated water is not highly diluted by streams and other waters, the contaminated water is not detected, and sufficient quantities of the contaminated water are consumed for drinking or agricultural purposes so that members of the public receive radiological doses or exposures of concern. Overall, the probability of this exact sequence of events occurring would be low, although some aspects, including contact with the buried wastes or contaminated soils, are likely. It is also likely that some contaminated groundwater would migrate to streams on the Project Premises that flow into Buttermilk Creek on the balance of the site. It is much less likely that the radionuclide concentrations in Buttermilk Creek would be high and that sufficient quantities of untested water would be consumed.

Finally, the fourth category of hypothetical scenarios involves the potential dose to individuals using water from Buttermilk Creek on the balance of the site for an extended period of time after the Project Premises and SDA area had eroded, causing buried waste to collapse into the creeks and transporting high concentrations of radionuclides into Buttermilk Creek. This scenario is a concern because conservative estimates of erosion (worst case) (see Appendix L) indicate that portions of the disposal areas could erode without active erosion control measures.

5.1.4 Radiological Impacts on the Natural Environment

EIS impact assessments estimate the concentration of potentially hazardous substances in the physical environment, including the atmosphere, groundwater, surface water, some animal and aquatic species, and indirectly, in crops grown for human consumption. Evaluating the magnitude of the potential impact of these changes on environmental quality are qualitative by nature, generally involving comparison with acceptable levels found in regulations promulgated by the EPA and NRC. Frequently, these levels are established to protect human health and do not necessarily protect other species and the non-human environment. Because standard ecological effects models are not available (Suter 1993), more rigorous evaluations of potential impacts are not developed as a formal ecological risk assessment. In addition, while agency work is underway for development of a framework for ecological risk assessment (EPA 1992), no agency guidance exists at the present time. Thus, while quantitative evaluations of impact on non-human species are not provided, the EIS qualitatively evaluates impacts to biotic resources including wetlands. The human impacts are believed to be representative in a comparative fashion to impacts on other species.

5.2 ALTERNATIVE I: REMOVAL AND RELEASE TO ALLOW UNRESTRICTED USE

Under Alternative I, site structures and facilities would be decontaminated, demolished, and removed. Stored and buried waste would be removed or exhumed and disposed of off site. In-ground structures would be removed and disposed of off site. Soils contaminated above the assumed contaminant cleanup level described in Appendix C would be removed and either treated to levels which allow release for unrestricted use and returned to the site or disposed of off site. The implementation of this alternative would require large amounts of labor and waste transportation because contamination at the site would be remediated to levels which allow release for unrestricted use. The disturbed area would be 80 ha (199 acres), and no structures or waste volumes would remain on the Center.

The total volume of contaminated waste and soil to be removed would be approximately 265,000 m^3 (9.34 million ft^3). The types and volumes of waste expected to be generated by implementing this alternative are presented in Section 3.3.3. The following volume of wastes would be generated: 236,000 m^3 (8.34 million ft^3) of Class A waste and soil, 11,000 m^3 (389,000 ft^3) of Class B waste, 9,120 m^3 (322,000 ft^3) of Class C waste, 7,710 m^3 (272,000 ft^3) of GTCC waste, and 300 m^3 (10,600 ft^3) of HLW. Approximately 0.14 m^3 (5 ft^3) of hazardous waste and 51 m^3 (1,810 ft^3) of mixed waste would also be shipped off site. It is estimated that as much as 145,000 m^3 (5.13 million ft^3) of industrial waste could be generated (modified from WVNS 1994a through n).

The environmental impacts from implementing Alternative I would vary depending on the success of the design-basis assumptions for certain engineering features. For example, if the soil treatment effectiveness is reduced, then a larger volume of contaminated soil would have to be managed as part of site closure. Likewise, if some of the waste currently classified as industrial waste is determined to be LLW after characterization, then a larger volume of LLW would have to be managed. These potentially larger volumes would affect the number of waste shipments that would have to be made to an off-site disposal facility. Likewise, occupational dose to workers and emissions could vary depending on the success of the remote excavation systems for NDA and SDA disposal areas. The uncertainties in implementation lead to uncertainties for particular environmental impacts. These uncertainties are discussed in Section 5.2.3.

5.2.1 Implementation Phase Impacts

The actions that would be performed to implement Alternative I are discussed in Section 3.3 and summarized in Figure 5-1. During the implementation phase:

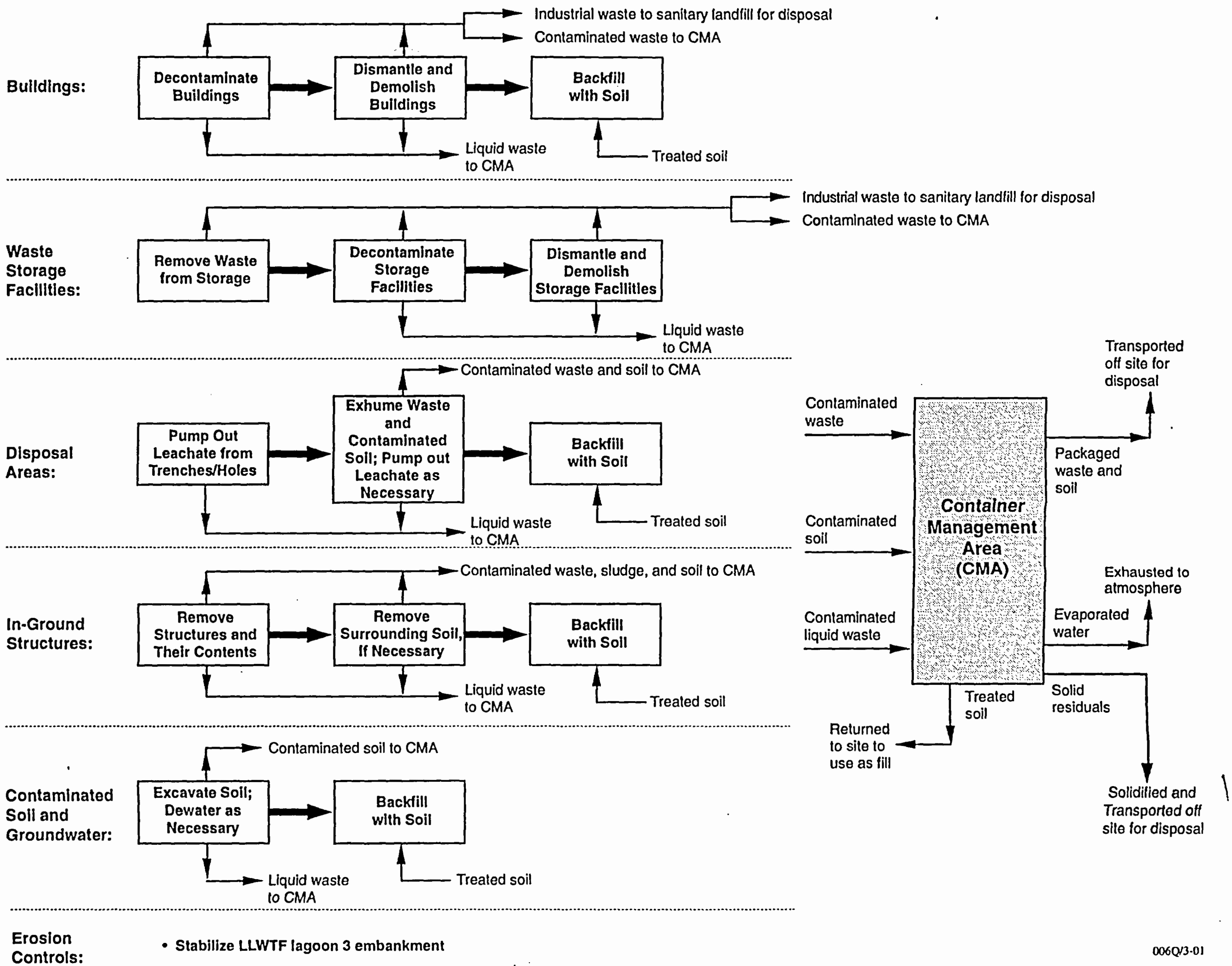

Figure 5-1. General Strategy for Implementing Alternative I (Removal).

- Contaminated buildings in WMAs 1, 2, and 3 would be decontaminated and demolished, disturbing about a 0.4-ha (1.1-acre) area.

- In-ground structures (e.g., lagoons, ponds, and tanks) would be removed, disturbing approximately a 1.0-ha (2.5-acre) area in WMAs 2, 3, 6, and 8.

- Buried waste in the NDA, SDA, and CDDL would be exhumed along with contaminated soil in these disposal areas, disturbing approximately 11 ha (28 acres) of land in WMAs 4, 7, and 8.

- Remaining facilities in WMAs 1, 2, 3, 6, 10, 11, and 12 would be demolished and removed (including draining and backfilling the reservoirs), disturbing approximately a 20-ha (49-acre) area on the Project Premises, the SDA and on the balance of the site.

- Areas with contaminated soil would be excavated, including soil from the cesium prong (see Section C.3.4.1 in Appendix C) and contaminated soil in the groundwater plume on the north plateau (see Section C.3.2.2 in Appendix C), disturbing about 14 ha (35 acres) on the Project Premises (WMAs 1, 2, 3, 4, and 5) and 14 ha (34 acres) on the balance of the site.

- Stored waste in WMAs 5, 6, 7, and 9 and waste generated by the activities described above would be shipped off site. The waste storage facilities in these WMAs would be demolished, disturbing about 1.1 ha (2.8 acres).

- A new container management area for treating and packaging waste (see Section 3.3.2.2) would be constructed (possibly in WMA 6), disturbing about 0.5 ha (1.2 acres) on the Project Premises.

- The LLWTF lagoon 3 embankment would be stabilized to control soil erosion during the implementation phase.

5.2.1.1 Resource Requirements

Alternative I requires resources for constructing new facilities during the implementation phase (e.g., repackaging, volume reduction, and soil treatment facilities) and for decontamination, demolition, and exhumation. Resource requirements (electrical power, natural gas, and diesel fuel) for each facility are summarized in Table 5-2.

Most of the electrical power would be required for closure of the process building and SDA and the construction, operation, and demolition of the container management area. The greatest volume of natural gas used for heating would be consumed by the larger facilities (i.e., the process building, vitrification facility, RTS drum cell, and the container management area). The largest fuel requirements would be for exhumation of the NDA and construction and demolition of the container management area.

During implementation of Alternative I, electrical power and natural gas requirements would be less than the current consumption rates projected to be used from 1996 to 2000 during HLW solidification, but the fuel requirements are greater than current consumption rates. The average electrical power consumption rate would be 2,700 MW-hr/yr, which is much less than the projected consumption rate of 32,000 MW-hr/yr during HLW solidification (Kawski 1995). Even the maximum electrical power consumption rate (4,400 MW-hr/yr), which has been conceptualized to occur in 2004, would be much less than the projected consumption rate. Likewise, the average natural gas consumption rate would be 310,000 m^3/yr (11 million ft^3/yr) which is much less than the projected consumption rate of 2,500 million m^3/yr (89,000 million ft^3/yr) during HLW solidification (Kawski 1995). The maximum natural gas consumption rate [620,000 m^3/yr (22 million ft^3/yr)], which would occur from 2006 to 2013, would be much less than the projected consumption rate. However, the average consumption rate of gasoline and diesel fuel would be 300,000 L/yr (79,000 gal/yr), which is approximately three times greater than the current consumption rate of 93,000 L/yr (24,500 gal/yr) (Kawski 1995).

Table 5-2. Estimated Energy and Fuel Requirements for Alternative I (Removal)

	Implementation Phase[a,b]		
WMA/Facility	Electrical Power (MW-hr)	Natural Gas (ft^3)[c]	Diesel Fuel and Gasoline (gal)[d]
1—Process Building	33,000	9.7×10^7	130,000
01/14 Building	120 (260)[e]	240,000	8,200
2—LLWTF and Lagoons 1-5	93	72,000	51,000
3—HLW Tanks/Vitrification Facility	770 (1,500)	6.6×10^7	180,000
4—CDDL	0	0	51,000
5—CPC Waste Storage Area	0	0	790 (8,300)
Lag Storage Building/Additions	29	0	4,300 (8,400)
7—NDA	13	0	380,000
8—SDA	12,000	0	120,000
9—RTS Drum Cell	800	8.4×10^6	36,000
Other Facilities (including WMAs 6,10,11,12)	0	0	170,000
Erosion Control	0	0	1,100
Container Management Area	18,000	1.0×10^8	790,000
Total	65,000	2.7×10^8	1.9×10^6

a. All values have been rounded to two significant figures.
b. No post-implementation phase would be required.
c. To convert cubic feet to cubic meters, multiply by 0.02832.
d. To convert gallons to liters, multiply by 3.785.
e. Values in parentheses are those in the 1995 versions of the closure engineering reports. The Final EIS will use the final versions of the closure engineering reports.

Sources: WVNS (1994a through n)

There would be no post-closure annual requirements because the entire site would have been released for unrestricted use.

In addition to the above resources, approximately 0.45 million m^3 (15.8 million ft^3) of soil would be needed to backfill and landscape excavated areas on the Project Premises and SDA (WVNS 19941), of which approximately 362,000 m^3 (12.8 million ft^3) would be treated soil that had been processed through the container management area. Some areas could be regraded without backfilling. Nearly 1,900 m^3 (67,000 ft^3) of sand and gravel and 31,900 m^3 (1.1 million ft^3) of concrete would be needed to implement Alternative I.

5.2.1.2 Environmental Impacts

Radiological (Occupational and Transportation)

Radiological impacts expected during the implementation phase include exposure of the public to small quantities of radioactive material from controlled releases to the atmosphere, exposure of workers to direct radiation and contaminated material, exposure of the public to direct radiation during off-site transportation of waste material, and increased risk to workers and the public from potential accidents. Evaluation of the impacts of the projected activities is based on estimates of doses to workers, to a maximally exposed individual off site, and to the surrounding population to a distance of 80 km (50 mi). Appendices D through G give detailed descriptions of the database and methods used in this analysis.

The decontamination and decommissioning and closure actions described in Chapter 3 are designed to remove contamination with the smallest possible release to the environment. However, excavation, decontamination, and waste handling would result in unavoidable releases of radioactive material to the atmosphere and exposure of workers to direct radiation, dermal contact, and potential inhalation of contaminated material. Potential releases of radioactivity to the environment during closure would be possible from 5 of the 12 WMAs as shown in Table 5-3. Unavoidable releases from these five WMAs would include the filtered release of airborne dust from temporary isolation structures, atmospheric entrainment of contaminated dust, and controlled release of treated decontamination and trench leachate solutions to the atmosphere. The conceptual engineering designs do not have planned releases to surface water. In addition to these normal operational releases, unforeseen events such as accidents could release radioactive material to the environment. Closure of the CDDL, lag storage building, lag storage additions, CPC waste storage area, rail spur, and the remaining facilities in WMAs 6 and 10 on the north and south plateaus would not be expected to release radioactivity.

Off-Site Impacts. To conservatively estimate the potential public doses, the off-site individual and the surrounding population are assumed to receive direct radiation from airborne and deposited contaminated material, to breathe contaminated air, and to consume locally grown food contaminated by material deposited on crops from the air. The off-site individual is assumed to be located 1,500 m (4,900 ft) northwest of the Project Premises, at the current location of the nearest permanent residence. The calculated internal doses for

WMA releases during cleanup are summarized in Table 5-3. External doses for the air pathway varied from two to four orders of magnitude less than the internal doses presented in Table 5-3.

Table 5-3. Impacts to the Public from Implementation Phase Releases for Alternative I (Removal)

	Air Pathway[a]				
WMA/Facility	Off-Site Individual (mrem/yr)	Collective Dose (person-rem/yr)	Duration of Release (yr)	Total Collective Dose (person-rem)	Latent Cancer Fatalities (LCF)
1—Process Building	0.62	4.2	8	33.6	0.017
2—LLWTF and Lagoons 1-5	0.004	0.03	1	0.03	0.00002
3—HLW Tanks/Vitrification Facility	0.58	3.6	3	10.8	0.0054
7—NDA	0.30	1.9	6	11.4	0.0057
8—SDA	0.87	3.0	19	57.0	0.029
Total				112.8	0.057

a. Since the facilities are not decontaminated and decommissioned at the same time, the peak doses are not additive. Even if the peak doses were to occur simultaneously, these doses would be very low.

b. The average annual risk of a latent cancer fatality due to the total atmospheric release is 6.6×10^{-7} for the maximally exposed individual, and 2.2×10^{-9} for the average individual in the population.

For the air pathway impacts, doses from inhalation would dominate the food ingestion and direct exposure modes. The controlling nuclide for atmospheric releases would be strontium-90 for releases from WMA 2, tritium for releases from WMA 8, and plutonium-239 for releases from the other WMAs. In each case, the estimated incremental doses would be less than 2 percent of the dose that the maximally exposed individual would receive from background radiation and below applicable EPA dose limits (40 CFR Part 190, Protection of Environment, "Environmental Radiation Protection Standards for Nuclear Power Operations"; 40 CFR Part 61, Protection of Environment, "National Emission Standards for Hazardous Air Pollutants"). The average annual risk of a latent cancer fatality due to the total atmospheric release is 6.6×10^{-7} for the maximally exposed individual and 2.2×10^{-9} for the average individual in the population.

The total collective dose to the regional population for the implementation phase is approximately 113 person-rem with no expected additional latent cancer fatalities. This corresponds to an estimated 0.057 latent cancer fatalities from releases during closure.

Occupational Doses. Radiation doses to workers are determined by multiplying the average radiation dose rate that workers would be exposed to during specific tasks by the number of person-hours required to complete the tasks. Information on person-hours is from the closure engineering reports (WVNS 1994a through n). The estimates were compared to historical occupational exposure data for related activities at DOE facilities to determine if the estimated worker doses for activities at the Center were within the same range. Appendix F presents details on the methodology used to estimate occupational doses during routine operations. The estimated doses and the corresponding health effects in terms of latent cancer fatalities resulting from these exposures as a function of the WMA are summarized in Table 5-4. The highest collective occupational exposure would be from the

Table 5-4. Cumulative Occupational Radiological Impacts for Alternative I (Removal)

WMA/Facility[a]	Collective Occupational Dose (person-rem)	Latent Cancer Fatalities
1—Process Building	554	0.22
01/14 Building	4.0	0.0016
2—LLWTF and Lagoons 1-5	40	0.016
3—HLW Tanks/Vitrification Facility	203	0.081
4—CDDL	0	0
5—CPC Waste Storage Area	0.3	0.0001
Lag Storage Building/Additions	3.0	0.0012
7—NDA	129	0.052
8—SDA	45	0.018
9—RTS Drum Cell	2	0.0008
Other Facilities (including WMAs 6,10,11,12)	0	0
Container Management Area	252	0.10
Total	1,230	0.49

a. Doses attributable to individual facilities are given when appropriate. If no facilities are listed, then the dose estimates are applicable to the WMA.

decontamination and decommissioning of the process building, HLW tanks, and vitrification facility; the recovery of the wastes from the NDA and SDA; and construction and operation of the container management area. The overall impacts on the work force in terms of latent cancer fatalities are estimated to be less than 1 additional latent cancer fatality (actual estimate, 0.49) from the occupational radiation exposures.

Occupational exposures would also be received by the transportation crew during shipment of the radioactive wastes by either truck or rail. Estimated doses for these workers are discussed below. Estimated doses to the on-site workers loading waste drums onto trucks or railcars is included in the overall occupational exposure estimates in Table 5-4.

Transportation Impacts. Transportation impacts from implementing Alternative I include the local, regional, and national impacts of the 20 to 30 thousand (or more) shipments of radioactive and industrial waste and the impacts due to worker and construction traffic near the Center. The off-site disposal of radioactive and industrial waste generated by the implementation actions under this alternative is estimated to require a large number of shipments over the implementation phase. The number of truck or railcar shipments by WMA are shown in Table H-2 of Appendix H.

It is estimated there would be approximately 21,074 and 9,968 truck shipments of radioactive waste and industrial waste, respectively. If waste were shipped by rail, the estimated number of rail-car shipments would be 30 to 37 percent less. The largest number of radioactive waste shipments would be from WMA 7 (the NDA) and WMA 8 (the SDA), which account for 31 and 35 percent, respectively, of the total radioactive waste shipments. The remaining facilities in WMAs 6 and 10 account for about half of the total industrial waste shipments.

Because of the uncertainty in the potential cleanup efficiency of radioactively contaminated soils, the impact of shipping a large volume of contaminated soils was evaluated in Appendix H. The worst case represents an extreme for impact evaluation as described in Section 5.2.3.

Potential impacts from shipping waste were evaluated in several areas:

- Radiological impacts to transportation workers and the general public from direct exposure to low levels of gamma radiation from the radioactive waste containers
- Radiological impacts from transportation accidents that have radioactive releases from waste containers
- Nonradiological injuries and fatalities from transportation accidents
- Air pollution effects from truck or train exhaust.

The impact from each of these areas could statistically increase the number of fatalities among the people using, working, or residing near the selected highway or rail corridors. The radiological impact of direct exposure to the waste containers and the radiological impact of transportation accidents are reported in terms of potential latent cancer fatalities among the exposed population. The effects from air pollution are expressed as fatalities, including latent cancers. Nonradiological impacts of transportation accidents are reported as traffic fatalities.

Each area is evaluated in the following sections. The impact of transporting waste locally, work force commuting, and deliveries to and from the Center are also discussed.

Radiological Impacts of Incident-Free Transportation. The radiological impact of incident-free transportation would result from exposure to the waste containers during transportation. The exposure an individual could receive would be proportional to the distance from the waste containers, the radioactivity emitted, and the time spent near the waste containers. The actual exposure or dose to any single member of the general public is expected to be very low (much lower than a dental x-ray), but large numbers of people would be slightly exposed. Collectively, as discussed in Section 5.1, these small exposures to large numbers of people are predicted to result in a statistical increase in the number of latent cancer fatalities among the exposed population using, working, and residing along the transportation corridors.

The site or sites that could receive the radioactive wastes from the Center would be selected in the future as discussed in Section 3.2.3.1. Both commercial and DOE waste disposal sites might be considered to receive portions of the radioactive waste. The analyses in this EIS use the Hanford Site, in the State of Washington, and the Nevada Test Site as destinations for radioactive wastes from the Center because they are the two major DOE sites being evaluated for waste disposal in the *Waste Management Programmatic Environmental Impact Statement (PEIS)*. These two sites are farthest from the Center and are used to bound the estimates of potential environmental impacts from transporting radioactive waste. The transportation analyses in Appendix H assume that the radioactive waste is shipped to one of these two sites although other sites under consideration in the PEIS for off-site disposal of waste include sites closer to the Center. Both incident-free transportation impacts and accident risks would be reduced with shorter transportation distances.

The method used for transportation analysis was developed for the NRC to analyze the nationwide impact of transporting radioactive materials; this method is incorporated in the RADTRAN4 computer code (see Appendix H). The first step in the analysis was to identify the transportation routes and to estimate the population density along the routes to determine the potentially exposed population. Representative highway and rail routes were analyzed using the routing computer codes HIGHWAY (Johnson et al. 1993a) and INTERLINE (Johnson et al. 1993b). The calculated routes conformed to current routing practices and applicable routing regulations and guidelines. The second step in the analysis was to characterize the radioactive waste, including evaluating shielding requirements and selecting transportation packages. This analysis evaluates the use of 208-L (55-gal) drums, B-25 boxes, and seven additional truck and rail transportation packages. For a waste volume, the selected transportation package determines the required number of shipments and the related transportation risks. The third step in the analysis was to integrate the radiation doses to the workers and population along the transportation routes.

The waste was radiologically characterized based on data from the facility waste characterization reports and the closure engineering reports. Waste with similar surface dose rates and disposal classifications was grouped into categories for each of the WMAs. Dose rates for 39 combinations of waste types and waste containers were estimated as shown in Table H-4 in Appendix H. The contaminated soil volume was estimated as described in Appendix C and processed through the proposed container management area soil treatment area to reduce the volume. Table 5-5 presents the incident-free radiological transportation results by WMA.

The shipment of radioactive waste was evaluated for two cases: case 1 is the expected case and assumes that the design basis treatment efficiencies for soil as described in Section 3.3.2.2 would be met; case 2 assumed that design basis conditions were not met and

Table 5-5. Total Estimated Radiation-Induced Latent Cancer Fatalities from Incident-Free Transportation for Alternative I (Removal)

	Hanford Site				Nevada Test Site			
	Occupational		General Population		Occupational		General Population	
WMA	Truck	Rail	Truck	Rail	Truck	Rail	Truck	Rail
1—Process Building	0.031	0.00065	0.038	0.0031	0.029	0.00067	0.036	0.0028
2—LLWTF and Lagoons 1-5	0.032	0.0035	0.14	0.017	0.030	0.0036	0.13	0.015
3—HLW Tanks/Vitrification Facility	0.040	0.010	0.51	0.050	0.037	0.011	0.47	0.046
4—CDDL								
5—Waste Storage Area Lag Storage Building/Additions	0.049	0.0046	0.17	0.022	0.046	0.0047	0.16	0.019
6 & 10—Central Project Premises and Support and Services Area	1.8×10^{-5}	4.4×10^{-7}	2.1×10^{-5}	2.1×10^{-6}	1.6×10^{-5}	4.6×10^{-7}	2.0×10^{-5}	1.9×10^{-6}
7—NDA	0.027	0.0010	0.044	0.0050	0.026	0.0011	0.041	0.0044
8—SDA	0.38	0.12	5.0	0.59	0.36	0.13	4.6	0.52
9—RTS Drum Cell	0.0012	2.6×10^{-5}	0.0015	0.00013	0.0012	7×10^{-5}	0.0014	0.00011
Total	0.56	0.14	5.9	0.69	0.53	0.15	5.5	0.60

and is a sensitivity case. The number of shipments under the sensitivity case approximately doubles because there would be more shipments of contaminated soil. Case 1 (the expected conditions) is discussed in Chapter 5. Appendix H presents results for both cases.

A total of 21,074 truck shipments or 13,292 rail car shipments, would be required to ship radioactive waste off site over the 26-year implementation phase under expected conditions for Alternative I. This corresponds to an average of about 15.6 truck shipments or 9.8 rail car shipments per week during the implementation phase. For all shipments, the main radiological impact is from direct exposure to radiation (principally gamma radiation) emitted from the waste packages. The radiological impacts to either the transportation workers or the nearby members of the public are proportional to the radiation coming from the waste package, the number of shipments, the time exposed, and the distance from the radiation source. The radiological impacts decrease rapidly with distance. For this analysis, a shielding evaluation was performed to conservatively estimate the radiation dose rate near the packages, and radioactive waste was assumed to be shipped the same distance. Therefore, the radiological impact to either transportation workers or nearby members of the public is approximately proportional to the number of shipments and the distance shipped.

The direct radiation exposure to transportation workers for shipping waste by truck to the Hanford Site or Nevada Test Site was conservatively estimated to result in a collective dose of about 1,300 to 1,400 person-rem over the implementation phase, corresponding to an additional 0.53 to 0.56 latent cancer fatalities among these workers. The highest risk contributors to this exposure are shipments from WMA 8, the SDA, which accounts for approximately 68 percent of the occupational exposures to transportation workers over the implementation phase.

If the radioactive wastes were shipped by rail instead of truck, the estimated collective dose to the transportation work force from the 13,292 rail car shipments would be about 360 to 370 person-rem over the implementation phase. This would result in 0.14 to 0.15 latent cancer fatalities from radiation exposure to the wastes among the transportation work force. Collective occupational exposures are higher for truck than for rail transportation because the truck drivers are closer to the waste packages.

With truck shipment, the maximally exposed worker is the truck driver. If the waste packages are at the regulatory limit for radiation exposure, a truck driver assumed to drive shipments for 2,000 hours per year was estimated to receive a radiation dose of 4.0 rem/yr. With rail shipment, the maximally exposed worker is assumed to be a railyard worker inspecting, classifying, and repairing railcars. The estimated maximum annual exposure for the rail worker is 0.53 rem/yr. The latent cancer risk to a worker receiving 0.53 or 4.0 rem is approximately 0.0002 or 0.0016, respectively.

The direct radiation exposure of the general population along the transportation routes was also estimated with very conservative assumptions. For the 21,074 truck shipments of waste, the radiological exposures were estimated to result in 5.5 to 5.9 latent cancer fatalities among the population along the highways. The rail shipments were estimated to cause 0.60 to 0.69 latent cancer fatalities among the population along the railroad routes. Collective population exposures are higher per truck shipment than per rail shipment because of a greater chance for exposure to people traveling the same highway and exposure while the trucks are stopped.

With both truck and rail transport, the estimated direct radiation exposure to the maximally exposed member of the general population could vary considerably. The estimated dose to the maximally exposed member of the general population is 0.097 rem/yr (truck) and 0.26 rem/yr (rail), corresponding to a latent cancer risk of 0.00005 and 0.00013, respectively.

Postulated Facility Accidents. A wide range of accidents could occur during the implementation phase of Alternative I. These incidents could result from operational accidents, such as handling mishaps, on-site transportation accidents, fires, and spills, or from external initiators, such as natural phenomena including high winds and earthquakes. Although many accidents can be postulated during decontamination and demolition of the facilities, excavation of buried waste, and packaging and handling of the wastes before shipment, only a few accidents could potentially result in an uncontrolled release of radioactive material to the environment.

Although the proposed closure operations and supporting facilities and processes have not yet been fully designed, accident scenarios would have been considered in the development of the final design. It is assumed that current safety design and construction standards would be applied to future operations so that the accident risks to the workers and public are reduced to as low as is reasonably achievable (ALARA) levels.

A range of postulated accidents was analyzed for each WMA containing significant radiological contamination (see Appendix G). These analyses are intended to present reasonable, credible, and conservative estimates of the maximum radionuclide releases that could potentially occur during and after implementation of an alternative. The postulated accident conditions, including accident initiators, release fractions, and meteorological conditions, are conservative. Because the designs evaluated are preliminary or preconceptual, conservative assumptions were made to determine source terms and the progression of the accident scenarios. It is likely that later accident assessments based on actual design information would result in lower estimated doses. Taken together, these conservative assumptions ensure that actual radiation doses for accidents similar to those postulated would likely be much less than those estimated in this EIS.

The operational accidents that could lead to significant radiological releases are assumed to be extremely unlikely, with probabilities in the range of 1 in 10,000 to 1 in 1 million or lower per year during the implementation phase. Such low probabilities are reasonable because closure processes and equipment must be designed to meet DOE guidance requiring estimated accident probabilities of less than 1 in 1 million per year for events which would cause off-site doses greater than 25 rem. Preliminary designs specify that where there are significant quantities of radioactive materials, activities must be conducted within containment structures with high-efficiency particulate air filtration systems. Accidents resulting in significant releases to the environment would have to breach the confinement system designed to survive the accident. Previous accident analyses for similar types of operations at other DOE and NRC sites indicate that the probabilities for these types of accidents are in the extremely unlikely (in the range of 1 in 10,000 to 1 in 1 million) to incredible range.

Bounding accidents initiated by natural phenomena, including tornadoes and earthquakes, were also considered. For the implementation phase, low probability beyond design basis earthquakes present the greatest risk of a major, bounding release among the natural phenomena initiators. The original design criterion applied to plant buildings was to accommodate peak ground accelerations of 0.12g. For new DOE or NRC moderate hazard nuclear facilities, the design basis earthquakes have estimated return periods of several thousand years. For the Center, the design basis earthquake has an estimated peak ground acceleration of 0.2 g. This peak ground acceleration would likely cause structural damage to some of the original former reprocessing facility buildings; many industrial, commercial, and residential structures; and to supporting infrastructures such as bridges, highways, and pipelines, unless these structures were designed to accommodate the seismic motion. To better understand the overall risk of the closure activities, accidents initiated by beyond design basis earthquakes (estimated peak ground acceleration of 0.33 g) were also considered among the range of accident initiators.

The accident scenarios with the largest potential consequences required a mechanism, such as a fire or explosion, for large amounts of waste to become airborne and a concurrent major failure of the building ventilation system. In theory, these events could be initiated by either a combination of extremely unlikely operational failures or by severe, beyond design basis earthquakes.

The postulated accidents for Alternative I having the largest potential radiological consequences to the public are summarized by WMA in Table 5-6 and described in detail in Section G.2 of Appendix G. The impacts are summarized in terms of the maximally exposed off-site individual [i.e., an individual residing at the Center boundary in the downwind direction who is assumed to be located 1,000 m (3,300 ft) from the point of release]; the maximum dose to the projected population residing within 80 km (50 mi) of the Center; and the estimated latent cancer fatalities that might occur within that population of 1,350,000 people as a result of the accident. On-site co-located workers could receive a dose about a factor of 10 higher than the maximally exposed off-site individual. The primary worker dose could be higher as described in Appendix G. The estimated frequencies for these accidents ranges from 1 in 10,000 years of operation to 1 in 100 million years of operation.

Although the potential radiological impacts of certain bounding accidents are high, with off-site doses of 25 rem or less, doses are not high enough that immediate radiation-related health impacts would be expected. Mitigation measures, including firefighting during the accident, would likely reduce the off-site exposures. Emergency personnel would be expected to wear respiratory protection equipment to minimize their radiological exposures.

Table 5-6. Summary of Upper-Bound Accidents and Calculated Radiological Consequences for Alternative I (Removal)

WMA/Facility	Description of Upper-Bound Accident	Maximum Individual Dose (rem)	Collective Dose[a] (person-rem)	Latent Cancer Fatalities
1—Process Building	Process building ventilation system confinement fails during decontamination operations[b]	0.6	7,000	3.5
2—LLWTF and Lagoons 1-5	Fire/explosion destroys containment structure during Lagoon 1 excavation[b]	7	90,000	45
3—HLW Tanks/Vitrification Facility	Piping failure during removal of tank 8D-2 sludge[b]	0.1	1,000	0.5
5—Lag Storage Building/ Additions	Drum handling accident results in breach of lag storage addition drums[c]	0.00007	0.8	0.0004
7—NDA	Exposed waste in NDA burns and breaches containment structure[b]	20	300,000	150
8—SDA	Exposed waste in SDA burns and breaches containment structure[b]	30	400,000	200
9—RTS Drum Cell	Design basis earthquake results in breach of drums[c]	0.00009	1	0.0005
Container Management Area	Operational accident releases radioactive material[c]	0.9	10,000	5

a. Collective dose from airborne releases to the projected population (year 2000) of 1,350,000 people residing within 80 km (50 mi) of the Center.
b. Estimated annual accident probability is 1 chance in 1,000,000 to 1 chance in 100,000,000 (10^{-6} to 10^{-8}).
c. Estimated annual accident probability is 1 chance in 10,000 to 1 chance in 1,000,000 (10^{-4} to 10^{-6}).

Because of the inherently large uncertainty in trying to estimate the radiological impacts to the on-site work force for facilities that have not yet been designed, explicit consequence estimates for workers were not considered practical. However, the impact on workers from bounding accidents could be high. The direct effects of these extremely unlikely accidents, including fire, explosion, and collapsing roofs could be fatal to workers within the facility. Radiological exposures to facility workers could also be high, although they would not likely be immediately life threatening because the workers have intensive radiological worker training and would have personal protection equipment such as special clothing and respiratory protection.

On-site workers away from the immediate vicinity of an accident could also receive high exposures from some of these postulated accidents. If the doses approached 25 rem at the Center boundary, doses in the range of a few hundred rem could be received immediately downwind of the accident. On-site workers are trained, however, to respond to accidents by evacuating the immediate area and in other emergency response actions that should reduce the incidental exposures to the on-site work force.

Radiological Transportation Accidents. The shipping of radioactive wastes by either truck or rail presents a risk of accidents that could result in injuries, fatalities, and radiation exposures. The packaging requirements by NRC ensure that for all but the most severe truck or rail accidents the risk of severe radiological exposures is very low. For most accidents, it is more likely that injuries or death would result from accidents than from radioactive materials.

Accident frequencies and radiological and nonradiological consequences of transportation accidents are evaluated in Appendix H, and the results are combined to present the overall risks of fatalities from the waste shipments. Accident fatality risks are calculated for short-term fatalities resulting from nonradiological injuries and for longer-term latent cancer fatalities resulting from potential radiological exposures.

Accident risks from transportation were evaluated in Appendix H for the two cases of waste volumes as described previously. The number of shipments under the sensitivity case (Case 2 in Appendix H) approximately doubles because there would be more shipments of slightly contaminated soil. Nonradiological accident risks would also be expected to approximately double for sensitivity cases, but radiological accident risks would not double because about the same amount of radioactivity is shipped under expected conditions or in the sensitivity case.

The estimated number of latent cancer fatalities per year from shipping radioactive wastes to either the Hanford Site or the Nevada Test Site by truck are much less than 1; they are in the range of 0.0013 (expected conditions) to 0.0019 (sensitivity case). Estimated traffic fatalities per year are 0.44 (Hanford) or 0.41 (Nevada Test Site) for the expected conditions and 0.98 (Hanford) or 0.92 (Nevada Test Site) for the sensitivity case. The risk of fatalities from routine traffic accidents is several hundred times the risk of fatalities because of radiological releases in the accidents.

Similar, but lower radiological accident risks were found for shipping radioactive wastes by rail to either site. The estimated number of latent cancer fatalities per year resulting from shipping radioactive waste is estimated to be in the range of 0.00021 (Hanford) or 0.00018 (Nevada Test Site) for expected conditions. Estimated latent cancer risks increase about 48 percent if the higher waste volumes in the sensitivity case are shipped. Estimated traffic fatalities risks are about a factor of 2,000 higher than the latent cancer accident risks. For expected conditions, the estimated number of traffic fatalities per year are 0.41 (Hanford) or 0.39 (Nevada Test Site) for shipments by rail and 1.0 (Hanford) or 0.97 (Nevada Test Site) for the sensitivity case.

Thus, traffic fatality risks dominate the overall accident risks and are similar for shipments by truck or rail to either site.

Truck or rail accidents would normally not result in the release of radioactive materials to the environment because the wastes would be shipped in strong, tight containers. The more highly radioactive wastes are shipped in Type B containers that are designed and tested to not release their contents in severe traffic accidents.

A range of potential radiological accidents was considered in Appendix H, and the specific consequences were estimated for the bounding, maximum reasonably foreseeable transportation accidents for the waste types that would be shipped. Under Alternative I, the maximum reasonably foreseeable accident in an urban population zone, which involves a train shipment of remote-handled TRU waste, has a probability of 3.0×10^{-7} per year and could result in 41 latent cancer fatalities if the accident occurred during stable weather conditions. The probability of this accident occurring in a suburban population zone is about 1.3×10^{-6} per year and could result in 8 latent cancer fatalities during stable weather conditions. The probability of this accident in a rural population zone is 6.16×10^{-6} per year, and the likelihood of a single latent cancer fatality in the exposed population is about 4 in 10.

Nonradiological (Occupational and Transportation)

Nonradiological impacts from implementing Alternative I include injuries, illnesses, and fatalities related to completing construction, decontamination, waste retrieval, waste packaging, and transportation activities. Appendices F and H detail the methodologies for estimating these impacts. Although the operations during implementation would be noisy, noise impacts were not evaluated in detail because the Center is located in a rural setting.

Occupational Injuries. Table 5-7 summarizes implementation phase occupational lost workday cases resulting from illnesses and injuries and the estimated number of occupational fatalities for each WMA from implementing Alternative I. The estimates are based on accident statistics for similar activities and on the work force requirements. Events that could result in personal injury, illness, or death include exposure to toxic materials, overexertion, falls, and crushing, pinching, and mechanical impacts from machinery or vehicles. The methods used to calculate occupational lost workday cases and fatalities from nonradiological causes are detailed in Appendix F.

Nonradiological Transportation Impacts. The principal local nonradiological impacts from transporting waste under Alternative I are from work force commuter traffic, truck or rail shipments of materials, supplies and equipment, and off-site shipments of radiological and nonradiological wastes. The principal supplies arriving at the site would include concrete, fuel oil, steel, and waste containers. With careful scheduling, some waste containers could arrive on the same truck (or rail cars) used for shipping wastes off site. All of the clean earth materials (sand, gravel, etc.) are expected to be obtained on site and not require off-site road use.

Table 5-7. Total Estimated Lost Workday Cases and Fatalities for Alternative I (Removal)

	Lost Workdays[a]				Fatalities[b]			
WMA/Facility	Construction	Operations	Services	Total[c]	Construction	Operations	Services	Total[c]
1—Process Building	4.1	4.3	20	28	0.013	0.005	0.014	0.031
01/14 Building	0.0	0.0	0.4	0.5	0.0002	0.0000	0.0003	0.0005
2—LLWTF and Lagoons 1-5	0.3	0.1	0.9	1.3	0.001	0.0001	0.0006	0.002
3—HLW Tanks/Vitrification Facility	1.3	1.7	8.3	11	0.004	0.002	0.006	0.012
4—CDDL	0.2	0.0	0.3	0.5	0.0006	0.0000	0.0002	0.0008
5—CPC Waste Storage Area	0.0	0.0	0.0	0.0	0.0000	0.0000	0.0000	0.0000
Lag Storage Building/ Additions	0.1	0.0	0.4	0.5	0.0003	0.0000	0.0002	0.0006
7—NDA	4.1	3.9	19	27	0.013	0.004	0.013	0.03
8—SDA	0.8	5.3	19	25	0.003	0.006	0.013	0.021
9—RTS Drum Cell	0.0	0.1	0.5	0.7	0.0003	0.0001	0.0004	0.0008
Other Facilities (including WMAs 6, 10, 11, 12)	1.3	0.0	2.3	3.7	0.004	0.0000	0.002	0.006
Container Management Area	4.2	12	44	60	0.013	0.013	0.030	0.056
Total[c]	16	27	230[d]	273[d]	0.053	0.030	0.17[e]	0.25[e]

a. An entry of 0 indicates that no lost workday cases have been estimated on the basis of the 0 person-hours estimated (see Appendix F); an entry of 0.0 indicates that the estimated lost workday cases is less than 0.1.
b. An entry of 0 indicates that no fatalities have been estimated on the basis of the 0 person-hours estimated (see Appendix F); an entry of 0.0000 indicates that the estimated fatalities is less than 0.0001.
c. Totals may not equal the sum of the numbers in the columns because of rounding.
d. Includes an estimated 115 cases from site support services.
e. Includes an estimated 0.09 fatalities from site support services.

Over the 26-year implementation phase, waste shipments would occur for 20 years. Assuming all shipments are made by truck, the average number of vehicles arriving or leaving the site per day (with a 5-day workweek) would be 2,000 or fewer vehicles; 1.6 concrete trucks [calculated assuming there would be 32,000 m^3 (1.1 million ft^3) of concrete], a truck could transport 7.6 m^3 (270 ft^3) of concrete per load, the implementation phase would last 26 years, and there are 200 workdays per year]; 7.8 truckloads of empty waste containers; 5.3 trucks for off-site radioactive waste (calculated assuming there would be 21,074 shipments, 20 years of shipments, and 200 workdays per year); and 2.5 trucks for off-site industrial waste (calculated assuming there would be 9,968 individual shipments, 20 years of shipments, and 200 workdays per year). Trucks are projected to be on the order of 1 percent of the overall number of vehicles using the nearby public access roads to the Center during the implementation phase.

As with current operations, the principal type of vehicular traffic would be work force commuter vehicles. During recent years, the typical vehicular traffic on Rock Springs Road was approximately 2,000 vehicles per day, primarily from Center work force commuting. Traffic levels typically peak during shift changes at the site.

Local transportation impacts from implementing Alternative I would include vehicle emissions, wear and tear on the roadways, and risk of traffic accidents. Peak employment (and likely commuter traffic) for Alternative I are similar to those currently for the WVDP HLW solidification and would occur early in the project (see Section 5.2.1.4 and Appendix I). Truck counts on Rock Springs Road would be approximately 20 per day. Peak daily rates for some years could be higher, with projected peak shipping rates for radioactive and industrial waste approximately twice the average rates.

Overall daily vehicle counts on Rock Springs Road would be expected to remain at about current levels, with impacts principally a result of commuter traffic. The additional impacts from truck traffic associated with Alternative I would not be expected to impact the local peak traffic levels associated with shift changes because the truck shipments would normally be scheduled for off-peak times. Overall vehicle emissions and accident rates would remain approximately the same. The increased level of truck use on roadways would be expected to increase overall road wear.

Regional and national transportation impacts would result from the long-distance shipment of radiological and industrial wastes. These impacts would include the risk of personal injury or fatality in a vehicular accident and an increased risk of fatality from the contribution of the exhaust emissions to urban air pollution. The exhaust emissions include combustion products, fugitive dust, and tire particulates. The total risk of fatality for a transportation campaign is estimated as the product of the average accident rate per distance, number of shipments, and distance per shipment. Similarly, to estimate the potential fatality risk for urban populations near the transportation route from truck exhaust emissions, a factor of 1.0×10^{-7} fatalities per kilometer (see Appendix H), mean levels of sulfur dioxide and particulates emitted per mile was used, along with the number of shipments, and distance per shipment. The estimate of potential health effects by WMA for transporting radioactive waste to the Hanford Site and industrial waste to a disposal site 640 km (400 mi) away are presented in Table 5-8. Impacts for transporting radioactive waste to the Nevada Test Site, presented in detail in Appendix H, differ only slightly from the values for the Hanford Site. Table 5-8 summarizes the cumulative risk (i.e., the risk by WMA to individuals using the transportation route during the implementation phase).

For the implementation phase, the total estimated number of vehicular accident fatalities for radioactive shipments to the Hanford Site would be approximately 3.3 by truck and 3.0 by rail and for industrial waste shipments would be 0.24 by truck and 0.25 by rail. The cumulative fatalities because of vehicular pollution from shipping radioactive waste is 0.24 for truck shipment and 0.48 for rail shipment. Similarly, the cumulative vehicular pollution fatalities from industrial waste shipments are 1.3 for truck shipment and 1.2 for rail shipment.

Figure 5-2 summarizes the results in Tables 5-5 and 5-8 and illustrates the total estimated impacts in projected fatalities from the estimated 21,074 and 9,968 truck shipments of radioactive and industrial waste, respectively, over the 26-year implementation phase. Figure 5-3 presents similar projections if the waste were shipped by rail.

These figures show that more potential fatalities would occur among the general public from shipping radioactive waste than from shipping industrial waste. The radioactive waste shipments by truck account for 9.5 of the 11 estimated fatalities, or about 86 percent. There are two reasons for this: the distance to the assumed waste disposal sites [4,000 km (2,500 mi) each way for radioactive waste] and the number of shipments. Trucks would drive a total of 168,000,000 km (105,000,000 mi) resulting in an estimated 3.3 traffic fatalities and 5.9 latent cancer fatalities due to public radiation exposures. The contribution from urban air pollution is small since most routes would be in rural areas.

For industrial waste shipping, the shorter distance to the assumed waste disposal site and less shipments (about one half the number of radioactive waste shipments) results in a lower expected number of traffic accident fatalities. The effects of vehicular air pollution are relatively higher, because the routes were conservatively assumed to be in urban areas. With either truck or rail shipment, the SDA (WMA 8) is the dominant contributor to public impacts and represents about 57 percent of the truck impacts, and about 35 percent of the rail impacts.

Air Quality

Air quality impacts from implementing Alternative I would generate dust from site preparation, construction, decontamination, waste retrieval, and waste packaging; release of combustion products from operating equipment and vehicles, and transporting waste on the Project Premises and the SDA. Under Alternative I, a considerable amount (peaking at approximately 33,000 operating hours in 2012) of heavy equipment would be operating to demolish facilities and construct the container management area. Thus, the pollutant of primary concern would be particulate matter, especially PM-10, which particles measure less than 10 μm in diameter, can be inhaled, and adversely affects human health.

Table 5-8. Cumulative Nonradiological Impacts of Waste Transportation for Alternative I (Removal)[a]

	Vehicular Accident Fatalities				Vehicular Air Pollution Fatalities			
	Radioactive Waste		Industrial Waste		Radioactive Waste		Industrial Waste	
WMA/Facility	Truck[b]	Rail	Truck[b]	Rail	Truck	Rail	Truck	Rail
1—Process Building	0.26	0.18	0.043	0.040	0.018	0.030	0.22	0.20
2—LLWTF and Lagoons 1-5	0.26	0.29	0.002	0.002	0.018	0.046	0.012	0.011
3—HLW Tanks/Vitrification Facility	0.10	0.08	0.030	0.028	0.0070	0.013	0.15	0.14
4—CDDL	—[c]	—[c]	0.021	0.020	—[c]	—[c]	0.11	0.097
5—CPC Waste Storage Area Lag Storage Building/Additions	0.17	0.19	0.004	0.004	0.013	0.030	0.020	0.018
6&10—Central Project Premises and Support and Services Area	0.001	0.001	0.124	0.117	6.7×10^{-5}	1.5×10^{-4}	0.63	0.57
7—NDA	1.05	0.84	0.008	0.008	0.074	0.14	0.043	0.039
8—SDA	1.17	1.17	0.0004	0.0003	0.083	0.19	0.0019	0.0017
9—RTS Drum Cell	0.34	0.24	0.018	0.017	0.024	0.039	0.092	0.084
Total	3.3	3.0	0.25	0.24	0.24	0.48	1.3	1.2

a. Cumulative risk for the implementation phase by WMA.

b. The difference in accident fatalities between radioactive and industrial waste shipments is from the difference in distance the waste is shipped. Radioactive waste is assumed to be shipped 4,000 km (2,500 mi) and industrial waste is assumed to be shipped 640 km (400 mi).

c. Radioactive waste from the construction and demolition debris landfill was contaminated soil and is included with the impacts from WMA 2.

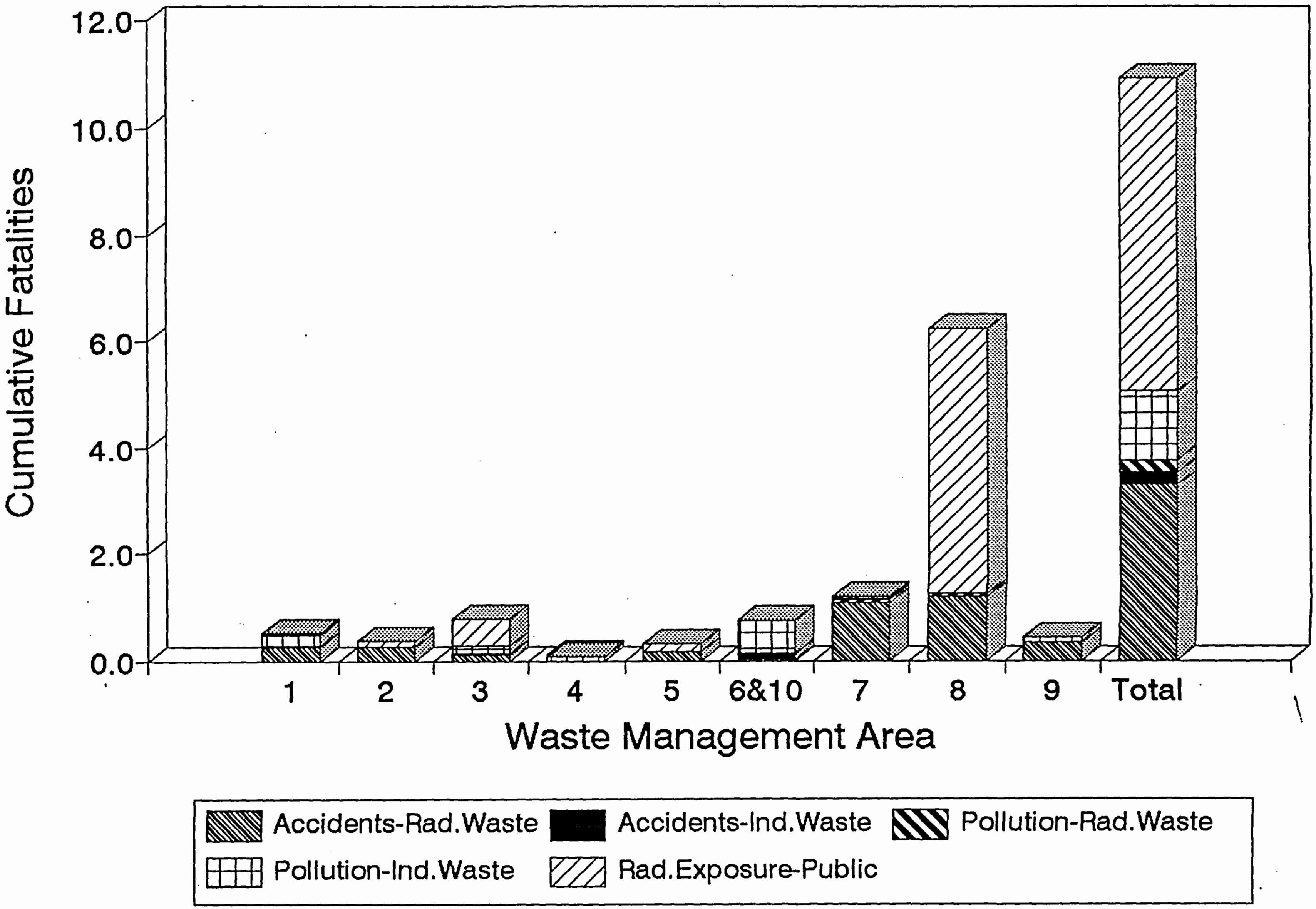

Figure 5-2. Cumulative Public Fatalities—Truck Shipments for Alternative I (Removal).

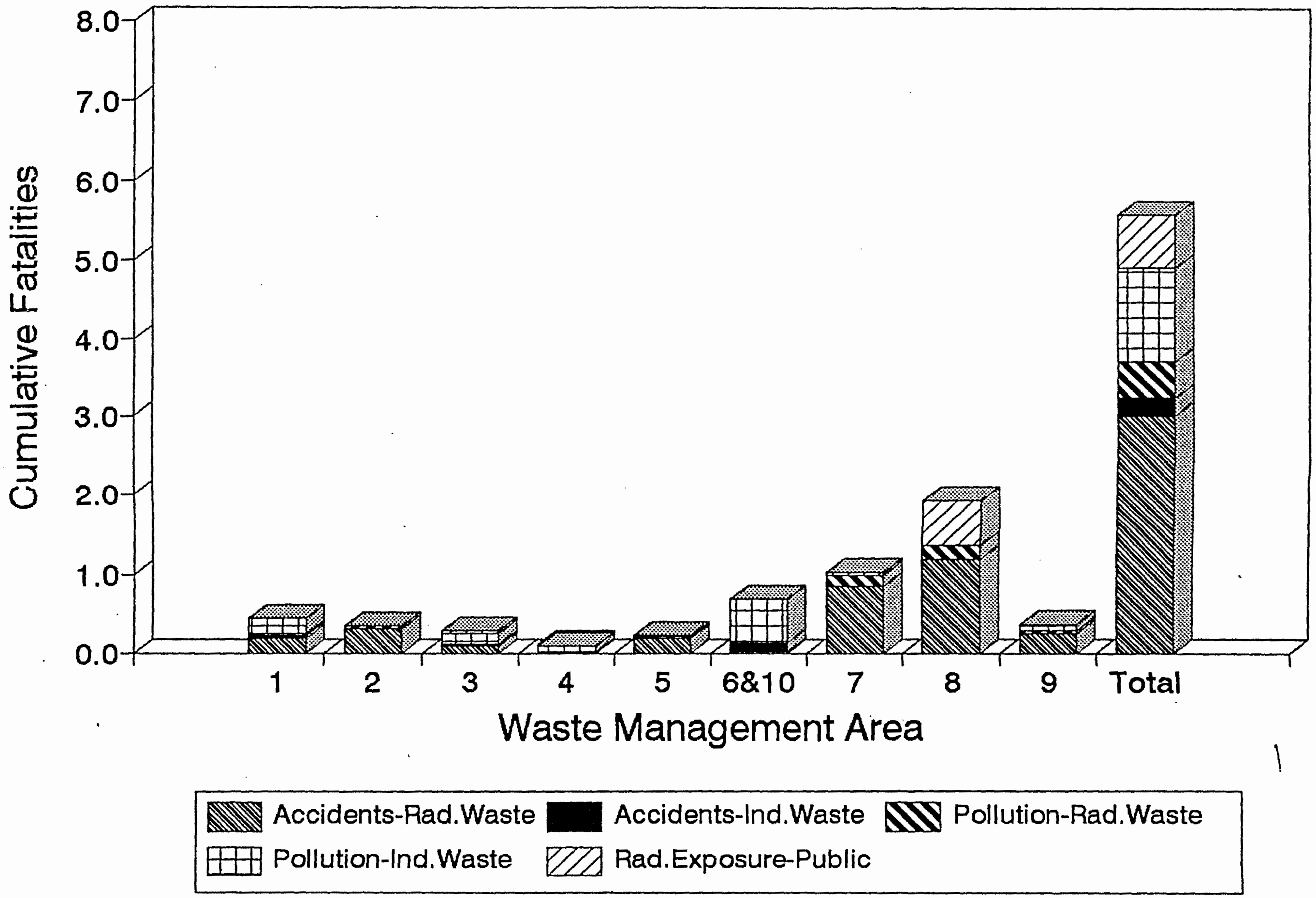

Figure 5-3. Cumulative Public Fatalities—Rail Shipments for Alternative I (Removal).

The PM-10 concentration and fugitive dust emissions during the implementation phase were estimated based on dispersion modeling using data from the closure engineering reports (WVNS 1994a through n). Details of this analysis are presented in Appendix K. The highest releases of PM-10 particulates would be during earthmoving and site grading operations. Standard dust mitigation techniques such as water sprays could be applied to reduce the volume of airborne particulates. The modeling results show that the Project Premises boundary along Rock Springs Road would be the closest public area potentially receiving the highest concentration of particulates. The potentially elevated concentrations at this location would be of short duration and would depend on the specific operation and meteorological conditions at the time. The highest modeled PM-10 concentrations at the nearest public access point during implementation were 1.5 percent of the National Ambient Air Quality Standards annual standard (50 $\mu g/m^3$). The predicted maximum annual concentrations of PM-10 particulates at the Center boundary were predicted to be far below the National Ambient Air Quality Standards concentrations. Other criteria pollutants (nitrogen oxides, sulfur dioxide, and carbon monoxide), principally from vehicle emissions, were also modeled and the predicted concentrations were well below the National Ambient Air Quality Standards limits.

The Center and Cattaraugus County are "in attainment" or "unclassifiable" with respect to the National Ambient Air Quality standards criteria pollutants; therefore, a conformity determination with the applicable State Implementation Plan is not required (see Section 4.5.2).

Water Quality

Surface water impacts from implementing Alternative I would result from increased runoff, including increases in sheet erosion, downstream sedimentation, and uncontrolled migration of chemical or radiological (dissolved and total) constituents. Accidental release of contaminants from spillage or container breach could result in subsequent transport to adjacent streams. Sheet and gully erosion could be increased by removing surface cover (e.g., asphalt and hardpan) and structures. Standard erosion control practices would be used during implementation of Alternative I to minimize soil loss, downgradient sedimentation, and degradation of the surface water quality. Erosion control measures could include using sediment traps, minimizing outdoor work in wet weather, and covering bare soil with plastic or vegetation. The conceptual engineering designs have NDA, SDA, LLWTF lagoons 1 and 2, process building, and HLW tanks enclosed during decontamination and decommissioning to prevent uncontrolled release of contaminants. Over the long term, the water quality would improve because the contamination sources would be removed under Alternative I. For a more detailed discussion of the hydrogeologic models used to evaluate the groundwater flow and transport, see Appendix J.

Removing the contaminated water on the north and south plateau to prepare for removing contaminated soils would eliminate the source for contaminated groundwater and ultimately eliminate the flow of contaminated groundwater to the creeks. With no inflow into the creeks, the surface water quality would start to return to predevelopment levels on the Project Premises.

Biotic Resources

On the Project Premises and the SDA, implementing Alternative I would have little impact on plants and animals because this area is developed, with little habitat for plants or animals (see Figure 4-17). Within the Project Premises boundary and including the SDA, 90 percent of the area has been previously disturbed and 10 percent is forested. About 20 ha (50 acres) of vegetated area that is mowed and maintained on the Project Premises and the SDA would be disturbed. The plant species are grasses and rapidly growing herbaceous species adapted to disturbance (e.g., goldenrod).

Implementing Alternative I would result in an overall decrease in contaminated ground surface area and the absolute level of contamination. The container management area in Alternative I could be constructed in WMA 6, an area that has been completely disturbed by previous activities and is currently used mostly for storage. Therefore, construction of the container management area would not be expected to have an impact on biotic resources as described for the Project Premises above. After the implementation phase is completed, the container management area would be dismantled and removed, and the area would revert by natural successional processes. Cleared areas would be regraded and revegetated with native plants and trees to restore habitat and control erosion. Some animals (e.g., birds and deer) could alter their usual movements to avoid noisy construction. Animals that live in the developed areas (e.g., groundhogs, killdeer, and mice) would lose their habitat, be displaced, or die.

No threatened or endangered plant or animal species are present on the Project Premises or the SDA (FWS 1994). Therefore, there would be no impact to protected plant or animal species on the Project Premises or the SDA.

On the balance of the site, Alternative I implementation phase actions would disturb a total of 20 ha (50 acres): a 14-ha (34-acre) area in the cesium prong on the Center north of Quarry Creek (see Figure C-14) and a 6.5-ha (16-acre) area near the reservoirs.

According to soil sampling results in Dames & Moore (1995), contamination in the cesium prong is limited to the top 10 cm (4 in.) of soil; therefore, soil in the 14-ha (34-acre) cesium prong on the balance of the site would be scraped off, removing the vegetation and disrupting habitat in this area. This area has been mapped as containing old field successional bottomland forest and beech-birch-maple-hemlock forest plant communities as described in Table 4-9 (WVNS 1994o). The old field successional area, located on the top of the plateau north of the Project Premises, contains plants such as goldenrod, wood mint, ox-eye daisy, sheep sorrel, and musk mallow. In the upland areas, forests consisting of beech, maple, and birch trees would have to be uprooted to remove the surface contamination. Bottomland forest communities in the floodplain of Quarry Creek would also have to be uprooted to remove surface contamination. No impacts to endangered, threatened, or rare species are expected to occur in this area based on a 1992 survey (WVNS 1994o). Animals in this area would temporarily lose their habitat, be displaced or killed by earthmoving.

Removal of the north and south reservoir dams would disturb about 6.5 ha (16 acres) on the balance of the site, south of the Project Premises and SDA area. The disturbed plant communities adjacent to the dams would include bottomland forest (sycamore, black willow, and cottonwood) and upland forest communities as described for the area north of Quarry Creek. The reservoirs support an aquatic habitat of bluegill sunfish, largemouth bass, and common shiners (see Section 4.6.3). The removal of the dams would eliminate the aquatic habitat.

A stand of Rose Pinks, a State-Endangered plant species, is growing on the east face of the south reservoir dam on the balance of the site. These plants would be destroyed when the north and south reservoir dams were removed if mitigation measures such as moving them were not implemented. This plant species has not been proposed for inclusion on the Federal list of threatened and endangered species. Consultation with NYSDEC on ways to compensate for loss of this plant would be required before removing the dam.

The U.S. Fish and Wildlife Service would be consulted to control impacts to wildlife and prevent major losses.

Wetlands and Floodplains. Under 10 CFR Part 1022 ("Compliance with Floodplain/Wetlands Environmental Review"), DOE is required to assess the impacts of the actions on wetlands as described in this section. Within the Project Premises boundary, there are 28 jurisdictional wetlands with a total area of 3.4 ha (8.5 acres). Most of these wetlands cover less than 0.4 ha (1 acre), the average size is 0.12 ha (0.3 acre), and none of these wetlands have been designated a New York State jurisdictional wetland. It is estimated that within the Project Premises boundary about six wetland areas in WMAs 2, 5, and 6, which total about 0.8 ha (2 acres), could be destroyed by implementing Alternative I. The potentially destroyed wetlands formed naturally by overland surface flow into topographic depressions. Because these wetlands are small and not critical habitat for endangered, protected, or rare species, their removal would not result in a major impact to wetlands. Larger continuous wetlands covering about 3.6 ha (9 acres) on the south side of the Project Premises and the SDA (Figure 4-17) could be disturbed by increased siltation from surface runoff during implementation phase actions. These wetlands are located near the headwaters of Franks Creek, occur in its channel, are frequently flooded and also receive overland flow. The 2.6-ha (6.5-acre) wetland community located south of WMA 10 was formed by beavers. Implementation phase actions on the Project Premises and the SDA could disrupt and displace the habitat in this area. Although NYSDEC has determined that none of these wetlands are New York State jurisdictional wetlands because of their size, close coordination with NYSDEC could be required before implementing actions under Alternative I. No impacts to floodplains would be anticipated under this alternative.

Wetlands have not been surveyed on the balance of the site in the cesium prong north of the Project Premises; however, the plant communities and topographic setting in this area are very similar to those on the Project Premises. Assuming the distribution of wetlands in the surveyed area near the Project Premises is representative of the entire Center, about 1.8 ha (4.4 acres) of unmapped wetlands in this 14-ha (34-acre) area could either be disturbed or destroyed by implementing Alternative I. Like the Project Premises, it is expected that these would be small, discrete wetlands less than 0.4 ha (1 acre) in size, formed naturally by overland flow into ponds.

The reservoirs, which cover a total area of approximately 6.5 ha (16 acres), would drain after the earthen dams are removed. The impact of removing the reservoirs would be possible death of aquatic and riparian biota, loss of habitat, and loss of a source of drinking water for wildlife. Wetlands in this area occur naturally, primarily from ponded overland flow. Three of the wetlands were formed by beavers. Common plants in the wetlands include common cattail, rushes, black willow, and red fescue. Two wetlands contain relatively less common plants such as bergamot mint, autumn olive, coral berry, brackenfern, and Pennsylvania smartweed (WVNS 1994o).

Disturbance and reestablishment of wetlands would occur under authority from the U.S. Army Corp of Engineers (COE). Destroyed wetlands would be artificially replaced to avoid a net loss of wetland acreage. Such a project would be coordinated through the COE. Wetlands could be restored with native plants to encourage rehabitation by diverse animal species. DOE would consult with the U.S. Fish and Wildlife Service and NYSDEC under the Fish and Wildlife Coordination Act before removing the reservoirs to determine the impact to wildlife and to modify the removal plans as necessary. No activities would occur in the 100-year floodplain under Alternative I.

5.2.1.3 Costs

The costs from implementing Alternative I are given in Table 5-9. Cost data for materials, labor, and contingencies were compiled from closure engineering reports (WVNS 1994a through n). Cost data for waste transportation and disposal were calculated from unit cost estimates for individual package types as reported in the closure engineering reports. It was assumed that Class A waste would be placed in 208-L (55-gal) drums or B-96 boxes, Class B and C waste would be placed in metal high integrity containers, and GTCC and HLW would be placed in 3.8 m^3 (135 ft^3) NUHOMS canisters (refer to container descriptions in Section 3.3.3). Class A soil would be placed in B-96 boxes, while low specific activity soil ($<$100 pCi/g cesium-137) would not be containerized. These costs assume industrial waste is not contaminated and that the contaminated soil volume remaining after treatment is 25 percent of the original volume. It was assumed that LLW would be shipped a distance of 4,000 km (2,500 mi) and that GTCC waste would be shipped to either the Hanford Site or the Nevada Test Site as described in Section 3.2.3.1.

The total cost for implementing Alternative I is dominated by the waste transportation and disposal costs. The biggest cost contributors are the large volumes of waste to be exhumed from the NDA, the SDA, and the CDDL; the stored waste in the lag storage building and additions; and the contaminated soil volume.

There are no post-implementation phase costs because the Center would be released to allow other uses. Actions for use of the site after closure were not evaluated.

Table 5-9. Summary of Closure Costs for Implementing Alternative I (Removal)

	$ 1996 Costs (thousands)[a]					
	Implementation Phase					Post-Implementation Phase[b]
WMA/Facility	Materials and Fuels	Labor	Waste Transportation and Disposal	Contingency	Total	Annual
1—Process Building	45,530	116,112	100,133	65,444	327,219	0
01/14 Building	447	2,181	880	877	4,385	0
2—LLWTF and Lagoons 1-5	3,460	4,794	28,260	9,129	45,643	0
3—HLW Tanks/Vitrification Facility	16,781	47,261	94,094	79,068	237,204	0
4—CDDL	887	1,795	454,174	114,214	571,070	0
5—CPC Waste Storage Area	33	397 (720)[c]	45,842	11,568	57,840	0
Lag Storage Building/Additions	153	1,993	242,209	61,089	305,444	
7—NDA	67,854	110,012	455,346	316,606	949,818	0
8—SDA	32,849	112,326	1,890,016	1,017,596	3,052,787	0
9—RTS Drum Cell	241	2,907	90,137	23,321	116,606	0
Other Facilities (including WMAs 6,10,11,12)	3,158	12,919	16,939	8,254	41,270	0
Container Management Area	70,642	512,357	10,681	148,420	742,100	0
Erosion Control	247	109	2	90	448	0
Soil	4,930	2,168	764,395	192,873	964,366	0
Site Support Operations	0	789,407 (1,400,000)	0	0	789,407	0
Total	247,212	1,716,738	4,193,108	2,048,549	8,205,607	0

a. Original costs were in 1993 dollars. Escalation factor used was 1.1703.
b. Alternative I does not have a post-implementation phase; therefore, there are no associated costs.
c. Values in parentheses are those in the 1995 version of the closure engineering reports. The Final EIS will use final versions of the closure engineering reports.

Sources: Modified from WVNS (1994a through n)

5.2.1.4 Socioeconomic Impacts

The direct employment and expenditures for goods and services required to implement Alternative I would produce a socioeconomic impact in the two-county region comprising Erie and Cattaraugus County, which includes the 20-km (12-mi) primary impact area where secondary effects (i.e., effects on housing and public services) would be felt the most. The detailed schedule of direct employment and expenditures for goods and services were analyzed according to the methods described in Appendix I. The analysis estimated indirect employment and provides a basis for estimating the changes in population or demand for housing or public services as a result of implementing Alternative I.

Implementing Alternative I would result in direct employment and expenditures for goods and services starting in the year 2000. Direct employment and expenditures would peak around the year 2011 and then decline until the year 2026. The schedule for starting Alternative I would be integrated with completing the WVDP HLW solidification so that no sharp increase or decrease in employment would occur. Peak employment during implementation of the decontamination or decommissioning and closure actions would be comparable to those for the WVDP HLW solidification from 1996 to 1998.

The direct employment and expenditures would provide a positive impact on the 20-km (12-mi) primary impact area by providing continued employment for personnel who would otherwise be unemployed after HLW solidification is complete. At the peak year of the implementation phase (2011), about 6 percent of the direct and indirect employment in the primary impact area would result from the site employment and expenditures. It is estimated that 868 jobs would be generated in the primary impact area in the peak year; 847 jobs would be direct site employees and another 21 jobs would be indirect. In the two-county region, peak year total employment would be 1,700, which would account for 0.2 percent of the total primary impact area employment.

Layoffs would occur at the end of implementation, resulting in a negative socioeconomic impact. About 900 jobs would be eliminated over a 15-year period starting in 2011 representing about a 0.4 percent annual decrease in employment in the 20-km (12-mi) primary impact area and a negligible annual decrease (about 0.01 percent per year) in the two-county region.

Because minimal changes in employment would result from implementing Alternative I, a corresponding minimal change in housing availability would be expected. The demand for public services would remain unchanged because no large personnel moves would be required. As the alternative is completed and employment is gradually reduced, personnel could leave the area, resulting in additional houses on the market and reduced demand for local public services.

The State payment in-lieu of taxes are determined by the State legislature, and the future levels of payment during or after implementation of Alternative I are unknown. If the State legislature were to reduce or eliminate the payments in-lieu of taxes, the local governments could have a more difficult time funding public services.

Growth Inducing Aspects of the Alternative. Implementing Alternative I would maintain site employment and expenditures similar to current levels for 20 years. After the Center was released, the land could be reused by the State or sold for private ownership. Neither of these land ownership options is expected to produce or induce noticeable growth in the local or regional area. If portions of the Center were released for private ownership, the tax base of the area could increase.

5.2.1.5 Cultural Resources

No adverse impacts to significant historical and archaeological resources would occur on the Project Premises and the SDA from implementing Alternative I because the affected areas were severely disturbed by construction of the former reprocessing facility during the 1960s (WVNS 1992a). Modifying and demolishing structures and excavating soils would disturb 40 ha (100 acres) on the Project Premises and the SDA.

Three archaeologic historic sites and structures exist on the Project Premises: Erdman/Gentner site, the Goodemote/Spittler site, and the Rider/Harvey/Whiteman Silo, but none of the artifacts collected from these sites were culturally significant and the areas were destroyed during construction of the former reprocessing facility (WVNS 1992a). The process building and structures on the Project Premises and SDA would be destroyed during Alternative I. However, the SHPO has determined that these structures are not eligible for the *National Register of Historic Places* (SHPO 1995). Therefore, demolition would not be an adverse impact.

No significant archaeological or architectural resources were found within the vicinity of the bulk storage warehouse in WMA 11 or on the balance of the site.

The 14-ha (35-acre) area located in the cesium prong on the balance of the site has not been surveyed. Before disturbing this area, an archaeological survey would be conducted to determine if cultural resources were present. The archaeological predictive model for the Center indicates that a portion of the 14-ha (35-acre) area has a potential for prehistoric archaeologic sites.

Removal of the north and south reservoir dams would disturb about 6.3 ha (16 acres) on the balance of the site southwest of the Project Premises and SDA area. Although the archaeologic predictive model indicates this is an area for potential prehistoric sites, walkovers and shovel testing in portions of the potentially affected area did not find cultural material (WVNS 1992a). Before disturbing this area, an archaeological survey would be conducted to determine if cultural resources were present.

DOE is working to establish mechanisms for ongoing consultation with the Seneca Nation of Indians to determine if there would be an impact on traditional use or sacred areas.

5.2.1.6 Relationship to Land Use Plans and Visual Impacts

The Center was originally established for the development of nuclear technology. Release of the site to allow unrestricted use would be consistent with the Cattaraugus County Land Use Plan, which promotes an environmental and conservation policy of curtailing air and water pollution, retaining and developing forested land, and preserving and promoting cleanup of areas of natural beauty (Cattaraugus County Planning Board 1978, updated 1982). This plan also encourages continued use of the Center, with caution regarding public health and safety and protection of the environment.

Most of the closure activities under Alternative I would occur on the Project Premises and SDA. The visual impact would be limited to passersby because no one resides close enough to the Project Premises and the SDA to have an unobstructed view. Although the Project Premises and the SDA are visible from Route 240, this vantage point is at a distance and any visual impacts would not be easily seen. The visual impacts would be limited to glimpses of the Project Premises and SDA while driving by on Rock Springs Road. More visual impact is possible in winter than in summer because the absence of foliage would reveal more of the Center. Figure 3-13 (schedule for implementing Alternative I) shows the timing of each potential visual impact. A corresponding description of activities is in Section 3.3.2.

Implementation Phase. Potential visual impacts would result from the appearance of demolition and exhumation activities. Removal of buildings from the Project Premises (for example, the process building, RTS drum cell, and vitrification facilities) would involve the presence of wrecking cranes and the buildings in various stages of dismantlement. Exhumation of contaminated soil around the Project Premises and the SDA could have a negative visual impact because of the heavy equipment (such as dump trucks, front-end loaders, and bulldozers), temporary covered soil piles and barren areas that had not revegetated.

New and temporary facilities would be built that could have a visual impact from Rock Springs Road. No visual impact would be expected from building the container management area, which could potentially be located on the east side of a warehouse and hidden from Rock Springs Road. Temporary confinement enclosures used to prevent the spread of contamination during exhumation activities would produce a visual impact. An air-supported confinement enclosure would cover a portion of the SDA while it is exhumed. This enclosure would probably look like a smaller version of the white lag storage tents in WMA 2. Sprung structures, which also look like tents, would be placed over the remote exhumation demonstration area at the NDA, the caisson area at the NDA, and the old interceptor and lagoons 1 and 2. Confinement structures which look like prefabricated corrugated metal-sided storage buildings would be placed over tanks 8D-1 and 8D-2, the east and west exhumation areas at the NDA, and portions of the SDA. The temporary confinement structures at the SDA and NDA would probably be visible 305 to 460 m (1,000 to 1,500 ft) from Rock Springs Road. The visual impact from removing other facilities on the Project Premises (for example, trailers, meteorological towers, parking lots) would be an increase in empty space on the Project Premises.

No visual impact is expected from removing facilities on the balance of site (for example, the bulk storage warehouse) because they cannot be seen from nearby roads. The balance of the site in the cesium prong north of Quarry Creek would be deforested prior to excavating the contaminated soil. A visual impact would occur because these areas border Rock Springs Road.

Post-implementation Phase. At completion of Alternative I, the Project Premises, the SDA, and the balance of site would be open land. The perimeter fences of the Project Premises and the Center would be gone. The site topography would be regraded and revegetated with native trees and plants.

5.2.1.7 Impacts of Disposing of Radioactive and Industrial Wastes at Off-Site Facilities

Under Alternative I, large quantities of radioactive and industrial wastes would be shipped to off-site disposal facilities. Tables 3-4 through 3-6 present total waste volumes. The estimated contaminated waste and soil volume to be shipped under Alternative I is 265,000 m^3 (9.34 million ft^3) over the disposal period. The estimated industrial waste volume to be shipped is 145,000 m^3 (5.13 million ft^3) over the disposal period. In addition to the impacts at the Center and along the transportation routes, additional impacts would occur at the off-site disposal sites from disposing of these wastes. On average, approximately 16 truckloads of radioactive waste would be shipped each week over the 26-year implementation phase. Peak rates could be higher. Receipt of waste shipments from a single source at this rate is typical for industrial waste disposal facilities, but not typical for LLW disposal facilities.

Radioactive Waste. The principal impacts to disposal facilities from waste generated under Alternative I actions is the need for additional disposal capacity, the health impacts to the disposal facility workers, and short- and long-term impacts to populations living near the facilities.

The overall environmental impacts of the larger disposal facility would proportionately increase the amount of disturbed land, buffer land, biotic impacts, and air emissions. The environmental impacts of disposal of LLW have been characterized in a number of environmental documents, including analysis of generic facilities in NYSDEC (1993) and NRC (1982a), as well as analysis of specific commercial disposal sites.

The NRC analysis in the EIS for the Code of Federal Regulations (10 CFR Part 61) rulemaking (NRC 1982b) modeled the environmental impacts from LLW disposal at four regional LLW disposal facilities that could dispose of between 500,000 to 700,000 m^3 (18 million to 25 million ft^3) of LLW over 20 years. This analysis indicated that the land use requirements would be 170,000 to 250,000 m^2 (1.8 million to 2.7 million ft^2), or about 0.35 m^2 (3.8 ft^2) of facility area per cubic meter of LLW disposed of. If this requirement were applied to the contaminated waste and soil to be disposed of under Alternative I, the additional land use requirements would be approximately 9.2 ha (23 acres).

The LLW disposal requirements would require additional capacity at DOE or commercial sites. Several existing DOE LLW disposal facilities have capacities in this range. For example, low activity waste concrete vaults at the Savannah River Site are 196 m long x 44 m wide x 8 m high (643 ft long by 145 ft wide x 27 ft high) and have approximately 48,000 m^3 (1.7 million ft^3) of disposal capacity. Approximately six vaults of this size would be needed for the volume of wastes generated by implementing Alternative I. At the Hanford Site current LLW capacity is approximately 85,000 m^3 (3 million ft^3), but preliminary calculations indicate it is possible to dispose of more than 2.3 million m^3 (800 million ft^3) at the site (DOE 1994).

Most of the radioactive wastes are LLW and GTCC waste. Although the specific disposal site for these wastes is not known, it is reasonable to expect that the wastes would be disposed of at an existing or new commercial or DOE-operated disposal facility that meets the current standards for waste disposal. By implication, a LLW disposal facility would be designed and operated to meet the NRC LLW performance objectives. Meeting these objectives ensures that the public health impacts of the disposal of these wastes would be small.

One of the larger impacts of LLW disposal is the radiological impacts on the disposal facility workers. Individually, the exposures to the workers are limited by DOE and NRC requirements. The collective dose to the disposal facility work force is largely a function of the volume of waste handled. On the basis of the volumes assumed, occupational exposure was estimated to be in the range of 0.0032 to 0.0036 person-rem/m^3 of disposed LLW. For the shipment of the waste volume under Alternative I, this exposure would correspond to approximately 851 to 958 person-rem or about 1 additional latent cancer fatality among the disposal site work force over the disposal period.

Radiological impacts on the public from normal LLW disposal site operations would be less than those for the disposal facility workers. NRC did not predict that there would be significant short-term operational releases of radionuclides. Over the long term, however, NRC assumed that if loss of institutional control of the site were to occur, impacts could occur. These impacts could result from an intruder using the site for construction, agriculture, or a drinking water well or from gradual erosion. The siting criteria and performance objectives of 10 CFR Part 61 were specified to reduce the threats of either intrusion or erosion. Radiological impacts were found to decrease rapidly with time and, with time, the radiological decay of the LLW inventory decreased. The dose to an intruder at 100 years after closure was found to be several hundred millirem/yr, but after 500 years, the dose would be reduced to approximately 10 mrem/yr. Erosion was postulated to occur after 2,000 years and the impacts were less than 1 mrem/yr (NRC 1982b).

Industrial Waste. A total volume of 145,000 m^3 (5,130,000 ft^3) of industrial waste would be generated by implementing Alternative I. The industrial waste would consist of typical construction and demolition debris (e.g., concrete, steel, wood, asphalt, and equipment). This volume of waste would be disposed of over about 22 years (refer to Figure 3-13), so the average disposal rate would be 6,590 m^3 (233,180 ft^3) per year. Using an average density of 1,400 kg/m^3 (89 lb/ft^3) (Lynch 1995), this would be equivalent to 9,230 metric tons (10,380 tons) per year. This amount is only 5 percent of the waste that is disposed of in western New York (Buffalo region) and only 0.6 percent of the waste volume that is disposed of in the entire State of New York (Lynch 1995). Because it is assumed that industrial waste generated by closure could be disposed of within a 640-km (400-mi) radius of the Center, the percentage would be even lower. Thus, the volume of waste to potentially be disposed of would not be significant relative to the current volume of industrial waste being disposed of in the State of New York and would not consume significant capacity in sanitary landfills.

5.2.2 Evaluation of Long-Term Impacts

The implementation phase is followed by a post-implementation phase of closure. The post-implementation phase evaluated for environmental impacts in this EIS is 1,000 years, although calculations for the long-term performance assessment were carried out as far as 10,000 years to establish the potential contribution of long-lived relatively mobile radionuclides. The nature and magnitude of long-term impacts that may occur under Alternative I depend on the extent of removal of disposed waste and contaminated soil. The long-term performance assessment assumed disposed inventories would be completely removed, packaged, and disposed of off site; and treated soils meeting the release criteria would be used as backfill on the site. This analysis also assumed that contaminated groundwater and soil in voidspace within the disposed waste was removed, passed through a liquid waste treatment system, and released to the environment during the implementation phase. Environmental impacts of the implementation phase are described in Subsection 5.2.1.2. Sources of radiological impacts are low-level soil contamination in areas that did not require treatment and low-level contamination in areas backfilled with contaminated soil that passed through the treatment process.

A number of impact areas are not described in detail for the long-term period because there is either no impact or the impact would not be different among the alternatives. The principal impact areas are discussed briefly below.

During the post-implementation phase, there would be no occupational or transportation impacts because there would be no workers and no waste would be shipped. Because there would be no earthmoving activities to disturb areas and generate dust and runoff, there would be no direct impact to air quality, water quality, biota, or cultural resources over the long term. Because most of the soil contamination would be removed, the potential for uptake by vegetation and animals would be expected to substantially decline.

5.2.2.1 Long-Term Impacts from Expected Environmental Conditions

The long-term impacts to inhabitants of areas on the Project Premises and the SDA were evaluated for a 1,000-year period after release of the site to allow unrestricted use. Potential receptors include individuals who take up residence on this area and grow crops for personal use. Radionuclide concentrations in soil were measured as part of the RFI sampling described in Section 4.10 (WVNS 1994p). Sampling program-based dose estimates for areas on the Project Premises that would not be cleaned up are below the 15 mrem/yr level adopted as the assumed contaminant cleanup criteria. Because of the low level of residual contamination, the impact to off-site individuals and the surrounding population would be negligible.

Radiological Impacts. In general, the highest potential impacts would be to individuals who took up residence on either the Project Premises or SDA immediately after its release to the public. The expected consequences of using this area at that time would be relatively minor because the areas would have been cleaned to levels where the annual risk would be expected to be 8.0×10^{-6} or less, resulting in an annual dose of 15 mrem or less. Appendix E presents the WMA-specific radionuclide distribution which would produce the largest dose level.

5.2.2.2 Long-Term Impacts from Less Likely Events

After the implementation phase of closure, small amounts of contamination could remain in the soil. The contamination remaining would be limited to those concentrations that could result in a maximum annual effective dose equivalent of 15 mrem to an individual residing in the area (see Appendix D for a discussion of this 15 mrem criterion). This dose corresponds to an annual risk of 8.0 x 10^{-6}. No additional release mechanisms from the occurrence of a severe natural phenomenon such as a fire, earthquake, or tornado were identified that could increase the doses to individuals residing in the area. Thus, no impacts from less likely events have been postulated.

5.2.3 Uncertainty Associated with Alternative I

Implementing Alternative I has technical uncertainties during the implementation phase that affect the magnitude of the environmental impact. The effect of this uncertainty on the environmental consequences both during the implementation and post-implementation phase is discussed in this section.

Under Alternative I, radioactive waste is disposed of off site during the implementation phase. The volume of waste to be transported off site depends on whether design basis assumptions (expected conditions) are met for the soil treatment method (i.e., that the treatment method would reduce the volume of contaminated soil to 25 percent of the original volume, see discussion in Section 3.3.2.2). The greatest impact this technical uncertainty has on the implementation phase is in the volume of waste that would have to be shipped off site. Under worst case conditions (i.e., the soil treatment method has zero efficiency), the result would be 20,932 additional shipments or doubling the number. The latent cancer fatalities from transporting waste off site would increase from 5.9 to 6.4, and the nonradiological fatalities from traffic accidents and urban air pollution would increase from 3.7 to 7.2 fatalities.

The uncertainty in post-implementation phase impacts results from not knowing the amount and location of residual radioactivity in soils after the implementation phase actions. Because most of the radioactivity is removed and because of the conservative assumptions used to compensate for uncertainties in the model parameters, it is expected that the impacts would be below predicted levels.

5.3 ALTERNATIVE II: REMOVAL, ON-PREMISES WASTE STORAGE, AND PARTIAL RELEASE TO ALLOW UNRESTRICTED USE

This alternative is similar to Alternative I in that existing structures (with the exception of some minor support structures and the RTS drum cell) would be decontaminated, demolished, and removed. The difference between Alternatives I and II is that under Alternative II radioactive and mixed waste would be stored in retrievable storage areas on the Project Premises instead of being disposed of off site. Hazardous and industrial waste would be disposed of off site. Stored waste, buried waste, and in-ground structures would be removed or exhumed and then stored, with the exception of the RTS drum cell, which would remain a waste storage facility. Contaminated soils on the Project Premises, the SDA and on the balance of the site would be exhumed, treated and replaced as backfill or stored on premises. Contaminated liquid wastes from dewatering would be treated. Implementing this alternative would require labor to demolish existing structures and build the retrievable storage areas. Waste transportation would be reduced because most of the waste would remain on the Project Premises. The Project Premises and SDA would be extensively disturbed. Contaminated waste generated by the alternative would be consolidated into storage facilities, with the balance of the site available for unrestricted use.

The waste volumes generated for this alternative are similar to the volumes for Alternative I, except that the 5,950 m^3 (210,000 ft^3) of Class C waste in the RTS drum cell would remain in place for long-term storage, a use consistent with its original design. The total volume of contaminated waste and soil under Alternative II would be approximately 259,000 m^3 (9.13 million ft^3). The volumes of Class A, Class B, GTCC, HLW, hazardous, and mixed waste generated would be the same as those described for Alternative I (Section 5.2). It is estimated that as much as 116,000 m^3 (4.08 million ft^3) of industrial waste would be generated (modified from WVNS 1994a through n).

Like Alternative I, the environmental impacts of implementing Alternative II would vary depending on the success of the same engineering design-basis assumptions discussed for Alternative I in Section 5.2.1. However, under Alternative II, radioactive waste would be stored on the Project Premises. The uncertainty of the environmental impacts from implementing Alternative II are discussed in Section 5.3.3.

5.3.1 Implementation Phase Impacts

The actions that would be performed to implement Alternative II would be the same as those performed for Alternative I, except that the RTS drum cell would be managed as-is and minor facilities would remain to support long-term storage. The specific actions that would be taken are described in Section 3.4.2, and the details for implementing the alternative are shown in Figure 5-4.

The implementation phase actions for Alternative II would last 28 years, followed by an indefinite period of storage. During the implementation phase:

- Contaminated buildings in WMAs 1, 2, and 3 would be decontaminated and demolished, disturbing about a 0.4-ha (1.1-acre) area.
- In-ground structures (e.g., lagoons, ponds, and tanks) would be removed, disturbing approximately 1.0 ha (2.5 acres) of land in WMAs 2, 3, 6, and 8.
- Buried waste in the NDA, SDA, and CDDL would be exhumed along with contaminated soil, disturbing approximately 11 ha (28 acres) of land in WMAs 4, 7, and 8.
- Remaining facilities in WMAs 1, 2, 3, 6, 10, 11, and 12 would be demolished and removed (including draining and filling the reservoirs), disturbing approximately 19 ha (48 acres) of land.
- Areas with contaminated soil on the Project Premises, the SDA, and on the balance of the site would be excavated including contaminated soil in the groundwater plume in the north plateau (see Section C.3.2.2 in Appendix C), which would

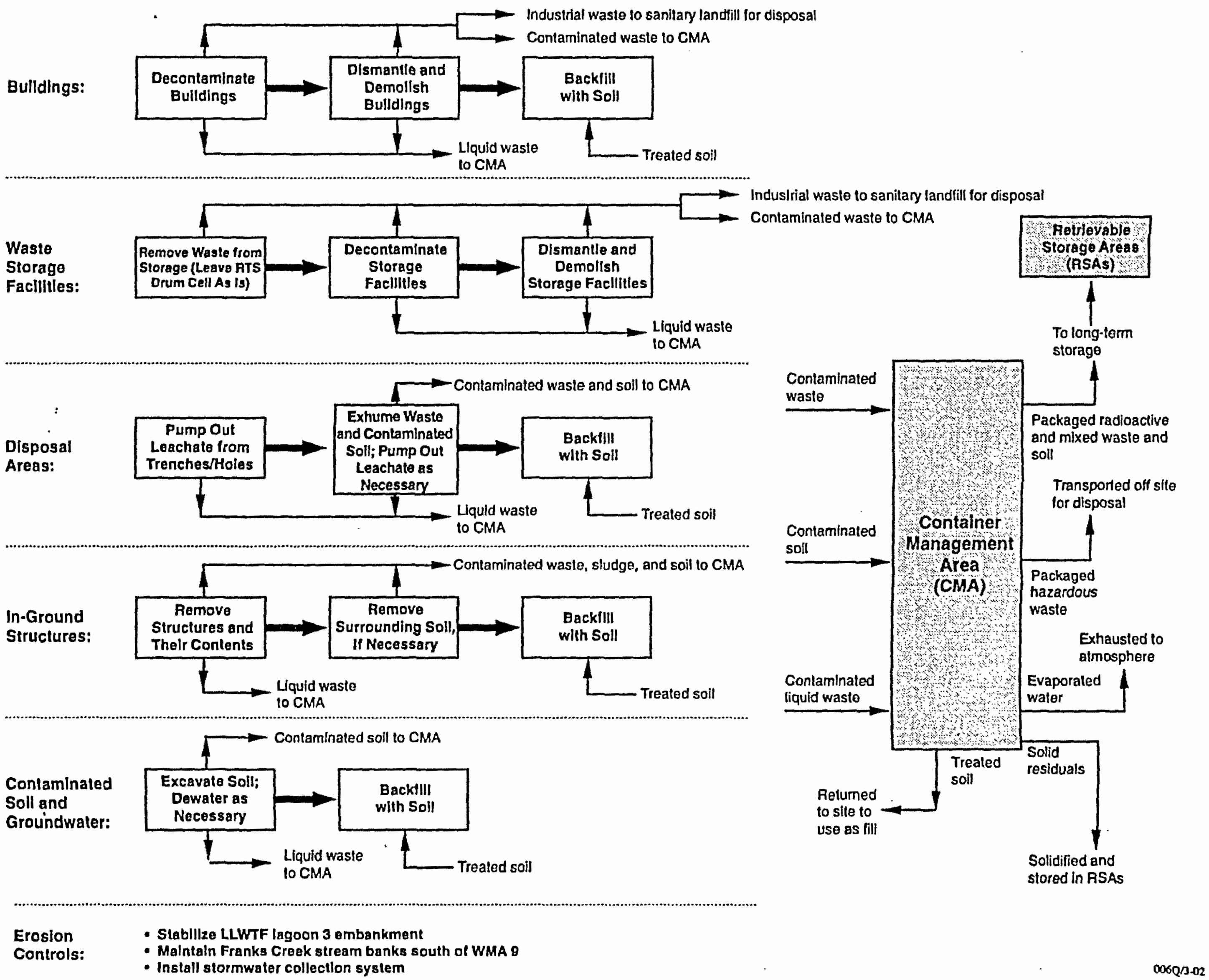

Figure 5-4. General Strategy for Implementing Alternative II (On-Premises Storage).

disturb approximately 14 ha (35 acres) on the Project Premises (WMAs 1, 2, 3, 4, and 5), and 14 ha (34 acres) on the balance of the site.

- Stored waste in WMAs 5, 6, and 7 and waste generated by the activities described above would be placed in new retrievable storage areas on the Project Premises. The existing waste storage facilities, except for the RTS drum cell, would be demolished, disturbing about 1 ha (2.4 acres) in WMAs 5, 6, and 7.

- In addition to the container management area constructed in WMA 6, new retrievable storage areas would be constructed in WMAs 1,2,5,6, and 10 for on-premises storage of radioactive waste (see Section 3.4.2.2). A total of approximately 5.7 ha (14 acres) would be disturbed in these WMAs.

- Hazardous and industrial waste would be disposed of off site.

- Erosion control measures would include stabilizing the LLWTF lagoon 3 embankment and the Erdman Brook stream banks, which would disturb approximately 0.7 ha (1.7 acres) of land on the Project Premises, and stabilizing the Franks Creek stream banks on the south and east side of WMAs 9 and 8, respectively, disturbing about 0.6 ha (1.4 acres).

If, at some future time radioactive wastes were retrieved and disposed of off site, the transportation impacts would be similar to those described for Alternative I, except for reduced levels of radioactivity because of radioactive decay. Because the RTS drum cell (WMA 9) is assumed to remain a waste storage facility for this alternative, key facilities that contribute to the risk because of their radionuclide inventory are the same as those described in Section 5.0.

The radioactive waste containers would be expected to deteriorate while in storage. Repackaging would be performed as necessary to meet NRC and U.S. Department of Transportation packaging requirements before the package failed so there would be no serious environmental impact.

5.3.1.1 Resource Requirements

Alternative II requires resources—electrical power, natural gas, and diesel fuel and gasoline—for constructing new facilities needed for the implementation phase (e.g., a container management area) and for decontamination, demolition, and exhumation. The resource requirements for Alternative II are the same as for Alternative I, except that the RTS drum cell would remain as a waste storage facility and retrievable storage areas would be constructed. The retrievable storage areas require power, gas, and fuel for construction. Both the RTS drum cell and the retrievable storage areas would require power and gas during the post-implementation (storage) phase. Resource data were compiled from closure engineering reports (WVNS 1994a through n). The resource requirements by WMA are summarized in Table 5-10.

Table 5-10. Estimated Energy and Fuel Requirements for Alternative II (On-Premises Storage)[a,b]

	Implementation Phase			Post-Implementation Phase (Annual)		
WMA/Facility	Electrical Power (MW-hr)	Natural Gas (ft^3)	Diesel Fuel and Gasoline (gal)	Electrical Power (MW-hr)	Natural Gas (ft^3)	Diesel Fuel and Gasoline (gal)
1—Process Building	33,000	9.7×10^7	1.3×10^5	0	0	0
01/14 Building	120 (260)[c]	2.4×10^5	8,200	0	0	0
2—LLWTF and Lagoons 1-5	93	72,000	51,000	0	0	0
3—HLW Tanks/Vitrification Facility	770 (1,500)	6.6×10^7	1.8×10^5	0	0	0
4—CDDL	0	0	51,000	0	0	0
5—CPC Waste Storage Area	0	0	790 (8,300)	0	0	0
Lag Storage Building/Additions	29	0	4,300 (8,400)	0	0	0
7—NDA	13	0	3.8×10^5	0	0	0
8—SDA	12,000	0	1.2×10^5	0	0	0
9—RTS Drum Cell	18 (0)	2.4×10^6 (0)	0	18 (36)	2.4×10^6	0
Other Facilities (including WMAs 6,10,11,12)	0	0	1.6×10^5	0	0	0
Container Management Area	18,000	1.0×10^8	7.9×10^5	0	0	0
Retrievable Storage Areas	1.2×10^5	6.0×10^8	6.6×10^5	2,800	3.0×10^6	0
Erosion Control	0	0	1,100	0	0	0
Total	1.8×10^5	8.7×10^8	2.5×10^6	2,800	5.4×10^6	0

a. To convert cubic feet to cubic meters, multiply by 0.02832. To convert gallons to liters, multiply by 3.785.
b. All values have been rounded to two significant figures. Values in columns may not add to totals due to rounding.
c. Values in parenthesis are those in 1995 versions of the closure engineering reports. The Final EIS will use final versions of the closure engineering reports.

Sources: WVNS (1994a through n)

More resources are required for implementing Alternative II than Alternative I. As for Alternative I both the average and maximum electrical power (6,900 and 14,000 MW-hr/yr, respectively) and the average and maximum natural gas requirements [930,000 and 2.0 million m^3/yr (33 and 71 million ft^3/yr), respectively] would be much less than projected consumption rates of 32,000 MW-hr/yr and 2,500 million m^3/yr (89,000 million ft^3/yr) to be used from 1996 to 2000 during HLW solidification (Kawski 1995). However, the average consumption rate of gasoline and diesel fuel would be 360,000 L/yr (96,000 gal/yr), which is approximately four times greater than the current consumption rate of 93,000 L/yr (24,500 gal/yr) (Kawski 1995). During the post-implementation phase of Alternative II, no fuel would be required, and the consumption rates of natural gas [150,000 m^3/yr (5.4 million ft^3/yr)] and electrical power (2,800 MW-hr/yr) would be 16 to 40 percent lower than during the implementation phase.

Alternative II would require 0.3 million m^3 (12 million ft^3) of soil. Construction of the container management area and the contact and shielded retrievable storage areas would require 148,000 m^3 (5.2 million ft^3) of concrete and 41,200 m^3 (1.5 million ft^3) of sand and gravel (WVNS 1994n).

5.3.1.2 Environmental Impacts

Radiological (Occupational and Transportation)

Activities during the implementation phase of Alternative II are expected to be like those under Alternative I. The defining difference between the alternatives, on-premises storage (Alternative II) versus off-site disposal (Alternative I), is not expected to result in major changes in releases of radioactivity to the environment or to occupational impacts because the same actions would be occurring. With each alternative, once the wastes are recovered and packaged for shipping, the radioactive releases to the environment should be negligible.

Off-Site Impacts. Radiological releases from the Project Premises and SDA area for Alternative II are estimated to be identical to those estimated for Alternative I. Internal doses projected for Alternative II are the same as for Alternative I as summarized in Table 5-3. Inhalation, food, and external exposure modes were evaluated for the air pathway and plutonium dominates the estimated dose in most cases. Details of the assessment are identical to those discussed for Alternative I in Section 5.2.1.2. Estimated doses are small compared to normal background radiation. Average annual risks of a latent cancer fatality from the total atmospheric release are 6.6×10^{-7} and 2.2×10^{-9} for the maximally exposed individual and the average member of the public, respectively.

Occupational Doses. The estimated occupational doses from this alternative are nearly identical to those estimated for Alternative I in Section 5.2.1.2 because the implementation phase actions are identical for each facility (except the RTS drum cell, which would be monitored as-is for Alternative II). Additional doses from placing waste in the retrievable storage areas were included in this alternative. Table 5-11 summarizes the estimated doses and the corresponding health effects, in terms of latent cancer fatalities,

Table 5-11. Cumulative Occupational Radiological Impacts for Alternative II (On-Premises Storage)

WMA/Facility[a]	Collective Occupational Dose (person-rem)	Latent Cancer Fatalities
1—Process Building	554	0.22
01/14 Building	4	0.0016
2—LLWTF and Lagoons 1-5	40	0.016
3—HLW Tanks/Vitrification Facility	203	0.081
4—CDDL	0	0
5—CPC Waste Storage Area	0.3	0.0001
Lag Storage Building/Additions	3.0	0.0012
7—NDA	129	0.052
8—SDA	45	0.018
9—RTS Drum Cell	0	0
Other Facilities (including WMAs 6,10,11,12)	0	0
Container Management Area	252	0.10
Retrievable Storage Areas	48	0.019
Total	1,278	0.51

a. Doses attributable to individual facilities are given when appropriate. If no facilities are listed, then the dose estimates are applicable to the entire WMA.

resulting from these exposures as a function of the WMA. As with Alternative I, the highest collective occupational exposure would be from the decontamination and decommissioning of the process building, HLW tanks, vitrification facility; recovery of the wastes from the NDA and SDA; and the construction and operation of the container management area. The overall work force impacts of implementing Alternative II in terms of latent cancer fatalities are estimated to be less than 1 additional latent cancer fatality (actual estimate, 0.51) from occupational radiation exposures.

Transportation Impacts. Because the radioactive waste exhumed, stored, or generated would be stored on the Project Premises for an indefinite period of time in the retrievable storage areas, no radiological impacts from off-site transportation would occur.

Postulated Accidents. The accidents postulated for each WMA (except WMA 9) and the container management area for this alternative are identical to those postulated for Alternative I in Section 5.2.1.2 because the implementation phase actions are identical for each facility. There would be no implementation phase action for the RTS drum cell (WMA 9) because it would be monitored and maintained as-is under this alternative. A drum handling accident was postulated for operation of the retrievable storage areas. The maximum potential radiological consequences to the public from the postulated accidents are summarized in Table 5-12. On-site co-located workers could receive a dose about a factor of 10 higher than the maximally exposed off-site individual. The primary worker dose could be higher, as described in Appendix G. Potential impacts of radiological accidents during the long-term period are described in Section 5.3.2.

Table 5-12. Summary of Upper-Bound Accidents during the Implementation Phase and Calculated Radiological Consequences for Alternative II (On-Premises Storage)

WMA/Facility	Description of Upper-Bound Accident	Maximum Individual Dose (rem)	Collective Dose[a] (person-rem)	Latent Cancer Fatalities
1—Process Building	Process building ventilation system confinement fails during decontamination operations[b]	0.6	7,000	3.5
2—Lagoon 1	Fire/explosion destroys containment structure during lagoon 1 excavation[b]	7	90,000	45
3—HLW Tanks	Piping failure during removal of tank 8D-2 sludge[b]	0.1	1,000	0.5
5—CPC Waste Storage Area Lag Storage Building/Additions	Drum handling accident results in breach of lag storage addition drums[c]	0.00007	0.8	0.0004
7—NDA	Exposed waste in NDA burns and breaches containment structure[b]	20	300,000	150
8—SDA	Exposed waste in SDA burns and breaches containment structure[b]	30	400,000	200
Container Management Area	Operational accident releases radioactive material[c]	0.9	10,000	5
Retrievable Storage Areas	Drum handling accident breaches drums arriving from the container management area[c]	0.9	10,000	5

a. Collective dose from airborne releases to the projected population (year 2000) of 1,350,000 people residing within 80 km (50 mi) of the Center.
b. Estimated annual accident probability is 1 chance in 1,000,000 to 1 chance in 100,000,000 (10^{-6} to 10^{-8}).
c. Estimated annual accident probability is 1 chance in 10,000 to 1 chance in 1,000,000 (10^{-4} to 10^{-6}).

Nonradiological (Occupational and Transportation)

Nonradiological impacts during the Alternative II (On-Premises Storage) implementation phase are expected to be like those for Alternative I except for the off-site transportation impacts because no radioactive waste is disposed of off site in Alternative II. Although the operations during implementation would be noisy, noise impacts were not evaluated in detail because the Center is located in a rural setting.

Occupational Injuries. The estimated number of occupational lost workday cases resulting from illnesses and injuries and the estimated number of occupational fatalities related to the implementation of Alternative II by each WMA or facility are shown in Table 5-13.

Table 5-13. Total Estimated Lost Workday Cases and Fatalities for Alternative II (On-Premises Storage)

	Lost Workdays[a]				Fatalities[b]			
WMA/Facility	Construction	Operations	Services	Total[c]	Construction	Operations	Services	Total[c]
1—Process Building	4.1	4.3	20	28	0.013	0.005	0.014	0.031
01/14 Building	0.0	0.0	0.4	0.5	0.0002	0.0000	0.0003	0.0005
2—LLWTF and Lagoons 1-5	0.3	0.1	0.9	1.3	0.001	0.0001	0.0006	0.002
3—HLW Tanks/Vitrification Facility	1.3	1.7	8.3	11	0.004	0.002	0.006	0.012
4—CDDL	0.2	0.0	0.3	0.5	0.0006	0.0000	0.0002	0.0008
5—CPC Waste Storage Area	0.0	0.0	0.0	0.0	0.0000	0.0000	0.0000	0.0000
Lag Storage Building/ Additions	0.1	0.0	0.4	0.5	0.0003	0.0000	0.0002	0.0006
7—NDA	4.1	3.9	19	27	0.013	0.004	0.013	0.030
8—SDA	0.8	5.3	19	25	0.003	0.006	0.013	0.021
9—RTS Drum Cell	0	0	0.0	0.0	0	0	0.0000	0.0000
Other Facilities (including WMAs 6,10,11,12)	1.0	0.0	1.9	2.9	0.003	0.0000	0.001	0.005
Container Management Area	4.2	12	44	60	0.013	0.013	0.03	0.056
Retrievable Storage Areas	8.0	4.7	46	59	0.026	0.005	0.031	0.062
Erosion Control	0.3	0.1	0.4	0.8	0.001	0.0001	0.0002	0.001
Total[c]	24	32	267[d]	323[d]	0.08	0.04	0.19[e]	0.31[e]

a. An entry of 0 indicates that no lost workday cases have been estimated based on the 0 person-hours estimated (see Appendix F); an entry of 0.0 indicates that the estimated lost workday cases are less than 0.1.
b. An entry of 0 indicates that no fatalities have been estimated based on the 0 person-hours estimated (see Appendix F); an entry of 0.0000 indicates that the estimated fatalities are less than 0.0001.
c. Totals may not equal the sum of the numbers in the columns because of rounding.
d. Includes an estimated 106 cases from site support services.
e. Includes an estimated 0.084 fatalities from site support services.

Transportation Impacts. Principal nonradiological local and regional impacts from transportation under Alternative II are similar to those under Alternative I and are dominated by the air emissions, road wear and tear, and accident risk impacts of the work force commuter traffic on the local roadways near the site. The predicted impacts may differ slightly because of higher numbers of on-site workers during the implementation phase, additional construction-related traffic supporting construction of the retrievable storage areas, and a reduction in near-term traffic to and from the site for off-site radioactive waste shipments as under Alternative I (Removal).

The peak number of workers would increase to about 1,000, resulting in a slight increase in the number of daily commuters. Additional construction-related traffic would be required to bring concrete, steel, and similar resources from off site to the Center for building the new retrievable storage areas. Concrete use rises from about 32,000 m^3 (1.1 million ft^3) from Alternative I (Removal) to about 161,000 m^3 (5.7 million ft^3) under Alternative II, increasing the average daily concrete truck traffic to about 7.5 trucks per day in or out over the implementation period [calculated assuming there would be 161,000 m^3 (5.7 million ft^3) of concrete, a truck could transport 7.6 m^3 (270 ft^3) of concrete per load, the implementation phase would last 28 years, and there would be 200 workdays per year].

The number of off-site radioactive waste shipments would decrease to zero during the storage period. If at some later time, the radioactive waste were shipped off site, the local, regional, and national impacts from these shipments would be similar to the projected impacts of the comparable shipments under Alternative I.

Regional and national transportation impacts would result from shipping industrial wastes. The nonradiological impacts of transporting industrial waste include vehicular accident fatalities and increased risk of latent cancer fatalities from inhalation of transportation emissions, including combustion products, fugitive dust, and tire particulates. The impacts of shipping by WMA to a sanitary landfill 640 km (400 mi) from the Center are summarized in Table 5-14. The risks presented are cumulative risks for the implementation phase by WMA.

For the implementation phase of closure, the estimated total number of vehicular accident fatalities with either truck or rail shipment would be approximately 0.28 for the industrial waste shipments. The cumulative vehicular pollution latent cancers from industrial waste shipments would be 1.0 for truck shipment and 0.96 for rail shipment.

Air Quality

The potential consequences of implementing Alternative II would be similar to those described for Alternative I in Section 5.2.1.2. The National Ambient Air Quality Standards of 50 $\mu g/m^3$ for PM-10 would not be exceeded. Emissions under Alternative II would be smaller than Alternative I because the RTS drum cell would not be dismantled and removed. Estimated maximum 24-hour average downwind concentrations for PM-10 are approximately 16 percent of the standard.

The Center and Cattaraugus County are "in attainment" or "unclassifiable" with respect to the National Ambient Air Quality standards criteria pollutants; therefore, a conformity determination with the applicable State Implementation Plan is not required (see Section 4.5.2).

Table 5-14. Cumulative Nonradiological Impacts of Transporting Industrial Waste Off Site for Alternative II (On-Premises Storage)[a]

	Vehicular Accident Fatalities		Vehicular Air Pollution Fatalities	
WMA	Truck	Rail	Truck	Rail
1—Process Building Area	0.043	0.041	0.22	0.20
2—LLWTF and Lagoons 1-5	0.002	0.002	0.012	0.011
3—HLW Tanks	0.030	0.028	0.15	0.14
4—CDDL	0.021	0.020	0.11	0.097
5—CPC Waste Storage Area Lag Storage Building/Additions	0.004	0.004	0.020	0.018
6&10—Central Project Premises and Support & Services Area	0.092	0.087	0.40	0.37
7—NDA	0.008	0.008	0.043	0.039
8—SDA	0.0004	0.0003	0.0019	0.0017
9—RTS Drum Cell	0.077	0.073	0.092	0.084
Total	0.28	0.26	1.0	0.96

a. Cumulative risk for the implementation phase by WMA.

Water Quality

Water quality impacts during the implementation phase of Alternative II would be the same as those described for Alternative I in Section 5.2.1.2. The effects from Alternative II would differ from Alternative I if there were releases from the retrievable storage areas. However, because the wastes are assumed to be retrieved before the storage facility fails, no releases to the environment from storage on the Project Premises would be expected to occur. Discharges from the wastewater treatment area at the end of implementation would be permitted under the SPDES and, therefore, would not be allowed to exceed permit limits. Removal of the contaminant source would prevent further deterioration of groundwater quality in the long term.

Biotic Resources

The impacts to biota from implementing Alternative II would be very similar to those described for Alternative I because the same actions would occur on the Project Premises, the SDA, and the balance of the site. Unlike Alternative I, the radioactive waste would not be disposed of off site, but it would be stored on-premises in four contact retrievable storage areas that each cover about 1.2 ha (2.9 acres) and one shielded retrievable storage area that covers about 0.5 ha (1.2 acres). Potential locations for the retrievable storage area locations are shown on Figure 3-17. Potential locations for the contact retrievable storage areas would be an area on the north side of WMA 10, the southwest side of WMA 5 and in WMA 2 on the north plateau. A potential location for the shielded retrievable storage area would be in WMA 1, also on the north plateau. Because these locations are in previously disturbed areas on the Project Premises (some of these areas are currently parking lots), no direct effects to biota would be expected. For those areas in WMAs 2 and 5 that currently are mowed and maintained, animals in those locations would lose their habitat, be displaced, or be killed by the construction activities. The areas where the facilities could be constructed would be unavailable as habitat for plants and animals.

Potential impacts to protected species would be the same as described for Alternative I in Section 5.2.1.2.

Wetlands and Floodplains. Potential impacts to wetlands and floodplains would be the same as described for Alternative I in Section 5.2.1.2.

5.3.1.3 Costs

The costs from implementing Alternative II are shown in Table 5-15. Cost data for materials, labor, and contingencies were compiled from WVNS (1994a through n). Cost data for waste transportation and disposal were calculated as described for Alternative I in Section 5.2.1.3. Because radioactive waste is stored on the Project Premises rather than being disposed of off site, the waste transportation and disposal costs would not be the greatest cost contributor. The transportation and disposal costs shown on Table 5-15 would be primarily from cost of the waste packages. Labor would be the largest overall cost for this alternative because of the construction and operation of the container management area and retrievable storage areas. For analysis purposes this EIS assumes that the borosilicate glass canisters, LLW, GTCC, and mixed waste would be transferred to the retrievable storage areas. Hazardous waste and industrial waste would be shipped off site.

There would be annual costs for the post-implementation phase of closure for maintaining the retrievable storage areas and erosion control structures. The annual cost for post-implementation reflects two cost components. The first component would be the expected annual cost for routine maintenance (e.g., checking the ventilation system, changing ventilation filters, and checking erosion control structures). The second component would be the annual cost for nonroutine major maintenance that would occur at greater time intervals. Nonroutine maintenance could include replacing the retrievable storage area roof, replacing control room instrumentation with new equipment, or filling gullies formed after a major storm. The annual cost for maintaining the retrievable storage areas is about $1.3 million for routine maintenance and $1.3 million for non-routine maintenance. There would also be an annual cost of approximately $133,000 for erosion control (e.g., maintaining stream banks). The maintenance costs for the RTS drum cell are expected to be a small fraction of the costs for maintaining the retrievable storage areas and erosion control because the facility is comparatively small and it has no active features that would require maintenance.

Table 5-15. Cost Summary for Implementing Alternative II (On-Premises Storage)

	$ 1996 Costs (Thousands)[a]					
	Implementation Phase					Post-Implementation Phase
WMA/Facility	Materials and Fuels	Labor	Waste Transportation and Disposal	Contingency	Total	Annual
1—Process Building	45,531	116,112	11,642	43,321	216,606	0
01/14 Building	447	2,181	470	775	3,873	0
2—LLWTF and Lagoons 1-5	3,461	4,794	5,962	3,554	17,771	0
3—HLW Tanks/Vitrification Facility	16,781	47,261	21,666	42,854	128,562	0
4—CDDL	887	1,795	15,372	4,514	22,568	0
5—CPC Waste Storage Area	33	397 (720)[b]	18,112	4,636	23,178	0
Lag Storage Building/Additions	153	1,993	42,772	11,230	56,148	0
7—NDA	67,854	110,013	151,389	164,628	493,884	0
8—SDA	32,848	112,327	309,549	227,362	682,086	0
9—RTS Drum Cell	0	0 (51)[b]	0	0	0	0[c]
Other Facilities (including WMAs 6,10,11,12)	2,385	10,136	9,759	5,570	27,850	0
Container Management Area	70,642	512,357	4,438	146,859	734,296	0
Retrievable Storage Areas	121,649	267,243	0	97,223	486,115	2,651
Erosion Control	247	109	2	90	448	133
Soil	4,930	2,168	20,548	6,911	34,557	0
Site Support Operations	0	789,407 (1,400,000)[b]	0	0	789,407	0
Total	367,849	1,978,293	611,681	759,527	3,717,349	2,784

a. Original costs were in 1993 dollars. Escalation factor used was 1.1703.
b. Values in parentheses are those in the 1995 versions of the closure engineering reports. The Final EIS will use final versions of the closure engineering reports.
c. Costs would be a small fraction of the costs for the retrievable storage areas and are included in those costs.

Sources: Modified from WVNS (1994a through n)

5.3.1.4 Socioeconomic Impacts

The direct employment and expenditures for goods and services from implementing Alternative II would be similar to those described for Alternative I in Section 5.2.1.4.

Implementing Alternative II actions would result in direct employment and expenditures for goods and services starting in the year 2000. Direct employment and expenditures would peak around the year 2011 and then decline until the year 2027. The schedule for starting Alternative II would be integrated with completing the WVDP HLW solidification so a sharp increase or decrease in employment would be avoided. Peak site employment levels would be comparable to that during WVDP HLW solidification.

The direct employment and expenditures would produce a positive impact on the 20-km (12-mi) primary impact area by providing continued employment for personnel who would otherwise be unemployed after HLW solidification is complete. At the peak year (2011), about 7.5 percent of the direct and indirect employment in the primary impact area would result from the site employment and expenditures. The peak year would involve 1,049 jobs in the primary impact area; 1,026 jobs would be direct site employees and another 23 jobs would be indirect jobs. In the two-county ROI, peak year total employment would be 1,968, which would account for 0.3 percent of the total primary impact area employment.

Layoffs would occur at the end of the implementation phase in about 2027. A small staff of about 32 persons would continue to support long-term monitoring and maintenance. These layoffs would result in a negative socioeconomic impact. Alternative V, Discontinue Operations, would eliminate about 900 jobs over 5 years starting in 1998, while Alternative II would eliminate approximately the same number of jobs over a 16-year period starting in 2011. This job reduction for Alternative II would represent about a 0.5 percent annual decrease in employment in the primary impact area and a negligible decrease (about 0.01 percent) in the two-county ROI.

The impacts on housing availability and funding of local public services would be the same as those discussed for Alternative I in Section 5.3.1.4.

Growth Inducing Aspects of the Alternative. Site employment, site expenditures, and land ownership under Alternative II would be similar to that described for Alternative I in Section 5.2.1.4 except portions of the Center would be retained indefinitely.

5.3.1.5 Cultural Resources

On the Project Premises and SDA, the impact to archaeological and architectural resources would be similar to those discussed for Alternative I, as described in Section 5.2.1.5, except the retrievable storage areas would be constructed disturbing an additional 5.3 ha (13 acres) of land on the Project Premises. There would be no impact to archaeological resources by their construction because of the severe disturbance to the area during construction of the former reprocessing facility.

On the balance of the site and off site, the same actions would occur under Alternative II that occurred under Alternative I; therefore, the impacts would be the same as described for Alternative I in Section 5.2.1.5. Like Alternative I, areas would be disturbed that have not had an archaeological survey. Before these areas were disturbed, a survey would be conducted to determine the presence of cultural resources.

5.3.1.6 Relationship to Land Use Plans and Visual Impacts

As discussed in Section 5.2.1.6, Alternative II actions would be consistent with the Cattaraugus County Land Use Plan (Cattaraugus County Planning Board 1978, updated 1982) because the balance of the site would be released except for the portion used for continued monitored waste storage.

With the exception of building retrievable storage areas on the Project Premises and maintaining the RTS drum cell, the closure activities under Alternative II are identical to Alternative I. Like Alternative I, visual impacts would be limited to glimpses of the Project Premises and SDA while driving by on Rock Springs Road. More visual impact is possible in winter than in summer because foliage is absent. Figure 3-18 (schedule for implementing Alternative II) shows the timing of each potential visual impact. A corresponding description of activities is in Section 3.4.2.

Implementation Phase. The visual impacts would be identical to those described under Alternative I for the Project Premises (except the RTS drum cell is retained) and the balance of the site.

Post-implementation Phase. At completion of Alternative II, retrievable storage areas and the RTS drum cell would be present on the Project Premises surrounded by a security fence. Four contact retrievable storage areas and one shielded retrievable storage area would be present. The four contact retrievable storage areas would potentially be located between 18 and 30 m (60 and 100 ft) from Rock Springs Road. Landscaping would be used to minimize the visual impact of these facilities. The shielded retrievable storage area would potentially be located in WMA 1 on the north plateau.

Under the sensitivity case for Alternative II (i.e., soil treatment is not effective), 10 contact retrievable storage areas and one shielded retrievable storage area would be constructed. Seven of the contact retrievable storage areas could potentially be located between 18 and 152 m (60 and 500 ft) from Rock Springs Road. The remaining three could potentially be located on the northeastern side of the north plateau, between 305 and 460 m (1,000 and 1,500 ft) from Rock Springs Road and would be partially hidden from passersby. The shielded retrievable storage area would potentially be located as described above, and, as above, landscaping would be used to minimize the visual impact of these facilities.

The SDA and balance of site would be vacant land and the Center fence would be gone if portions of the site were released for other purposes.

5.3.1.7 Impacts of Disposing of Radioactive and Industrial Wastes at Off-Site Facilities

No radioactive waste would be disposed of off site under Alternative II. Therefore, there would be no impact to facilities licensed to dispose of radioactive waste under this alternative. There would be a small impact from disposing of industrial waste off site.

A total of 116,000 m^3 (4,080,000 ft^3) of industrial waste would be generated by implementing Alternative II over about 22 years (refer to Figure 3-18), giving an average disposal rate of 5,270 m^3 (185,450 ft^3) per year. Using an average density of 1,400 kg/m^3 (89 lb/ft^3) (Lynch 1995), this would be equivalent to 7,380 metric tons (8,250 tons) per year, which is 4 percent of the waste that is disposed of in western New York (Buffalo region) and 0.5 percent of the waste volume that is disposed of in the State of New York (Lynch 1995). Because it has been assumed that industrial waste could be disposed of within a 640-km (400-mi) radius of the Center, the percentage would be even lower. Thus, the quantity of waste that could potentially be disposed of would not be significant relative to the current volume of industrial waste disposed of in the State of New York, and would not consume a significant capacity in sanitary landfills.

5.3.2 Evaluation of Long-Term Impacts

The implementation phase would be followed by a post-implementation phase where the stored waste would be monitored. The post-implementation phase evaluated for environmental impacts in this EIS is 1,000 years, although calculations for the long-term performance assessment were carried out as far as 10,000 years to establish the potential contribution of long-lived, relatively mobile radionuclides. For Alternative II, local erosion control measures as described in Section 3.4.2.3 were assumed to be implemented as part of site monitoring and maintenance. Most potential impacts would be similar to those described for Alternative I.

For expected conditions during the post-implementation phase, there would be no transportation impacts because no radioactive waste would be shipped. Unlike Alternative I, there would be minimal occupational doses to the staff remaining on the Project Premises to monitor and maintain the retrievable storage areas and the RTS drum cell. Because there would be no earthmoving activities to directly disturb areas and generate dust and runoff, there would be no impact to air quality, water quality, biota or cultural resources over the long term. Because most of the soil contamination would be removed, the potential for uptake by vegetation and animals would be expected to substantially decline.

For conditions considered unlikely, institutional control could be lost and radionuclides released by deterioration of storage facilities. The maintenance of erosion control structures could end, allowing the stream banks to erode back to the facilities. Loss of institutional control would pose a public health and safety risk as the waste storage facilities deteriorate, water could seep into the facility, and radionuclides could potentially be released to the environment.

5.3.2.1 Long-Term Impacts from Expected Environmental Conditions and Loss of Institutional Control

During the post-implementation phase individuals could establish residence on released portions of the Center and potentially come into contact with residual radioactive material. Low-level occupational doses would also be expected. The retrievable storage areas could deteriorate potentially releasing radionuclides to the environment if institutional control were lost. The potential impacts from the expected conditions and from loss of institutional control are presented in this section.

Expected Conditions Case

Radiological Impacts. The radiological impacts for expected conditions and from residential or agricultural use of the Center in areas other than the retrievable storage areas and RTS drum cell would be similar to those discussed for Alternative I. Annual doses would be expected to be less than 15 mrem/yr for areas that would have been remediated during the implementation phase, and annual risks of a latent cancer fatality would be less than 8.0×10^{-6}.

Occupational Doses. At the end of the implementation phase of Alternative II, personnel would remain on site to monitor the retrievable storage areas, the RTS drum cell and to maintain erosion control structures as needed. Therefore, there would be minimal long-term occupational impacts.

It was assumed that two full-time security officers would be required to safeguard the retrievable storage areas, and that monitoring and maintenance would be performed by part-time workers (WVNS 1994n). The same estimates were applied for the monitoring and maintenance of the RTS drum cell (WVNS 1994d). The low level of occupational activities would result in collective occupational doses of less than 1 person-rem/yr, less than 1 lost workday case per year, and less than 0.001 fatalities per year (i.e., less than a 0.1 percent chance of a fatality per year).

These estimates do not address replacing the retrievable storage areas after 100 years, the projected design life of the facility. Details of activities and potential impacts for moving waste containers (if necessary), replacing the building, or repackaging the waste in containers suitable for additional storage or for shipment off site for disposal are unknown.

Replacing the local erosion control measures about every 50 years would result in minimal occupational doses (less than 1 person-rem collectively), but this action would result in an estimated 3 lost workday cases and 0.006 fatalities (i.e., a 0.6 percent chance of a fatality) within the first 100 years.

Loss of Institutional Control Case

If institutional control were lost, the retrievable storage areas would deteriorate and erosion control structures would not be maintained. Two cases were considered to evaluate potential impacts. In the first case, the site and its potential transport pathways remain undisturbed by natural processes. In the second case, erosion was assumed to occur, disturbing the site and the waste storage facilities. In an undisturbed site, reduction or loss of structural integrity of the retrievable storage areas could potentially release radioactive material to infiltrating water and the environment. In a disturbed site, erosional processes could decrease facility containment capability, leading to potential radionuclide releases to the environment. This section describes potential radiological impacts from the loss of institutional control in undisturbed and disturbed sites.

Radiological Impacts for an Undisturbed Site. To evaluate the potential impact of abandoning the retrievable storage areas, it was assumed that their confining capability was lost after 100 years, and water percolated through the stored waste, leaching radionuclides, and transporting contamination in groundwater to on-site and off-site residents. For EIS analysis, the retrievable storage areas were assumed to be located on the north plateau, with a residential garden and well located 50 m (164 ft) from the facility. On the south plateau, for analysis of the RTS drum cell, it was assumed that a garden was located between the RTS drum cell and the headwaters of Franks Creek. Doses for the year of maximum exposure for the north and south plateau residents were estimated as 1.3×10^8 and 440 mrem, respectively. The north plateau impacts were severe with potential for illness or fatality.

Dissolved radionuclides in groundwater could also be transported in surface water off site. Potential impacts for this scenario evaluated a Buttermilk Creek resident and the surrounding population. Doses for the Buttermilk Creek resident in the year of maximum impact for the retrievable storage area and RTS drum cell were estimated to be 652.0 and 6.3 mrem, respectively. The collective (population) dose for the year of maximum impact for the retrievable storage areas and the RTS drum cell were estimated to be 50.9 and 0.5 person-rem, respectively. Estimates of the annual risk were 3.3×10^{-4} for the Buttermilk Creek resident and 7.3×10^{-8} for the average member of the population.

Radiological Impacts for a Disturbed Site. The local erosion control strategy plan would require effective periodic maintenance or replacement of the engineered structures. The failure to maintain the engineered structures would allow the south plateau to erode into the RTS drum cell within 1,000 years. The potential off-site impacts from failure to control erosion were evaluated using the erosion release model described in Appendix E. The erosion process discussed in Appendix L was assumed to start immediately after the loss of institutional control and proceed at a rate expected to be exceeded 10 percent of the time under current conditions. Appendix L describes the method developed to estimate the rate. The impacts from erosional collapse of the RTS drum cell inventory into the creeks were evaluated for a Buttermilk Creek resident and the surrounding population. Radiation doses for the year of maximum impact for the Buttermilk Creek resident and the population were estimated as 4,500 mrem and 360 person-rem, respectively. The annual risk of a latent cancer fatality for the Buttermilk Creek resident and the average member of the population were estimated as 2.3×10^{-3} and 5.1×10^{-7}, respectively.

5.3.2.2 Long-Term Impact from Less Likely Events

In addition to the operational accidents evaluated during waste recovery, accidents were also evaluated for the long-term monitoring and maintenance period. The bounding accident during that period was assumed to be a beyond design basis earthquake of sufficient magnitude to collapse and destroy the RTS drum cell and the retrievable storage areas. For the RTS drum cell, a beyond design basis earthquake with an estimated peak ground acceleration of 0.33 g was assumed to completely destroy the facility. Because the retrievable storage areas have not been designed, the impacts of the earthquake are unknown, but similar damage can be assumed. The analysis assumes that the facility would be designed so that even in a beyond design basis earthquake, the potential impacts would be limited so that the maximum off-site individual would not likely receive more than 25 rem. The estimated impacts from releases from these two facilities because of a beyond design basis earthquake are presented in Table 5-16. Details on the accident analysis are presented in Appendix G.

Table 5-16. Long-Term Impacts to the Public from Severe Natural Phenomena for Alternative II (On-Premises Storage)

WMA/Facility	Description of Upper-Bound Accident	Maximum Individual Dose (rem)	Collective Dose[a] (person-rem)	Latent Cancer Fatalities
9—RTS Drum Cell	Beyond design basis earthquake destroys RTS drum cell	20	200,000	100
Retrievable Storage Areas	Beyond design basis earthquake causes breach of waste containment	20	200,000	150

a. Collective dose from airborne releases to the projected population (year 2000) of 1,350,000 people residing within 80 km (50 mi) of the Center.

5.3.3 Uncertainty Associated with Alternative II

Like Alternative I, Alternative II has technical uncertainties during the implementation phase that could affect the magnitude of the environmental consequences. Under Alternative II, radioactive waste is stored on the Project Premises rather than being disposed of off site. As described for Alternative I in Section 5.2.3, because of the potential uncertainty of meeting design basis assumptions for soil treatment and because waste assumed to be industrial waste could potentially be characterized as LLW, more area could be required to store the waste as analyzed in Appendix N.

Under design basis conditions in the expected case, a total volume of 259,000 m^3 (9.13 million ft^3) of contaminated waste and soil and 116,000 m^3 (4.08 million ft^3) of industrial waste would be generated. If design basis conditions were not met, the potential volume of waste could increase by 138 percent, requiring an additional 7.2 ha (18 acres) for storage (see Appendix N). The requirement for additional acreage would increase the environmental impacts to biota from a loss of habitat, since the additional retrievable storage areas would be constructed on the Project Premises in areas already disturbed by the implementation actions. There would be no impact to cultural resources since the entire

Project Premises and SDA were previously disturbed during construction of the former reprocessing facility and there are no structures of historical significance.

The uncertainty in predicting the post-implementation (long-term) impact relative to residual soil contamination would be similar to that described in Section 5.2.3 for Alternative I. The storage of radioactive waste has uncertainty from not knowing the duration of the storage period and the potential hazard should waste be stored beyond the design life of the retrievable storage areas.

5.4 ALTERNATIVE III: IN-PLACE STABILIZATION AND ON-PREMISES LOW-LEVEL WASTE DISPOSAL

Under Alternative III, major contaminated buildings would either be backfilled with concrete {Alternative IIIA [In-Place Stabilization (Backfill)]} or broken down into a rubble pile and capped {Alternative IIIB [In-Place Stabilization (Rubble)]}. Buildings with little contamination would be decontaminated to free release levels, dismantled, and disposed of off site as industrial waste. Buried waste would be stabilized in-place; contaminated in-ground structures such as the LLWTF lagoons would be stabilized, backfilled, and capped; and the HLW tanks would be backfilled with concrete. Contaminated soils would be stabilized in place. Stored waste in WMAs 5, 6, and 7 would be disposed of either on the Project Premises in an existing structure, such as the process building (Alternative IIIA) or in a new LLW disposal facility (Alternative IIIB). Implementing this alternative would have low labor and waste transportation requirements compared to Alternative I because facilities would be stabilized in-place and only the vitrified HLW waste canisters, mixed, hazardous, and industrial wastes, and spent fuel fines would be shipped off site. A maximum of 57 ha (142 acres) could be disturbed if a global erosion control strategy were selected. Waste would remain in multiple locations on the Project Premises and the SDA. The post-implementation phase would consist of active monitoring and maintenance indefinitely.

The estimated volume of waste to be generated under Alternatives IIIA and IIIB are described in Section 3.5.3. For Alternative IIIA, the volume of Class A waste is estimated at 11,000 m^3 (390,000 ft^3), Class B waste at 1,170 m^3 (41,400 ft^3), Class C waste at 2,200 m^3 (77,800 ft^3), GTCC waste at 428 m^3 (15,100 ft^3), HLW at 267 m^3 (9,420 ft^3), mixed waste at 63 m^3 (2,220 ft^3), and hazardous waste at 0.06 m^3 (2 ft^3). No contaminated soil volumes would be generated. The volume of industrial waste could be 40,800 m^3 (1.44 million ft^3) if a local erosion control strategy were used, or 68,300 m^3 (2.41 million ft^3) if a global erosion control strategy were used.

For Alternative IIIB, the volume of Class A waste would be 12,400 m^3 (436,000 ft^3). The volumes of Class B, C, GTCC, HLW, mixed, and hazardous waste would be the same as for Alternative IIIA. The volume of industrial waste could be 40,200 m^3 (1.42 million ft^3) if a local erosion control strategy were used or 68,000 m^3 (2.40 million ft^3) if a global erosion control strategy were used.

The environmental impacts from implementing Alternative III would vary if the industrial waste generated by this alternative is actually classified as LLW after characterization, thereby, increasing the volume of LLW to be disposed ~~of~~ on the Project Premises. The effect on the environment would be that more land area would be required for constructing LLW disposal facility modules. Because the conceptual design for the stabilization activities evaluated under Alternative III are substantially different for the process building and the disposal areas (i.e., stabilize in-place) compared to Alternatives I and II, the occupational dose to workers and emissions would not be as potentially variable under this alternative. The effect of an increased volume of LLW to be disposed of and the uncertainties with the long-term performance assessment are discussed in Section 5.4.3.

5.4.1 Implementation Phase Impacts

The actions to implement Alternative III are summarized in Section 3.5.1. A detailed discussion on the implementation of Alternative III is given in Sections 3.5.2 through 3.5.5. The general actions are summarized in Figures 5-5 and 5-6.

The implementation phase for Alternatives IIIA [In-Place Stabilization (Backfill)] and IIIB [In-Place Stabilization (Rubble)] is approximately 10 and 26 years, respectively. Implementation of Alternative IIIB would take longer because the process building and vitrification facility would be entirely dismantled. During the implementation phase:

- Highly contaminated buildings, such as the process building and vitrification facility, would be backfilled with concrete (Alternative IIIA), or broken down into rubble (Alternative IIIB), resulting in less disturbance of land compared to either Alternative I or Alternative II. Other smaller contaminated buildings in WMAs 1 and 2 would be decontaminated and demolished, disturbing about 0.03 ha (0.07 acres) of land.

- In-ground structures would be excavated and removed or backfilled and capped, disturbing about 0.8 ha (2.1 acres) in WMAs 2, and 6. The HLW tanks would remain and be backfilled with concrete.

- Buried waste in the NDA and SDA would be stabilized in-place (by slurry walls, in-situ waste solidification techniques, and capping), disturbing about 11 ha (26 acres) of land in WMAs 7 and 8. (The CDDL would remain as-is.)

- Remaining facilities in WMAs 1, 2, 3, 6, 10, 11, and 12 would be demolished and removed, disturbing about 11 ha (28 acres) of land.

- The RTS drum cell (WMA 9) would be converted into a tumulus, disturbing about 0.5 ha (1.1 acres) of land.

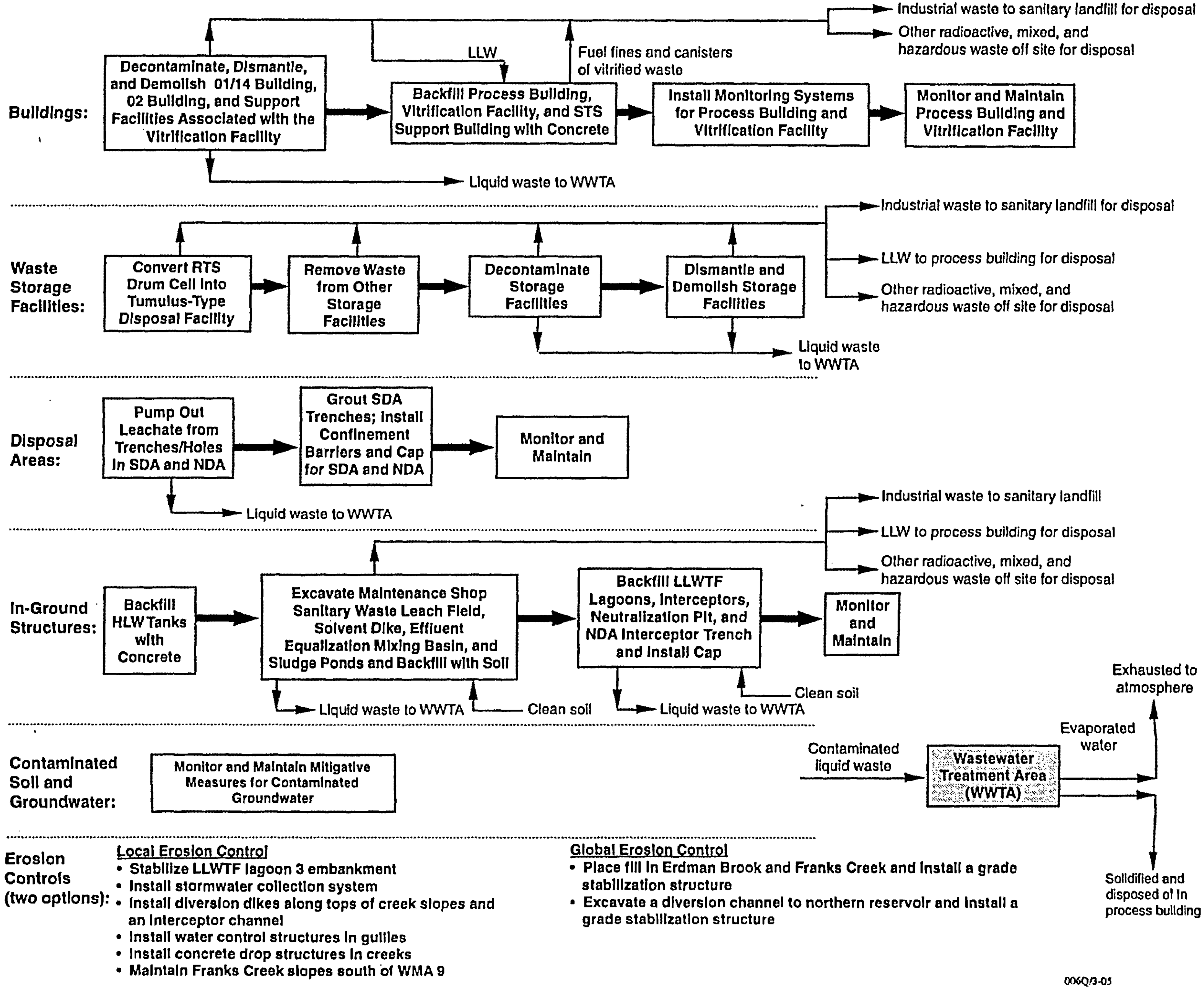

Figure 5-5. General Strategy for Implementing Alternative IIIA [In-Place Stabilization (Backfill)].

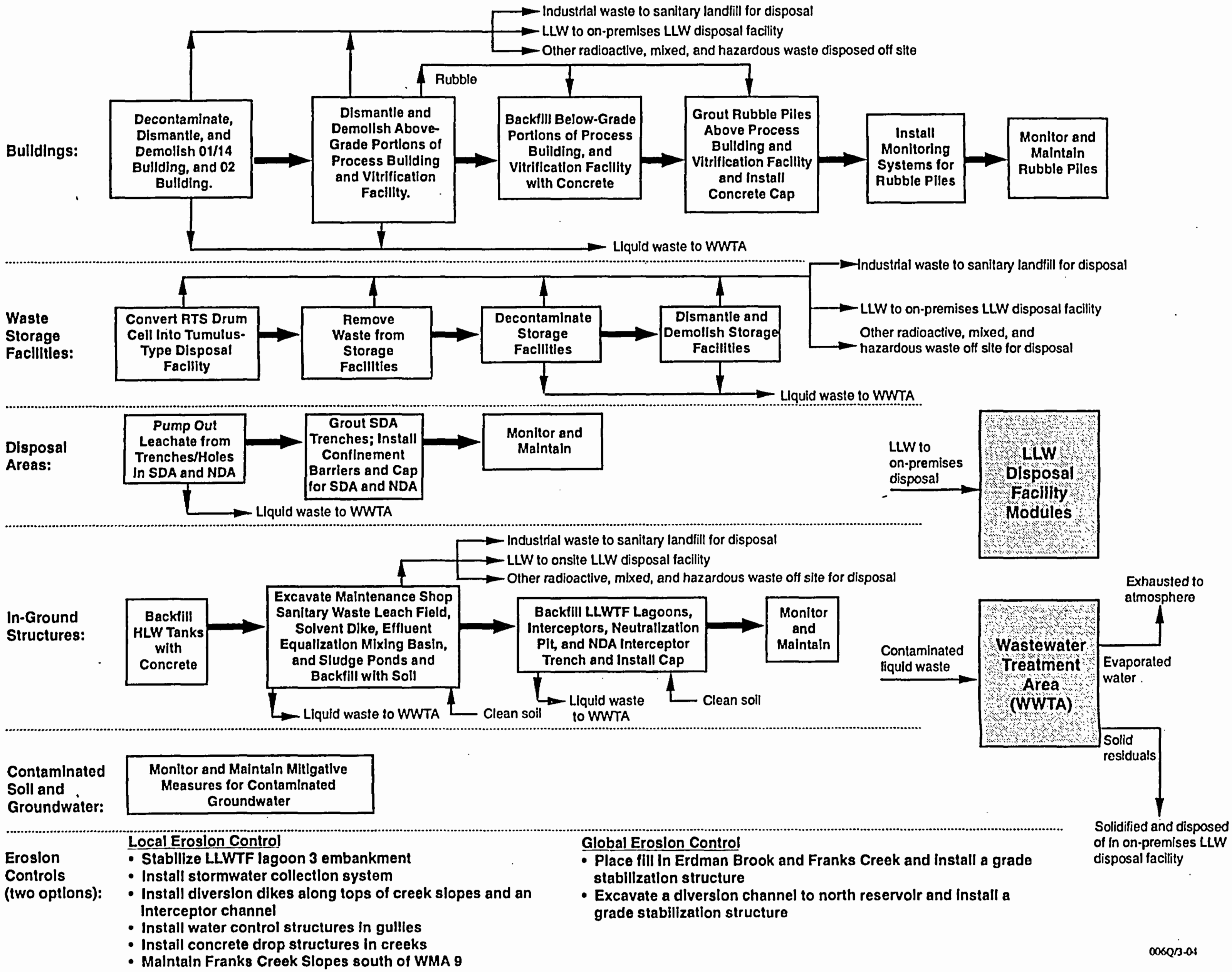

Figure 5-6. General Strategy for Implementing Alternative IIIB [In-Place Stabilization (Rubble)].

- Mitigative measures to control contaminated groundwater on the north plateau would continue.

- Stored waste in WMAs 5, 6, 7, and 8 would be removed, and radioactive waste would be disposed of either in the process building or vitrification facility (Alternative IIIA) or in a new on-premises LLW disposal facility (under Alternative IIIB). The existing waste storage facilities in these WMAs would be demolished, disturbing a 1-ha (2.4-acre) area.

- A wastewater treatment area would be constructed in WMA 6, disturbing about 790 m^2 (8,500 ft^2) area. Under Alternative IIIB, three new LLW disposal facility modules (potentially located in WMAs 5 and 10) (see Subsection 3.5.2.2) would be constructed and converted into tumuli. This would disturb about 1.6 ha (4.0 acres).

- Hazardous, industrial, and mixed waste and the vitrified HLW waste canisters and spent fuel fines would be disposed of off site.

- Either localized erosion control structures (e.g., diversion dikes and water control structures) would be used on the Project Premises and the SDA along the creeks or global erosion control measures on the balance of the site would be used to control erosion (e.g., large scale filling of streambeds) (see Subsection 3.5.2.3). The local erosion control strategy would disturb about 13 ha (31 acres), 7 ha (17 acres) on the Project Premises and 5.7 ha (14 acres) on the balance of the site. The global erosion control strategy would disturb approximately 18 ha (45 acres), 9.7 ha (24 acres) on the Project Premises and 8.4 ha (21 acres) on the balance of the site.

5.4.1.1 Resource Requirements

Alternative III requires resources for constructing new facilities during the implementation phase (e.g., a disposal facility) and for decontamination, demolition, and containment, such as the concrete confinement enclosure to be built over the process building in Alternative IIIB [In-Place Stabilization (Rubble)]. Resource requirements would include electrical power, natural gas, and diesel and gasoline fuel. Table 5-17 summarizes the resource requirements compiled from closure engineering reports (WVNS 1994a through n).

Approximately 120,000 m^3 (4 million ft^3) of soil would be required to cap the process building and HLW tanks, backfill ares on the site, and backfill Erdman Brook and Franks Creek if a global erosion control strategy were selected (WVNS 1994m). A total of 101,000 m^3 (3.6 million ft^3) of sand and gravel and 92,000 m^3 (3.2 million ft^3) of concrete would be needed to backfill lagoons 2 and 3, construct engineered caps and a confinement enclosure, and implement Alternative III erosion control measures (WVNS 1994l, 1994m). About 115,000 m^3 (4 million ft^3) of clay would be required to construct slurry walls and cap the NDA, SDA, and LLWTF lagoons (WVNS 1994l).

Table 5-17. Estimated Energy and Fuel Requirements for Alternative III (In-Place Stabilization)[a]

	Implementation Phase					
	Electrical Power (MW-hr)		Natural Gas[b] (ft^3)		Diesel Fuel and Gasoline[b] (gal)	
WMA/Facility	IIIA [In-Place Stabilization (Backfill)]	IIIB [In-Place Stabilization (Rubble)]	IIIA [In-Place Stabilization (Backfill)]	IIIB [In-Place Stabilization (Rubble)]	IIIA [In-Place Stabilization (Backfill)]	IIIB [In-Place Stabilization (Rubble)]
1—Process Building	1,200	90,000	1.9×10^{7}	1.1×10^{8}	69,000	1.1×10^{5}
01/14 Building	120 (260)[c]	120 (260)	2.4×10^{5}	2.4×10^{5}	8,200	8,200
2—LLWTF and Lagoons 1-5	93	93	72,000	72,000	26,000	26,000
3—HLW/Vitrification Facility	420	940 (2,100)	1.4×10^{7} (9.2×10^{5})	6.5×10^{7}	32,000	2.0×10^{5}
4—CDDL	0	0	0	0	0	0
5—CPC Waste Storage Area	0	0	0	0	790 (8,300)	790 (8,300)
Lag Storage Building/Additions	29	29	0	0	4,300 (8,400)	4,300 (8,400)
7—NDA	1.8	1.8	0	0	2.2×10^{5}	2.2×10^{5}
8—SDA	3,900	3,900	0	0	4.8×10^{5}	4.8×10^{5}
9—RTS Drum Cell	0	0	0	0	1.4×10^{5} (6.1×10^{5})	1.4×10^{4} (6.1×10^{5})
Other Facilities (including WMAs 6,10,11,12)	0	0	0	0	1.3×10^{5} (54,000)	1.3×10^{5} (54,000)
Wastewater Treatment Area	1,400	1,400	1.4×10^{7}	1.4×10^{7}	1.1×10^{5}	1.1×10^{5}
LLW Disposal Facility	0	3,000	0	0	0	7.1×10^{5}
Erosion Control Strategy						
Local erosion control	0	0	0	0	5.2×10^{4}[d]	5.2×10^{4}[d]
Global erosion control	0	0	0	0	1.9×10^{6}[e]	1.9×10^{6}[e]
Total	7,100	99,000	4.7×10^{7}	1.9×10^{8}	1.3×10^{6}[d] or 3.1×10^{6}[e]	2.1×10^{6}[d] or 4.1×10^{6}[e]

a. All numbers have been rounded to two significant figures. Values in columns may not add up to totals due to rounding.
b. To convert cubic feet to cubic meters, multiply by 0.02832. To convert gallons to liters, multiply by 3.785.
c. Values in parentheses are those in the 1995 version of the closure engineering reports. The Final EIS will use final versions of the closure engineering reports.
d. Assumes a local erosion control strategy was selected.
e. Assumes a global erosion control strategy was selected.

Sources: WVNS (1994a through m, and q)

Alternative IIIB requires more resources because confinement enclosures would be constructed around the process building and vitrification facility and the new LLW disposal facility would be constructed. In both Alternatives IIIA and IIIB, the construction, operation, and demolition of the wastewater treatment area requires large amounts of electricity, natural gas, and fuel.

Implementing Alternative IIIA would require less electrical power and natural gas but more fuel than implementing Alternatives I or II. Both the average and maximum electrical power requirements (790 and 1,500 MW-hr/yr, respectively) and the average and maximum natural gas requirements [150,000 and 180,000 m^3/yr (5.2 and 6.3 million ft^3/yr), respectively] would be much less than the projected consumption rates of 32,000 MW-hr/yr and 2,500 million m^3/yr (89,000 million ft^3/yr) to be used from 1996 to 2000 during HLW solidification (Kawski 1995). However, depending on whether a local or global erosion control strategy were selected, the average consumption rate of gasoline and diesel fuel could range from 530,000 to 910,000 L/yr (140,000 to 240,000 gal/yr), which is approximately 6 to 10 times greater than the current consumption rate of 93,000 L/yr (24,500 gal/yr) (Kawski 1995).

Implementing Alternative IIIB would require more electrical power and natural gas but less fuel than implementing Alternative IIIA. Both the average and maximum electrical power requirements (4,000 and 6,000 MW-hr/yr, respectively) and the average and maximum natural gas requirements [220,000 and 910,000 m^3/yr (7.6 and 32 million ft^3/yr), respectively] would be much less than the projected consumption rates to be used from 1996 to 2000. However, depending on whether a local or global erosion control strategy were used, the average consumption rate of gasoline and diesel fuel could range from 320,000 to 620,000 L/yr (84,000 to 164,000 gal/yr), which is approximately 3 to 7 times greater than the current consumption rate of 93,000 L/yr (24,500 gal/yr) (Kawski 1995).

The annual resources required during the post-implementation phase of Alternatives IIIA and IIIB would be negligible, since all facilities would be stabilized and maintenance would occur as necessary (i.e., checking erosion control structures).

5.4.1.2 Environmental Impacts

Radiological (Occupational and Transportation)

The implementation phase actions of Alternative III disturb less potentially contaminated soil and involve less worker contact with radioactive waste than activities conducted for Alternatives I and II. This section discusses the off-site and occupational doses for the implementation phase, which is estimated to take about 10 years for Alternative IIIA and 26 years for Alternative IIIB. The methods used in the assessment are given in Appendices D through G.

Off-Site Impacts. The stabilization actions on the Project Premises and SDA under Alternative III would produce smaller releases to the environment than the potential releases from exhuming radioactive waste under Alternatives I or II. However, implementation would require less time for Alternative III and annual release rates would be higher for the NDA and SDA than for Alternative I. The maximum individual and population doses estimated for Alternative IIIA, given in Table 5-18, reflect these differences.

Table 5-18. Impacts to the Public from Implementation Phase Releases for Alternative IIIA [In-Place Stabilization (Backfill)]

	Air Pathway[a]				
WMA/Facility	Off-Site Individual (mrem/yr)	Collective Dose (person-rem/yr)	Duration of Release (yr)	Total Collective Dose (person-rem)	Latent Cancer Fatalities
1—Process Building	0.24	1.7	1	1.7	8.5×10^{-4}
2—LLWTF and Lagoons 1-5	0.004	0.02	1	0.02	1.0×10^{-5}
3—HLW Tanks/Vitrification Facility	0.009	0.057	1	0.057	2.9×10^{-5}
7—NDA	0.22	1.50	2	3.0	0.0015
8—SDA	3.10	10.0	4	40.0	0.02
Total				44.8	0.022[b]

a. Since the facilities are not decontaminated and decommissioned at the same time, the peak doses are not additive. Even if the peak doses were to occur simultaneously, these doses would be very low.

b. The average annual risk of a latent cancer fatality due to the total atmospheric release is 1.6×10^{-6} for the maximally exposed off-site individual, and 4.2×10^{-9} for the average individual in the population.

Releases and impacts for Alternative IIIB are nearly identical to those presented for Alternative IIIA. Because potential release rates for the process building for Alternative III are less than those for Alternatives I and II, and because release rates from the SDA increased for Alternative III relative to Alternatives I and II, the dose impacts for Alternative III are dominated by release of tritium from the SDA. The doses estimated for Alternative III for the maximally exposed individual and the average member of the population are less than 3 percent and 0.01 percent, respectively, of the doses received from normal background radiation. The average annual risk of a latent cancer fatality due to the total atmospheric release is 1.6×10^{-6} for the maximally exposed individual and 4.2×10^{-9} for the average individual in the population.

Occupational Doses. Occupational doses for Alternative III were calculated using the same method described for Alternative I. In general, the doses calculated for Alternative III are substantially lower than those for Alternative I because Alternative III actions include minimal decontamination and not exhuming and processing of waste. The estimated doses and latent cancer fatalities by WMA are summarized in Table 5-19. No difference in occupational dose could be distinguished between Alternatives IIIA and IIIB.

Transportation Impacts. Under Alternative III, spent fuel fines from the process building and the borosilicate glass canisters of HLW would be disposed of off site. As with Alternative I, this analysis evaluated the impacts of shipping the spent fuel fines and vitrified HLW to DOE sites either in Washington or Nevada; the impacts are summarized in Appendix H for both truck and rail transport. The incident-free risks to transportation workers and members of the general public near the transportation routes are summarized in Table 5-20.

Table 5-19. Cumulative Occupational Radiological Impacts for Alternative III (In-Place Stabilization)[a]

WMA/Facility[b]	Collective Occupational Dose (person-rem)	Latent Cancer Fatalities
1—Process Building	1	0.0004
01/14 Building	4	0.0016
2—LLWTF and Lagoons 1-5	2	0.0008
3—HLW Tanks/Vitrification Facility	35	0.014
4—CDDL	0	0
5—CPC Waste Storage Area	0.3	0.0001
Lag Storage Building/Additions	3.0	0.0012
7—NDA	26	0.01
8—SDA	13	0.0052
9—RTS Drum Cell	4	0.0016
Other Facilities (including WMAs 6,10,11,12)	0	0
Wastewater Treatment Area	30	0.012
Total	118	0.048

a. For each WMA except WMAs 1 and 3, the disposition of facilities is identical for Alternatives IIIA and IIIB. For WMAs 1 and 3, there would be no difference between occupational doses for Alternatives IIIA and IIIB. Occupational doses from placing waste in the on-premises LLW disposal facility would be insignificant relative to the overall alternative.

b. Doses attributable to individual facilities are given when appropriate. If no facilities are listed, then the dose estimates are applicable to the entire WMA. Doses for the long-term monitoring and maintenance period are addressed in Section 5.4.2.1.

Table 5-20. Total Estimated Radiation-Induced Latent Cancer Fatalities from Incident-Free Transportation of Radioactive Waste for Alternative III (In-Place Stabilization)

	Hanford Site				Nevada Test Site			
	Occupational		General Population		Occupational		General Population	
WMA/Facility	Truck	Rail	Truck	Rail	Truck	Rail	Truck	Rail
1—Process Building	0.00059	6.7×10^{-6}	0.00039	3.2×10^{-5}	0.00055	6.9×10^{-6}	0.00037	7.8×10^{-5}
3—HLW/Vitrification Facility	0.027	0.0061	0.38	0.029	0.025	0.0063	0.36	0.026
5—Lag Storage Building/Additions	0.00012	2.2×10^{-6}	7.9×10^{-5}	1.1×10^{-5}	0.00011	2.3×10^{-6}	7.4×10^{-5}	9.4×10^{-6}
Total	0.028	0.0061	0.38	0.029	0.026	0.0063	0.36	0.026

The estimated health impacts to the transportation workers and the public are substantially lower under Alternative III than Alternative I. For Alternative III, the overall number of shipments is 61 times lower by truck shipment, and 74 times lower by rail shipment, compared to Alternative I. The estimated health effects are also proportionally lower.

Postulated Accidents. The accidents postulated for Alternative III differ from those postulated for Alternatives I and II because of the different implementation actions under this alternative. Because Alternative III has been conceptualized with minimal decontamination and waste removal activities, the potential for accidents involving large releases of radioactive materials to the environment during the implementation phase would also be reduced. Under Alternative III, stabilization actions for some WMAs (e.g., WMA 5) would be similar to those under Alternatives I and II; therefore, the postulated impacts would be similar. No accidents were postulated for WMAs 2, 7, and 8; however, the potential release of radioactive material to the environment from undermining waste containment in these areas is addressed in the long-term performance assessment discussion in Section 5.4.2.1. The maximum potential radiological consequences to the public from the postulated accidents are summarized in Table 5-21. On-site co-located workers could receive a dose about a factor of 10 higher than the maximally exposed individual shown in Table 5-21. The primary worker dose could be higher as described in Appendix G.

Table 5-21. Summary of Upper-Bound Accidents and Calculated Radiological Consequences for Alternative III (In-Place Stabilization)[a]

WMA/Facility	Description of Upper-Bound Accident	Maximum Individual Dose (rem)	Collective Dose (person-rem)[a]	Latent Cancer Fatalities
1—Process Building	Ventilation system fails in process building during vacuuming of spent fuel fines (Alternative IIIA)[b]	0.06	700	0.35
	Containment structure fails during demolition of the Process Mechanical Cell (Alternative IIIB)[c]	60	700,000	350
3—HLW Tanks	Ventilation system fails during backfilling of tank 8D-2[c]	2	30,000	15
5—Lag Storage Building/ Additions	Drum handling accident results in breach of lag storage addition drums[b]	0.00007	0.8	0.0004
9—RTS Drum Cell	Design basis earthquake results in breach of drums[b]	0.00009	1	0.0005
Wastewater Treatment Area	Tank failure releases untreated leachate to creek[b]	0.0001	0.09	0.00004
LLW Disposal Facility	Drum handling accident results in breach of drums (Alternative IIIB)[b]	0.00007	0.8	0.0004

a. Collective dose from airborne releases to the projected population (year 2000) of 1,350,000 people residing within 80 km (50 mi) of the Center.
b. Estimated annual accident probability is 1 chance in 10,000 to 1 chance in 1,000,000 (10^{-4} to 10^{-6}).
c. Estimated annual accident probability is 1 chance in 1,000,000 to 1 chance in 100,000,000 (10^{-6} to 10^{-8}).

Nonradiological (Occupational and Transportation)

The categories of potential nonradiological impacts expected for Alternative III are similar to those described for Alternative I. Although the implementation actions would be noisy, noise was not evaluated in detail because the Center is in a rural area with a low population density. Waste handling and transportation would result in occupational injuries and traffic accidents.

Occupational Injuries. The estimated number of occupational lost workdays resulting from illnesses and injuries, and the estimated number of occupational fatalities related to implementing Alternative III for each of the WMAs (including WMAs 1 and 3 for Alternatives IIIA and IIIB) are summarized in Tables 5-22 and 5-23, respectively.

Transportation Impacts. Principal nonradiological local and regional impacts from transportation under Alternative III are similar to those for Alternatives I and II and dominated by the air emissions, road wear and tear, and accident risk impacts of the work force commuter traffic on the local roadways near the Center. The predicted impacts differ from Alternative I and II because of the shorter implementation phase, reduced numbers of on-site workers for much of that time, different demands for construction materials, and reduced traffic for shipping radioactive waste off site.

The principal transportation impacts would be limited to the implementation phase, 10 years for Alternative IIIA [In-Place Stabilization (Backfill)] and 26 years for Alternative IIIB [In-Place Stabilization (Rubble)]. The average number of workers would remain approximately the same as current levels for the first few years of implementation, and then fall off rapidly. Traffic levels would be similar to or less than the current daily commuter traffic.

The need for receipt of consumable materials from off-site varies between Alternatives IIIA or IIIB. Few radioactive waste containers would be delivered for either alternative, compared to the thousands of deliveries for either Alternatives I or II. In contrast, more shipments from off site of other resources such as concrete would be required. Concrete use rises from about 32,000 m^3 (1.1 million $ft^{3)}$ with Alternative I to about 92,000 m^3 (3.2 million ft^3) for Alternative IIIA and 99,000 m^3 (3.5 million ft^3) for IIIB. The average daily concrete truck traffic would change to about 6 trucks per day in or out over the 10-year implementation period for Alternative IIIA and about 3 trucks per day over the 26-year implementation period for Alternative IIIB.

Other major resource needs (including soil, sand, gravel, clay and stone for riprap) are assumed to be obtained on the Center and not result in substantial local or regional road use.

Regional transportation impacts would result from shipping the industrial wastes. The nonradiological impacts of transporting radioactive and industrial waste include vehicular accident fatalities and increased risk of latent cancer fatalities from inhalation of transportation emissions, including combustion products, fugitive dust, and tire particulates.

Table 5-22. **Total Estimated Lost Workday Cases for Alternative III (In-Place Stabilization)[a]**

WMA/Facility	Alternative IIIA [In-Place Stabilization (Backfill)] Construction	Operations	Services	Total[b]	Alternative IIIB [In-Place Stabilization (Rubble)] Construction	Operations	Services	Total[b]
1—Process Building	1.0	0.3	3.1	4.4	9.7	3.0	24	36
01/14 Building	0.0	0.0	0.4	0.5	0.0	0.0	0.4	0.5
2—LLWTF and Lagoons 1-5	0.2	0.0	0.7	1.0	0.2	0.0	0.7	1.0
3—HLW Tanks/Vitrification Facility	0.6	0.1	2.0	2.8	3.2	0.3	6.3	9.8
4—CDDL	0	0	0	0	0	0	0	0
5—CPC Waste Storage Area	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lag Storage Building/Additions	0.1	0.0	0.4	0.6	0.1	0.0	0.4	0.6
7—NDA	1.7	0.1	3.3	5.1	1.7	0.1	3.3	5.1
8—SDA	3.7	0.2	6.3	10	3.7	0.2	6.3	10
9—RTS Drum Cell	0.3	0.0	0.5	0.8	0.3	0.0	0.5	0.8
Other Facilities (including WMAs 6,10,11,12)	0.8	0.0	1.4	2.2	0.8	0.0	1.4	2.2
Wastewater Treatment Area	0.3	1.5	5.1	6.9	0.3	1.5	5.1	6.9
LLW Disposal Facility	0	0	0	0	9.5	1.3	17	28
Erosion Control	1.6	0.6	1.7	3.9	5.4	0.4	8.7	15
Monitoring and Maintenance	0	29	53	81	0	29	53	81
Total[b]	10	32	85[c]	126[c]	35	36	147[d]	217[d]

a. An entry of 0 indicates that no lost workday cases have been estimated based on the 0 person-hours estimated (see Appendix F); an entry of 0.0 indicates that the estimated lost workday cases is less than 0.1.
b. Total may not equal the sum of the column numbers because of rounding.
c. Includes an estimated 7.2 cases from site support services.
d. Includes an estimated 20 cases from site support services.

Table 5-23. Total Estimated Fatalities for Alternative III (In-Place Stabilization)[a]

WMA/Facility	Alternative IIIA [In-Place Stabilization (Backfill)]				Alternative IIIB [In-Place Stabilization (Rubble)]			
	Construction	Operations	Services	Total[b]	Construction	Operations	Services	Total[b]
1—Process Building	0.003	0.0003	0.002	0.006	0.031	0.003	0.016	0.051
01/14 Building	0.0002	0.0000	0.0003	0.0005	0.0002	0.0000	0.0003	0.0005
2—LLWTF and Lagoons 1-5	0.0007	0.0000	0.0005	0.001	0.0007	0.0000	0.0005	0.001
3—HLW Tanks/Vitrification Facility	0.002	0.0001	0.001	0.004	0.010	0.0003	0.004	0.015
4—CDDL	0	0	0	0	0	0	0	0
5—CPC Waste Storage Area	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Lag Storage Building/Additions	0.0003	0.0000	0.0002	0.0006	0.0003	0.0000	0.0002	0.0006
7—NDA	0.005	0.001	0.002	0.008	0.005	0.0001	0.002	0.008
8—SDA	0.012	0.0003	0.004	0.017	0.012	0.0003	0.004	0.017
9—RTS Drum Cell	0.0008	0.0000	0.0003	0.001	0.0008	0.0000	0.0003	0.001
Other Facilities (including WMAs 6,10,11,12)	0.002	0.0000	0.001	0.003	0.002	0.0000	0.001	0.003
Wastewater Treatment Area	0.0009	0.002	0.003	0.006	0.0009	0.002	0.003	0.006
LLW Disposal Facility	0	0	0	0	0.031	0.001	0.012	0.044
Erosion Control	0.005	0.0006	0.001	0.007	0.017	0.0005	0.006	0.024
Monitoring and Maintenance	0	0.031	0.036	0.067	0	0.031	0.036	0.067
Total[b]	0.032	0.034	0.061[c]	0.13[c]	0.111	0.038	0.101[c]	0.25[c]

a. An entry of 0 indicates that no fatalities have been estimated based on the 0 person-hours estimated (see Appendix F); an entry of 0.0000 indicates that the estimated fatalities is less than 0.0001.
b. Total may not equal the sum of the column numbers due to rounding.
c. Includes an estimated 0.084 fatalities from site support services.

The impacts by WMA for transporting radioactive wastes off site to a distance of 4,000 km (2,500 mi) and industrial waste to a site 640 km (400 mi) away are summarized in Table 5-24.

For the implementation phase, the estimated total number of vehicular accident fatalities with either truck or rail shipment would be approximately 0.042 or 0.028,respectively, for the radioactive waste shipments and 0.018 for industrial waste shipments. The cumulative fatalities from vehicular air pollution because of the radioactive waste shipments would be 0.004 by truck and 0.007 by rail. Similarly, the cumulative vehicular pollution fatalities from industrial waste shipments would be 0.64 by truck and 0.59 by rail. Overall fatalities from shipping the radioactive waste would be approximately 0.43 for the 343 truck shipments and 0.064 for the 179 rail shipments. For industrial waste shipments, the estimated fatalities would be approximately 0.82 for the 5,037 truck shipments and 0.76 for the 3,526 rail shipments.

Air Quality

Potential nonradiological impacts to air quality would be generated by activities similar to those described for Alternative I in Section 5.2.1.2. Under this alternative, neither the disposal areas nor contaminated soil would be excavated, but PM-10 emissions would be generated by capping the NDA and SDA and by breaking the buildings into rubble. For Alternative IIIA, particulate concentrations were modeled at 0.15 $\mu g/m^3$ at the nearest public access downwind, and the concentrations for Alternative IIIB were modeled at 0.18 $\mu g/m^3$ for the same downwind distance. Both of these concentrations are well below the National Ambient Air Quality Standards for PM-10 (50 $\mu g/m^3$). Details on the dispersion modeling are described in Appendix K.

The Center and Cattaraugus County are "in attainment" or "unclassifiable" with respect to the National Ambient Air Quality standards criteria pollutants; therefore, a conformity determination with the applicable State Implementation Plan is not required (see Section 4.5.2).

Water Quality

The potential impact on surface water quality from implementing Alternative III would be less than that for Alternatives I and II because a smaller volume of soil would be disturbed by stabilization than by excavating contaminated facilities. Potential effects to surface water quality downgradient of the Project Premises and SDA area would be like those described for Alternative I in Section 5.2.1.2. Standard erosion control practices (e.g., sediment traps and minimal outdoor work during rain periods) would be used, as in Alternatives I and II, to minimize sheet erosion, downstream sedimentation, and uncontrolled migration of chemical and radiological constituents.

Complete stabilization of subsurface contaminants under Alternative III is not feasible from an engineering perspective. Groundwater quality near the stabilized facilities and disposal areas could degrade. A portion of the sand and gravel layer between the process

Table 5-24. Cumulative Nonradiological Impacts of Waste Transportation for Alternative III (In-Place Stabilization)[a]

	Vehicular Accident Fatalities				Vehicular Air Pollution Fatalities			
	Radioactive Waste		Industrial Waste		Radioactive Waste		Industrial Waste	
WMA/Facility	Truck	Rail	Truck	Rail	Truck	Rail	Truck	Rail
1—Process Building	0.0020	0.0014	0.0011	0.0011	0.00022	0.00036	0.0092	0.0083
2—LLWTF and Lagoons 1-5	NA[b]	NA	0.0011	0.0011	NA	NA	0.0044	0.0040
3—HLW Tanks/Vitrification Facility	0.036	0.027	0.0023	0.0022	0.0034	0.0055	0.015	0.014
4—CDDL	NA	NA	0.0041	0.0038	NA	NA	0.014	0.012
5—Waste Storage Area	0.004	NA	0.0039	0.0037	0.00026	0.00069	0.020	0.018
6&10—Central Project Premises and Support & Services Area	NA	NA	0.16	0.15	NA	NA	0.57	0.52
7—NDA	NA	NA	0.0027	0.0026	NA	NA	0.0060	0.0055
8—SDA	NA	NA	0.0013	0.0012	NA	NA	0.0019	0.0017
9—RTS Drum Cell	NA	NA	0.0005	0.0005	NA	NA	0.0010	0.00083
Total	0.042	0.028	0.18	0.17	0.004	0.007	0.64	0.59

a. Risk is the cumulative risk for the implementation phase for each of the WMAs.
b. NA = not applicable.

building in WMA 1, lagoons 1-3 in WMA 2, the CDDL in WMA 4, and the old hardstand in WMA 5 would continue to have radiological contamination from beta-emitting radionuclides. The waste buried in the SDA trenches would be grouted in situ and slurry walls would be installed around the NDA and SDA. The NDA, SDA, and lagoons 1 through 3 on the north plateau would be stabilized and capped to reduce contaminant migration to seeps and surface water. Groundwater would continue to migrate very slowly downward through the Lavery till on the north and south plateaus and could reach the underlying Kent recessional unit. The majority of groundwater flow, however, would be in the direction of Franks Creek or Erdman Brook, as described in Appendix J. Potentially contaminated groundwater would be very slowly released at rates of less than 151,400 L/day (40,000 gal/day) from both the north and south plateaus. After groundwater is discharged to the creeks, it would be diluted at a rate of 2.47 million L/day (625,000 gal/day) by surface water within the two watersheds.

At the point where groundwater discharged to the creeks, the concentration of strontium-90 could range from 500 to 1,000 pCi/mL, above maximum contaminant levels and requiring restrictions on water use for this stretch of the creek. The concentrations would drop to 40 through 70 pCi/mL before reaching the confluence of Franks Creek and Quarry Creek adjacent to the Project Premises. This concentration is close to the EPA proposed drinking water standards of 42 pCi/L for strontium-90 [56 FR 33120 (FR 1991b)]. Although some dilution would occur in Franks Creek, the majority of dilution would occur after the Franks Creek confluence with Buttermilk Creek. By the time the surface waters flowed off site, the concentrations would be below maximum contaminant levels.

Biotic Resources

Under Alternative III, there could be major impacts to biotic resources depending on the type of erosion control strategy selected. Contaminated soil on the Project Premises, the SDA, and on the balance of the site would remain in place. The reservoirs would remain in place.

On the Project Premises and the SDA, the impacts to terrestrial biotic resources would be less than that described for Alternatives I and II because less excavation of contaminated soil and exhumation of buried waste would occur. However, if the global erosion control plan were selected, Erdman Brook [530 m (1,700 ft) long] and a length of 640 m (2,100 ft) of Franks Creek would be filled, resulting in a large loss of aquatic and riparian habitat. The plant communities in the creek valleys include forests and old field successional areas. The placement of up to 12 m (40 ft) of fill could destroy large forested areas and reduce critical habitat for deer. However, because the entire Center area has been included in a designated critical habitat for deer by NYSDEC, a loss of 3 percent of the Center area would not likely be a serious impact. No threatened or endangered aquatic flora or fauna are known to exist in these creeks (WVNS 1994o). Also, approximately half of a new diversion channel [460 m (1,500 ft)] would be constructed in WMAs 6, 9, and 10. These areas are currently paved or mowed and maintained, so there could be a loss of habitat and displacement or death of small animals living in the potential area of construction.

For Alternative IIIB, three new LLW disposal facility modules would be constructed on the Project Premises, disturbing about a 1.6 ha (4.0 acre) area in the northern portion of WMA 10. This part of WMA 10 currently is either a parking lot or mowed and maintained; therefore, there would be a loss of habitat and displacement or death of small animals living in the potential area of construction.

There would be no impacts to threatened, endangered, or rare plant or animal species on the Project Premises because they have not been identified in this area.

On the balance of the site, if the global erosion control plan were selected, approximately half of a new diversion channel [550 m (1,800 ft)] would be constructed from the Project Premises area to the north reservoir. The construction of this channel would require the removal of up to 14 m (45 ft) of soil and filling the dug channel with concrete. About 3.6 ha (9 acres) of wet meadows and old field successional plant communities as described in Table 4-9 would be destroyed by this construction, resulting in a net loss of habitat, and displacement and mortality of small animals. No threatened, endangered, or rare plant and animal species are known to occur in the potentially affected area. Also, a 640-m (2,100-ft) length of upper Franks Creek and a 520-m (1,700-ft) length of lower Franks Creek would be filled, resulting in a large loss of aquatic and riparian habitat. No threatened or endangered aquatic flora or fauna are known to exist in these creeks.

Local erosion control measures would disturb less area [about 12 ha (31 acres)] in 12 separate areas around the Project Premises and the SDA] than implementing global measures and would disrupt less existing habitat.

Wetlands and Floodplains. Under 10 CFR Part 1022, DOE is required to assess the impacts of the action on wetlands as described in this section. No wetlands on the Project Premises and SDA area would be destroyed from implementing Alternative III, but about 1.9 ha (4.7 acres) could be disturbed by siltation during the waste stabilization activities. Like Alternatives I and II, although the disruption and disturbance of wetlands could reduce aquatic and riparian biota and decrease the habitat and drinking water source for wildlife, the majority of the wetlands are less than 0.4 ha (1 acre) in size and do not support critical habitat. Implementing the global erosion control strategy would completely modify the 100-yr floodplain since the drainage pattern would be modified.

On the balance of the site, in addition to filling the floodplains and waterways of Franks Creek, approximately 6.4 ha (16 acres) of wetlands including a New York State jurisdictional wetland (NYSDEC 1994) could potentially be destroyed if a global erosion control strategy were selected. The potentially destroyed wetlands occur naturally from ponded overland flow, at springs or seeps, in channel bottoms, and from stream flooding. Three of the wetlands were formed by beavers, and these wetlands typically contain common cattail, rushes, sphagnum moss, field horsetail, ferns, and Canada goldenrod. Two of these wetlands contain relatively less common plants such as elderberry, birds-foot trefoil, narrow-leaved plantain, bracken fern, and stout wood-reedgrass (WVNS 1994o). Before implementing Alternative III, the U.S. Fish and Wildlife Service would be consulted as appropriate to identify ways to adjust implementation phase activities so impacts to wildlife are controlled and major losses are prevented. As with Alternatives I and II, destroyed wetlands would be artificially replaced and enhanced to avoid a net loss of wetland acreage. Such a project would be coordinated through the COE as appropriate.

5.4.1.3 Costs

The costs from implementing Alternatives IIIA and IIIB are summarized in Table 5-25. Cost data for materials, labor, and contingencies were compiled from (WVNS 1994a through m and q). Cost data for waste transportation and disposal were calculated on the basis of unit costs for individual waste packages as described for Alternative I. These costs assume industrial waste is not contaminated and the design basis assumptions for soil treatment are met.

Labor is the dominant cost for both Alternatives IIIA and IIIB. The largest contributors to the labor costs are actions at the SDA and wastewater treatment area for Alternative IIIA [In-Place Stabilization (Backfill)], and at the process building, LLW disposal facility, and wastewater treatment area for Alternative IIIB [In-Place Stabilization (Rubble)].

The materials and fuels cost is highest for the process building, SDA, and wastewater treatment area under Alternative IIIA and for the process building and LLW disposal facility under Alternative IIIB. The stored waste in WMA 5 has the highest waste disposal costs because of the large volume of waste to be disposed of.

Alternatives IIIA and IIIB have post-implementation phase costs. Most of the post-implementation phase costs are for safety and quality assurance programs that have a high fixed cost, but are not facility- or activity-specific. About 75 percent of the total cost shown in Table 5-25 is for maintaining a laboratory to support environmental monitoring, a radiation protection program, and a quality assurance program for site activities. About 12 percent of the total cost shown in Table 5-25 is for site security to prevent the entry of unauthorized personnel. Most of the balance of the cost is for erosion control. Both routine and nonroutine inspection and maintenance would be included in this cost and would include repairing flow channels or filling in gullies following major storm events.

5.4.1.4 Socioeconomic Impacts

The direct employment and expenditures for goods and services that would be used to implement Alternatives IIIA or IIIB are like those described for Alternative I in Section 5.2.1.4. Baseline socioeconomic conditions would produce a socioeconomic impact in the two-county ROI, which includes the 20-km (12-mi) primary impact area.

Implementing either Alternative IIIA or IIIB would result in direct employment and expenditures for goods and services starting in the year 2000 and peaking in the year 2006. Site employment under Alternative IIIA would decline until the year 2011, to a monitoring and maintenance staff of 52 people. Site employment under Alternative IIIB would decline until the year 2027 to a monitoring and maintenance staff of 49 people. The schedule for

Table 5-25. Cost Summary for Implementing Alternative IIIA [In-Place Stabilization (Backfill)] and IIIB [In-Place Stabilization (Rubble)]

	$ 1996 Costs (Thousands)											
	Implementation Phase										Post-Implementation Phase	
	Materials and Fuels		Labor		Waste Transportation and Disposal		Contingency		Total		Annual	
WMA/Facility	IIIA	IIIB	IIIA	IIIB	IIIA	IIIB	IIIA	IIIB	IIIA	IIIB	IIIA	IIIB
1—Process Building	11,284	65,429	16,611	142,901	1,404	1,424	7,325	104,877	36,624	314,631		
01/14 Building	447	447	2,181	2,181	510	510	785	785	3,923	3,923		
2—LLWTF and Lagoons 1-5	1,242	1,242	3,469	3,469	200	200	1,228	1,228	6,139	6,139		
3—HLW Tanks/Vitrification Facility	2,955	11,423	10,555	36,451	23,892	24,033	9,351	35,954	46,753	107,861		
4—CDDL	0	0	0	0	0	0	0	0	0	0		
5—CPC Waste Storage Area	33	33	397 (720)[a]	397 (702)[a]	18,114	18,114	4,636	4,636	23,180	23,180		
Lag Storage Building/Additions	153	153	1,993	1,993	43,427	43,427	11,393	11,393	56,966	56,966		
7—NDA	5,179	5,179	17,120	17,120	3,267	3,267	6,392	6,392	31,958	31,958		
8—SDA	10,728	10,728	34,318	34,318	49	49	11,274	11,274	56,369	56,369		
9—RTS Drum Cell	2,561	2,561	2,820	2,820	0	0	1,345	1,345	6,726	6,726		
Other Facilities (including WMAs 6,10,11,12)	1,341	1,341	7,383	7,383	7,001	7,001	3,931	3,931	19,656	19,656		
Wastewater Treatment Area	9,023	15,990	25,135	61,513	483	550	8,660	19,513	43,301	97,566		
LLW Disposal Facility	0	25,922	0	58,833	0	0	0	21,189	0	105,944		
Soil	0	0	0	0	0	0	0	0	0	0		
Site Support Operations	0	0	66,209 (105,000)[a]	150,446 (340,000)[a]	0	0	0	0	66,209	150,446		
Erosion Control Strategy												
Local	1,650	1,650	2,034	2,034	1,166	1,166	1,213	1,213	6,063	6,063		
Global	34,779	34,779	44,889	44,889	8,005	8,005	21,918	21,918	109,591	109,591		
Total	46,596[b] or 79,725[c]	142,098[b] or 175,227[c]	190,225[b] or 233,080[c]	521,859[b] or 564,714[c]	99,513[b] or 106,352[c]	99,741[b] or 106,580[c]	67,533[b] or 88,238[c]	223,730[b] or 244,435[c]	403,867[b] or 507,395[c]	987,428[b] or 1,090,956[c]	11,000[d]	11,000[d]

a. Values in parentheses are those in the 1995 versions of the closure engineering reports. The Final EIS will use the final versions of the closure engineering reports.
b. Assumes a local erosion strategy was selected.
c. Assumes a global erosion strategy was selected.
d. For a discussion of the post-implementation phase costs, see Section 5.4.1.3.

Sources: Modified from WVNS (1994a through m and q) starting either Alternative IIIA or IIIB would be integrated with the completion of the WVDP HLW solidification; therefore, employment would not peak, but gradually decrease.

The employment reductions would result in a negative socioeconomic impact. The loss of jobs would be less than what would occur if no active long term alternative was implemented, and the losses would occur over a longer period of time. Alternative IV (No Action: Monitoring and Maintenance) would eliminate about 900 jobs over 5 years starting in 1998. Alternative IIIA would eliminate about 850 jobs (900 minus 52 for monitoring and maintenance) over 11 years and the same would be eliminated under Alternative IIIB over 27 years. In addition to these direct job losses, there would be an addition loss of 910 jobs in the two-county ROI including 17 jobs in the 20 km (12 mi) primary impact area. These job reductions would represent about a 0.5 percent annual decrease in employment in the 20 km (12 mi) primary impact area for Alternative IIIA and about a 0.2 percent annual decrease for Alternative IIIB. The decrease in the two-county ROI would be negligible, less than 0.01 percent for both Alternative IIIA and IIIB.

As employment was gradually reduced, personnel could leave the area resulting in additional houses on the market and reduced demand for local public services.

The state payments in-lieu of taxes are determined by the state legislature and the future levels of payment during or after implementation of the alternative are not known. If the state legislature were to reduce or eliminate the payments in-lieu of taxes, the local governments could have difficulty funding public services.

Growth Inducing Aspects of the Alternative. Implementing Alternatives IIIA or IIIB would result in a gradual decrease in employment to a maintenance staff of 50 people directly employed. Reuse of portions of the Center or its sale to private ownership could occur. Neither of these is expected to produce or induce noticeable growth in the local or regional area. If portions of the Center were released for private ownership, the tax base in the area would increase.

5.4.1.5 Cultural Resources

Under Alternative III, the potential impact to archaeological resources on the Project Premises and the SDA would be the same as described for Alternatives I and II since the area would have already been disturbed by industrialization and previous activities (e.g., constructing parking lots). On the balance of the site, the potential environmental impact would depend on whether local or global erosion control strategies were selected, because more area would be disturbed by a global erosion control strategy.

Impacts to archaeological resources on the Project Premises and SDA area would be similar to those for Alternative I. The likelihood of impacting archaeological resources from constructing the three new LLW disposal facility modules would be low because of the severe disturbance in this area from previous activities. An area of three 0.7 ha (1.7 acres) would be needed for these new facilities and the potential location evaluated in this EIS is on the northern portion of WMA 10 in an area that is now a paved parking lot. The Rider/Harvey/Whiteman site is located in an area that would be disturbed if either the local or global erosion control strategy were implemented (Section 4.9). This site was previously disturbed by construction of the former reprocessing facility (WVNS 1992a).

On the Project Premises and the balance of the site, 18 ha (45 acres) could be affected by filling portions of Franks Creek and Erdman Brook as part of the global erosion control measures. Although the predictive model described in Section 4.9, indicates there is a potential for prehistoric sites, walkovers and shovel testing in portions of the area potentially affected by implementing global erosion controls did not find cultural material. Before filling, areas not previously surveyed (WVNS 1992a) would be evaluated for cultural resources.

DOE is working to establish mechanisms for ongoing consultation with the Seneca Nation of Indians to determine if there would be an impact on traditional use or sacred areas.

5.4.1.6 Relationship to Land Use Plans and Visual Impacts

The Cattaraugus County Land Use Plan (Cattaraugus County Planning Board 1978, updated 1982) promotes an environmental and conservation policy of curtailing air and water pollution, retaining and developing forested land, preserving and promoting cleanup of areas of natural beauty. This plan also encourages continued use of the Center, with caution regarding public health and safety and protection of the environment. As discussed in Section 5.2.1.6 for Alternative I, the activities under Alternative III would be consistent with the Cattaraugus County Land Use Plan (Cattaraugus County Planning Board 1978, updated 1982). The actions would curtail air and water pollution by stabilizing wastes in place on the Project Premises and the SDA area; portions of the balance of the site could become available to the public after in-place stabilization was completed.

Implementation actions under Alternative III would occur on the Project Premises and SDA. Like Alternatives I and II, visual impacts would be limited to glimpses of the Project Premises and SDA while driving by on Rock Springs Road. Figures 3-35 and 3-36 (schedules for implementing Alternative IIIA and IIIB, respectively) show the timing of each potential visual impact. A corresponding description of activities is in Section 3.5.2.

Implementation Phase. Visual impacts on the Project Premises and SDA would occur from constructing new facilities, from demolishing facilities, and from converting the RTS drum cell into a tumulus. A new facility, the wastewater treatment area, would be constructed under Alternative III. Its construction would have little visual impact because its potential location would be near the NDA and SDA, about 370 m (1,200 ft) from Rock Springs Road. Under Alternative IIIB, three LLW disposal modules would be constructed. The construction could result in a negative visual impact because they could potentially be built about 150 m (500 ft) from Rock Springs Road.

The appearance of heavy equipment (such as dump trucks, front-end loaders, and bulldozers), stockpiled soil or clay, and areas of bare ground could produce a negative visual impact. Likewise, converting the RTS drum cell into a tumulus, and the process building, supernatant treatment system support building, and vitrification facility into capped rubble piles could produce a similar visual impact (Alternative IIIB).

The major activity on the balance of site (and also on the Project Premises) would be implementing the global erosion control plan, if selected. Filling the lower Franks Creek valley (and Erdman Brook) would not be readily visible to passersby on Rock Springs Road. However, a diversion channel from the south plateau to the northern reservoir, and the filling of upper Franks Creek could produce a visual impact. These activities would occur within 460 m (1,500 ft) of Rock Springs Road and could possibly be seen by passersby because of the major earthmoving activities.

Post-Implementation Phase. Visual impacts would be from either backfilled buildings or the capped rubble piles and the LLW disposal facility modules under Alternative IIIA and Alternative IIIB, respectively. The modules would look like earth-covered vegetated mounds approximately 9 m (30 ft) high. Landscaping could be used to minimize the visual impact of the facilities from Rock Springs Road. The top soil on the top of the capped rubble piles (former process building and vitrification facility) would allow them to be revegetated with a vegetative cover that would further reduce the visual impact. Under Alternative IIIA, the back-filled process building and vitrification facility would look like cement blocks, visible from Rock Springs Road. Under both Alternative IIIA and IIIB, a limited number of buildings and a parking lot would be needed to support monitoring and maintenance. No visual impact is expected from the support buildings because they would look similar to facilities now on the Project Premises.

5.4.1.7 Impacts of Disposing Radioactive and Industrial Wastes at Off-Site Facilities

Radioactive waste (with exception of the vitrified HLW and spent fuel fines) would be disposed of on-premises under Alternative III; therefore, there would be no impact to off-site facilities licensed to dispose of LLW. Impacts of storage and disposal of vitrified HLW and spent fuel have been addressed on previous occasions at other sites, and the increase in potential impacts from the approximately 350 borosilicate glass canisters and three canisters of spent fuel fines on the overall program is expected to be small. The spent fuel fines are present in very limited quantities (a few cubic feet) and the impacts of off-site disposal of them should be similar to the impacts for disposing of a comparable volume of spent fuel.

The industrial waste that would be generated by implementing Alternative III would consist of typical construction and demolition debris waste (e.g., concrete, steel, wood, asphalt, equipment, tree stumps, bushes, and vegetation). The waste volumes generated would depend on whether a local or global erosion control strategy was selected. Under Alternative IIIA, if a local erosion control strategy were used, an industrial waste volume of 40,800 m^3 (1.44 million ft^3) would be disposed of over about 9 years (refer to Figure 3-35) for an annual average disposal rate of 4,530 m^3 (160,000 ft^3). Using an average density of 1,400 kg/m^3 (89 lbs/ft^3) (Lynch 1995), this volume would be equivalent to 6,340 metric tons (7,200 tons) per year. If the global erosion control strategy were used, a total industrial waste volume of 68,300 m^3 (2.41 million ft^3) would be disposed of over about 9 years (refer to Figure 3-35), for an annual average disposal rate of 7,590 m^3 (268,000 ft^3) per year.

Using an average density of 1,400 kg/m^3 (89 lbs/ft^3), this would be equivalent to 10,600 metric tons (11,900 tons) per year.

Under Alternative IIIB, the industrial waste would be disposed of over a period of 13 years, i.e., during the first 9 years and the last 4 years of the 26-year total implementation phase (see Figure 3-36). If a local erosion control strategy were used, the disposal rate would vary from 1,440 to 27,900 m^3 (50,820 to 985,700 ft^3) per year during the years that industrial waste was being disposed of. Using an average density of 1,400 kg/m^3 (89 lbs/ft^3) (Lynch 1995), this would be equivalent to 2,020 to 39,000 metric tons (2,260 to 43,900 tons) per year. If a global erosion control strategy were used, the disposal rate would vary from 4,510 m^3 to 6,980 m^3 (159,050 ft^3 to 246,425 ft^3) per year during the years that industrial waste is disposed of. Using an average density of 1,400 kg/m^3 (89 lbs/ft^3) (Lynch 1995), this would be equivalent to 6,310 to 9,770 metric tons (7,080 to 11,000 tons) per year.

The maximum volumes to be disposed of under Alternative IIIA and IIIB (i.e., assuming a global erosion control strategy is used) would be about 6 percent of the waste that is disposed of in western New York (Buffalo region) and only 0.7 percent of the waste volume that is disposed of in the State of New York (Lynch 1995). Because it is assumed that industrial waste would be disposed of within a 640-km (400-mi) radius of the Center, the percentage would be even lower. Thus, the quantities of waste to be disposed of would not be significant relative to the current volume of industrial waste being disposed of in the State of New York and it would not consume a significant capacity in sanitary landfills.

5.4.2 Evaluation of Long-Term Impacts

After completing the implementation phase of stabilization, the post-implementation activities would include security to prevent intrusion, radiation monitoring and sampling, environmental monitoring and sampling, and maintenance to protect the stabilized areas, including erosion control as long as institutional controls are in effect. As long as control of and access to the Project Premises and SDA were maintained, the principal environmental risks would be to trained on-premises workers; therefore, risks to workers would be low. There could be some occupational injuries and potential occupational radiation exposure.

As long as access to the Project Premises and SDA were controlled, the main environmental risk to the public would be from natural processes such as the gradual leaching of radionuclides from the stabilized waste into groundwater. To be a risk to the public, contaminated groundwater would have to flow through stabilized buried waste, be discharged to surface water, and be carried to off-site locations by creeks that flow through the Center, and contaminant migration would either have to be undetected by the monitoring program or unmitigated. Finally, off-site individuals would have to either (a) drill wells that intercept the contaminated groundwater and use the water without testing for radioactivity or (b) use the highly diluted creek water without testing for radioactivity.

As long as the Project Premises and SDA are controlled and it is known that the area was used for radioactive waste disposal, it is unlikely that there would be potential for high radiation exposure for off-site residents for all facilities other than the HLW tanks. The presently assumed radionuclide inventory and closure plan for the HLW tanks results in doses for off-site individuals in excess of the 25 mrem/yr limit of 10 CFR Part 61 ("Licensing Requirements for Land Disposal of Radioactive Waste"). In-place treatment of the contaminated groundwater plume on the north plateau is assumed to be effective in eliminating or reducing this potential source of exposure to acceptable levels. In addition, there would be an occupational dose to security and maintenance workers during the post-implementation phase for Alternative III.

Potential intruder scenarios were also evaluated as specified for 10 CFR Part 61 requirements for LLW disposal facilities. These scenarios would be applied to this alternative only if institutional controls were lost and people used the Project Premises and SDA for purposes such as agriculture and a drinking water source without knowledge of the area's history as a nuclear waste disposal facility and understanding the hazards. Because Alternative III assumes access control to the stabilized waste disposal areas is maintained indefinitely, this loss of knowledge would be unlikely. For evaluation, intrusion was assumed approximately 100 years after the end of the implementation phase of closure. If intrusion occurred later, the corresponding doses received would be less because of radionuclide decay in the waste.

An important element in evaluating the loss of institutional control is failure to maintain erosion control structures. For analysis of the erosion control strategy, it was assumed that maintenance of the local erosion control structures would be required every 50 years. It was assumed that structures in the global erosion control strategy had a longer design life of 1,000 years, and that they required less short-term maintenance. The structures in the global erosion control strategy may lose their effectiveness at the end of their design life. Therefore, the potential impact from failure of erosion control structures was evaluated. This section describes impacts from less likely events, such as an earthquake; expected conditions; and the loss of institutional control. If an alternative were selected that implemented a global erosion control strategy, the erosion plan would be designed to meet applicable standards including seismic design criteria.

5.4.2.1 Long-Term Impact from Expected Environmental Conditions and Loss of Institutional Control

Under expected conditions, the potential long-term impact of site closure could include exposure of site maintenance and security staff to radioactive materials and gradual release of radionuclides and hazardous chemicals from the disposal areas by groundwater infiltration. The primary exposure pathway for off-site individuals and the surrounding population would be contact with surface water recharged by contaminated groundwater. At the loss of institutional control, the disposal areas could be eroded and waste inventories potentially released to the creeks after the collapse of the stream banks. The potential impacts are discussed below.

Expected Conditions Case

Radionuclides and hazardous constituents could be released to groundwater under expected conditions. The dissolved material would be transported by horizontal groundwater flow to Erdman Brook, Franks Creek, and Buttermilk Creek and ultimately to off-site residents along Cattaraugus Creek. The radiological impact analysis considered a Cattaraugus Creek resident, a person of the Seneca Nation who resides on the Cattaraugus Reservation, and the surrounding Cattaraugus Creek population. The hazardous chemical analysis considered only a Cattaraugus Creek resident.

The results of the analysis are presented in tables and figures. The figures show the radiation dose for an individual from all facilities as a function of time, after implementing an alternative for a specific scenario under the case being evaluated. The peaks and valleys on the figures result from the combination from the 71 different radionuclides evaluated in this EIS. The amount of each radionuclide that arrives at the creek at a particular time is determined by differing mechanisms of release, decay, and transport (e.g., how well the different radionuclides adsorb to the weathered till or the sand and gravel layer). The details of these mechanisms are discussed in Appendices D, E, and J.

Off-Site Radiological Impacts. The potential radiological releases from the process building and HLW tanks for both Alternatives IIIA and IIIB were assumed to be controlled by diffusion within the encapsulating cement matrix. At the NDA and SDA for Alternatives IIIA and IIIB and at the LLW disposal facility for Alternative IIIB, radiological releases were assumed to be solubility-limited in groundwater infiltrating through the facility. At the RTS drum cell, a combination of diffusion and solubility-limited release mechanisms could occur. Off-site residents were assumed to fish, drink water, and obtain crop irrigation water from Cattaraugus Creek. Table 5-26 summarizes the potential impacts to off-site residents in the year of maximum impact from these scenarios with institutional control at the Center.

The time-history of the cumulative impacts from all facilities for Alternative IIIA for the groundwater release scenario is summarized in Figures 5-7 and 5-8 for a Cattaraugus Creek resident and Seneca Nation resident on the Cattaraugus Reservation, respectively, under expected conditions. The potential impact is dominated by release from tank 8D-2 in WMA 3. The off-site impact from tank 8D-1 and the vitrification facility are small compared to those from tank 8D-2. On the north plateau, the impact is dominated by the potential release of the short-lived, but mobile radionuclide strontium-90 from all of the facilities. On the south plateau, strontium-90 movement is retarded by adsorption on the clays in the till; therefore, the impact is from longer-lived but mobile radionuclides including carbon-14 and technitium-99. In the year of maximum impact from potential releases for all facilities, the annual risk of a latent cancer fatality was estimated to be 3.6×10^{-5} for the Cattaraugus Creek resident, 6.3×10^{-5} for the Seneca Nation resident on the Cattaraugus Reservation, and 6.2×10^{-8} for the average member of the population. Peak cumulative impacts from the other facilities, except the HLW tanks, were estimated to be 1.2 mrem/yr for the Cattaraugus Creek resident, 2.2 mrem/yr for the Seneca Nation resident on the Cattaraugus Reservation on Cattaraugus Creek, and 0.72 person-rem/yr for the population. The risk of a latent cancer fatality was estimated to be 6.0×10^{-7} for the Cattaraugus Creek resident, 1.1×10^{-6}

Table 5-26. Impacts to the Public from Expected Conditions for Alternative III (In-Place Stabilization) (Groundwater Release Scenario)[a]

WMA/Facility (Alternative)	Cattaraugus Creek Individual Dose (mrem)	Seneca Indian Individual Dose[b] (mrem)	Off-Site Population Collective Dose (person-rem)	Off-Site Population Latent Cancer Fatalities
1—Process Building (IIIA)	0.6 [2182]	1.1 [2182]	0.4 [2182]	0.0002
1—Process Building (IIIB)	0.2 [2196]	0.3 [2196]	0.1 [2196]	6.0×10^{-5}
2—LLWTF	1.2 [2050]	2.1 [2050]	0.7 [2050]	0.0004
3—HLW Tanks (IIIA)	71.9 [2181]	126.0 [2181]	43.1 [2181]	0.02
3—HLW Tanks (IIIB)	71.9 [2196]	126.0 [2196]	43.1 [2196]	0.02
5—LLW Disposal Facility (IIIB)	0.01 [2051]	0.03 [2051]	0.006 [2051]	3.0×10^{-6}
7—NDA	0.003 [2141]	0.007 [2141]	0.002 [2141]	9.0×10^{-7}
8—SDA	0.1 [2321]	0.2 [2321]	0.06 [2321]	3.0×10^{-5}
9—RTS Drum Cell	0.14 [2156]	0.32 [2156]	0.08 [2156]	4.2×10^{-5}

a. Doses are for year of maximum impact for that facility, the year of occurrence is provided in brackets.
b. Assumes location on Cattaraugus Reservation, 24 km (15 mi) downstream from the Center on Cattaraugus Creek.

for the Seneca Nation resident on the Cattaraugus Reservation, and 1.0×10^{-9} for the average member of the population. The overall results for Alternative IIIB are the same as those described for Alternative IIIA because the long-term effects are dominated by the HLW tank, which is managed the same way in both alternatives (see Table 5-26).

Occupational Doses. Most of the radioactive waste in the Project Premises and SDA area would be stabilized in place or would be placed in a LLW disposal facility on the Project Premises. This facility would require a continuous, long-term monitoring program that could include periodic erosion control measures to ensure waste containment integrity.

Occupational doses and occupational injuries and illnesses were estimated from information in the closure engineering reports, in particular the *Overall Site-Wide Closure Engineering Report* (WVNS 1994l). For both Alternatives IIIA and IIIB, this analysis estimated that the collective doses to monitoring and maintenance workers would be a maximum of 10 person-rem per year initially, and a maximum of 1 person-rem per year after 100 years (the decrease is attributable to radioactive decay of cesium-137, the primary dose

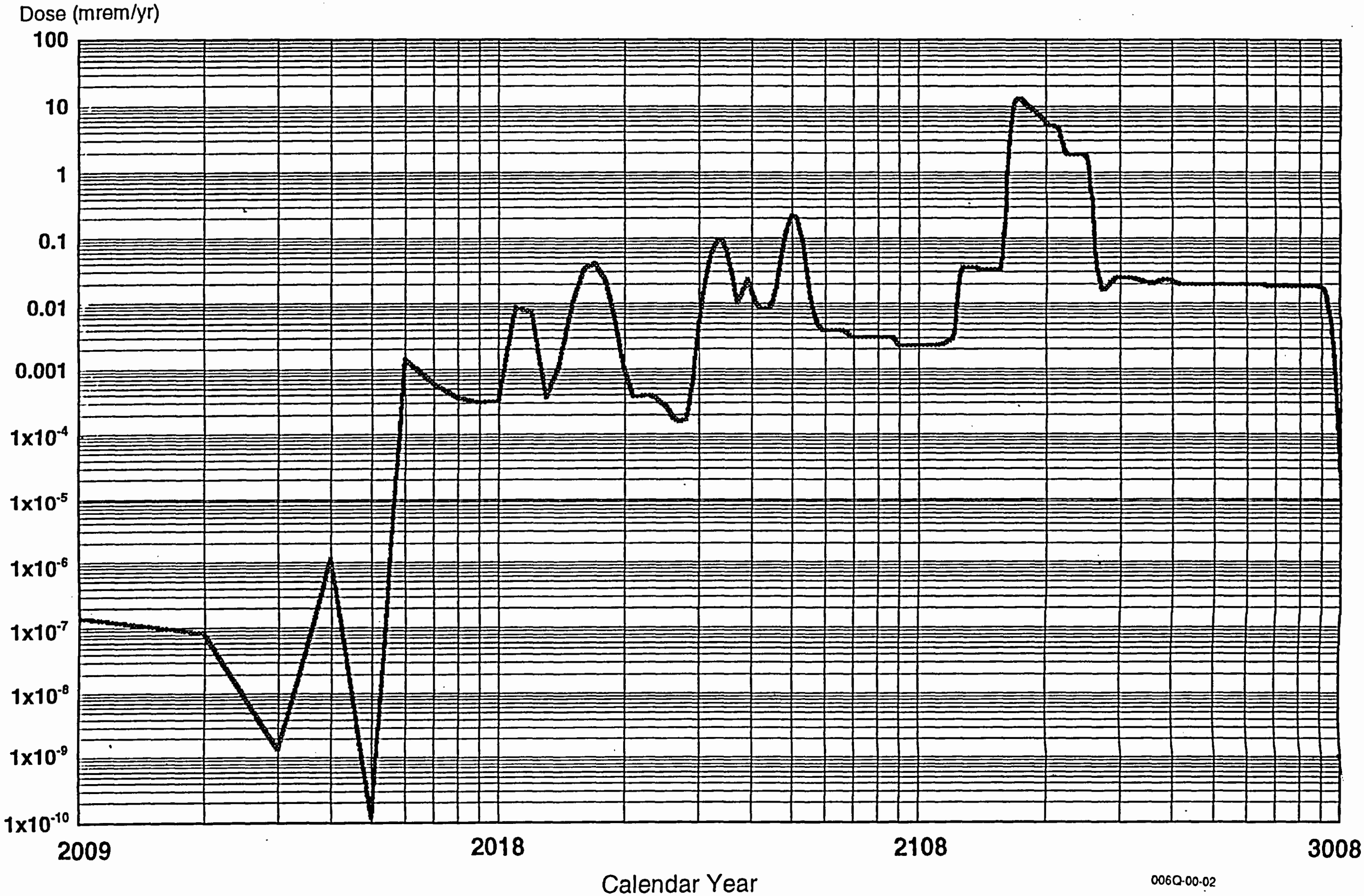

Figure 5-7. Alternative IIIA [In-Place Stabilization (Backfill)] Expected Conditions Case Groundwater Release Scenario Impacts for a Cattaraugus Creek Resident.

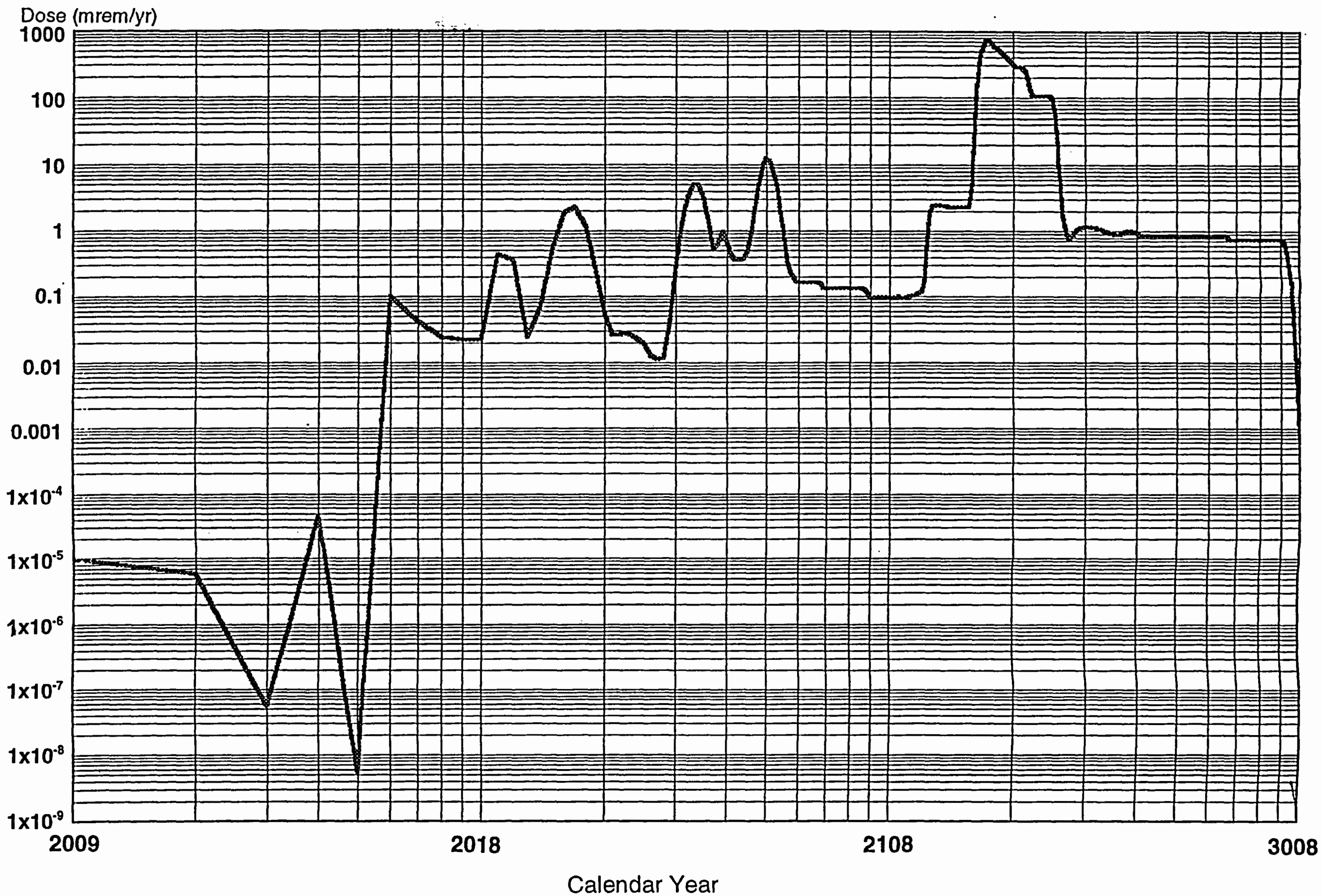

Figure 5-8. Alternative IIIA [In-Place Stabilization (Backfill)] Expected Conditions Case Groundwater Release Scenario Impacts for a Seneca Indian Resident.

contributor during this period). The total collective dose over the first 100-year period was estimated at a maximum of 400 person-rem.

This analysis estimated that 0.9 lost workdays cases and 0.002 fatalities from routine monitoring and maintenance would occur annually or 90 lost workday cases and 0.2 fatalities within the first 100 years. The selection of a local erosion control strategy (assumed to be necessary every 50 years) would result in an estimated 12 lost workday cases and 0.03 fatalities, and the selection of a global erosion control strategy would result in 46 lost workday cases and 0.09 fatalities within the first 100 years.

The above estimates do not address impacts beyond 100 years. In general, annual doses would be less than the estimated doses because of radioactive decay, unless major modifications or replacements occur as part of waste management practices. Lost workday cases and fatalities from occupational injuries or illnesses would remain relatively stable over time except during periods of unusually high maintenance activity.

Hazardous Chemical Impacts. Results of the RFI sampling programs (WVNS 1994p, E&E 1994) determined that low levels of potential hazardous chemical contamination may exist. The sampling programs measured concentrations at points in the environment, but disposed inventory estimates were not developed. Thus, the nonradiological impact evaluations assumed continuing releases at a rate consistent with the values measured in the sampling program. The results from the analysis indicates that only the CDDL, NDA, and SDA could potentially release hazardous chemicals. The implementation phase actions under Alternative III remove trench water from the SDA and stabilize the NDA and SDA where suspected exposure to chemical contamination could occur. Thus, contact with potentially contaminated groundwater and sediments are the only reasonable exposure paths for off-site individuals. The lifetime risk (70 years of exposure) above background of a latent cancer fatality for the off-site (Cattaraugus Creek) individual was estimated as 4.4×10^{-7}, with an equivalent annual average risk of 6.2×10^{-9}. These chemical risks are below the EPA threshold for concern.

Other Impacts

There would be no long-term impact on air quality after the implementation phase for Alternative III because air pathway sources would have been either capped, dismantled, or removed. Complete stabilization of subsurface contaminants is not feasible from an engineering perspective. Groundwater quality near the stabilized facilities and disposal units would remain as-is. A portion of the sand and gravel layer between the process building (WMA 1), CDDL (WMA 4), lagoons 1 through 3 (WMA 2), and the old hardstand (WMA 5) would continue to have gross beta contamination (see Section 4.10). Slurry walls would be installed, and the SDA (WMA 8), NDA (WMA 7), and lagoons 1 through 3 would be stabilized and capped; these activities would reduce contaminant migration to seeps and surface water. Groundwater would continue to migrate very slowly through the Lavery till on the north and south plateaus, and it could contaminate deeper aquifers. Because of higher levels of subsurface contaminants and long-term potential for contaminants to migrate to the surface and streams, the potential for uptake by biota is higher than for Alternatives I or II.

Loss of Institutional Control Case

If institutional control was lost, individuals could move near buried waste and the disposal areas could be eroded. The section below describes potential impacts from the loss of institutional control for radiological and hazardous chemical releases.

Radiological Impacts for an Undisturbed Site. After facilities in the WMAs were stabilized, it was assumed institutional control was lost and individuals could establish a residence on the Project Premises and SDA and inadvertently come into contact with contaminated areas. The potential hazards from intrusion were evaluated using methods consistent with NRC procedures for evaluating generic LLW disposal sites, which are described in Appendix D. The scenarios included consuming crops grown in a garden, constructing a residence, and drilling a well. On the south plateau, the use of well water for consumption and irrigation was not considered because of the limited water-producing capacity of the Lavery till; however, on the north plateau, a well for drinking water and crop irrigation was assumed to be located 50 m (164 ft) from the facility under evaluation. Table 5-27 summarizes the estimated impacts for the year of maximum exposure from these on-premises exposure scenarios. The risk for on-premises agricultural residents are high, including illness and fatality. For facilities on the north plateau, the impacts are dominated by release of soluble, mobile strontium-90. At the disposal areas on the south plateau, doses from a garden are precluded because the NDA and SDA would have a concrete intruder barrier and engineered cap and their proximity to the creeks would prevent room for a garden. Because constructing a home and drilling a well are single instance events and the estimated doses are low, no adverse health effects are predicted from these activities.

Radionuclides transported by groundwater discharges to surface water could be used by off-site residents. Potential impacts were evaluated for a Buttermilk Creek resident and the surrounding population, which were assumed to fish, drink water, and obtain crop irrigation water from potentially contaminated streams. Table 5-28 summarizes the estimated impacts. The on-premises resident impacts were dominated by releases from the stabilized HLW tanks, with strontium-90 the dominant dose-contributing radionuclide. The risk of a latent cancer fatality for the year of maximum impact for the Buttermilk Creek resident and average member of the population was estimated to be 2.7×10^{-4} and 6.1×10^{-8}, respectively.

Table 5-27. Impacts to an Intruder from the Assumed Loss of Institutional Control for Alternative III (In-Place Stabilization)

WMA/Facility (Alternative)	Dose[a] (mrem) Agriculture/ Residential	Construction	Drilling
1—Process Building (IIIA)	3.8×10^5 [2108]	NA[b]	3.3 [2000000][c]
1—Process Building (IIIB)	3.8×10^5 [2123]	NA	3.3 [2000000]
2—LLWTF and Lagoons 1-5	2.2×10^5 [2127]	0.8 [2108]	0.00008 [2508]
3—HLW Tanks (IIIA)	8.9×10^7 [2108]	NA	0.4 [2508]
3—HLW Tanks (IIIB)	8.9×10^7 [2108]	NA	0.4 [2523]
5—LLW Disposal Facility (IIIB)	25.1 [33823]	NA	NA
7—NDA	NA	NA	0.05 [2508]
8—SDA	NA	NA	0.09 [2508]
9—RTS Drum Cell	29.0 [2568]	NA	0.004 [2508]
Cesium Prong On Site (IIIA)	7.3 [2108]	NA	NA
Cesium Prong On Site (IIIB)	5.1 [2123]	NA	NA
North Plateau Plume (IIIA)	840 [2108]	NA	NA
North Plateau Plume (IIIB)	590 [2123]	NA	NA

a. Doses are for year of maximum impact for that facility, the year of occurrence is provided in brackets.
b. NA = Because of the nature of the scenario and the WMA, the scenario is not applicable.
c. The year of peak dose for the drilling scenario is 2 million years in the future and reflects the time required for uranium daughters to build up and reach peak concentrations.

Table 5-28. Impacts to the Public from an Assumed Loss of Institutional Control for Alternative III (In-Place Stabilization) (Groundwater Release Scenario)[a]

WMA/Facility (Alternative)	Buttermilk Creek Individual Dose (mrem)	Off-Site Population: Collective Dose (person-rem)	Off-Site Population: Latent Cancer Fatalities
1—Process Building (IIIA)	4.8 [2182]	0.4 [2182]	0.0002
1—Process Building (IIIB)	1.1 [2196]	0.1 [2196]	6.0×10^{-5}
2—LLWTF and Lagoons 1-5	0.14 [2387]	0.7 [2050]	0.0004
3—HLW Tanks (IIIA)	541.0 [2181]	43.1 [2181]	0.02
3—HLW Tanks (IIIB)	541.0 [2196]	43.1 [2181]	0.02
5—LLW Disposal Facility (IIIB)	0.002 [33823]	0.006 [2051]	3.0×10^{-6}
7—NDA	0.02 [2141]	0.002 [2141]	9.0×10^{-7}
8—SDA	0.80 [2321]	0.06 [2321]	3.2×10^{-5}
9—RTS Drum Cell	1.1 [2156]	0.08 [2156]	4.2×10^{-5}
North Plateau Plume (IIIA)	0.26 [2108]	0.27 [2000]	0.0001
North Plateau Plume (IIIB)	0.18 [2123]	0.27 [2000]	0.0001

a. Doses are for year of maximum impact for that facility, the year of occurrence is provided in brackets.

Hazardous Chemical Impacts for an Undisturbed Site. After institutional control was lost, on-site residents could contact contaminated sediments or use contaminated water and off-site residents could use contaminated surface water. For a resident on the Project Premises and SDA, the lifetime risk of a latent cancer fatality above background was estimated to be 3.0×10^{-5} with an average annual risk of 4.3×10^{-7}. For the balance of site (Buttermilk Creek) resident, lifetime risk above background was estimated to be 3.3×10^{-6}, with an average annual risk of 4.7×10^{-8}. The chemical risk is small compared to the radiological risk and below the threshold for concern.

Radiological Impacts for a Disturbed Site. If institutional control were lost, erosion control structures could deteriorate and the disposal facilities could be eroded. The erosion modeling described in Appendix L indicates that the LLWTF, NDA, SDA, and RTS drum cell could be affected by erosion within 1,000 years. The design-life for the global erosion control strategy is 1,000 years control compared to 50 years for local erosion. For analysis it was assumed that the global erosion control structures would fail after 1,000 years and that the natural drainage pattern was reestablished. The erosion rate used is considered to be conservative. It is estimated that there is only a 1 in 10 chance that the average long-term erosion would be higher. Appendix L describes the method developed to estimate the rate. The impacts from waste inventories collapsing into the creeks was evaluated using the trench collapse release model described in Appendix E. The potential impact from these scenarios for a Buttermilk Creek resident and the surrounding population are summarized in Tables 5-29 and 5-30 for the global and local erosion control strategies, respectively. In each case, the potential impacts would be severe for the Buttermilk Creek resident. The risk of a latent cancer fatality in the year of maximum impact for the average member of the

Table 5-29. Impacts to the Public from an Assumed Loss of Institutional Control for Alternative III (In-Place Stabilization) (Global Erosion Control Strategy: Erosional Collapse Scenario)[a]

WMA/Facility	Buttermilk Creek Individual Dose (mrem)	Off-Site Population: Collective Dose (person-rem)	Off-Site Population: Latent Cancer Fatalities
2—LLWTF	200 [3688]	8.1 [3688]	0.004
7—NDA	9,400 [3298]	742.6 [3298]	0.37
8—SDA	6.7×10^4 [3228]	5,300 [3228]	2.7
9—RTS Drum Cell	900 [3108]	71.1 [3108]	0.04

a. Doses are for year of maximum impact for that facility, the year of occurrence is provided in brackets.

Table 5-30. Impacts to the Public for an Assumed Loss of Institutional Control for Alternative III (In-Place Stabilization) (Local Erosion Control Strategy: Erosional Collapse Scenario)[a]

WMA/Facility	Buttermilk Creek Individual Dose (mrem)	Off-Site Population: Collective Dose (person-rem)	Off-Site Population: Latent Cancer Fatalities
2—LLWTF	520 [2780]	41 [2788]	0.02
7—NDA	4.7×10^4 [2390]	3,700 [2398]	1.9
8—SDA	2.8×10^5 [2320]	2.2×10^4 [2328]	11.1
9—RTS Drum Cell	4,500 [2200]	360 [2208]	0.18

a. Doses are for year of maximum impact for that facility, the year of occurrence is provided in brackets.

population was estimated to be 7.6×10^{-6} for the global erosion control strategy and 3.1×10^{-5} for the local erosion control strategy.

Hazardous Chemical Impacts for a Disturbed Site. Erosion of the north and south plateau could also release hazardous constituents from the Project Premises and SDA. The potential impact was evaluated by assuming that the present levels of chemicals and dissolved metals were released into water used by a Buttermilk Creek resident. The total concentration of potentially toxic chemicals in the creek water was estimated as 17 percent of the threshold for observable effects. The risk from hazardous constituents is expected to be small for the erosional collapse scenario.

5.4.2.2 Long-Term Impacts from Less Likely Events

After the implementation phase was completed, potential releases from stabilized waste could occur by severe natural phenomena such as major earthquakes. Other natural phenomena, such as erosion, were evaluated earlier. Other than erosion, the worst-case accident postulated for the long-term disposal period is a beyond design basis earthquake, with a peak ground acceleration of approximately 0.33 g. Such an earthquake is estimated to have a return period of 33,000 years (see Appendix M), and its occurrence would be expected to stress the engineered structures beyond their design and result in failures. The potential effects of such a major earthquake on each of the WMAs are considered in Appendix G. No credible release mechanisms were identified that would result in significant short-term atmospheric releases to the environment. For example, if damage to the concrete monolith of the entombed process building were extensive, mitigation activities with the monitoring and maintenance program could ensure that the public is adequately protected from releases over the long term. The impacts from an earthquake would not be very different from those that resulted from the long-term degradation of the entombed structure with eventual contact of the radioactive materials with groundwater. These impacts were addressed as a part of the long-term performance assessment and are reported in Appendix D and Section 5.4.2.1.

5.4.3 Uncertainty Associated with Alternative III

The uncertainty in implementation phase impacts for Alternative III are similar to those described for Alternative II. That is, if design-basis assumptions regarding contaminated soil and industrial waste volumes are not met, additional area would be required for construction of the LLW disposal facility modules. Under Alternative III, less area would be disturbed than in Alternative II because the disposal areas would not be exhumed and soil contamination on the Project Premises and on the balance of the site would not be removed. Under worst-case conditions, two more LLW disposal facility modules, covering a total area of 0.4 ha (1.1 acre), would be required for waste disposal. Like Alternative II, these two facilities would be constructed on the Project Premises in areas already disturbed when the former reprocessing facility was constructed. Potential habitat where the LLW disposal facility modules were constructed would be lost.

There are many uncertainties associated with predicting the post-implementation phase that have greater potential impacts on human health and the environment. Because waste would be disposed of on the Project Premises, an understanding of natural physical processes such as erosion, the success of erosion control methods, and the ability to restrict access to contaminated areas becomes important as demonstrated in Section 5.4.2.1.

5.5 ALTERNATIVE IV: NO ACTION: MONITORING AND MAINTENANCE

Under Alternative IV (No Action: Monitoring and Maintenance), existing facilities and the disposal areas would be managed "as-is," with a long-term monitoring and maintenance program. Radioactive wastes would remain on the Project Premises indefinitely, and facilities would be maintained in a shutdown status. Activities would include:

- Removing the stacks on the process building and vitrification facility and removing PCB-containing capacitors from the 02 building
- Backfilling and capping the LLWTF lagoons, disturbing about 0.7 ha (1.8 acres) in WMA 2
- Exhuming and backfilling the sludge ponds, disturbing about 930 m^2 (10,000 ft^2) in WMA 6
- Constructing a new wastewater treatment area in WMA 6 to periodically treat leachate from the SDA, disturbing about a 790-m^2 (8,500-ft^2) area
- Mitigation of the contaminated groundwater plume on the north plateau would continue
- Localized erosion control structures would be installed around the Project Premises and the SDA (see Section 3.6.2.3), potentially disturbing about 12 ha (30 acres) of land: 7 ha (17 acres) on the Project Premises and 4.4 ha (11 acres) on the balance of the site.

Wastes generated by Alternative IV would include 430 m^3 (15,200 ft^3) of Class A waste, 6,000 m^3 (212,000 ft^3) of industrial waste, and 0.03 m^3 (1 ft^3) of hazardous waste from the removal of PCB-contaminated capacitors (refer to Section 3.6.3). There would be no Class B, Class C, GTCC, HLW, mixed waste, or contaminated soil generated.

Unlike Alternatives I, II, and III, the environmental impacts during the implementation phase are not expected to vary substantially from the analysis presented in this section because there would be very few actions during the implementation phase.

5.5.1 Implementation Phase Impacts

Monitoring and maintenance activities would include routine inspection, preventive and corrective maintenance of facilities, and a regular program of radiation and environmental monitoring. Examples of the anticipated types of preventive maintenance could include painting buildings and structures, replacing filters, replacing the fabric tents that cover the CPC waste storage area and lag storage additions, replacing electrical equipment, resurfacing roadways, and repairing or replacing the erosion control structures (e.g., dikes, channels, and water control structures). Examples of corrective maintenance activities could include repairing storm and fire damage, and replacing failed equipment. Immediate action would be taken to correct unusual or potentially unsafe conditions. Comprehensive inspection of the facilities and the Project Premises and SDA area would be performed annually.

5.5.1.1 Resource Requirements

Alternative IV would require resources for implementation phase activities (lagoon capping, sludge pond excavation, and erosion control); construction and operation of the wastewater treatment area; and annual monitoring and maintenance thereafter, as shown in Table 5-31.

During implementation of Alternative IV which involves preparing for monitoring and maintenance), limited electrical power (18 MW-hr/yr) and natural gas [68,000 m^3/yr (2.4 million ft^3/yr)] would be required, and the consumption rates would be much less than the projected consumption rates during HLW solidification from 1996 to 2000. Consumption of diesel fuel and gasoline would be approximately 112,000 L/yr (29,500 gal/yr), which is 1.2 times greater than the current consumption rate of 93,000 L/yr (24,500 gal/yr) (Kawski 1995). More resources would be required during the post-implementation phase than during the implementation phase [87 MW-hr/yr electrical power, 88,000 m^3/yr (3.1 million ft^3/yr) of natural gas, and 19,000 L/yr (5,100 gal/yr) of fuel], but the consumption rates would all be less than the current projected consumption rates during HLW solidification.

Implementing erosion control measures and stabilizing the LLWTF lagoons would require 28,100 m^3 (992,000 ft^3) of sand, gravel, and rock (riprap); 3,520 m^3 (124,000 ft^3) of concrete; and 8,440 m^3 (298,000 ft^3) of clay and bentonite. Additional volumes of clay would be required annually for maintenance of the NDA, SDA, and CDDL caps. An adequate supply of clay could be obtained from on-site borrow areas located east of Franks Creek.

5.5.1.2 Environmental Impacts

Radiological (Occupational and Transportation)

The potential radiological impacts of implementing Alternative IV would be minimal because it includes limited implementation phase activities for the major structures or facilities on the Project Premises and the SDA (e.g., process building or disposal areas).

Table 5-31. Estimated Energy and Fuel Requirements for Implementing Alternative IV (No Action: Monitoring and Maintenance)[a]

	Implementation Phase			Post-Implementation Phase (Annual)		
WMA/Facility	Electrical Power (MW-hr)	Natural Gas (ft^3)	Diesel Fuel and Gasoline (gal)	Electrical Power (MW-hr)	Natural Gas (ft^3)	Diesel Fuel and Gasoline (gal)
1—Process Building	0	0	0	0	0	0
01/14 Building	0	0	0	0	0	0
2—LLWTF and Lagoons 1-5	0	0	23,000	0	0	0
3—HLW Tanks/Vitrification Facility	0	0	0	0	0	0
4—CDDL	0	0	0	0	0	0
5—CPC Waste Storage Area	0	0	0	0	0	0
Lag Storage Building/Additions	0	0	0	0	0	0
7—NDA	0	0	0	0	0	0
8—SDA	0	0	0	0	0	0
9—RTS Drum Cell	18 (3.6)[b]	2.4×10^6	0	18 (3.6)[b]	2.4×10^6	0
Other Facilities (including WMAs 6,10,11,12)	0	0	700	0	0	0
Wastewater Treatment Area	0	0	1,700	69	7×10^5	5,100
Erosion Control	0	0	63,000	0	0	0
Total	18	2.4×10^6	88,400	87	3.1×10^6	5,100

a. To convert cubic feet to cubic meters, multiply by 0.02832. To convert gallons to liters, multiply by 3.785.

b. Values in parentheses are those in the 1995 versions of the closure engineering reports. The Final EIS will use the final versions of the closure engineering reports.

Sources: WVNS (1994a through n)

Off-Site Impacts. With the exception of the process building, normal operational releases to the atmosphere are expected to be negligible for all WMAs. For the process building, releases to the atmosphere from residual contamination would be expected to be less than current releases and those during the planning phase of Alternative I. No liquid releases would be expected. For the SDA, releases to the atmosphere could occur from treatment of contaminated water removed from disposal trenches. Doses through the atmospheric pathway for the maximally exposed individual and the population are 1.7×10^{-1} mrem/yr and 5.7×10^{-1} person-rem/yr, respectively. The annual impact for the population was estimated as 2.9×10^{-4} latent cancer fatalities. The estimated doses are small fractions of normal background radiation dose and of the 40 CFR Part 61 limit of 10 mrem/yr. Annual risks of a latent cancer fatality for the maximally exposed individual are 2.9×10^{-7} and for the average member of the population are 2.1×10^{-10}.

Occupational Doses. Occupational doses and expected latent cancer fatalities from implementation phase actions would be minor, as shown in Table 5-32 because no major stabilization activities would occur as in Alternative III. The radioactivity from closing the LLWTF lagoons dominates the occupational impacts during the implementation phase. Doses and impacts from the long-term monitoring and maintenance are discussed in Section 5.6.2.1.

Table 5-32. Cumulative Occupational Radiological Impacts for Alternative IV (No Action: Monitoring and Maintenance)

WMA/Facility[a]	Collective Occupational Dose (person-rem)	Latent Cancer Fatalities
1—Process Building	0	0
01/14 Building	0	0
2—LLWTF and Lagoons 1-5	12	0.0048
3—HLW Tanks/Vitrification Facility	0	0
4—CDDL	0	0
5—CPC Waste Storage Area	0.07	0.00003
Lag Storage Building/Additions	0.4	0.0002
7—NDA	0	0
8—SDA	0	0
9—RTS Drum Cell	0	0
Other Facilities (including WMAs 6,10,11,12)	0	0
Total	12	0.0050

a. Doses attributable to individual facilities are given as appropriate. If no facilities are listed, then the dose estimates are applied to the entire WMA. Doses from long-term monitoring and maintenance are addressed in Section 5.5.2.1.

Transportation. No radioactive waste would be shipped off site under Alternative IV. Small amounts of industrial and hazardous waste would be shipped off site.

Postulated Accidents. Because only limited decontamination and stabilization activities involving earthmoving activities would occur, no operational accidents were postulated. Events initiated by natural phenomena are evaluated in Section 5.5.2.2.

Nonradiological (Occupational and Transportation)

Nonradiological operational impacts would be minimal because limited actions would occur before long-term monitoring and maintenance. These implementation actions would be less noisy than Alternatives I, II, and III. Noise impacts were not evaluated because the Center is in a rural area.

Occupational Injuries. The estimated number of occupational lost workdays and fatalities resulting from illnesses and injuries by WMA are presented in Table 5-33.

Transportation. Principal nonradiological local and regional impacts associated with transportation under Alternative IV would be dominated by the air emissions, road wear and tear, and accident risk impacts of the work force commuter traffic on the local roadways near the site. The predicted impacts occur principally during the short implementation period during the transition to the monitoring and maintenance phase. After approximately 2005, the number of workers would be reduced to the caretaker phase, with overall site employment less than 20 percent of current levels.

Materials and supplies necessary for implementing this alternative would be minimal, so truck traffic would be limited and much less than current levels.

Regional and national transportation impacts would result from the shipping industrial waste to a sanitary landfill.

Implementing Alternative IV would involve shipping about 4.2 percent [6,000 m^3 (212,000 ft^3) compared to 145,000 m^3 (5.13 million ft^3)] of the industrial waste volume shipped under Alternative I. The expected impacts would, therefore, also be proportionally less. Thus, for the implementation phase actions, the total number of truck shipments would be 480 or rail shipments would be 340. The estimated total number of vehicular accident fatalities with either truck or rail shipment would be approximately 4.2 percent of the comparable rates in Table 5-8 or 0.009 (4.2 percent of 0.19). The cumulative latent cancer fatalities from vehicular air pollution because of the industrial waste shipments would also be approximately 4.2 percent of the comparable values in Table 5-8 or 0.047 for truck shipments and 0.042 for rail shipments.

Air Quality

Nonradiological impacts to air quality would be minimal because limited excavation, building demolition, or building construction would occur. A PM-10 concentration of approximately 0.02 $\mu g/m^3$ at the nearest public access downwind was calculated for this alternative. This value is significantly less (about 0.04 percent) than the applicable standard of 50 $\mu g/m^3$ for average annual PM-10 concentrations.

Table 5-33. Total Estimated Lost Workday Cases and Fatalities for Alternative IV (No Action: Monitoring and Maintenance)

	Lost Workdays[a]				Fatalities[b]			
WMA/Facility	Construction	Operations	Services	Total[c]	Construction	Operations	Services	Total[c]
1—Process Building	0.0	0.0	0.5	0.5	0.0000	0.0000	0.0006	0.0007
2—LLWTF and Lagoons 1-5	0.2	0.0	0.4	0.6	0.0006	0.0000	0.0005	0.001
3—HLW Tanks/Vitrification Facility	0	0.0	0.4	0.4	0	0.0001	0.0004	0.0006
4—CDDL	0	0	0	0	0	0	0	0
5—CPC Waste Storage Area Lag Storage Building/Additions	0	0.0	0.1	0.1	0	0.0000	0.0002	0.0002
7—NDA	0	0	0	0	0	0	0	0
8—SDA	0	0	0	0	0	0	0	0
9—RTS Drum Cell	0	0	0.0	0.0	0	0	0.0000	0.0000
Other Facilities (including WMAs 6,10,11,12)	0.0	0.0	0.0	0.0	0.0000	0.0000	0.0001	0.0001
Wastewater Treatment Area	0.3	0.0	0.0	0.3	0.0009	0.0000	0.0000	0.0009
Total[c]	0.5	0.0	1.4	1.9	0.0015	0.0001	0.0018	0.0035

a. An entry of 0 indicates that no lost workday cases have been estimated based on the 0 person-hours estimated (see Appendix F); an entry of 0.0 indicates that the estimated lost workday cases are less than 0.1.

b. An entry of 0 indicates that no fatalities have been estimated based on the 0 person-hours estimated (see Appendix F); an entry of 0.0000 indicates that the estimated fatalities are less than 0.0001.

c. Totals may not equal the sum of the column numbers from rounding.

The Center and Cattaraugus County are "in attainment" or "unclassifiable" with respect to the National Ambient Air Quality standards criteria pollutants; therefore, a conformity determination with the applicable State Implementation Plan is not required (see Section 4.5.2).

Water Quality

Surface water discharges and lagoon storage would be greatly reduced after the year 2000 because the WVDP HLW solidification would be completed. The activities described above would result in short-term periods of increased sedimentation from surface water runoff. Surface water quality degradation from contaminants in point source discharges would be reduced by decay of radioactive and biological constituents. Sheet erosion and downstream sedimentation would continue, but the erosion control measures would minimize these impacts.

The groundwater contamination on the north plateau would result in the continued migration of the gross beta plume, with elevated levels of strontium-90 migrating to Franks Creek and Quarry Creek. Groundwater discharge to these creeks would increase the strontium-90 concentration in surface water and contribute to degradation of surface water quality in the creeks next to the Project Premises.

Biotic Resources

Because Alternative IV would be a continuation of present-day activities there would be little impact to biota and habitat on the Project Premises and the SDA. The two implementation actions under this alternative would be capping the LLWTF lagoons and conducting periodic localized erosion controls as described above (WVNS 1994m). Because the lagoons are not used by animals as a water source or aquatic habitat, capping them would not disrupt the biota. Grading and reseeding the capped lagoons with native plants would create a vegetated area on the Project Premises for animal habitation.

The local erosion control measures, include controlling gully migration at the NDA (WMA 7), SDA (WMA 8), the lagoon 3 outfall area (WMA 2), and along Franks Creek; and controlling runoff from paved areas. These actions could kill or displace terrestrial and aquatic animals. The local erosion control measures could result in a decrease in flow rate and sediment load for Franks Creek, Quarry Creek, and Erdman Brook that could affect the diversity and population of aquatic species in these waterways.

Under Alternative IV, no implementation phase actions are proposed for the balance of the site; therefore, there would be no direct impact to biotic resources on the balance of the site. Aquatic biota in streams could be affected by runoff from the Project Premises and SDA area. Filling the lagoons on the Project Premises and implementing local erosion control measures could result in localized disturbances to aquatic habitat from increased siltation. The use of standard engineering practices to control runoff would mitigate the impacts to aquatic biota.

There would be no impact to threatened, endangered or rare plants or animals on the Project Premises and the SDA or the balance of the site from implementing Alternative IV.

Wetlands and Floodplains. Under 10 CFR 1022, DOE is required to assess the impacts of the actions on wetlands as described in this section. The local erosion control measures would potentially disturb 0.6 ha (1.4 acres) of wetlands at the northeast corner of the SDA and in Erdman Brook on the Project Premises and the SDA. The disturbed wetlands occur naturally from ponding of overland flow, in channel bottoms and from stream flooding. Plants in these wetlands include common cattail, field horsetail, rushes, sedges, mint, and blueflag (WVNS 1994o). Wetlands on the balance of the site could be affected by implementing the erosion control measures from increased siltation during earthmoving operations. There would be no construction in floodplains under this alternative.

5.5.1.3 Costs

The costs from implementing Alternative IV include stabilizing specific facilities and for annual monitoring and maintenance as shown in Table 5-34.

The post-implementation phase costs would be for three major cost categories. The first category would be for direct activities related to engineering and maintenance of the facilities to assure safe operation. The second category would be for support programs that provide radiation protection and analytical laboratories needed to support the monitoring and maintenance activities. The third category would be for indirect support not directly related to safety, such as site security, site engineering, and project integration. The last two categories would not be for any specific facility and account for about 55 percent of the total costs reported in Table 5-34; i.e., $16.5 million. Of the remaining costs for engineering and maintenance, a portion would be a fixed cost that is not facility-specific; another portion would be for facility-specific monitoring and maintenance. Of the $29.9 million annual post-implementation cost given in Table 5-34, about $4.6 million is for facility-specific monitoring and maintenance. The monitoring and maintenance of the process building dominates the facility-specific costs, followed by the new wastewater treatment area, the CPC waste storage area, HLW tanks, and the LLWTF. The remaining other facilities or operations would be smaller contributors to the overall monitoring and maintenance costs.

5.5.1.4 Socioeconomic Impacts

The direct employment and expenditures for goods and services that would be used to implement Alternative IV would be similar to those described for Alternative I in Section 5.2.1.4.

Implementing Alternative IV would result in direct employment and expenditures for goods and services starting in the year 2000. The direct employment for the implementation

Table 5-34. Cost Summary for Implementing Alternative IV (No Action: Monitoring and Maintenance)

	$ 1996 Costs (thousands)					
	Implementation Phase					Post-Implementation Phase
WMA/Facility	Materials and Fuels	Labor	Waste Transportation and Disposal	Contingency	Total	Annual
1—Process Building	0	1,406	0	352	1,758	
01/14 Building	0	254	0	64	318	
2—LLWTF and Lagoons 1-5	790	1,576	2	592	2,960	
3—HLW Tanks/Vitrification Facility	0	1,423	0	356	1,779	
4—CDDL	0	0	0	0	0	
5—CPC Waste Storage Area	0	69	0	17	86	
Lag Storage Building/Additions	0	69	0	17	86	
7—NDA	0	0	0	0	0	
8—SDA	0	0	0	0	0	
9—RTS Drum Cell	0	0 (51)[a]	0	0	0	
Other Facilities (including WMAs 6,10,11,12)	10	221	195	107	534	
Wastewater Treatment Area	4,827	2,640	0	1,867	9,334	
Erosion Control	247	109	4	90	450	
Total	5,874	7,767	201	3,462	17,305	30,000[b]

a. Values in parentheses are those in the 1995 versions of the closure engineering reports. The Final EIS will use final versions of the closure engineering reports.
b. For a discussion of post-implementation phase costs, see Section 5.5.1.3.

Sources: WVNS (1994a through n)

phase of Alternative IV would range from 15 to 24 from the years 2000 through 2005. After 2005, monitoring and maintenance would require a site staff of 187. Because the staffing required for long term monitoring and maintenance would be small compared to that required to support WVDP HLW solidification, the schedule for starting Alternative IV would be integrated with completing the HLW solidification to maintain site employment.

Reductions in site employment would result in a negative socioeconomic impact. Alternative V (Discontinue Operations) would eliminate about 900 jobs over 5 years starting in 1998. Alternative IV would eliminate about 713 jobs (900 minus 187 for monitoring and maintenance) over 5 years. In addition to these direct job losses, there would be an addition loss of about 1,041 jobs in the two-county ROI including 18 jobs in the 20-km (12-mi) primary impact area. These job reductions would represent about a 1 percent annual decrease in employment in the primary impact area. The decrease in two-county ROI would be negligible, less than 0.02 percent.

The impacts on housing availability and funding of local public services would be the same as those discussed for Alternative I in Section 5.3.1.4.

Growth Inducing Aspects of Alternative IV. Implementing Alternative IV would result in the continuation of site employment but at reduced levels. Land ownership impacts would be the same as those described for Alternative I in Section 5.2.1.4.

5.5.1.5 Cultural Resources

Since implementation phase actions under Alternative IV consist of monitoring and maintaining the Center, there would be limited impacts to potential cultural resources on the Project Premises, the SDA, and on the balance of the site.

Local erosion control measures consisting of concrete drop structures, water control structures, and sheet piling implemented under Alternative IV, would disturb a 7-ha (17-acre) area on the Project Premises and the SDA. The archaeologic predictive model indicates the potential for prehistoric archaeological resources in the areas where these erosion measures would be constructed. Walkover cultural surveys of the potentially affected area discovered one prehistoric artifact, but over much of the area no cultural material was found. Additional investigation would be required before disturbing areas along the creeks.

On the balance of the site, about 4.4 ha (11 acres) would be disturbed by using local erosion control measures. Like the area on the Project Premises, this area has the potential for prehistoric archaeologic resources, and additional investigation would be required before disturbing areas along creeks.

5.5.1.6 Relationship to Land Use Plans and Visual Impacts

Alternative IV activities would be consistent with the Cattaraugus County Land Use Plan (Cattaraugus County Planning Board 1978, updated 1982) with respect to retaining the Center. Monitoring and maintenance of the Center to prevent releases and protect the environment would be consistent with the land use policy.

There would be no visual impacts from implementing Alternative IV, because the Center would be maintained in its present appearance.

5.5.1.7 Impacts of Disposing of Radioactive and Industrial Wastes at Off-Site Facilities

No radioactive waste would be disposed of off site under Alternative IV; therefore, there would be no impact to off-site facilities that manage radioactive waste. The industrial waste generated by the implementation phase of Alternative IV would result from the construction of erosion control structures. The waste volume is estimated at 6,000 m^3 (212,000 ft^3) that would be disposed of over 2 years (refer to Figure 3-38) for an average disposal rate of 3,000 m^3 (106,000 ft^3) per year. Given an average density of 1,400 kg/m^3 (89 lbs/ft^3) (Lynch 1995), this volume would be equivalent to 4,300 metric tons (4,720 tons) per year, which is 2 percent of the annual waste volume disposed of in western New York (Buffalo region) and only 0.3 percent of the waste volume that is disposed of in the State of New York (Lynch 1995). Thus, the volume of waste to potentially be disposed of would not be significant relative to the current volume of industrial waste disposed of in the State of New York and would not consume a significant capacity in sanitary landfills.

5.5.2 Evaluation of Long-Term Impacts

Long-term impacts under expected conditions for Alternative IV could include exposure of workers during monitoring and maintenance activities and of off-site individuals from groundwater leaching of sediments at the LLWTF and waste disposed of at the NDA and SDA. Impacts from the process building, HLW tanks, lag storage building and additions, and RTS drum cell are expected to be negligible because it was assumed they would be maintained in their present condition. The mitigative measures for the contaminated groundwater plume on the north plateau are assumed to eliminate potential off-site impacts for this alternative. Erosion control measures were assumed to be effective for stabilizing facilities. Intrusion would not occur because security measures would be in place to prevent it. Thus, for the case in which institutional control is maintained, the only potential release scenarios would be groundwater leaching of radionuclides from inventories at the LLWTF, NDA, and the SDA.

The potential impacts if institutional control were lost 100 years or later in the future were also evaluated. The concerns would be twofold: the impact of natural processes, such as rainfall and erosion on the waste, and the potential for intrusion into the disposal areas on the Project Premises and SDA.

The radiological consequence could be serious if institutional controls were lost and the disposal areas were intruded into, the area were explored, and disposal areas were used for construction, water wells, or agriculture without knowledge of or concern for the presence of radioactive waste. To quantify the risk for the loss of institutional control case, hypothetical scenarios including agriculture, construction, discovery, drilling for on-premises intruders and use of contaminated surface water by off-site residents were evaluated. Surface water can become contaminated by contaminated groundwater discharging to the creeks or by waste inventories collapsing into the creeks because of erosion.

5.5.2.1 Long-Term Impact from Expected Environmental Conditions and Loss of Institutional Control

Expected Conditions Case

Under expected conditions, radiological and hazardous constituents could potentially be released by groundwater leaching of hazardous material from subsurface disposed inventories and transporting the dissolved constituents to nearby creeks. Low level occupational doses would also occur. Potential impacts from these scenarios are discussed in this section.

Radiological Impacts. Potential environmental impacts from Alternative IV would be limited to the gradual transport of contaminants off site. Details of analysis for the cesium prong and contamination in creeks are presented in Appendix D. The maximum groundwater velocity predicted by the three-dimensional groundwater flow model for each WMA was input into a one-dimensional release-transport-dose code to estimate potential impacts for groundwater release scenarios. Appendix D describes the scenario analysis approach and model parameter values. As a conservative analysis, the maximally exposed off-site individual was assumed to be located near Cattaraugus Creek on the balance of the site, to obtain fish and drinking water from the creek, and to use creek water to irrigate a garden. The radiological impact to a Seneca Nation resident on the Cattaraugus Reservation who fished, drank water and irrigated crops using water from Cattaraugus Creek was also evaluated.

Under the expected conditions, potential releases of radioactive material could occur at the LLWTF, NDA, and SDA. At the LLWTF in WMA 2, horizontal groundwater flow through sediments in lagoons 1, 2, and 3 was assumed to dissolve radionuclides and transport the contaminants to Erdman Brook. At the NDA and SDA in WMAs 7 and 8, respectively, groundwater moves horizontally through buried waste in the weathered Lavery till, then downward through waste disposed of in the unweathered till. Groundwater moving through the weathered till discharges to Erdman Brook and Franks Creek. Downward groundwater flow through the unweathered till enters the Kent recessional unit and flows horizontally to discharge points at Buttermilk Creek. Releases at the NDA and SDA are dominated by flow through the weathered Lavery till. Table 5-35 presents the impacts estimated by WMA for the year of maximum exposure to a Cattaraugus Creek resident, a Seneca Nation person on the Cattaraugus Reservation, and the surrounding population. The estimated cumulative dose for the Cattaraugus Creek and Seneca Nation individuals are presented in Figures 5-9 and 5-10. The distribution of collective doses follows the same curve as that for the individual dose. The maximum annual Cattaraugus Creek individual dose of 1.2 mrem occurs after 50 years. For the year of maximum individual dose, the collective dose is estimated as 0.72 person-rem. The annual risk of a latent cancer fatality for the maximally exposed individual is 6.0×10^{-7} and for the average member of the population is 1.0×10^{-9}. For the year of maximum exposure, impacts for the LLWTF are dominated by release of cesium-137 with a secondary contribution from uranium-234 and uranium-238. At the NDA, impacts for

Table 5-35. Impacts to the Public from Expected Conditions for Alternative IV (No Action: Monitoring and Maintenance) (Groundwater Release Scenario)[a]

WMA/Facility	Cattaraugus Creek Individual Dose (mrem)	Seneca Indian Individual Dose[b] (mrem)	Off-Site Population: Collective Dose (person-rem)	Off-Site Population: Latent Cancer Fatalities
2—LLWTF and Lagoons 1-5	1.2 [2050]	2.1 [2050]	0.72 [2050]	0.0004
7—NDA	0.005 [2068]	0.01 [2068]	0.003 [2068]	0.000002
8—SDA	0.1 [2248]	0.3 [2248]	0.06 [2248]	0.00003

a. Doses are for year of maximum impact for that facility, the year of occurrence is provided in brackets.
b. Assumes location on the Cattaraugus Reservation 24 km (15 mi) downstream from the Center on Cattaraugus Creek.

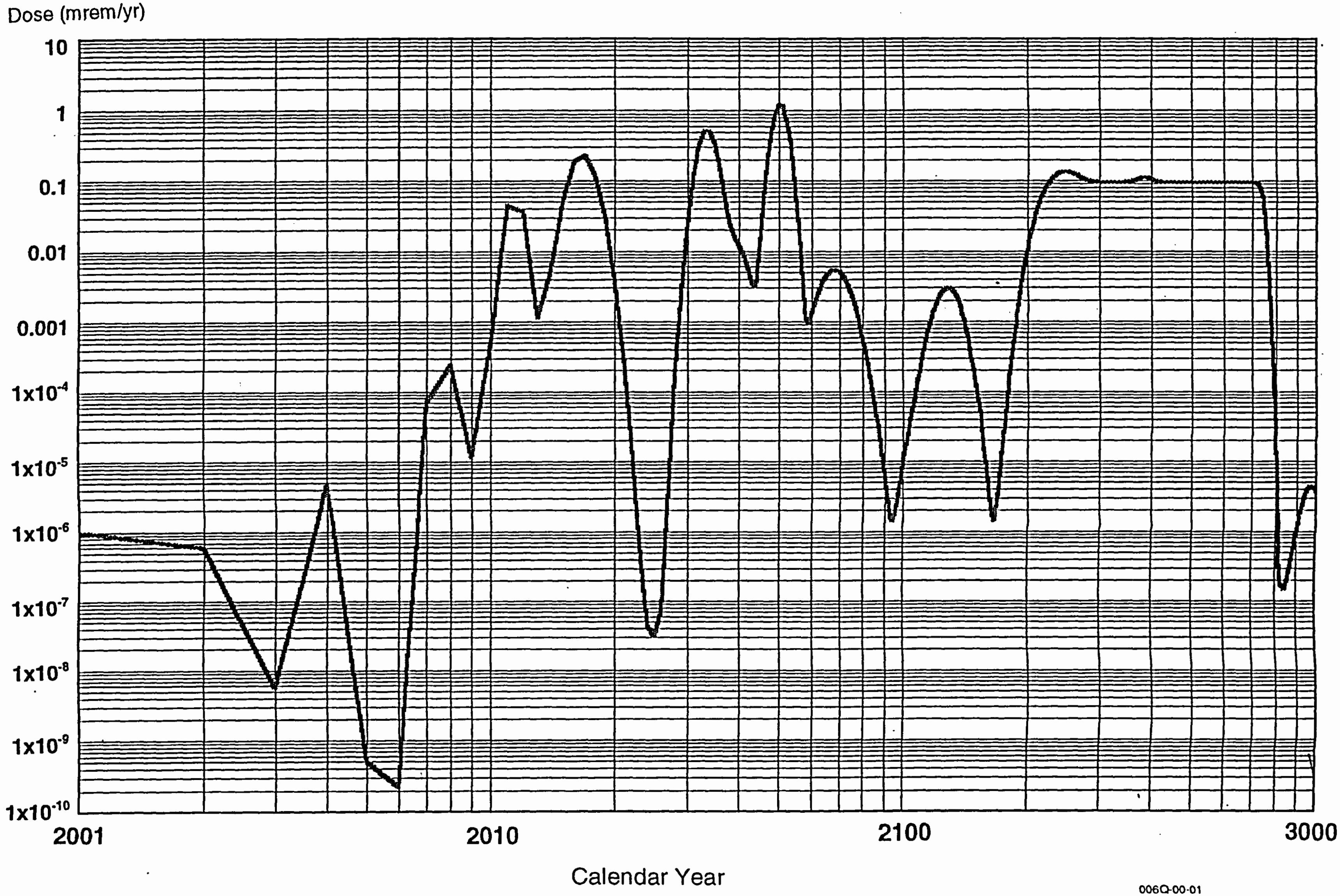

Figure 5-9. Alternative IV Expected Conditions Case Groundwater Release Scenario Impacts for a Cattaraugus Creek Resident.

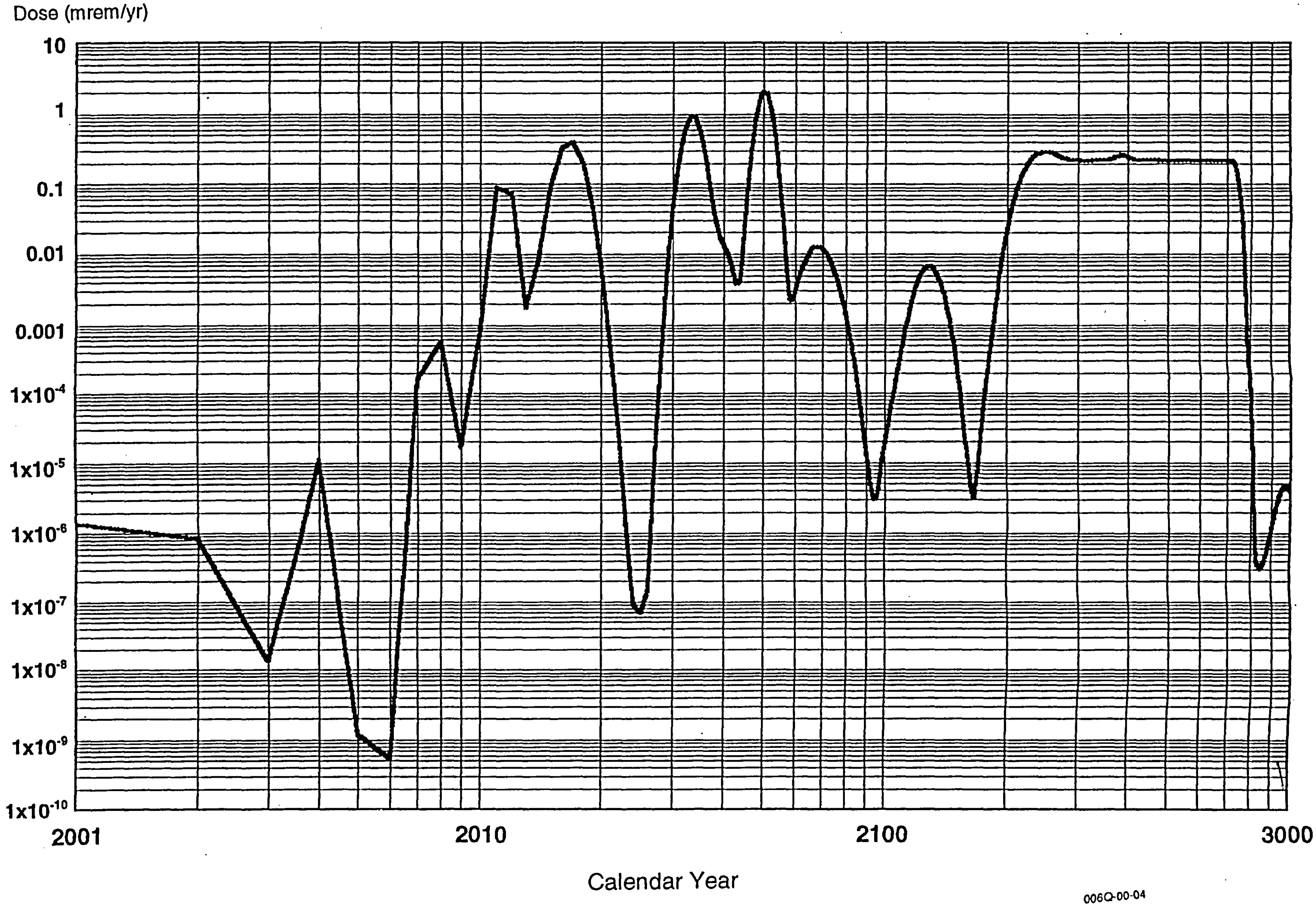

Figure 5-10. Alternative IV Expected Conditions Case Groundwater Release Scenario Impacts for a Seneca Indian Resident.

the year of maximum exposure are dominated by release of strontium-90, with a minor contribution from neptunium-237. At the SDA, impacts for the year of maximum exposure are dominated by release of carbon-14, with comparable effects for release of iodine-129.

Hazardous Chemical Impacts. The impact from potential hazardous chemicals is also from gradual transport in groundwater that discharges to creeks used by the off-site residents. The CDDL, NDA, and SDA are the only areas with the potential for release of hazardous chemicals as described in Section 5.4.2.1 and Appendix D. An off-site resident who uses Cattaraugus Creek as a drinking water source and consumes fish from the creek is the maximally exposed individual. The lifetime risk (70 years of exposure) above background of a latent cancer fatality for the maximally exposed individual was estimated as 5.7×10^{-7}, with an equivalent annual average risk of 8.1×10^{-9}. These risks were from arsenic and beryllium in the water. Estimates of the potential for noncarcinogenic toxic effects were below threshold values for all chemicals covered in the sampling programs.

Occupational Doses. Limited stabilization activities would occur during the implementation phase of Alternative IV. The post-implementation phase consists of long-term monitoring and maintenance of the Project Premises and SDA. The monitoring and maintenance activities would include periodic maintenance of erosion control measures to ensure waste containment integrity. These activities could result in occupational exposures.

Estimates of both occupational doses and injuries and illnesses were derived from WVNS (1994l). It was estimated that the collective doses to monitoring and maintenance workers would initially be a maximum of 30 person-rem/yr, and decrease to a maximum of 3 person-rem/yr after 100 years because of the decay of cesium-137, the primary contributor to dose during this period (WVNS 1994l). The total collective dose over the first 100-year period was estimated at a maximum of 1,200 person-rem.

Routine monitoring and maintenance activities were estimated to result in 3.6 lost workday cases and 0.007 fatalities yearly, or an estimated 360 lost workday cases and 0.7 fatalities within the first 100 years. Performing periodic erosion control measures (assumed to be required every 50 years) would result in an estimated 12 lost workday cases and 0.03 fatalities within the first 100 years.

The above estimates do not consider impacts beyond 100 years. In general, annual doses would be lower than the above estimates because of radioactive decay, except when major facility modification or replacements occurred. Lost workday cases and fatalities from occupational injuries or illnesses would be expected to be stabilize with time, except during periods of high maintenance activities.

Evaluation of the potential occupational effects related to the presence of hazardous chemicals considered contact with soils and sediment and inadvertent ingestion of soil. Latent cancer fatality lifetime risk (70 years of exposure) above background was 1.8×10^{-5}, with an average annual risk of 2.6×10^{-7}. Background lifetime risk of a latent cancer fatality was estimated as 7.7×10^{-5}, with an equivalent annual average risk of 1.1×10^{-6}. The estimated risks are well below those normally encountered in the construction trades.

Other Impacts. During the post-implementation phase, there would be no direct impacts to air, biota, or water quality because there would be no major earthmoving projects. If erosion control measures beyond those planned became necessary, then activities that produce more dust, disturb large areas, or result in substantial surface water runoff could impact air, biota, or water quality. The groundwater quality would remain degraded, but mitigative measures would continue to control the off-premises migration of contaminated groundwater.

Loss of Institutional Control Case

Radiological Impacts. If loss of institutional control occurred, individuals could move near buried waste and the disposal areas could be eroded. The potential impacts from the loss of institutional control were evaluated for radiological and hazardous chemical releases as described below.

Under conditions not expected to occur, site security, monitoring, and maintenance could fail. Facilities containing waste would be exposed to the elements, and natural processes like erosion could undermine the integrity of the facilities. Two sets of scenarios were evaluated for this unlikely event. In the first scenario, the facilities degrade and rainwater percolates through the waste and transports dissolved radionuclides to the gardens of people residing on the Project Premises and SDA. On-premises individuals would construct homes, enter abandoned facilities, or drill through buried waste. Table 5-36 summarizes the potential severe consequences of this intrusion scenario, which would include potential injury and fatalities. Contaminated groundwater would transport dissolved radionuclides to Buttermilk Creek, thereby affecting off-site individuals and populations. The potential consequences for this scenario are summarized in Table 5-37. Releases from the HLW tanks and the process building dominate the potential impacts by producing high doses. The groundwater release scenarios are dominated by release of soluble, short-lived radionuclides, particularly strontium-90.

In the second scenario, erosion encroaches upon the facilities, and waste inventories collapse into the creek. For this erosion scenario, an individual living along Buttermilk Creek who obtained drinking and irrigation water and fished from the creek would be the maximally exposed individual. Table 5-38 presents the estimated consequences when facilities erode within 1,000 years. The consequences were severe and involved potentially lethal effects. The doses were dominated by long-lived radionuclides, especially americium-241.

Table 5-36. Impacts to an Intruder from the Assumed Loss of Institutional Control for Alternative IV (No Action: Monitoring and Maintenance)

	Dose[a] (mrem)			
WMA/Facility (Alternative)	Agriculture/ Residential	Construction	Discovery	Drilling
1—Process Building	5.8×10^6 [2117]	NA[b]	4,000 [2100]	NA
2—LLWTF and Lagoons 1-5	2.2×10^5 [2127]	0.8 [2100]	NA	0.17 [2100]
3—HLW Tanks/Vitrification Facility	1.1×10^9 [2117]	NA	8,000 [2100]	NA
5—CPC Waste Storage Area Lag Storage Building/ Additions	1.6×10^6 [2117]	0.3 [2100]	1,000 [2100]	NA
6,10—Balance of Site	0.9 [2100]	1.5 [2100]	NA	NA
7—NDA	6.5×10^6 [2100]	4.1×10^5 [2100]	7,000 [2100]	2.1 [2100]
8—SDA	3.1×10^5 [2108]	260 [2100]	26,000 [2100]	0.56 [2100]
9—RTS Drum Cell	440 [2100]	NA	0.0001	NA
Cesium Prong On Site	8.8 [2100]	NA	NA	NA
North Plateau Plume	1,000 [2100]	NA	NA	NA

a. Doses are for the year of maximum impact for that facility, the year of occurrence is provided in brackets.
b. NA = Because of the nature of the scenario and the WMA, the scenario is not applicable for this case.

Table 5-37. Impacts to the Public from an Assumed Loss of Institutional Control for Alternative IV (No Action: Monitoring and Maintenance) (Groundwater Release Scenario)[a]

WMA/Facility	Buttermilk Creek Individual Dose (mrem)	Off-Site Population: Collective Dose (person-rem)	Off-Site Population: Latent Cancer Fatalities
1—Process Building	66.8 [2161]	5.3 [2161]	0.003
2—LLWTF and Lagoons 1-5	0.18 [2387]	0.01 [2387]	6.9×10^{-6}
3—HLW Tanks/Vitrification Facility	4,700 [2172]	371 [2172]	0.19
5—CPC Waste Storage Area Lag Storage Building/Additions	48.5 [2161]	3.8 [2161]	0.002
7—NDA	4.4×10^{-4} [2535]	3.5×10^{-5} [2535]	1.7×10^{-8}
8—SDA	1.0 [2248]	0.08 [2248]	0.00004
9—RTS Drum Cell	6.3 [2225]	0.50 [2225]	0.0002
North Plateau Plume	0.32 [2100]	0.27 [2000]	0.0001

a. Doses are for year of maximum impact for that facility, the year of occurrence is provided in brackets.

Table 5-38. Impacts to the Public from the Assumed Loss of Institutional Control for Alternative IV (No Action: Monitoring and Maintenance) (Erosional Collapse Scenario)[a]

WMA/Facility	Buttermilk Creek Individual Dose (mrem)	Off-Site Population: Collective Dose (person-rem)	Off-Site Population: Latent Cancer Fatalities
2—LLWTF and Lagoons 1-5	520 [2780]	41 [2780]	0.02
7—NDA	47,000 [2390]	3,700 [2390]	1.9
8—SDA	2.8×10^{5} [2320]	22,000 [2320]	11.1
9—RTS Drum Cell	4,500 [2200]	360 [2200]	0.18

a. Doses are for year of maximum impact for that facility, the year of occurrence is provided in brackets.

Hazardous Chemical Impacts. If institutional control were lost, a residence could be established on site and hazardous constituents and dissolved metals could be released to surface water used by the Buttermilk Creek resident either by groundwater transport or erosional collapse. For the resident on the Project Premises, lifetime risk (70 years) above background for undisturbed conditions was estimated to be 3.5 x 10^{-4} with an annual average of 5.0 x 10^{-6}. For the Buttermilk Creek resident, the lifetime risk above background for undisturbed conditions was estimated to be 4.3 x 10^{-6} with an annual average of 6.1 x 10^{-8}. For the erosional collapse case, the total concentration of potentially toxic chemicals was estimated as 17 percent of the threshold for observable effects, indicating that potential impacts from hazardous constituents are small relative to the potential radiological impacts.

5.5.2.2 Long-Term Impact from Less Likely Events

Limited action would be taken after completing the WVDP HLW solidification to stabilize radioactive waste and contamination. The Center would be monitored and maintained indefinitely. The monitoring and maintenance activities would be adequate to prevent off-site impacts from minor events. In addition, intrusion would not occur. However, in the event of a severe natural phenomenon such as an earthquake, radioactive material could be released from some of the facilities. The maximum estimated doses to a member of the public from such postulated events are presented in Table 5-39. No accidents were postulated for the disposal areas (WMAs 7 and 8). The results in Table 5-39 are based on a beyond design basis (0.33g peak ground acceleration) earthquake occurring in the year 2000. (See Appendix G for additional discussion of these accidents.)

Table 5-39. Long-Term Impacts to the Public from Severe Natural Phenomena for Alternative IV (No Action: Monitoring and Maintenance)

WMA/Facility	Description of Upper-Bound Accident[a]	Maximum Individual Dose (rem)	Collective Dose (person-rem)	Latent Cancer Fatalities
1—Process Building	Beyond design basis earthquake results in failure of Process Building and release of radioactive material[b]	100	1,000,000	500
3—HLW Tanks	Beyond design basis earthquake results in ventilation system failure and release of airborne radioactivity[b]	5	60,000	30
5—CPC Waste Storage Area Lag Storage Building/Additions	Severe winds destroy waste storage facilities[b]	9	100,000	50
9—RTS Drum Cell	Beyond design basis earthquake destroys RTS drum cell[b]	20	200,000	100

a. These accidents are assumed to occur in the year 2000.
b. Estimated annual accident probability is 1 chance in 10,000 to 1 chance in 1,000,000 (10^{-4} to 10^{-6}).

5.5.3 Uncertainty Associated with Alternative IV

Under Alternative IV, the implementation phase is limited to capping lagoon 3 and installing local erosion control structures. Like Alternative III, the uncertainty is associated with making long-term predictions for the post-implementation phase. The ability of man-made and natural features to protect the waste in existing facilities such as the disposal areas for 1,000 years is uncertain. Likewise, the ability to monitor and maintain for 1,000 years and to restrict unintended access to contaminated buildings, waste storage areas, and buried waste is uncertain. The potential impact from this uncertainty was evaluated in Section 5.4.3.

5.6 ALTERNATIVE V: DISCONTINUE OPERATIONS

Under Alternative V, the major buildings, stored waste, buried waste, in-ground structures, and other facilities would remain in place, and wastes would not be generated or removed from the site. The borosilicate glass canisters would remain on the Project Premises in the process building. The ventilation systems in buildings would be shut down to reduce the potential for release of material to the atmosphere. The process building doors would be locked, the fences padlocked, and no-trespassing signs posted, but there would be no active security. Implementing this alternative would have minimal labor and transportation requirements. No areas would be disturbed, and waste would remain at multiple locations on the Project Premises and SDA. No effort would be taken to mitigate existing environmental contamination. No erosion control measures would be implemented, and erosion would continue.

5.6.1 Implementation Phase Impacts

For purposes of analysis, it was assumed that institutional control would be lost in the year 2000, and the consequences are described in Section 5.6.2. A long-term period of 1,000 years was evaluated to allow comparison with the other alternatives. This alternative would not involve any active maintenance such as building improvements, movement of stored wastes, periodic inspection of the disposal areas to check for erosion or subsidence, weed control, grass mowing, or maintenance of signs and fences. Although this alternative would not be implemented except under extreme financial limitations, it was evaluated to provide an environmental baseline. There are no implementation phase impacts for Alternative V.

5.6.1.1 Resource Requirements

No resources are required for Alternative V because no actions would be taken beyond shutting down active systems.

5.6.1.2 Environmental Impacts

Radiological (Occupational and Transportation)

Because operations would be discontinued and the site would be abandoned, there would be no implementation phase impacts. Therefore, there would be no radiological impacts. Long-term radiological impacts are described in Section 5.6.2.

Nonradiological (Occupational and Transportation)

Because operations would be discontinued and the site would be abandoned, there would be no implementation phase impacts. Therefore, there would be no nonradiological impacts from accidents and transportation from implementation phase actions.

Air Quality

Because operations would be discontinued and the site would be abandoned, there would be no implementation phase impacts. Therefore, there would be no impacts to air quality from implementation phase actions.

Water Quality

Because operations would be discontinued and the site would be abandoned, there would be no implementation phase impacts. Therefore, there would be no impacts to water quality from implementation phase actions.

Biotic Resources

Because operations would be discontinued and the site would be abandoned, there would be no implementation phase impacts. Therefore, there would be no impacts to biota from implementation phase actions.

Wetlands and Floodplains. Because operations would be discontinued and the site would be abandoned, there would be no implementation phase impacts. Therefore, there would be no impacts to wetlands and floodplains from implementation phase actions.

5.6.1.3 Costs

No costs would be incurred from implementing Alternative V.

5.6.1.4 Socioeconomic Impacts

Implementation of Alternative V would involve no additional direct employment or expenditures for goods and services beyond that required to complete the HLW solidification operations. This represents the baseline situation that is described in Section 4.8.

Because Alternative V would provide no additional employment, total site employment would be reduced from 900 to 0 between 1998 and 2004. In addition to this reduction in direct employment, implementation of Alternative V would result in the loss of about 1,700 jobs in the two-county ROI including 21 in the 20-km (12-mi) primary impact area. These job reductions would represent about a 1 percent annual decrease in employment in the primary impact area. The decrease in two-county ROI would be negligible, less than 0.02 percent.

The impacts on housing availability and funding of local public services would be the same as those discussed for Alternative I in Section 5.3.1.4.

Growth Inducing Aspects of Alternative V. Implementation of the alternative would result in the elimination of site employment over a 6-year period. It is not expected to result in reuse of the land as State property or the sale of the land to private ownership. Neither of these impacts would be expected to produce or induce noticeable growth in the local or regional area.

5.6.1.5 Cultural Resources

Because there is no implementation action under Alternative V, there would be no impacts to cultural resources.

5.6.1.6 Relationship to Land Use Plans and Visual Impacts

Site abandonment under Alternative V would not be consistent with the original designated land use of developing nuclear technology or with the policies contained in the Cattaraugus County Land Use Plan (Cattaraugus County Planning Board 1978, updated 1982). Over time, contamination could migrate beyond the site boundary and compromise potential off-site use.

As facilities on the Project Premises begin to degrade, fall into disrepair, and collapse, a negative visual impact could result from Alternative V (Discontinue Operations). The Project Premises and the SDA would not be mowed or maintained, and vegetation could grow up around the facilities, trailers, and fences, further contributing to a negative visual impact. No visual impact would result on the balance of the site because most of the Center is in a natural state.

5.6.1.7 Impacts of Disposing of Radioactive and Industrial Wastes at Off-Site Facilities

Under Alternative V, no radioactive or industrial waste would be disposed of off site; therefore, there would be no impact at off-site facilities.

5.6.2 Evaluation of Long-Term Impacts

Potential long-term impacts of abandoning the Center include gradual transport of contaminants off site through the air or water and possible occupation of the Project Premises and SDA area by individuals unaware of the danger of intruding into the disposed waste.

The magnitude of the exposure of individuals and the public would be affected by gradual natural physical processes, such as wind and stream erosion, and by intermittent natural phenomena, such as earthquakes and tornadoes. In addition to the 10 WMAs on the Project Premises including the SDA, the cesium prong, and contaminated groundwater on the north plateau were evaluated separately. The long-term performance assessment for these areas and other scenarios is discussed below and in Appendix D.

5.6.2.1 Long-Term Impacts from Expected Environmental Conditions

Radiological Impacts. The long-term environmental impacts would be concentrated on individuals living on or near the abandoned Project Premises and SDA. Exposure modes for the population, such as inhalation of contaminated dust and ingestion of contaminated water, would be expected to contribute only low doses because of the low rate of release into the air and the substantial dilution of concentrations in water. However, individuals on the Project Premises and the SDA could experience high radiation exposures from direct contact with radioactive waste or ingestion of water with relatively high concentrations of dissolved contaminants.

For the impact analysis for Alternative V, undisturbed scenarios for the Project Premises and SDA were constructed to evaluate the potential radiological impacts for a resident on the north or south plateau who uses well water for drinking and crop irrigation and a Buttermilk Creek resident on the balance of the site who obtains drinking water, fish, and crop irrigation water from the creek as described in Section 5.1.3. Erosion processes described in Appendix L provide a basis for estimating impacts of the disturbed scenario for the Project Premises and SDA and Buttermilk Creek residents. Intrusion scenarios were evaluated to assess potential impacts for residents on the north or south plateau on the Project Premises and SDA who may directly contact waste.

Under undisturbed conditions, structures on the Project Premises, including the process building, HLW tanks, lag storage building and additions, and RTS drum cell, would deteriorate with time, allowing precipitation to infiltrate and leach radionuclides from the rooms and containers within the structures. Contamination leached from the process building and HLW tanks on the north plateau could enter groundwater and reach a nearby water well and Franks Creek. Water contacting containers at the lag storage building and additions on the north plateau and the RTS drum cell on the south plateau could contaminate groundwater or flow overland to either Quarry Creek or Erdman Brook, respectively. Groundwater would flow through the lagoon sediments at the LLWTF and buried waste at the NDA and SDA. Contamination in the sand and gravel layer on the north plateau could impact a resident on the north plateau. The potential impacts for an individual on the Project Premises and SDA being affected by groundwater release scenarios were estimated using a residential/agriculture/well water scenario.

After abandonment of the Center, individuals could directly contact contaminated sediments and stored or buried wastes on the north and south plateau on the Project Premises or SDA that had not been stabilized or protected against intrusion by agriculture, home construction, drilling, and waste discovery. Potential doses estimated for the hypothetical intruder are summarized in Table 5-40. At the process building, the first two activities are unlikely or impossible, but an individual could gain access to the building itself. In the scenario evaluated, a person enters the process building and spends 5 minutes visiting each of approximately 70 rooms, where the individual is exposed to direct radiation from activity remaining on the walls and floor. At the LLWTF, an individual is assumed to construct a home and well at lagoon 1. At the HLW tank area, an individual is assumed to gain access to a riser and view the interior of tank 8D-2 for 5 minutes. At the lag storage building and additions and the RTS drum cell, an individual enters the buildings and remains for 30 minutes. At the NDA and SDA, home construction and direct discovery could occur. The disposal holes and trenches were assumed to resaturate, allowing continuous groundwater flow through waste disposed of in the weathered Lavery till. This situation is similar to trench overflow and causes contamination of near-surface soils. In the case of

Table 5-40. **Impacts to an Intruder from the Assumed Loss of Institutional Control for Alternative V (Discontinue Operations)**

	Dose[a] (mrem)			
WMA/Facility	Agriculture/ Residential	Construction	Discovery	Drilling
1—Process Building	5.8×10^7 [2017]	NA[b]	40,000 [2000]	NA
2—LLWTF and Lagoons 1-5	5.0×10^5 [2017]	5.2×10^5 [2001]	NA	1.8 [2001]
3—HLW Tanks/Vitrification Facility	9.2×10^9 [2017]	NA	80,000 [2000]	NA
5—Lag Storage Building/Additions	1.6×10^7 [2017]	0.6 [2000]	10,000 [2000]	NA
6,10—Balance of Site	24.0 [2000]	9.4 [2000]	NA	NA
7—NDA	5.7×10^8 [2000]	4.1×10^6 [2000]	70,000 [2000]	21.0 [2000]
8—SDA	4.4×10^7 [2016]	2,600 [2000]	2.6×10^5 [2000]	27.0 [2000]
9—RTS Drum Cell	4,400 [2000]	NA	0.001 [2000]	NA
Cesium Prong On Site	88.0 [2000]	NA	NA	NA
North Plateau Plume	11,000 [2000]	NA	NA	NA

a. Doses are for year of maximum impact for that facility, the year of occurrence is provided in brackets.
b. NA = Because of the nature of the scenario and the WMA, the scenario is not applicable.

discovery, an individual excavates into a trench containing waste and is exposed to direct radiation for 5 hours. For the rail spur and facilities in WMAs 6 and 10 on the north plateau, an individual is exposed to residual contamination and home construction activities. For the agricultural exposure scenarios on the north plateau and at the NDA and SDA on the south plateau, estimated impacts are dominated by release of short-lived, soluble radionuclides, particularly strontium-90 and cesium-137. Impacts at the RTS drum cell on the south plateau are dominated by release of iodine-129.

Impacts from groundwater release scenarios affecting a Buttermilk Creek individual and the surrounding population were from using surface water recharged by contaminated groundwater. The individual and population were assumed to obtain fish, drinking water, and crop irrigation water from the contaminated surface water. The estimated impacts for this scenario for the years of maximum impact are summarized in Table 5-41. As in the case of on-site groundwater release scenarios, north plateau facility impacts were dominated by release of short-lived soluble radionuclides, particularly strontium-90. On the south plateau, slightly longer transport distances than applicable in the on-site case produce greater doses for long-lived but mobile radionuclides, such as carbon-14 and technitium-99.

Table 5-41. Impacts to the Public from the Assumed Loss of Institutional Control for Alternative V (Discontinue Operations) (Groundwater Release Scenario)[a]

WMA/Facility	Buttermilk Creek Individual Dose (mrem)	Off-Site Population	
		Collective Dose (person-rem)	Latent Cancer Fatalities
1—Process Building	670 [2061]	53 [2061]	0.026
2—LLWTF and Lagoons 1-5	11.3 [2050]	0.9 [2050]	0.0004
3—HLW Tanks/Vitrification Facility	45,000 [2072]	3,600 [2072]	1.8
5—Lag Storage Building/Additions	490 [2061]	39 [2061]	0.019
7—NDA	0.04 [2068]	0.0032 [2068]	1.6×10^{-6}
8—SDA	1.0 [2248]	0.079 [2248]	4.0×10^{-5}
9—RTS Drum Cell	6.3 [2125]	0.50 [2125]	0.0002
North Plateau Plume	3.4 [2000]	0.27 [2000]	0.0001

a. Doses are for year of maximum impact for that facility, the year of occurrence is provided in brackets.

For conditions under which natural processes disrupt the site, the erosion analysis for 1,000 years indicates that as much as 242,000 m^2 (2.6 million ft^2) of the north plateau and as much as 232,000 m^2 (2.5 million ft^2) of the south plateau could be eroded if an erosion control strategy were not implemented (Figure 5-11). Because of the wide range of values and uncertainty from the erosion impacts, computer modeling of the stream system was used to provide a best estimate of erosion as described in Appendix L. On the north plateau, lagoon 2 and 3 and part of lagoon 1 (WMA 2) and the facilities in the southern part of WMA 10 could be eroded. On the south plateau, the northern ends of trenches 2 through 5, the eastern side of trench 8, and the SDA north lagoon (WMA 8) could be eroded. As shown in Figure 5-11, a portion of the NDA could also be eroded. Based on gully migration rates calculated in WVNS (1993), the CDDL (WMA 4) and trench 1 in the SDA (WMA 8) could be eroded by gullies by the year 2100 and 2200, respectively.

Erosion would affect waste stored or disposed of on the north and south plateaus as described above. Gully development or the slumping of stream banks on the edge of disposal areas could cause waste to collapse into the streams allowing high concentrations of radionuclides to be transferred to a Buttermilk Creek resident on the balance of the site as described in Appendix D. Doses for the year of maximum impact are summarized in Table 5-42 for the Buttermilk Creek resident and the surrounding population. Three dose peaks were predicted before 250 years related to the release of cesium-137 and strontium-90 after collapse of lagoon 3 at the LLWTF. Doses in later years would be from release of

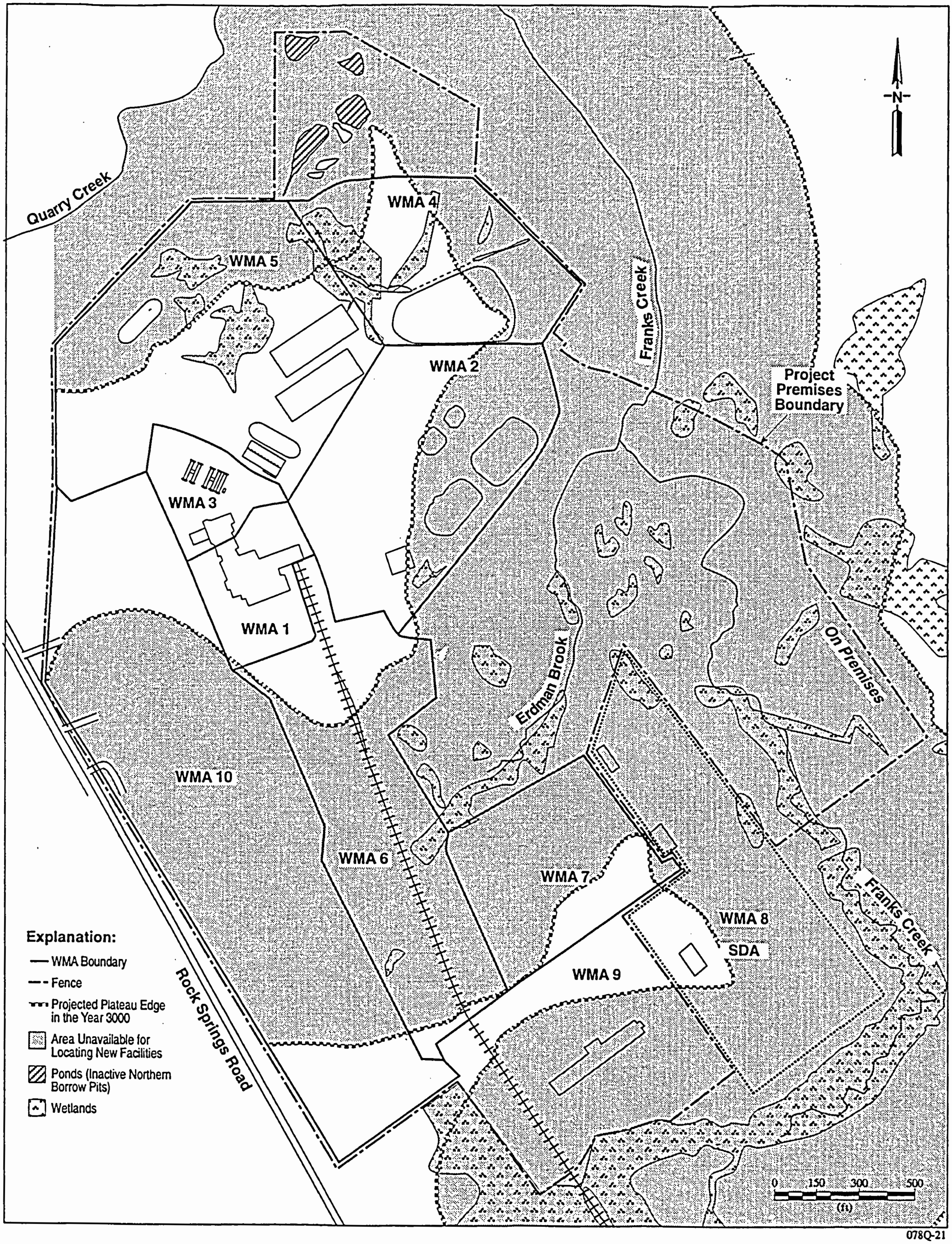

Figure 5-11. Projected Stream Valley Growth to the Year 3000 (1,000 years).

Table 5-42. **Impacts to the Public from the Assumed Loss of Institutional Control for Alternative V (Discontinue Operations) (Erosional Collapse Scenario)[a]**

WMA/Facility	Buttermilk Creek Individual Dose (mrem)	Off-Site Population	
		Collective Dose (person-rem)	Latent Cancer Fatalities
2—LLWTF and Lagoons 1-5	520 [2680]	41 [2680]	0.02
7—NDA	47,000 [2290]	3,700 [2290]	1.9
8—SDA	3.3×10^5 [2220]	26,000 [2220]	13.0
9—RTS Drum Cell	4,500 [2100]	360 [2100]	0.18

a. Doses are for year of maximum impact for that facility, the year of occurrence is provided in brackets.

americium-241 after collapse of near-creek portions of the NDA and SDA, with some contribution from the plutonium isotopes. Health effects from releases of this magnitude are acute and include radiation sickness and possibly a fatality.

Hazardous Chemical Impacts. Because of the potential for chemical contamination at the CDDL, NDA, and SDA, a resident could be exposed to excess cancer risk through groundwater use, contact with contaminated soil and sediments, and consumption of garden produce. In addition, groundwater leaching of contaminants under undisturbed conditions with a pulse release caused by erosional collapse could potentially affect a resident on the balance of the site. On the south plateau, the NDA, SDA, and RTS drum cell could be lost to erosion within 1,000 years. For the resident on the north or south plateau on the Project Premises and the SDA, the lifetime risk (70 years) above background of a latent cancer fatality for undisturbed conditions was estimated as 3.5×10^{-4} with an equivalent annual average of 5.0×10^{-6}. For the Buttermilk Creek resident, the lifetime risk above background of a latent cancer fatality for undisturbed conditions was estimated as 4.3×10^{-6} with an equivalent annual average of 6.1×10^{-8}. Erosional collapse (disturbed conditions) could release contaminated trench water containing chemicals and dissolved metals into water used by the Buttermilk Creek resident. The total concentration of potentially toxic chemicals in the creek water was estimated as 17 percent of the threshold for observable effects. Thus, the risk from hazardous chemicals potentially present are predicted to be small for each of the scenarios considered.

Occupational Doses. Under Alternative V, all personnel would leave the Center after the completion of WVDP HLW solidification activities. Therefore, there would be no long-term occupational impacts.

Other Impacts. Since there is no implementation phase under Alternative V, there would be no impacts to air because no major earthmoving projects would be undertaken that would produce large quantities of dust. Contaminated groundwater and soil would remain in place with the potential for spreading by either flowing off site in surface water runoff or through groundwater seeps or being carried off site from uptake by animals. Because of the contamination on the Project Premises and SDA, animals could be exposed to radiation and hazardous constituents from deterioration of structures on the Project Premises, from burrowing in contaminated soil, or from drinking contaminated water. Natural successional processes from field to forest would continue on the Project Premises and the SDA.

5.6.2.2 Long-Term Impacts from Less Likely Events

No action would be taken to stabilize the radioactive waste and contamination, and the Center would be abandoned. In the event of a severe natural phenomenon such as an earthquake or severe winds, radioactive material could be released from some of the facilities as described in Section 5.5.2.2.

5.6.3 Uncertainty Associated with Alternative V

Since there is no implementation phase for Alternative V, there would be no uncertainty with implementation phase impacts. Likes Alternatives III and IV, there is greater uncertainty for predicting long-term impacts because of the natural physical processes like erosion that can undermine the integrity of waste containment without institutional control. Since the erosion rate is variable depending on natural phenomena (e.g., precipitation, soil type), the time that it could take for waste to be threatened by erosion is uncertain. Hence, the amount of radioactive decay and the magnitude of the radiological impacts are uncertain. The future use of the Center and the ability to restrict access to contaminated facilities and buried waste on the Project Premises and the SDA would be most uncertain under Alternative V.

5.7 CUMULATIVE IMPACTS

A cumulative impact on the environment results from the incremental impact of an action when added to other past, present, and reasonably foreseeable actions. These other actions include other DOE and NYSERDA projects at the Center unrelated to the completion of the WVDP and closure or long-term management of the Center as well as projects proposed by other government agencies, private businesses, or individuals. This type of an assessment is important because significant cumulative impacts can result from several smaller actions that by themselves do not have significant impacts.

The Center is located in a rural area with no other major industrial or commercial centers surrounding it. No other planned activities at the Center other than completing the WVDP and closure or long-term management of the facilities would contribute to site cumulative impacts; therefore, no cumulative impacts could be identified.

As shown in the impact analysis in this chapter, the principal geographic regions and populations that could be affected by implementing one of the five alternatives are either on or very near the Center. For some of the alternatives, there would also be transportation impacts to the population along routes to off-site waste disposal sites. For the regional population, the magnitude of the impacts from releases to the environment decreases very rapidly with distance from the Center.

Projects that were assessed to determine the potential cumulative impact fall into three broad operational categories. The first category assessed past operations that affected the population or areas that might be affected by the alternatives being considered in this EIS. These operations would include past NFS fuel processing and radioactive waste disposal operations and past WVDP activities. Because the immediate vicinity of the Center is largely rural, a low population area with little industry, and no other nuclear activities, no other operations were assessed.

The second category assessed is any current and near-term operations (until approximately the year 2000). The principal operation assessed for its cumulative effect is the WVDP HLW solidification currently in progress.

The third category assessed the potential impacts from other reasonably foreseeable actions that could have a cumulative impact. The only identified project that might affect the same population and area is the proposed widening for U.S. Highway 219, located approximately 0.8 km (0.5 mi) west of the Center boundary and 1.6 km (1 mi) west of the Project Premises boundary.

Future WVDP-specific or Center-specific activities were also evaluated. No other DOE or NYSERDA projects were identified for the same period being evaluated in the EIS that would substantially increase or decrease the impacts projected for the alternatives.

The Center has been proposed as a potential location for a new LLW disposal facility for the State of New York. Current New York State law explicitly forbids siting of a new LLW disposal facility at the Center. While this future activity may not be purely speculative, it is not considered a reasonably foreseeable action and is not considered further in the EIS.

The potential incremental impacts of the alternatives coupled with other past, present, and reasonably foreseeable future actions are discussed in the following sections.

5.7.1 Cumulative Local and Regional Radiological Impacts

Past Operations. Past fuel processing and radioactive waste disposal operations on the Project Premises and the SDA area have resulted in airborne and liquid releases, some soil and groundwater contamination, limited sediment contamination in the creeks, and some detectable contamination off site, principally the cesium prong and localized contamination in Cattaraugus Creek. This existing contamination has been investigated and is discussed in Appendix C and Section 4.10.

Past airborne releases of radionuclides to the environment occurred mainly during operation of the reprocessing plant from 1966 to 1972, during which a total of approximately

2.2 Ci of fission product particulates cesium-137, krypton-85, and limited amounts of iodine-131 were released (JAI 1980).

The net impact of these past releases to the environment were estimated in terms of collective radiological dose to the regional population near the Center. This dose from past operations was estimated to be approximately 13 person-rem. Among the potentially affected population near the Center, this dose corresponds to an increase of approximately 0.007 latent cancer fatalities.

Past operations also resulted in occupational radiological exposure. During the reprocessing operations, the estimated cumulative exposure to the work force was 4,206 person-rem (JAI 1980). Among that work force, this dose corresponds to an increase of approximately 1.7 additional latent cancer fatalities.

Current Operations. The main environmental impact of current operations are radiological exposures to the Center work force with very limited radiological or hazardous chemical releases to the environment. These impacts are routinely monitored and reported in the annual environmental monitoring reports.

Potential impacts resulting from the WVDP HLW solidification were projected in the EIS for HLW vitrification (DOE 1982). The WVDP HLW solidification phase was estimated to result in approximately 1,800 person-rem to the work force and in 340 person-rem from short-term (100-year) impacts to the general population. By subtracting the post-2000 transportation impact estimates from these values, the WVDP HLW solidification phase is estimated to result in 1,590 person-rem for workers and 50 person-rem for the general population. These estimates are the expected principal radiological impacts from overall operations between 1982 and 2000.

Among the work force, this exposure corresponds to approximately 0.64 additional latent cancers from the WVDP HLW solidification phase activities. Among the potentially affected population near the site, the dose corresponds to an increase of approximately 0.025 latent cancer fatalities because of the current and near-term releases.

Reasonably Foreseeable Actions. The cumulative radiological impacts of the alternatives coupled with past and present activities are summarized in Table 5-43. The principal impacts of concern are the radiological impacts to the workers and the general population near the Center. Consistent with prior analysis of generic low-level waste disposal facilities (NRC 1982b), impacts of off-site disposal of project waste are expected to be small. A small fraction of the Center-related radiological impacts to the nearby general population would be from the radioactive waste shipments. The activities discussed in this EIS are expected to encompass reasonably foreseeable activities at the Center with potential for radiological impacts.

Table 5-43. Cumulative Nearby Impacts (Latent Cancer Fatalities)

	Work Force Impacts	Nearby General Population
Past Fuel Processing Operations	1.7	0.007
WVDP HLW Solidification Activities	0.64	0.025
<u>Alternatives Under Consideration in this EIS</u>		
I—Removal		
— Implementation Phase[a]	0.5	0.06
— Post-Implementation Phase[b]	0	0
II—On-Premises Storage		
— Implementation Phase[a]	0.5	0.06
— Post-Implementation Phase[b]	0	0
III—In-Place Stabilization		
— Implementation Phase[a]	0.05	0.02
— Post-Implementation Phase[b]	0	0.8
IV—No Action: Monitoring and Maintenance		
— Implementation Phase[a]	0.005	0.001
— Post-Implementation Phase[b]	0	0.003
V—Discontinue Operations		
— Post-Implementation Phase[a]	0	13

a. Impacts are integrated over implementation period.
b. Impacts are integrated over 70 years following completion of implementation phase.

5.7.2 Cumulative Transportation Impacts

The shipping of radioactive and industrial wastes from the Center would affect hundreds of thousands of people nationwide located along the highway and rail corridors between the Center and the off-site disposal facilities. These impacts include the direct effect of radiation exposure to people using, working, and residing along the selected corridors, measured in latent cancer fatalities, and traffic accident and urban air pollution-related fatalities from the shipments of radioactive and industrial waste.

Under Alternative I, the estimated impacts with truck shipment are 5.9 latent cancer fatalities from the radioactive waste shipments and 5.1 traffic and urban air pollution-related fatalities from both radioactive and industrial waste shipments. For Alternative II, the industrial waste shipments are estimated to result in 1.3 fatalities along the transportation corridors. For Alternative III, the estimated impacts with truck shipment are 0.38 latent cancer fatalities from the radioactive waste shipments and 0.86 traffic and urban air pollution-related fatalities from the radioactive and industrial waste shipments.

Transportation workers and the general public using, working, and residing along the selected transportation corridor could also be affected by shipments of radioactive materials from other sites. This situation would be particularly true for individuals residing along the major interstate highways used as access routes to the waste disposal sites.

The cumulative impacts from both the Center waste shipments and these other waste (particularly radioactive waste) shipments is uncertain and difficult to estimate. As a part of a programmatic EIS on the shipment of spent nuclear fuel, DOE has recently evaluated the cumulative impacts of the historical, current, and reasonably foreseeable commercial and DOE shipments of radioactive materials along the major U.S. transportation corridors (DOE 1995). The total estimated number of cumulative latent cancer fatalities from these past and reasonably foreseeable shipments (from 1943 to 2035) was 130 for transportation workers and 160 for the general population (DOE 1995). For the alternatives under consideration, the cumulative (i.e., not annual) number of latent cancer fatalities estimated for 21,074 truck shipments of radioactive material from the Center under Alternative I are 0.56 for transportation workers and 5.9 for the general population. The expected number of latent cancer fatalities from shipping radioactive waste for Alternative III are less than 0.5. When the impacts from shipping radioactive waste from the Center are added to the impacts estimated by DOE, less than 131 latent cancer fatalities were estimated for transportation workers and 166 for the general population.

Transportation-related cancer fatalities from nuclear material and industrial waste would be indistinguishable from other cancer fatalities, and the transportation-related cancer fatalities would be about 0.0006 percent of the total number of cancer fatalities that occur over the same period.

5.7.3 Air Quality

Cumulative nonradiological impacts to air quality are expressed in terms of concentrations of criteria and toxic air pollutants in ambient air (i.e., public access locations such as along Rock Springs Road). Concentrations at the nearest public access using the conservative modeling approach described in Appendix K (i.e., that all actions during the implementation phase of closure occur simultaneously, when in reality they would be spread over a 30-year period) demonstrated that the concentrations of criteria pollutants and PM-10 would be less than 2 percent of the applicable standards. Even if the closure actions at the Center were to occur simultaneously with the road-widening on U.S. Highway 219, no impact on ambient air quality is expected.

5.7.4 Water Quality

Cumulative impacts to water quality would vary by alternative. Past operations at the site have resulted in some adverse impacts to groundwater quality as indicated by the groundwater plume on the north plateau and localized areas of groundwater contamination on the south plateau. This contamination could migrate off site and contribute to degradation of Franks Creek and Erdman Brook. The effects of implementing the closure alternatives would vary. For example, under Alternatives I (Removal) and II (On-Premises Storage), the contaminant source would be removed. Under the other alternatives, the contamination would remain as-is or be treated in place. Groundwater impacts, if they were to occur, would be localized in nature as the near-surface groundwater which could potentially become contaminated by release from site facilities does not have significant hydraulic communication with other aquifers. Movement of radionuclides through the near-surface groundwater to surface water could occur resulting in overall degradation of surface water quality of the receiving waters (i.e., Franks Creek, Buttermilk Creek, Cattaraugus Creek). Alternative III (In-Place Stabilization) analysis of expected conditions indicates that for all facilities other than the HLW tanks, impacts to off-site surface water would be below the EPA 4 mrem/yr drinking water limit. Under present closure design and inventory conditions, releases from the stabilized HLW tanks could potentially yield off-site doses for surface water pathways in excess of 25 mrem/yr. Under expected conditions for Alternative IV (No Action: Monitoring and Maintenance), site monitoring and maintenance activities are expected to improve groundwater and surface water quality. Under Alternative V (Discontinue Operations), abandonment of site facilities could lead to radionuclide releases producing significant adverse impacts for both on-site groundwater and off-site surface water.

5.7.5 Biotic Resources

Constructing new facilities (e.g., the container management area, retrievable storage areas, or LLW disposal facility) or implementing a global erosion control strategy would result in the disturbance of a maximum of 58 ha (145 acres) or about 4 percent of the land on the Center. Of this total, about 50 ha (125 acres) would be on the Project Premises and the SDA, an area already disturbed by construction of the former reprocessing facility. About 8.4 ha (21 acres) on the balance of the site or less than 1 percent of the acreage on the Center would be disturbed from implementing a global erosion control strategy. The loss of habitat from closure activities at the Center in conjunction with the potential road widening activities on U. S. Highway 219 could result in the cumulative loss of plant communities representative of western New York.

No rare, threatened, or endangered plant or animal species occur on the Project Premises or the SDA. However, removing the reservoir dams under Alternative I and II would destroy a State endangered plant species, Rose Pinks, thereby reducing the population of this State-listed species.

Wetlands. Implementation of the alternatives could result in either disturbing or destroying a maximum of 9.6 ha (24 acres) of wetlands on site. These wetlands are small [average size of 0.3 ha (0.8 acres)], naturally occurring, and are not critical habitat for any plant or animal species. However, their destruction would contribute to the regional loss of wetlands in western New York. There are no other planned Center actions that would result in the loss of wetlands.

5.7.6 Socioeconomics

The cumulative impact on regional employment in Cattaraugus and Erie Counties from implementing any of the alternatives would be negligible because employment at the Center represents a small fraction (about 0.2 percent) of regional employment. The Center, with its direct and indirect employment, currently provides about 7 percent of the employment in the 20-km (12-mi) primary impact area. All of the alternatives would ultimately result in a gradual decline in employment but the implementation schedule would be integrated with the completion of the WVDP HLW solidification to minimize the rate of job loss. This would allow some current employees to transition into jobs for implementing the selected alternative.

The baseline projections for employment in the primary impact area showed continued employment growth until 2010 with gradual decreases (a few tenths of a percent per year) after this time. Alternatives I, II, III, and IV involve employment reductions when the primary impact area employment is projected to be decreasing. The reductions resulting from completing the implementation of the alternatives will be of similar magnitude, therefore, the combined effect could result in annual decreases in employment of about 1 percent as the implementation is completed.

5.7.7 Cultural Resources

No known cultural resources would be disturbed by implementing any of the closure alternatives because the implementation phase actions would mostly occur on the Project Premises and the SDA in areas that were previously disturbed. Although some actions have the potential for prehistoric archaeologic resources as described in Section 4.9, cultural material was not found in walkover surveys and shovel tests in some of these areas. However, there could be a possible net loss of cultural resources from activities along creeks, since they have a greater potential for cultural resources, but these impacts would be mitigated as described in Section 5.10.

5.7.8 Land Use

Implementing some of the alternatives could release all or parts of the Center to allow unrestricted use. The Center is in a rural area where the demand for land for development is low. The maximum acreage that would be disturbed under any of the alternatives is about 80 ha (200 acres) or about 6 percent of the total Center area, and most of the disturbance would be in the industrialized Project Premises and SDA area. A maximum of about 28 ha (69 acres) of undisturbed area could be affected by implementing Alternatives I and II, or about 2.0 percent of the total Center area. Under Alternatives II, III, and IV the land would be irreversibly and irretrievably committed in areas maintained for waste storage (Alternative II); for waste disposal, and erosion control (Alternative III); and for monitoring and maintenance of the Center (Alternative IV). Under Alternative V (Discontinue Operations) areas of contaminated soil, sediment, and groundwater would be irreversibly and irretrievably committed.

5.8 ENVIRONMENTAL JUSTICE

In February 1994, Executive Order 12898, titled *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* [59 FR 7629-7633 (FR 1994)], was released to Federal agencies. This Order directs Federal agencies to incorporate environmental justice as part of their missions. As such, Federal agencies are specifically directed to identify and address as appropriate disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations. In addition to describing environmental justice goals, the Order directs the Administrator of the EPA to convene an interagency Federal Working Group on Environmental Justice. The Working Group is directed to provide guidance to Federal agencies on criteria for identifying disproportionately high and adverse human health or environmental effects on minority populations and low-income populations. The Working Group is also directed to coordinate with each Federal agency to develop an environmental justice strategy, if a strategy is required by the proposed activities. At the time of this analysis, the Working Group had not issued final guidance on the approach to be used in analyzing environmental justice, as directed by the Order. The Working Group has issued draft definitions of terms in the Draft Guidance for Federal Agencies on Terms in Executive Order 12898, dated November 28, 1994. These definitions, with slight modifications, were used in the following analysis. Further, in accordance with the Working Group, DOE is developing internal guidance for the implementation of the Order, which has not yet been adopted. Because both DOE and the Working Group are still in the process of developing guidance, the approach used in this analysis might depart somewhat from whatever guidance is eventually issued.

This section provides an assessment of the potential for disproportionately high and adverse human health or environmental effects of completing the WVDP on minority and low-income populations that ware within areas surrounding the Center, including potential adverse impacts from on-site activities during WVDP completion and from the transportation of waste.

5.8.1 Description of the Assessment Areas

Demographic information obtained from the U. S. Census Bureau was used to identify the minority populations and low-income communities in two zones of potential impact surrounding the Center. The outer zone is within the ROI, a circle that has an 80-km (50-mi) radius from the Center. This radius is consistent with that used to evaluate the collective dose for human health effects, air impact modeling, and socioeconomic impacts and is judged to encompass all of the impacts that may occur. The inner zone evaluated is within the primary impact area, a circle with a 20-km (12-mi) radius from the Center. This radius is consistent with that used to assess the socioeconomic impacts closer to the site, where secondary effects from implementing the alternatives are expected to be more pronounced.

Demographic maps were prepared using 1990 census data available from the U. S. Bureau of the Census. Figures 5-12 and 5-13 illustrate census tract distributions for both minority populations and low-income populations for the ROI and the primary impact area.

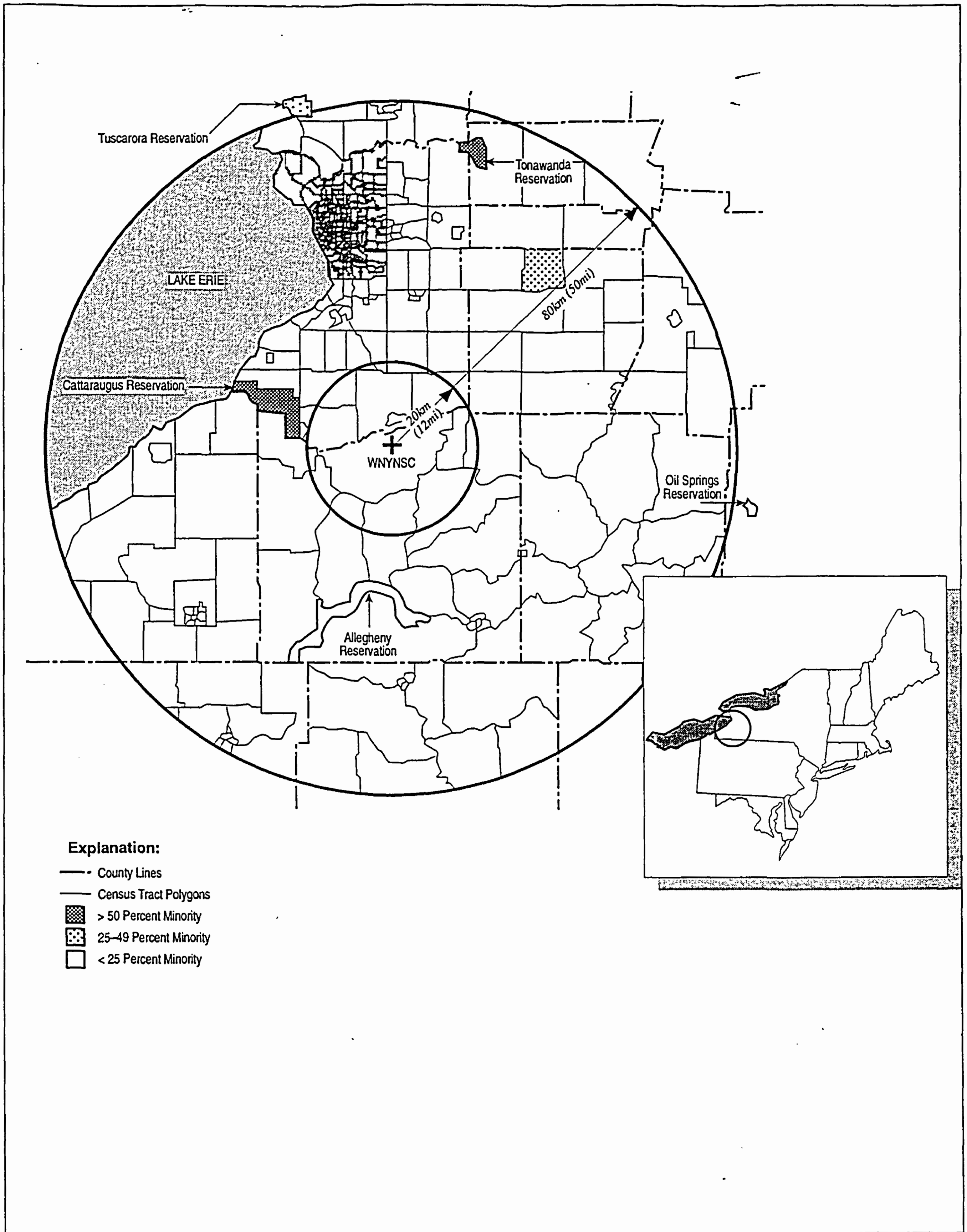

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Figure 5-12. Minority Population Distribution within 80 km (50 mi) of the Western New York Nuclear Service Center.

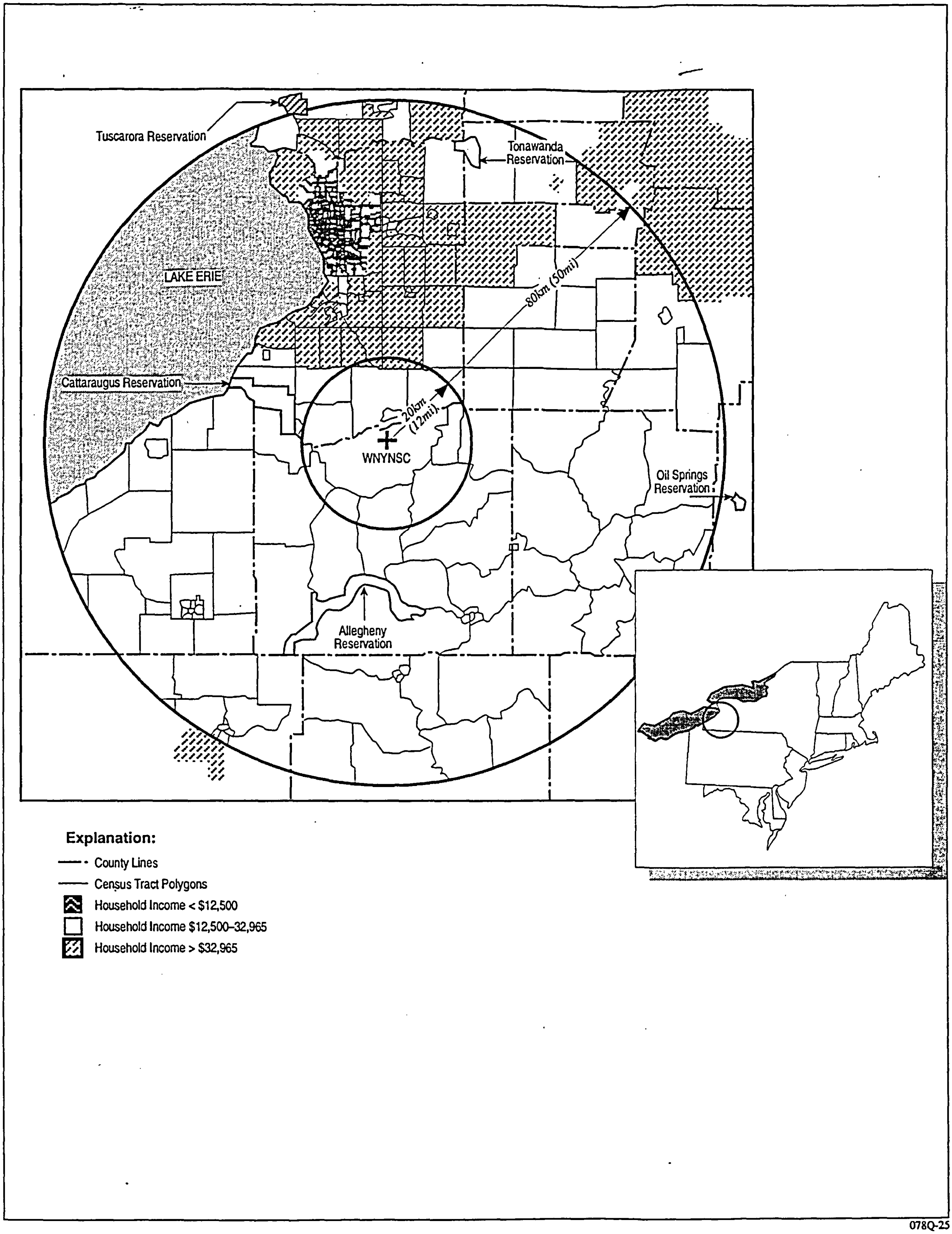

Figure 5-13. Low Income Population Distribution within 80 km (50 mi) of the Western New York Nuclear Service Center.

These maps are based on an analysis of 1990 U. S. Bureau of the Census Tiger Line files, which contain political boundaries and geographical features, and Summary Tape Files 3A (as processed by the U. S. Environmental Protection Agency), which contain demographic information. Data were resolved to the census tract group level.

The region of influence [80-km (50-mi)] or the primary impact area [20-km (12-mi)] radius is shown on the maps, defining the zones of potential impact. As discussed above, these zones of potential impact for minority and low-income populations are the same as those used for analyses included in the EIS. This circle has been indexed to the Center.

The minority and low-income population characteristics within the 80-km (50-mi) ROI and the 20-km (12-mi) primary impact area are shown on Tables 5-44 and 5-45. Table 5-44 lists the number of minority individuals within these two areas and Table 5-45 lists the number of low-income individuals living in the two areas.

The minority population within the 80-km (50-mi) ROI accounts for 14 percent of the total population in the area or about 200,000 people. The racial and ethnic composition of this population is predominantly African-American and Hispanic. American Indians account for less than 1 percent of the total population in the region of influence or 7,369 people. The racial and ethnic composition of the population within the primary impact area is predominantly white (98.9 percent). The minority population residing in the primary impact area is also predominantly African-American and Hispanic.

The low-income population characteristics within the ROI are summarized in Table 5-45. The spatial distribution by census tract of low-income individuals residing within the ROI is shown in Figure 5-13. The census tracts have been shaded according to the percentage of low-income population within the area. This figure indicates there is no low-income population within the ROI at the census tract level; however, Table 5-45 shows about 13 percent of the population in the ROI are low-income households if the data are compiled by zip code.

5.8.2 Environmental Justice Assessment

Analysis of environmental justice concerns was based on an assessment of the impacts reported in Sections 5.2 through 5.6. This analysis was performed to identify any disproportionately high and adverse human health or environmental impacts on minority populations or low-income populations surrounding the Center. The following definitions were used for this analysis:

Disproportionately high and adverse human health effects: Adverse health effects are measured in risks and rates that could result in latent cancer fatalities, as well as other fatal or nonfatal adverse impacts to human health. Disproportionately high and adverse human health effects occur when the risk or rate for a minority population or low-income population from exposure to an environmental hazard significantly exceeds the risk or rate to the general population and, where available, to another appropriate comparison group (DOE 1995).

Table 5-44. Minority Individuals Residing Near the Western New York Nuclear Service Center, 1990

Area	Number of Block Groups Considered	Individuals Residing Within Area	Minority Individuals Within Area	Percent of Individuals that are Minority[a]
Region of Influence [80 km (50 mi)]	1,586	1,573,847	198,185	13
Primary Impact Area [20 km (12 mi)]	27	29,723	451	1.5

a. For comparison purposes, the percent of minority individuals in the State of New York is 38 percent.

Table 5-45. Low-Income Households Near the Western New York Service Center, 1993[a]

Area	Households Within Area	Low Income Households Within Area	Percent of Households that are Low Income
Region of Influence [80 km (50 mi)]	907,617	119,310.1	13.15
Primary Impact Area [20 km (12 mi)]	15,292	1,487.9	9.73

a. Low income households include poverty families [family of four with an income of less than $12,670 in 1989 (DOC 1994b) and non-family households.

Source: CACI (1993)

Disproportionately high and adverse environmental impacts: An adverse environmental impact is a deleterious environmental impact determined to be unacceptable or above generally accepted norms. A disproportionately high impact refers to an impact (or risk of an impact) in a low-income or minority community that significantly exceeds that on the larger community. In assessing cultural and aesthetic environmental impacts, impacts that uniquely affect geographically dislocated or dispersed low-income or minority populations were considered (DOE 1995).

The human health effects and environmental impacts associated with the closure alternatives were reviewed to identify potential impacts on air resources, biotic resources, water resources, socioeconomics, land use, cultural resources, implementation phase actions, and transportation. With regard to health effects, both incident-free and accident conditions were examined, with accident scenarios evaluated in terms of the risk to the public. Special exposure pathways were evaluated with respect to subsistence consumption of fish, game, or native plants since the Cattaraugus Reservation of the Seneca Nation of Indians is located 24 km (15 mi) downstream of the Center on Cattaraugus Creek.

This EIS considers the impacts from the implementation phase and post-implementation phase of closure. Both incident-free operations and accidents during the implementation phase were considered. Transportation corridors associated with shipment of the waste off site were also evaluated in the ROI.

Off-site health effect impacts from implementation phase actions and accidents are propagated by different pathways such as meteorological conditions and surface water and groundwater pathways. Impacts from incident-free implementation phase actions would be dominated by the prevailing pattern in these pathways. Impacts from an accident, should one occur, would be random based on the meteorological conditions at the time.

5.8.2.1 Incident-Free Impacts during the Implementation Phase

The expected impacts during the implementation phase are a result of controlled release of treated effluents to the atmosphere and direct radiation from trucks or trains transporting radioactive waste to off-site disposal facilities. Potential impacts to a maximally exposed individual and the surrounding population from atmospheric releases were summarized by alternative in earlier sections of this chapter. Potential impacts to a resident of the Cattaraugus Reservation of the Seneca Nation of Indians are estimated to be a factor of 100 less than those projected for the maximally exposed individual. The maximum annual dose for the maximally exposed off-site, non-Seneca individual would be approximately 3.6 mrem (for emissions from the SDA under Alternatives IIIA and IIIB). Maximum annual dose for the Seneca Indian resident would be approximately 0.03 mrem, or 0.01 percent of natural background radiation. In addition, the atmospheric release impacts to the west, in the direction of the Cattaraugus Reservation, are on the average lower than those of the other 15 compass directions. Potential doses from transportation are also expected to be low because residences are not immediately adjacent to Interstate Highway 90 and the highway passes through the narrowest portion of the reservation. Transportation routes would be selected in accordance with federal guidance intended to minimize potential impacts. Thus, potential impacts to a resident of the Cattaraugus Reservation during the implementation phase would neither be large nor disproportionate.

5.8.2.2 Reasonably Foreseeable Accidents

Impacts from reasonably foreseeable accidents are predominantly from airborne releases. The concentrations of airborne radionuclides, and therefore potential doses, decrease rapidly with distance from the release point because of atmospheric dispersion. Therefore, it follows that the effects of any reasonably foreseeable accidents under normal meteorological conditions would also decrease rapidly with distance from the accident site. Table K-3 (Appendix K) shows that at the edge of the primary impact area, 20 km (12 mi) from the center of the Project Premises and SDA, the concentration of materials released to the atmosphere would be less than 1 percent of their maximum concentration at the boundary of the Project Premises. Therefore, even for those low probability accidents with high potential consequences at the boundary of the Project Premises, no high and adverse impact is expected to either a member of the general public in the vicinity or the Cattaraugus Reservation or a Seneca Indian resident of the Reservation.

This pronounced decrease in airborne concentrations of materials released during a potential accident at the Center indicates that the effects would be very localized, with the highest impacts near the accident and very low impacts further away. Therefore, the highest impacts would be expected in the primary impact area, along Rock Springs Road under normal meteorological conditions.

5.8.2.3 Transportation

The impacts from transportation for each of the alternatives is principally from commuter traffic on roads to the Center. The incremental increase from truck traffic carrying deliveries, shipping waste off site, and delivering construction materials such as concrete was determined to be small relative to the commuter traffic.

Alternatives I, II, IIIA, and IIIB maintain road use at levels approximately consistent with current use during the first few years of the implementation phase. Road use would decline at the end of the implementation phase. None of the alternatives would be expected to increase traffic counts on local roads within the primary impact area or within the 80-km (50-mi) study area.

Within the ROI, for the majority of the distance traveled, off-site waste shipments would be made along routes that include the better roads leading to the Interstate highways. To the extent practicable, the local routes would be chosen to avoid highly populated areas. Because the actual radioactive and industrial waste disposal sites are unknown, the actual route that would be used to ship waste within the ROI is also unknown. For the purposes of analysis, a highway route for shipping radioactive waste between the Center and potential disposal sites in Washington (the Hanford Site) and Nevada were selected. The analyzed route included County Road 85, U.S. Highway 219, State Road 391, and Interstate-90 (Interstate 90 crosses the Cattaraugus Reservation of the Seneca Nation of Indians at the Erie and Chautauqua County border). Other routes within the ROI could also be used to reach the Interstate highway system. The impacts from shipping waste primarily would be to other users of the road and, to a lesser extent, to residents along the transportation routes. The impacts from an accident along any one segment of these roads would not be high and adverse.

In addition, there is no potential for disproportionate impacts because, to the extent discernible, the fraction of the populations along these corridors that are minority and low-income reflect the overall makeup of the region.

5.8.2.4 Subsistence Consumption of Fish, Wildlife, or Native Plants

Consumption of food and water is the major source of exposure to potentially hazardous substances for U.S. residents. These pathways are also expected to be the primary routes through which a resident of the Cattaraugus Reservation of the Seneca Nation could be exposed to long-term releases from the Center. Under Alternatives III, IV, and V, groundwater could transport dissolved radionuclides to Cattaraugus Creek, contaminating fish, drinking water, and crop irrigation water used by a resident. While there is no known use of Cattaraugus Creek as a drinking water supply and DOE has no information on fish consumption patterns for the Seneca Nation [although the Seneca Nation has informed DOE of its concern for contamination of traditional fishing areas (Seneca Nation of Indians 1993)], to provide a conservative estimate of potential impacts on a Seneca Nation resident of the Cattaraugus Reservation and a non-Seneca resident along Cattaraugus Creek, both residents were assumed to obtain fish, drinking water, and irrigation water from the Creek. Irrigation water was assumed to be used to grow crops for personal and livestock consumption. Food, poultry, and livestock consumption rates used in the analysis were those recommended by the NRC for residential agriculture exposure scenarios (NRC 1994).

The major difference between the two assumed residents was fish consumption. A fish consumption rate of 50 kg/yr (110 lb/yr) was assumed for the Seneca Nation resident. Studies have indicated that Native Americans derive larger fractions of their diet from subsistence sources (e.g., fishing, hunting, home grown produce and livestock) than other Americans. For example, studies of the Mohawk Indians of New York reported that 50 percent of Mohawk adults consumed more than 11 kg/yr of locally caught fish while only 5 percent of Mohawk adults consumed more than 50 kg/yr (110 lb/yr) of locally caught fish (Forti 1993). The assumed rate is also consistent with EPA guidance on fish intake for subsistence consumption (EPA 1991). Studies of the general U.S. population report fish consumption rates lower by a factor of approximately ten (Ruffle 1994); the fish consumption rate assumed for the non-Seneca resident along Cattaraugus Creek was correspondingly lower.

Under Alternatives I and II, all waste inventories would be exhumed and either transported off site or stored on premises in secure, maintained facilities. Thus, under expected conditions, no impacts from groundwater or surface water were projected for off-site residents, including the Seneca Nation resident and the non-Seneca resident along Cattaraugus Creek. Under Alternative III, waste inventories would be stabilized on premises and leaching of radionuclides into groundwater could occur. The impacts from possible leaching are analyzed on a facility-by-facility basis in Section 5.4.2. The results indicate that, for failure of all facilities other than the HLW tanks, impacts for the Seneca Nation resident in the year of maximum impact would be approximately 2.2 mrem, corresponding to an annual risk of a latent cancer fatality of 1.1×10^{-6}. Analysis of failure of the HLW tanks, however, estimated a maximum annual dose of 126 mrem for the Seneca Nation resident, with a corresponding annual risk of latent cancer fatality of 6.3×10^{-5}. The corresponding dose to the non-Seneca resident along Cattaraugus Creek was estimated as 72 mrem with an annual risk of a latent cancer fatality of 3.6×10^{-5}. Possible mitigation measures for the HLW tanks are presented in Section 5.10.

Because DOE does not have adequate information on Seneca Nation fish consumption rates, DOE cannot determine whether impacts to the Seneca Nation from fish consumption are disproportionately high and adverse. DOE is consulting with the Seneca Nation on this issue. The final EIS will include results of that consultation and any conclusion that DOE has reached based on the Seneca Nation-specific information.

5.8.2.5 Other Environmental Impacts

No significant adverse impacts to biotic resources, air resources, socioeconomics, land use, or cultural resources were identified in Chapter 5. Therefore, no disproportionately high and adverse impacts were identified for any segment of the population.

None of the alternatives would have a significant adverse impact on the previously mentioned resources because under all of the alternatives a limited amount of previously undisturbed land would be used on site and off site. Communications with the Seneca Nation of Indians have increased DOE's awareness of Tribal interests.

Cumulative Impacts

Based on the analysis of the environmental impacts evaluated in this EIS, along with the impact of other past, present, and reasonably foreseeable future activities, no reasonably foreseeable cumulative adverse impacts are expected to the surrounding minority and low-income populations. Because DOE does not have adequate information on the Seneca lifestyle (particularly fish consumption) it cannot be determined whether impacts to the Seneca are disproportionately high and adverse.

5.9 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

This section evaluates the extent to which each alternative would cause a loss of nonrenewable resources. An irreversible resource commitment results from the use or destruction of a specific resource that cannot be replaced within a reasonable period, like materials or labor. An irretrievable commitment occurs if a resource is consumed that cannot be replaced in any period of time. Implementation of the alternatives would cause some irreversible and irretrievable resource commitments of labor, energy, and materials needed during the implementation phase (relatively little commitment of resources would be expected in the long-term post-implementation phase, and they are not quantified here). Most notably, these resource commitments would concern materials needed to construct the new storage or disposal facilities as well as the energy required to construct the new facilities, demolish existing facilities, or exhume wastes. The resource commitments for each alternative are shown in Table 5-46.

Total electrical energy, natural gas, steel, and labor use would be greatest under Alternative II because the Center would be remediated to levels allowing unrestricted use and the retrievable storage areas would be constructed and filled. Total diesel and gasoline use would be greatest under Alternative IIIB because of the earthmoving associated with the global erosion control strategy. Total sand and gravel, concrete, and clay use would be greatest under Alternative IIIA because of backfilling and capping activities at the process building.

Land irreversibly committed would vary based on the alternative selected in the Record of Decision. The land irreversibly committed would be greatest under Alternative IV because the Center would be retained [1,350 ha (3,340 acres)], monitored, and maintained. There would be no land irreversibly committed under Alternative I because the Center would be remediated to levels allowing release for unrestricted use. For Alternative II and Alternative III about 332 ha (830 acres) and 352 ha (880 acres) would be irreversibly committed, respectively, or about 10 percent of the area on the Center. Under Alternative V, no institutional controls would be in place to prevent the use of contaminated land and buildings. The land irreversibly committed under Alternative V would consist of 47 ha (115 acres) of contaminated surface soil and sediment that potentially could not be renewed or replaced.

5.10 UNAVOIDABLE ADVERSE IMPACTS AND MITIGATIVE MEASURES

This section summarizes unavoidable impacts and mitigation measures that would be implemented to control or reduce impacts to the environment. Mitigation measures would generally be the same for all alternatives and are summarized by impact area. Although the environmental effects described in Chapter 5 may not require mitigation, the range of potential mitigation actions is described.

In addition to the mitigative measures described for each impact area, the analysis indicates the potential for mitigating impacts by modifying the details of the conceptual engineering designs. In particular, Alternatives IIIA and IIIB could be modified to change the design details for the stabilization of the HLW tanks and the process building. In particular, the long-term impacts from these alternatives could be lowered by reducing the residual sludge in the HLW tanks below the 3 percent assumed in the current conceptual designs. Additives that retard the leaching of radionuclides in cement could be used to solidify the waste in the HLW tanks and the process building.

Table 5-46. Irreversible and Irretrievable Commitment of Resources for Alternatives I through V[a]

Resource	Quantity by Alternative									
		II On-Premises Storage		IIIA In-Place Stabilization (Backfill)		IIIB In-Place Stabilization (Rubble)		IV No Action: Monitoring and Maintenance		V[b]
	I Removal	Initial Quantity	Annual	Initial Quantity	Annual	Initial Quantity	Annual	Initial Quantity[c]	Annual	Discontinue Operations
Electrical energy (MW-hr)	6.5×10^4	1.8×10^5	2,800	7.1×10^3	Negligible	9.9×10^4	Negligible	18	87	NA[g]
Natural gas (ft^3)[d]	2.7×10^8	8.7×10^8	5.4×10^6	4.7×10^7	Negligible	1.9×10^8	Negligible	2.4×10^6	3.1×10^6	NA
Diesel and gasoline fuel (gal)[d]	1.9×10^6	2.5×10^6	0	1.3×10^6[e] or 3.1×10^6[f]	Negligible	2.1×10^6[e] or 4.1×10^6[f]	Negligible	8.8×10^4	5,100	NA
Concrete (yd^3)[d]	4.2×10^4	2.0×10^5	0	1.2×10^5	0	1.3×10^5	0	4,600	0	NA
Steel (tons)	2,500	2,700	0	19	0	140	0	19	0	NA
Labor (person-yr)	1.4×10^4	1.9×10^4	31	2,100[e] or 2,600[f]	48	5,600[e] or 6,200[f]	48	130	200	NA
Soil (m^3)[d]	4.5×10^5	3.0×10^5	0	1.2×10^5	0	NA	0	0	NA	NA
Sand and gravel (m^3)[d]	1,900	2.9×10^4	0	1.0×10^5	0	NA	0	2.8×10^4	NA	NA
Clay (m^3)[d]	0	0	0	1.1×10^5	0	1.1×10^5	0	8,400	NA	NA
Land (ha)[d]	0	340	0	350	0	350	0	1,350	NA	47

a. All values have been rounded to two significant figures.
b. Since the site is abandoned under Alternative V, irreversible and irretrievable commitments of these resources would not occur except for land. About 46 ha (115 acres) of land would be committed because of soil, sediment, and groundwater contamination on the Project Premises and SDA.
c. Resource requirements for closing LLWTF lagoons, stabilizing gullies near the SDA, exhuming the sludge ponds, and constructing the wastewater treatment area.
d. To convert cubic feet to cubic meters, multiply by 0.02832. To convert gallons to liters, multiply by 3.785.
e. Assumes a local erosion control strategy would be selected.
f. Assumes a global erosion control strategy would be selected.
g. NA = not applicable.

Sources: WVNS (1994a through n, and q)

5.10.1 Pollution Prevention

The implementation actions under the alternatives would generate waste with the potential for releases to air and water. To control the volume of waste generated and to reduce impacts on the environment, pollution prevention practices would be implemented. DOE is responding to Executive Order 12856 ("Federal Compliance with Right to Know Laws and Pollution Prevention Requirements") and associated DOE Orders and guidelines by reducing the use of toxic chemicals; improving emergency planning, response, and accident notification; and encouraging the development and use of clean technologies.

The WVDP has implemented a pollution prevention program that includes waste stream minimization, source reduction and recycling, procurement processes that preferentially procure products made from recycled materials, inventory management, and technology transfer with other interagency working groups that have waste minimization as part of their charter (WVNS 1995). The pollution prevention practices that have been started during HLW solidification will be continued throughout decontaminating and decommissioning of the WVDP.

5.10.2 Air Quality

During implementation of Alternatives I, II, and III, increased amounts of dust (particulates) would be generated from digging and hauling, but these would be generated for a short duration. Conventional engineering practices would be used to control the release of particulate matter. Exhumation of the disposal areas would be conducted under an inflatable structure so that releases to the atmosphere would be filtered. Roads and construction sites would be periodically wet down to reduce wind erosion and soil disruption from heavy equipment operations. Contaminated soil would be transported in covered trucks to reduce or prevent spillage and wind erosion during transport.

5.10.3 Water Quality

Unavoidable impacts to surface water and groundwater would occur under Alternatives I, II, III, and IV. These impacts include increased runoff to surface water, downstream sedimentation, and disruption of hydraulic properties for both surface and subsurface flow.

Under Alternatives I and II, contaminated soil, facilities, and structures would be excavated and removed. Standard erosion control practices would be used during the implementation phase to mitigate surface runoff and erosion, including constructing sediment traps and retention basins, avoiding excavation work during wet weather, and covering soil piles. These measures would reduce, but not completely eliminate surface runoff, and some sedimentation of creeks would be unavoidable. After each area was excavated, the ground surface would be regraded and revegetated.

Excavation of areas on the Project Premises and the SDA would change the water table elevation, groundwater flow pathways, and near-surface porosity and permeability.

Regrading the surface would reduce the amount of topographic relief. Although not adverse, the unavoidable impact would be to decrease the velocity of surface runoff to brooks and creeks, thus, affect the rate of erosion and development of gullies.

Similarly, under Alternative III, existing facilities and contaminated areas would be stabilized in place, a LLW disposal facility would be constructed (Alternative IIIB only), and a local or global erosion control plan would be implemented. Surface water control measures would be used to mitigate surface runoff and erosion during stabilization and construction activities. As noted above, some sedimentation of creeks and surface erosion would be unavoidable.

Demolished facilities, disposal areas, and contaminated soil areas would be stabilized by installing impermeable caps, slurry walls, or other engineered structures to minimize water infiltration through these areas. An unavoidable impact of these stabilizing activities would be to alter groundwater flow.

The global erosion control plan reroutes portions of surface water runoff from Franks Creek and Erdman Brook to the northern reservoir and subsequently to Buttermilk Creek (see Section 3.5.2.3.2), thus, moving the point of entry of this flow volume in Buttermilk Creek upstream of the Franks Creek confluence. An unavoidable impact of this plan may be an unquantified increase in the rate of stream downcutting and valley-widening along this segment of Buttermilk Creek.

5.10.4 Biotic Resources

Unavoidable impacts to biotic resources from implementing Alternatives I, II, and III would include loss of vegetation, loss of aquatic habitat, and displacement and death of small animals on the Project Premises and on the balance of site.

On the Project Premises, excavation and construction activities would displace or kill animals living in the developed areas under Alternatives I, II, and III. Construction of the retrievable storage areas (Alternative II) or LLW disposal facility modules (Alternative III) would cause a permanent loss of land. Under Alternatives III, 1.9 ha (4.7 acres) of wetlands on the Project Premises could be disturbed.

In addition to wetland loss under the global erosion control plan, unavoidable loss of established aquatic and terrestrial habitat could occur if 1,907 m (6,255 ft) of Erdman Brook and 466 m (1,530 ft) of Franks Creek valleys were filled—disturbing an 18-ha (45-acre) area. The valley walls of Franks Creek are largely forested; the Erdman Brook drainage consists mainly of wetlands. Mitigation measures could include restoring habitat by reseeding and revegetating filled valley areas with native plants and trees and reestablishing wetlands on the filled valleys or elsewhere on site. Specific mitigation measures would be developed in consultation with the COE and NYSDEC as appropriate.

On the balance of the site, excavation of the cesium prong area north of Quarry Creek would cause an unavoidable loss of vegetation and top soil under Alternatives I and II.

On the balance of the site, excavation of the cesium prong area north of Quarry Creek would cause an unavoidable loss of vegetation and top soil under Alternatives I and II. Animals living in this area would temporarily lose their habitat, be displaced, or killed. Mitigation measures could include restoring the topsoil, then reseeding the area with native plants and trees. Removal of the north and south reservoir dams would cause an unavoidable loss of aquatic habitat under Alternatives I and II. Consultation with the Fish and Wildlife Service as appropriate under the Fish and Wildlife Coordination Act would be used to minimize the impacts to biota prior to dam removal and draining of the reservoirs. Under Alternative III, global erosion controls on the balance of the site would cause unavoidable destruction of terrestrial habitat and including 3.6 ha (9 acres) of wetlands in the area of the diversion channel, and 6.4 ha (16 acres) of wetlands near Franks Creek. As on the Project Premises, mitigation measures for the wetlands could include restoring habitat and reestablishing wetlands elsewhere on the site. The mitigation measures would be developed in consultation with the COE and NYSDEC as appropriate.

5.10.5 Cultural Resources

Impacts to cultural resources would generally occur during construction and earthmoving activities required for the closure alternatives. Areas of proposed ground disturbance would be assessed for the potential to contain important archaeological resources. Mitigation measures would be defined in consultation with the SHPO, Advisory Council for Historic Preservation, and the Seneca Nation of Indians. An example of a mitigation measure for archaeological resources would be avoidance or data recovery before construction.

Although most of the activities would occur on the Project Premises, a highly disturbed area, some activities have been proposed in areas that have a greater potential for cultural resources. These areas would be surveyed before initiation of activities; if cultural resources were found, mitigation measures would be developed in consultation with the agencies previously identified.

5.11 RELATIONSHIP BETWEEN SHORT-TERM USE AND LONG-TERM PRODUCTIVITY

The activities under each alternative affect the availability of land resources after the implementation phase. After Alternative I is completed, the land comprising the Project Premises and SDA and the balance of the site would be available for unrestricted use. A wide range of uses would be possible, including recreation; wildlife and critical habitat preservation; oil and gas exploration and development; residential, commercial, or industrial development; agriculture; and timber harvesting. However, certain aspects of the balance of the site would no longer be available. Eliminating the north and south reservoirs by removing the earthen dams would eliminate aquatic habitat and water source for people and wildlife. The rail spur would be removed. Approximately 479,000 m^3 (16.9 million ft^3) of soil would be removed from the Project Premises by excavating contaminated soil. A maximum of 14,000 m^3 (495,000 ft^3) of top soil would be removed from the balance of the site in the cesium prong, disturbing 14 ha (34 acres) of land. Residual downstream

The impact of Alternative II would be very similar to Alternative I. However, land area [360 ha (830 acres) or about 25 percent of the total Center] would have to be reserved to allow monitoring of the retrievable storage areas, RTS drum cell, and creek channels on site.

Alternative III would stabilize contaminated soil and facilities in place, and sitewide erosion controls would be implemented. Approximately 350 ha (860 acres) or 26 percent of the land on the Center would be reserved to allow monitoring of the stabilized areas, including the area required for the LLW disposal facility under Alternative IIIB; creek channels on site; and the cesium prong on the balance of the site. Contaminated groundwater on the north plateau would be unavailable as a potential water source. The long-term productivity of 7.3 ha (18 acres) of wetlands could be disturbed or destroyed by site stabilization activities. Wetlands destroyed under this alternative could be restored, and aquatic habitat would be reestablished on the waterways engineered as part of the global erosion control plan. After the Project Premises and SDA were stabilized, the balance of the site could be made available for the uses described under Alternative I.

Under Alternative IV, site conditions would remain as they are today. The Project Premises and SDA and the balance of the site would remain controlled areas unavailable for other uses. However, control of the Center would increase long-term productivity of plants and wildlife by effectively preserving their habitat including the deer wintering ground critical habitat.

The Project Premises and SDA would not be usable after abandonment under Alternative V. Land areas occupied by the existing facilities, including contaminated structures, would not be available for home sites or agriculture, although short-term occupation of the construction trailers would be possible. Radiological contamination in soil, sediment, and groundwater could affect the long-term productivity of biological receptors (i.e., humans, plants, and wildlife located on and off the site). Eventual failure of lagoons and reservoirs would wash out nearby stream valleys and increase downstream sedimentation. Lagoon and reservoir failure would affect productivity of aquatic and riparian biota by destroying or harming wildlife and habitat in the stream valleys and be eliminating the reservoirs as aquatic habitat.

5.12 ASSESSMENT OF UNAVAILABLE INFORMATION

The EIS used the best available information to estimate environmental impacts. The impacts result from activities that disturb areas for excavation of buried waste or contaminated soil, construction of new facilities, removal of existing facilities, area stabilization, or erosion control. There is an effect from the long-term radiological impact that follows implementation of the alternatives. Conservative assumptions were made to model the hydrologic and erosion processes that were evaluated in the prediction of long-term radiological impacts. These assumptions are discussed in the various appendices to the EIS.

The disturbed area depends on the erosion control strategy selected, the soil treatment efficiency in those cases where the soil would be treated, and the volume of contaminated soil that must be removed. There is adequate information for estimating the environmental impact in the area required for the local and global erosion strategies. There is incomplete information on the efficiency of the proposed soil treatment processes. The impact from this uncertainty is discussed in sections 5.2.3 and 5.3.3, because it is specific to the alternative. These discussions also present estimates for the worst case impacts.

The contaminated soil volume potentially requiring removal will be a function of the final NRC decontamination and decommissioning criteria and NYSDEC closure requirements, which are unavailable information. The baseline analysis in the EIS assumes that free release concentrations for soil are based on a maximum dose of 15 mrem/yr which is considered a conservative assumption. It is possible that less restrictive standards could be applied to the selected alternative. A review of the data on soil contamination indicates that if a 100 mrem/yr rather than 15 mrem/yr free release concentration were applied, the soil volume to be removed would decrease by about two-thirds. An area of about 46.5 ha (115 acres) would be disturbed from excavating contaminated soil resulting in doses of 15 mrem/yr or more. It is estimated that about one third of this area, about 16 ha (40 acres), would be disturbed if a 100 mrem/yr standard were applied. The smaller area would be localized around the existing facilities. Removal of these soils would be less likely to destroy or disrupt wetland areas.

In addition to the area required for excavating contaminated soils, area is also required for new storage facilities under Alternative II and for new disposal facilities under Alternative IIIB. Under the baseline Alternative II, about one third of the storage area is allocated to soil storage. If the reduced soil volume from a 100 mrem/yr standard was subjected to soil treatment with similar volume reduction, the required storage area would decrease by about 25 percent. If soil treatment was neither efficient nor cost effective, the required area for waste storage would increase by less than 20 percent. For Alternative IIIB, about 3 percent of the LLW disposal facility is required for contaminated soil. Applying the 100 mrem/yr standard would have little impact on the area required for the LLW disposal facility because less contaminated soil would be excavated under Alternative III, compared to Alternatives I and II.

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This draft Environmental Impact Statement was prepared under the supervision of the Department of Energy and New York State Energy Research and Development Authority. The individuals who contributed to the preparation of this document are listed below. Table 6-1 summarizes, for each preparer, the sections of the draft for which inputs were prepared.

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VOLUME II

Department of Energy,
New York State Energy Research
and Development Authority

Draft Environmental Impact Statement for Completion of the West Valley Demonstration Project and Closure or Long-Term Management of Facilities at the Western New York Nuclear Service Center

January 1996

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New York State Energy Research and Development Authority

VOLUME II

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APPENDIX A

ACRONYMS, GLOSSARY, AND UNITS OF MEASUREMENT

APPENDIX A

ACRONYMS, GLOSSARY, AND UNITS OF MEASUREMENT

A.1 ACRONYMS

ACI	American Concrete Institute
AEA	Atomic Energy Act
AEC	Atomic Energy Commission
ALARA	As Low as Reasonably Achievable
CDDL	Construction and Demolition Debris Landfill
CERCLA	Comprehensive Emergency Response, Compensation, and Liability Act
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
COE	Corps of Engineers
CPC	Chemical Process Cell
CWA	Clean Water Act
DOE	U.S. Department of Energy
EA	Environmental Assessment
ECL	Environmental Conservation Law
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
FSFCA	Federal and State Facility Compliance Act
GTCC	Greater-than-Class-C Waste
HLW	High-Level (Radioactive) Waste
ICRP	International Commission on Radiological Protection
IHWMA	New York State Industrial Hazardous Waste Management Act
IWSF	Interim Waste Storage Facility
LLW	Low-Level (Radioactive) Waste
LLWTF	Low-Level Waste Treatment Facility
MCL	Maximum Contaminant Level
MOU	Memorandum of Understanding
MSU	Miscellaneous Small Units
NDA	Nuclear Regulatory Commission-Licensed Disposal Area
NEPA	National Environmental Policy Act

NESHAP	National Emission Standards for Hazardous Air Pollutants
NFS	Nuclear Fuel Services, Inc.
NOI	Notice of Intent
NOAA	National Oceanic Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NYCRR	New York Code of Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSERDA	New York State Energy Research and Development Authority
NUHOMS	Nutech Horizontal Modular System
PCB	Polychlorinated Biphenyl
PEIS	Programmatic Environmental Impact Statement
pH	Potential for Hydrogen
PM	Particulate Matter
PUREX	Plutonium Uranium Extraction
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
ROD	Record of Decision
ROI	Region of Influence
RTS	Radwaste Treatment System
SDA	New York State-Licensed Disposal Area
SEQRA	New York State Environmental Quality Review Act
SHPO	State Historic Preservation Office
SPDES	State Pollutant Discharge Elimination System
TCLP	Toxicity Characteristic Leaching Procedure
THOREX	Thorium Extraction
TRU	Transuranic Elements
USGS	U.S. Geological Survey
WMA	Waste Management Area
WNYNSC	Western New York Nuclear Service Center (referred to as Center)
WVDP	West Valley Demonstration Project
WVNS	West Valley Nuclear Services Company, Inc.

A.2. GLOSSARY

abrasion—To rub or wear off; to waste or wear away by friction, as to abrade rocks.

accident—An unplanned sequence of events that results in undesirable consequences.

actinides—A series of heavy radioactive metallic elements of increasing atomic number (Z number) beginning with actinium (89) and continuing through lawrencium (103).

activated carbon—A highly adsorbent powdered or granular carbon made usually by carbonization and chemical activation and used chiefly for purifying by adsorption.

aggregate—Hard inert materials such as sand, gravel, or slag used for mixing with a cementing material to form concrete.

air quality—A measure of the levels of constituents in the air.

air-quality standards—The legally prescribed level of constituents in the outside air that cannot be exceeded during a specified time in a specified area.

alpha-emitter—A radioactive substance that decays by releasing an alpha particle.

alpha radiation—Emission of positively charged particles made up of two neutrons and two protons by atoms undergoing radioactive decay.

alteration—A change in biological form, structure, or characteristics.

ambient air—The surrounding atmosphere, usually the outside air, as it exists around people, plants, and structures. (It is not the air in immediate proximity to emission sources.)

as low as reasonably achievable (ALARA)—A process by which a graded approach is applied to maintaining dose levels to workers and the public, and releases of radioactive materials to the environment as low as reasonably achievable.

attenuation—Becoming weak.

aquifer—A water-bearing stratum of permeable rock or soil that can transmit significant quantities of water under ordinary hydraulic gradients; the water can be pumped to the surface through a well or it can emerge naturally as a spring or outcrop.

background concentration—The level of chemical elements or radionuclides in the natural environment, found by taking measurements in areas unaffected by contamination.

background radiation—Radiation from cosmic sources; naturally occurring radioactive materials, including radon; and global fallout from the testing of nuclear explosive devices.

ballast resistor—A device used to provide the starting voltage or to stabilize the current in a circuit (as of a fluorescent lamp).

bedload—Soil, rock particles, or other debris rolled along the bottom of a stream by the moving water, as contrasted with the "silt load" carried by suspension.

beta-emitter—A radioactive substance that decays by releasing a beta particle.

beta radiation—Emission of negatively charged particles identical to an electron by atoms undergoing radioactive decay.

bioaccumulation—The accumulation or buildup of contaminants in living systems by biological processes.

biota (biotic)—The plant and animal life of a region.

borrow pit—An excavated area where material has been dug for use as fill at another location, e.g., a gravel pit.

braid—To branch and rejoin producing a netlike pattern, as with some streams.

caisson—As used in this EIS, a cylindrical, steel-lined, underground concrete vault used for storage of radioactive waste.

cask—A heavily shielded shipping container for radioactive materials.

Center—The Western New York Nuclear Service Center; the site as used in this EIS.

cesium prong—As used in this EIS, the area of surface soil contaminated by cesium-137, both on site and off site. This area resulted from abnormal releases to the atmosphere caused by reprocessing plant ventilation system failures.

characteristic hazardous waste—See ***hazardous waste***.

characterization—The determination of waste composition and properties, whether by review of process knowledge, nondestructive examination or assay, or sampling and analysis, generally done for the purpose of determining appropriate storage, treatment, handling, transport, and disposal requirements.

Climax [stage]—Relatively stable plant community that occupies an area and represents the final stage in succession.

collective dose—The overall, whole-body radiation dose to the off-site population (public) from a given event.

committed effective dose equivalent—The sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissues. The International Commission on Radiological Protection defines this as the committed effective dose.

communities—Assemblage of plants and animals (dominated by one to a few species) that live in the same environment that are mutually sustaining and interdependent.

compressive strength—The greatest longitudinal squeezing stress a substance can bear without rupturing.

concentration—The quantity of a substance in a unit quantity of a sample (e.g., milligrams per liter, or micrograms per kilogram).

contact-handled waste—Packaged waste whose external surface dose rate does not exceed 200 millirem per hour.

contamination—Unwanted chemical elements, compounds, or radioactive material on structures, areas, environmental media, objects, or personnel.

contour—Line connecting points of equal elevation on a map.

contour interval—The difference in value between two adjacent contour lines.

creep—An imperceptibly slow, more or less continuous downward and outward movement of slope-forming soil or rock. The movement is essentially viscous, under shear stresses sufficient to produce permanent deformation but too small to produce shear failure, as in a landslide.

cultural resources—A prehistoric or historic district, site, building, structure, or object considered to be important to a culture, subculture, or community for scientific, traditional, religious, or other reason. Usually divided into three major categories: pre-historic and historic archaeological resources, architectural resources, and traditional cultural resources.

curie (Ci)—The basic unit used to describe the intensity of radioactivity in a sample of material. The curie is equal to 3.7×10^{10} disintegrations per second, which is approximately the rate of decay of 1 gram of radium. A curie is also a quantity of any radionuclide that decays at a rate of 37 billion disintegrations per second.

decommissioning—Removing facilities such as processing plants, waste tanks, and burial grounds from service and reducing or stabilizing radioactive contamination; includes the following concepts: the decontamination, dismantling, and return of an area to its original condition without restrictions on use or occupancy; partial decontamination, isolation of remaining residues, and continued surveillance and restrictions on use or occupancy.

decontamination—The actions taken to reduce or remove substances that pose a substantial present or potential hazard to human health or the environment, such as radioactive contamination from facilities, soil, or equipment by washing, chemical action, mechanical cleaning, or other techniques.

dermal—Relating to the skin.

dilation—The state of being expanded.

direct employment—As used in this EIS, direct employment refers to those jobs at the Center.

disposal—Emplacement of waste so as to ensure isolation from the biosphere without maintenance and with no intent of retrieval, and requiring deliberate action to gain access after emplacement.

disposal area—A place for burying unwanted (i.e., radioactive) materials in which the earth acts as a receptacle to prevent the dispersion of wastes in the environment and the escape of radiation.

disposal facility—A man-made structure in which waste is disposed. (Also see *disposal*).

DOE orders—Requirements internal to the U.S. Department of Energy (DOE) that establish DOE policy and procedures, including those for compliance with applicable laws.

dose (or radiation dose)—The radiation delivered to a specific part of the body or to the body in general. A generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent.

dose rate—The radiation dose delivered per unit time (e.g., rad per year, millirad per year).

drainage basin—A region or area bounded by a drainage divide and occupied by a drainage system; specifically, the tract of country that gathers water originating as precipitation and contributes to a particular stream channel or system of channels or a lake, reservoir, or other body of water.

drinking-water standards—The prescribed level of constituents or characteristics [maximum contaminant levels (MCLs)] in drinking water that cannot be exceeded legally.

endangered species—Species of plants and animals that are threatened with either extinction or serious depletion in an area, and formally listed by the U.S. Fish and Wildlife Service.

effective dose equivalent—The sum of the products of the dose equivalent to the organ or tissue and the weighting factors applicable to each of the body organs or tissues that are irradiated. It includes the dose from radiation sources internal and/or external to the body and is expressed in units of rem. The International Commission on Radiological Protection defines this as the effective dose.

environmental impact statement (EIS)—A document prepared pursuant to Section 102(2)(c) of the National Environmental Policy Act (NEPA) of 1969 for a major Federal action significantly affecting the quality of the human environment.

ephemeral—Lasting a very short time.

erosion—The loosening and removal of soil by running water, moving ice, or winds.

evapotranspiration—The release of water to the atmosphere by plants.

existing facilities—Facilities that are projected to exist as of completion of high-level [radioactive] waste (HLW) solidification, scheduled to be completed before January 2000.

exposure to radiation—The incidence of radiation from either external or internal sources to persons by accident or intent: background-exposure to natural background ionizing radiation; occupational-exposure to ionizing radiation that takes place during a person's working hours; population-exposure - exposures to persons who inhabit an area.

external accident—Accidents initiated by man-made energy sources not associated with operation of a given facility. Examples include airplane crashes, induced fires, transportation accidents adjacent to a facility.

fault (geologic)—Fracture in earth's crust accompanied by displacement of one side of the fracture with respect to the other.

fission products—Elements resulting from nuclear fission.

floodplain—That portion of a river valley, adjacent to the river channel, which is built of sediments during the present regimen of the stream and which is covered with water when the river overflows its banks at flood stages.

flux—Rate of flow through a unit area.

gamma-emitter—A radioactive substance that decays by releasing gamma radiation.

gamma ray (gamma radiation)—High-energy, short wavelength electromagnetic radiation (a packet of energy) emitted from the nuclei of radioactive atoms. Gamma radiation frequently accompanies alpha and beta emissions and always accompanies fission. Gamma rays are very penetrating and are best stopped or reduced by dense materials, such as lead or uranium. Gamma rays are similar to x-rays, but are usually more energetic.

gantry—A platform made to carry a traveling crane and supported by towers or side frames running on parallel tracks.

geologic repository—A system that is intended to be used for, or may be used for, the disposal of radioactive waste or spent nuclear fuel in excavated geologic media. A geologic repository includes (a) the geologic repository operations area, and (b) the portion of the geologic setting that provides isolation. A near-surface disposal area is not a geologic repository.

gradient—Slope, particularly of a stream or a land surface.

groundcover—Plant species (mainly herbaceous) that grow close to the ground (e.g., grasses, vines).

groundwater—Generally, all water contained in the ground. Water held below the water table is available to freely enter wells.

grouting—A fluid mixture of cementitious materials and liquid waste that sets up as a solid mass and is used for waste fixation and immobilization.

gully—Any erosion channel so deep that it cannot be crossed by a wheeled vehicle or eliminated by plowing.

habitat—The place or type of site where a plant or animal naturally or normally lives and grows.

half-life—Time required for a half of a radioactive isotope to decay away.

hazardous chemical—A term defined under the Occupational Safety and Health Act and the Emergency Planning and Community Right-to-Know Act as any chemical that is a physical hazard or a health hazard.

hazardous constituent—See *hazardous chemical.*

hazardous waste—Under the Resource Conservation and Recovery Act, a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may (a) cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (b) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed. Source, special nuclear material, and by-product material, as defined by the Atomic Energy Act, are specifically excluded from the definition of solid waste.

head (hydraulic)—The driving force for fluid (water) flow. The head is typically measured in pounds per square inch or feet of water.

high-efficiency particulate air filter—A filter with an efficiency of at least 99.95 percent used to separate particles from air exhaust streams prior to releasing that air into the atmosphere.

high-level [radioactive] waste (HLW)—The highly radioactive waste material that results form the reprocessing of spent nuclear fuel, including liquid waste produced directly from reprocessing and any solid waste derived from the liquid that contains a combination of transuranic and fission product nuclides in quantities that require permanent isolation. HLW may include other highly radioactive material that the U.S. Nuclear Regulatory Commission, consistent with existing law, determines by rule requires permanent isolation.

high-level [radioactive] waste (HLW) solidification—See ***solidification (of high-level [radioactive] waste).***

hydraulic conductivity—A measure of the ability of a subsurface unit to transmit fluid at a specified pressure and temperature; also, water flow rate in volume per unit time through a unit cross-section under a unit hydraulic gradient. (Also see ***hydraulic gradient.***)

hydraulic (water) head—Height of water with a free surface above a reference elevation.

hydric—Characterized by or requiring an abundance of moisture.

hydrogeology—The study of the geological factors relating to water.

hydrology—The study of water, including groundwater, surface water, and rainfall.

hydrophytic—A property of a plant that can grow in water or in soil too water logged for most plants to survive.

incise—Cut down into, as a river cuts into a plateau.

indirect employment—As used in this EIS, indirect employment refers to those jobs that result from purchases made by the Center or personal purchases made by employees who work at the Center.

industrial waste—As used in this EIS, solid or semisolid material resulting from site cleanup activities. This waste does not contain hazardous constituents regulated by the Resource Conservation and Recovery Act and do not contain source, special nuclear by-product material, as defined by the Atomic Energy Act of 1954.

in-ground structures—As used in this EIS, man-made structures that are set in the ground, but are not underground (e.g. lagoons, pits, storage tanks).

in situ—In the natural or original position.

institutional control—Controls applied by State or Federal organizations or their agents. The controls could include site access control, site monitoring, facility maintenance, and erosion control.

intensity (of an earthquake)—A number describing the effects of an earthquake at a particular place, based on its effects on man, on structures built by man, and on the earth's surface.

interim status, RCRA—A condition by which hazardous waste treatment, storage, or disposal facilities that were in existence on November 19, 1980, which meet certain conditions, to continue operating as if they have a permit until their permit application is issued or denied. Interim status requirements are self-implementing and are primarily "good housekeeping practices" that owners and operators must follow to properly manage hazardous wastes until they obtain a permit.

inventory, radionuclide—The amount of radioactive material in a container, building, disposal area, etc.

ion exchange—A chemical process involving the movement of various chemical ions from a solution onto a solid material or from the solid material into the solution.

isotherm—A line on a map or chart of the earth's surface connecting points having the same temperature.

isotope—One of two or more atoms with the same number of protons, but different numbers of neutrons, in their nuclei. Thus, carbon-12, carbon-13, and carbon-14 are isotopes of the element carbon, the numbers denoting the approximate atomic weights. Isotopes have very nearly the same chemical properties, but often different physical properties (for example, carbon-12 and -13 are stable, carbon-14 is radioactive).

isotropic—Exhibiting properties with the same values when measured along axes in all directions.

knickpoint—A point of abrupt change or inflection in the longitudinal profile of a stream or its valley, resulting from rejuvenation, glacial erosion, or the outcropping of a resistant bed.

latent cancer fatality—A death because of radiation-induced cancer that occurs years after the exposure to radiation.

leachate—The solution formed when a liquid has percolated through a substance, e.g., the solution formed when water percolates through buried waste.

listed hazardous waste—See ***hazardous waste***.

long-term storage—The storage of hazardous waste (a) on site (a generator site) for a period of 90-days or greater, other than in a satellite accumulation area, or (b) off site in a properly managed treatment, storage, or disposal facility for any period of time.

low-level [radioactive] waste (LLW)—Waste that contains radioactivity and is not classified as high-level [radioactive] waste, transuranic waste, or spent nuclear fuel.

maximally exposed individual—A hypothetical individual who receives the greatest dose.

maximum contaminant level (MCL)—Under the Safe Drinking Water Act, the maximum permissible concentrations of specific constituents in drinking water that is delivered to any user of a public water system that serves 15 or more connections and 25 or more people. The standards set as maximum contaminant levels take into account the feasibility and cost of attaining the standard.

meanders—One of a series of somewhat regular bends in the course of a stream, developed when the stream is flowing at grade, through lateral shifting of its course toward the convex sides of the original curves.

millirem—One thousandth of a rem (Also see ***rem***).

mixed waste—Waste that contains both hazardous waste under the Resource Conservation and Recovery Act and source, special nuclear, or by-product material subject to the Atomic Energy Act of 1954.

mitigative measures—Those actions that avoid impacts altogether, minimize impacts, rectify impacts, reduce or eliminate impacts, or compensate for the impact.

Modified Mercalli—A scale of earthquake intensities.

monolith—A huge, massive structure or unit formed as a single piece.

morphology—The observation of the form of lands.

natural phenomena accidents—Accidents that are initiated by natural phenomena such as earthquakes, tornadoes and floods.

nuclide—An atomic nucleus specified by its atomic weight, atomic number, and energy state; a radionuclide is a radioactive nuclide.

occupational dose—Whole-body radiation dose received by workers participating in a given task.

off-site—Outside of the Western New York Nuclear Service Center boundary.

Old Field Successional Community—Plant and animal assemblage that reflects historic disturbance (e.g., logging or farming) and currently dominated by grasses and other non-woody plant species and animals of open areas.

on-premises—As used in this EIS, on the West Valley Demonstration Project Premises.

on-site—Within the Western New York Nuclear Service Center boundary.

permeability—In hydrology, the capacity of a rock, sediment, or soil for transmitting groundwater. Permeability depends on the size and shape of the pores and how they are interconnected.

person-rem—The unit of collective radiation dose commitment to a given population; the sum of the individual doses received by a population segment.

picocurie—One trillionth of a curie (Also see ***curie***).

piezometer—An instrument used for measuring pressure.

pollution prevention—The use of any process, practice, or product that reduces or eliminates the generation and release of pollutants, hazardous substances, contaminants, and wastes, including those that protect natural resources through conservation or more efficient utilization.

polychlorinated biphenyls (PCBs)—A class of chemical substances formerly manufactured as an insulating fluid in electrical equipment that is highly toxic to aquatic life. In the environment, PCBs exhibit many of the characteristics of dichloro diphenyl trichloroethane (DDT); they persist in the environment for a long time and accumulate in animals.

population dose—See ***collective dose.***

porosity—Porosity is an index of relative pore volume. It is the total unit volume of the soil or rock divided into the void volume.

primary impact area (PIA)—The area within a 20-km (12-mi) radius from the Western New York Nuclear Service Center.

processing (of spent nuclear fuel)—Applying a chemical or physical process designed to alter the characteristics of the spent nuclear fuel matrix.

public—Anyone outside the Western New York Nuclear Service Center boundary at the time of an accident or during normal operation. With respect to accidents analyzed in this EIS, anyone outside the DOE site boundary at the time of an accident.

radioactive decay—The decrease in the amount of any radioactive material with the passage of time, due to the spontaneous emission from the atomic nuclei of either alpha or beta particles, often accompanied by gamma radiation. (Also see ***half-life***).

radioactive waste—Solid, liquid, or gaseous material of negligible economic value that contains radionuclides in excess of threshold quantities.

radioactivity—The property or characteristic of material to spontaneously "disintegrate" with the emission of energy in the form of radiation where one nuclide may transform into a different nuclide or into a different energy state of the same nuclide. The unit of radioactivity is the curie.

radiological survey—The evaluation of the radiation hazard accompanying the production, use, or existence of radioactive materials under a specific set of conditions. Such evaluation customarily includes a physical survey of the disposition of materials and equipment, measurements, or estimates of the levels of radiation that may be involved, and a sufficient knowledge of processes affecting these materials to predict hazards resulting from unexpected or possible changes in materials or equipment.

radionuclide—An unstable nuclide of an element that decays or disintegrates spontaneously, emitting radiation.

record of decision—A public document that records the final decision(s) concerning a proposed action. The Record of Decision (ROD) is based in whole or in part on information and technical analysis generated either during the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process or the National Environmental Policy Act (NEPA) process, both of which take into consideration public comments and community concerns.

region of influence (ROI)—The region within a 80-km (50-mi) radius from the Western New York Nuclear Service Center. As used in the socioeconomic analysis, a 50-km (35-mi) radius from the Center.

release fraction—The fraction of the radioactivity that could be released to the atmosphere in a given accident.

rem—Quantity used in radiation protection to express effective dose equivalent for all forms of ionizing radiation. It is the product of the adsorbed dose in rads and factors related to relative biological effectiveness.

remote-handled waste—Packaged waste whose external surface dose rate exceeds 200 millirem per hour.

repository—A permanent deep geologic disposal facility for high-level or transuranic wastes and spent nuclear fuel.

reprocessing (of spent nuclear fuel)—Processing of reactor irradiated nuclear material (primarily spent nuclear fuel) to recover fissile and fertile material, in order to recycle such materials. Historically, reprocessing has involved aqueous chemical separations of elements (typically uranium or plutonium) from undesired elements in the fuel.

resins—Material used to absorb contaminants.

Resource Conservation and Recovery Act (RCRA)—A Federal law addressing the management of waste. Subtitle C of the law addresses hazardous waste under which a waste must either be "listed" on one of the U.S. Environmental Protection Agency's (EPA's) hazardous waste lists or meet one of EPA's four hazardous characteristics of ignitability, corrosivity, reactivity, or toxicity, as measured using the toxicity characterization leaching procedure (TCLP). Cradle-to-grave management of wastes classified as RCRA hazardous wastes must meet stringent guidelines for environmental protection as required by the law. These guidelines include regulation of transport, treatment, storage, and disposal of RCRA-defined hazardous waste. Subtitle D of the law addresses the management of nonhazardous, nonradioactive, and solid waste such as municipal wastes.

retrieval—The process of recovering wastes that have been stored or disposed of on site so they may be appropriately characterized, treated, and disposed of.

rill erosion—When soil particles are removed by a series of tiny rivulets connecting one water-filled hollow with another on rough terrain.

riprap—An assemblage of stones or chunks of concrete thrown together without order, often used on embankment slopes to present erosion.

risk—Quantitative expression of possible loss that considers both the probability and the consequences of that event.

runoff—The quantity of water discharged through surface streams.

sanitary landfill—A landfill that accepts industrial waste, as defined in this EIS, or garbage (Also see *industrial waste*).

saturated zone—That part of the earth's crust in which all naturally occurring voids are filled with water.

scabble—See *scarify*.

scarify—To make scratches or small cuts to break up and loosen the surface of, e.g., to remove thin layers of contaminated concrete.

scientific notation—A notation adopted by the scientific community to deal with very large and very small numbers by moving the decimal point to the right or left so that only one number above zero is to the left of the decimal point. Scientific notation uses a number times 10 and either a positive or negative exponent to show how many places to the left or right the decimal place has been moved. For example, in scientific notation, 120,000 would be written as 1.2×10^5, and 0.000012 would be written as 1.2×10^{-5}.

seep—A spot where water discharges from the earth, often forming the source of a small trickling stream.

seismic—Relating to earthquakes.

seismicity—The phenomenon of earth movements; seismic activity. Seismicity is related to the location, size, and rate of occurrence of earthquakes.

sheet erosion—When soil particles are removed by a continuous film of water moving over smooth soil surfaces.

shielding—Bulkheads, walls, or other constructions used to absorb radiation in order to protect personnel or equipment.

slump block—A mass of soil that slides down a bank as a single unit. Slump blocks from when water moves into deep fractures within banks, causes an increase in soil pore pressures, and reduces the length of the soil.

slumping—The downward slipping of a mass of rock or unconsolidated material of any size, moving as a unit or as several subsidiary units, usually with backward rotation on a more or less horizontal axis parallel to the cliff or slope from which it descends.

slurry wall—An underground wall made of a watery mixture of insoluble matter (e.g., clay) used for preventing groundwater flow in a certain direction.

sole source aquifer—A designation granted by the U.S. Environmental Protection Agency when groundwater from a specific aquifer supplies at least 50 percent of the drinking water for the area overlying the aquifer. Sole-source aquifers have no alternative source or combination of sources that could physically, legally, and economically supply all those who obtain their drinking water from the aquifer. Sole-source aquifers are protected from federally financially assisted activities determined to be potentially unhealthy for the aquifer.

solid waste—Any garbage, refuse, or sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations and from community activities. It does not include solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges, which are point sources subject to permits under Section 402 of the Federal Water Pollution Control Act, as amended, or source, special nuclear, or by-product material as defined by the Atomic Energy Act of 1954, as amended [Public Law 94-580, 1004(27) Resource Conservation and Recovery Act)].

solidification—(Of high-level [radioactive] waste) As used in this EIS, the process of vitrifying high-level [radioactive] waste produced by the West Valley Demonstration Project during 1996 to 2000 (Also see *vitrification*).

solvents—Liquid chemicals, usually organic compounds, that are capable of dissolving another substance.

somatic—Relating to or affecting the body.

source term—The quantities and characteristics of materials released to air or water pathways used for determining accident consequences.

spent fuel assemblies—Assemblies which contain spent fuel rods in either a fixed array or concentric tubes.

spent fuel fines—Portions of a spent fuel assembly. At West Valley, spent fuel was cut prior to reprocessing. The spent fuel fines are pieces from these cutting operations that were not reprocessed. These spent fuel fines could be pieces as large as a couple of inches and as small as sand particles.

spent nuclear fuel—Fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated. Spent nuclear fuel is packaged in an assembly which holds the fuel material.

sprung structure—A large tent-like structure made of metal and fabric.

stabilization—Treatment of waste or a waste site to protect the biosphere from contamination.

stakeholder—Any person or organization with an interest in or affected by DOE activities. Stakeholders may include representatives from Federal agencies, State agencies, Congress, Native American Tribes, unions, educational groups, industry, environmental groups, other groups, and members of the general public.

stochastic—Probabilistic.

storage (waste)—The collection and containment of waste in a retrievable manner, requiring surveillance and institutional control, as not to constitute disposal.

storage facility (RCRA)—A building used for storing radioactive or hazardous wastes for greater than 90 days.

stream downcutting—When the debris supplied to a stream is less than its capacity for carrying load, the stream abrades its bed and is said to be eroding, downcutting, or degrading the streambed.

stream terrace—One of a series of level surfaces in a stream valley, flanking and more or less parallel to the stream channel, originally occurring at or below, but now above, the level of the stream, and representing the dissected remnants of an abandoned floodplain, stream bed, or valley floor produced during a former stage of erosion or deposition.

Succession—Relatively orderly, predictable, and progressive replacement of one plant community (called a stage) by another until a relatively stable Climax community occupies the site.

sump—A pit or reservoir serving as a drain or receptacle for liquids prior to their transfer.

supernatant—The clear liquid overlying material deposited by settling precipitation, or centrifugation.

tectonic—Relating to the deformation of the crust of the earth.

tensile strength—The greatest longitudinal stretching stress a substance can bear without tearing.

thalweg—The line defined by the series of lowest points along a stream channel

till—Unstratified glacial draft consisting of clay, sand, gravel, and boulders intermingled.

topographic map—A map showing the relief of the land surface generally by means of contour lines.

transuranic elements—Elements with atomic number (Z number) greater than 92.

transuranic waste—Any waste material measured or assumed to contain more than a specified concentration of transuranic elements.

tumulus—An artificial hillock or mound.

unsaturated zone—See *vadose zone*.

vadose zone—The zone between the land surface and the water table. Saturated bodies, such as perched groundwater, may exist in the vadose zone. Also called the zone of aeration and the unsaturated zone.

vermiculite—A lightweight, highly water-absorbent material made of various micaceous minerals that are hydrous silicates.

vitrification—A waste treatment process that encapsulates or immobilizes radioactive wastes in a glassy matrix (e.g., borosilicate glass) to prevent them from reacting in disposal sites; involves adding chemicals and waste to a heated vessel and melting the mixture into a glass that is then poured into a canister.

waste management area (WMA)—For the purposes of this EIS, a geographic unit on site consisting of facilities and the surrounding grounds, including soil, piping, tanks, stored or buried waste, other underlying materials, and associated soil or groundwater contamination within a geographical boundary. There are 12 WMAs discussed in this EIS.

wetlands—Land or areas exhibiting the following: hydric soil conditions, saturated or inundated soil during some portion of the year, and plant species tolerant of such conditions; also, areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

wind rose—A depiction of wind speed and direction frequency for a given period of time.

worker—Any worker whose day-to-day activities are controlled by process safety management programs and a common emergency response plan associated with a facility or facility area. This definition includes any individual within a facility/facility area who would participate or support activities required for implementation of the alternatives.

zeolite—Any of various hydrous silicates held especially as adsorbents and catalysts.

A.3. UNITS OF MEASUREMENT

Btu	British thermal units
Ci	curie
cm	centimeter
d	day
ft	feet
ft^2	square foot
ft^3	cubic foot
g	gram, or gee of acceleration
gal	gallon
ha	hectare
hr	hour
in	inch
kg	kilogram
km	kilometer
km^2	square kilometer
kW-hr	kilowatt-hours
L	liter
lbs	pounds
m	meter
m^2	square meter
m^3	cubic meter
mCi	millicurie
mg	milligram
mi	mile
mi^2	square mile
mL	milliliter
mph	miles per hour
mR	millirad
mrem	millirem
MW-hr	megawatt-hours
nCi, ηCi	nanocurie
pCi	picocurie
psi	pounds per square inch
R	rad
sec(s)	second
yd^3	cubic yard
yr	year
μCi	microcurie
μg	microgram
°C	degrees Celsius
°F	degrees Fahrenheit

APPENDIX B

STATUTES AND REGULATIONS RELATING TO IMPLEMENTATION ACTIVITIES

APPENDIX B

STATUTES AND REGULATIONS RELATING TO IMPLEMENTATION ACTIVITIES

This appendix identifies statutes and regulations that may apply to the alternatives being evaluated in this Environmental Impact Statement (EIS). Environmental standards contained in these regulations are used as a baseline for comparison to determine if a given alternative would be protective of human health and the environment and to determine the significance of an impact. Section B.1 discusses federal and state regulations that set standards for concentration limits in environmental media, such as groundwater and surface water; Section B.2 addresses location-specific regulations, such as wetlands and cultural resources; and Section B.3 discusses action-specific regulations that could be effective during the implementation and post-implementation phases of each alternative.

B.1 CONCENTRATION LIMITS IN ENVIRONMENTAL MEDIA

Current discharges to surface water as regulated under the Clean Water Act (CWA) are discussed in Section B.1.1, drinking water standards are discussed in Section B.1.2, and air quality standards are in Section B.1.3. Table B-1 summarizes applicable standards for releases to surface water (i.e., Franks Creek) and New York State drinking water standards. These regulations set health- or risk-based concentration limits in various environmental media for specific hazardous substances or pollutants.

B.1.1 Clean Water Act (33 U.S.C. §1251 et seq.)

Discharges to surface waters are principally regulated by the Federal Water Pollution Control Act or Clean Water Act (CWA), which mandates restoration and the maintenance of the chemical, physical, and biological integrity of the nation's waters. The National Pollutant Discharge Elimination System (NPDES) permit program created by the CWA authorizes specific point source discharges to waters of the U.S. The NPDES permit program in New York was delegated to New York State Department of Environmental Conservation (NYSDEC) under the State Pollutant Discharge Elimination System (SPDES) (New York State Environmental Conservation Law, Article 3, Title 6, as implemented in 6 NYCRR Parts 750 through 758). The State sets goals for improving the quality of surface waters within its jurisdiction as part of this program. A major component of the State's program establishes water quality standards to protect existing and attainable use or uses of the receiving water (such as recreation, public water supply, and commercial fishing). The State water quality standards for surface water and the constituents with discharge limits in the current Western New York Nuclear Service Center (Center) SPDES permit are presented in Table B-1.

The New York State water quality regulations also apply to waters of particular health concern, including groundwaters requiring protection as specified in wellhead protection programs. These regulations apply because the Center is within the Carraraugus Creek Basin Aquifer (discussed further in Section B.2). The water quality standards for fresh groundwater are given in Table B-1.

Table B-1. New York State Water Quality Standards for Surface Water and Groundwater

Parameter	Water Quality Standard in Class C Receiving Stream[a] (mg/L)	Current SPDES Permit Discharge Limit[b] (mg/L)	Maximum Contaminant Levels for Fresh Groundwater[c] (mg/L)
Ammonia (NH_3)	[d]	2.1[e]	2.0 (NH_3+NH_4, as N)
Biological Oxygen Demand-5	— —[f]	5.0[g]	— —
Suspended Solids	[h]	45.0	— —
Cyanide Amenable to Chlorination	0.0052, as cyanide	0.022	— —
Settleable Solids	[h]	0.3 mL/L	— —
pH (standard units)	6.5 - 8.5	6.0 - 9.0	6.5 - 8.5
Oil and Grease	[i]	15.0	— —
Sulfate	— —	Monitor	250
Nitrate, Nitrite (as N)	0.1 nitrite for warm fishery waters	Monitor	10 for nitrate and nitrite (as N)
Aluminum (total)	0.10 as ionic aluminum	Monitor	
Antimony	— —	1.0	— —
Arsenic (dissolved)	0.19	0.15	0.025
Barium	— —	0.5	1.00
Cadmium (total recoverable)		0.007	0.010
Hexavalent chromium (total recoverable)	0.011	Monitor	0.050
Chromium (total)		0.050	0.050
Copper (total recoverable)		0.03	0.20
Iron (total)	0.30	0.31[e]	0.30
Lead (total recoverable)		0.15	0.025
Nickel (total)		2.7	— —
Selenium (total)	0.001 for acid-soluble selenium	0.040	0.01
Silver (total)	0.0001 for ionic silver	0.008	0.05
Vanadium	0.014	0.19	— —

Table B-1. Water Quality Standards for Surface Water and Groundwater (Continued)

Parameter	Water Quality Standard in Class C Receiving Stream[a] (mg/L)	Current SPDES Permit Discharge Limit[b] (mg/L)	Maximum Contaminant Levels for Fresh Groundwater[c] (mg/L)
Zinc (total recoverable)	0.030	0.48	0.30
Bis (2-ethylhexyl) phthalate	0.0006	1.6	0.050
Chloroform	— —	0.3, outfall 001 0.020, outfall 007	0.007
Dichlorodifluoromethane	— —	0.01	— —
3,3-dichlorobenzidine	0.005 as Dichlorobenzenes	0.01	— —
4-dodecene	— —	0.6	— —
Tributyl phosphate	— —	32	— —
Trichlorofluoromethane	— —	0.01	— —
Total Purgeable and Unspecified Organic compounds	— —	— —	0.10
Combined Radium-226 & Radium-228	— —	— —	5 pCi/L
Gross Alpha	— —	— —	15 pCi/L
Gross Beta	— —	— —	1000 pCi/L

a. Standards for industrial point discharges, 6 New York Code of Rules and Regulations (NYCRR Part) 703.
b. SPDES-State Pollutant Discharge Elimination System. Source: WVNS (1994a.)
c. Surface water and groundwater classifications and standards, 6 NYCRR Part 700-705
d. This standard is dependent on water pH and temperature at the time of sample measurement.
e. Reported as flow-weighted average of outfalls 001 and 007.
f. — —: no surface or drinking water standard established.
g. Reported as flow-weighted average of outfalls 001, 007, and 008.
h. None from sewage, industrial wastes or other wastes that will cause deposition or impair the waters for their best usages.
i. No residue attributable to sewage industrial wastes or other wastes, nor visible oil film nor globules of grease.
j. This standard is dependent on water hardness at the time of sample measurement.

B.1.2 Safe Drinking Water Act (42 U.S.C. §300f et seq.)

The Safe Drinking Water Act was enacted in 1974 to establish minimum national standards for public water supply systems. The federal standards are in the form of maximum contaminant levels (MCLs) and maximum contaminant level goals for approximately 95 contaminants that are either acknowledged or believed to negatively affect human health. These regulations are promulgated in 40 CFR Parts 141 ("National Primary Drinking Water and Standards") and 143 ("National Secondary Drinking Water Regulations"). The federal MCLs for tritium (20,000 pCi/L) and strontium-90 (8 pCi/L) are used in this EIS in the absence of state standards as discussed in Chapter 4. The New York State standards, given in Table B-1, are relevant to compare groundwater quality, but they are not directly applicable because groundwater is not currently used as a public water supply at the Center.

B.1.3 Clean Air Act, as amended 1990 (42 U.S.C. 7401 et seq.)

The Clean Air Act (CAA), amended 1990, is intended to protect public health and welfare by establishing National Ambient Air Quality Standards (NAAQS) and protecting clean air from significant deterioration. The CAA requirements are enforced in New York State through the NYSDEC Division of Air Resources, which administers the air quality program found in 6 NYCRR Parts 200 through 257. The State program generally defers to the standards in the federal National Ambient Air Quality Standards program (Tierman 1994).

The National Ambient Air Quality Standards set limits on ambient air concentrations of sulfur dioxide, nitrogen dioxide, respirable particulate matters, carbon monoxide, lead, and ozone. In addition to the federal criteria pollutants, New York State has promulgated ambient air quality standards (6 NYCRR Part 257, "Air Quality Standards"). Table B-2 gives the State ambient air quality standards for the air pollutants expected to be generated during the closure activities under Alternatives I (Removal), II (On-Premises Storage), and III (In-Place Stabilization).

Table B-2. National and State Ambient Air Quality Standards[a]

Pollutant	Average Time	Primary Standard
Carbon Monoxide	1 hour	40 mg/m^3 (35 ppm)
	8 hour	10 mg/m^3 (9 ppm)
Hydrocarbons	3 hour	0.24 ppm
(non-methane)	(6:00 am - 9:00 am)	
Nitrogen Dioxide	annual	100 μg/m^3 (0.053 ppm)
Particulates	24 hour	150 μg/m^3
(PM-10)[a]	annual	50 μg/m^3
Sulfur Oxides	24 hour	365 μg/m^3 (0.14 ppm)
(measured as sulfur dioxide)	annual	80 μg/m^3 (0.03 ppm)
Aldehydes	No available standard	No available standard

a. Source: 40 CFR Part 50 (Protection of Environment, "National Primary and Secondary Ambient Air Quality Standards") and 6 NYCRR Part 257

b. State standards: 24-hour 250 μg/m^3; annual 45-75 μg/m^3 according to level designation.

The U.S. Environmental Protection Agency (EPA) has set National Emission Standards for Hazardous Air Pollutants (NESHAPs) for arsenic, asbestos, benzene, beryllium, mercury, radionuclides, radon, and vinyl chloride. The regulations for NESHAPs are found in 40 CFR Part 61 ("National Emission Standards for Hazardous Air Pollutants"), enforcement authority currently rests with EPA. NESHAPs apply to both existing and new stationary sources.

Subpart H of 40 CFR Part 61 addresses U.S. Department of Energy (DOE) activities and, in addition to establishing emission standards, requires DOE to notify and obtain needed approvals before constructing a new source of radionuclide emissions. The standards also apply to closure activities (e.g., demolition or excavation) that result in fugitive emissions of radionuclides into unrestricted (public access) areas. The emission standards for radionuclide releases to ambient air must not exceed amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem/yr. Compliance with this requirement would be determined for the maximally exposed individual, who is assumed to reside at the boundary of the Center.

Subpart I of 40 CFR Part 61 addresses facilities licensed by the NRC and federal facilities not covered by Subpart H. Under Subpart I, emissions of radionuclides to ambient air must not exceed amounts that would cause any member of the public to receive an effective dose equivalent of 10 mrem in any year. Iodine emissions must not exceed amounts that would cause any member of the public to receive an effective dose of 3 mrem in any year. These standards would be applicable, if the NRC license is re-instated (depending on the selected alternative).

B.2 LOCATION-SPECIFIC REGULATIONS

Location-specific regulations may either restrict or preclude certain actions or may apply only to certain portions of the site. Examples of location-specific regulations pertinent to the Center include federal and state regulations for minimizing or avoiding adverse effects to wetlands, flood plains, and cultural resources. These statutes and regulations are summarized below.

B.2.1 Groundwater

The Cattaraugus Creek Basin Aquifer is designated as a sole source aquifer pursuant to Section 1424(e) of the Safe Drinking Water Act. A sole source aquifer is a sole or principal source of drinking water for an area which, if contaminated, would create a significant hazard to public health. The Cattaraugus Creek Basin Aquifer is an area totalling approximately 842 km^2 (325 mi^2), parts of which occur in Concord and Ashford townships. The designated area consists of the stream flow and recharge source zone of the southernmost part of the Erie-Niagara drainage basin [52 FR 36100 (FR 1987)]. The Center falls within the designated area.

As a result of this designation, all federal financially assisted projects constructed in the Cattaraugus Creek Basin will be subject to EPA review to ensure that these projects are designed and constructed so that they do not create a significant hazard ~~to~~ public health. Federal law requires EISs to be reviewed and commented upon by the EPA Administrator. The EPA review of the potential effect of site closure on the Cattaraugus Creek Basin Aquifer will be included in the EPA review of this EIS.

B.2.2 Ecological Resources, Floodplains, and Wetlands

Regulations protecting biota, floodplains, and wetlands at the Center are applicable to the alternatives. The Center contains jurisdictional wetlands that could be affected by the actions. The closure actions affecting the floodplains of Franks and Buttermilk Creek, and certain biota dwelling in these and other site habitat, may also be subject to regulation. These regulations and their applicability are summarized below.

B.2.2.1 33 CFR Part 320 (Navigation and Navigable Waters, "General Regulatory Policies Pursuant to the Clean Water Act")

The CWA protects waterways and wetlands under 33 CFR Part 320. The lead agency for enforcement of wetland requirements is the U.S. Corps of Engineers (COE). Permit applications for activities affecting waterways and wetlands are reviewed by the COE in consultation with the U.S. Fish and Wildlife Service, the Soil Conservation Service, the EPA, and NYSDEC. A permit would need to be obtained from the U.S. Corps of Engineers (COE) before implementing any of the actions that could disturb wetlands. Under Alternatives I, II, and III, wetlands could be disturbed or disrupted from earthmoving activities and if certain erosion controls were selected.

B.2.2.2 Executive Orders 11990 (Protection of Wetlands) and 11988 (Floodplain Management)

Executive Order 11990 establishes wetland protection as the official policy of all federal agencies. The order directs that each agency take action "to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands." Work conducted or funded by a federal agency should not call for new construction in wetlands unless there is no practicable alternative and the proposed action includes all practicable measures to minimize damage to wetlands. Under a memorandum of understanding between EPA and COE, this executive order has been interpreted as a mandate requiring "no net loss" of wetlands.

Executive Order 11988 states that federal agencies shall avoid, to the extent possible, long- and short-term adverse impacts from occupying and modifying floodplains. Although the Order emphasizes reducing the risk of flood loss and minimizing the impact of floods on human safety, health, and welfare, if also mandates that actions must be taken "to restore and preserve the natural and beneficial values served by floodplains in conducting federal activities and programs affecting land use."

DOE regulations implementing Executive Orders 11988 and 11990 are in 10 CFR Part 1022 ("Compliance with Floodplain/Wetlands Environmental Review Requirements"). Under

Alternatives I, II, and III, both wetlands and the 100-yr floodplain could be affected by the actions. Alternatives I, II, and III could disturb or destroy wetlands from either earthmoving activities or implementing erosion control strategies. Under Alternative III, the 100-yr floodplain would be completely modified if a global erosion control strategy were selected. DOE would need to take measures to minimize damage to wetlands. If a global erosion control strategy were selected, it would need to be designed to reduce the risk of flood loss and minimize the potential impact from flooding.

B.2.2.3 New York Freshwater Wetlands Act (New York State Environmental Conservation Law, Article 24)

NYSDEC regulates activities within State jurisdictional wetlands. Article 24 of the New York State Environmental Conservation Law preserves, protects, and conserves freshwater wetland areas of 5 ha (12.4 acres) or larger. Wetlands of smaller size are subject to regulation if NYSDEC determines that they have unusual local importance and are listed by the regional permit administrator. Activities subject to regulation include draining, filling, or excavating wetlands and changing or obstructing the flow of water into or through wetland areas or within 30 m (100 ft) of designated wetland areas. These activities require a permit from the county or State. The State permit process must be integrated with the federal permit process, as discussed in Section B.2.2.1.

Eight linked wetland areas identified on the southern portion of the Project Premises on the Center have been listed as a single State-jurisdictional wetland pursuant to the Freshwater Wetlands Act and 6 NYCRR Part 663 ("Freshwater Wetlands Permit Requirements") (DOE 1994).

Under 6 NYCRR Part 608 ("Use and Protection of Waters"), applications filed pursuant to Section 404 of the WCA for work within federally-delineated jurisdictional wetlands may also require issuance by NYSDEC. Therefore, both federal and state permits would be required if an alternative were selected where wetlands could either be disturbed or destroyed.

The New York State procedures for processing applications for Freshland Water Permits and Water Quality Certifications are contained in 6 NYCRR Part 621 ("Uniform Procedures").

Since NYSDEC has identified a single State-jurisdictional wetland on the Center, a permit would be required before certain activities within the wetland and its 30 m (100 ft)-wide adjacent area could be implemented. Under Alternative III, if a global erosion control strategy were implemented, the State-jurisdictional wetland could be destroyed or disturbed. Consultation with NYSDEC would be required.

B.2.2.4 Endangered Species Act (16 U.S.C. 1531-1544)

The Endangered Species Act of 1973 mandates the protection of threatened and endangered species and critical habitats. The Act requires federal agencies to consult with the

U.S. Fish and Wildlife Service to ensure that actions do not jeopardize threatened or endangered species or result in the destruction or adverse modification of critical habitat. Rules for consultation by federal agencies are promulgated in 50 CFR Part 402 ("Consultation by Federal Agencies"). New York State endangered species laws are implemented under 6 NYCRR Part 182 ("Endangered and Threatened Species of Fish and Wildlife; Species of Special Concern"), which lists endangered species, threatened species, and species of special concern and prohibits taking such wildlife except under permit of NYSDEC. New York State-listed threatened and endangered plant species receive limited protection under 6 NYCRR Part 193.2 ("Protected Trees") and Part 193.3 ("Protected Native Plants").

The U.S. Fish and Wildlife Service has notified DOE that no species or critical habitat protected under the Act are present (see Appendix P). Site surveys have confirmed this. Therefore, DOE is not required to take further action under the Act unless a federally protected species would be disturbed by the actions.

Under Alternatives I and II, the reservoir dams would be removed, thus destroying a stand of a State-protected species, Rose Pinks. Therefore, NYSERDA would need to consult with NYSDEC to minimize disturbance of this critical habitat. Under 6 NYCRR Part, the protected species could only be removed by permission of the landowner (NYSERDA).

The NYSDEC Bureau of Wildlife has not notified DOE of protected species at the Center, but they have identified a 1,620-ha (4,000-acre) area, including all of the Center, on the State critical habitat map as a deer wintering ground. Implementation activities potentially impacting confirmed State-listed, threatened and endangered plant species and the State critical habitat would need to be coordinated through the Bureau of Wildlife.

B.2.2.5 Fish and Wildlife Coordination Act of 1965 (16 U.S.C. 661-666c)

The Fish and Wildlife Coordination Act of 1965 ensures that fish and wildlife resources receive equal consideration with other resources during project planning involving water resources larger than 4 ha (10 acres). The Act requires federal agencies to consult with the U.S. Fish and Wildlife Service and state agencies to assess impacts on wildlife resources and to modify project plans by "justifiable means and measures" to prevent loss or damage to those resources. DOE must comply with the Act and inform the U.S. Fish and Wildlife Service Regional Office and NYSDEC of their intentions. The U.S. Fish and Wildlife Service and the State agency would then produce a Fish and Wildlife Coordination Act Report. The Fish and Wildlife Coordination Act would apply to Alternatives I and II, where the reservoirs would be removed.

B.2.3 <u>Land Uses and Resources</u>

Completing the West Valley Demonstration Project (WVDP) and closure or long-term management of facilities at the Center will mostly occur on the Project Premises and the New York State-licensed disposal area (SDA). The Cattaraugus County Land Use Plan was evaluated to determine if the proposed closure activities are inconsistent with development policies in Cattaraugus County (Cattaraugus County Planning Board 1978, updated 1982).

The land use plan calls for encouraging continued use of the Center with extreme caution regarding public health and safety and protection of the environment.

In terms of environment and conservation, the land use plan encourages curtailing air and water pollution and aiding agriculture in nonpoint source pollution control, maintaining watershed drainage courses and cooperating with basin and wetlands planning boards, conserving and enhancing open-space areas, retaining and developing forested land, preserving and promoting cleanup of areas of natural beauty, and encouraging local enforcement of existing State and local laws and ordinances regarding land use.

B.2.4 Cultural Resources

Three primary federal statutes regarding the protection and preservation of cultural and archaeological resources are applicable to the completion of the WVDP and closure or long-term management of facilities at the Center. The National Historic Preservation Act (16 U.S.C. 470 et seq.) contains procedures for evaluating historic properties and consulting with interested parties, and the Archaeological and Historic Preservation Act (16 U.S.C. 469 et seq.) establishes procedures for preserving historical and archaeological resources. The American Indian Religious Freedom Act (42 U.S.C. 1996) protects Native Americans' right of freedom to believe, express, and exercise traditional religions.

The National Historic Preservation Act establishes the National Register of Historic Places (National Register) and requires federal agencies to consider the effects of their actions on cultural resources that are listed or are eligible for listing in the National Register. To evaluate possible effects of the proposed actions, Section 106 of National Historic Preservation Act requires an agency to identify and evaluate historic properties, assess the effects of the project on the properties, consult with the State Historic Preservation Office (SHPO), and solicit comments from the Advisory Council on Historic Preservation. Recent amendments to National Historic Preservation Act emphasize the need to solicit concerns from Native Americans to protect traditional religions and culturally important properties.

The implementing regulations for the Act of 1980 are contained in 36 CFR Part 800 ("Protection of Historic and Cultural Properties"). Additional regulations pursuant to the National Historic Preservation Act include 36 CFR Part 78 ("Waiver of Federal Responsibilities Under Section 110 of the National Historic Preservation Act") and 36 CFR Part 60 ("National Register of Historic Places") which collectively establish criteria for evaluating the eligibility of cultural resources for National Register listing. The New York State Historic Preservation Act (New York State Parks, Recreation and Historic Preservation Law, Article 14) contains provisions for protecting and preserving cultural resources in the State. The implementing regulations for this Act are in 9 NYCRR Part 426 ("Authority and Purpose; Definition of Terms; Notification and Inquiries"), 9 NYCRR Part 427 ("State Register of Historic Places"), and 9 NYCRR Part 428 ("State Agency Activities Affecting Historic or Cultural Properties").

The New York SHPO has determined that the West Valley Demonstration Project Site is not eligible for inclusion in the National Register of Historic Places (SHPO 1995), and there are no other facilities at the Center that are included on the National Register of Historic Places.

If erosion control strategies are implemented as part of a selected alternative, there is the potential for disturbing areas that have a higher potential for prehistoric archaeological resources along stream banks. Therefore, additional investigations could be required to evaluate prehistoric archaeological resources if certain areas were disturbed as required under 36 CFR Part 800 and 9 NYCRR Part 426.

Communications are in progress with the Indians of the Seneca Nation to determine if there are artifacts, traditional burial grounds, or sacred areas that could be affected by completing the WVDP, as required under the American Indian Religious Freedom Act.

B.3 ACTION-SPECIFIC REGULATIONS

Action-specific regulations set controls or restrictions on activities related to the management of radioactive and hazardous substances or constituents and could be triggered depending on the selected alternative. For example, treatment and storage standards under New York's hazardous waste management program would be applicable if hazardous or mixed waste were generated by the actions. Potential action-specific regulations are summarized below.

B.3.1 U.S. Nuclear Regulatory Commission Regulations

Procedures for the closure or long-term management of facilities at the Center are established under the U.S. Nuclear Regulatory Commission (NRC) operating license CSF-1. Upon completion of the WVDP, NYSERDA has several regulatory options under the existing NRC operating license for long-term management or closure of facilities at the Center. Four regulatory options would be most likely available for NYSERDA:

- *Termination of the Existing 10 CFR Part 50 License.* This would be the licensing action for decommissioning to allow unrestricted use [Alternative I (Removal)]. The regulatory requirements to terminate an operating license are specified in 10 CFR Part 50 ("Domestic Licensing of Production and Utilization Facilities"). NRC would need to consider the intent of 10 CFR Part 51 ("Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions"), which requires that a geologic repository be available for disposition of all high-level [radioactive] waste (HLW) and a disposal site be available for low-level [radioactive] waste (LLW), mixed waste, and transuranic wastes.

- *Amendment to Current License.* The existing license has provisions for 10 CFR Parts 20 ("Standards for Protection Against Radiation"), 30 ("Rules of General Applicability to Domestic Licensing of Byproduct Material"), 40 ("Domestic Licensing of Source Material"), and 70 ("Domestic Licensing of Spent Nuclear Fuel"). The current license permits the disposal of solid radioactive waste generated by operation of the facility by burial in the soil, in accordance with the technical specifications. Therefore, it could potentially be amended to permit solid radioactive waste disposal in aboveground structures. A licensing amendment could potentially be applicable under Alternative II (On-Premise Storage) for the storage of LLW, Alternative III (In-Place Stabilization) for LLW disposal on the Project Premises, or under Alternative IV (No Action: Monitoring and Maintenance) for long-term monitoring and maintenance.

- *License Conversion.* A third licensing option is to convert the 10 CFR Part 50 license to some other type of license, for example, a license under 10 CFR Part 61 ("Licensing Requirements for Land Disposal of Radioactive Waste"). This option would limit the extent of decommissioning of facilities at the Center. The choice of license would be driven by the ultimate use of the site by NYSERDA. A license conversion could be applicable where for Alternative IIIA [In-Place Stabilization (Backfill)] or for Alternative IIIB [In-Place Stabilization (Rubble)], where disposal on the Project Premises is evaluated.

- *Rulemaking.* This process is implemented where existing rules do not particularly apply to a given situation. For example, rulemaking could be considered to permit monitored retrievable storage of wastes under Alternative II (On-Premises Storage), because current rules for storage under 10 CFR Part 72 ("Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste") only apply to spent nuclear fuel and solidified HLW.

B.3.2 New York State Department of Environmental Conservation Radioactive Waste Facility Permitting

Regulatory options for closing the SDA would include terminating or modifying the existing 6 NYCRR Part 380 ("Rules and Regulations for Prevention and Control of Environmental Pollution by Radioactive Materials") Land Burial permit, depending upon the selected alternative.

Design, construction, operation, site safety planning, monitoring, closure, and institutional control of new LLW land disposal facilities used for the permanent disposal of LLW are regulated under 6 NYCRR Part 383 ("Regulation of Low-Level Radioactive Waste (LLRW) Disposal Facilities: Design, Construction, Operation, Closure, Post-Closure,and Institutional Control"). A land disposal facility includes both subsurface and aboveground methods of disposal. Only aboveground disposal is evaluated in this EIS. Regulations in 6 NYCRR Part 382 ("Regulation of LLRW Disposal Facilities: Certification of Proposed Sites and Disposal Methods") set the minimum requirements for new disposal sites and disposal methods. Permits for new disposal facilities include 6 NYCRR Part 382 requirements by reference under 6 NYCRR Part 383. The equivalent federal regulations are contained in 10 CFR Part 61, which are discussed in detail in Section 3.9. These regulations would be applicable if the selected alternative required a state permit for a new LLW disposal facility.

B.3.3 Resource Conservation and Recovery Act

The regulations under the Resource Conservation and Recovery Act, 42 U.S.C. 6901 et seq., as amended by the Hazardous and Solid Waste Amendments of 1984, Pub. L. No. 98-616, 98 Stat. 3221 (1984), and the Federal Facility Compliance Act of 1992, Pub. L. No. 102-386, 106 Stat. 1505 (1992) (collectively referred to as "RCRA") and the regulations of New York's hazardous waste management program would apply to closure of facilities at the Center either having interim status or designated as solid waste management units. These facilities are identified in Chapter 3.

The Federal and State Facility Compliance Agreement was negotiated by and between EPA, NYSDEC, DOE, NYSERDA, and West Valley Nuclear Services Company, Inc. (WVNS). The Federal and State Facility Compliance Agreement specifies terms and conditions under which DOE, NYSERDA, and WVNS shall characterize, store, treat, and minimize mixed wastes prohibited form land disposal and directs DOE and NYSERDA to achieve compliance with certain interim status treatment and storage requirements found in 6 NYCRR Parts 370 through 373 and 376 ("Land Disposal Restrictions") (EPA 1992). The requirements of the Federal and State Facility Compliance Agreement would apply during the implementation phase only if its current expiration date of March 1998 is extended beyond the year 2000. Mixed waste handling and management at the container management area (Alternatives I, II, and III) would have to conform with the Federal Facility Compliance Act, including documentation and accountability of the amounts and characteristics of wastes before and after processing in this facility (DOE 1995).

B.3.4 Air Quality

Action-specific air quality regulations would be applicable to emission-producing closure activities (such as construction, excavation, and demolition) and vehicle emissions. Treatment processes at the container management area (to be constructed under Alternatives I through III) may also produce emissions. Implementation phase activities at Center that emit air pollutants must comply with applicable federal, State, and local requirements to control and abate air pollution (see Section B.1.3).

Emissions of the criteria pollutants would be expected during the implementation phase of Alternatives I (Removal), II (On-Premise Storage), and III (In-Place Stabilization) when earthmoving and demolition activities would occur. Cattaraugus County is located in the Northeastern Ozone Transport Region, which currently is not in attainment for ozone; however, in addition to meeting NAAQS air emissions during the implementation phase would have to meet limits imposed by EPA for ozone in this region. NESHAPs, particularly for radionuclides, would be applicable during the operation of facilities at the container management area (e.g., the wastewater treatment area).

B.3.5 Surface Water

As noted in Section B.1.1, wastewater discharges from the Center are regulated by New York State's SPDES permit program. While both the federal and state programs have historically permitted process and certain nonprocess wastewater discharges, the scope of the NPDES program has recently been expanded to include permits for storm water discharges (40 CFR Part 122, "EPA Administered Permit Programs: The National Pollutant Discharge Elimination System").

NYSERDA and DOE jointly applied to New York State for an Individual Storm Water Permit in October 1992. Under an effective storm water permit, a storm water pollution prevention plan must be prepared for review and approval by NYSDEC. The permit also requires that all construction activities be conducted in conformance with State-derived performance standards for erosion control and storm water management. These standards include provisions for treating the first 1.27 cm (0.5 in.) of site runoff and designing storm water control systems for 2-, 10-, and 100-yr state 24-hour storm events.

A SPDES permit would be necessary for the mobile wastewater treatment units that would be used at the end of the implementation phase under Alternatives I through III. The container management area has been conceptualized as using evaporation rather than discharging liquid waste streams.

A SPDES permit that includes provisions for long-term monitoring of surface water and surface water discharges could be required under Alternative IV. For all alternatives, the potential also exists for degradation of surface waters because of sedimentation. Significant addition or modification to existing facilities and discharges would require modifying the SPDES permit. The wastewater treatment facilities constructed under Alternatives I, II, III, and IV would need to be approved by NYSDEC.

B.3.6 Groundwater

To protect groundwater sources, the Safe Drinking Water Act mandated the establishment of a permit program that regulates the construction and operation of underground injection wells. New York State is authorized to administer this program under 6 NYCRR Part 370 ("Hazardous Waste Management System—General"). Closure of the injection well in Waste Management Area 11 would be conducted in accordance with these regulations.

B.3.7 Soil

Existing guidelines or standards for nonradiological soil decontamination are not directly applicable to the implementation phase of each alternative. NYSDEC has issued a Technical and Administrative Guidance Memorandum as guidance for establishing nonradiological soil cleanup levels at federal and state Superfund sites (NYSDEC 1994). Action levels for hazardous concentrations in soils are also given in 40 CFR Part 264, proposed Subpart S [55 FR 30798-30882 (FR 1990)]. These action levels are applicable to solid waste management units at hazardous waste management facilities permitted under RCRA. As discussed in Section 4.10 and in Appendix C, RCRA corrective action is not likely to be required for facilities on the Project Premises based on the RFI sampling results.

B.3.8 Radiation Protection

Activities undertaken during site closure must be conducted in a manner that protects public health and safety from exposure to radiation. Under the Atomic Energy Act (AEA), DOE is responsible for developing, using, and controlling atomic energy for the common defense and security and for conducting and assisting research related to the development of atomic energy uses. DOE implements these responsibilities through Orders that include Orders specific to environmental and radiation protection. DOE Orders are discussed in Section B.3.8.1. The AEA gives NRC responsibility for licensing and regulating commercial uses of atomic energy. NRC has responsibility for radiation protection under 10 CFR Part 20, which establishes dose and concentration limits for protection of workers and the public. Under the New York Agreement State Program, New York implements these regulations under 6 NYCRR Part 380. These regulations are discussed in Section B.3.8.2.

The Nuclear Waste Policy Act (42 USC 10101 et seq.) governs the disposal of high-level radioactive waste and spent nuclear fuel. EPA has promulgated public health and safety radiation protection standards under the Nuclear Waste Policy Act, which are briefly discussed in Section B.3.8.3.

B.3.8.1 DOE Orders

DOE Orders for worker and public radiation protection and environmental safety and health would be applicable to activities conducted by DOE during the implementation phase of Alternatives I (Removal), II (On-Premises Storage), III (In-Place Stabilization), and IV (No Action: Monitoring and Maintenance). In some cases DOE Orders have been codified. Applicable DOE Orders and corresponding federal codes are summarized in Table B-3.

B.3.8.2 Standards For Protection Against Radiation

The regulations promulgated in 10 CFR Part 20 establish standards for protection against ionizing radiation resulting from activities conducted under licenses issued by NRC. The regulations apply to NRC licensees that receive, possess, use, transfer, or dispose of byproduct, source, or special nuclear material. The current 10 CFR Part 50 license, however, is in abeyance during the period that DOE is in possession of the Project Premises.

New York State has established standards for radiation worker protection under 12 NYCRR Part 38 ("Ionizing Radiation Protection"). New York State is authorized by NRC to establish standards to control the disposal and discharge of radioactive materials under 6 NYCRR Part 380; however, 6 NYCRR Part 380 regulations do not apply to DOE or its contractors. After completing Alternatives II (On-Premises Storage) and III (In-Place Stabilization), a 6 NYCRR Part 380 license might be needed to store or stabilize in place the nuclear material remaining on the Project Premises if NRC discontinues licensing. Activities would have to be conducted within an established radiation protection program plan to ensure that doses to individual members of the public are ALARA. Under 6 NYCRR Part 380, the maximum total effective dose equivalent for individual members of the public is 0.10 rem/yr.

Table B-3. Description of Applicable DOE Orders

DOE Order	Description	Applicability
General Environmental Protection Program, DOE Order 5400.1	Serves as umbrella directive for oversight of all DOE environmental programs. Establishes requirements, authorities, and responsibilities for DOE operations to ensure control of environmental pollution and compliance with environmental protection laws and Executive Order 12088. Establishes guidelines for effluent monitoring and environmental surveillance programs for radiological and nonradiological constituents in all media.	Implementation phase actions under Alternatives I, II and III must comply with federal and state environmental protection laws. Would apply to effluents and emissions at the container management area under Alternatives I, II, and III.
Hazardous and Radioactive Mixed Waste Program, DOE Order 5400.3	Specifies the management of hazardous and radioactive mixed waste will comply with the requirements of Atomic Energy Act (AEA). The Order establishes hazardous and radioactive mixed waste policies and requirements, and implements Resource Conservation and Recovery Act (RCRA) requirements. RCRA applies to the hazardous and mixed wastes to the extent that it is consistent with the requirements of the AEA. The hazardous portion of mixed waste is under RCRA jurisdiction, and any radionuclides in the wastes are under DOE jurisdiction.	Mixed wastes generated under Alternatives I, II, and III must be handled in accordance with RCRA and AEA requirements.
Radiation Protection of the Public and the Environment, DOE Order 5400.5 (10 CFR Part 834, final rule expected 1995)[a]	Establishes requirements to reduce and quantify radioactive releases. Specifies applicable criteria for protection of the public. Establishes residual radioactive materials criteria for the site and operations. Specifies best available technology must be used to treat wastes before disposal.	May influence cleanup criteria of site environmental media and facilities, and treatment technologies used at the container management area under Alternatives I, II, and III. Radiation dose limits for the public are:

Dose Limit	Average Time	Standard, effective dose equivalent
All exposure modes	annual	100 mrem
Airborne emissions	annual	10 mrem
Management & storage of spent nuclear fuel, high-level waste, and transuranic, HLW, and TRU waste at disposal facilities	annual-whole body annual-organs	25 mrem 75 mrem
Drinking water	annual	4 mrem
Radium-226/-228		$5x10^{-9}$ µCi/mL
Gross alpha, includes Radium-228, excludes radon and uranium		$1.5x10^{-8}$ µCi/mL

Table B-3. Description of Applicable DOE Orders (continued)

DOE Order	Description	Applicability
Environmental Protection, Safety and Health Protection Standards, DOE Order 5480 (10 CFR Part 830, partial final rule effective May 1994, complete final rule by June 1996)[b]	Sets forth environmental safety and health protection standards applicable to all DOE operations and its contractors.	Would apply to implementation phase actions under Alternatives I, II, and III. These activities would have to be performed in accordance with approved health and safety protocols.
Requirements for Radiation Protection, DOE Order 5480.11 (10 CFR Part 835)	Establishes radiation protection standards and requirements for workers from ionizing radiation. Gives concentration guidelines for airborne effluents, liquid effluents, and drinking water and establishes exposure standards aimed at achieving ALARA dosage rates for individuals and population groups in uncontrolled areas.	Would apply to implementation phase actions under Alternatives I, II, and III. Would apply to effluents and emissions at the container management area under Alternatives I, II, and III. The radiation protection standards limiting values for assessed dose from exposure of workers to radiation are: Organ — Standard, annual dose equivalent Stochastic effects — 5 rem Non-stochastic effects- Lens of eye — 15 rem Extremity — 50 rem Skin of whole body — 50 rem Organ or tissue — 50 rem Unborn child, entire gestation period — 0.5 rem
Radioactive Waste Management, DOE Order 5820.2A	Identifies policies, guidelines, and minimum requirements by which DOE manages its radioactive and mixed waste and contaminated facilities. Covers all types of radioactive waste, as well as hazardous waste and mixed waste. One objective is to protect groundwater and soil resources to avoid future remedial actions. Although the requirements are established for the management of radioactive wastes, they are also designed for RCRA compliance with regard to hazardous waste.	Would apply to waste handling and management during implementation phase actions and at the container management area under Alternatives I, II, and III. Applies to waste management associated with monitoring and maintenance under Alternative IV.

a. Ringie (1995).
b. 59 FR 57054 (FR 1994a).

The dose in any unrestricted area from external radioactive sources must not exceed 0.002 rem in any one hour and 0.05 rem/yr.

B.3.8.3 Nuclear Waste Policy Act

The Nuclear Waste Policy Act of 1982 governs the disposal of high-level radioactive waste and spent nuclear fuel. Both EPA and NRC have promulgated regulations pursuant to the Act that establish standards to protect the public and to license disposal repositories. Under the Nuclear Waste Policy Act, EPA has promulgated standards to protect public health and safety in 40 CFR Part 191 ("Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Wastes") for NRC or Agreement State regulated facilities. The standards are 25 mrem for whole body, 75 mrem for thyroid, and 25 mrem for critical organs (other than the thyroid). Annual dose equivalent standards under 40 CFR Part 191 could be used as guidelines for high-level waste, transuranic waste, or spent nuclear fuel storage under Alternative II (On-Premises Storage).

B.3.9 Residual Radioactivity

NRC sets permissible levels of radiation in unrestricted areas under 10 CFR Part 20.1302 ("Permissible Levels of Radiation in Unrestricted Areas"). NRC will approve an area for unrestricted use if residual radiation levels are not likely to cause any individual to receive an annual dose to the whole body over 0.5 rem.

NRC is considering amending 10 CFR Part 20 to provide specific radiological criteria for decommissioning soils and structures, and remediation of residual radioactivity resulting from the possession or use of source, byproduct, and special nuclear material [59 FR 21643 (FR 1994b)]. The limit for release of a site would be 15 mrem/yr total effective dose equivalent for residual radioactivity distinguishable from background. If promulgated, these criteria would be applicable to Alternatives I, II, and III where all or parts of the Project Premises would be released for unrestricted use. The amendment would also consider land use restrictions or other types of institutional controls to allow terminating NRC licenses and releasing sites under restricted conditions if decommissioning criteria for soils and structures cannot be met. A final rule is expected in August 1995 [59 FR 21643 (FR 1994b)]. A 15 mrem/yr release criteria was assumed in this EIS as criteria for cleanup and stabilization of contaminated facilities and to estimate the volume of contaminated soil that would have to be managed under Alternatives I, II, and III.

EPA standards for protection of the public from residual radioactivity in the environment from nuclear fuel cycle operations are given in 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations." The whole body annual dose equivalent to a member of the public should not exceed 25 mrem.

NYSDEC issued a Technical and Administrative Guidance Memorandum for soils contaminated with radioactive materials (NYSDEC 1993). This guidance established a dose limit of 10 mrem over background in any 1 year after cleanup for the maximally exposed individual members of the public. The dose limit applies to land areas released for unrestricted use.

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APPENDIX C

DESCRIPTION OF WASTE MANAGEMENT AREAS, PROJECTED WASTE INVENTORIES, AND ENVIRONMENTAL CONTAMINATION

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Figure C-15. Contaminated Surface Soil in the Cesium Prong Exceeding 15 mrem/yr. . C-87

APPENDIX C

DESCRIPTION OF WASTE MANAGEMENT AREAS, PROJECTED WASTE INVENTORIES, AND ENVIRONMENTAL CONTAMINATION

C.1 INTRODUCTION

The purpose of Appendix C is twofold: (1) to describe the facilities in each of the 12 waste management areas (WMAs) (see Figure C-1 for WMAs 1 through 10 and Figure C-2 for WMAs 11 and 12) on the Project Premises, the New York State-licensed disposal area (SDA), and in other areas of the Project Premises and (2) to characterize and quantify, to the extent possible, radiological and hazardous chemical contamination at the facilities and the surrounding environment in the year 2000, at the time the alternatives could be implemented. This information supports the definition of source terms for the risk assessment and the development of waste volume estimates.

To give a complete description of the condition of the facilities in the year 2000, all components of the facilities were addressed.

- For buildings:
  - — The use, size, construction materials, types of major equipment or other structures, and current status
  - — Projected radioactive inventory of building surfaces and equipment at closure
  - — The type and amount of hazardous materials [e.g., hazardous chemicals, polychlorinated biphenyl (PCB)-contaminated capacitors or transformers, and lead-based paint] that would have to be managed as hazardous waste
  - — A characterization of stored waste.
- For stored waste:
  - — The type of wastes
  - — Characterization of the waste (radiological and hazardous)
  - — Estimated volume present at the end of HLW solidification and before implementation of the alternatives.
- For buried waste:
  - — The type of wastes

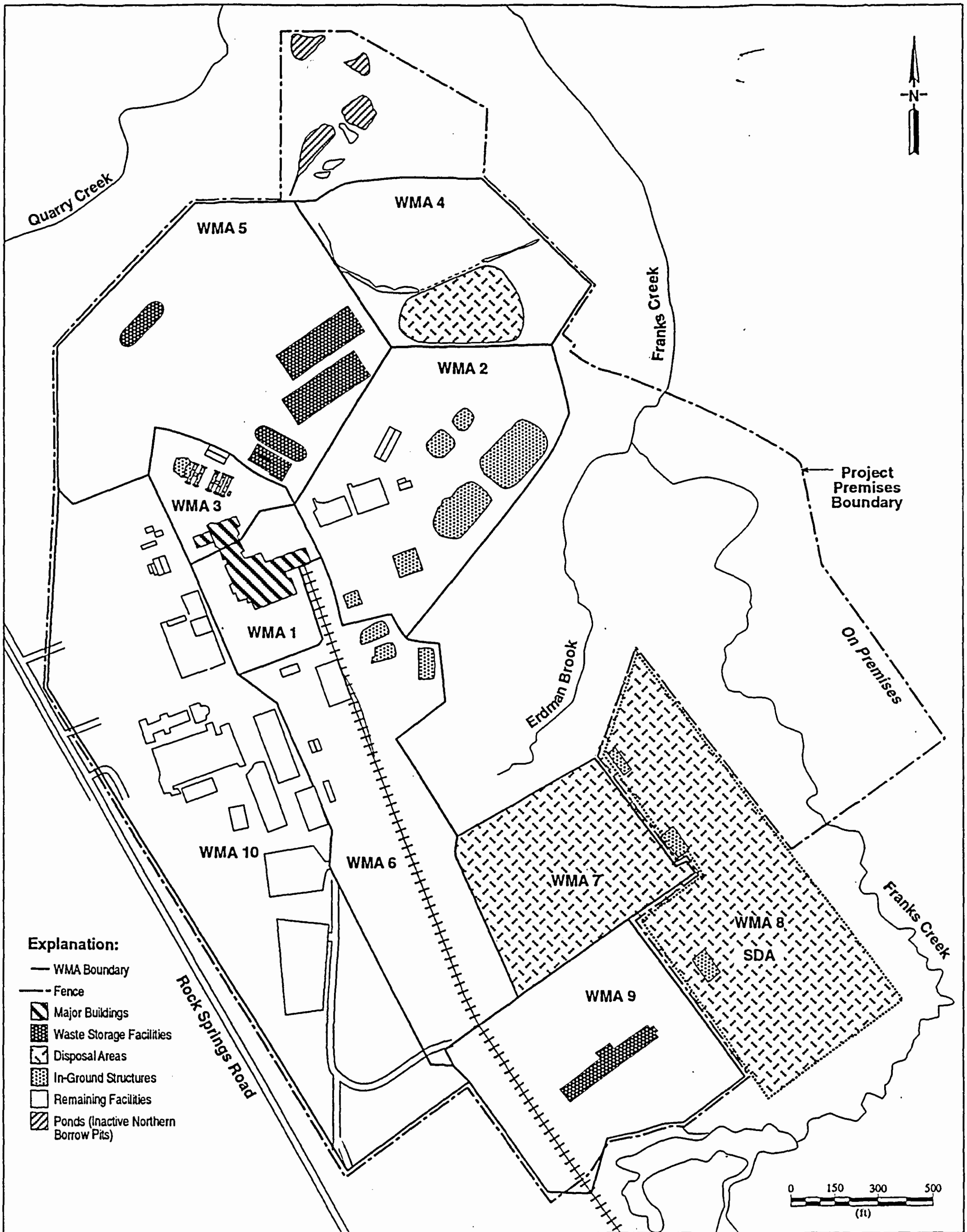


Figure C-1. Waste Management Areas 1 through 10.

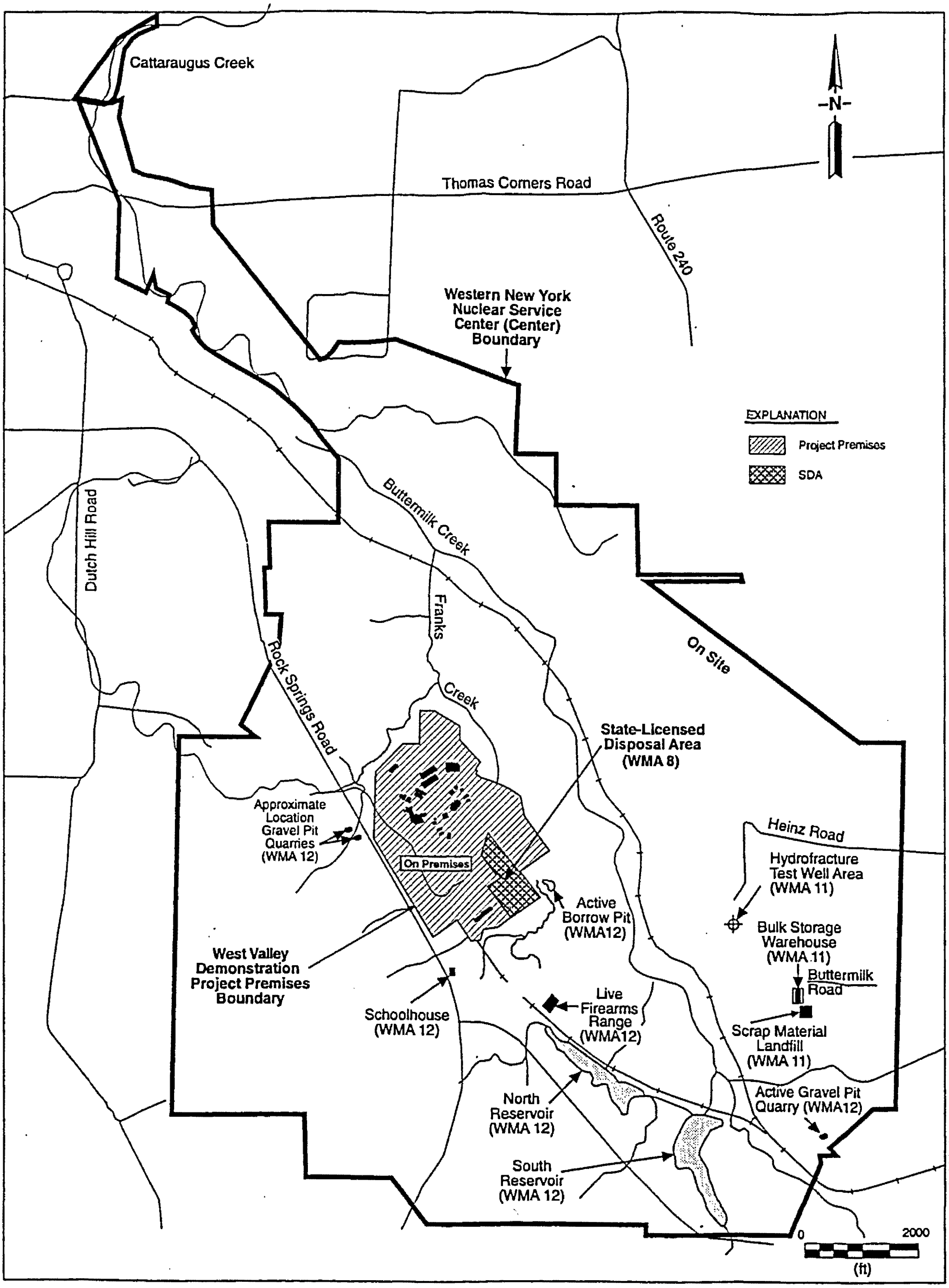


Figure C-2. Waste Management Areas 11 and 12.

- Characterization of the waste (radiological and hazardous)
- Estimated volume that would be retrieved if excavation was performed when implementing an alternative
- The volume of soil or sediments that is intermixed with buried waste and may become contaminated
- Characterization and estimated volume of leachate from buried waste in the disposal areas.

- For environmental contamination:
  - The definition of action levels for soil and groundwater, which would be used to determine if soil would have to be removed or groundwater treated
  - Characterization of the contamination (radiological and hazardous)
  - The depth and area of soil contamination
  - Estimated volume of soil above an action level.

Refer to Chapter 3 of this Environmental Impact Statement (EIS) for the estimated volumes that would be generated by implementing each alternative.

Much of the radiological characterization information presented in this EIS has been adapted from the waste characterization reports prepared by West Valley Nuclear Services, Inc. (WVNS) to write this EIS. Waste characterization reports were prepared for all facilities having significant radiological contamination. The radionuclide inventories in the waste characterization reports were developed based on reviews and analyses of multiple sources of inventory information. Complex modeling was necessary to predict future radionuclide inventories and contamination levels in some cases. For example, complex modeling was required to accurately predict contamination levels for facilities used in the West Valley Demonstration Project (WVDP) before implementation of the alternatives.

In many cases, this appendix provides a qualitative description of the radionuclide inventories present at contaminated facilities, followed by quantitative estimates and a reference to the relevant waste characterization reports. Because of the number of different and sometimes complex methods used to estimate inventories, limited information is presented in this EIS regarding the specific methods used. Waste characterization reports should be consulted to determine the specific methods used to estimate radionuclide inventories for various facilities and contaminated equipment.

This appendix limits the consideration of radiological contaminants to those radionuclides important for either the risk assessment or the accident consequence assessment because they were a significant contributor to (i.e., would have an impact on) the risk.

Appendix E describes the screening process used to identify the significant risk contributors, an activity threshold of 10 μCi was established for dismissing a specific radionuclide from further consideration in this EIS.

In many cases, specific radionuclide inventories for portions of facilities were not estimated because available general information indicated that the radionuclide activities were low enough that they would not impact the risk assessment. Therefore, expending additional resources to derive specific inventory estimates was not warranted. Generally, specific radionuclide inventories were not defined if (a) following a review of all available information, the total inventory for that portion of the facility or WMA was less than one percent of the total inventory and (b) incorporating the inventory into the risk assessment for that facility or WMA would not change the maximum calculated individual or collective doses. (Including these inventories in the risk assessment would probably impact the total doses calculated for individual alternatives by less than 10 percent, which is much less than the total errors inherent in the risk assessment process.)

Facilities with a radionuclide inventory that was a significant risk contributor (referred to as key facilities) are shaded in the WMA figures.

This appendix is organized by WMA. Section C.2 describes the major buildings, in-ground structures, stored waste, buried waste, remaining facilities by WMA, and other features or areas on the Project Premises which are not located within a WMA. The environmental (soil and groundwater) contamination that could require management during implementation of an alternative is described by WMA in Section C.3.

C.2 BUILDINGS AND FACILITIES

This section describes the facilities listed in Table 1-1 [the WMA buildings and facilities at the Western New York Nuclear Service Center (Center)] and gives information about technology options identified in the description of alternatives in Chapter 3. The projected radiological and waste inventories in the year 2000 (when implementation of an alternative would begin) are also discussed. Based on available data, if neither radiological nor hazardous chemical contamination is expected to be present, it is noted after the facility description.

C.2.1 Waste Management Area 1

WMA 1 (see Figure C-3) covers 1.6 ha (4 acres) and includes the process building, 01/14 building, utility room, laundry room, the plant office building, and an electrical substation. The buildings and remaining facilities contaminated with radionuclides are the process building and the 01/14 building. The process building has significant radionuclide contamination (up to approximately 3,000 Ci of strontium-90 and 3,400 Ci of cesium-137). Two structures adjacent to the process building—the utility room and the laundry room—have low levels (<0.5 Ci for the utility room) of radiological contamination. The residual radioactivity in these structures is low enough that it did not drive the risk assessment performed for WMA 1. Buildings and facilities in WMA 1 will have small volumes (less

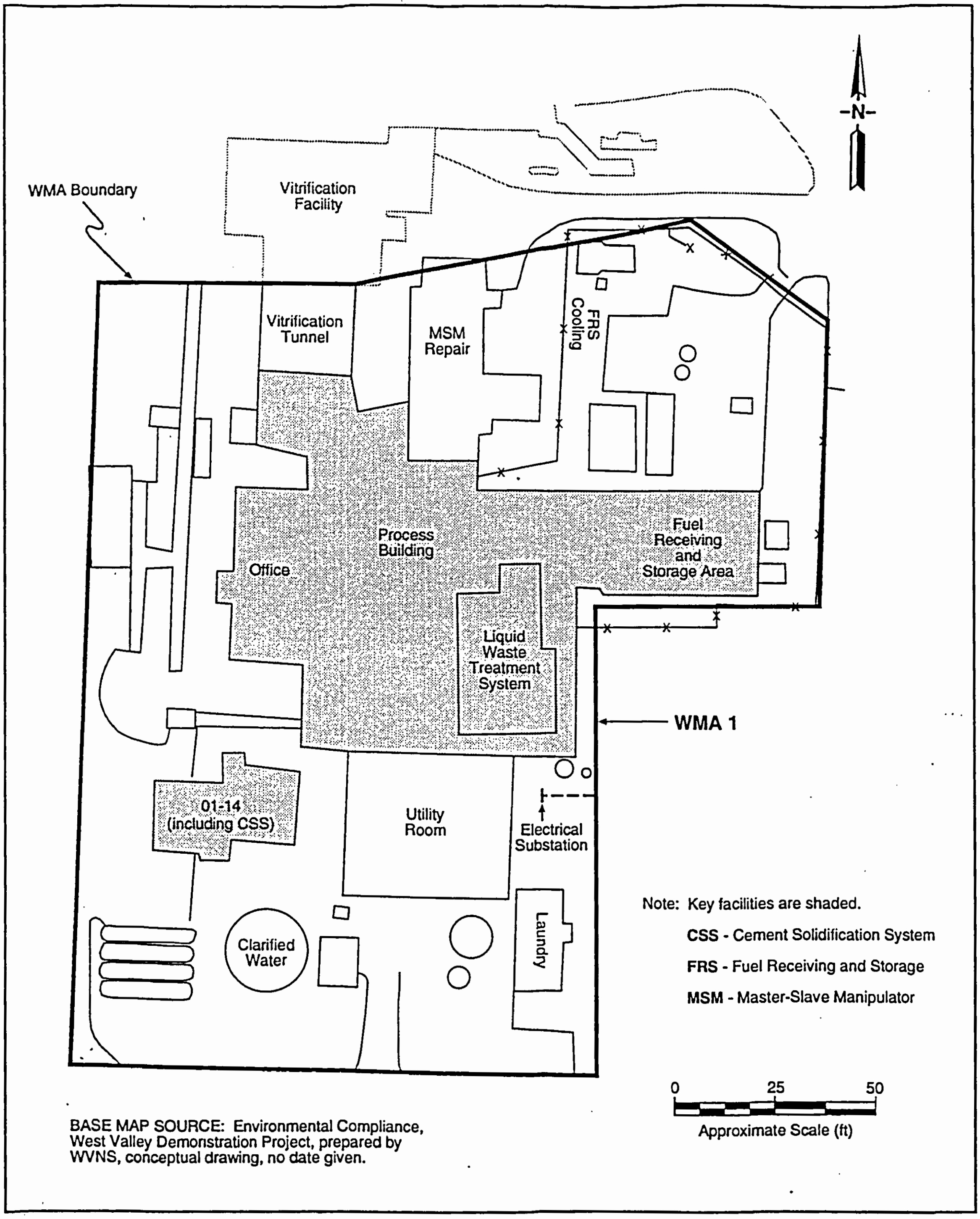


Figure C-3. Waste Management Area 1—Process Building Area.

than 140 m³ [5,000 ft³]) of hazardous or mixed waste. Radiologically contaminated soil and groundwater in WMA 1 originated from the process building area.

C.2.1.1 Process Building

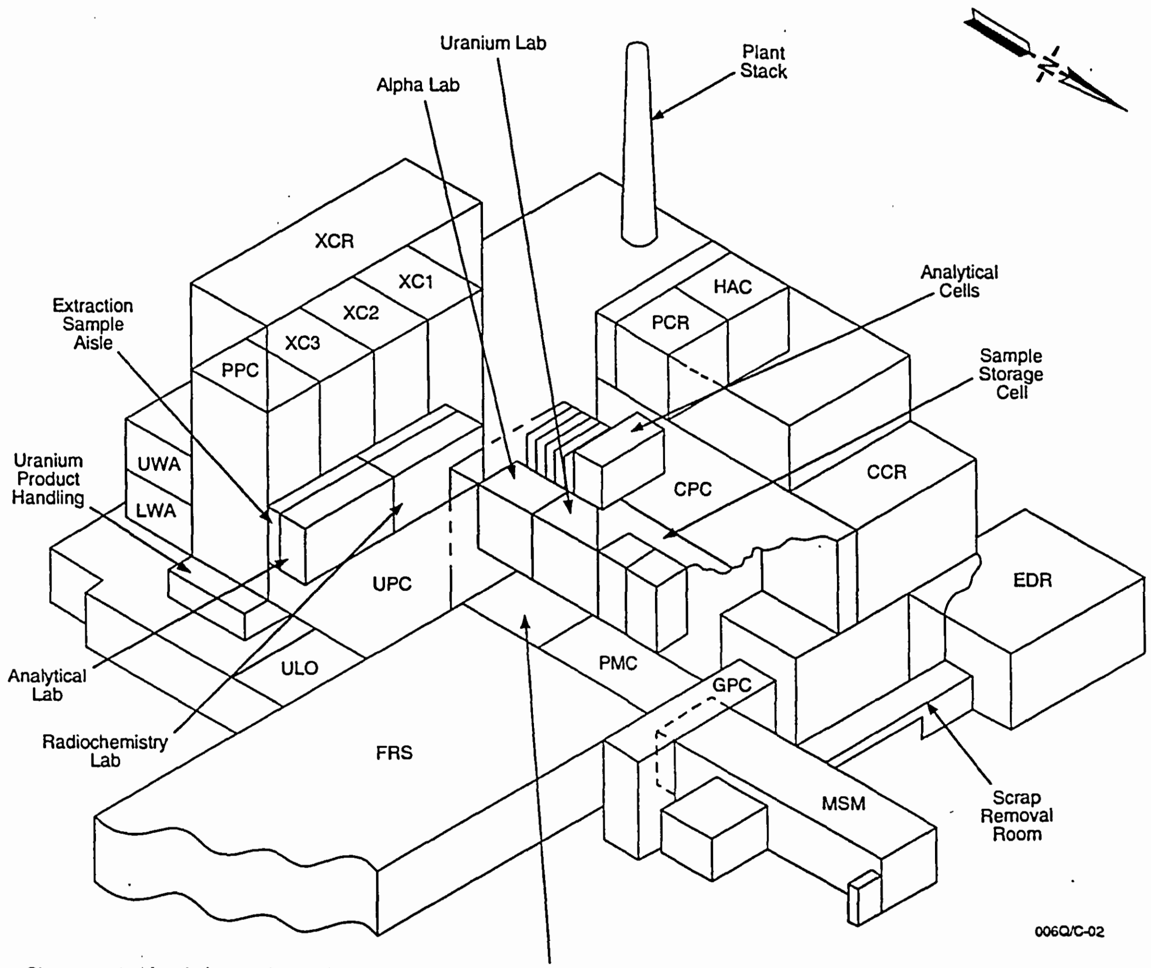
Description of Facility. Nuclear Fuel Services, Inc. (NFS) used the process building to recover uranium and plutonium from irradiated fuel. Part of the facility has been reused by the WVDP to house the evaporators for the liquid waste treatment system, and the chemical process cell (CPC) will be used to store solidified HLW generated by the vitrification facility. Other facilities used by the WVDP include laboratories, hot cells, and a utility room.

The process building was designed for remote mechanical and chemical processing, which occurred within a few centrally located cells (e.g., the CPC) and was controlled from the nearby outside cells (see Figure C-4). These cells are constructed of reinforced concrete with 0.3 to 2-m (1 to 6-ft) thick walls, floors, and ceilings. The reinforced concrete walls are surrounded by lighter concrete and masonry wall construction and metal deck flooring. The process building covers an area of approximately 82 x 40 m (270 x 130 ft). The adjacent fuel receiving and storage area, on the east side of the process building, measures approximately 40 x 15 x 15 m (130 x 50 x 50 ft). An active ventilation system is used for contamination control; it moves air from less contaminated to more contaminated areas, exhausting through a high-efficiency particulate air filter and through the building stack.

The evaporation portion of the liquid waste treatment system is located within the eastern portion of the process building. It received liquid effluent from the supernatant treatment system and other WVDP activities and concentrated the effluent by evaporation. Then the concentrate was piped to the cement solidification system, located in the 01-14 building.

Projected Radionuclide Inventory. The *West Valley Demonstration Project, Process Building Characterization* estimates the radioactive material inventories in the process building rooms and cells based on a review and analysis of measurements conducted in the 1970s and 1980s (WVNS 1994a). Although most areas of the process building are contaminated to some extent, a few cells and rooms contain the most of the radioactive material. These areas, including the general purpose cell and the process mechanical cell, were highly contaminated as a result of fuel reprocessing operations and remain contaminated today. Other cells that were highly contaminated have since been decontaminated to accommodate the WVDP. Table C-1 gives estimates of the residual activities in the most contaminated cells and rooms based on the information presented in WVNS (1994a), with corrections for radioactive decay to January 1, 2000. In general, the decay corrections reduced the activity estimates for cesium-137 and strontium-90 almost by a factor of two, but the activity estimates for uranium and plutonium isotopes did not change significantly.

Several factors were considered in deriving the process building residual inventories presented in Table C-1. Radionuclides that may be present but are not listed in the table contribute little to the short-term and long-term risk (see Appendix E for an explanation of the rationale used to eliminate radionuclides from consideration. The process building



Note: Shown rotated for clarity -- not to scale

CCR = Chemical Process Cell Crane Room
CPC = Chemical Process Cell
EDR = Equipment Decontamination Room
FRS = Fuel Receiving and Storage
GPC = General Purpose Cell
HAC = Hot Add Cell
LWA = Lower Warm Aisle
MSM = Master-Slave Manipulator Repair Shop
PCR = Process Chemical Room
PMC = Process Mechanical Cell
PPC = Product Purification Cell
ULO = Uranium Loadout Area
UPC = Uranium Product Cell
UWA = Upper Warm Aisle
XC1 = Extraction Cell #1
XC2 = Extraction Cell #2
XC3 = Extraction Cell #3
XCR = Extraction Chemical Room

Figure C-4. Detail of the Process Building.

Table C-1. Process Building Rooms and Cells that Will Have the Majority of Residual Activity[a]

	Activity (Ci) in Room/Cell[b,c]								
Radionuclide	CPC	XC1	XC2	GPC	LWC	OGC	PMC	PMC CR	Totals
H-3	1.1×10^{-4}	0.003	3.1×10^{-5}	0.011	0.0017	1.7×10^{-4}	0.012	1.2×10^{-4}	0.028
C-14	3×10^{-4}	0.0083	8.7×10^{-5}	0.031	0.0048	4.7×10^{-4}	0.033	3.5×10^{-4}	0.078
Co-60	0.022	0.62	0.0064	2.3	0.36	0.034	2.5	0.026	5.87
Sr-90	12	300	3.4	1,200	190	18	1,300	14	3,040
Tc-99	0.0038	0.11	0.0011	0.39	0.061	0.0059	0.42	0.0044	1.00
Cd-113m	0.0029	0.08	8.3×10^{-4}	0.29	0.046	0.0045	0.32	0.0033	0.75
Sb-125	4.2×10^{-4}	0.012	1.2×10^{-4}	0.043	0.0067	6.5×10^{-4}	0.046	4.8×10^{-4}	0.11
Sn-126	9.6×10^{-5}	0.0027	2.8×10^{-5}	0.0099	0.0015	1.5×10^{-4}	0.011	1.1×10^{-4}	0.025
I-129	8.9×10^{-7}	2.5×10^{-5}	2.6×10^{-7}	9.1×10^{-5}	1.4×10^{-5}	1.4×10^{-6}	9.8×10^{-5}	1×10^{-6}	2.3×10^{-4}
Cs-137	13	400	3.8	1,300	210	20	1,400	15	3,400
Eu-154	0.1	2.9	0.03	11	1.7	0.16	11	0.12	27
Ac-227	1.6×10^{-5}	4.4×10^{-4}	4.5×10^{-6}	0.0016	2.5×10^{-4}	2.4×10^{-5}	0.0017	1.8×10^{-5}	0.0041
Ra-228	1.6×10^{-6}	4.4×10^{-5}	4.5×10^{-7}	1.6×10^{-4}	2.5×10^{-5}	2.4×10^{-6}	1.7×10^{-4}	1.8×10^{-6}	4.0×10^{-4}
Pa-231	3.5×10^{-5}	9.8×10^{-4}	1×10^{-5}	0.0036	5.6×10^{-4}	5.5×10^{-5}	0.0039	4.1×10^{-5}	0.0075
Th-232	3.8×10^{-6}	1.1×10^{-4}	1.1×10^{-6}	3.9×10^{-4}	6.1×10^{-5}	5.9×10^{-6}	4.2×10^{-4}	4.4×10^{-6}	1.0×10^{-4}
U-232	0.0034	3.8	0.099	0.35	0.054	0.0053	0.38	0.0039	4.7
U-233	0.0052	5.8	0.15	0.54	0.084	0.0081	0.58	0.006	7.2
U-234	0.0025	2.8	0.072	0.25	0.04	0.0038	0.27	0.0029	3.4
U-235	5.5×10^{-5}	0.061	0.0016	0.0056	8.8×10^{-4}	8.5×10^{-5}	0.0061	6.3×10^{-5}	0.07
Np-237	5.9×10^{-5}	0.0016	1.7×10^{-5}	0.006	9.4×10^{-4}	9.1×10^{-5}	0.0065	6.8×10^{-5}	0.014
U-238	4.6×10^{-4}	0.51	0.013	0.047	0.0073	7.1×10^{-4}	0.051	5.3×10^{-4}	0.63
Pu-238	0.79	890	23	82	13	1.2	88	0.92	1,100
Pu-239	0.22	0.025	6.4	0.23	3.5	0.34	25	0.26	36
Pu-240	0.17	0.019	4.9	17	2.7	0.26	19	0.2	44
Pu-241	5.7	6400	170	590	92	8.9	640	6.6	7,900
Am-241	0.25	6.9	0.072	25	4.0	0.38	27	0.29	64
Cm-243	5.1×10^{-5}	0.0014	1.5×10^{-5}	0.0052	8.2×10^{-4}	7.9×10^{-5}	0.0056	5.9×10^{-5}	0.013
Cm-244	0.027	0.76	0.008	2.8	0.44	0.043	3.0	0.032	7.1

a. Activities derived from *West Valley Demonstration Project, Process Building Characterization* (WVNS 1994a), decayed to January 2000.
b. CPC = chemical process cell
XC1 = extraction cell 1
XC2 = extraction cell 2
GPC = general purpose cell
LWC = liquid waste cell
OGC = off-gas cell
PMC = process mechanical cell
PMC CR = process mechanical cell crane room
c. Refer to Figure C-4 for location of cells.

includes many rooms not listed in Table C-1; however, the risks from decontaminating these unlisted rooms is low relative to the risks from decontaminating the rooms listed in Table C-1 because the total inventories are generally several orders of magnitude lower in the unlisted rooms. Based on the information presented in WVNS (1994a) and the considerations described, the estimates presented in Table C-1 represent the available data to support the risk assessment for the alternatives.

The radioactive material in the rooms listed in Table C-1 is present as residual contamination in piping, filters, or process equipment; debris and loose contamination on floors and other surfaces; and fixed contamination that has been incorporated into structural material, such as concrete. Each type of radioactive material has a different release potential and is modeled differently for alternatives involving potential releases.

Several of the process building cells have been decontaminated to house the evaporation portion of the liquid waste treatment system. These cells include the extraction chemical room, extraction cell 3, product purification cell, upper warm aisle, lower warm aisle, uranium product cell, and uranium loadout area. Although much of the original contamination has been removed, minor amounts of mostly fixed contamination remain. After completing the liquid waste treatment system mission, additional contamination in these cells is expected. Most of the additional contamination is expected to be from the liquid waste treatment system process equipment and not the walls and floors of the cells.

The residual contamination levels are expected to be low; the total residual activity in the liquid waste treatment system is estimated to be less than 10 Ci (WVNS 1994b). The residual activities in each liquid waste treatment system area are several orders of magnitude lower than the highly contaminated rooms presented in Table C-1 and lower than other rooms in the process building. The estimated residual activity in the liquid waste treatment system before implementation of the alternatives will not impact the risk assessments performed for WMA 1.

Releases from the process building have resulted in contaminated soil and groundwater. The groundwater plume on the north plateau is contaminated with strontium-90 and extends through WMA 2 to WMA 4. The contaminated soil and groundwater in WMA 1 is addressed in Section C.3.2 of this appendix.

<u>Projected Waste Inventory</u>. Five sources of hazardous or mixed waste are expected to be in the process building at the time of closure (WVNS 1994a):

1. Toxic chemicals used in reprocessing and decontamination operations left as residues in vessels, processing cells, and piping. A review of historic purchase order records and surveys indicated that the hazardous waste volumes will be negligible.

2. Lead used for shielding. Lead shielding in the liquid waste treatment system is principally associated with the cement solidification system, which is described in Section C.2.1.2.

3. Lead-based paint waste (containing lead chromate) scabbling from mechanical surface decontamination to reduce dose rates. The volume of waste generated depends on paint removal methods and is estimated to be 130 m^3 (4,700 ft^3) (WVNS 1994a).

4. Zinc bromide present in shielding viewing windows. This volume is estimated to be approximately 2,600 L (690 gal) (WVNS 1994a).

5. Acidic residues on the surfaces of walls, floors, and equipment as a result of spills. The records reviewed and surveys indicate that the hazardous waste volumes would be negligible.

It was assumed that the chemicals and wastes in the analytical laboratory would be taken to the interim waste storage facility (IWSF) in WMA 7 before implementation of the alternatives. These waste volumes are included in the IWSF volumes described in Section C.2.7.3.

C.2.1.2 01/14 Building

Description of Facility. The 01/14 building is a concrete building measuring 12 x 10 x 18 m high (41 x 33 x 60 ft high). It houses the ex-cell off-gas equipment to support the vitrification facility operations and the cement solidification system used to solidify the liquid waste generated by the evaporator portion of the liquid waste treatment system. The 01/14 building ventilation system maintains constant air flow from clean areas to those with higher potential for contamination and exhausts through two stages of high-efficiency particulate air filters.

Projected Radionuclide Inventory. Because the 01/14 building was never used by NFS, little contamination was present before construction and installation of the ex-cell off-gas system and the cement solidification system. After the cement solidification system mission to mix waste into a cement matrix is completed, residual contamination is expected to be present in the process equipment at an activity of several millicuries or less (primarily cesium-137 and strontium-90) (WVNS 1994b). This residual activity is substantially lower than that expected for several areas of the process building. The residual activity from the ex-cell off-gas system and the cement solidification system portion of the 01/14 building (less than 200 mCi) would not impact the risk assessments performed for WMA 1.

Projected Waste Inventory. There will be two sources of mixed waste at the time of closure: approximately 0.03 m^3 (1 ft^3) from one PCB-contaminated capacitor and 0.3 m^3 (10 ft^3) of lead shielding present in the liquid waste treatment system (mainly the cement solidification system) and the supernatant treatment system (WVNS 1994b).

C.2.1.3 Utility Room

Description of Facility. The utility room is an addition to the south side of the process building. It supplies steam, compressed air, water, and emergency electricity to the entire plant. The building is a steel-framed concrete block structure measuring approximately 24 x 27 x 6.1 m (79 x 88 x 20 ft). The floor is a concrete slab, and the north wall (common to the process building) is 20-cm (8-in.) thick concrete, while the other walls are 20-cm (8-in.) concrete block.

Projected Waste Inventory. The utility room has low-level radioactivity from fixed contamination in the walls, floor, and piping, as well as some contaminated equipment. However, the residual activity will not impact the risk assessments performed for WMA 1.

Hazardous materials in the utility room include water chemistry control chemicals and fuel oil (WVNS 1994a). It was assumed that these materials would be removed before implementation of the alternatives.

C.2.1.4 Laundry Room

Description of Facility. The laundry room is adjacent to the south side of the process building. It is constructed with a steel beam frame, 20-cm (8-in.) concrete block walls, and a metal roof. The building has a concrete foundation and the flooring is a 15-cm (6-in.) thick concrete slab. The structure measures 7.9 x 17 x 6.1 m (26 x 56 x 20 ft) high. A dividing wall, constructed of plywood and wood framing approximately 15 cm (6 in.) thick, divides the building into a contaminated and an uncontaminated side. Both sides of the laundry room are used to launder site materials, such as coveralls and towels.

Projected Waste Inventory. The contaminated side of the laundry room has fixed contamination in the fume hood ventilation system filter, in the washer and dryer filter and motors, and in the water lines beneath the concrete floor. The concrete floor also has fixed contamination that has been painted over (WVNS 1994c). Lead-based paint waste (containing lead chromate) scabbling from mechanical surface decontamination would be mixed waste. However, the residual activity in the waste would not impact the risk assessments performed for WMA 1.

C.2.1.5 Plant Office Building

The plant office building is a three-story structure alongside the west wall of the process building. The plant office building measures 12 x 29 x 13 m (40 x 95 x 44 ft) high, with 30-cm (12-in.) thick outer walls of concrete block. This building is primarily used for office space. No radioactive or hazardous contamination has been identified for this building (WVNS 1994a).

C.2.1.6 Electrical Substation

Description of Facility. The electrical substation, located on the east side of the process building, is where overhead power lines end, voltage is reduced, and power lines are connected to the process building. It consists of a 34.5 kV/480V transformer, a steel-framed dead end structure, and a reinforced concrete foundation. The steel-framed structure has two 9.2-m (30-ft) steel I-beams with two 2.1-m (7-ft) steel I-beams attached at the top. The electrical equipment is attached to five cross-beams of varying sizes.

Projected Waste Inventory. No radiologically contaminated areas are have been identified at the electrical substation. The transformer holds 2,200 L (586 gal) of PCB-contaminated oil with a concentration of 292 ppm that will have to be disposed of as State-regulated hazardous waste (WVNS 1994c).

C.2.2 Waste Management Area 2

WMA 2 encompasses approximately 5.7 ha (14 acres) and consists of the low-level waste treatment facility, which includes a treatment facility (02 building), four active lagoons (lagoons 2 through 5), one closed lagoon (lagoon 1), the old and new interceptors, and a neutralization pit; the solvent dike; the test and storage building; and the maintenance shop and maintenance shop leach field (see Figure C-5). The lagoons cover a total area of approximately 0.93 ha (2.3 acres). The 02 building has low levels (less than 10 Ci) of radiological contamination. The LLWTF neutralization pit, interceptors, and lagoons 2 through 5 are radiologically contaminated lagoons or ponds. Lagoon 1 contains radiologically contaminated soils and debris. The other structures in WMA 2 have low-level radiological contamination (was not estimated), but they will not affect the risk assessments performed for WMA 2. The only facility in WMA 2 that has known hazardous contamination is the 02 building. The contaminated soils beneath the sediments of the lagoons are discussed in Section C.3.2.1. There is groundwater contamination in WMA 2.

The *West Valley Demonstration Project, Low-Level Waste Treatment Facility Characterization Report* estimates the projected radionuclide inventory of the LLWTF as of January 1, 1993 (WVNS 1994d). It is necessary to account for radioactive decay from this date until the time of facility closure (assumed as January 1, 2000) to project accurately the radionuclide inventory. The projected radionuclide inventory uses estimates from WVNS (1994d), with corrections for radioactive decay.

C.2.2.1 02 Building

Description of Facility. The 02 building is a steel-framed, concrete building enclosing an area of 8.2 x 12 m (27 x 39 ft). The building, 9 m (30 ft) high, is located mostly abovegrade. The treatment equipment for incoming liquid waste is housed in this building, except for a flocculator, which is located on a 7.6 x 15-m (25 x 50-ft) concrete slab outside of the building. The chief process equipment in the 02 building includes a flash mixer, centrifuge, anthracite filter, ion-exchange system, and sludge drumming station.

In the waste processing system, designed specifically to remove cesium and strontium radioisotopes from the incoming stream, chemical additives concentrate the radioactivity in the precipitate. Equipment then separates the radioactive precipitate in a clarifier-centrifuge

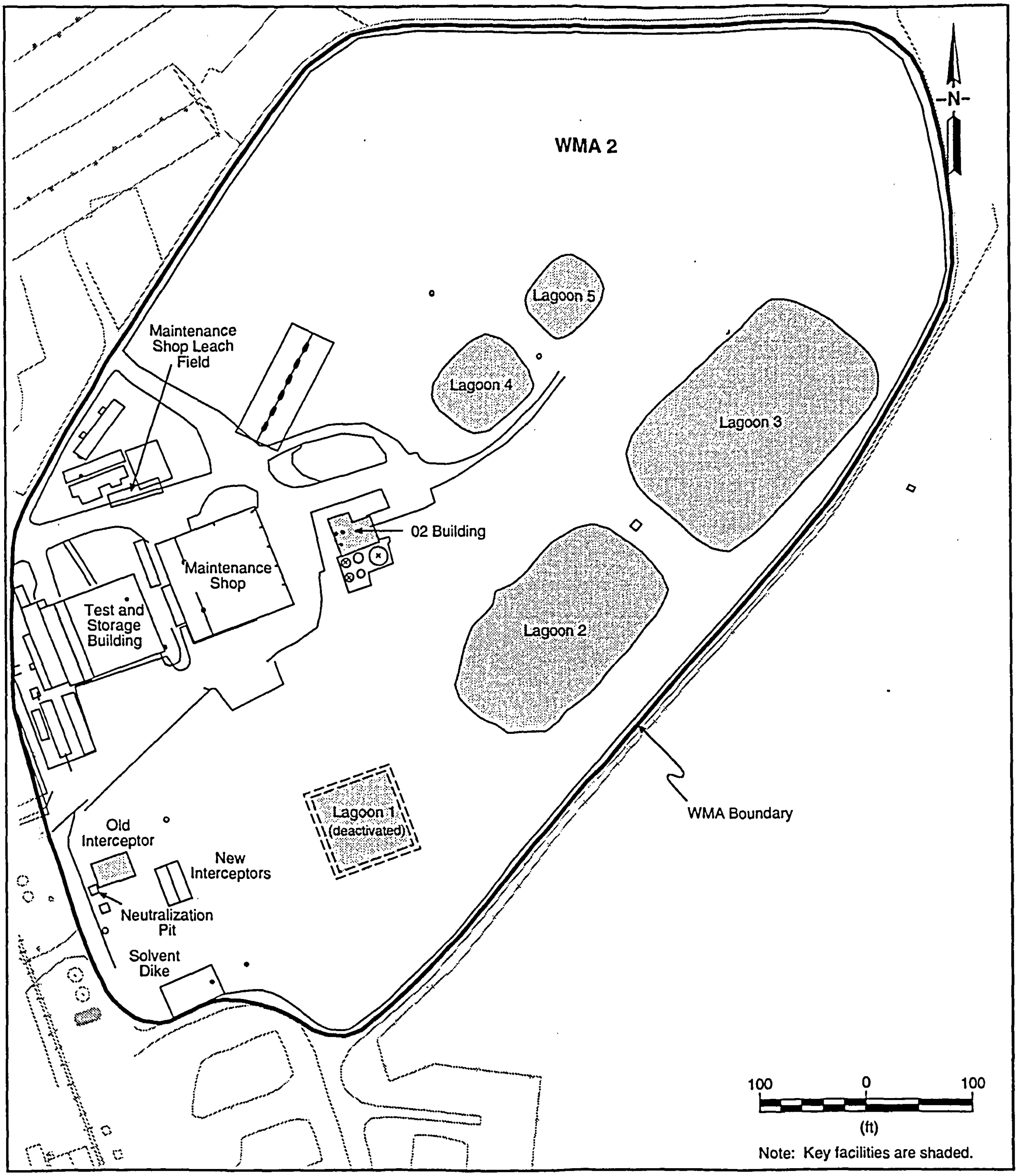


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Figure C-5. Waste Management Area 2—Low-Level Waste Treatment Facility Area.

system. Particulates greater than 1 μm are separated by passing the liquid stream through an anthracite filter bed.

Projected Radionuclide Inventory. Estimated residual radioactivity levels in the 02 building were reported separately for five designated building sections (A through E), the process equipment, and interconnecting lines and piping (WVNS 1994d). These levels are relatively low (less than 10 Ci), and strontium-90 and cesium-137 comprise the majority of the radioactivity. Table C-2 lists the estimated total residual inventories in building sections A through E; equipment and piping inventories are not presented here because the levels are several orders of magnitude lower.

Projected Waste Inventory. Sources of hazardous waste consist of lead shielding and PCB-contaminated capacitors. Upon building demolition, radioactively contaminated lead-based paint would be a source of mixed waste (WVNS 1994d). Resins and sludges generated in the 02 building are not hazardous as defined by the Resource Conservation and Recovery Act (RCRA) (WVNS 1994e).

C.2.2.2 Lagoon 1

Description. Five lagoons are or were used as part of the LLWTF. Lagoon 1, an unlined pit excavated into the sand and gravel layer with a storage capacity of approximately 1.1 million L (300,000 gal), was fed directly from the old interceptor. The lagoon was removed from service in 1984 after it was determined to have caused tritium contamination of nearby groundwater. The liquid and sludge were transferred to lagoon 2, and lagoon 1 was filled with approximately 1,300 m^3 (1,700 yd^3) of contaminated debris from the old hardstand (asphalt, trees, stumps, roots, and weeds); capped with clay; covered with topsoil; and revegetated. Lagoon 1 continues to store the buried debris and serves no other function.

Projected Radionuclide Inventory. The most significant residual contamination (up to 700 Ci) in WMA 2 is expected to be in lagoon 1. Contamination is present in the clay cap, sediment, and buried debris; the majority (>99 percent) is present in the sediment. Table C-3 presents the estimated radionuclides present in lagoon 1.

Projected Waste Inventory. The lagoon 1 volume [1,300 m^3 (1,700 yd^3)] is radioactively contaminated. In 1993, sampling for hazardous constituents was performed at four locations immediately downgradient of lagoon 1. Contaminants detected (predominantly polyaromatic hydrocarbons) have been attributed to the asphalt placed in lagoon 1 from the old hardstand (WVNS 1994e).

Table C-2. Residual Activity in 02 Building Sections A Through E[a]

Radionuclide	Activity (Ci)
C-14	5×10^{-5}
Co-60	0.003
Se-79	6×10^{-6}
Sr-90	2
Tc-99	2×10^{-4}
Cd-113m	1×10^{-4}
Sb-125	6×10^{-5}
Sn-126	1×10^{-5}
I-129	4×10^{-7}
Cs-137	4
Eu-154	0.004
Ra-226	7×10^{-11}
Ac-227	9×10^{-7}
Ra-228	8×10^{-8}
Th-229	6×10^{-7}
Pa-231	2×10^{-6}
Th-232	2×10^{-7}
U-232	1×10^{-4}
U-233	2×10^{-4}
U-234	1×10^{-5}
U-235	2×10^{-6}
Np-237	3×10^{-6}
U-238	3×10^{-5}
Pu-238	0.007
Pu-239	0.01
Pu-240	0.007
Pu-241	0.3
Am-241	0.03
Cm-243	1×10^{-5}
Cm-244	3×10^{-4}

a. Total activity based on *West Valley Demonstration Project, Low-Level Waste Treatment Facility Characterization Report* (WVNS 1994d), decayed to January 2000.

Table C-3. Residual Activity in Lagoon 1[a]

Radionuclide	Activity (Ci)
C-14	0.053
Sr-90	24
Tc-99	0.20
Cd-113m	0.11
Sb-125	0.060
I-129	0.029
Cs-137	700
Eu-154	3.9
U-233	0.23
U-234	0.011
U-235	0.0027
Np-237	0.0031
U-238	0.025
Pu-238	7.1
Pu-239	3.8
Pu-241	260
Am-241	4.0
Cm-244	0.33

a. Activity from *West Valley Demonstration Project, Low-Level Waste Treatment Facility Waste Characterization Report* (WVNS 1995a) decayed to January 2000.

C.2.2.3 Lagoons 2, 3, 4, and 5

Description. Lagoon 2, an unlined pit with a storage capacity of 9.1 million L (2.4 million gal), is used as a storage basin for wastewater discharged from the new interceptors before treatment in the 02 building. Before the 02 building was constructed, wastewater with low-level radioactivity was routed through lagoons 1, 2, and 3 in series to remove particulates and decay radioactive contaminants before being discharged to Erdman Brook. Lagoon 2 became the initial receiving lagoon after closure of lagoon 1. Currently, lagoon 2 receives low-level radioactive wastewater from all site activities except for leachate pumped from the SDA disposal trenches, wastewaters that do not meet discharge limits (held in the old interceptor), and some wastewater generated in the 02 building.

Lagoon 3, an unlined pit with a storage capacity of approximately 12 million L (3.3 million gal), receives only treated wastewater from lagoons 4 and 5. Before installation of the LLWTF system, lagoon 3 received untreated wastes from lagoon 1 through lagoon 2. After construction of the LLWTF, lagoons 2 and 3 were disconnected. Lagoon 3 was emptied, the sediment removed, and it was relined with clay (WVNS 1994d).

Lagoons 4 and 5, abovegrade lagoons constructed of till material with approximate capacities of 772,000 L (204,000 gal) and 628,000 L (166,000 gal), respectively, alternately receive the treated liquid effluent from the 02 building. The effluent is sampled as the lagoon is filled, and then it is transferred to lagoon 3 for subsequent discharge to Erdman Brook. Membrane liners (hypalon) were added later, after initial construction, to control leakage.

Projected Radionuclide Inventory. The residual radionuclide inventory in lagoon 2 is estimated to be approximately two orders of magnitude lower than that in lagoon 1, and the inventory in lagoons 3 through 5 is expected to be one or more orders of magnitude lower than the lagoon 2 inventory. The residual radioactivity in lagoons 2 and 3 is expected to be located in the top several inches of the bottom sediment; in lagoons 4 and 5 it is expected to be in sediment on the lagoon liners. The assumptions for radioactivity estimates in the lagoons are discussed in the WVNS (1994d). The projected inventory of lagoon 2 at the year 2000 is presented in Table C-4. The inventory is not presented for lagoons 3 through 5 because the inventories are three or more orders of magnitude lower than the lagoon 1 inventory, and they would not impact the risk assessments performed for the LLWTF.

Projected Waste Inventory. The volume of radioactively contaminated sediment in lagoons 2 and 3 is about 1,180 and 660 m^3 (41,500 and 23,200 ft^3), respectively (WVNS 1993a). Contaminated soil underlying the lagoon sediments is addressed in Section C.3.2.1. Hazardous constituents detected in lagoons 2 and 3 were below concentrations for defining a hazardous waste (WVNS 1990a). No sampling has been performed on lagoons 4 and 5, but no hazardous contamination is expected. Ninety percent of the radiological contamination in sediments in lagoons 4 and 5 is estimated to be in the top 5 cm (2 in.) (WVNS 1994d).

C.2.2.4 Neutralization Pit and Interceptors

Description of Facilities. The neutralization pit is a 2.7 x 2.1 x 1.7-m (9 x 7 x 5.5-ft) concrete tank constructed with 15-cm (6-in.) thick concrete walls and floor. The tank had an acid-resistant coating that eventually failed and was replaced by a stainless-steel liner. During past operations, wastewater flow from the process building to the interceptors (discussed below) passed through the neutralization pit, where the pH was adjusted with sodium hydroxide to neutralize the slightly acidic wastes. It is still used as a neutralization station in the LLWTF.

The old interceptor is a 12 x 7.6 x 3.5-m (40 x 25 x 11.5-ft) unlined, concrete liquid waste storage tank located belowgrade. The walls and floors are 30 cm (12 in.) thick and covered by a steel roof. An additional 30 cm (12 in.) of concrete was later poured on the bottom of the interceptor. The old interceptor received all of the low-level liquid waste generated at the plant from the time of initial plant operation until the new interceptors were

Table C-4. Residual Activity in Lagoon 2[a]

Radionuclide	Activity (Ci)[b]
H-3	—[c]
C-14	5.5×10^{-4}
Co-60	—
Sr-90	5.8
Tc-99	0.0021
Cd-113m	0.0012
Sb-125	5.1×10^{-4}
I-129	4.4×10^{-6}
Cs-137	6.1
Eu-154	0.0032
U-233	0.0023
U-234	0.0019
U-235	0.006
Np-237	3.2×10^{-5}
U-238	7.2×10^{-4}
Pu-238	0.051
Pu-239/240	0.043
Pu-241	2.7
Am-241	0.053
Cm-244	0.0034

a. Activity from *West Valley Demonstration Project, Low-Level Waste Treatment Facility Waste Characterization Report* (WVNS 1994d), decayed to January 2000.
b. Residual activity in lagoon sediment.
c. — = not reported.

constructed. It is no longer routinely used for transferring low-level liquid waste to the low-level waste treatment facility because of contamination. It is currently used for storing radioactively contaminated liquids that exceed effluent standards (0.005 μCi/mL gross beta) to be blended with other plant wastes.

The new interceptors are twin concrete storage tanks that are located completely belowgrade and are lined with 14-gauge type 304 L stainless steel. Each interceptor measures 6.7 x 6.1 x 3.5 m (22 x 20 x 11.5 ft), with 36-cm (14-in.) thick concrete walls and floor, and is covered by a metal roof. The new interceptors replace the old interceptor and are the sampling point before transfer to either lagoon 2 or the old interceptor.

Projected Radionuclide Inventory. Relatively small amounts of residual radioactivity (less than 0.01 Ci) are expected to be present in the neutralization pit and the interceptors, except for the old interceptor. Fixed contamination is expected in the concrete walls and floor on the stainless-steel liner and liner in the neutralization pit. Most of the contamination in the old interceptor is from (a) the inventory encapsulated by concrete used as shielding material and (b) the fixed inventory in concrete used for encapsulation. There is no estimate for the encapsulated inventory. Most of the contamination in the new interceptors is expected on the stainless-steel liner. Strontium-90 and cesium-137 dominated the residual radioactivity in the neutralization pit and interceptors.

Projected Hazardous Waste Inventory. No known RCRA-regulated constituents are at the neutralization pit. No RCRA-constituent analyses have been conducted on media near the interceptors, but no hazardous contamination is expected (WVNS 1994e).

C.2.2.5 Solvent Dike

The solvent dike, located 90 m (300 ft) east of the process building, was a 9.1 x 9.1-m (30 x 30-ft) unlined basin for the original processing facility installed in the sand and gravel layer. It received rainwater runoff from the solvent storage terrace, which housed both an acid storage tank and a n-dodecane solvent storage tank. The solvent dike contained radioactive and solvent-contaminated spills and leaks and roof drainage.

Low-level radioactive sediments were excavated from the solvent dike in 1987, packaged as low-level [radioactive] waste (LLW), and the area was backfilled. The packaged waste is stored in the lag storage area in WMA 5. Soil sampling indicates that the backfilled area is radioactively contaminated (WVNS 1994f). The radioactively contaminated soils in this area are discussed in Section C.3.2.1. No RCRA-regulated hazardous constituents have been identified.

C.2.2.6 Test and Storage Building

Description of Facility. The test and storage building (see Figure C-5) measures 24 x 37 m (80 x 120 ft) and is located northeast of the process building. It is approximately 6.7 m (22 ft) high and has timber frame and metal siding construction with steel beams. It was initially used as a pipe/fabrication shop, later as the maintenance shop, and currently houses office space, the vitrification scale model, vitrification labs, the tool crib, and garage space. A 5.5 x 7.9 x 3.6-m (18 x 26 x 12-ft) concrete block addition houses the radiation and safety operations, and office space for these operations is in a 3.6 x 5.2 x 3.4 m (12 x 17 x 11-ft) trailer.

Projected Waste Inventory. No radiologically contaminated areas are in the test and storage building. No reported leaks or spills of hazardous materials have been reported. However, the ballasts in fluorescent light fixtures and an electrical transformer may contain PCB-contaminated oils (WVNS 1994c).

C.2.2.7 Maintenance Shop and Sanitary Waste Leach Field

Description. The maintenance shop, an 18 x 30-m (60 x 100-ft) metal building with steel supports and light metal roofing, measures 4 m (13 ft) high at the roof peak and houses locker rooms, lavatories, instrument shops, work areas, and a finished office area. The maintenance shop is used for metal and wood cutting, manufacture of assembly equipment, and storage. The floor is concrete, supported by a concrete foundation wall and concrete piers. Two office trailers are attached to the western side of the building.

Before the maintenance shop was connected to the sanitary sewer system (WMA 6) in 1988, a sanitary leach system serving both it and the test and storage building was used (see location in Figure C-5). The maintenance shop leach field measures 140 m^2 (1,500 ft^2) and consists of three septic tanks, a distribution box, a tile drain field, and associated piping.

Projected Waste Inventory. No hazardous or radiologically contaminated areas are at the maintenance shop. No radiological contamination of the three septic tanks in the maintenance shop leach field has been documented (WVNS 1994g). However, hazardous constituents (including mercury, toluene, and creosol) have been detected in the sediment of one septic tank (WVNS 1994f). None of the concentrations exceeded RCRA hazardous waste criteria or action levels. Therefore, the sediment would not be managed as hazardous waste.

C.2.3 Waste Management Area 3

WMA 3 covers approximately 1 ha (2.6 acres) and includes two facilities with significant radioactive contamination (more than 200,000 Ci of strontium-90 and cesium-137: the HLW tanks and the vitrification facility. Five other facilities have lower levels of radiological contamination: the permanent ventilation system building, the equipment shelter, the Con-Ed building, the supernatant treatment system support building, and the cold chemical building. After competing HLW solidification and before implementation of the alternatives, the HLW tanks will contain about 69 m^3 (2,445 ft^3) of mixed waste. The vitrification facility will also have small amounts of mixed waste [approximately 0.06 m^3 (2 ft^3)]. Figure C-6 illustrates the facilities that comprise WMA 3. In addition, surface soil within WMA 3 is radioactively contaminated with cesium-137. The contaminated area (i.e., the cesium prong) extends across WMAs 3, 4, 5, and 12 and is the result of airborne releases from the process building stack during ventilation system failures during NFS operations. The surface soil contamination resulting from the cesium prong is discussed in Section C.3.4.1.

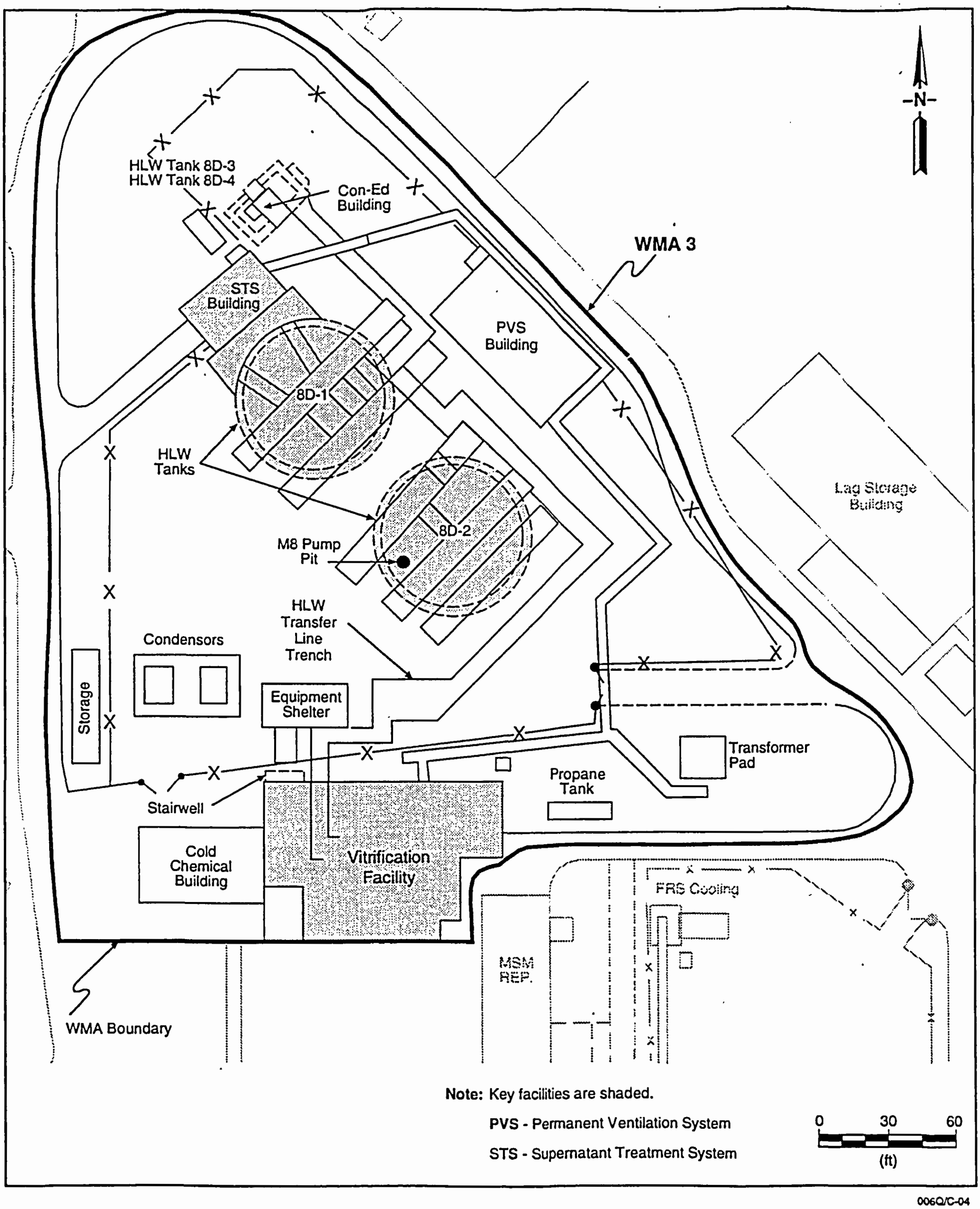

Figure C-6. Waste Management Area 3—High-Level Waste Storage and Vitrification Facility Area.

C.2.3.1 High-Level Waste Storage Tanks and Vaults

Description of Facilities. Approximately 2.3 million L (600,000 gal) of HLW from fuel reprocessing was stored in underground tanks. After completion of the WVDP, most of this waste will have been solidified into a form suitable for transportation and disposal off site. However, significant quantities of radioactivity (up to 200,000 Ci of a single radionuclide) will remain in the tanks. The most significant inventory (up to 200,000 Ci of strontium-90 and 200,000 Ci of cesium-137) will be present as sludge in tank 8D-2. The sludge will consist of cesium-contaminated zeolite, washed plutonium uranium extraction (PUREX) sludge, and neutralized thorium extraction (THOREX) waste. Residual contamination will also be present in tanks 8D-1, 8D-3, and 8D-4.

Tank 8D-1 measures 21 m (70 ft) in diameter and 8 m (27 ft) high, with a capacity of 2.8 million L (750,000 gal). It is constructed of carbon steel ranging in thickness from 1.1 to 1.7 cm (0.44 to 0.66 in.). It is contained in an underground concrete vault housing the supernatant treatment system equipment and has an internal gridwork of I-beams for roof support. Tank 8D-1 was built as a duplicate spare to tank 8D-2 and was not originally used for HLW storage, but it was contaminated by condensate from tank 8D-2 and radionuclide-loaded zeolite from supernatant treatment system processing.

Tank 8D-2, identical in size and construction to tank 8D-1, is also located in an underground concrete vault. Tank 8D-2 was used to store neutralized HLW, consisting of an alkaline supernatant and sludge, from the PUREX fuel reprocessing operations. The vaults that house tank 8D-1 and tank 8D-2 both measure 24 m (79 ft) in outer diameter, are 11 m (37 ft) high and have a 0.6-m (2-ft) concrete roof.

Tank 8D-3 measures 3.7 m (12 ft) in diameter, 4.9 m (16 ft) high, and has a capacity of 51,100 L (13,500 gal). It is constructed of type 304 L stainless steel with 0.953-cm (0.375-in.) thick sides and bottom and a 0.795-cm (0.313-in.) thick top. Built as a duplicate spare to tank 8D-4, it was not used to store reprocessed waste. However, it was used in the supernatant treatment system process to store decontaminated supernatant and sludgewash water for sampling before transfer to the liquid waste treatment system. Tank 8D-4, identical in size and construction to tank 8D-3, was used to store THOREX waste and as a storage tank for the vitrification waste header system after the THOREX waste was removed. Both tank 8D-3 and tank 8D-4 are co-located in one underground concrete vault, measuring 9.8 x 5.8 x 8.2 m (32 x 19 x 27 ft). The sides and roof are 53 cm (21 in.) and 0.6 m (2 ft) thick, respectively. The bottom and 46 cm (18 in.) of the sides are lined with stainless steel.

Projected Radionuclide Inventory. Table C-5 presents the projected residual radionuclide content of tanks 8D-1, 8D-2, and 8D-4 as of January 1, 2000. As indicated in Table C-5, the activity estimates for tanks 8D-1 and 8D-2 are from the sludges left in the tanks. Radiological inventories from corrosion of and absorption of contaminants onto the

Table C-5. Residual Activity in High-Level Waste Tanks[a]

Radionuclide	Activity (Ci) Tank 8D-1[b]	Tank 8D-2[c]	Tank 8D-4	Total
H-3	—[d]	1	0.01	1.01
C-14	—	4	0.02	4.02
Co-60	—	6	7×10^{-5}	6
Sr-90	400	200,000	900	201,300
Tc-99	—	50	0.3	50.3
Cd-113m	—	40	3×10^{-4}	40
Sb-125	—	20	4×10^{-5}	20
Sn-126	—	3	0.002	3.002
I-129	—	0.01	2×10^{-6}	0.01
Cs-137	200,000	200,000	1,000	401,000
Eu-154	—	1,000	10	1,010
Ra-226	—	5×10^{-6}	—	5×10^{-6}
Ac-227	—	0.2	0.001	0.201
Ra-228	—	0.02	1×10^{-4}	0.0201
Th-229	—	0.006	3×10^{-5}	0.006
Pa-231	—	0.5	0.002	0.502
Th-232	—	0.05	3×10^{-4}	0.0503
U-232	—	0.2	6×10^{-5}	0.2
U-233	—	0.3	8×10^{-5}	0.3
U-234	—	0.1	6×10^{-5}	0.1
U-235	—	0.003	2×10^{-7}	0.003
Np-237	—	0.7	0.004	0.704
U-238	—	0.03	8×10^{-6}	0.03
Pu-238	80	200	1	281
Pu-239	20	50	0.3	70.3
Pu-240	—	40	0.02	40.02
Pu-241	600	200	10	810
Am-241	—	2,000	8	2,008
Cm-243	—	3	0.02	3.02
Cm-244	—	200	1	201

a. Activity taken from *West Valley Demonstration Project, HLW Storage Area and Vitrification Facility Characterization Study* (WVNS 1993b), decayed to January 2000.
b. Residual activity in zeolite heel in tank.
c. Residual activity in tank heel.
d. — = not reported.

tank surfaces, tank supports, and the supernatant treatment system equipment located in tank 8D-1 were less than 1 percent of the radioactivity in the sludge which does not affect the results of the analysis. The residual radioactivity in tank 8D-3 (0.7 Ci) is small relative to the other tank inventories.

Projected Waste Inventory. The sludges in tanks 8D-1 and 8D-3 are expected to be radioactive only. However, the sludges in tanks 8D-2 and 8D-4 are expected to contain RCRA toxicity characteristic metals and, thus, be considered mixed waste. The residual sludge after HLW solidification and before implementation of the alternatives is assumed to be three percent of the tanks' total capacities (WVNS 1993b). Therefore, approximately 68 m^3 (2,400 ft^3) in tank 8D-2 and 1.3 m^3 (45 ft^3) in tank 8D-4 will be mixed waste because of the metals barium, cadmium, chromium, mercury, and selenium (WVNS 1995b).

C.2.3.2 Vitrification Facility

Description of Facility. The vitrification facility is constructed at the 30.5-m (100-ft) level of the process building with cell dimensions measuring 10 x 20 x 13 m (34 x 65 x 42 ft). A pit measuring 10 x 7.6 x 4.3 m (34 x 25 x 14 ft) and lined with stainless steel holds process equipment. Major pieces of equipment in the vitrification facility include the melter, the melter feed hold tank, and the turntable. The vitrification facility will be used to convert the liquid HLW currently in tanks 8D-2 and 8D-4 into borosilicate glass. The in-cell off-gas system is located in the vitrification cell (the ex-cell portion is located in the 01/14 building), and it consists of a submerged bed scrubber, high-efficiency mist eliminators, and prefilters.

Projected Radionuclide Inventory. Most of the residual radioactivity in the vitrification facility is expected to be present in the melter as residual glass and in the in-cell off-gas system as solidified sludge material in the submerged bed scrubber. For analysis, considering the melter and the submerged bed scrubber residual radioactivity is sufficient to estimate the overall risk of the closure alternatives for this facility. The projected residual radioactivity in the melter and in the in-cell off-gas system, is shown in Tables C-6 and C-7, respectively; cesium-137 represents most of the radioactivity that will be present in the off-gas system.

The residual radioactive inventory in other areas of the vitrification facility, including the vitrification cell and canister turntable, were not considered for the risk assessment, but would be considered when planning and performing the actual decontamination activities. The residual contamination and dose rates in most areas of the facility will be high enough to be of concern.

Projected Waste Inventory. Three PCB-contaminated capacitors with a volume of approximately 0.6 m^3 (2 ft^3) from the ventilation supply room and head-end ventilation blower in the vitrification facility (WVNS 1993c) would be hazardous waste if they are removed.

Table C-6. Residual Activity in Melter[a]

Radionuclide	Activity (Ci)
Co-60	0.2
Sr-90	5,000
Tc-99	0.1
Cd-113m	1
Sb-125	0.6
Sn-126	0.1
Cs-137	6,000
Eu-154	40
Ac-227	0.007
Ra-228	3×10^{-4}
Th-229	3×10^{-6}
Pa-231	0.02
Th-232	0.003
U-232	0.007
U-233	0.01
U-234	0.005
U-235	5×10^{-9}
Np-237	0.02
U-238	1×10^{-12}
Pu-238	8
Pu-239	2
Pu-240	1
Pu-241	70
Am-241	60
Cm-243	0.1
Cm-244	5

a. Activity taken from *West Valley Demonstration Project, HLW Storage Area and Vitrification Facility Characterization Study* (WVNS 1993b), decayed to January 2000. The projected activities are those that are expected to remain in the melter following full-scale operation.

Table C-7. Residual Activity in In-Cell Off-Gas System in the Vitrification Facility[a]

Radionuclide	Activity (Ci)
Co-60	0.01
Sr-90	100
Tc-99	0.007
Cd-113m	0.03
Sb-125	0.02
Sn-126	0.002
Cs-137	1,000
Eu-154	2
Pu-238	1
Pu-239	0.2
Pu-240	0.2
Pu-241	7
Am-241	1
Cm-244	0.1

a. Activity from *West Valley Demonstration Project, HLW Storage Area and Vitrification Facility Characterization Study* (WVNS 1993b), decayed to January 2000.

C.2.3.3 Permanent Ventilation System Building

Description of Facility. The permanent ventilation system building is located at the north perimeter of tank 8D-2 and measures 23 x 12 x 4.9 m (75 x 40 x 16 ft). It houses the programmable logic controller that operates the sludge mobilization and wash system, and it maintains operating air flow requirements in the supernatant treatment system support building, valve aisle, and pipeway during radioactive operations. Air flow is exhausted through a mist eliminator, heater, roughing filter, and two sets of high-efficiency particulate air filters (WVNS 1992a).

Projected Waste Inventory. The permanent ventilation system building is divided into four main rooms, none which contain surface contamination. Most of the residual contamination in this building will be in the two high-efficiency particulate air filters, which could contain as much as 7.5 Ci of cesium-137 and much smaller activities of other radionuclides. The radioactive inventory of the two high-efficiency particulate air filters will not impact the risk assessments performed for WMA 3. No hazardous contamination is expected (WVNS 1993b).

C.2.3.4 Equipment Shelter

The equipment shelter, located north of the vitrification facility (see Figure C-6), measures approximately 12 x 5.8 x 5.2 m (41 x 19 x 17 ft) and houses the waste tank farm ventilation system that ventilates to the HLW tanks and the supernatant treatment system process vessels in tank 8D-1. The ventilation system draws air through a condenser, a knockout drum, a heater, and two sets of high-efficiency particulate air filters and blowers, and it finally vents to the plant stack.

Low-level radioactive contamination is present in the filter housing, ductwork, and blowers (WVNS 1993b), but it will not impact the risk assessments performed for WMA 3. No hazardous contamination exists at this facility.

C.2.3.5 Con-Ed Building

The Con-Ed building is a concrete block shelter constructed on top of the underground vault containing tanks 8D-3 and 8D-4, measuring 4.0 x 3.0 x 3.4 m (13 x 10 x 11 ft). It houses instrumentation and valves to monitor and control the two tanks.

No hazardous contamination exists at this facility. Also, residual radioactivity will not impact the risk assessments performed for WMA 3.

C.2.3.6 Supernatant Treatment System Support Building

The supernatant treatment system support building, constructed of concrete and steel and located next to and on top of the tank 8D-1 vault, houses several tanks for preparing and adding fresh zeolite to the ion exchange columns. The supernatant treatment system valves are located in and controlled from this building.

While the supernatant treatment system valves may have residual radioactivity, they will not impact the risk assessments performed for WMA 3. No hazardous contamination exists at this facility.

C.2.3.7 Cold Chemical Building

The cold chemical building, located west of the vitrification facility, measures 17 x 10 x 12 m (56 x 34 x 38 ft) and houses storage tanks for cold chemicals used in the vitrification process.

This building has no radioactive contamination (WVNS 1993b). Although the tanks in the cold chemical building may contain residual nitric acid and caustic (WVNS 1993b), it is assumed these small amounts will be rinsed before implementation of the alternatives.

C.2.4 Waste Management Area 4

WMA 4 is located on the northeastern portion of the Project Premises on the north plateau and encompasses a 4-ha (10-acre) area (see Figure C-1). The construction and demolition debris landfill (CDDL) is the only facility located in this WMA. The CDDL is assumed to be radiologically contaminated as a result of contact with contaminated groundwater. Small volumes of mixed waste were assumed to be present in the CDDL.

Description of Facility. The CDDL is located approximately 300 m (1,000 ft) northeast of the process building, covers an area of 0.6 ha (1.5 acres), and was used for the burial of nonradioactive construction, office, and plant waste from 1963 until 1984. The CDDL is excavated into the sand and gravel layer on the north plateau (as indicated by the five boreholes nearest the CDDL) and has a depth of 3 to 5 m (10 to 15 ft) below preoperational grade. It does not have a liner or leachate detection/collection system, which allows groundwater to flow through it.

The disposed waste volume at the CDDL is estimated at approximately 8,200 m³ (291,000 ft³) (WVNS 1994h). Solid waste (paper, plastic, cardboard, packaging materials, steel cans, bottles, and food waste) and construction and demolition debris (electrical wiring, wood scrap wire, piping, concrete, and light fixtures) make up 93 percent of the total volume. Other wastes buried at the CDDL include drums, wooden pallets, miscellaneous steel and boiler parts, vehicles and appliances, tires, incinerator ash, boiler blowdown, paint cans, batteries, and maintenance shop waste (WVNS 1995c).

Projected Waste Inventory. Only nonradioactive waste was buried in the CDDL. However, groundwater monitoring data collected downgradient of the CDDL indicates groundwater has become radioactively contaminated from the north plateau groundwater plume. No waste or leachate samples have been collected from the CDDL, but groundwater samples from the area indicate that the CDDL may be contaminated with both radioactive and hazardous constituents. The EIS assumes that leachate from the waste in the CDDL may migrate into groundwater because the CDDL is not lined. Groundwater monitoring results in well 801 [6 m (20 ft) upgradient of the CDDL] demonstrate increasing gross beta concentrations (WVNS 1993d; WVNS 1994i). In spring of 1994, gross beta concentrations of 14,160 and 1,950 pCi/L were identified at a groundwater seepage point approximately 37 m (120 ft) southwest of the CDDL and in well 801, respectively (WVNS 1994j), indicating that the southwestern portion of the CDDL has become radioactively contaminated (refer to Figure C-13). It is estimated that gross beta concentrations of approximately 10,000 pCi/L would be present in the CDDL by the year 2000. As discussed in Section C.3.2, this contamination is part of the north plateau groundwater plume, which is assumed to have contaminated the entire CDDL by the year 2000. It has also been assumed that leachate would not be confined within the CDDL, and that the volume of contaminated leachate or groundwater would be very dependent on engineering measures. The contaminated soil volume near the CDDL is discussed in Section C.3.2.2.

Because radioactively contaminated groundwater is assumed to have migrated through the CDDL by the time the alternatives are implemented, the waste is expected to be radioactively contaminated. Two waste streams could be hazardous, and they would be managed as mixed waste. Paint cans are expected to be hazardous from lead and chromium in the paint residues, and the batteries in the maintenance shop waste are expected to be hazardous from lead and mercury. Approximately 15,800 m³ (557,000 ft³) of soil used as fill is expected to be radioactively contaminated.

Freon (dichlorodifluoromethane), 1,1,1-trichloroethane, and 1,1-dichloroethane have been detected in groundwater wells located downgradient of the CDDL at concentrations below RCRA Subpart S action levels, (i.e., 7.0, 3.0, and 7.0 mg/L, respeetively) (WVNS 1993d, WVNS 1994i). The origin of these hazardous constituents may have been from wastes in the CDDL that leached into groundwater. Because the source of these hazardous constituents is unknown and the concentrations are very low [all were below 50 μg/L (WVNS 1994i)], no additional hazardous waste volumes were estimated.

C.2.5 Waste Management Area 5

WMA 5, located due north of the process building, encompasses an area of 8 ha (20 acre). This area is used for the storage of radioactive waste generated during WVDP activities. As shown in Figure C-7, facilities in WMA 5 include the lag storage building; lag storage additions 1, 3, and 4; the CPC waste storage area; the foundation for lag storage addition 2 (the addition has been removed); and the hazardous waste storage lockers. It is estimated that the lag storage building; lag storage additions 1, 3, and 4; and the CPC waste storage area will have relatively small volumes [approximately 100 m^3 (3,500 ft^3)] of mixed waste in storage at the year 2000, the time that the alternatives are assumed to be implemented. Soil near lag storage additions 3 and 4 (the old hardstand area) is radioactively contaminated. Also, soil in WMA 5 is contaminated from the cesium prong as discussed in Section C.3.4.1.

C.2.5.1 Lag Storage Building and Lag Storage Additions

Description of Facilities. The lag storage building is a preengineered metal structure supported by a clear span frame and anchored to a 43 x 18-m (140 x 60-ft) concrete slab foundation that is thickest at its center [51 cm (20 in.)] and slopes downward to a thickness of 20 cm (8 in.) at the outside edges. A 15-cm (6-in.) concrete curb encloses the inner perimeter. The roof is sloped and the center ridge height is 5 m (17 ft). The lag storage building contains a size-reduction facility, a hydraulic supercompactor, a radioactive waste compactor, and a mixer for adding cement to liquid wastes and sludges (WVNS 1992b). Seven continuous ventilators, with chain-operated dampers on top of the building, exhaust through a high-efficiency particulate air filter.

Lag storage addition 1, a preengineered metal frame and fabric enclosure measuring 15 x 58 x 7 m (50 x 191 x 23 ft), is made up of 1,300 m^2 (13,800 ft^2) of fabric material and 14 metric tons (15 tons) of aluminum and steel superstructure. The floor is compacted gravel.

Lag storage additions 3 and 4 are also preengineered metal frame and fabric enclosures. They are identical in size, each measuring 27 x 89 x 12 m (88 x 291 x 40 ft), and constructed over a poured concrete pad with 15-cm (6-in.) perimeter curbing.

The lag storage building and lag storage additions 1, 3, and 4 protect packaged Class A and some Class B and C wastes that resulted from operations, decontamination, maintenance, and construction activities from weather. The lag storage building stores packaged LLW, including greater-than-class C (GTCC) waste and mixed waste. The design storage capacity for the lag storage building is 2,120 m^3 (75,000 ft^3). Lag storage addition 1 stores LLW and has a design storage capacity of 2,220 m^3 (78,500 ft^3). Lag storage

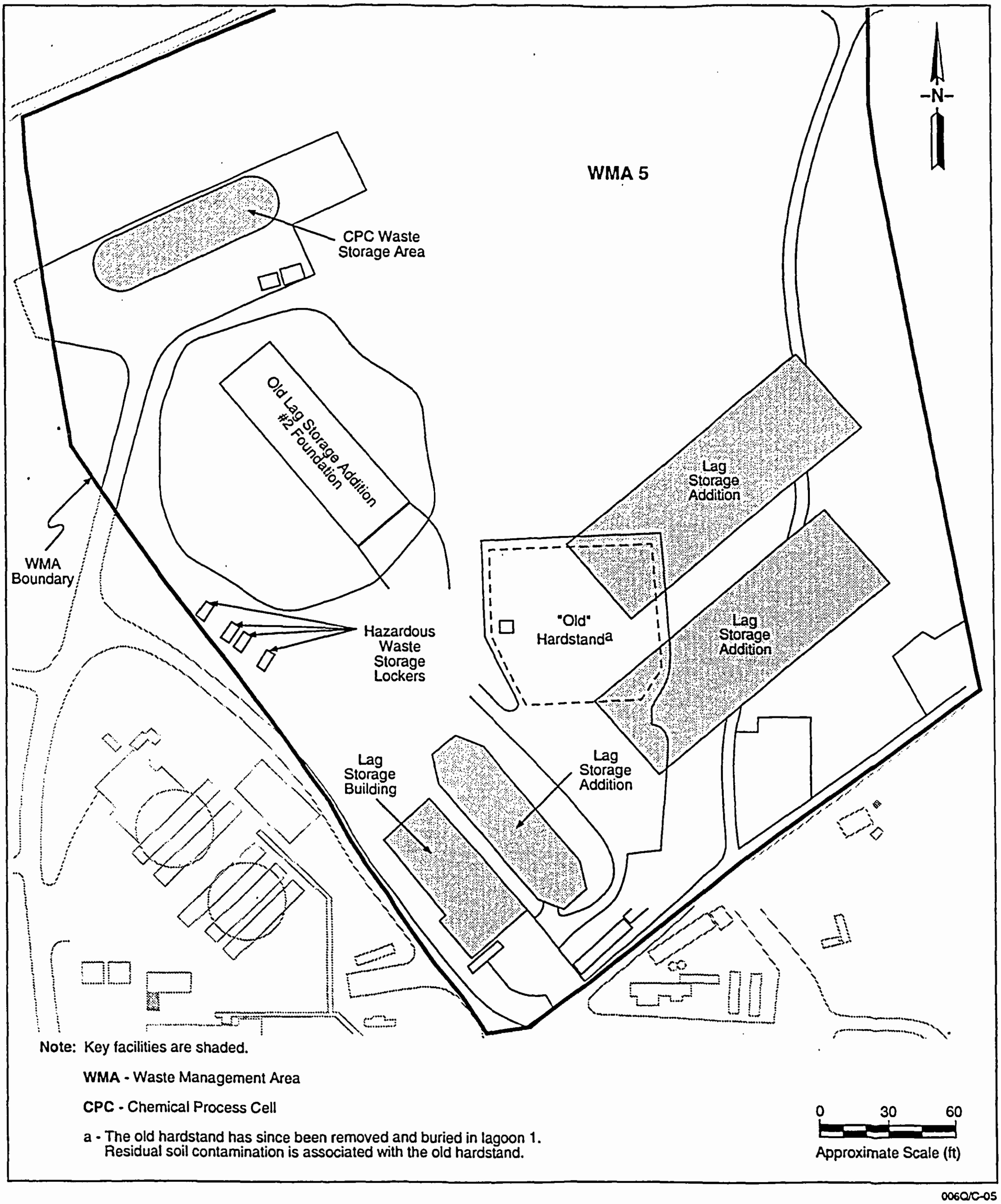

Figure C-7. Waste Management Area 5—Waste Storage Area.

additions 3 and 4 store containers of LLW and mixed waste. The design storage capacity of lag storage additions 3 and 4 is 4,250 m^3 (150,000 ft^3).

Projected Waste Inventory. A variety of waste types are stored at the lag storage building and lag storage additions as described below:

- Lag storage building—metal pipes, vessels, hardware from the process building and support areas, cloth, paper, rubber and plastic, wood, concrete, soil, and waste stabilized in cement (e.g., sludges from the LLWTF and uranyl nitrate hexahydrate)

- Lag storage addition 1—miscellaneous contaminated equipment, stabilized and partially stabilized sludges from the LLWTF, stabilized and unstabilized resins and anthracite, and contaminated lead

- Lag storage additions 3 and 4—miscellaneous contaminated equipment, stabilized and partially stabilized sludges from the LLWTF, contaminated soil, and stabilized resins and anthracite.

Based on information presented in the *West Valley Demonstration Project, LLW (Lag) Storage Area Waste Characterization Report* (WVNS 1994k), a projected waste volume of 12,800 m^3 (453,500 ft^3) will be stored in the lag storage building and lag storage additions before the alternatives are implemented. This waste volume consists of 8,100 drums and 4,500 boxes and assumes that each building is filled to capacity. Because one-third of the current waste inventory has not been evaluated, the unevaluated waste is assumed to have the same distribution as the evaluated waste, and stored waste in the year 2000 will have the same distribution as currently stored waste.

Waste in storage in the year 2000, before implementation of the alternatives, would total 12,800 m^3 (453,500 ft^3). Of this volume, 12,700 m^3 (450,000 ft^3) is estimated to be radioactive only, with a distribution based on projecting to full capacity the stored volumes identified in the inventory listing of the Federal and State Facility Compliance Agreement (WVNS 1993e). The projected distribution would be as follows:

- 86.8 percent will be Class A
- 0.2 percent will be Class B
- 7 percent will be Class C
- 6 percent will be GTCC.

Limited data are available for estimating radionuclide distributions in waste stored in the lag storage building and lag storage additions. Present estimates (WVNS 1994k) indicate that the current inventory of cesium-137 in the lag storage building and lag storage additions is less than 510 Ci. Using projected waste volumes, this cesium-137 activity estimate, and the waste profile developed for reprocessing waste (WVNS 1994l), a radionuclide distribution may be developed for packaged waste in the lag storage building and lag storage additions. The distribution estimated in this manner would include 1,450 Ci of strontium-90, 1,560 Ci of cesium-137, 87 Ci of plutonium-238, 820 Ci of plutonium-241, and 25 Ci of americium-241. Although some localized residual activity is expected on facility surfaces and equipment (e.g., high-efficiency particulate air filters), the residual activity will be an insignificant risk contributor.

Using the same estimating approach described above, about 99 m³ (3,500 ft³) of the total year 2000 volume is projected to be mixed waste. Hazardous constituents in the mixed waste would include paint or paint-related materials containing chromates or lead; PCBs; lead; methylene chloride; mercury; and other hazardous metals (WVNS 1994k; WVNS 1993e).

When surveys of soil and asphalt near lag storage additions 3 and 4 (the old hardstand area) were taken, a maximum reading of 9,000 counts per minute was recorded. Although there was not enough information given on the instrumentation used to estimate an activity, the results clearly indicate radioactive contamination above background levels (WVNS 1993f). Soil contamination in this area is discussed in Section C.3.2.1.

C.2.5.2 Dismantled Lag Storage Addition 2 Foundation

Description of Facility. The dismantled lag storage addition 2 foundation is 20 cm (8 in.) of crushed stone covering a 20 x 61-m (65 x 200-ft) area. Lag storage addition 2 was used to store slag produced during the solidification of radioactive wastes. The foundation has 10 concrete footings that reach a total depth of 1.2 m (4 ft): six are 0.5 m² (5 ft²) and four are 0.3 m² (3 ft²).

Projected Waste Inventory. A 12 x 20-m (40 x 65-ft) area of the old lag storage addition 2 foundation is radiologically contaminated. The estimated volume is 74 m³ (2,600 ft³) (WVNS 1994c). No data are available on the radionuclide inventories, but the generated waste has been assumed to be Class A LLW. No hazardous contamination has been identified.

C.2.5.3 Chemical Process Cell Waste Storage Area

Description of Facility. The CPC waste storage area is a metal and fabric tent serving as a temporary storage facility for LLW; Class A, B, C; and GTCC waste that will be remotely size reduced and decontaminated. The removable spring frame is made of aluminum and steel that measures 15 x 57 x 8.5 m (50 x 188 x 28 ft) and sits on a compacted gravel pad with a tar and chip surface. The spring frame is covered with fabric to protect the area from weather.

Projected Radiological Waste Inventory. The CPC waste storage area no longer receives waste, and the current storage volume is assumed to be the same in the year 2000. The CPC waste storage area houses 22 boxes containing mostly stainless-steel equipment contaminated with residues of dissolved nuclear fuel and 13 boxes containing other LLW used for shielding. The total volume of all 35 boxes is about 586 m³ (20,700 ft³) (WVNS 1994m). About 812 208-L (55-gal) drums in the facility contain contaminated sludge from the LLWTF, contaminated soil, and secondary waste from support and maintenance activities in the process building. An additional 133 drums of uncontaminated waste are used for shielding. The total waste volume of all drums is approximately 197 m^3 (6,950 ft^3) (WVNS 1994m).

It is estimated that 97 percent of the total waste volume [783 m^3 (27,650 ft^3)] will be radioactive assuming that the distribution in unevaluated waste is the same as the distribution in evaluated waste. The projected activity of the boxes in the CPC waste storage area is shown in Table C-8. The residual radioactivity in the drums and boxes is largely from cesium-137 (200 Ci) and strontium-90 (200 Ci). The total activity in the drums will be an insignificant contributor to site risk assessments because it is less than 1 Ci. Of the 812 drums, 95 percent are Class A waste, 2 percent are Class B waste, and 3 percent are Class C waste.

Table C-8. Projected Radionuclide Activity in Boxes Stored in Chemical Process Cell Waste Storage Area

Radionuclide	Activity (Ci)[a]
Cs-137	200
Sr-90	200
Am-241	5
Pu (all isotopes)	200

a. Activity based on *West Valley Demonstration Project, Chemical Process Cell Waste Storage Area (CPC WSA) Waste Characterization Study* (WVNS 1994m), decayed to January 2000.

Projected Inventory of Hazardous Chemicals/Waste. Using the same approach described for the radiological inventory, six containers [1.2 m^3 (44 ft^3)], are projected to be mixed waste. The known hazardous constituents in the mixed waste are chromate- or lead-containing paint and paint-related materials (WVNS 1994m, WVNS 1993e).

C.2.5.4 Hazardous Waste Storage Lockers

Description of Facilities. The hazardous waste storage lockers are used for short-term storage of hazardous waste until the waste is shipped off site for treatment or disposal. The hazardous waste storage lockers are four preengineered, steel buildings, measuring 2.4 x 4.6 x 2.4 m (8 x 15 x 8 ft), and they contain a total waste volume of 200 kg (440 lb). Wastes are packaged in 208-L (55-gal) drums and 19-L (5-gal) pails.

Projected Inventory. The inventory of the hazardous waste storage lockers fluctuates because they only temporarily store hazardous waste. The hazardous waste storage lockers are assumed to be empty before implementation of the alternatives. No leaks or spills have occurred from the storage lockers (WVNS 1993g); therefore, no hazardous waste contamination is expected.

C.2.6 Waste Management Area 6

WMA 6 is contiguous with WMA 1 (process building) and covers an area of approximately 6 ha (15 acres). The facilities within this WMA, as shown in Figure C-8, include two demineralizer sludge ponds, an effluent mixing equalization basin, an old warehouse, the sewage treatment plant, an incinerator, a cooling tower, the proposed contaminated soil consolidation area, and a rail spur that extends to the process building. The sludge ponds, cooling tower, and rail spur have radioactive contamination. The old warehouse may contain light fixtures and a transformer that have PCB contamination.

C.2.6.1 Sludge Ponds

Description. The two sludge ponds (north and south) are separate, unlined basins excavated in the sand and gravel layer that measure approximately 30 x 15 x 1.5 m (100 x 50 x 5 ft). Only the south sludge pond is currently being used because the north pond is nearly filled with sediment. The sludge ponds receive several utility room sources: water softener regeneration waste, clarifier overflow, clarifier blowdown, boiler blowdown, sand filter backwash, and demineralizer regeneration waste.

Projected Waste Inventory. Both sludge ponds are radiologically contaminated. cesium-137 has been detected in the top 0.6 to 0.9 m (2 to 3 ft) of sediments in the north pond and in the top 0 to 0.6 m (0 to 2 ft) of sediments in the south pond (WVNS 1993f), producing a total volume of about 425 m^3 (15,000 ft^3). However, radiological contamination was not detected in the 1993 RCRA facility investigation (RFI) sampling. Metals have been detected in the south sludge ponds at concentrations of 32 mg/kg chromium, 32.7 mg/kg copper, 5.37 mg/kg mercury, 62.3 mg/kg lead and about 900 mg/kg zinc (WVNS 1994f).

C.2.6.2 Effluent Mixing Equalization Basin

The effluent mixing equalization basin measures 23 x 38 x 3 m (75 x 125 x 10 ft). Like the sludge ponds, it is excavated into the sand and gravel layer, but it is lined and is underlain by a sand drain. The basin originally received effluents from the sanitary sewage treatment plant, some utility room flows, and cooling water blowdown. Later, it received effluents from the sludge ponds. The basin currently is used as a settling pond for the utility room flows. No known hazardous or radiological contamination is in the effluent mixing equalization basin (WVNS 1994h).

C.2.6.3 Old Warehouse

The old warehouse is a preengineered steel building with three sections. The main warehouse section measures 24 x 44 m (80 x 144 ft) and is approximately 6.4 m (21 ft) high at the roof peak. A blueprint room [12 x 13 x 4.6 m (38 x 42 x 15 ft)] is attached to the north end of the building, and a double-wide office trailer [8.5 x 20 x 3.4 m (28 x 65 x 11 ft)] is attached to the south end of the building. The building rests on a concrete

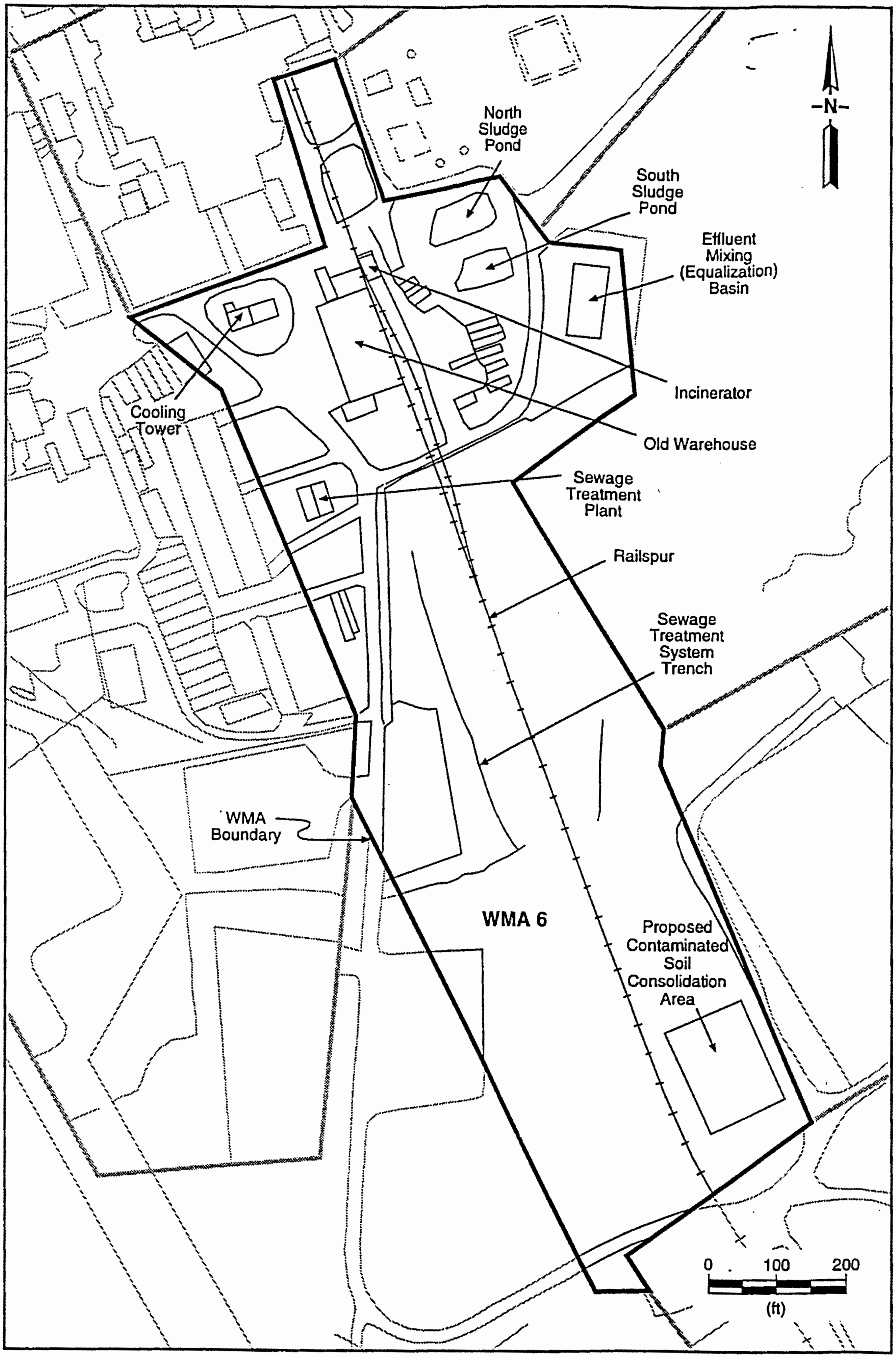

Figure C-8. Waste Management Area 6—Central Project Premises.

foundation wall about 20 cm (8 in.) thick and 15 cm (6 in.) high. The main warehouse is used to store parts, equipment, and supplies for the WVDP. The blueprint room houses graphic reproduction machines, and the trailer serves as office space.

No radiologically contaminated areas are in the old warehouse. No known hazardous materials spills occurred at this location. However, ballasts in light fixtures and a transformer could contain PCB-contaminated oils (WVNS 1994c).

C.2.6.4 Sewage Treatment Plant

The sewage treatment plant, a wood frame structure with metal siding and roofing, measures 12 x 13 x 4.6 m (41 x 44 x 15 ft). It contains a waste characterization lab 4 x 4.8 x 2.4 m (13 x 16 x 8 ft) with a 15-cm (6-in.) concrete floor. The base of the rest of the facility is 15 cm (6 in.) to 3 m (10 ft) of crushed stone. There are eight process tanks at the plant: six in-ground concrete tanks, one aboveground polyethylene tank, and one aboveground stainless steel tank. The tanks are used for aeration, chlorination, settling, and sludge holding. Only sanitary waste is treated at this plant, which processes approximately 57,000 L (15,000 gal) per day. There is no hazardous or radiological contamination at the sewage treatment plant (WVNS 1994c).

C.2.6.5 Incinerator

The incinerator is mounted on two rails on a concrete pad, but it has been out-of-service since the mid-1980s. It was used to burn paper, packaging (e.g., cardboard) and wood (no radioactive or hazardous waste). There is no hazardous or radiological contamination at the incinerator (WVNS 1994h).

C.2.6.6 Cooling Tower

Description. The cooling tower, located south of the process building, stands on a concrete basin measuring 8.2 x 11 x 0.9 m (27 x 37 x 3 ft) with an 8.2 x 3.7-m (27 x 12-ft) addition. The 20-cm (8-in.) concrete slab basin floor is supported by a 1.2 m (4 ft) deep retaining wall. Materials of construction include steel beam frame and brace rods, wood filling piping, louvers, metal fans, and corrugated sheathing. The cooling tower is used for closed-loop cooling of the entire process building, including the condensers on evaporators and air compressors. Water treatment chemicals are added to the cooling tower to control scale, corrosion, algae, and fungus.

Projected Waste Inventory. No hazardous contaminated areas are in the cooling tower (WVNS 1994c). A fixed 1989 direct radiation survey of the cooling tower stairs, which are a radiologically controlled area, detected activity ranging from 100 to 200 counts per minute with localized hot spots of up to 10,000 counts per minute (WVNS 1989). Contaminated soil near the cooling tower is addressed in Section C.3.2.1.

C.2.6.7 Rail Spur

Description. The rail spur is located immediately south of the process building, and it runs about 2,400 m (8,000 ft) before connecting into the main line of the railroad. This track was used to transport spent nuclear fuel to the Center but is not currently in use. The rails are made of cast iron and the ties are creosote pressure-treated wood. However, off-site transportation of waste by rail is evaluated in this EIS.

Projected Waste Inventory. Low levels of radiological soil contamination (13 pCi/g of cesium-137) have been detected in an 9.1 x 30-m (30 x 100-ft) area along a section of dual track east of the old warehouse (WVNS 1994c). Contaminated soil is discussed in Section C.3.2.1.

C.2.6.8 Proposed Contaminated Soil Consolidation Area

The proposed contaminated soil consolidation area would be located east of the rail spur and west of the Nuclear Regulatory Commission-licensed disposal area (NDA) (see Figure C-8), measure 30 x 76 m (100 x 250 ft) in area, and consist of a lined pad with a leachate collection system. Up to 6,120 m^3 (216,000 ft^3) of nonhazardous, radiologically contaminated, uncontainerized soil may also be stored on this pad, up to a height of 6 m (20 ft) (DOE 1994). The soil would be covered with a tarp to minimize water infiltration and leachate generation. The soil pile would include approximately 740 m^3 (26,000 ft^3) of radiologically contaminated soil excavated from the old interceptor trench in WMA 2, which is presently stored in roll-off dumpsters in WMA 9. The soil in the dumpsters, soil stored in the lag storage building and lag storage additions, and soil excavated from future construction projects would be stored at this area (DOE 1994).

C.2.7 Waste Management Area 7

WMA 7 consists of the NDA and ancillary structures. Three main areas comprise the NDA: (1) the NFS disposal area, (2) the WVDP disposal area, and (3) the area occupied by the trench interceptor project. Other structures and facilities include the IWSF, a hardstand, an inactive plant water line, an inactive leachate transfer line, and a former lagoon. The NFS and WVDP disposal areas and the IWSF contain known radiological and hazardous waste.

Five categories of waste have been identified at the NDA: NFS and WVDP buried wastes in the disposal area; leachate in the disposal areas; stored waste in the IWSF; contaminated soil within the NDA; and contaminated groundwater under the NDA. The first three are discussed in this section, along with soil intermixed with waste in the disposal areas. Soil contamination surrounding the disposal areas and groundwater contamination are discussed in Section C.3.3. Although other contaminant sources exist in this WMA, their relative contribution to risk in WMA 7 is minor.

C.2.7.1 Nuclear Fuel Services, Inc. and West Valley Demonstration Project Disposal Areas

Description of Facilities. The U.S. Nuclear Regulatory Commission (NRC) (and the former Atomic Energy Commission) licensed the NDA in conjunction with the fuel reprocessing plant in the early 1960s. The NDA was used by NFS between 1966 and 1981 for the disposal of radioactive wastes from fuel reprocessing and associated activities, such as decontamination and decommissioning. Between 1982 and 1986, the waste generated during the WVDP was disposed of in the NDA. Disposal operations were suspended at the NDA in 1986.

The NDA measures about 120 x 180 m (400 x 600 ft) on top of the south plateau and is located approximately 360 m (1,200 ft) southeast of the process building (see Figure C-9). The NFS wastes were disposed of in a U-shaped area along the eastern, western, and northern boundaries of the NDA. There are 239 disposal holes in this area, many with dimensions of 81 x 198 cm (32 x 78 in.) by 15 to 21 m (50 to 70 ft) deep, used by NFS for disposal of leached hull waste. Other wastes were disposed of in shallow special holes, at an average depth of 6 m (20 ft).

The WVDP disposed of approximately 5,700 m^3 (200,000 ft^3) of Class A waste in the NDA. The WVDP waste, consisting of decontamination and decommissioning wastes from cleanup activities, was placed in trenches located in the unused parcel of land contained within the U-shaped area, except for disposal in four steel-lined caissons [18-m (60-ft) deep, 2-m (7-ft) diameter, cylindrical concrete vaults] outside the NFS disposals (see Figure C-9).

All of the WVDP disposal units, with the exception of the four caissons and trenches 9 and 11, were capped with clay. All waste placed in the caissons was in drums; the caissons were plugged with concrete for shielding and covered with a plastic shield to prevent rainwater infiltration. Trenches 9 and 11 were constructed with composite liners and caps. Each of the disposal holes and trenches were backfilled with soils excavated from on site.

Projected Radionuclide Inventory. The buried waste in the NDA includes a variety of waste types, activities, and packaging configurations (Duckworth 1981). The *West Valley Demonstration Project, Characterization Report for the NRC-Licensed Disposal Area* (WVNS 1994n) classified the buried waste into 12 categories: reactor hardware (all components, including hulls), spent fuel from the Hanford Site's N-Reactor (which was not processed because of ruptured cladding), ion exchangers and sludges, degraded extractants, filters, failed and discarded equipment, compactible trash, noncompactible trash, dirt, low-specific activity general, combination (waste that consists of a combination of the above waste forms, such as compactible and noncompactible), and special (very large, unique items, such as the NFSX-1 railcar). The radionuclide distribution for these 12 waste categories is shown in Table C-9.

The total waste volume, except for the reactor hardware category, was determined by a records review of the NDA disposal database and assigning each entry a waste classification code (WVNS 1994n). Radionuclide activities in each waste category were

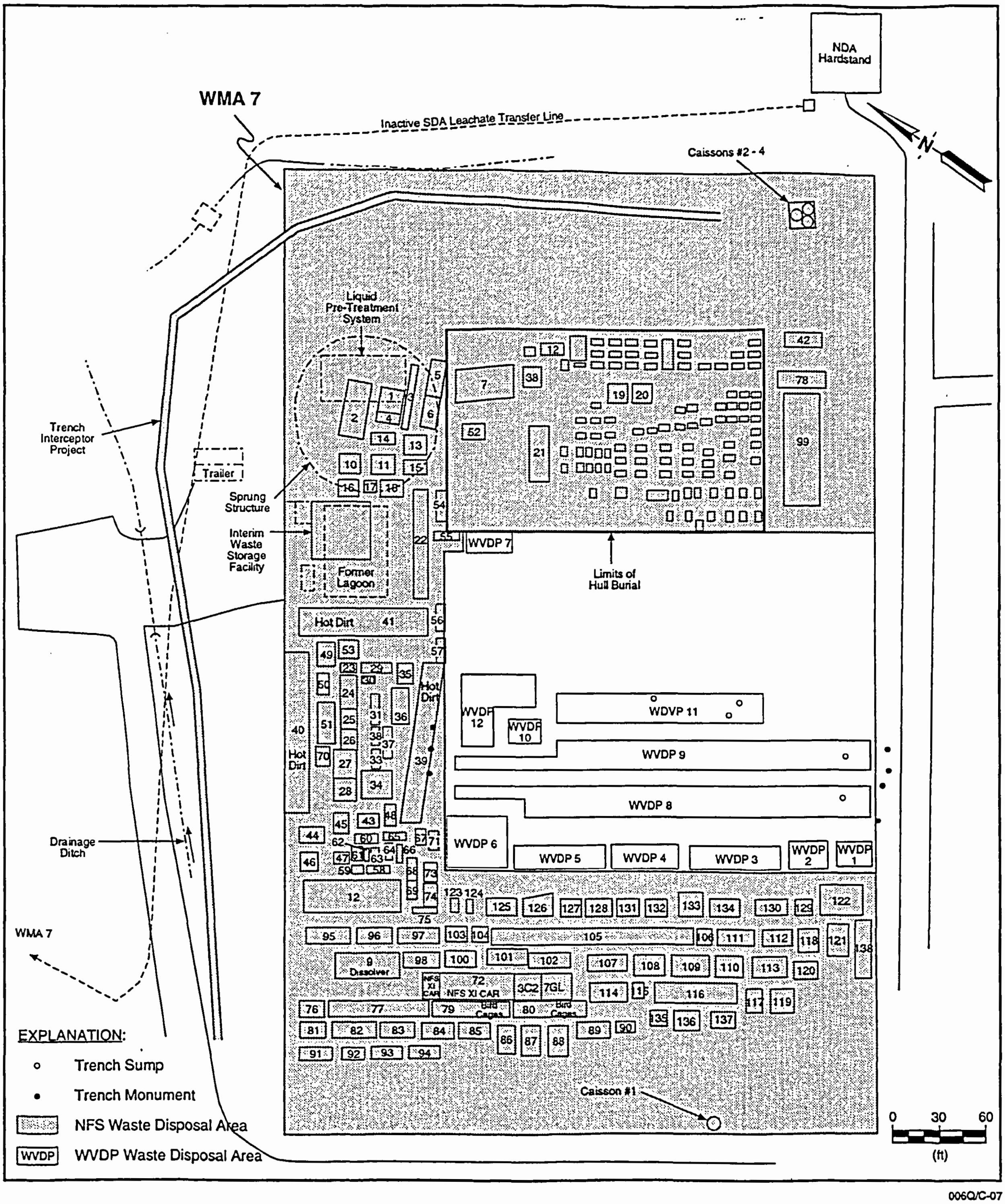

Figure C-9. Waste Management Area 7—NRC-Licensed Disposal Area and Associated Facilities.

Table C-9. Projected Radionuclide Activities of Nuclear Fuel Services, Inc. and West Valley Demonstration Project Wastes Buried in the NRC-Licensed Disposal Area on January 1, 2000

	Activity (Ci) by Waste Category[a]												
Radionuclide	Hardware	Fuel	Ion Exchange	Degraded Extraction	Filters	Failed Equipment	Compacted Trash	Non-Compacted Trash	Dirt	Low Specific Activity General	Combination	Special	Total
H-3	10,000	1	—[b]	—	—	0.02	—	—	—	0.2	—	—	10,000
C-14	600	0.06	0.02	1×10^{-5}	0.09	0.2	0.001	9×10^{-4}	6×10^{-4}	0.07	0.04	4×10^{-4}	600
Co-60	30,000	3	2	9×10^{-4}	7	20	0.07	0.07	0.04	5	3	0.03	30,000
Sr-90	10,000	600	900	0.5	4,000	8,000	40	40	20	3,000	2,000	20	29,000
Tc-99	5	0.2	0.3	2×10^{-4}	1	3	0.01	0.01	0.007	0.8	0.5	0.005	10
Cd-113m	3	0.1	—	—	—	0.002	—	—	—	0.02	—	—	3
Sb-125	700	0.07	0.03	2×10^{-5}	0.1	0.3	0.001	0.001	8×10^{-4}	0.1	0.05	6×10^{-4}	700
Sn-126	0.2	0.01	0.008	4×10^{-6}	0.03	0.07	3×10^{-4}	3×10^{-4}	2×10^{-4}	0.02	0.01	1×10^{-4}	0.3
I-129	0.01	5×10^{-4}	—	—	—	6×10^{-6}	—	—	—	8×10^{-5}	—	—	0.01
Cs-137	20,000	8,000	1,000	0.5	4,000	9,000	40	40	20	3,000	2,000	20	47,000
Eu-154	80	4	8	0.004	30	70	0.4	0.3	0.2	20	10	0.1	200
Ra-226	1×10^{-6}	6×10^{-8}	—	—	—	7×10^{-10}	—	—	—	1×10^{-8}	—	—	1×10^{-6}
Ac-227	0.01	0.007	—	—	—	9×10^{-6}	—	—	—	1×10^{-4}	—	—	0.02
Ra-228	0.001	6×10^{-5}	—	—	—	8×10^{-7}	—	—	—	1×10^{-5}	—	—	0.001
Th-229	0.01	5×10^{-4}	—	—	—	6×10^{-6}	—	—	—	8×10^{-5}	—	—	0.01
Pa-231	0.03	0.002	—	—	—	2×10^{-5}	—	—	—	3×10^{-4}	—	—	0.03
Th-232	0.003	2×10^{-4}	—	—	—	2×10^{-6}	—	—	—	3×10^{-5}	—	—	0.003
U-232	2	0.08	2	0.01	30	3	0.01	0.01	0.006	0.8	0.4	0.005	40
U-233	4	0.2	3	0.02	40	5	0.02	0.02	0.01	1	0.6	0.007	53

Table C-9. Projected Radionuclide Activities of Nuclear Fuel Services, Inc. and West Valley Demonstration Project Wastes Buried in the NRC-Licensed Disposal Area on January 1, 2000 (Continued)

Radionuclide	Activity (Ci) by Waste Category[a]												
	Hardware	Fuel	Ion Exchanger	Degraded Extraction	Filters	Failed Equipment	Compacted Trash	Non-Compacted Trash	Dirt	Low Specific Activity General	Combination	Special	Total
U-234	0.2	0.009	2	0.01	20	2	0.008	0.008	0.005	0.6	0.3	0.003	25
U-235	0.05	0.003	0.03	2×10^{-4}	0.4	0.05	2×10^{-4}	2×10^{-4}	1×10^{-4}	0.01	0.007	8×10^{-5}	0.5
Np-237	0.07	0.003	0.005	2×10^{-6}	0.02	0.04	2×10^{-4}	2×10^{-4}	1×10^{-4}	0.01	0.007	8×10^{-5}	0.2
U-238	0.8	0.04	0.3	0.002	3	0.4	0.002	0.001	9×10^{-4}	0.1	0.05	6×10^{-4}	5
Pu-238	100	7	500	3	6,000	700	3	3	2	200	10	1	7,500
Pu-239	300	10	100	0.9	2,000	200	0.7	0.7	0.4	50	30	0.3	2,600
Pu-240	200	8	100	0.7	1,000	200	0.6	0.5	0.3	40	20	0.2	1,500
Pu-241	6,000	300	4,000	20	4,000	5,000	20	20	10	1,000	700	8	21,000
Am-241	700	30	20	0.01	0.7	200	0.8	0.7	0.4	60	30	0.3	1,000
Cm-243	0.2	0.01	0.004	2×10^{-6}	0.02	0.04	2×10^{-4}	2×10^{-4}	9×10^{-5}	0.01	0.006	7×10^{-5}	0.3
Cm-244	7	0.3	2	0.001	8	20	0.09	0.08	0.05	6	3	0.04	46

a. Derived from WVNS 1994n.
b. — = not reported.

assigned one of four isotopic distributions depending on the waste origin within the reprocessing facility. Waste inventories were then calculated using the computer code ISOSHLD-II based on the measured dose rates from the waste. Waste category information was organized in another database to determine activities of each radionuclide of interest for the EIS.

The reactor hardware radionuclide activity was estimated from the radionuclide inventories introduced during the 26 reprocessing campaigns of intact reactor fuel assemblies at West Valley. The fraction of remaining radionuclides in the hulls and other hardware, after the campaign, was estimated and corrected for radioactive decay. The radionuclide inventory at the NDA was calculated using the ORIGEN 2 computer code. The remaining radioactivity was estimated by assuming that 0.2 percent of fission products and actinides and 100 percent of the activation products remained (WVNS 1994n). Table C-10 lists the projected radionuclide activities as of January 1, 2000.

Projected Waste Inventory. The most complete description of buried waste in the NDA is in the *West Valley Demonstration Project, Draft RCRA Facility Investigation (RFI) Report, Nuclear Regulatory Commission-Licensed Disposal Area* (WVNS 1995d). The major waste types disposed of were characterized as contaminated soils, general plant waste, fuel receiving and storage area wastes, and LLWTF waste. These wastes comprise 83 percent of the total waste volume. Other types of waste include scrap, junk, and debris; fuel canisters; hulls; lead; process solvent-contaminated material; analytical waste; fuel; and miscellaneous waste. Approximately 5,400 m^3 (190,000 ft^3) of waste has been buried at the NFS disposal area, and approximately 5,700 m^3 (200,000 ft^3) of waste has been buried at the WVDP disposal area (exclusive of soil intermixed with waste and leachate). Specific information is known about a small volume of waste buried in the WVDP disposal area, which consisted of analytical wastes generated following cleanout and decontamination of the analytical and environmental laboratories. The analytical wastes consisted of laboratory utensils, tar paper used on laboratory floors, benches and hoods, plastic gloves, laboratory coats, reagents, and labpacks generated during decontamination activities. When the laboratories were cleaned out and decontaminated, liquid chemicals (e.g., stock solutions and samples) were neutralized, mixed with an absorbent, and solidified with concrete in pails. The filled pails were placed in drums with solid chemicals that were placed in layers of vermiculite. The drums were sealed and disposed of in the WVDP disposal area.

The information presented in the NDA RFI (WVNS 1995d) and other data referenced here were used to estimate the volumes of various wastes that would have to be managed if the NDA was excavated. This waste characterization was used to develop the conceptual design for waste handling and treatment facilities that would be used for managing retrieved waste. The conceptual designs depend upon the assumed waste characteristics and regulatory requirements, i.e., whether waste is radioactive and only subject to NRC requirements or mixed waste and subject to both NRC and New York State Department of Environmental Conservation (NYSDEC) requirements.

Table C-10 summarizes the waste volume estimates according to location in the NDA (NFS or WVDP disposal areas), waste classification (radioactive only or mixed), and waste

Table C-10. **Estimated Volumes of Contaminated Waste, Soil, and Leachate at the NRC-Licensed Disposal Area**

Location-Waste Classification	Waste Category	Waste Volumes (ft^3)
NFS Disposal Area—Radioactive Only	Water Filters, Fuel Receiving and Storage Area Waste, Air Filters	53,700
	Contaminated Soils	42,000
	LLWTF Sludges and Resins	40,700
	General Plant Waste	20,400
	Scrap, Junk, Debris	15,700
	Fuel Canisters	7,500
	Hulls	7,400
	Solvent-Contaminated Materials	5,000
	Degraded Extraction Solvents	600
	Spent Fuel	40
	Soil Intermixed with Waste in Holes[b]	440,000
	Contaminated Leachate in Holes[c]	80,000
NFS Disposal Area—Mixed	Analytical Wastes[d]	1,000
	Lead	200
WVDP Disposal Area—Radioactive Only	Contaminated Soil	103,000
	HLW and General Plant Waste	56,700
	LLWTF Sludge and Resins	12,900
	Scrap, Junk, and Debris	11,600
	Miscellaneous[e]	10,500
	Fuel Canisters	3,800
	Water Filters, Fuel Receiving and Storage Area Waste, and Air Filters	1,200
	Solvent-Contaminated Materials	400
	Soil Intermixed with Waste in Trenches[b]	300,000
	Contaminated Leachate in Trenches[c]	45,000
WVDP Disposal Area—Mixed	Analytical Wastes[f]	400
	Lead	9

a. To convert cubic feet to cubic meters, multiply by 0.02832.
b. For each disposal area, soil volume = (total volume of holes or trenches) - (volume of buried waste).
c. Leachate volume = (average leachate pump-out rate of SDA trenches, i.e., 1.0 gal/ft^3) x (total volume of holes or trenches).
d. Estimated volume. It is expected that hazardous constituents may be found in this waste, but there is insufficient information to properly characterize the waste or to estimate how much will actually be considered mixed.
e. There is not enough known about this waste stream to properly characterize it.
f. This waste consisted of solid chemicals that were placed in layers on vermiculite, and liquid chemicals that were neutralized, absorbed, and concreted. This waste was packaged in 18 drums (WVNS 1995d).

Source: WVNS (1994o)

category (e.g., filters, general plant waste, and contaminated soil). The buried waste was assumed to be radioactively contaminated. Two categories of waste, lead used as shielding and analytical wastes, were assumed to be mixed waste. A regulatory analysis made in conjunction with the NDA RFI concluded that it could not be determined if any of the chemicals in the analytical waste streams could meet the definition of a RCRA-listed or characteristic hazardous waste because available information did not indicate if the chemicals were used or unused before disposal, and if they would exhibit a toxicity characteristic (WVNS 1995d). NYSDEC is reviewing the RFI and has not yet made a regulatory determination as to whether the chemicals could be classified as a RCRA hazardous waste. However, from the documented lists (types and amounts) of the chemicals that were disposed of, the lab packs contain hazardous constituents and could result in small amounts of hazardous wastes. Therefore, this analysis assumed the volume of analytical wastes buried in the WVDP disposal area was mixed waste. It was also assumed that potentially hazardous wastes have not migrated outside the drums. Likewise, although there is insufficient information to characterize the volume of analytical wastes disposed of in the NFS disposal area, this analysis also assumed the waste was mixed, because of the potential presence of hazardous chemicals.

Other hazardous chemicals potentially disposed of that would be mixed waste when retrieved include fuel reprocessing chemicals, solvents used for decontamination (e.g., methyl ethyl ketone), paint removers (containing methylene chloride), and paint residues (possibly containing lead and chromates) (WVNS 1994n; WVNS 1994o). However, insufficient records are available to estimate the exact amounts and types of hazardous wastes disposed of.

Contaminated Leachate. The total volume of leachate that could be present in the holes and trenches at closure was estimated by assuming that leachate would fill holes up to grade level, above the top of buried waste (Hubert 1994). Because limited leachate data are available for the NDA disposal areas, the leachate volume as a percent of total hole or total trench volume was assumed to be the same as the SDA (see Section C.2.8.1 for more details). The basis for this assumption are data from SDA leachate pump-out campaigns (NYSERDA 1994) where an average volume of 134 L/m^3 (1.0 gal/ft^3) of leachate per total hole/trench volume was derived. The product of the leachate volume/total hole volume value and the hole/trench volume gives the leachate volume. Following this derivation, approximately 3,540 m^3 (125,000 ft^3), or 3.54 million L (935,000 gal) of leachate was estimated to be in the NDA.

Leachate was assumed to be radioactive. Radioactivity levels in measured leachate samples from six disposal holes suspected of containing n-dodecane solvent, had gross alpha and gross beta concentrations that ranged from below detection limit to 0.01 μCi/mL and 0.1 μCi/mL respectively (Blickwedehl et al. 1989). These data indicated that americium-241 was a major source for the alpha activity and that cesium-137, strontium-90, iodine-129, and antimony-125 were the major sources of the measured beta activity. Concentrations of other potential significant risk contributors, such as plutonium isotopes and neptunium-237, were not reported. The wide range in measured concentrations from just six holes make it difficult to accurately estimate average and maximum leachate concentrations that would be representative for all 239 disposal holes.

On the basis of fluid sampling of special holes 10 and 11 (Roberts 1986), sampling of monitoring wells containing n-dodecane (Roberts 1990), and knowledge of the buried waste, the leachate was assumed not to be mixed waste.

Contaminated Groundwater. Contaminated groundwater at the NDA is discussed in Section C.3.3.2.

Soil Intermixed with Waste. The volume of soil used as fill intermixed with waste in the holes and trenches was estimated by subtracting the volume of buried waste from the total volume of the disposal holes and trenches. Approximately 21,000 m^3 (740,000 ft^3) of soil was used as fill in the disposal holes or trenches and may have become contaminated by contact with surrounding waste. The total volume of contaminated soil, including soil disposed of as waste and soil used as fill that has become radioactively contaminated from leachate, is estimated at 25,000 m^3 (885,000 ft^3). Contaminated soil volumes outside and below the disposal holes or trenches are addressed in Section C.3.3.1.

C.2.7.2 Trench Interceptor Project

Description of Facility. The trench interceptor project measures 262-m (875-ft) long x 1.2 m (4 ft) wide x 3.7 to 6.4 m (12 to 21 ft) deep. The trench interceptor project trench was installed to intercept potentially contaminated groundwater migrating from the NDA, and it is connected to a liquid pretreatment system. It was installed after groundwater contaminated with tributyl phosphate, n-dodecane, and several radionuclides was detected in a well downgradient of the NDA.

The trench is located on the northeast and northwest boundaries of the disposal area as shown in Figure C-9. The base of the trench extends to a minimum of 0.3 m (1 ft) below the contact of the weathered and unweathered till and the trench is drained by a drainpipe that directs contaminated water to a collection sump. The collection sump has a submersible pump to transfer groundwater to the liquid pretreatment system.

The liquid pretreatment system consists of seven tanks made of carbon steel: one 19,000-L (5,000-gal) holding tank, two 3,800-L (1,000-gal) prefiltration holding tanks, two 2,650-L (700-gal) tanks containing granular activated carbon, and two 3,800-L (1,000-gal) post-filtration holding tanks. All seven tanks are in a Quonset-style building except the granular activated carbon tanks, which are housed in a 3.7 x 3-m (12 x 10-ft) wooden shed.

Groundwater in the sump is sampled and either sent to the pretreatment system or transferred to the LLWTF for processing. To date, none of the water collected in the trench required pretreatment, and the pretreatment system has never been used (WVNS 1994o, Martin and Weiss 1991).

Projected Waste Inventory. Some localized areas of the trench interceptor project could be radioactively contaminated and potentially contain hazardous chemical constituents (WVNS 1994n). It was assumed that the concentration of hazardous constituents would not be high enough for the waste to be classified as hazardous. The radiological contamination was not quantified because the activity present is orders of magnitude less than the activity in the NFS and WVDP disposal areas and, thus, would have no impact on the risk assessments performed for WMA 7.

C.2.7.3 Interim Waste Storage Facility

Description of Facility. The IWSF, a preengineered metal structure measuring approximately 11 x 11 x 4.6 m (36 x 36 x 15 ft), is located on the north side of the NDA. The building is anchored to a concrete slab with a curbed perimeter. The IWSF is used to store liquid wastes classified as radioactive only, nonhazardous/nonradioactive, recyclable, and mixed, and for temporary storage for all materials requiring further evaluation. As the materials are classified, they may be removed and placed in another facility, but wastes classified as mixed remain in storage at the IWSF (WVNS 1993e). As a result, the inventory of the IWSF continuously changes, but waste categories remain the same and the total stored volume has varied slightly.

Projected Waste Inventory. Only the stored waste inside the IWSF contains radiological and hazardous contamination; no contamination is in the building itself. About 500 waste containers are stored in the IWSF. As of December 1992, 512 containers were stored (WVNS 1994n); in May 1993, 499 containers were stored (WVNS 1993e), and the same categories of waste were present. Waste stored at the IWSF has been classified into nine categories as shown in Table C-11. The projected waste volume in storage at the IWSF at closure includes the current inventory plus a small waste volume from the process building analytical laboratory [approximately 3.2 m^3 (112 ft^3)] (Gramling 1994). Because most of the wastes were hazardous wastes generated in radioactively-contaminated areas, the stored waste was assumed to be mixed LLW, but no data are available for the specific radionuclides or for the activities.

C.2.7.4 Hardstand

The hardstand was an interim storage area where radioactive waste was staged before disposal in the NDA. The hardstand is a three-sided structure with cinderblock walls that is located on a 6 x 6-m (20 x 20-ft) sloped pad of crushed rock, which allowed drainage to the southern lagoon near trench 6 in the SDA (see Figure C-9). The pad had curbed concrete to control the drainage direction.

No hazardous contamination above the RCRA proposed Subpart S standards is associated with the hardstand. It is assumed to be radioactively contaminated because radionuclides have been detected in nearby soils (WVNS 1994f).

Table C-11. Estimated Waste Volumes Stored in the Interim Waste Storage Facility at the Time of Site Closure[a,b]

Category Number	Waste Category	Total Volume (ft^3)
1	Petroleum Products—motor oil, hydraulic fluid, diesel fuel, lubricating fluids, grease, transmission fluid, antifreeze	1,037
2	Residues from Chemical Spills (other than petroleum product)—NaOH, roof cement, mercury, nitric acid, citric acid, methylene chloride, acetone, absorbents	44
3	Groundwater Sampling Wastes—from equipment decontamination residues and well purge waters, nitric acid, methanol, hexane, other groundwater contaminants	125
4	Laboratory Wastes—lab samples, plutonium extraction wastes, plutonium scintillation wastes, pyridine/cyanide wastes, phosphorus pentoxide	109
5	Photographic and Blueprint Reproduction Wastes—color developers, fixative, reproduction fluids	56
6	Paints and Associated Wastes—empty paint cans, old paint, methylene chloride, paint contaminated debris	25
7	Lead Acid Batteries and Battery Acid (neutralized)	17
8	All Other Wastes Generated During Normal Operations— roofing tar, protective sealer, cleaning compounds, manometer fluids, gasket form, instrument oil with mercury, contaminated waters, silicone, water treatment chemicals	37
9	Zinc Bromide Wastes—zinc bromide solutions used as shielding in windows	48
Total Volume		1,498

a. To convert cubic feet to cubic meters, multiply by 0.02832.
b. Volume fluctuates as waste is characterized or moved to other waste storage facilities if treated and disposed of off site.

Sources: WVNS (1993h) and Gramling (1994)

C.2.7.5 Inactive Plant Water Line

A deactivated 20-cm (8-in.) cast iron water line from the plant, taken out of service in 1986, runs along the southwestern border of the NDA. It was used to supply clean water to the process building and was capped with cement after it was taken out of service.

The water line is not radiologically contaminated and is assumed to have no hazardous contamination (WVNS 1994n).

C.2.7.6 Inactive Leachate Transfer Line

A 5-cm (2-in.) galvanized-steel leachate transfer line runs along the northeastern and northwestern boundaries of the NDA. The 1,200-m (4,000-ft) line transferred leachate from the pumphouse next to the NDA hardstand to the LLWTF. It is no longer used and has been capped.

The transfer line has low-level radioactive contamination, but the activity is so low that it would not be a significant risk contributor for WMA 7. No hazardous contamination is in the inactive leachate transfer line.

C.2.7.7 Former Lagoon

A lagoon, used for collecting surface water runoff, was located in the northeastern portion of the NDA (the approximate location is shown in Figure C-9). It was later filled with radiologically contaminated soil from clean up after a high-efficiency particulate air filter was dropped at the NDA during disposal operations. The lagoon was reportedly closed in 1972.

Soil contamination at the former lagoon will be managed as part of the overall soil removal operations at the NDA. Contaminated soil volumes at the NDA are described in Section C.3.3.1.

C.2.8 Waste Management Area 8

WMA 8 consists of the SDA and ancillary structures. The SDA is an inactive LLW disposal area located on the southeast edge of the south plateau (see Figure C-1). The disposal area operated from 1963 until 1975. Approximately 68,000 m^3 (2.4 million ft^3) of waste was buried in 14 trenches (shown in Figure C-10): 12 long trenches (trenches 1 through 5 and 8 through 14), a series of 19 holes in a straight line (trench 6), and a shallow trench where wastes were placed on a poured concrete pad, then encased in cement (trench 7). Ancillary structures in the SDA include three filled lagoons, a barrier wall, and the mixed waste storage facility (see Figure C-10). In addition, cutoff walls were used to reduce the potential for flow along a buried gravel road west of trench 5.

The disposal areas are radioactively contaminated, and about half of the buried waste and soil was assumed to be mixed waste. Although the abovegrade structures in the SDA may contain radioactive contamination and the filled lagoons do contain radioactive contamination, the activities are expected to be insignificant compared to the activities of buried waste in the trenches. Therefore, the structures and filled lagoons would not be significant risk contributors for WMA 8.

C.2.8.1 Disposal Trenches

Description of Trenches and Buried Waste. The northern portion of the SDA consists of five long trenches (1 through 5); trench 6, a series of holes used for the disposal of high-

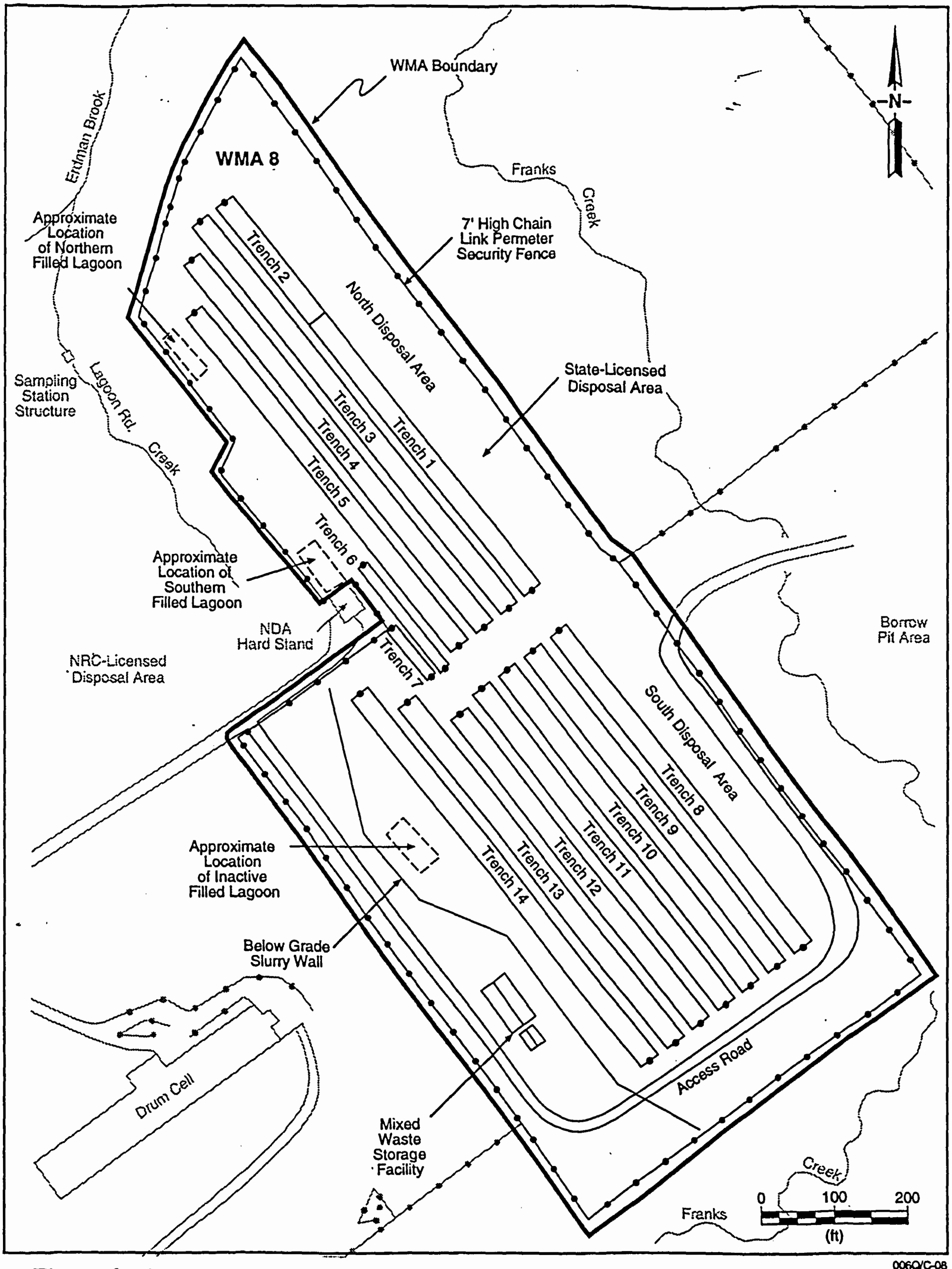

Figure C-10. Waste Management Area 8—State-Licensed Disposal Area and Associated Facilities.

activity waste that required immediate shielding; and trench 7, a shallow trench where high-activity wastes were placed on a poured concrete pad and encased in concrete (E&E 1994). The northern trenches were used from 1963 to 1969. The southern portion of the SDA consists of seven long trenches (8 through 14), used from 1969 to 1975. The waste volumes in the SDA trenches are shown in Table C-12.

A total LLW volume of approximately 68,000 m^3 (2.4 million ft^3) was received from various sources, including institutions, industries, governmental facilities, nuclear power plants, waste brokers, and decontamination facilities (Envirosphere 1986, E&E 1994, Kelleher and Michael 1973, Phillips 1991). The waste forms were diverse and included nuclear power plant processing wastes (e.g., resins filters and evaporator bottoms); biological wastes (e.g., animal wastes and excreta); research wastes and absorbed liquids; sealed sources; and activated metals. Waste was disposed of in the original shipping containers, including 19-, 114-, and 208-L (5-, 30-, and 55-gal) steel drums; wooden crates; cardboard boxes; fiber drums; and plastic bags (E&E 1994).

The types, volumes, and activities of trench waste were determined from burial records and generic profiles of waste obtained from the waste generators that transported waste to the SDA (WVNS 1994l; Stiles et al. 1992). The waste buried in the SDA trenches was grouped in the following general categories (WVNS 1994l, Stiles et al. 1992, Phillips 1991):

- Special purpose reactor wastes (30 percent of SDA waste volume). These wastes came from naval, experimental, and research reactors. There are little data on the specific waste items included in this category; however, the waste is thought to be similar in form to the commercial power reactor waste described below, although the radioactivity levels will be significantly different.

- Commercial power reactor wastes (24 percent of SDA waste volume). These wastes were generated during routine operation of commercial reactors and include wet wastes (ion-exchange resins from coolant water filtration systems), dry wastes (contaminated rags, protective clothing, ventilation filters, tools, etc), and activated wastes (metal reactor components containing activation products, such as cobalt-60). Wet wastes comprise a small volume, but a large fraction of the radioactivity.

  Reactor decontamination and decommissioning waste, such as building rubble and soil, is also included in this category.

- Nuclear fuel cycle waste (19 percent of SDA waste volume). These wastes include those from UF_6 conversion processes, fuel fabrication and refining, fuel reprocessing, and forming depleted uranium. The waste forms are variable: UF_6 wastes include calcium fluoride, lime, filters, sludges, failed equipment, and trash; fuel fabrication and reprocessing wastes include limestone, oxides from calcines, filter sludges, oil, failed equipment, and trash; and depleted uranium wastes include uranium scrap and fines, failed equipment, lubricants, solvents, rags, filters, and trash.

Table C-12. State-Licensed Disposal Area Trench Dimensions and Waste Volumes

Trench	Open Date	Close Date	Months Open	Length (m)	Length (ft)	Nominal Width (m)	Nominal Width (ft)	Nominal Depth (m)	Nominal Depth (ft)	Nominal Volume (m^3)	Nominal Volume (ft^3)	Buried Waste Volume (m^3)	Buried Waste Volume (ft^3)	Percent Used
1	11/63	5/64	6	111	365	8.8	29	6.7	22	6,595	232,870	1,566	55,300	24
2	5/64	10/64	5	102	335	8.8	29	6.7	22	6,053	213,730	3,234	114,200	53
3	7/64	11/65	16	212	695	8.8	29	6.7	22	12,557	443,410	5,627	198,700	45
4	10/65	6/67	8	201	660	8.8	29	6.7	22	11,925	421,080	7,771	274,400	65
5	5/67	3/69	22	163	535	8.8	29	6.7	22	9,666	341,330	7,884	278,400	82
6	6/70	3/73	—[a]	—	—	—	—	—	—	850[b]	30,000[b]	14	500	2
7	11/65	3/66	4	22	73	3	10	4.5	15	310	10,950	71	2,500	23
8	1/69	11/70	23	172	565	8.8	29	6.7	22	10,208	360,470	7,147	252,400	70
9	10/70	7/71	9	171	560	8.8	29	6.7	22	10,118	357,280	4,978	175,800	49
10	6/71	5/72	11	171	560	8.8	29	6.7	22	10,118	357,280	5,261	185,800	52
11	5/72	1/73	7	171	560	8.8	29	6.7	22	10,118	357,280	5,176	182,800	51
12	12/72	10/73	10	169	555	8.8	29	6.7	22	10,028	354,090	5,570	196,700	56
13	10/73	6/74	8	186	610	8.8	29	6.7	22	11,022	389,180	5,884	207,800	53
14	6/74	3/75	9	200	655	8.8	29	6.7	22	11,835	417,890	6,570	229,800	55

a. — = not applicable.
b. Estimated volume of the 19 disposal holes.

Sources: Envirosphere (1986), Table 2-2; Duckworth (1981), Table IV and Table XII.

- Institutional wastes (14 percent of SDA waste volume). Most of this waste consists of dry solids (e.g., paper, plastic, gloves, labware, and syringes) from universities, industrial and pharmaceutical research facilities, and hospitals. Other wastes in this category include liquid scintillation waste (glass vials and scintillation fluid, usually packed with absorbent material), absorbed organic and aqueous liquids, and biological waste (e.g., animal carcasses and culture media).

- Isotope production wastes (8 percent of SDA waste volume). Waste in this category includes vials, bottles, filters, absorbent material, aqueous solutions of inorganic salts, and trash from producing radioisotopes, such as tracer solutions and sealed sources.

- Industrial wastes (5 percent of SDA waste volume). Waste in this category arose from using radioactive materials in commercial manufacturing or research. These wastes are comprised of compactible and noncompactible trash, contaminated test media, scintillation vials and cocktails, absorbed liquids, gloves, and trash. The industrial wastes are expected to have low specific activities. Very small volumes of high specific activity wastes (e.g., sealed sources and accelerator foils) are also in the waste category.

Trench-specific information on unique burials include the following (Kelleher 1979, Kelleher and Michael 1973, Duckworth 1981):

- Strontium-90 space power sources buried in trench 4

- Plutonium-238 Systems for Nuclear Auxiliary Power (SNAP) space power sources

- High-activity cobalt-60 sealed sources buried in trench 5

- Tritium targets

- Radium-226 sealed sources

- Depleted uranium counterweights and castings

- Uranium mill tailings

- Sealed americium oxide sources and radium-barium neutron sources

- Reactor parts (e.g., control rods) with relatively high activities (especially cobalt-60) buried in holes in trench 6

- Special waste (i.e., unique waste forms, high-activity waste), primarily spent ion exchange resins, buried in trench 7.

While the approximate volumes of each waste category and the total waste volumes in each trench are known, volume of each waste category in a given trench is unknown.

Projected Radionuclide Inventory. Radioactive contamination in the SDA consists of buried waste in trenches, leachate that has accumulated in the trenches, soil intermixed with waste, and groundwater contamination. Buried waste, leachate, and soil intermixed with waste are discussed in this section. Soil contamination outside the trenches and groundwater contamination is discussed in Section C.3.3. The projected radionuclide activity for each SDA trench on January 1, 2000, before implementation of the alternatives, is shown in Table C-13.

Projected Volumes of Contaminated Leachate, Buried Waste, and Soil Intermixed with Waste. The limited information on waste buried in the SDA was used to develop estimates of the radioactive, hazardous, or mixed characterization of waste at the time of closure. Because of the types of waste known to have been buried, all buried waste in the SDA was considered to be radioactive. There are no records of hazardous waste disposed of in the SDA. However, hazardous constituents have been detected in trench leachate samples. For analysis, it was assumed that if hazardous constituents were detected in leachate samples at or above the concentration for defining a hazardous waste, leachate that is removed would be classified as a characteristic hazardous waste and that the entire volume of waste that generated the leachate would be classified as a characteristic hazardous waste upon removal.

Assumptions must be made to quantify how much of the soil intermixed with the buried waste would be radioactive, hazardous, or mixed. Because most of the waste transported to the SDA was contained in 208-L (55-gal) drums that may have degraded with time, it was assumed that much of the waste in the SDA will likely be commingled with the trench soil used as backfill. Thus, if it is assumed that the entire volume of waste in a trench is hazardous or radioactive (as indicated by concentrations of constituents in leachate as described above), the entire volume of soil intermixed with the waste could not be separated from the waste and, therefore, the soil would have the same classification (i.e., hazardous, mixed, or radioactive only). Leachate data for individual trenches, assumptions, and estimated waste volumes are discussed below.

Contaminated Leachate. Trench leachate sampling data are available for 12 of the waste trenches (NYSERDA 1989). No leachate data are available for trench 6 or for trench 7, but because of the nature of these trenches, very little, if any, leachate would exist. For analysis, leachate volumes were assumed to be negligible.

Radioactivity levels measured in 1987 from leachate trenches 1 through 5 and 8 through 13 had tritium concentrations ranging from 200 pCi/mL (trench 1) to 2,000,000 pCi/mL (trenches 8, 10, and 11); cesium-137 concentrations ranging from below detection limit (trench 1) to 500 pCi/mL (trenches 3 and 11); and strontium-90 concentrations ranging from 10 pCi/mL (trench 1) to 5,000 pCi/mL (trench 4) (E&E 1994). These levels are higher than those reported by Prudic (1986) for samples collected from 1976 through 1978. Thus, it is assumed that the leachate that will be present in all trenches (except trenches 6 and 7) will be radioactive.

Table C-13. Projected Radionuclide Activities of Wastes Buried in the State-Licensed Disposal Area Trenches on January 1, 2000

	Activity (Ci) by Trench[a]														
Radionuclide	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
H-3	90	100	200	400	100	300	0.2	60	50	40	50	50	60	70	1,600
C-14	10	20	40	50	20	20	0.01	20	20	10	10	10	20	20	270
Co-60	900	900	2,000	4,000	900	7,000	4	100	50	40	80	90	100	100	16,000
Sr-90	100	2,000	500	8,000	1,000	2	0.001	1,000	900	2,000	3,000	3,000	4,000	5,000	31,000
Tc-99	0.2	0.6	1	1	1	0.01	8×10^{-6}	1	0.8	1	0.9	0.9	1	1	10
Sb-125	—[b]	—	1×10^{-7}	3×10^{-5}	1×10^{-4}	—	—	1×10^{-4}	1×10^{-4}	2×10^{-4}	1×10^{-4}	2×10^{-4}	6×10^{-5}	1×10^{-4}	0.001
Sn-126	—	—	3×10^{-5}	0.006	0.01	—	—	0.01	0.006	0.01	0.005	0.005	0.002	0.002	0.06
I-129	0.05	0.2	0.4	0.7	0.3	—	—	0.2	0.3	0.1	0.1	0.1	0.8	0.9	4
Cs-137	2,000	2,000	4,000	8,000	2,000	5,000	3	2,000	1,000	2,000	2,000	3,000	3,000	4,000	40,000
Eu-154	—	—	0.003	0.7	2	7,000	—	2	1	2	1	1	0.4	0.6	7,000
Ra-226	—	—	—	0.01	0.01	—	—	0.01	0.01	0.07	0.001	0.001	0.001	0.8	0.9
U-232	—	—	8×10^{-4}	0.1	0.3	—	—	0.3	0.2	0.3	0.2	0.2	0.06	0.08	1.7
U-233	—	—	0.001	0.3	0.6	—	—	0.6	3	0.6	0.3	0.3	0.1	0.1	6
U-234	—	—	7×10^{-4}	0.2	0.3	—	—	0.3	0.1	0.3	0.1	0.1	0.04	0.07	1.5
U-235	0.02	0.07	0.1	0.02	0.02	—	—	0.03	0.01	0.01	0.02	0.02	0.03	0.02	0.4
Np-237	—	—	2×10^{-5}	0.004	0.006	—	—	0.007	0.004	0.007	0.003	0.003	0.001	0.001	0.04
U-238	0.004	5×10^{-4}	0.04	0.05	0.08	—	—	0.09	0.05	0.07	0.1	0.1	0.1	0.1	0.8
Pu-238	0.008	0.002	0.2	40	300	—	—	4,000	5,000	10,000	6,000	6,000	10	20	31,000
Pu-239	0.002	5	10	20	40	—	—	30	10	30	10	10	4	5	170
Pu-240	0.002	7×10^{-4}	0.05	0.1	20	—	—	20	10	20	9	9	3	4	95
Pu-241	0.4	30,000	2	100	200	0.1	7×10^{-5}	200	100	200	100	100	50	60	31,000
Am-241	4×10^{-4}	1×10^{-4}	0.06	10	30	0.009	5×10^{-6}	30	10	30	10	10	4	6	140
Cm-243	0.002	9×10^{-4}	0.009	0.02	0.01	—	—	0.02	0.01	0.05	0.08	0.08	0.1	0.1	0.5
Cm-244	3×10^{-6}	—	0.003	0.6	1	—	—	1	0.7	1	0.6	0.7	0.2	0.3	6

a. Activity based on *West Valley Demonstration Project, New York State Licensed Disposal Area Waste Characterization Report* (WVNS 1994l), decayed to January 2000.
b. — = not reported.

Hazardous constituents have also been analyzed in trench leachate samples. These analyses have indicated the presence of RCRA hazardous constituents in leachate from all trenches (E&E 1994), but concentrations above RCRA characteristic criteria were only detected in some trenches. Benzene and 1,2 dichloroethane were detected in trenches 3, 12, and 14 in concentrations ranging from 150 to 2,000 μg/L. Benzene was detected at concentrations of 2,100 and 2,500 μg/L in trenches 5 and 10, respectively. Barium was detected at concentrations of 541,000 μg/L in trench 4. NYSDEC has determined the SDA leachate is not a listed hazardous waste, but it could be a RCRA characteristic waste (Nosenchuck 1994). Based on the NYSDEC determination and the limited leachate sampling, leachate from trenches 3, 4, 5, 10, 12, and 14 was assumed to be characteristic mixed waste; leachate from the other trenches (trenches 1, 2, 8, 9, 11, and 13) would have to be tested for hazardous constituents, but it has been assumed that it would be radioactive only. If the volume of leachate in each trench is estimated, the volume of mixed and radioactive leachate can be estimated as described below.

The trench leachate volumes were estimated from 1981 through 1994 fluid levels in the SDA. Because the trench volumes fluctuate and could change depending on future pumping and leachate treatment methods, assumptions were made to calculate leachate volumes. The projected volume of additional stored leachate from future pump-out operations were not estimated. Assuming current fluid level trends continue, approximately 8 million L (2.1 million gal) of leachate are estimated to be present in the SDA trenches at closure; approximately 4.9 million L (1.3 million gal) of leachate from trenches 3, 4, 5, 10, 12, and 14 [including 28,400 L (7,500 gal) stored in tank T-1]; and approximately 3.1 million L (810,000 gal) from trenches 1, 2, 8, 9, 11, and 13. Using the available sampling data summarized above, 4.9 million L (1.3 million gal) was estimated to be mixed waste leachate, and 3.1 million L (810,000 gal) was assumed to be radioactive. No leachate was estimated for trenches 6 (series of disposal holes) and 7 (waste encased in concrete) because they are unlike the other disposal trenches. The potential leachate volumes were assumed to be negligible.

Buried Waste. The trench leachate sampling data were used to estimate the volume and classification of wastes in the SDA trenches. The estimated volumes of mixed and radioactive waste are shown in Table C-14.

Soil Intermixed with Waste. The total volume of soil intermixed with wastes that was used as fill was estimated by subtracting the volume of buried waste from the total trench volume. The total volume of soil in all of the trenches, [approximately 54,000 m^3 (1.9 million ft^3)], was assumed to be radioactively contaminated by contact with radioactive-contaminated leachate. Also, the soil in all trenches was assumed to be commingled with the waste and would have the same classification (i.e., either radioactive only or mixed) as the

Table C-14. Estimated Volume of Contaminated Waste, Leachate, and Soil in the State-Licensed Disposal Area Trenches

Waste Form	Waste Volume	
	Radioactive Only	Mixed
Leachate[a]	3.1 million L (810,000 gal)[b]	4.9 million L (1.3 million gal)[b]
Buried Waste[c]	28,000 m^3 (990,000 ft^3)[d]	37,000 m^3 (1,300,000 ft^3)[d]
Soil Intermixed with Waste[e]	28,000 m^3 (980,000 ft^3)[f]	28,000 m^3 (980,000 ft^3)[f]

a. Volume adapted from NYSERDA (1994). Does not include leachate volumes from trenches 6 and 7 because these volumes were assumed to be negligible. Although no leachate data are available for trenches 6 and 7, because of the nature of these trenches, it is expected that negligible volumes of leachate will be generated.
b. Classification estimated using analytical sampling data from E&E (1994).
c. Waste volumes adapted from Envirosphere (1986).
d. Classification implied from classification of leachate.
e. Soil volume = (nominal trench volume) - (buried waste volume).
f. Classification implied from classification of buried waste.

buried waste. Because most of the waste disposed of in the SDA was contained in 208-L (55-gal) drums and the drums may have degraded, this is a reasonable assumption. Therefore, because the buried waste in trenches 3, 4, 5, 10, 12, and 14 were estimated to be mostly mixed waste, the soil intermixed with the waste in these trenches [i.e., 28,000 m^3 (980,000 ft^3)] would be mostly mixed waste. Likewise, because the buried waste in trenches 1, 2, 6, 7, 8, 9, 11, and 13 was estimated to be mostly radioactive only, the soil intermixed with the waste in these trenches [i.e., 28,000 m^3 (980,000 ft^3)] would be mostly radioactive only (see Table C-14). Volumes of contaminated soil below and surrounding the trenches are addressed in Section C.3.3.1.

Contaminated Groundwater. Groundwater contamination at the SDA is discussed in Section C.3.3.2.

C.2.8.2 Filled Lagoons

Three lagoons stored water removed from the SDA trenches. The northern and southern lagoons serviced the northern trenches (see Figure C-10). Both lagoons were unlined and collected water pumped out of the trenches. The southern lagoon also collected water from the adjacent NDA hardstand. Water in the lagoons was either treated or discharged, depending on its chemical and radiological characteristics. In 1971, the lagoons were connected by a pipeline to the LLWTF in WMA 2 (E&E 1994). After 1975, the lagoons were closed by filling them with absorbent material (vermiculite-type material) and compacted native soil (E&E 1994).

The inactive filled lagoon (see Figure C-10) is located approximately 15 m (50 ft) west of trench 14. This lagoon, unlined with a capacity of 380,000 to 475,000 L (100,000 to

125,000 gal), was originally used to store water pumped from covered trenches that were accumulating water (E&E 1994). From 1975 to 1981, it was used as a holding, pretreatment, and settling lagoon for approximately 11 million L (2.8 million gal) of leachate pumped from trenches 1 through 5 and 8 through 14. The lagoon was closed during 1991 and 1992 by removing accumulated sludge, installing a vinyl liner, backfilling it with compacted native till, and capping it with clay till (E&E 1994).

Approximately 250 m^3 (9,000 ft^3) of radioactively (up to 25,000 pCi/g strontium-90) and hazardous [up to 3,050 mg/kg barium (E&E 1944)] contaminated sediment is estimated to be in the three filled lagoons. Contaminated soil surrounding the filled lagoons is addressed in Section C.3.3.1.

C.2.8.3 Mixed Waste Storage Facility

The mixed waste storage facility is a storage facility with RCRA interim status comprised of a 35,000-L (9,200-gal) fiberglass-reinforced plastic leachate collection tank (tank T-1) and two 79,500-L (21,000-gal) stainless steel frac tanks (E&E 1994). Tank T-1 is used to store untreated leachate that was pumped from trench 14 in 1991. To date, approximately 28,400 L (7,500 gal) of leachate have been transferred to tank T-1. The two 79,500-L (21,000-gal) stainless steel frac tanks are empty and serve as contingency leachate storage capacity for trench 14. Solid radioactive (and potentially mixed) waste is also stored in this facility.

New York State Energy Research and Development Authority (NYSERDA) has contingency plans to build a leachate treatment system, if needed. Tank T-1 would be used as a feed batching tank for the treatment system, and the frac tanks would be used to store treated leachate before batch discharge.

Residual radioactive and possibly hazardous contamination is expected in the mixed waste storage facility. The residual radioactive contamination has not been quantified because the levels would be an insignificant risk contributor for WMA 8.

C.2.8.4 Slurry Wall

A slurry wall, located along the western side of trench 14, was installed to control groundwater infiltration into the SDA and to control trench water levels. Its dimensions are 259 m (850 ft) long x 0.9 m (3 ft) wide x 9 m (30 ft) deep, and it is made from a mixture of native clay and at least 1 percent bentonite. No radioactive or hazardous contamination of the slurry wall is expected.

C.2.9 Waste Management Area 9

WMA 9, located adjacent to the NDA (WMA 7) and the SDA (WMA 8) on the south plateau, encompasses a 5-ha (12.4-acre) area. The radwaste treatment system (RTS) drum cell is the only facility in WMA 9, and it is used to store radioactively contaminated waste

Description of Facility. The RTS drum cell is located approximately 600 m (2,000 ft) southeast of the process building, and it is enclosed inside a temporary weather structure, which is a pre-engineered metal building measuring 114 x 18 x 7.9 m (375 x 60 x 26 ft). It consists of a base pad, shield walls, and the temporary weather structure. The drum cell houses remote waste handling equipment, container storage areas, and a control room. The shield walls at the drum cell perimeter are 4.6 m (15 ft) high and 50-cm (20-in.) thick reinforced concrete. The storage area measures about 105 x 15 m (345 x 50 ft). The base pad consists of concrete blocks set on a layer of compacted crushed stone, underlain by geotextile fabric and compacted clay, which is designed to enhance water drainage. Instrumentation at various levels in the clay layer measure moisture content and settlement. Concrete curbs to support the drum stacks are on top of the base pad.

The RTS drum cell is designed to store Classes B and C radioactive waste and receives cement-filled drums of stabilized LLW from the cement solidification system. It can accommodate up to 21,500 drums and currently contains cement-solidified uranyl nitrate hexahydrate and PUREX wastes (supernatant and sludge wash solutions) from HLW tank 8D-2. The RTS drum cell will store solidified scrubber wastes generated by the vitrification process and also THOREX liquid wastes.

Projected Radionuclide Inventory. The final inventory of the RTS drum cell is unknown; therefore, it was conservatively assumed it would be filled to capacity (21,500 square drums) in the year 2000 and all drums would contain 269 L (71 gal) of waste. The projected year 2000 inventory, based on this assumption is shown in Table C-15. The facility itself is not expected to have significant contamination (activities less than 4,000 Ci), and it would be an insignificant risk contributor for WMA 9.

Table C-15. Projected Radionuclide Activity of Waste in the Radwaste Treatment System Drum Cell[a]

Radionuclide	Activity (Ci)
H-3	6
C-14	4
Sr-90	1,000
Tc-99	4,000
I-129	0.6
Sb-125	10
Cs-137	1,000
Pu[b]	400
Pu-241	3,000

a. Activity from *West Valley Demonstration Project, RTS Drum Cell Waste Characterization Study* (WVNS 1993i), decayed to January 2000. (Radionuclides not listed will not impact the risk assessments performed for WMA 9.)
b. Includes all isotopes other than Pu-241.

Projected Hazardous Waste Inventory. Although the original uranyl nitrate hexahydrate and PUREX waste streams were considered hazardous waste based on process knowledge, it was assumed that the solidified vitrification scrubber wastes would also be nonhazardous.

C.2.10 Waste Management Area 10

WMA 10 encompasses approximately a 10-ha (25-acre) area on the north plateau (Figure C-11) and includes warehouses, the office trailers for site employees, and parking lots. None of these facilities are known to be radioactively contaminated. Potential sources of hazardous waste may be in the new warehouse from stored chemicals and at the main security gate from PCB-contaminated fluorescent light fixtures.

C.2.10.1 OB-1 Office Building

The OB-1 office complex is a one-story high building constructed of light wood and metal siding and roofing that consists of 10 modular units. The building dimensions are 21 x 43 m (70 x 140 ft) x 3.1 m (10 ft) high. No hazardous or radiologically contaminated areas are in the OB-1 building (WVNS 1994c).

C.2.10.2 New Warehouse

Description of Facility. The new warehouse and a warehouse extension are a preengineered steel building that rests on concrete piers and a poured concrete foundation wall. The overall dimensions are 24 x 76 m (80 x 250 ft) by approximately 6.7 m (22 ft) high at the roof peak. The concrete floor averages 15 cm (6 in.) thick, and the foundation wall is 20 cm (8 in.) wide by approximately 1.8 m (6 ft) high. A fire wall divides the building into two sections. The north section is used for storing supplies and all chemicals for the WVDP, and it has RCRA interim status. The south section is used for storage of nonhazardous industrial waste and lead bars and sheets.

Projected Waste Inventory. No radiologically contaminated areas are in the new warehouse. There are no known hazardous material spills in the building.

C.2.10.3 Administrative Building and Office Trailers

The administrative building and annex trailers are located at the main entrance to the WVDP Project Premises. The administrative building is a single-story wood frame structure with metal siding measuring 12 x 40 m (40 x 130 ft) x 3.7 m (12 ft) high at the roof peak, and the adjoining entrance lobby measures 3.7 x 8.5 m (12 x 28 ft). The base of the building is 23-cm (9-in.) thick concrete. The administration building addition is approximately 9 x 29 m (30 x 94 ft) with a 15-cm (6-in.) concrete base.

Eighteen double-wide [7 x 18 m (24 x 60 ft)] trailers and two single-wide [3.7 x 18 m (12 x 60 ft)] are annexed to the building. They are constructed of light wood framing, wood siding, roofing, and a metal base. The annex conference room consists of three one-story modular units with dimensions of 12 x 20 m (41 x 66 ft), and the adjacent entrance area measures 7.3 x 8.2 m (24 x 27 ft). Two corridors connect all the trailers.

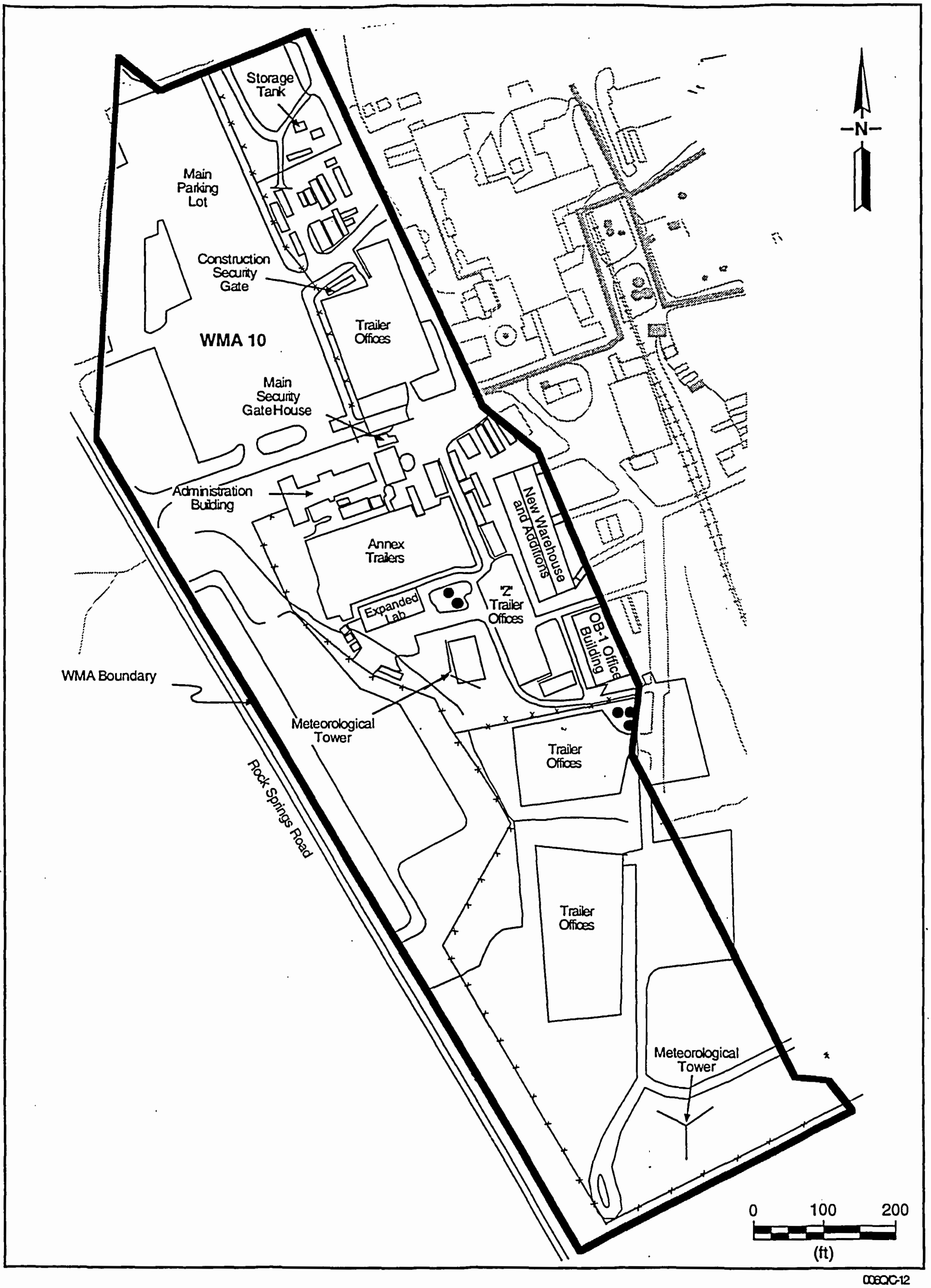

Figure C-11. Waste Management Area 10—Support and Services Area.

Trailer City is a complex of 12 trailers located northeast of the main entrance gate and interconnected by an enclosed walkway. These trailers are made of wood frames and metal siding and roofing and house office space, nurse's station, rest rooms and storage areas, a cafeteria, and a photographic laboratory. Each of eight double trailers measures 7.6 x 17 m (25 x 56 ft); the vitrification office trailer measures 11 x 18 m (36 x 60 ft); the cafeteria measures 19 x 18 m (62 x 60 ft); and the rest rooms and storage areas measure 3 x 5.2 m (10 x 17 ft). Each trailer is 3.4 m (11 ft) high.

Approximately 41 "Z" series trailers are located throughout the site. There are 36 single-wide trailers [each measuring 3.7 x 18 x 3.4 m (12 x 60 x 11 ft)] and five double-wide trailers [each measuring 8.5 x 20 x 3.4 m (28 x 65 x 11 ft)] constructed of wood frame with metal siding and a metal base frame. They are used for office space.

No hazardous or radiological contamination is at the administration building or the trailers (WVNS 1994c).

C.2.10.4 Parking Lots

Two parking lots are located off Rock Springs Road: the south parking lot and the main parking lot. The south lot is an irregularly-shaped area covering about 7,430 m^2 (80,000 ft^2), with a 20-cm (8-in.) thick asphalt-paved surface and two 600 m^2 (6,400 ft^2) driveways.

The main parking lot is a series of three squares with a total area of 16,700 m^2 (180,000 ft^2). The lot has a 15 to 30-cm (6 to 12-in.) gravel base covered by 7.6 to 10-cm (3 to 4-in.) asphalt paving. Two driveways for the lot measure 7.3 x 64 m (24 x 210 ft) and 7.3 x 70 m (24 x 230 ft). No hazardous or radiologically contaminated areas are in the parking lots (WVNS 1994c).

C.2.10.5 Expanded Laboratory

The expanded laboratory is located to the south of the administration building/annex trailers and consists of eight one-story modular units with total dimensions measuring 28 x 15 m (92 x 50 ft). Construction materials consist of light wood framing and metal roofing and siding. The lab has two sections: the expanded environmental lab and the expanded analytical annex. The expanded environmental lab is used for nonradioactive sample analysis, characterizing chemical contamination. Fume hoods located in the expanded environmental lab vent outside. The expanded analytical annex is used as office space, but it will house additional analytical equipment and instrumentation. An addition to the lab measures 6.1 x 15 m (20 x 50 ft). No hazardous or radiologically contaminated areas are at the expanded laboratory complex (WVNS 1994c).

C.2.10.6 Security Gate Houses

Description of Facilities. There are two security gate houses. The main security gate house is located adjacent to the administration building, and the construction security gate house is adjacent to the trailer city trailers. The main security gate house has a concrete foundation, concrete blockwalls, a 15-cm (6-in.) concrete slab floor, and a built up roof with metal deck. The dimensions of the gate house are approximately 6.1 x 10 x 2.7 m (20 x 34 x 9 ft). The construction gate house is a single-wide trailer with dimensions of 3.7 x 18 m (12 x 60 ft). The trailer has a light wood frame and metal siding and roofing. An addition to the trailer has dimensions of 2 x 6.1 m (6 x 20 ft).

Projected Waste Inventory. No radiologically contaminated areas are in the security gate houses. The ballasts in fluorescent light fixtures in the main security gate house contain PCB-contaminated oils and are potential sources of hazardous contamination (WVNS 1994c).

C.2.10.7 Meteorological Towers

Two meteorological towers are located to the south of the administration building/ annex trailers. They are approximately 61 m (200 ft) high, constructed of steel, and supported by concrete foundations. Each tower has three main support columns and interior trusses. Monitoring equipment is located on the towers at various levels. The standby generator and electrical boxes rest on a 1.5 x 1.8 m (5 x 6 ft) and 15-cm (6-in.) high concrete pad. No hazardous or radiologically contaminated areas are at the two meteorological towers (WVNS 1994c).

C.2.11 Other Areas on the Project Premises

Two areas are located on the Project Premises, but are not part of one of the 12 WMAS: the inactive northern borrow pits and Erdman Brook and a portion of Franks Creek. The borrow pits do not contain radiological or hazardous contamination, but the sediments along the streams do have radiological and hazardous contamination.

C.2.11.1 Inactive Northern Borrow Pits

Several abandoned borrow pits are located on the north side of WMA 4 in a fenced area just outside the perimeter fence (see Figure C-1). Material was excavated from the pits to construct the process building and associated features (Picazo 1994). The excavated areas have since ponded, serving as a water source and habitat for plants and animals. None of the borrow pits contain radioactive or hazardous contamination (WVNS 1994c).

C.2.11.2 Erdman Brook and a Portion of Franks Creek

Erdman Brook and a portion of Franks Creek are located on the Project Premises as shown in Figure C-1. Erdman Brook is between WMA 2 and WMAs 7 and 8. A portion of Franks Creek is east of WMA 8, and it joins with Erdman Brook. Sediments along these streams are contaminated with radionuclides and hazardous metals. This environmental contamination is discussed in Section C.3.4.2.

C.2.12 Waste Management Area 11

WMA 11 comprises three structures located on the balance of the site: the bulk storage warehouse, the scrap material landfill, and hydrofracture test well area (see Figure C-2), none of which have radiological contamination. The bulk storage warehouse may have a small volume of hazardous waste.

C.2.12.1 Bulk Storage Warehouse

The bulk storage warehouse is approximately 4 km (2.5 mi) south of the main plant area and was previously known as the plutonium storage facility. It currently stores office furniture, miscellaneous supplies, computers, and electrical equipment. The outside dimensions of the warehouse measure 24 x 49 m (80 x 160 ft) with a height of 7.6 m (25 ft) at the roof edge. It is constructed of steel beams with light metal siding and roofing and has 10-cm (4-in.) concrete flooring atop a concrete foundation. An interior, 20-cm (8-in.) concrete block wall separates the office area from the main warehouse. A sunken loading dock measuring about 4.0 x 11 m (13 x 35 ft) on the east side of the building is surrounded by a 96-cm (38-in.) high reinforced concrete wall.

No radiological contamination is at the bulk storage warehouse. The only potential source of hazardous contamination is PCB-contaminated oil contained in ballasts in fluorescent light fixtures (WVNS 1994c).

C.2.12.2 Scrap Material Landfill

The scrap material landfill, originally a 3 x 37 x 4.3-m (10 x 120 x 14-ft) trench, is located about 30 m (100 ft) south of the bulk storage warehouse. In 1984, NYSERDA disposed of nonhazardous construction and demolition debris, including 326 decontaminated empty steel and concrete containers, and an aluminum transfer hood in this landfill. The expanded area measured about 12 x 40 m (40 x 130 ft) after it was backfilled. No hazardous or radiological contamination is at the landfill (WVNS 1994c).

C.2.12.3 Hydrofracture Test Well Area

An injection well and four monitoring wells were installed in 1969 to conduct hydraulic fracturing experiments. Each well reaches a depth of 457 m (1,500 ft) and is cased with steel for its entire length. Each monitoring well is located about 46 m (150 ft) from the injection well. Four of five injections used zirconium-95 to tag the injected water. The fifth injection consisted of cement and bentonite to inject a grout sheet into the rock column.

A few years after the injections were performed, all of the injected zirconium-95 would have decayed to niobium-95 and then to a stable state. No hazardous or radiologically contaminated areas are at the injection well (WVNS 1994c).

C.2.13 Waste Management Area 12

WMA 12 comprises several structures located on the balance of the site: the schoolhouse, a firing range, a borrow pit, gravel pit quarries, earthen dams, and reservoirs (see Figure C-2). None of these structures have radiological contamination. The schoolhouse is the only facility that may have hazardous waste.

A 28-ha (69-acre) on the balance of the site is contaminated with cesium-137. During the 1960s, ventilation system failures resulted in airborne releases from the process building exhaust stack and soil deposition. Most of the contaminated area is in WMA 12; WMAs 3, 4, and 5 are also affected. Contaminated soil in the cesium prong is discussed in Section C.3.4.1.

C.2.13.1 Schoolhouse

The schoolhouse is a two-room, single-story structure that was built with a timber frame and clapboard siding. The overall exterior dimensions of the schoolhouse are 5.6 x 12 m (18.5 x 41 ft). The northern section of the building rests on a fieldstone foundation, which ranges from 0.9 m (3 ft) in height at the north end to 15 cm (6 in.) at the south end. This section of the building measures 5.6 x 9.6 m (18.5 x 31.5 ft) and is approximately 5.2 m (17 ft) high at the roof peak. The southern section of the building is an addition that measures 2.9 x 5.6 m (9.5 x 18.5 ft) and is approximately 6.4 m (21 ft) high at the peak. A brick chimney is located on the western side of the building.

A covered entry [approximately 1.1 x 1.2 m (3.5 x 4 ft)] constructed of corrugated metal siding and pressure treated lumber is on the eastern side. The roof of the building is asphalt shingles with the original wood shingle roof underneath. The schoolhouse has been used as an environmental laboratory, and it is currently used as a training center.

The potential contamination of concern is PCB-contaminated oils that may be contained within the ballasts in fluorescent light fixtures (WVNS 1994c).

C.2.13.2 Live Firearms Range

The live firearms range is approximately 2.4 km (1.5 mi) southeast of the process building. The perimeter of the live firearms range is approximately 120 x 30 m (400 x 100 ft). Two small buildings and three cargo body trailers are located just outside the south side perimeter. One of the buildings, the range house, measures 2.4 x 3.1 m (8 x 10 ft) and is 3.1 m (10 ft) high at the roof peak. The range house is constructed of a concrete slab floor, light wood frame, wood siding, and asphalt roofing, and it is used to store first aid equipment and supplies. The other building has a light wood frame, waferboard siding and roofing, and crushed stone flooring.

There is no hazardous or radiological contamination of the buildings at the live firearms range (WVNS 1994c). The soil potentially may have lead contamination in the target area (WVNS 1994c). No sampling has been conducted in this area.

C.2.13.3 Borrow Pits

One borrow pit is located between Franks Creek and Buttermilk Creek, south of the Project Premises and east of the SDA (see Figure C-2). This area was excavated to provide clay fill for various facilities, including the NDA and SDA. The pit is used as needed. The borrow pit does not contain radioactive or hazardous contamination (WVNS 1994c).

C.2.13.4 Gravel Pit Quarries

Two gravel pits were excavated west of the main plant area and across Rock Springs Road. The gravel pits are not used and are now overgrown. An active gravel quarry in the southeastern portion of the Center is leased to the town of Ashford. The quarries contain no radioactive or hazardous contamination (WVNS 1994c).

C.2.13.5 Earthen Dams and Reservoirs

Two earthen dams and two reservoirs are in the southeastern portion of WMA 12 (see Figure C-2). The two reservoirs are part of the Center's water supply system and have a combined capacity of 782,000 m^3 (27.6 million ft^3) (Dames & Moore 1986) or 7,770 ha-m (630 acre-ft). These structures do not contain radiological or hazardous contamination.

C.3 ENVIRONMENTAL CONTAMINATION

This section describes and quantifies radiological and hazardous environmental contamination expected to be present before implementation of the alternatives (the year 2000). The discussion focuses on contaminated soil, including stream sediments, and groundwater volumes that may be managed during implementation of an alternative. Because the hydrogeology differs on the north and south plateaus (i.e., sand and gravel layer at the surface on the north plateau, weathered Lavery till at the surface on the south plateau), soil and groundwater contamination are addressed for the north plateau (WMAs 1 through 6, 10), the south plateau (WMAs 7, 8, and 9), and for the balance of the site (WMAs 11 and 12).

C.3.1 Definition of Contamination Levels

This section discusses the standards used to define contaminated soil and groundwater (i.e., soil and groundwater contaminated above background or to levels that require action to release a facility or area for unrestricted use). The final determination of allowable residual contamination levels will be made in the context of a NRC-licensing action or State RCRA-closure action; however, applicable regulations as described in Appendix B were used to estimate assumed contaminant cleanup levels.

C.3.1.1 Radiological Contamination Criteria

The NRC is in the process of developing generic criteria for radiologically contaminated sites. The proposed rule for 10 CFR Part 20 [59 FR 43200-43232 (FR 1994)] issued on August 22, 1994, states that a site may be released for unrestricted use when the predicted total effective dose equivalent to the average member of the critical group is less than 15 mrem/yr and when the residual activity has been reduced to a level that is ALARA [proposed 10 CFR Part 20.1404 (FR 1994)]. No regulatory determination has been made concerning the dose standard that would be applied to areas that would be free released. It is expected that a standard similar to the NRC standard would be applied.

The proposed NRC rule also requires that residual radioactivity in groundwater that is a current or potential source of drinking water cannot exceed the limits specified in the U.S. Environmental Protection Agency (EPA) drinking water standards presented in 40 CFR Part 141 [proposed 10 CFR Part 20.1403 (FR 1994)]. Proposed EPA drinking water standards are based on a 4 mrem/yr dose standard. In keeping with the proposed NRC rule, the proposed EPA drinking water standard was used as the assumed contaminant cleanup levels for potential groundwater sources. These levels are presented in Table C-16.

Table C-16. Assumed Contaminant Cleanup Levels in Drinking Water Resulting in a 4 mrem/yr Dose

Radionuclide	Concentration (pCi/L) Resulting in Dose of 4 mrem/yr
Ra-228	7.8
Ra-226	15.7
Sr-90	42
Cs-137	120
Tc-99	3,790
H-3	60,000

Source: FR 1991

Using a dose standard of 15 mrem/yr, the assumed contaminant cleanup levels in soil was determined by using the RESRAD computer code, which calculates a dose based on the assumed scenario that a farmer lives, grows crops, and raises cattle on contaminated soil. The RESRAD code description is presented in Section D.3.1.1 in Appendix D. Computer simulations that both considered and ignored the water pathway (i.e., drinking or irrigation) were run. The radionuclide concentrations that would result in a dose of 15 mrem/yr are presented in Table C-17 for those nuclides that have been detected at the site.

Table C-17 shows that radionuclide concentrations that result in a 15 mrem/yr dose are not sensitive to whether the water pathways are considered or ignored, except for tritium, iodine, technetium, and uranium isotopes. The assumed contaminant cleanup levels in the soil for a specific area was taken from the appropriate column of Table C-17, after it was determined whether there were any reasonable water pathways. Soil is considered to be contaminated when the sum of the fractions of limits is equal to or greater than 1.0. For example, for soil containing only strontium-90 and cesium-137, the sum of the fraction of limits would be found by:

Table C-17. Assumed Contaminant Cleanup Levels in Soil Resulting in a 15 mrem/yr Total Effective Dose Equivalent

	Concentration in Soil (pCi/g) Resulting in Dose of 15 mrem/yr	
Radionuclide	All Pathways Considered[a]	All Pathways Except Water Pathways Considered[a]
Am-241	27	27
Co-60	1.5	1.5
Cs-137	6.9	6.9
H-3	118	1×10^7
I-129	0.17	16
Pu-238	31	31
Pu-239/240	28	28
Pu-241	900	900
Ra-226	0.35	0.35
Ra-228	2.6	2.6
Sr-90	6.1	6.1
U-234	7.2	73
U-235	6.0	73
U-238	6.6	76
Tc-99	4.9	390
Gross alpha	NA[b]	NA
Gross beta	NA	NA

a. Determined using the RESRAD code.
b. NA = not applicable because concentrations include a variety of radionuclides.

(concentration of strontium-90 in soil)/(concentration of strontium-90 resulting in dose of 15 mrem/yr)
+ (C-1)
(concentration of cesium-137 in soil)/(concentration of cesium-137 resulting in dose of 15 mrem/yr).

Using the values given in Table C-17, the formula becomes

(concentration of strontium-90 in soil)/6.1 + (concentration of cesium-137 in soil)/6.9. (C-2)

If this sum is greater or equal to 1.0, then the soil is considered to be radioactively contaminated.

C.3.1.2 Hazardous Contamination Criteria

Hazardous contamination (i.e., contamination from hazardous constituents) has been detected in soil and groundwater at the Project Premises. Because residual contamination levels for hazardous constituents have not been established for the Center, a risk-based approach was used to determine assumed hazardous constituent cleanup levels. The assumed radionuclide contaminant cleanup levels are based on an estimated lifetime excess cancer risk of one in 4 x 10^{-4} [59 FR 43200-43232 (FR 1994)]. By comparison, some risk-based contamination levels have also been established for hazardous constituents where the lifetime risk of an excess cancer is on the order of 1 in 10^{-5} to 10^{-6} [55 FR 30865-30873 (FR 1990)].

Assumed hazardous contaminant cleanup levels for soil are either the proposed RCRA Subpart S action level standards [55 FR 30865-30873 (FR 1990)] or three times the maximum site background concentrations, whichever are higher and for groundwater are the same as the EPA Drinking Water Standards (40 CFR Part 141, "National Primary Drinking Water Regulations"). The RCRA Subpart S regulations were proposed in 1990 as standards for determining whether RCRA corrective action should be performed at hazardous waste management units with releases of hazardous constituents into the environment, but the regulations have not been finalized. The assumed contaminant cleanup levels for soil are consistent with the approach used in several RFIs. The assumed contaminant cleanup levels for metals detected in soil at the Center are presented in Table C-18.

Some organic compounds were detected in soil or sediment samples. However, these organic compounds do not have proposed RCRA Subparts action levels and were not measured in samples taken to determine background concentrations. However, these compounds are polynuclear aromatic hydrocarbons, which are often products of incomplete hydrocarbon combustion, and they are typically found in soil affected by surface runoff from roads. Because these compounds are thought to be from runoff, are not widespread, and are present only in low concentrations, they were not considered important when characterizing the nature and extent of contamination.

Federal and State maximum contaminant levels, action levels, and drinking water standards for groundwater are shown in Table C-19. Only those chemical constituents that have been detected in groundwater at the Project Premises or the SDA are shown. No groundwater contamination from hazardous metals is suspected. Analytical results for metals from unfiltered groundwater samples were rejected because turbid samples caused elevated

Table C-18. Assumed Contaminant Cleanup Levels for Metals in Soil and Sediment

Metal	Proposed RCRA Subpart S Action Level[a] (mg/kg)	Site Background Concentrations[b] (mg/kg)	Assumed Contaminant Cleanup Levels[c] (mg/kg)
Antimony	30	ND[d] - 5.09	30
Arsenic	80	2.44 - 15.5	80
Barium	4,000[e]	53.2 - 144	4,000
Beryllium	0.2	ND - 1.1	3.3
Cadmium	40	ND - 1.6	40
Chromium	400[f]	12.1 - 20.4	400
Cobalt	none listed	8.45 - 14	42
Copper	none listed	5.72 - 27.1	81
Lead	none listed	11.2 - 27.3	82
Mercury	20	ND - 0.065	20
Nickel	2,000	13 - 35.3	2,000
Selenium	none listed	ND - 0.178	0.53
Silver	200	ND	200
Thallium	6[g]	ND	6
Vanadium	700[h]	13.8 - 24.5	700
Zinc	none listed	45.4 - 345	1,035

a. Source: 55 FR 30865-30873 (FR 1990).
b. Range of background concentrations from the SDA (E&E 1994), WVDP RFI samples at BH-39, SS-7, ST-18, ST-26, ST-6 (WVNS 1994f), and off-site background samples (WVNS 1990).
c. The assumed contaminant cleanup levels are either the EPA proposed RCRA action level or three times the maximum site background concentration, whichever is higher.
d. ND = not detected.
e. Proposed action level for ionic barium.
f. Proposed action level for hexavalent chromium.
g. Proposed action level for thallic oxide.
h. Proposed action level for vanadium pentoxide.

Table C-19. Metal and Organic Contaminant Groundwater Concentrations Above Regulatory Thresholds (mg/L)[a]

Contaminant	Well Identification Number	Maximum Concentration[b]	Annual Average Concentration[b]	EPA Drinking Water MCL[c,d]	EPA Proposed RCRA Action Level[e]	New York State Drinking Water MCL[c,f]	New York State Class GA Groundwater Standard[g]
Chromium	8613B	0.240	0.096	0.1	[h]	0.1	0.05
	403	0.188	<0.053	0.1	[h]	0.1	0.05
Cadmium	1111A	0.066	<0.0046	0.005	[h]	0.05	0.05
	1103B	0.0065	<0.0046	0.005	[h]	0.05	0.05
1,1-dichloroethane	8612	0.0358	0.0324	[i]	[i]	0.005[j]	0.005[j]
Dichlorodifluoromethane	803	0.030	0.0156	not listed	7.0	0.005[j]	0.005[j]
	8612	0.0095	0.00685	not listed	7.0	0.005[j]	0.005[j]
Lead	103	0.106	<0.031	0.015	[h]	0.015	0.025

a. Polychlorinated biphenyls, pesticides, and semivolatile compounds were sampled for but not detected in groundwater.
b. Concentrations from filtered 1992 samples analyzed for metals and 1993 groundwater samples analyzed for organic compounds as reported in the 1992 and 1993 annual reports (WVNS 1994i).
c. MCL = maximum contaminant level.
d. From 40 CFR Part 141 ("National Primary Drinking Water Standards").
e. From 55 FR 30865-30873 (FR 1990).
f. From 10 NYCRR Part 5 ("Drinking Water Supplies").
g. From 6 NYCRR Part 703 ("Surface Water and Groundwater Quality Standards and Groundwater Effluent Standards"). Class GA waters are fresh groundwaters (i.e., potable water source).
h. Proposed action level defers to EPA drinking water MCL.
i. No EPA drinking water or RCRA action level defined.
j. New York State drinking water and groundwater standards for volatile organic compounds are based on EPA Method 8240/624 detection levels.

metal readings. Cadmium, chromium, and lead concentrations in groundwater samples have been sporadically identified above EPA or New York State regulatory action levels in a few wells. However, as shown in Table C-19, the 1992 average cadmium and chromium concentrations were all below the EPA and New York State groundwater maximum contaminant levels. Lead was identified above 0.025 mg/L in one out of the four 1992 sampling events. Two organic compounds, 1,1-dichloroethane and dichlorodifluoromethane, were identified above the New York State groundwater maximum contaminant level of 0.005 mg/L, although this standard is based on the analytical method detection level and is not health-based. Although n-dodecane has also been detected in groundwater at the site, there are no federal or State standards for this contaminant. However, n-dodecane has been included in the chemical risk assessment in Appendix D, which demonstrates that n-dodecane would not pose a health hazard. Therefore, for analysis, n-dodecane by itself would not require removal.

C.3.1.3 Background Concentrations

Certain radionuclides and metals occur naturally in the environment. The background concentration must be known to determine if contamination is present. Background soil and subsurface soil samples have been collected from both on-site and off-site locations (E&E 1994, WVNS 1990, WVNS 1994f). Background radiological concentrations are given in Table C-20. Only cesium-137, radium-226, and radium-228 have been found in background samples at more than 10 percent of the contamination criteria shown in Table C-17. As shown in Table C-20, background concentrations of cesium-137 range from less than 0.013 to 1.55 pCi/g. Concentrations above 0.3 pCi/g are found only in the top 15 cm (6 in.) of soil reflecting world-wide fallout from atomic testing. Radium-226 background concentrations exceed the assumed contaminant cleanup levels shown in Table C-17, indicating that naturally-occurring radium in soil in this area is very high. Radium-226 values greater than 3.9 pCi/g (maximum background) were considered contaminated for this analysis. Background metal concentrations are given in Table C-18. As shown in Table C-18, the assumed contaminant cleanup levels for these metals are often equal to the maximum site background concentration.

C.3.2 North Plateau

This section describes the nature and extent of contaminated soil and groundwater on the north plateau, which contains WMAs 1 through 6, and 10.

Distinct areas of radiologically contaminated soil have been identified in WMAs 1, 2, 5, and 6, and these areas are discussed in Section C.3.2.1. The north plateau also contains a contaminated groundwater plume. The contaminated groundwater and soil in this plume are contained in WMAs 1, 2, and 4; this plume is discussed in Section C.3.2.2. A 25-ha (63-acre) area of surface soil contamination (i.e, the cesium prong) extends across north plateau WMAs 3, 4, and 5 and onto the balance of the site north of Quarry Creek; the cesium prong is discussed in Section C.3.4. No contamination has been identified in WMA 10.

Table C-20. Background Concentrations of Radionuclides

Radionuclide	Number of Background Samples	Background Concentrations (pCi/g)[a]
Am-241	24	<0.00773 - 0.388
Co-60	11	—[b] - <0.045
Cs-137	24	0.013 - 1.55
H-3	3	— - <0.3
I-129	3	— - <7.0
Pu-238	12	<0.003 - 0.075
Pu-239/240	24	<0.00486 - 0.098
Pu-241	9	<0.88 - 5.2
Ra-226	14	0.927 - 3.9
Ra-228	8	0.98 - 1.3
Sr-90	24	<0.027 - 1.86
U-234	15	0.091 - 0.32[c]
U-235	15	<0.00431 - 0.011/<0.07[d]
U-238	17	0.056 - 1.3
Tc-99	3	<0.7 - 0.88
Gross alpha	14	3.8 - 17.1/<20
Gross beta	14	8.6 - 61

a. Background samples from seven locations on the Project premises and the SDA and ten off-site locations (WVNS 1994f, WVNS 1994i, WVNS 1990, E&E 1994).
b. — = Background sample concentration was less than the lower limit of detection or analytical uncertainty.
c. Background samples may contain a very small contribution from U-233.
d. U-235 results for isotopic analysis were summarized, and gamma spectroscopy values were not used. Note that the revised SDA U-235 results (November 1994) are taken into account.

Hazardous (chemical) contamination has been detected in groundwater above background on the north plateau, but it is below the criteria for soil and water discussed in Section C.3.1.2. Since 1990, this contamination was detected in several monitoring wells in the north plateau.

C.3.2.1 Contaminated Soil

Figure C-12 shows the location of soils on the north plateau that are contaminated above the assumed contaminant cleanup levels presented in Table C-17. Isopleth maps for the sediment and soil concentrations shown on Figure C-12 were not generated because collected data are of limited areal extent; they represent multiple horizons, and there is potentially more than one contaminant source. Cesium-137 and strontium-90 are the primary contaminants in unsaturated soils on the north plateau. Much of the soil contamination is within the cesium prong north of the process building (see Section C.3.4). Tables C-21 through C-23 identify the estimated contaminated area, depth, volume, and the maximum radiological concentration or suspected radiological contaminant in soils in the north plateau. The volumes in Section C.3.5 represent the volumes that are contaminated above the assumed contaminant cleanup level of 15 mrem/yr described in Section C.3.1.1.

Waste Management Area 1. Six areas containing soil with contamination have been identified in WMA 1. Contamination resulting from liquid radioactive releases exists in soils under several facilities near the process building: the acid recovery cell, utility room and courtyard, condensate tanks, areas south and north of the fuel receiving and storage building, and nitric acid and sodium hydroxide storage tanks (WVNS 1993a). Table C-21 summarizes soil contamination in WMA 1.

Waste Management Area 2. Four areas containing soil contaminated with primarily cesium-137 and strontium-90 have been identified in WMA 2. These areas include the old interceptor/lagoon 1, the former solvent dike, lagoon 2 and lagoon 3. The contaminated soil volumes at each of these locations are presented in Table C-22. Most of the contaminated soil volume is at the old interceptor/lagoon 1, lagoon 2, and lagoon 3. The total volume of contaminated unsaturated soil within WMA 2 (including fill in lagoon 1) is estimated to be 4,800 m^3 (170,000 ft^3). The total volume of contaminated subsurface soil in the saturated zone is estimated at 16,000 m^3 (516,000 ft^3).

Soil contaminated mainly by cesium-137 and strontium-90 in the old interceptor/ lagoon 1 area is within the sand and gravel layer. No radiological contamination has been detected in the underlying unweathered Lavery till at BH-8, located adjacent to lagoon 1 (see Figure C-13). The contaminated area is about 3,700 m^2 (40,000 ft^2), with an average unsaturated thickness of 1.2 m (4 ft) and an average saturated thickness of 2.4 m (8 ft).

Soil and subsurface soil below the solvent dike is also contaminated with cesium-137 and strontium-90. The contaminated area is about 150 m^2 (1,600 ft^2) with an average unsaturated and saturated thickness of 1.8 m (6 ft) and 2.4 m (8 ft), respectively. The contamination levels are 100 to 1,000 times lower than those at lagoons 1, 2, and 3.

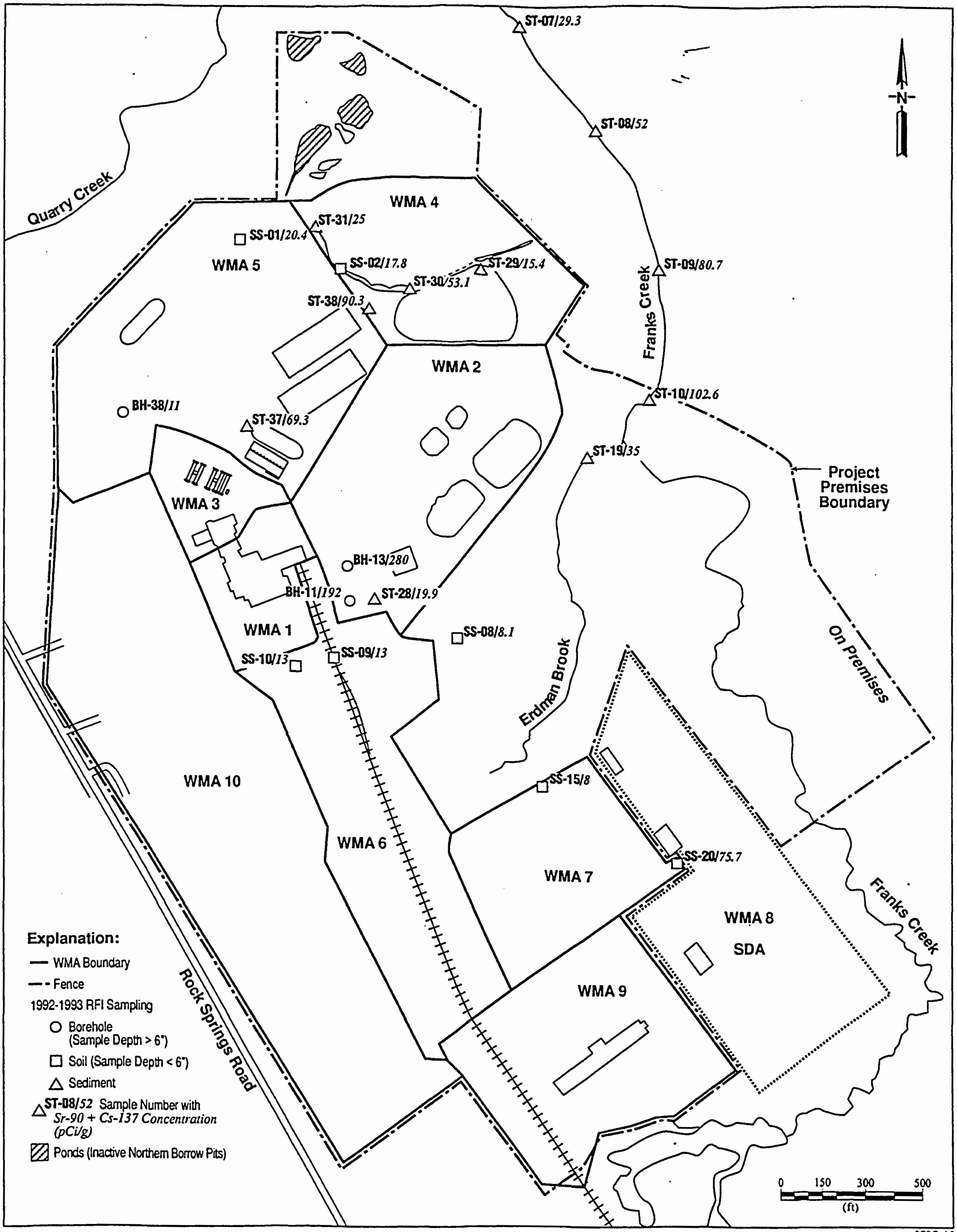

Figure C-12. Distribution of Strontium-90 and/or Cesium-137 in Surface Soil and Stream Sediment that Exceeds the 15 mrem/year Contamination Criteria at the Project Premises, SDA, and Adjacent Creeks.

Table C-21. Estimated Contaminated Soil Volumes Above the Assumed Contaminant Cleanup Levels in the North Plateau (excluding the Cesium Prong and North Plateau Groundwater Plume), WMA 1

Description	Area (ft^2)[a]	Depth (ft)[b]	Volume (ft^3)[c]	Maximum Concentration
Acid Recovery Cell				
Unsaturated	1,100	0-5	5,500	Fission products and transuranic elements from fuel reprocessing activities are expected to be present
Saturated	5,000	5-9	20,000	
Utility Room and Courtyard				
Unsaturated	5,100	0-2	10,200	Fission products and transuranic elements from fuel reprocessing activities are expected to be present
Condensate Tanks				
Unsaturated	2,500	0-2	5,000	Fission products and transuranic elements from fuel reprocessing activities are expected to be present
Fuel Receiving and Storage (South)				
Unsaturated	2,000	0-12	24,000	20 pCi/g, Cs-137
Fuel Receiving and Storage (North)				
Unsaturated	2,500	0-12	30,000	20 pCi/g, Cs-137
HNO_3 and NaOH Storage Tanks				
Unsaturated	1,000	0-2	2,000	Fission products and transuranic elements from fuel reprocessing activities are expected to be present

a. To convert square feet to square meters, multiply by 0.0929.
b. To convert feet to meters, multiply by 0.3048.
c. To convert cubic feet to cubic meters, multiply by 0.02832.

Sources: WVNS (1993a), (1993f), and (1994f), and assumptions made by SAIC.

Table C-22. Estimated Contaminated Soil Volumes Above the Assumed Contaminant Cleanup Levels at the North Plateau (excluding the Cesium Prong and Groundwater Plume), WMA 2

Description	Area (ft^2)[a]	Depth (ft)[b]	Volume (ft^3)[c]	Maximum Concentration
Old Interceptor/Lagoon 1 Area (Plume)				
Unsaturated	40,000	0-4	160,000	
Saturated	40,000	4-12	320,000	1,870 pCi/g, Am-241 270 pCi/g, Co-60 36,000 pCi/g, Cs-137 680 pCi/g, Pu-238 1,830 pCi/g, Pu-239/240 5,100 pCi/g, Pu-241 280 pCi/g, Ra-226 15,000 pCi/g, Sr-90 29 μg/g total U
Solvent Dike				
Unsaturated	1,600	0-6	9,600	180 pCi/g, Cs-137 56 pCi/g, Sr-90 41 pCi/g, Ra-226
Saturated	1,600	6-12	9,600	
Lagoon 2				
Saturated Till	High Water Area: 12,600	8	100,000	Lagoon sludge which is: 44,300 pCi/g, Cs-137 36,300 pCi/g, Sr-90
Lagoon 3 Sediment				
Saturated Till	High Water Area: 43,000	2	86,000	No data but concentration will be less than lagoon sludge data which is: 2,070 pCi/g, Cs-137 105 pCi/g, Sr-90 16.3 pCi/g, Co-60

a. To convert square feet to square meters, multiply by 0.0929.
b. To convert feet to meters, multiply by 0.3048.
c. To convert cubic feet to cubic meters, multiply by 0.02832.

Sources: WVNS (1993a), (1993f), and (1994f), and assumptions made by SAIC.

Table C-23. **Estimated Contaminated Soil Volumes in the North Plateau (excluding the Cesium Prong and North Plateau Groundwater Plume), WMAs 5 and 6**

Description	Area (ft²)[a]	Depth	Volume (ft³)[b]	Maximum Concentration
WMA 5				
Old Hardstand Area	15,000	0-4[c]	60,000	1,000 pCi/g alpha 5,000 pCi/g beta
WMA 6				
Railroad Spur	7,500	0-5 in.[d]	3,700	13 pCi/g, Cs-137
Cooling Tower	1,350	0-5 in.	700	13 pCi/g, Cs-137

a. To convert square feet to square meters, multiply by 0.0929.
b. To convert cubic feet to cubic meters, multiply by 0.02832.
c. Measured in feet. To convert feet to meters, multiply by 0.3048.
d. To convert inches to centimeters, multiply by 2.54.

Sources: WVNS (1993a), (1993f), and (1994f), and assumptions made by SAIC.

The unweathered till underlying lagoons 2 and 3 is contaminated to a depth of 2.4 and 0.6 m (8 and 2 ft), respectively. The depth of contamination below lagoon 3 is shallower than at lagoon 2 because lagoon 3 handled material with lower radionuclide concentrations.

Waste Management Area 4. Drainage ditch sediments sampled in WMA 4 contained up to 84 pCi/g of strontium-90 and 61 pCi/g of cesium-137, but these are highly localized occurrences and the volume is estimated not to be greater than 57 m³ (2,000 ft³). Because these contaminated drainage ditch sediments are within the cesium prong area, the volumes are discussed in Section C.3.4.

Waste Management Area 5. Elevated gross alpha and gross beta readings in soil at depths to 1.2 m (4 ft) were detected during excavation around the western edge of lag storage additions 3 and 4, near the former old hardstand (WVNS 1990). This area is estimated to contain 1,700 m³ (60,000 ft³) of contaminated soil. Estimated contaminated soil volumes are shown in Table C-23.

Waste Management Area 6. Soil samples collected near the railroad spur and cooling tower detected cesium-137 at concentrations slightly above the 15 mrem/yr cleanup level. The contaminated area near the railroad spur is estimated to be 345 m² (3,700 ft²), and the area near the cooling tower is estimated to be 65 m² (700 ft²) (see Table C-23).

C.3.2.2 Contaminated Soil and Groundwater in the North Plateau Groundwater Plume

A groundwater plume contaminated with strontium-90 has been identified in the sand and gravel layer between the process building and the drainage ditch immediately north of the CDDL (WMAs 1, 2, and 4) as shown in Figure C-13. Contamination in some of the soil samples within the groundwater plume (e.g., near the test and storage building) are not above the assumed contaminant cleanup levels, but contamination in the groundwater is above the assumed contaminant cleanup levels shown in Table C-16.

The process building area has been identified as one possible source of contamination (WVNS 1995e). Mitigative measures will be used to control the plume migration and prevent it from moving beyond its present area and volume. It was assumed that the entire thickness of the sand and gravel layer in the plume area [i.e., an average thickness of 4.3 m (14 ft)], has been or will become contaminated and that the estimated area of contamination is 26,900 m² (290,000 ft²). A maximum concentration of 6.3 million pCi/g of strontium-90 has been detected in soil, and a maximum concentration of over 1 million pCi/L has been detected in groundwater (WVNS 1995e). The contaminated soil volume was estimated at 113,000 m³ (4.0 million ft³), and using a conservative porosity of 25 percent [the average porosity of the sand and gravel layer is approximately 22 percent (WVNS 1993j)], then approximately 28,900 m³ (1 million ft³) of this volume is estimated to be contaminated groundwater.

C.3.3 South Plateau

This section describes the nature and extent of contaminated soil and groundwater on the south plateau, which is south of Erdman Brook. This area includes WMAs 7, 8, and 9. The most common soil contaminants in WMAs 7 and 8 are tritium, cesium-137, and strontium-90. Elevated levels of plutonium isotopes have been detected in n-dodecane floating product in groundwater wells in WMA 7. No environmental contamination has been identified in WMA 9 (the RTS drum cell).

C.3.3.1 Contaminated Soil

Figure C-12 shows the location of surface soils and sediment samples on the south plateau that are contaminated above the assumed contaminant cleanup levels presented in Table C-17. Figure C-13 shows the distribution of contaminated soil from boreholes [at a depth greater than 15 cm (6 in.)]. Estimates of contaminated soil volumes above the assumed contaminant cleanup levels for both the weathered and unweathered Lavery till and the maximum concentration of constituents that have been detected are shown in Table C-24.

Waste Management Area 7. About 1,200 m² (13,000 ft²) of radiologically contaminated soil is estimated to be northeast of the NDA near Erdman Brook (WVNS 1993a). The depth of contamination is estimated to be 15 cm (6 in.) and to have a total volume of 180 m³ (6,500 ft³) of contaminated soil.

All of the weathered till in the NDA, a 120- x 150-m (400- x 500-ft) area, was assumed to be contaminated above the assumed radiological contaminant cleanup levels. The total area of the NDA less the actual area of the disposal holes and trenches is estimated to be 15,000 m² (160,000 ft²). The average thickness of the weathered till is 3 m (10 ft). The total volume of contaminated weathered till was thus estimated at 45,000 m³ (1,600,000 ft³). Cesium-137 and cobalt-60 have been identified in the weathered till in the northeast portion of the NDA (WVNS 1985).

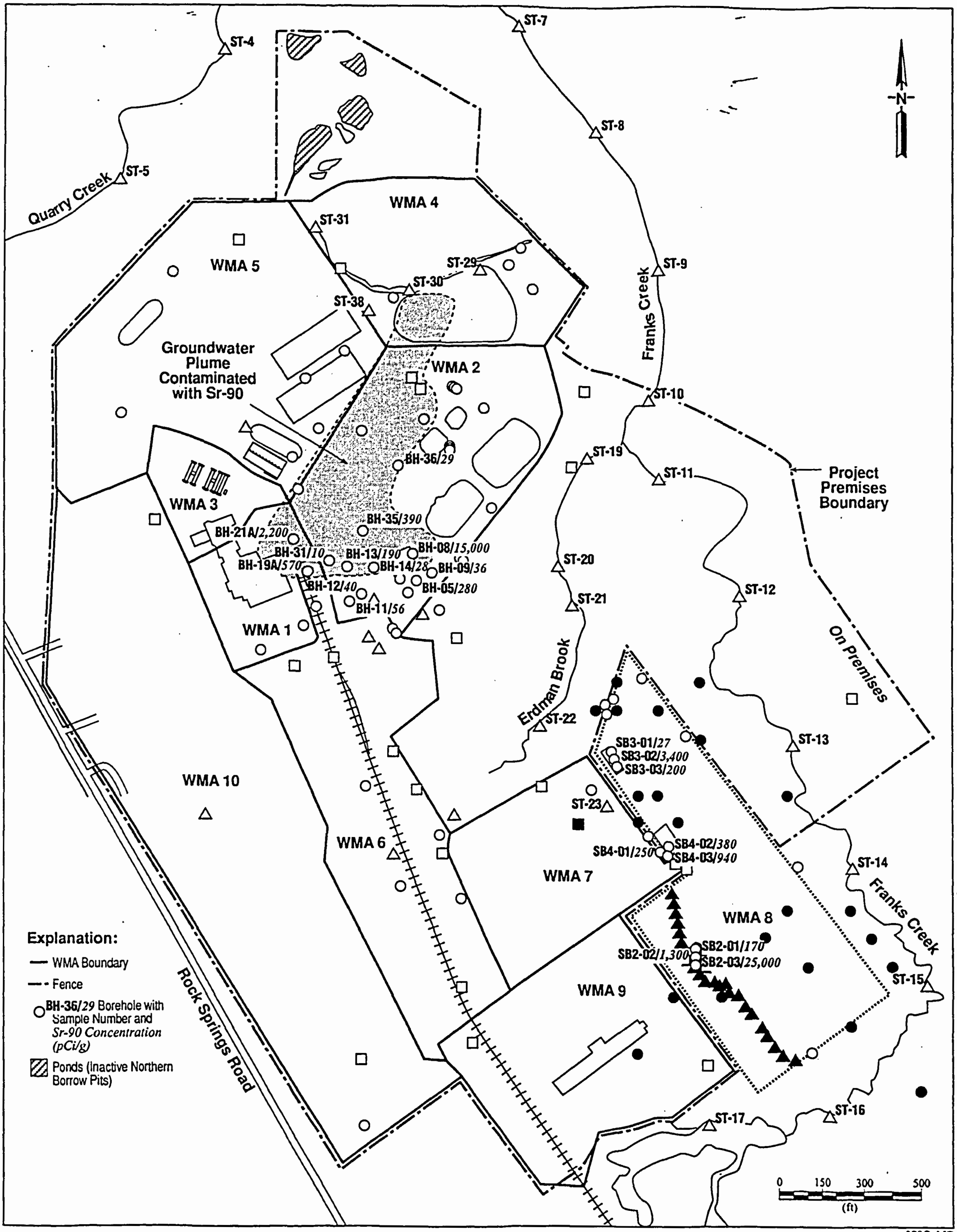

Figure C-13. Subsurface Soils and Groundwater Plume Contaminated with Sr-90 Above the 15 mrem/yr Assumed Contaminant Cleanup Level.

Table C-24. Estimated Contaminated Soil Volumes Above the Assumed Contaminant Cleanup Levels at the South Plateau

Description	Area (ft²)[a]	Depth (ft)[b]	Volume (ft³)[c]	Estimated Maximum Concentration
WMA 7				
Erdman Brook	13,000	0.5	6,500	No sampling data.
NDA				
Weathered Till	160,000	0-10	1,600,000	Samples near Special Holes 10 and 11: 461 pCi/g, Cs-137 25.9 pCi/g, Co-60
Unweathered Till	120,000	10-30 ft for Special Hole Area; 10-65 ft for Deep Hole Area; 10-40 ft for WVDP Disposal Trenches	Between Trenches: 2,300,000 Below Trenches: 390,000	No sampling data
WMA 8				
SDA Disposal Trenches				
Weathered and Reworked Till Above and Around Trenches	320,000	15	4,800,000	15.2 pCi/g, Cs-137 20.2 pCi/g, Sr-90 1,000,000 pCi/g, H-3
Unweathered Till Beneath Trenches	200,000	10	2,000,000	
Northern, Southern, and Inactive Filled Lagoons		30[d]		1,880 pCi/g, Cs-137 25,000 pCi/g, Sr-90 320 pCi/g, Am-241
Weathered Till	3,000		6,000	1,100 pCi/g, Pu-238 220 pCi/g, Pu-239/240
Unweathered Till	3,000		18,000	470 pCi/g, Pu-241 12,000 pCi/g, tritium 380 pCi/g, C-14 6 pCi/g, U-238 4.7 pCi/g, I-129 47 pCi/g, U-233/234

a. To convert square feet to square meters, multiply by 0.0929.
b. To convert feet to meters, multiply by 0.3048.
c. To convert cubic feet to cubic meters, multiply by 0.02832.
d. Contamination extends from the base of the lagoons to a maximum depth of 30 ft below ground surface.

Sources: Prudic (1986) WVNS (1985), WVNS (1993a), and E&E (1994)

The area of the NDA disposal holes and trenches is estimated to ~~be~~ 11,000 m^3 (120,000 ft^2). Using an average depth of 6 m (20 ft) for special holes, 17 m (55 ft) for deep holes, and 9 m (30 ft) for WVDP trenches, the estimated volume of contaminated soil between these holes and trenches is 65,000 m^3 (2,300,000 ft^3). The area below the waste [3,700 m^2 (39,500 ft^2)] was assumed to be contaminated to a depth of 3 m (10 ft) in the unweathered till on the basis of analogy to the profiles observed under the inactive SDA lagoons as discussed below. This adds 11,000 m^3 (390,000 ft^3) to the contaminated soil volume.

No hazardous soil contamination above the assumed contaminant cleanup levels has been detected in the NDA.

Waste Management Area 8. The 4.6 m (15 ft) of weathered and reworked till in the SDA is contaminated with tritium (Prudic 1986). No contaminated soil is thought to be present next to trenches 6 and 7 because trench 6 is a series of small-volume holes [less than 14 m^3 (500 ft^3) total] where reactor components were buried, and trench 7 is a shallow trench where wastes were placed on a concrete pad and encased in concrete. Iodine was detected in a single soil sample at a concentration of 4.7 ± 4.2 pCi/g (E&E 1994); however, this result is anomalous, and tritium is considered to be the dominant contaminant. Based on an area of 29,700 m^2 (320,000 ft^2) for the SDA trenches and surrounding contaminated soil, the volume of tritium-contaminated weathered and reworked till was estimated at 136,000 m^3 (4.8 million ft^3).

No hazardous contamination in soil was detected in the SDA RFI sampling of 10 boreholes. Eight boreholes were located around the SDA perimeter and two boreholes were located downgradient of the northern and southern filled lagoons (Figure C-13).

The unweathered till below SDA disposal trenches 4, 5, and 8 is contaminated with tritium to a depth of 3 m (10 ft) (Prudic 1986), assuming the vertical contamination profile is analogous to that in the unweathered till below disposal trenches 1 through 5 and 8 through 14. Using this approach, the estimated volume of contaminated unweathered till in these areas is 57,000 m^3 (2 million ft^3).

Radiologically contaminated soils are at the three filled lagoons at the SDA. It is estimated that 170 m^3 (6,000 ft^3) of tritium contaminated weathered till underlies the southern filled lagoon. The unweathered till directly underlying the northern and inactive filled lagoons and under the southern filled lagoon is contaminated with strontium-90 or tritium (E&E 1994). The estimated volume of contaminated unweathered till is 510 m^3 (18,000 ft^3).

No hazardous soil contamination above the assumed contaminant cleanup levels has been detected in the SDA.

C.3.2.2 Contaminated Groundwater

Groundwater contamination on the south plateau is highly localized because the till has low permeability (refer to discussion in Chapter 4, Section 4.10.4.1). Wells screened in undisturbed till produce limited quantities of water [less than 190 L/day (50 gal/day)] indicating little potential for rapid hydrologic transport of contaminants. The till is poorly drained, and the majority of the water would be retained in the till if it were excavated. The volume of contaminated water that could be removed from the till on the south plateau would be very small. Trench water or leachate in the SDA trenches would be managed as part of the waste and is described in Section C.2.8.1.

No hazardous contamination above the assumed contaminant cleanup levels has been detected in groundwater at either the NDA or the SDA.

C.3.4 Cesium Prong and Stream Sediment Contamination

Soil contamination on the Project Premises, the balance of the site in WMA 12 north of Quarry Creek, and off site has been identified in an area referred to as the cesium prong. Radiologically-contaminated sediments in Franks Creek and Erdman Brook have also been detected on the balance of the site. These contaminated areas are discussed in this section.

C.3.4.1 Cesium Prong

Abnormal releases to the atmosphere caused by reprocessing plant ventilation system failures have produced contamination of surface soil in the vicinity of the plant. The primary incident occurred in 1968 when a high efficiency particulate air filter in the main plant ventilation system ruptured releasing contaminated material through the 60 m (200 ft) plant stack. Remediation activities included removal of contaminated filter material from the filter and blower housings and from outside areas near the base of the stack. The ground area affected by this release, extending northwestward from the plant stack for a distance of 6.0 km (3.7 mi) is termed the cesium prong.

The contaminated area has been investigated several times over the last 30 years using aerial surveys of gamma radiation levels and ground surveys that involve measuring gamma radiation levels and collecting soil samples. The methods and results of these surveys are described in the Site Radiological Surveys Environmental Information Document (WVNS 1992c). The data show cesium-137 levels elevated above background in the cesium prong on the Project Premises, on the balance of the site, and off site (outside of the Center). A ground survey conducted by NYSDEC in 1971 including collecting a limited number of soil samples in the cesium prong showed 1971 cesium-137 soil levels as high as 30 pCi/g off site and 80 pCi/g on site (Hannum 1983).

A recent survey of the off-site area in the cesium prong measured fine scale gamma radiation levels and involved collecting soil samples at three depths at and below the ground surface (Dames & Moore 1995). The study showed that contamination levels decreased with depth; with 75 percent of the activity in the upper 5 cm (2 in.), 20 percent of the activity in the 5 to 10 cm (2 to 4 in.) layer, and 5 percent of the activity in the 10 to 15 cm (4 to 6 in.) layer. The maximum localized cesium-137 concentration was 44 pCi/g and the maximum cesium-137 concentration averaged over 2,500 m^2 (26,900 ft^2) was 21 pCi/g. In disturbed areas, cesium-137 concentrations were only slightly distinguishable from background. The off-site cesium-137 concentrations in the cesium prong are illustrated in Figure C-14.

The residential/agriculture scenario analyzed to derive the soil concentration levels corresponding to a 15 mrem/yr dose assumes that the site under consideration is cleared and suitable for construction of a home and garden. Because the portion of the cesium prong outside the Center boundary is heavily wooded and would require clearing and regrading, the existing soil contamination profile would be altered. This analysis assumes that the clearing and grading activities would distribute the existing activity uniformly through the uppermost 45 cm (18 in.) of the soil profile. Application of these assumptions to the maximum 2,500 m^2 area averaged concentration measured in the cesium prong outside of the Center produces a dose of 6 mrem in the year of maximum exposure. Thus, no soil would be removed from this area.

Aerial surveys and soil samples collected in the cesium prong indicate that contaminated soil exists on the Project Premises and on the balance of the site north of Quarry Creek. The estimated volumes of contaminated soil (i.e., exceeding 15 mrem/yr cesium-137) in these two areas are presented in Table C-25. The volume was estimated by assuming contamination is within the top 10 cm (4 in.) of soil. The contaminated area on the balance of the site north of Quarry Creek was taken as the area falling within the contour line greater than or equal to 1.7 μrem/hr (which is approximately equivalent to the 15 mrem/yr criterion assuming continuous occupancy and no shielding) on the 1984 aerial survey (see Figure C-15). The maximum concentration in this area within the Project Premises was estimated by extrapolating the 1.7 μrem/yr contour line to the process building. The maximum concentration within the Project Premises was based on a soil sample with the greatest concentration collected in this area, decayed to the year 2000.

No hazardous soil contamination has been detected in the cesium prong.

C.3.4.2 Stream Sediment Contamination

Sediment contaminated above 20 pCi/g cesium-137 was detected in RFI samples collected within the Project Premises along Franks Creek, between its confluence with Erdman Brook and Quarry Creek, and along Erdman Brook, downstream of the lagoon 3 outfall. The total stream length contaminated with cesium-137 is estimated to be about 760 m (2,500 ft). Because the contamination is expected to be highly localized, estimating a volume is difficult. The contaminated volume would be small, less than 300 m^3 (10,000 ft^3), if contaminated sediment is assumed to occupy a depth of 15 cm (6 in.) across an average stream width of 1.2 m (4 ft).

Neither contaminated sediment nor surface water has been identified at downstream monitoring locations in Buttermilk and Cattaraugus Creeks since 1986 (WVNS 1994i). The maximum cesium-137 concentration detected in off-site sediment was during 1986 and was 7.56 pCi/g as reported in the annual environmental monitoring report (WVNS 1994c). However, since 1987, average annual cesium-137 concentrations at the Buttermilk and Cattaraugus Creek sampling locations have been below 2.0 pCi/g (WVNS 1994c).

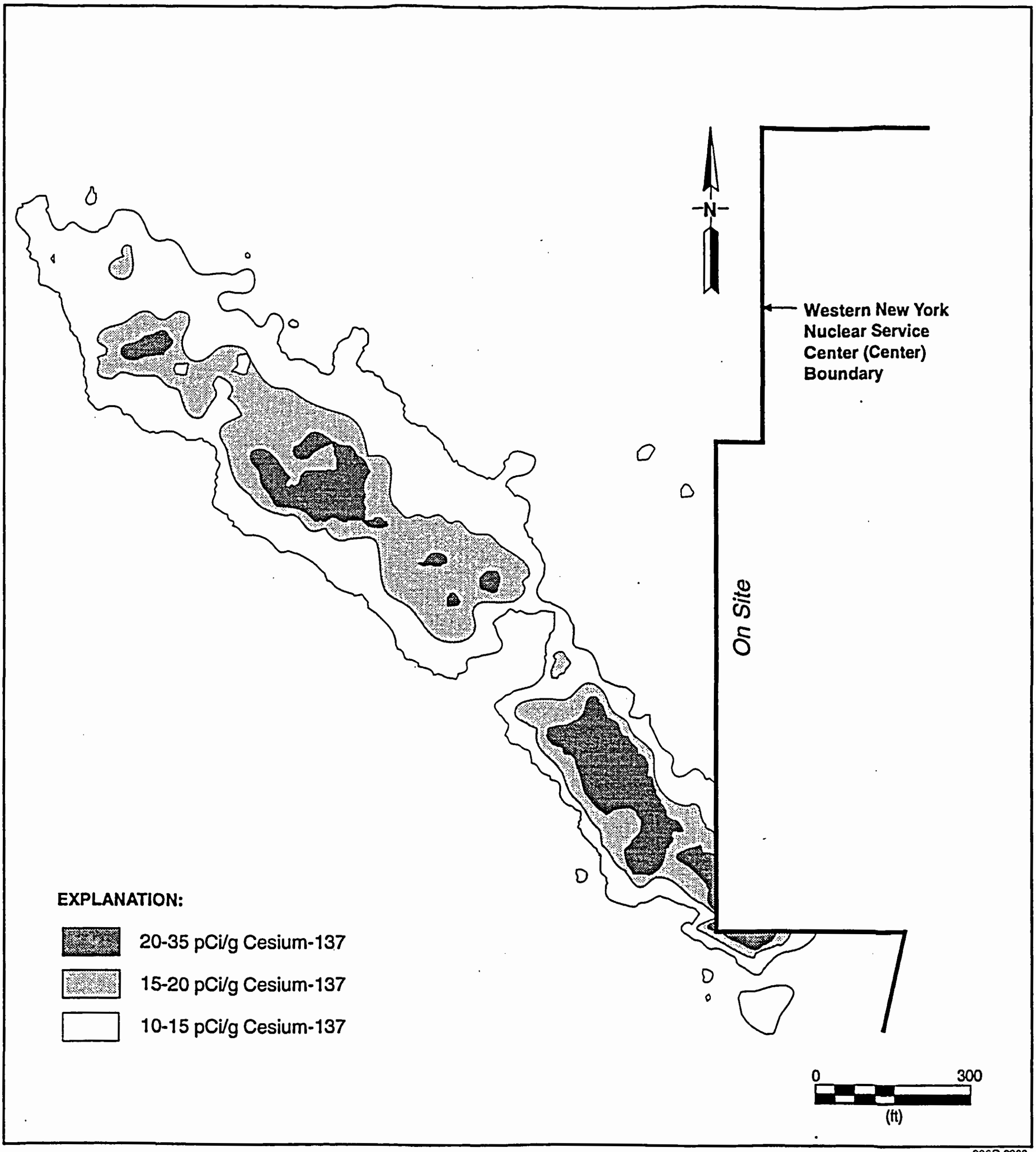

Figure C-14. Contaminated Surface Soil in the Off-Site Portion of the Cesium Prong.

Table C-25. Estimated Volumes of Soil Above the Assumed Contaminant Cleanup Levels (15 mrem/yr) in the Cesium Prong

Area of Cesium Prong	Area (ft²)[a]	Depth (ft)[b]	Volume (ft³)[c]	Estimated Maximum Concentration
Project Premises (WMAs 3, 4, and 5)	1,240,000	0.33	409,000	40 pCi/g, Cs-137 (excluding sediment in drainage ditches)
Center (North of Quarry Creek, WMA 12)	1,500,000	0.33	495,000	40 pCi/g, Cs-137

a. To convert square feet to square meters, multiply by 0.0929.
b. To convert feet to meters, multiply by 0.3048.
c. To convert cubic feet to cubic meters, multiply by 0.02832.

Sources: EG&G Idaho (1991), WVNS (1982), WVNS (1994f), Dames & Moore (1995)

No hazardous contamination has been detected in stream sediment samples.

C.3.5 Conclusions

Estimated contaminated soil volumes for the Project Premises and the Center are summarized on Table C-26. A total of 479,000 m³ (16,900,000 ft³) of soil, including that which is likely to be incorporated during excavation, is estimated to be radiologically contaminated above the 15 mrem dose criterion. Cesium-137, strontium-90, and tritium are the dominant radiological contaminants. Over one-half of the contaminated soil would be at the NDA and SDA (WMAs 7 and 8) on the south plateau. The other major source of contaminated soil is the groundwater plume on the north plateau. Relatively minor volumes of soil contamination are associated with specific facilities (old interceptor/lagoon 1, lagoon 2, and lagoon 3). The cesium prong comprises approximately 25,600 m³ (904,000 ft³) of contaminated soil.

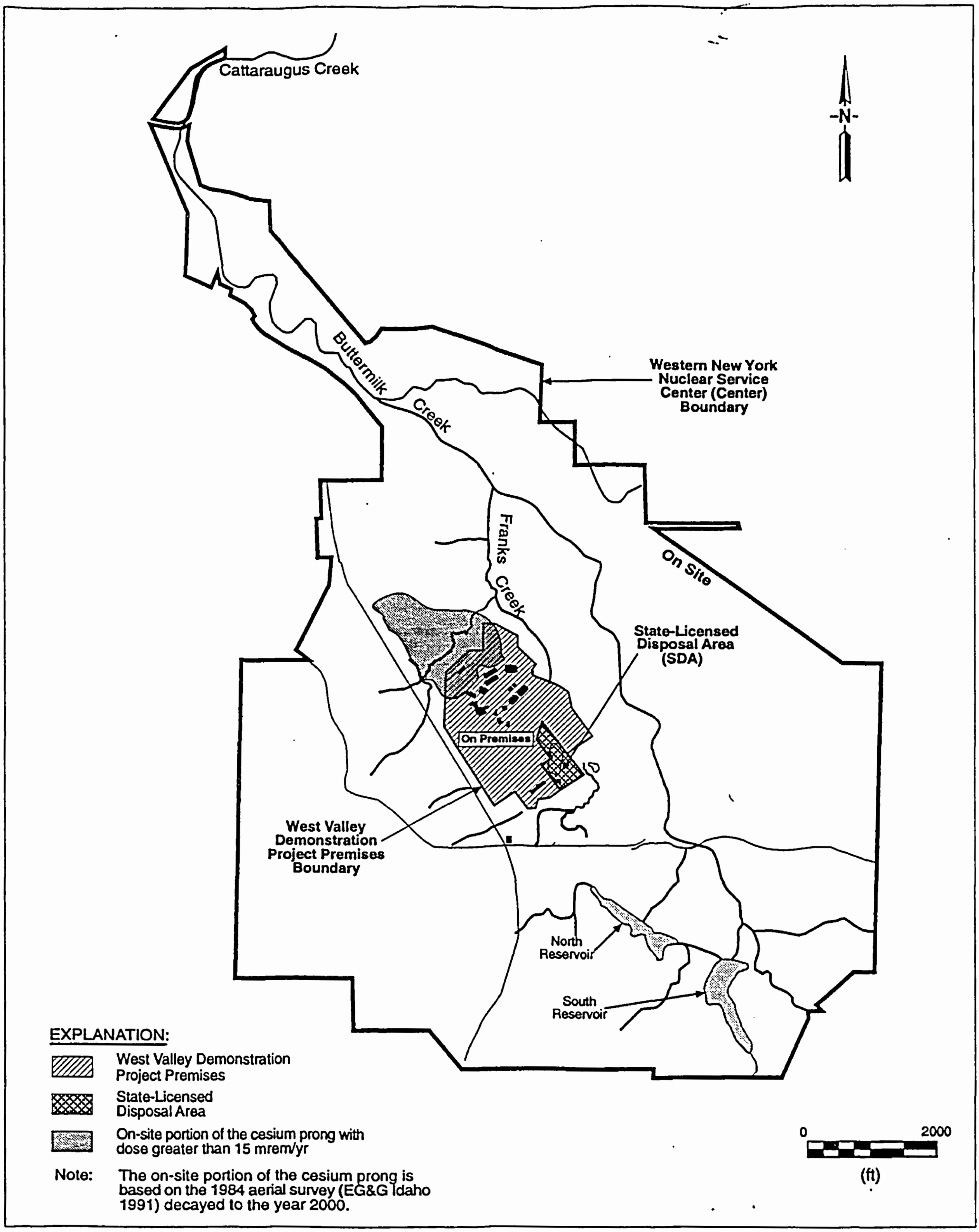

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Figure C-15. Contaminated Surface Soil in the Cesium Prong Exceeding 15 mrem/yr (modified from WVNS 1982).

Table C-26. Summary of Contaminated Soil Volumes On and Around the Western New York Nuclear Service Center[a]

Location of Contaminated Soil	Estimated Volume (ft^3)[b]
North Plateau (excluding cesium prong)	
Unsaturated Zone	311,000
Saturated Zone	4,540,000
South Plateau	
Weathered Till	6,410,000
Unweathered Till	4,710,000
Cesium Prong	904,000
Stream Sediments	10,000
Total	16,900,000

a. All values rounded off to three significant figures.
b. To convert cubic feet to cubic meters, multiply by 0.02832.

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APPENDIX D

RISK ASSESSMENT METHODS

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ACRONYMS

ATSDR	Agency for Toxic Substances and Disease Registry
CEDE	committed effective dose equivalent
COCs	chemicals of concern
COPC	contaminant of potential concern
CRAVE	carcinogen risk assessment verification endeavor
CTE	central tendency exposure
D/Q	deposition concentrations per unit source
ECLR	excess (incremental) lifetime cancer risk
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HQ	hazard quotient
ICRP	International Commission on Radiation Protection
IRIS	Integrated Risk Information System
LIMS	Laboratory Information Management System
LOAEL	lowest-observable-adverse-effect level
NOAEL	no-observable-adverse-effect level
PAHs	polycyclic aromatic hydrocarbons
RAGS	Risk Assessment Guidance for Superfund
RfCs	reference concentrations
RfDs	reference doses
RME	reasonable maximum exposure
UCL	upper confidence limit
X/Q	atmospheric concentrations per unit source

APPENDIX D

RISK ASSESSMENT METHODS

Completing the West Valley Demonstration Project (WVDP) and closure or long-term management of facilities at the Western New York Nuclear Service Center (Center) will involve a range of activities that may include long-term isolation of waste, which introduces the potential for adverse impacts to the public and the environment. This appendix describes the methods used to assess the nature and magnitude of these potential impacts. Because of the impracticality of observing potential health effects or of monitoring for contaminants in the environment over long periods of time, the impacts of site closure are by necessity estimated using mathematical models of physical processes. The risk assessment conducted using these models is intended to give a comparative evaluation of the potential impacts from implementing the Environmental Impact Statement (EIS) alternatives. The potentially harmful materials which are considered in this risk assessment include radionuclides and hazardous chemicals processed, stored, and disposed of at the Center. Consequences considered include acute radiological and toxic effects and stochastic latent cancer effects for selected individuals located near the Center and for the surrounding population to a distance of 80 km (50 mi). The balance of this appendix presents an introduction to risk assessment methods, descriptions of the methods used to evaluate implementation phase and post-implementation phase (long-term) impacts for radioactive materials and hazardous chemicals, discussion of the estimation of risk for a given dose, and description of an approach to develop Center closure criteria.

D.1 INTRODUCTION TO RISK ASSESSMENT METHODS

During the implementation phase of an alternative, the actions could potentially release radionuclides and hazardous chemicals to the environment. The contaminants released during implementation phase actions and accidents could be transported through the environment to potential receptors. Likewise, cleanup actions could result in worker exposure to radioactive and hazardous materials. During the post-implementation (long-term) isolation phase, naturally occurring meteorological and hydrologic processes could transport contaminants from the buried waste to potential receptors. Natural events which occur intermittently, such as earthquakes and tornadoes, could also potentially release radioactive or hazardous materials to the environment by altering the ability of the waste management systems to isolate the waste.

The risk assessment approach used to evaluate and integrate these diverse factors comprises five steps. The first step is to analyze the physical conditions of the site and incorporate them into a site conceptual model. The second step is to describe the waste inventory, engineered facilities, and planned closure activities. The third step is to identify environmental and human receptors that could contact contaminants released from the Center. The fourth step is to analyze the site and facility conditions, receptor locations and activity patterns to identify potential exposure pathways. The fifth step is to apply a mathematical model to the identified releases and pathways to estimate potential impacts. These five steps are required to develop a set of analytical scenarios to quantify the potential effects of implementation phase and post-implementation phase impacts. A scenario is defined as a combination of facility and environmental conditions that could release radioactive or hazardous material to a receptor.

The scenarios are categorized by the following factors from the risk assessment procedure:

- site environmental conditions
- facility design and operating characteristics
- receptor location and activity pattern
- source and type of contamination
- contaminant release mode
- contaminant transport mode
- receptor exposure mode.

Site environmental conditions include geohydrologic factors, such as groundwater flow, erosion, frequency of seismic activity, and meteorological conditions, including average wind speed and direction and precipitation. Descriptions of the environmental conditions are summarized in Chapter 4 of this EIS and discussed in detail in Appendices J, K, L, and M. Facility and operating design include characteristics of engineered barriers, their response to natural forces, and worker activities proposed for the implementation phase. Receptors include individuals located on the Project Premises and the SDA, such as workers and intruders, who may come into direct contact with contaminants, individuals located on the balance of the site who are not directly affected by site releases, and the surrounding population off site who are also indirectly affected by potential releases from the Center.

Contamination has been characterized in groundwater, soil, facilities, and in disposed inventories. Details on the nature and extent of groundwater and soil contamination are presented in Appendix C and Section 4.10 of this EIS. Details on contamination in site facilities and disposed inventories are detailed in Appendix C. Meteorologic and hydrologic processes affect the transport of contaminants allowing a set of release modes to be developed. For example, the frictional force of wind entrains contaminated soil to the atmosphere while the frictional force of stormwater runoff entrains contaminated soil to surface water. The methods used to estimate release rates from various sources are presented in Appendix E. Contaminants released from a source may be transported through the environment by groundwater flow, surface water flow, or atmospheric diffusion. Receptors may be exposed to environmental contamination through direct exposure, ingestion, inhalation, or dermal contact.

These elements are uniquely specified to define a scenario. The risk assessment is comprised of the selection, analysis, and integration of impacts for a set of scenarios representative of expected and foreseeable conditions at the site. The nature of the planned activities and interaction with the environment is such that the scenarios are organized by implementation and post-implementation phase impacts. For the purposes of analysis, sets of scenarios were developed to evaluate the potential effects of a loss of institutional control.

The durations of the periods used in the analysis are 0 to 30 years for implementation, 100 years for institutional control, and 1,000 to 10,000 years for long-term.

D.2 METHODS FOR ESTIMATING IMPLEMENTATION PHASE RADIOLOGICAL IMPACTS

Decontamination of facilities, excavation of waste, and storage and disposal of waste are implementation phase actions in the EIS alternatives. Chapter 3 describes the actions for each alternative. Completing these activities would result in contaminants potentially being released to the environment and workers being exposed to controlled levels of radiation. Because the implementation phase is relatively short, the conditions on the Center are assumed to be the same as the present. Environmental conditions that change over long time frames, such as climatic change or mass wasting, are not incorporated into implementation phase scenarios. Intermittent environmental conditions such as earthquakes and tornadoes, are considered as accident initiators in the implementation phase. This section describes the analytic methods used to estimate the impacts of routine Center closure actions for workers and off-site receptors. Methods to evaluate nonradiological impacts to workers and impacts to the off-site population from radiological accidents are discussed in Appendices F and G, respectively. For radioactive contaminants, impacts are quantified using variations of the dose concept presented in Table D-1.

D.2.1 Methods for Estimating Off-Site Implementation Phase Impacts

Radioactive materials in the environment may be transported through the air, by surface water, or by groundwater to receptors. During the implementation phase, the Center would have institutional control and the receptor representative of potential public exposure is an individual located at the Center boundary and the population out to a distance of 80 km (50 mi). To estimate the maximum reasonable impact, the Center boundary individual is assumed to live at the boundary and eat potentially contaminated food grown at that location. An Indian of the Seneca Nation residing on the Cattaraugus Reservation on Cattaraugus Creek was also considered in the analysis. The analysis in Appendix J indicates that because of decay and geochemical retardation, the groundwater flowpath will not contribute significantly to implementation phase impacts. Consequently, the implementation phase focuses on exposure modes related to the air and surface water transport pathways. To estimate contaminant concentrations in the environment a combination of mass, momentum, and energy balances were formulated around a defined pathway. Similarly, to estimate the accumulation of a contaminant or deposition of energy in a receptor, physiologic models were used. For radioactive materials, the GENII computer code (Napier et al. 1988), an integrated dose estimation and transport model that incorporates the most recent developments in dose assessment methods and exposure modes was used. To estimate off-site radiological impacts from implementation actions, the GENII code was used.

Table D-1. Terms Used to Describe Radiation Doses

Term	Description
Dose	Amount of energy deposited in the body by ionizing radiation per unit body mass. [units: rad or mrad (1 rad = 1000 mrad)]
Dose Equivalent	Dose received by the human body weighted by type of radiation. The weighting factor for beta and gamma radiation is 1 and for alpha radiation is approximately 20. [units: rem or mrem. Thus, 1 rad from gamma radiation = 1 rem; 1 rad from alpha radiation = 20 rem]
External Dose Equivalent	Dose equivalent received from exposure to penetrating (e.g., gamma) radiation originating external to the body. [units: rem or mrem]
Committed Dose Equivalent (CDE)	Dose equivalent received by an organ or organs from exposure to radioactive materials deposited in the human body. The primary distinction between CDE and external dose equivalent is that CDE implies dose that will be delivered over the lifetime of the individual, usually considered to be a 50-yr or 70-yr period after the intake, rather than immediately. [units: rem or mrem]
Effective Dose Equivalent (EDE)	Measure of radiation dose to the human body expressed as the sum of the external dose equivalent and the CDE, with weighting factors applied to CDEs to individual organs for differences in sensitivity to radiation. The EDE is considered to be an appropriate measure of the risk of fatal cancer induction and, therefore, is the primary measure of dose used in this report. [units: rem or mrem]
Annual Dose	The EDE received by an individual in any one year. This dose is used for comparison with both occupational and public dose limits and recommended criteria.
Accumulated Dose	The dose equivalent delivered to an individual (including the appropriate organ weighting factors) over the individual's lifetime (50 or 70 years). Thus, this dose includes the external dose equivalent received plus that portion of the CDE actually delivered over the individual's lifetime. This dose relates most closely to the risk of health effects from lifetime radiation exposure.
Collective Dose	The EDE summed over all individuals in a population over a defined period of time (up to 10,000 years). This quantity is a measure of the total radiological impact of a very long time-dependent release to the environment.

The GENII code uses the physiologic models and procedures recommended in International Commission on Radiological Protection ICRP-26 (ICRP 1977) and ICRP-30 (ICRP 1979) to estimate internal and external dose conversion factors. The body is represented as a set of compartments connected by transfer pathways. Each compartment is characterized by a total mass and transfer coefficient and the model calculates time dependent nuclide concentrations in each compartment considering decay and daughter ingrowth. For internal exposures, GENII evaluates energy deposited in each target organ from a number of source organs for a commitment period specified by the user. For this EIS, impacts are reported for a single year of intake and the commitment period is fifty years. For inhalation, particle size and nuclide-specific solubility class determine initial deposition in the lung, while ingestion transfer from the small intestine to other organs is specified by a nuclide-specific translocation factor. The committed effective dose equivalent (CEDE) is calculated as the weighted product of individual organ doses. For external exposure to penetrating radiation, GENII evaluates attenuation and build-up to estimate organ doses from a specified atmospheric concentration of each nuclide. Effective doses are calculated as the weighted sum of the individual organ doses.

Figure D-1 shows the relationship of source, transport pathway and exposure mode in the GENII code. For atmospheric releases, the receptor may be exposed to direct radiation either from airborne radionuclides, from radionuclides deposited on the ground, from inhalation, or from ingestion of food contaminated with radionuclides deposited from the air. GENII has the capability to estimate atmospheric concentrations per unit source (X/Q) and deposition per unit source (D/Q) or to accept user input for these variables. For this EIS, the meteorological modeling procedures described in Appendix K were used to generate X/Q and D/Q values as a function of distance and direction for input to GENII. The inhalation rate of a specific radionuclide is calculated as the product of X/Q, nuclide release rate, breathing rate, and exposure period. The CEDE for the intake period is the product of the nuclide dose conversion factor and the nuclide intake. For the drinking water ingestion pathway, the CEDE for a nuclide is the product of the nuclide concentration in the water, drinking rate for the specified period, the time frame, and the dose conversion factor. The water concentration is estimated using mixing models and a user-specified release rate.

Nuclides may be deposited on vegetation either from the atmosphere or from irrigation water. GENII can estimate the nuclide concentration in vegetables, grain, and fruit used as human or animal food. Nuclide-specific doses to human receptors are calculated for consumption of contaminated crops and of animal products produced from contaminated crops. The calculation considers crop yield, weathering and retention, bioaccumulation, decay, and consumption rates to develop the dose estimates.

The GENII features used in this EIS analysis are summarized above. A more complete description of GENII features is in the code documentation (Napier et al. 1988).

D.2.2 Radiological Impacts to Workers

Workers involved in the implementation phase of closure could receive radiation doses via several exposure pathways. The most dominant exposure pathway is direct radiation emitted by sources in close proximity to the workers. This pathway dominates because the nature of the work (e.g., waste excavation and facility decontamination) requires handling of highly radioactive material. Other exposure pathways include inhalation of radioactive material, a relatively minor pathway because existing regulations require engineering and administrative controls to prevent significant radionuclide intake; and ingestion of radioactive material, an insignificant pathway because of existing regulations and established radiation protection practices.

The preferred method to estimate external radiation doses to workers is to determine the dose rates that workers would likely encounter during implementation and multiply it by

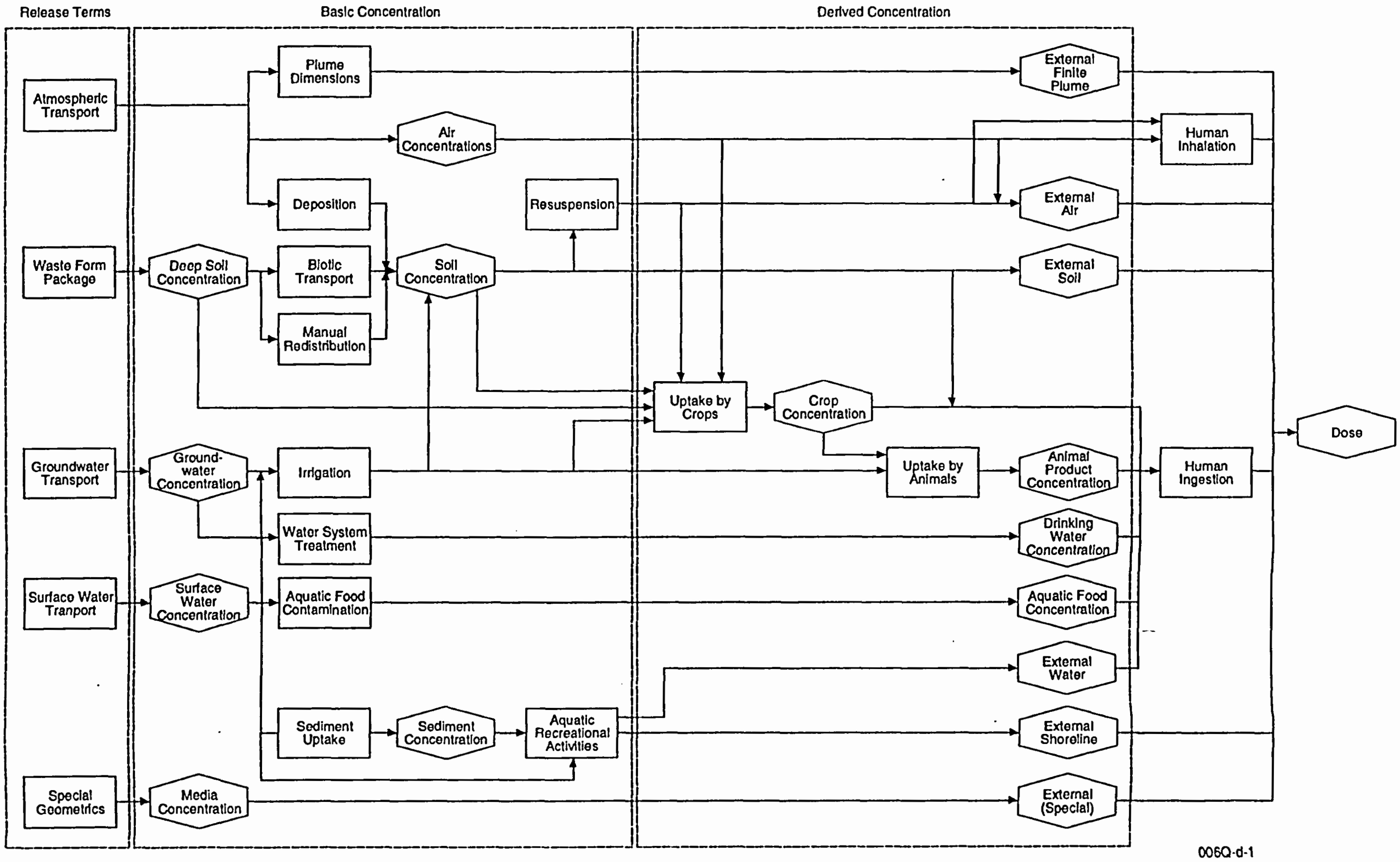


Figure D-1. GENII Exposure Pathways.

the time workers would be exposed. However, the specific radiological conditions that would be encountered during implementation are unknown because detailed engineering designs for remote handling and shielding system equipment are not yet fully developed. The dose rates reported in waste characterization and closure engineering reports by waste management area (WMA) were used to estimate the external radiation fields from the decontamination and decommissioning work (WVNS 1993a, 1993b, and 1994a through 1994v). The estimate of labor-hours to perform a task were multiplied by the estimate of average radiation levels to calculate the collective dose in person-rem. Because cleanup plans are presently at the conceptual level, dose estimates are not available for workers not directly involved in decontamination and decommissioning or closure operations in the given area or for the maximally exposed worker in the area. Operations would be conducted so that no worker would receive an annual dose greater than the 5 rem level specified in Department of Energy (DOE) Orders (See Appendix B).

Where the occupational dose estimate could not be confirmed because of the lack of radiological and engineering information, the estimate was validated using historical occupational exposure data for related activities at DOE facilities. These data were used to estimate average annual worker exposures for the duration of activities by WMA. The approach is justified since the implementation phase would be completed with equipment and procedures designed to control radiation exposures and the availability and productivity of the skilled and highly trained work force would not be limited. DOE Orders require appropriate radiation protection measures for these types of actions; worker experience indicates doses received during similar operations are a predictable fraction of the permissible dose limits. Using historic occupational exposure data, the average worker exposure was calculated as a fraction of the applicable DOE or administrative dose limits based on similar DOE activities.

The occupational dose to workers transporting radioactive waste off-site was calculated using estimates of the number and type of waste shipments and the RADTRAN 4 computer code. Details on this methodology are given in Appendix H.

Inhalation of radioactive materials is a minor contributor to the total occupational dose because DOE policy (DOE N 5480.6) states that internal exposures should be avoided to the extent practicable (DOE 1992). Since it is costly and difficult to accurately monitor, measure and record internal doses, DOE activities emphasize minimizing inhalation of radioactive material by using engineering controls, or if not possible or practicable, by wearing respiratory protection or using administrative controls.

To demonstrate that the occupational doses from inhalation of radioactive material would be minor, breathing air concentrations during decontamination of the process building and NDA under Alternative I (Removal) were estimated (see Appendix E). These actions were analyzed because they have the potential for high doses from inhalation if appropriate control measures were not taken. Doses are the product of the breathing air concentrations, the reference breathing rates for a standard worker (ICRP 1975), and the highest applicable dose conversion factor to convert intake of inhaled radioactivity to CEDE (ICRP 1979). The calculated doses were reduced by a respiratory protection factor of 50, which explains the lower concentrations breathed by workers wearing respirators compared to the air concentrations in the room. A protection factor of 50 is low compared to the actual protection factors used at DOE facilities during remediation activities. It was selected to conservatively estimate inhalation doses. Because regulations and guidance prohibit substantial inhalation worker doses during routine operations at DOE facilities, even if the calculations in this analysis indicate a substantial inhalation dose, appropriate measures would be taken during actual implementation to avoid this.

The worker dose from ingestion of radioactive material would be even less than that from inhalation because DOE procedures for personnel protection around unconfined radioactive material are stringent. Therefore, ingestion doses to workers were not calculated in this EIS.

D.3 METHODS FOR ESTIMATING POST-IMPLEMENTATION PHASE RADIOLOGICAL IMPACTS

Under undisturbed conditions, transport of radionuclides in groundwater is expected to be the primary exposure mechanism of on-site and off-site individuals to potentially hazardous material. Individuals on the Project Premises and the New York State-licensed disposal area (SDA) may drink contaminated groundwater or consume crops grown in contaminated soil. Contaminated groundwater may discharge to surface water used by a balance of site or off-site individual as a source of drinking water, irrigation water, or aquatic food. Over long periods of time, the geologic, hydrologic, and meteorological conditions may change and alter the release characteristics of the waste and the rate at which contaminants are transported through the environment. If institutional control of the Center were lost, a member of the public could get access to the WMAs on the Project Premises and the SDA. The risk assessment evaluates expected potential changes in site conditions through scenarios that analyze the potential impact of natural processes on the engineered barriers and the transport pathways. Because of the loss of institutional control assumed for analytical purposes, long-term scenarios consider intruders occupying the Project Premises and SDA, an individual at the Center boundary, and the population out to a distance of 80 km (50 mi). On-site individuals and individuals located immediately off site represent reasonably maximally exposed members of the population. In addition, a Seneca Indian using Cattaraugus Creek for subsistence fishing was also considered in the analysis. The balance of this section describes candidate long-term exposure scenarios and the models analyzed for potential impacts. The models used to analyze scenarios with the accidental release of radionuclides are discussed in Appendix G.

D.3.1 Evaluation of Impacts for Long-Term Exposure Scenarios

The first step in the performance assessment is to identify pathways that could transport contaminants to on-site and off-site receptors given undisturbed conditions. The recommended sets of pathways for generic site analyses (Kozak et al. 1990, Case and Otis 1988) were initially used for site-specific analysis of the Center. Variations of site conditions potentially important to public risk were identified through analysis of site-specific data and through review of related projects (Guzowski 1990). Table D-2 lists potentially disruptive natural phenomena and their effect. Table D-3 lists potentially disruptive events related to

Table D-2. Potentially Disruptive Natural Phenomena

Event	Potential Consequence
Increased precipitation	Increased infiltration into waste disposal units, increased sheet erosion
Seismic activity	Liquefaction of waste disposal unit, increased hydraulic conductivity along flowpaths, alteration of engineered barriers
Faulting	Creation of preferential flowpath
Stream erosion	Direct release of disposed waste
Tornado	Direct release of stored waste
Increased wind speed	Increased rate of erosion

Table D-3. Potentially Disruptive Human and Design Related Events on the Project Premises and the SDA

Event	Potential Consequence
Homesteading	Direct contact with waste during home construction, exposure to contaminated crops
Drilling	Direct contact with waste, creation of preferential flowpath
Discovery	Direct contact with waste
Disposal unit subsidence	Increased infiltration, increased release
Faulty cap design	Increased infiltration, increased release
Inadequate erosion control	Direct release of disposed waste
Ineffective waste grouting	Increased waste leaching

human activity and facility design. The scenarios evaluated for undisturbed and disturbed site conditions were analyzed using both published and site-specific models. These scenarios and models are described in this section and in Appendices E and G.

D.3.1.1 Exposure to On-site Occupants

Alternatives I (Removal), II (On-Premises Storage), and V (Discontinue Operations) permit public access to the Project Premises and the SDA immediately after closure. In addition, for conditions which are not expected to occur, the institutional control proposed for Alternatives III (In-Place Stabilization) and IV (No Action: Monitoring and Maintenance) could be lost and a member of the public would gain access to the site. The loss of institutional control was assumed, for the purpose of analysis, to occur 100 years after the end of the implementation phase. Therefore, a dose is calculated for a member of the public who gains access to this area.

The doses received by occupants on the Project Premises and the SDA area depend on the alternative and the occupancy scenario. For example, under Alternatives I and II, the Center could eventually be used as a recreational area; for construction of schools, office buildings, or homes; or as a farming community. Because of the multitude of possibilities and the current uncertainty over the eventual site use, a set of scenarios was used for dose assessment. The four scenarios comprising this set: agriculture, construction, discovery, and drilling; have been used by the U.S. Nuclear Regulatory Commission (NRC) to analyze the impacts of low-level waste (LLW) disposal (NRC 1982, Oztunali et al. 1986). In addition, intruder discovery scenarios specific to the Project Premises and SDA area were developed for Alternative V (Discontinue Operations). The contaminant concentrations at the exposure point used to estimate the intruder impacts are from waste characterization studies (WVNS 1993a, 1993b, and 1994a through 1994i), from the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) sampling program (WVNS 1994w), and from the results of subsurface transport analysis described in Section D.3.2.1. The balance of this section describes the methods used to analyze intruder scenarios.

Residential Agriculture Scenario

After the Project Premises and SDA are closed, individuals residing in the area could grow crops and raise animals that could contact residual radionuclides in the soil or use contaminated groundwater for gardening. The applicable exposure pathways for the resident family scenario include direct exposure to external radiation from the contaminated soil, internal exposure from inhalation of contaminated dust, and internal exposure from ingestion of contaminated food and water. The model used to perform these calculations is in the RESRAD computer code (Gilbert et al. 1989). The general features and application of the RESRAD code including the input parameters and assumptions are described below.

RESRAD Code Description. RESRAD is a personal computer-based code developed for the Formerly Utilized Sites Remedial Action Program that derives soil concentration guidelines for site closure and release of former DOE sites. It was developed at the Argonne National Laboratory with support from the Los Alamos National Laboratory, the Battelle Pacific Northwest Laboratory, and other DOE groups.

RESRAD is designed to calculate the annual dose to an individual who establishes a home on a decommissioned site, raises and consumes crops, raises livestock (which consumes contaminated feed) and consumes beef and milk, drinks contaminated water, and obtains fish from a contaminated pond.

The code permits transport of one or more radioactive materials in the environment. The time frame for transport and exposure ranges from one to 100,000 years after initial soil contamination. Potential exposure pathways during the transport of residual radioactive materials include:

- Direct external exposure from contaminated soil
- Inhalation of radioactive dust
- Ingestion of contaminated vegetables, grains, fruits, meat, milk, and aquatic foods including shellfish
- Ingestion of contaminated water.

To calculate potential exposure to radioactive materials with RESRAD, numerous parameters were used including the distribution of radioactive materials in the soil; transport of the radioactive material in soil, water and air; biological transport of radioactive material in plants and animals; and biological transport, uptake, and exposure in humans. The RESRAD code can model all of these parameters with either default (standard) values drawn from the RESRAD libraries or from site-specific values provided by the user.

Site and release scenario-specific values were used where applicable and available. Site-specific parameters used as input included the type and relative fraction of radioactive materials, groundwater transport and geohydrological parameters, and distribution of contaminated soil. Default parameters used as input included biological transport parameters within the agricultural and non-agricultural food inventory, dose conversion factors for the selected radionuclides, and human ingestion and inhalation parameters. These parameters are similar to those in the GENII code, described in Section D.2.1. If there was uncertainty over a parameter, a "reasonably conservative" value was chosen, i.e., one which overestimated the doses received by an individual but was credible. This approach is consistent with that used by the RESRAD code authors to define default parameters (Gilbert et al. 1989).

Tables D-4 through D-6 list the parameters used in the RESRAD code and those used in this EIS. The use of well-derived groundwater for drinking water and irrigation purposes was applied to reflect site-specific conditions. On the north plateau, well productivity was assumed adequate for drinking water and irrigation needs. On the south plateau, analysis showed that a well completed in the Lavery till would not provide a supply of water adequate for domestic and irrigation uses. Thus, use of well water for domestic and irrigation purposes was not considered for south plateau exposure scenarios. However, direct contact of contaminated groundwater with near-surface soils and crops was considered for south plateau agricultural scenarios.

Table D-4. RESRAD Parameters for which RESRAD Default Values Were Used

Parameter	Value
Dose conversion factors	Various (radionuclide-specific)
Food transfer factors (plant, beef, milk)	Various (radionuclide-specific)
Bioaccumulation factors (fish, crustacea)	Various (radionuclide-specific)
Inhalation and shielding factors	Various
Food and water consumption rates	Various
Well pump intake depth below water table	10 m
Irrigation rate	0.2 m/yr
Depth of soil mixing layer	0.15 m
Depth of roots	0.9 m
Soil erosion rate	0.00001 m/yr

Table D-5. RESRAD Parameters for which Site-Specific Values Were Used

Parameter	Value
Soil effective porosity	0.19
Water table drop rate	0
Precipitation rate	1.01 m/yr
Watershed area	566,560 m^2

Table D-6. Variable RESRAD Parameters Depending on the Waste Management Area or Alternative

Parameter	Values[a]
Area of contaminated zone	WMA-specific
Thickness of contaminated zone	WMA/Alternative-specific
Thickness of uncontaminated cover	WMA/Alternative-specific
Thickness of uncontaminated zone	WMA/Alternative-specific
Length of contaminated zone parallel to aquifer flow	WMA/Alternative-specific
Soil density	2.1 g/cm^3 (N); 1.68 g/cm^3 (S)
Soil porosity	0.219 (N); 0.407 (S)
Soil hydraulic conductivity, unsaturated soil	66 m/yr (N); 6.3 m/yr (S)
Soil hydraulic conductivity, saturated soil	132 m/yr (N); 12.6 m/yr (S)
Saturated soil hydraulic gradient	0.031 (N); 0.02 (S)
Evapotranspiration coefficient	0.458 (N); 0.507 (S)
Runoff coefficient	0.283 (N); 0.360 (S)
Distribution coefficients	Various (radionuclide-dependent)[b]

a. "N" refers to WMAs located on the north plateau; "S" refers to WMAs located on the south plateau
b. Separate radionuclide-specific values were used for the north plateau and south plateau. In general, the most conservative (i.e., lowest) values from a variety of sources were used.

For the dose calculations, all developed parameters, except the soil radionuclide inventory were fixed as a master input file. The input file was used for individual calculations of each radionuclide. The output files provided a breakdown of the annual effective dose equivalent by individual pathway over a 10,000 year time frame post implementation. The output was used to determine the maximum annual doses received by an individual from the residual contamination.

Residential Construction Scenario

An individual taking up residence on a site could construct a home in an area where buried waste is close to the surface. The worker constructing the home could be exposed to the waste while excavating the foundation and basement to the house. The exposure pathways comprising this scenario include direct exposure to external radiation and inhalation of contaminated dust. The assumptions for analysis of this scenario are the same as those used by NRC (NRC 1982, Oztunali et al. 1986). The radionuclide concentrations in each WMA were those presented in Appendix C. The excavation was assumed to be 20 m (66 ft) wide, 10 m (33 ft) long, and 3 m (10 ft) deep. Airborne dust concentrations were 0.258 mg/m^3 and the duration of exposure was 500 hours.

Intruder Discovery Scenarios

NRC analyses characterized the discovery scenario as a modification of the construction scenario in which the worker becomes aware of the hazard and discontinues the construction. This approach is consistent with the assumption that deliberate intrusion into the waste at an engineered facility need not be considered. However, on the Project Premises and the SDA, such intrusion could occur under Alternative V (Discontinue Operations). Therefore, a set of direct exposure scenarios were evaluated for the process building, high-level [radioactive] waste (HLW) tanks, lag storage building and additions, NRC-licensed disposal area (NDA), SDA, and the radwaste treatment system (RTS) drum cell. In each case, it was assumed an individual gained direct access to contamination in buildings, stored waste, or buried waste and received an external radiation dose. Maximum potential doses were either determined from maximum dose rates from the contamination based on literature values or calculated using the Microshield computer code and a nominal exposure time. For the process building, an individual was assumed to enter and tour the building, spending 5 minutes in each room. At the HLW tanks, the individual was assumed to gain access to a riser and be exposed for 5 minutes to direct radiation while viewing the tank contents. At the lag storage building and additions and at the RTS drum cell, the individual was exposed to direct radiation for 5 hours while walking through these waste storage areas. At the NDA and SDA, the individual was assumed to excavate into the waste and be directly exposed for 5 hours.

Drilling Scenario

An individual residing on the site could construct a well for domestic use. The driller completing the well could be indirectly exposed by waste brought to the surface with the drilling mud. In this scenario, the worker pumps potentially contaminated fluid to a mud pond assumed to be 2.4 m (8 ft) wide, 2.7 m (9 ft) long, and 1.2 m (4 ft) deep containing 0.6 m (2 ft) of water. The drill hole had a 0.2 m (0.7 ft) diameter, was 61 m (201 ft) deep, and surfaced a waste volume calculated from the thickness of the disposal horizon and the borehole diameter. The surfaced waste was deposited in the mud pond and the worker was exposed for 6 hours.

D.3.1.2 Exposures to the Off-Site Population

The population residing outside of the Center boundary may receive radiation exposures from the long-term transport of residual contamination off site. The three primary transport modes to the off-site population are leaching of disposed waste and transport through groundwater, surface water transport, and atmospheric transport. The method for calculating impacts from the atmospheric pathway were discussed in Section D.2.1. The methods for calculating impacts from groundwater leaching or dissolution of exposed waste are discussed below.

Over long periods of time, groundwater in contact with disposed inventories of radioactive waste will dissolve radionuclides. The solubilized nuclides may be transported by groundwater to local wells and gardens or to surface water discharge points where human or animal exposure could potentially occur. This release-transport-exposure process was evaluated using five one-dimensional transport models that incorporated specialized modules to represent WMA-specific design and flowpath features. Each of the five models used the same upper level organization, allowed the same choice of receptors and exposure routes, and used the same radionuclide decay and dose factor data. The five models differed by the nature of the release and the velocity and direction of groundwater flow. These one-dimensional transport models are assumed to be applicable to flowpaths of limited extent. The magnitude and direction of groundwater flow along the one-dimensional path varied by WMA and was predicted using the three-dimensional groundwater flow model described in Appendix J.

Release modules were used to estimate radionuclide concentrations in groundwater at the start of the flowpath and included solubility limited leaching to groundwater moving through the waste, diffusion-limited release from cemented drums, and diffusion-limited release from grouted slabs. Groundwater flow paths were either purely horizontal or vertical followed by horizontal. Table D-7 summarizes the characteristics of the five models. Details on the major modules are presented below. Release models are detailed in Appendix E.

Code Organization and Dose Calculation

Each of the five release-transport-exposure codes read radionuclide and scenario-specific input files and perform release, transport, and dose calculations. Radionuclide data include decay constants and decay chain parent-daughter identification reported by the ICRP (ICRP 1988). Scenario-specific data include dimensions and concentrations of disposed waste, duration of the scenario and of time intervals to vary scenario parameters, and identification of receptor types and locations. After input data are read, each code calculates radionuclide concentrations at the beginning and end of the flow path using the models described below. The principle of supposition was used to represent the time variation of scenario parameters including potential exhaustion of the source inventory. Three types of receptors were considered: an individual obtaining drinking water from a well located in the

Table D-7. Summary of Groundwater Transport Exposure Code Characteristics

Code Name		Description
PCHh	—	one-dimensional flow, one-dimensional dispersion in horizontal direction
	—	retardation and decay along flow path
	—	source term = solubility x horizontal flow rate
	—	in-growth of daughters at point of exposure
	—	time periods allow for finite release periods and for change in horizontal velocity
PCHvh	—	one-dimensional flow, one-dimensional dispersion in vertical direction
	—	retardation and decay along vertical flow path
	—	source term to vertical path = solubility controlled release of nuclide-specific inventory
	—	one-dimensional flow, one-dimensional dispersion in horizontal direction
	—	retardation and decay along horizontal flow path
	—	in-growth of daughters at point of exposure
	—	source terms to horizontal flow = combined diffusive and convective from vertical flow
	—	2 time periods (release/no release) for each nuclide
LLWtum	—	one-dimensional flow, no dispersion in vertical direction
	—	source term to horizontal flow = solubility x vertical flow rate
	—	time periods allow for finite release period and for change in vertical velocity
	—	one-dimensional flow, one-dimensional dispersion in horizontal direction
	—	retardation and decay along horizontal flow path
	—	in-growth of daughters at point of exposure
DCtum	—	shrinking core diffusional release from waste drums
	—	time periods to increase waste form porosity
	—	one-dimensional flow, one-dimensional dispersion in horizontal direction
	—	retardation and decay along flow path
	—	in-growth of daughters at point of exposure
TNKtum	—	shrinking core diffusional release form waste slab
	—	time periods to increase waste form porosity
	—	one-dimensional flow, one-dimensional dispersion in horizontal direction
	—	retardation and decay along flow path
	—	in-growth of daughters at point of exposure

flowpath, an individual growing crops in soil indirectly contaminated by irrigation water from the well or in soil directly contaminated by groundwater, and an individual living near a stream contaminated by discharge of radionuclide-bearing groundwater. The stream resident could fish, drink water, and use stream water to irrigate a garden. Drinking water doses were estimated as the product of radionuclide concentration in the groundwater or surface water, water intake rate [0.73 m^3/yr (26 ft^3/yr)], and radionuclide ingestion dose conversion factor. Doses from fish ingestion were estimated as the product of radionuclide concentration in the stream water, radionuclide-specific bioaccumulation factor, consumption rate [50 kg/yr (110 lb/yr) for the Seneca Indian resident, 21 kg/yr (46 lb/yr) for all other residents], and the ingestion dose conversion factor. Food doses were estimated as the product of groundwater concentration, radionuclide-specific distribution coefficient, and a unit dose factor derived using RESRAD. Population doses were estimated for the Buffalo Municipal Water Distribution system (350,000 people) based on a predicted stream water concentration and dilution in Lake Erie equivalent to mixing in the flow of the Niagara River [5.8 x 10^3 m^3/s (2.05 x 10^5 ft^3/s)].

Release Models

The release models used solubility- and diffusion-limited releases for the calculations. The solubility-limited releases are appropriate for unsolidified sediments or disposed waste such as the low-level waste treatment facility (LLWTF) in WMA 2, the NDA (WMA 7), the SDA (WMA 8), and in the proposed tumuli for the process building and the low-level waste disposal facility. Diffusion-limited releases are appropriate for the RTS drum cell and for the proposed cement slabs to be placed over the HLW tanks and the process building. For each case, the concentration at the point of release was calculated for set time intervals specified in the scenario. The release models are detailed in Appendix E.

Groundwater Transport Evaluation

The groundwater pathway exposure mode was evaluated using a transient, one-dimensional mass balance model that assumes physical properties such as hydraulic conductivity, porosity, hydraulic gradient, aquifer dispersion coefficient, and contaminant distribution coefficients are constant and independent of spatial position. The partitioning of the contaminant between soil and groundwater was assumed to be rapid relative to the transport velocity. Under these conditions, mass balances formed around the contaminant in each phase can be combined into a single dispersion equation. Radionuclide decay during transport can be represented in the model. Solution of the resulting equation, expressed as products of exponential and error function terms, estimates the time dependent concentration of the nuclide as a function of distance from a source. Representative results are presented in Figure D-2 for a release of carbon-14 and technetium-99 into horizontal groundwater flow. Parameters for this simulation were selected to demonstrate model capability, not to faithfully represent transport in a specific WMA. The rapid rate of increase in impact depicted in this figure is determined by the short travel time and small dispersion selected. This figure demonstrates the ability of the model to predict transients under conditions more demanding than those encountered in actual systems. The doses represented in this figure are hypothetical and are presented solely to illustrate the form of model estimates. The receptor uses a well 10 m (33 ft) from the contaminant source for drinking and irrigation water. Solubilities and inventories were selected to generate a release of finite duration. The groundwater velocity was 1 m/s and carbon-14 was modeled with no retardation while technetium-99 had some retention on the soil. The dose impacts are presented in Figure D-2.

D.3.2 Summary of Approach and Results for Site-Specific Issues

Past operating and disposal practices and the conceptual designs evaluated in this EIS introduce potential exposure pathways and impacts that are unique to the Center. Potential sources of these impacts include on-site and off-site streambed contamination, surface soil contamination related to specific reprocessing plant atmospheric releases, the north plateau groundwater contamination on the Project Premises, release of reprocessing plant solvent into

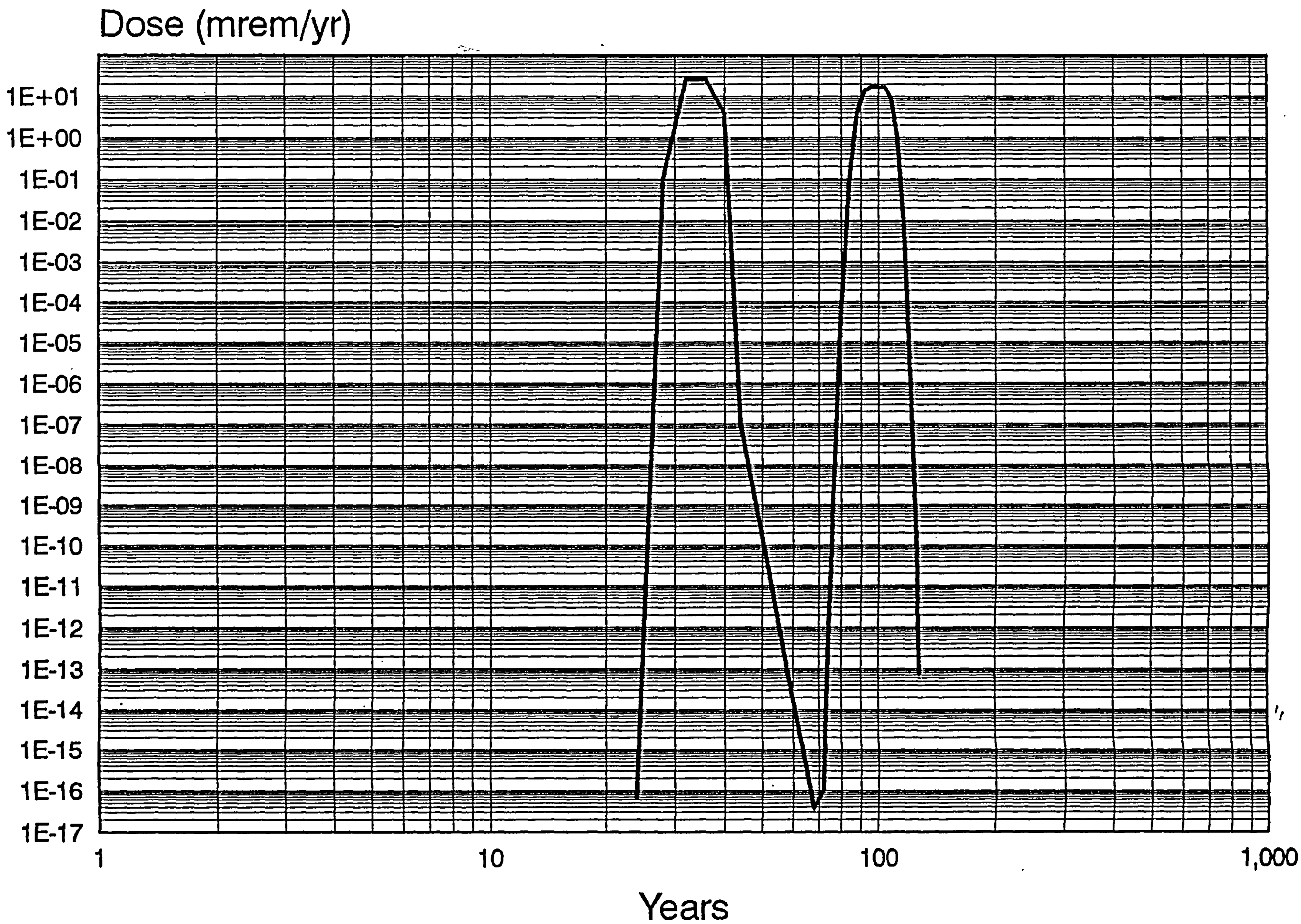


Figure D-2. Sample Case Impacts from One-Dimensional Radionuclide Transport Model.

groundwater in the south plateau, high levels of tritium in SDA trench water, and disposal of radioactive waste containing transuranic elements in concentrations greater than 10 ηci/g. This section reviews the nature of these site-specific issues and summarizes the analytical methods used to evaluate the potential impacts relative to each alternative.

D.3.2.1 Streambed Contamination

Three small streams, Quarry Creek, Erdman Brook, and Franks Creek, form the surface water drainage system for the Project Premises. The creeks discharge to Buttermilk Creek which flows northeastward to Cattaraugus Creek. Cattaraugus Creek flows westward and discharges into Lake Erie. During operation of the former reprocessing plant and since operations have ceased, treated liquid effluent containing radioactive material was discharged into Erdman Brook in accordance with applicable regulations. The operation of the former reprocessing plant, in particular, increased the level of radioactivity in both Buttermilk and Cattaraugus Creeks. Run-off which has contacted contaminated soil and, to a lesser extent, particulates deposited from atmospheric releases may contribute to contamination of surface water. Radiological contaminants; principally cesium-137, strontium-90, and transuranics; may concentrate on stream sediments due to adsorption, absorption, or ion exchange processes. The potential on-site and off-site impacts from stream sediment contamination are evaluated below using environmental monitoring data and dose calculations based on the monitoring data.

Concentrations of radionuclides in environmental media have been measured as part of the WVDP environmental monitoring program and as part of the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) conducted in 1993. Surveys of external dose rates provide supporting information. The WVDP environmental monitoring program includes sampling of surface water and fish in Cattaraugus Creek, and surface water and sediment in Buttermilk Creek. The RFI program included sampling of sediment in Quarry Creek, Erdman Brook, Franks Creek, Buttermilk Creek, and Cattaraugus Creek. The WVDP environmental monitoring program results for the period from 1985 to 1992 show the level of cesium-137 decreasing from 0.07 to 0.01 pCi/mL and strontium-90 levels stabilizing at less than 0.01 pCi/mL for surface water from Buttermilk Creek (WVNS 1993c). The concentrations of cesium-137 in sediment from Buttermilk Creek has varied from 1.5 to 3.2 pCi/g and from 0.1 to 0.4 pCi/g for strontium-90. The radionuclide concentration in fish from Cattaraugus Creek varied from 0.05 to 0.55 pCi/g for cesium-137 and from 0.05 to 0.1 pCi/g for strontium-90 over the same period. Radionuclide concentrations in both sediment and fish showed no definitive trend over this period. Table D-8 summarizes the results from the stream sediment from the RFI sampling program (WVNS 1994w). The stream sediment sampling results indicate near-background levels for Quarry Creek, Buttermilk Creek, and Cattaraugus Creek, but above background concentrations along Erdman Brook and Franks Creek as described in Section 4.10.

The potential impact to the public from existing streambed contamination was evaluated using 1991 environmental monitoring data and the GENII dose analysis computer code. Exposure pathways included ingestion of water, sediment, fish, and crops grown on land irrigated with contaminated water. The estimated impacts are expressed as the 50-yr

Table D-8. Summary of Sitewide Sampling Program Results for Sediments

		Radionuclide Concentration (pCi/g)	
Sample Number	Sample Location[a]	Sr-90	Cs-137
ST-4,-5,-6	Quarry Creek	0.04-0.46	0.14-0.40
ST-20,-21,-22,-24	Erdman Brook at the NDA and SDA	0.11-3.3	0.4-5.9
ST-19	Erdman Brook at Lagoon 3	1.6	35.0
ST-11,-12,-13,-14	Franks Creek at SDA	0.07-0.27	0.27-2.7
ST-7,-8,-9,-10	Franks Creek near CDDL	2.6-11.0	25.0-100.0
ST-1	Cattaraugus Creek	0.11	1.5
ST-2	Buttermilk Creek	0.3	1.9

a. Refer to Figure 4-23 for sampling locations.

dose from a single year's intake of water, fish, and sediments. The results indicated that ingestion of fish could yield a dose of 0.13 mrem and that intake of water, sediment, and crops had negligible contributions to dose. The levels reported for sediment contamination in Buttermilk and Cattaraugus Creeks would result in small potential external exposures. Because the predicted doses are primarily from strontium-90 and cesium-137, the impacts would decline to insignificant levels over the long-term because of radioactive decay.

The potential impact to an on-site person were also estimated using sediment data collected as part of the RFI sampling program and using surface water concentrations measured near the point of maximum sediment contamination level. Contamination levels in fish were estimated using standard bioaccumulation factors. Estimated doses for a single years intake included a contribution of 0.3 mrem for fish ingestion and of 0.2 mrem for sediment ingestion. These doses are small and will decline to insignificant levels because of radioactive decay. Although the estimate of external dose depends on the individuals location relative to the creek sediments and may not be significant because of shielding or configuration effects, the radiation surveys and the RFI sampling program indicate that portions of Erdman Brook and Franks Creek would require remediation to allow release for unrestricted use. For purposes of analysis, clean-up of stream sediment contamination was assumed for Alternatives I (Removal) and II (On-Premises Storage). For Alternative III (In-Place Stabilization), placement of rip-rap and filling of stream channels in the local and global erosion control plans would eliminate potential direct doses. For the assumed loss of institutional control scenarios of Alternatives IV (No Action: Monitoring and Maintenance) and V (Discontinue Operations), external doses from stream sediments would be small compared to the large doses from either direct or indirect contact with disposed radionuclide inventories.

D.3.2.2 Surface Soil Contamination in the Cesium Prong

Abnormal releases to the atmosphere caused by reprocessing plant ventilation system failures have produced contamination of surface soil in the vicinity of the plant. The primary incident occurred in 1968 when a high efficiency particulate air filter in the main plant ventilation system ruptured releasing contaminated material through the 60 m (200 ft) plant stack. Remediation activities included removal of contaminated filter material from the filter and blower housings and from outside areas near the base of the stack. The ground area affected by this release, extending northwestward from the plant stack for a distance of 6.0 km (3.7 mi), is termed the cesium prong. The area of contamination has been investigated using aerial surveys of gamma radiation levels and ground surveys involving measurement of gamma radiation levels and collection of soil samples.

Aerial surveys of gamma radiation levels at the Center have been conducted several times over the past thirty years. The methods and results of these surveys are described in the Site Radiation Conditions Environmental Information Document (WVNS 1992) and the reported gamma radiation levels are summarized in Figure C-15. The data show highest levels of external radiation on the Project Premises near the NDA and SDA but also clearly show levels of cesium-137 elevated above background in the cesium prong on the Project Premises, on the balance of the site and off site (outside of the Center). A ground survey conducted by the New York State Department of Environmental Conservation (NYSDEC) in 1971 including collection of a limited number of soil samples from off-site locations in the cesium prong with cesium-137 soil concentrations as high as 30 pCi/g and 88 pCi/g on site (Hannum 1983). A recently conducted survey of the off-site area included fine scale measurement of gamma radiation levels and collection of soil samples at three depths at and below the ground surface (Dames & Moore, 1995). The study found that contamination decreased with depth; 75 percent of the activity was in the upper 5 cm (2 in.), 20 percent of the activity in the 5 to 10 cm (2 to 4 in.) layer, and 5 percent of the activity in the 10 to 15 cm (4 to 6 in.) layer. The maximum localized cesium-137 concentration was 44 pCi/g and the maximum cesium-137 concentration averaged over 2,500 m^2 (26,900 ft^2) was 21 pCi/g. The study also showed that in disturbed areas, cesium-137 concentrations were only slightly distinguishable from background.

EIS evaluations of potential environmental impacts from cesium prong contamination were based on analysis of a residential-agricultural scenario. Although the scenario considered inhalation, ingestion, and direct exposure pathways, the direct exposure pathway dominated the results. For off-site areas, because a minimum area is required to establish a residence and garden, the maximum 2,500 m^2 (26,900 ft^2) area-averaged cesium-137 soil concentration of 21 pCi/g was used as the basis for the off-site impact analysis. Since fine-scale data are not available on the Center, the maximum reported cesium-137 soil concentration of 44 pCi/g was used for the on-site impact analysis. Data reported for two off-site locations immediately adjacent to the site boundary support selection of this concentration. The on-site value of 44 pCi/g could be interpolated between these two points. Because the off-site area of the cesium prong is hilly and heavily wooded, the exposure scenario assumed that site clearing and grading activities would reduce the effective concentrations. This consideration did not apply to the cleared areas of the Project Premises and the Center.

For a residence and garden established in the year 2000, maximum doses of 6 and 88 mrem/yr were estimated for off-site and on-site locations, respectively. These dose estimates would apply for off-site areas under all alternatives and to on-site areas for Alternative V (Discontinue Operations). For a residence and garden established in the year 2100, a maximum dose of 8.8 mrem/yr was estimated for the on-site resident. This dose impact would apply to loss of institutional control cases under Alternatives III (In-Place Stabilization) and IV (No Action: Monitoring and Maintenance). Under Alternative I (Removal) and Alternative II (On-Premises Storage), soil would be removed from all areas with potential for doses above 15 mrem/yr. The impact analysis results indicate that soil removal would not be required for off-site areas under any alternative, but on site removal would be required under Alternatives I (Removal) and II (On-Premises Storage).

D.3.2.3 North Plateau Plume

Leakage of solutions from the former reprocessing facility, of liquid effluent from transfer facilities, and of liquids from treatment lagoons has contaminated groundwater in the sand and gravel layer on the north plateau. Sampling of groundwater wells installed during the late 1980s and early 1990s determined that radioactively contaminated groundwater plumes extend from the process building area north to Franks Creek and east from the Lagoon 1 area to Erdman Brook. Geoprobe sampling of 80 points on the north plateau in 1994 detected strontium-90 levels above 1,000,000 pCi/L and tritium levels above 30,000 pCi/L (WVNS 1995a). Details on the nature and extent of contamination are presented in Section 4.10 and Appendix C. Mitigative measures are being evaluated to control groundwater contamination on the north plateau.

The potential impact from the north plateau groundwater plume were evaluated using residential-agriculture scenarios for both on-site and off-site residents. Under Alternatives I (Removal) and II (On-Premises Storage) contaminated soil would be exhumed from the north plateau area. Processing of the liquids generated by exhumation would release small quantities of radionuclides to the atmosphere, and the risk from transporting soil contaminated with strontium-90 are primarily non-radiological in nature. For the expected conditions case under Alternatives III (In-Place Stabilization) and IV (No Action: Monitoring and Maintenance), the potential impact from the groundwater plume would be controlled using mitigative methods. In the assumed loss of institutional control case for Alternative III, the Project Premises and Buttermilk Creek resident doses for the year of maximum exposure were estimated at 5,000 and 4.0 mrem, respectively. For the assumed loss of institutional control case for Alternative IV and for Alternative V (Discontinue Operations), the Project Premises and Buttermilk Creek resident doses for the year of maximum exposure were estimated at 10,000 and 8.0 mrem, respectively. The analysis indicates that site maintenance and institutional control are required to manage the plume and protect public health and safety.

D.3.2.4 Reprocessing Solvent in the NDA

When the former reprocessing facility operated, a mixture of tributyl phosphate dissolved in n-dodecane was used as the solvent for separation of fission products from actinides. With time, the solvent mixture chemically degraded and was discarded (WVNS 1985). The waste material was chemically treated to remove radionuclides, absorbed on vermiculite in 3,785-L (1,000- gal) tanks, and buried in the NDA. The total volume of absorbed material is estimated at 83,300 L (22,000 gal) with a radionuclide inventory of approximately 1 Ci. Burial records indicate the tanks were buried in eight holes in the northeast portion of the NDA. During November 1983, sampling of a well just outside of the NDA identified contaminated water and solvent (WVNS 1989).

Following solvent being identified in the well, investigative programs that included drilling and testing, surface water sampling, geophysical measurements, and laboratory tests of clay and solvent interaction were initiated. The drilling program identified contamination in soil and contaminated free solvent in burial holes (WVNS 1985, WVNS 1989). No contaminated surface water was found (WVNS 1985). The geophysical surveys confirmed the recorded burial locations and indicated there were no unrecorded burials. The sampling programs showed that the contamination was spatially irregular and it was concluded that transport likely occurred through randomly oriented preferential pathways (WVNS 1989). The remedial actions included exhuming eight solvent disposal tanks from two of the disposal holes and constructing an interceptor trench between the disposal area and Erdman Brook. Neither solvent nor radioactivity has been detected in the interceptor trench.

The potential impacts from the NDA disposals were evaluated using the set of scenarios described in Section D.3. For the purposes of establishing the relative importance of solvent-related impacts, the horizontal flow of groundwater through the weathered till with discharge to Erdman Brook is representative. The radionuclide inventory of the solvent waste was a small fraction (1 Ci) of the NDA waste inventory of approximately 130,000 Ci. Under expected conditions, the radionuclide release was modeled as solubility limited with retardation of flow by clay minerals. For this analysis, radionuclide concentrations measured in disposal holes (WVNS 1989) were used as estimates of elemental solubility. Results of laboratory studies of the effect of solvent on clay permeability vary with test conditions. Tests conducted in fixed-wall cells showed significant increase in permeability (Dames & Moore 1984, WVNS 1993d) while tests conducted in cells with variable walls (adjusted stress) showed no increase in permeability (WVNS 1993d). Because clays can shrink or swell in response to environmental conditions, the condition of no change in permeability was the expected case. The groundwater velocity [1.4 m/yr (4.6 ft/yr)] used in this sensitivity impact analysis was equal to the travel time indicated from the time of burial until solvent was detected in the NDA perimeter well. Laboratory studies indicated that clay has a capacity for retaining organics and that n-alkanes similar to the solvent disposed of in the NDA are readily degraded by microorganisms. For the reasons described above, the health and safety risk from the solvent is radiological rather than chemical and the solvent is not expected to significantly alter the physical or chemical properties of the clay. Under expected conditions, the dose in the year of maximum exposure to the Cattaraugus Creek individual from release from the entire NDA inventory was estimated as 0.2 mrem. The estimated contribution of the solvent radionuclide inventory was 1.3 x 10^{-6} mrem. Thus, impacts from the solvent are small relative to the overall impact of the buried waste in the NDA. The role of preferential pathways was evaluated by considering flow through individual fractures extending from the remaining six solvent burial holes to Erdman Brook. The groundwater velocity was again 1.4 m/yr (4.6 ft/yr), but retardation of radionuclides was ignored. The dose estimated for the Cattaraugus Creek individual was 0.03 mrem in the year of maximum exposure. As in the earlier case, the results indicate that the solvent inventory will not be a major contributor to potential radiological impacts from buried waste in the NDA.

D.3.2.5 SDA Trench Water Tritium

Measurement of radionuclide concentrations in SDA trench water have reported tritium levels as high as 4.3 μCi/mL with an average of 1.25 μCi/mL (Prudic 1986). Because water has a small but noticeable vapor pressure at trench conditions, the tritium may evaporate and flow to the surface. Changes in barometric pressure may enhance or oppose the upward flow of evaporating water and on the average are expected to be negligible. Thus, for the purposes of this analysis, diffusive flow of water is assumed to produce a flux of tritium at the SDA ground surface. Tritium entering the atmosphere could mix with the ambient air or deposit on plants, producing a dose to an on-site resident.

Under Alternatives I and II, pumping of trench water and removal of waste inventories would eliminate the tritium diffusion exposure pathway. For Alternative III, pumping of trench water, grouting of the trenches, and installation of a 0.61-m (2-ft) layer of concrete would reduce or eliminate this potential pathway. However, some tritium inventory could remain in the trenches, and in order to provide a conservative analysis, this potential inventory was assumed to result in initial trench water tritium concentrations equal to present conditions. At the end of the 100 year period of institutional control assumed for analytical purposes, this level would be reduced by a factor of 270. This trench water could contact the lower face of the concrete layer establishing a diffusion path through the concrete pore water to the overlying unsaturated zone. Transient effects were conservatively neglected and steady-state conditions were assumed to be immediately established. In this case, the diffusive flow of tritium through the unsaturated zone was assumed to be rapid and the tritium was assumed to mix in breathing zone air flowing at 2 m/s (4.9 mph) to a height of 2 m (6.6 ft). The dose to the on-site resident was estimated as 0.001 mrem in the year of maximum exposure for Alternative III.

In the case of Alternative IV (No Action: Monitoring and Maintenance), it was again assumed that after 100 years, a residence was established on the SDA. In this case the concrete layer is not present and the tritium is assumed to evaporate and diffuse upward through the unsaturated zone. The total vapor phase concentration of water at the surface of the trench water was assumed to be equal to that established by the equilibrium vapor pressure of water at 21°C (70°F). The vapor phase concentration of tritium was estimated as the ratio of liquid phase tritium-to-water concentrations multiplied by the equilibrium water vapor phase concentration. As above the tritium flowing at the SDA surface was assumed to mix into a 2-m (6.6-ft) breathing layer. Peak dose was estimated as

6.9 x 10^{-4} mrem/yr. Similar considerations apply to Alternative V (Discontinue Operations) with the exception that the assumed 100 year delay would not occur. Peak dose was estimated as 0.19 mrem/yr. In each case, the peak dose due to the diffusion pathway for the on-site resident was small relative to the dose which could occur through other pathways. Peak dose to an off-site individual for Alternative V was estimated as 1.6 x 10^{-3} mrem/yr. Peak doses to an off-site individual in any other alternative would be less than the Alternative V estimate.

The doses estimated for tritium evaporation scenarios for all alternatives are small relative to other scenarios analyzed for the same alternative. As implied above, the tritium release analyses for Alternative III (In-Place Stabilization) and for Alternatives IV (No Action: Monitoring and Maintenance) and V (Discontinue Operations) incorporate differing degrees of conservatism and therefore produce results which are not directly comparable. In particular, for Alternative III (In-Place Stabilization), the resistance to mass transfer was underestimated by neglecting the resistance to mass transfer through the unsaturated zone, thus the results are overestimated. If the resistance to mass transfer in the unsaturated zone were considered, the predicted impacts for Alternative III (In-Place Stabilization) would be below those for Alternative IV (No Action: Monitoring and Maintenance) given comparable release conditions.

D.3.2.6 RTS Drum Cell

To prepare tank 8D-2 for high-level waste vitrification, ion exchange of the tank supernatant was completed and the sludge was water washed. The cesium-137 concentration in the supernatant and sludge wash liquid were reduced by processing and the resulting liquids were encapsulated in a cement waste form packaged in 0.27 m^3 (71 gal) drums. The waste liquids also contained isotopes with atomic number greater than 92 and half-lives greater than 5 years, at levels such that the concentration of these radionuclides in the cement waste form was approximately 55 ηCi/g (WVNS 1995b). The waste form has been tested and meets NRC Branch Technical Position guidance for waste form stability and leachability. A total of approximately 21,500 drums of cement may ultimately require disposal (WVNS 1994p). Under Alternative I (Removal), the waste drums would be removed from the Project Premises and disposed of off site. Under Alternatives II (On-Premises Storage) and IV (No Action: Monitoring and Maintenance), the waste drums would be stored indefinitely at the existing storage facility (i.e., the RTS drum cell). Present plans for Alternative III (In-Place Stabilization) call for enclosing the stacked cements drums in an above-grade artificial hillock (i.e., a tumulus) located on the south plateau between the headwaters of Erdman Brook and Franks Creek. Under Alternative V (Discontinue Operations), the waste drums and storage facility would be abandoned in their present condition. This analysis addresses the potential environmental impacts of implementing the alternatives under conditions which are expected to occur (expected conditions) and under conditions where institutional control would be lost, a circumstance considered unlikely but which was assumed for the purposes of analysis.

Under expected conditions for Alternatives I, II, and IV, there would be no anticipated impacts from the stored drums in the RTS drum cell, either because the waste inventory has been removed or because the facility is continually inspected and maintained in its present condition. Under expected conditions for Alternative III, the facility would be converted into a tumulus for permanent closure and rainwater could percolate through the waste, dissolve radionuclides, and transport the dissolved contaminants to off-site residents. The physical and hydraulic characteristics of the tumulus influencing the potential infiltration are summarized in Appendix E. The EIS analysis adopts a steady-state approach for infiltration flow in which the flow rate is determined by the saturated hydraulic conductivity of the layers of the tumulus. Details on the infiltration rate estimate are presented in Appendix E. Radionuclides in the cement pore water cloud were assumed to diffuse through the matrix and dissolve into the downward water flow. The diffusional release analysis did not take credit for retardation in the cement and the diffusional release rate was estimated using the model described in Appendix E. Radionuclide concentrations in the cement pore water were those reported as averages for the first 14,500 drums stored in the facility (WVNS 1995b). Solubilities for the infiltrating water were either estimated using the PHREEQE computer code as described in Appendix E or from site-specific measurements. The distribution coefficients presented in Appendix E were used in the calculations. A time dependent release rate was determined using the diffusion release model if the release rate for the first year was less than that determined by the solubility limit for the infiltrating water, and as solubility limited if the converse were true. This approach is conservative as the diffusional release rate would decrease with time, while the infiltration rate and solubility-limited release rate would increase with time. Radionuclides carried downward by infiltrating water could ultimately enter the horizontal flow path through the weathered till and be transported to Franks Creek and potentially to off-site residents. In this analysis, a one-dimensional flow model was used to represent horizontal flow and an off-site resident and a Seneca Indian resident on the Cattaraugus Reservation, each located on Cattaraugus Creek, obtained fish, drinking water, and crop irrigation water from contaminated stream water. Under conditions which are not expected to occur, institutional control of the site was assumed to be lost and individuals could establish a residence and garden near the tumulus on the Project Premises or on Buttermilk Creek. Releases potentially affecting these residents were estimated as described above for the expected conditions case. In addition, for the loss of institutional control case, erosion could cause collapse of the waste inventory into the creek.

Analysis of the groundwater release scenarios indicated that the doses in the year of maximum impact were dominated by release of long-lived, mobile radionuclides including carbon-14, iodine-129, and technetium-99. Maximum doses for the Project Premises, Buttermilk Creek, Cattaraugus Creek, and Seneca Indian residents were 29, 1.1, 0.14, and 0.32 mrem/yr, respectively. For the year of maximum impact, the collective dose and number of latent cancer fatalities were estimated as 0.08 person-rem and 4.2×10^{-5}, respectively. The maximum doses were estimated to occur about 200 years after closure of the tumulus. For conditions which are not expected to occur, blockage of the drainage layer could cause an increase in flow though the waste. Under these conditions, maximum doses for the Project Premises, Buttermilk Creek, Cattaraugus Creek, and Seneca Indian residents were estimated as 450, 2.8, 0.37, and 0.64 mrem/yr, respectively. For the year of maximum impact, the collective dose and number of latent cancer fatalities were estimated as 0.22 person-rem and 1.1×10^{-4}, respectively. The relatively low solubility and high retardation of the transuranic radionuclides resulted in their negligible contribution to the dose for the year of maximum impact. The potential contribution of the transuranic radionuclides to dose was investigated by varying the solubility, retardation, and source concentration of these radionuclides. The scenario conditions and results of these analyses are summarized for four cases in Table D-9.

The results for case 1 indicate that for expected conditions the dose from transuranic radionuclides would be small. The solubility dependence was investigated by using observed concentrations in the SDA trenches as estimates of solubility for the transuranic radionuclides. Organic chemicals in the SDA trench water would be expected to enhance the solubility of these elements. The results for case 2 reflect this expected increase, but remain below acceptable levels of dose for both on-site and off site residents. The year of maximum impact for transuranic radionuclides was estimated to occur approximately 60,000 years after closure of the tumulus. The influence of a decrease in the expected large retardation of plutonium and americium, was investigated by a one-hundred-fold decrease in the distribution coefficient for these radionuclides. The results, presented as case 3 (Table D-9) show a decrease in the maximum dose from transuranic radionuclides because less radionuclides would be transferred to crops because of the decrease in the distribution coefficient. However, the year of maximum exposure occurred earlier, approximately 700 years after the tumulus was closed. An increase in the concentration of transuranic radionuclides in the cement waste form was investigated in case 4. The results showed no increase in maximum dose, because the release was limited by the solubility of plutonium and americium. In each of the investigated cases, doses for on-site individuals are below potentially applicable DOE and NRC standards.

Under conditions which are considered unlikely, institutional control of the site could be lost and erosion could cause the drum cell to collapse into the creek. The potential impacts of this scenario were evaluated using the erosional collapse model described in Appendix E. The peak rate of stream bank advance [0.15 m/yr (0.5 ft/yr) derived in Appendix L erosion analysis] was used in this impact analysis. Loss of institutional control was assumed to occur 100 years after the implementation phase for Alternatives II (On-Premises Storage), III (In-Place Stabilization), and IV (No Action: Monitoring and Maintenance), and immediately for Alternative V (Discontinue Operations). Under Alternative III, if a global erosion control strategy were selected, the onset of erosion was assumed to be delayed by 1,000 years. Thus, for the purposes of this analysis, erosion was assumed to begin immediately (the year 2000) for Alternative V; to be delayed 100 years for Alternatives II, Alternative IV, and under the local erosion control strategy for Alternative III; and to be delayed 1,000 years under the global erosion control strategy for Alternative III. The results were generally similar for each of the three delay periods. The creek bank was predicted to erode back into the drum cell 100 years after erosion began, with the maximum impact occurring at that time. Further releases occurred in an episodic manner for an additional 400 years until the entire inventory had been lost. Because of its high solubility and relatively long half life, americium-241 dominated doses in all cases. Doses in the year of maximum impact for zero, 100, and 1,000-yr delay periods were estimated at 4,500, 4,500, and 900 mrem, respectively. For each case, the estimated doses are above acceptable

Table D-9. Alternative III (In-Place Stabilization) Scenario Conditions and Impacts for Transuranic Radionuclides[a]

Case No.	Scenario Conditions	South Plateau Resident Dose (mrem)	Cattaraugus Creek Resident Dose (mrem)	Off-Site Population: Collective Dose (person-rem)	Off-Site Population: Latent Cancer Fatalities
1	• Clogged drainage layer • Waste characterization report inventory • No retardation in cement • Expected retardation in clay for Pu and Am • PHREEQE solubility for Pu and Am	0.004 [43500][a]	8.2×10^{-8} [79800]	4.9×10^{-8} [79800]	2.5×10^{-11}
2	• Clogged drainage layer • Waste characterization report inventory • No retardation in cement • Expected retardation in clay for Pu and Am • SDA solubility for Pu and Am	31.8 [61700]	8.3×10^{-4} [76200]	5.0×10^{-4} [76200]	2.5×10^{-7}
3	• Clogged drainage layer • Waste characterization report inventory • No retardation in cement • Degraded retardation in clay for Pu and Am • SDA solubility for Pu and Am	23.7 [2699]	0.02 [2699]	0.01 [2699]	6.0×10^{-6}
4	• Clogged drainage layer • 100 ηCi/g TRU inventory • No retardation in cement • Degraded retardation in clay for Pu and Am • SDA solubility	23.7 [2699]	0.02 [2699]	0.01 [2699]	6.0×10^{-6}

a. Doses are for year of maximum impact for those scenario conditions, the year of occurrence is provided in brackets.

standards but are considered very unlikely because site maintenance and institutional control is expected to occur.

D.3.3 Summary of Long-Term Exposure Scenarios

This section describes the WMA exposure scenarios by alternative, summarizes the rationale for scenario selection and discusses the results. The results are summarized in Chapter 5.

D.3.3.1 Alternative I: Removal and Release to Allow Unrestricted Use

Under Alternative I (Removal), waste and contamination would be removed from the WMAs to the extent feasible or necessary to allow release of the area for unrestricted use. It was assumed that the WMAs would be backfilled as necessary using nonradioactive soil (or, alternatively, the radioactivity in soils would be below assumed contaminant cleanup levels) based on screening measurements at the container management area. Removal of soil from the cesium prong on site and complete removal of contaminated facilities, buried sediments, and buried waste would eliminate the source term for off-site exposure scenarios. Thus, the impact analysis for this alternative is limited to consideration of on-site residents exposed to residual contamination.

Evaluation of potential impacts for releasing to allow unrestricted use depends on whether assumed contaminant site clean up levels are implemented. This approach assumes that released areas would have been sampled and cleaned up to contamination levels such that the dose through the residential/agricultural scenario would not exceed 15 mrem/yr. The annual risk of a latent cancer fatality from this dose is estimated as 7.5×10^{-6}. The WMA-specific radionuclide distributions which would produce this dose are given in Appendix E. No additional long term or natural phenomena-related events are expected for this alternative.

D.3.3.2 Alternative II: Removal, On-Premises Waste Storage, and Partial Release to Allow Unrestricted Use

This alternative is similar to Alternative I (Removal) except the waste generated and exhumed during the implementation phase of closure would be stored on the Project Premises rather than being transported to an off-site disposal facility. Based on the conceptual engineering designs for the retrievable storage areas (WVNS 1993e), it was assumed that members of the public residing on site would not receive additional doses from this facility because (1) the facility containment and monitoring activities would be designed to prevent the potential release of radioactive material to the environment, and (2) the shielding would be designed to prevent external exposures from the stored waste. Therefore, expected case long-term exposure scenarios for this alternative are the same as those for Alternative I. After the implementation phase, individuals could establish homes and garden on all areas of the site not occupied by the retrievable storage areas or the RTS drum cell. Individuals establishing residences or gardens in areas released for unrestricted use could be exposed to residual contamination at doses below 15 mrem/yr. Annual risk of a latent cancer fatality was estimated as 7.5×10^{-6}.

Under conditions considered unlikely to occur, it was assumed institutional control of the site was lost and additional impacts could occur. For the purposes of analysis, this loss of institutional control was assumed to occur 100 years after the end of the implementation phase. Upon loss of institutional control, the retrievable storage areas and RTS drum cell could be in need of maintenance and water could infiltrate into the facilities. In addition, the erosion control structures implemented for the local strategy could deteriorate, allowing erosion to resume. The long-term risk of the assumed loss of institutional control was evaluated using the groundwater release and erosional collapse scenarios.

For the groundwater release scenarios, the maximally exposed individuals included residents on the Project Premises located 50 m (164 ft) from the facilities, a Buttermilk Creek resident, and the surrounding population. NRC guidance stipulates that cement engineered barriers should be assumed to have the consistency of soil after 500 years (Bernero 1992). Thus, to provide a conservative analysis, it was assumed that after 100 years, water could percolate through the facilities, dissolve radionuclides, and contaminate groundwater used by residents on the Project Premises and surface water used by off-site residents. Doses for the year of maximum impact for the north and south plateau residents were estimated as 1.3×10^8 and 440 mrem, respectively. For the south plateau resident, the estimated dose was from direct and skyshine exposures from the cement waste drums. Doses for the Buttermilk Creek resident for the year of maximum impact for the retrievable storage areas and RTS drum cell were estimated as 652.0 and 6.3 mrem, respectively. Collective (population) doses for the year of maximum impact for the retrievable storage areas and the RTS drum cell were estimated as 50 and 0.5 person-rem, respectively. The annual risk of a latent cancer fatality for the Buttermilk Creek resident and average member of the population was estimated as 3.3×10^{-4} and 7.3×10^{-8}, respectively.

The analysis of erosion described in Appendix L indicated that if erosion controls were not used the RTS drum cell could be eroded into in approximately 100 years. The rate of advance of the stream bank was estimated as 0.15 m/yr (0.5 ft/yr). If the RTS drum cell was eroded into, waste drums could contact surface water and release contamination that could be carried to off-site residents. The potential impacts of this scenario were evaluated using the trench erosion model described in Appendix E. Active erosion was assumed to begin in 2025, 100 years after the end of the implementation phase and was predicted to erode back to the RTS drum cell after an additional 100 years, and to completely remove the inventory within another 400 years. Doses for the year of maximum impact for the Buttermilk Creek resident and the population were estimated as 4,500 mrem and 360 per-rem, respectively. Annual risks of a latent cancer fatality for the Buttermilk Creek resident and the average member of the population were estimated as 2.3×10^{-3} and 5.1×10^{-7}, respectively.

D.3.3.3 Alternative III: In-Place Stabilization and On-Premises Low-Level Waste Disposal

Under Alternative III (In-Place Stabilization), facilities would be minimally decontaminated before they were stabilized in-place. Soil contamination would decay to acceptable levels during the institutional control period. Because significant quantities of radioactive material would be on the Project Premises and SDA for a long time, long-term exposure scenarios for occupants on the Project Premises and members of the public were evaluated. Under this alternative, an effective long-term erosion control strategy would be implemented. The consequences of eroding disposal facilities is the expected case under an assumed loss of institutional control.

Expected Conditions Case

Under expected conditions, release of radionuclides from engineered disposal facilities could potentially occur by diffusion and groundwater leaching mechanisms. The conceptual engineering design for closure of the process building, HLW tanks, and vitrification facility use either monolithic concrete or grouting to stabilize the radionuclide inventories in-place. For the purposes of analysis, the waste inventory was assumed to be uniformly distributed throughout the concrete matrix and could diffuse through the concrete pore space.

Radionuclides exiting the concrete matrix would be transported in the sand and gravel layer to Erdman Brook, be discharged to surface water and ultimately carried to Cattaraugus Creek. For the LLW disposal facility, NDA, and SDA, to surface water, predominantly horizontal groundwater flow through the disposal media, the cap and the engineered barriers supported the selection of a solubility-limited release for these facilities. A combination of diffusional and solubility limitations were assumed applicable at the RTS drum cell. For expected conditions, potentially maximally exposed individuals were a Cattaraugus Creek resident and an Indian of the Seneca Nation residing on the Cattaraugus Reservation, also using water from Cattaraugus Creek. Impacts to the surrounding population were also evaluated. Each affected individual was assumed to obtain fish, drinking water, and crop irrigation water from potentially contaminated stream water.

The potential release of soluble strontium-90 and cesium-137 from the HLW tanks would produce the largest doses for off site residents. Table D-10 presents the potential impacts from the groundwater flow scenarios in the year of maximum impact by facility. The time history of the impact for all facilities for the Cattaraugus Creek and Seneca Indian residents for Alternative IIIA [In-Place Stabilization (Backfill)] are shown in Figures D-3 and D-4, respectively. The off-site resident results for Alternative IIIB [In-Place Stabilization (Rubble)] are similar to those for Alternative IIIA. The peak dose for the off-site individual was predicted to occur 173 years after closure, because of the potential release of strontium-90 from the HLW tanks. For the other facilities except the process building and HLW tanks, the peak dose for the off-site individual was predicted to occur 50 years after closure from the potential release of strontium-90 from lagoon 1 at the LLWTF.

In the year of maximum impact for the combined release from all facilities, the annual risks of a latent cancer fatality were estimated as 3.6×10^{-5}, 6.3×10^{-5}, and 6.2×10^{-8} for the Cattaraugus Creek resident, Seneca Indian resident, and average member of the population, respectively. Because the Lavery till has a high capacity to retard the movement of the radionuclides of concern, off-site resident doses predicted for the NDA and SDA on the south plateau are near or below 1 mrem for any given year. The potential doses for the NDA and SDA versus time are presented in Figures D-5 and D-6, respectively.

Table D-10. Impacts to the Public from Expected Conditions for Alternative III (In-Place Stabilization) (Groundwater Release Scenario)[a]

WMA/Facility (Alternative)	Cattaraugus Creek Individual Dose (mrem)	Seneca Indian Individual Dose (mrem)	Off-Site Population: Collective Dose (person-rem)	Off-Site Population: Latent Cancer Fatalities
1—Process Building (IIIA)	0.6 [2182]	1.1 [2182]	0.4 [2182]	0.0002
1—Process Building (IIIB)	0.2 [2196]	0.3 [2196]	0.1 [2196]	6.0×10^{-5}
2—LLWTF	1.2 [2050]	2.1 [2050]	0.7 [2050]	0.0004
3—HLW Tanks (IIIA)	71.9 [2181]	126.0 [2181]	43.1 [2181]	0.02
3—HLW Tanks (IIIB)	71.9 [2196]	126.0 [2196]	43.1 [2196]	0.02
5—LLW Disposal Facility (IIIB)	0.01 [2051]	0.03 [2051]	0.006 [2051]	3.0×10^{-6}
7—NDA	0.003 [2141]	0.007 [2141]	0.002 [2141]	9.0×10^{-7}
8—SDA	0.1 [2321]	0.2 [2321]	0.06 [2321]	3.0×10^{-5}
9—RTS Drum Cell	0.14 [2156]	0.32 [2156]	0.08 [2156]	4.2×10^{-5}

a. Doses are for year of maximum impact for that facility, the year of occurrence is provided in brackets.

Disposed waste at the NDA and SDA is in the weathered and unweathered Lavery till, and based on predictions from the three-dimensional groundwater flow model (see Appendix J), groundwater could reach Buttermilk Creek by horizontal flow through the weathered till, vertical flow through the unweathered till, followed by horizontal flow through the Kent recessional unit. For the retardation, solubility, and groundwater velocity values summarized in Appendix E, transport through the horizontal flow path dominates the predicted impacts.

Loss of Institutional Control Case

For Alternative III (In-Place Stabilization), for analytical purposes it was assumed that institutional control would be lost 100 years after the waste had been stabilized. Members of the public could enter the Project Premises, and gain direct access to the waste or be exposed to contamination by atmospheric, agricultural, and groundwater pathways that had been released because the engineered containment structure had degraded. The potential impact of exposure from residual contamination and direct intrusion was evaluated by WMA. On the south plateau, the installation of the engineered caps and regrading of the NDA and SDA would eliminate the potential movement of contaminated water to the surface where it could

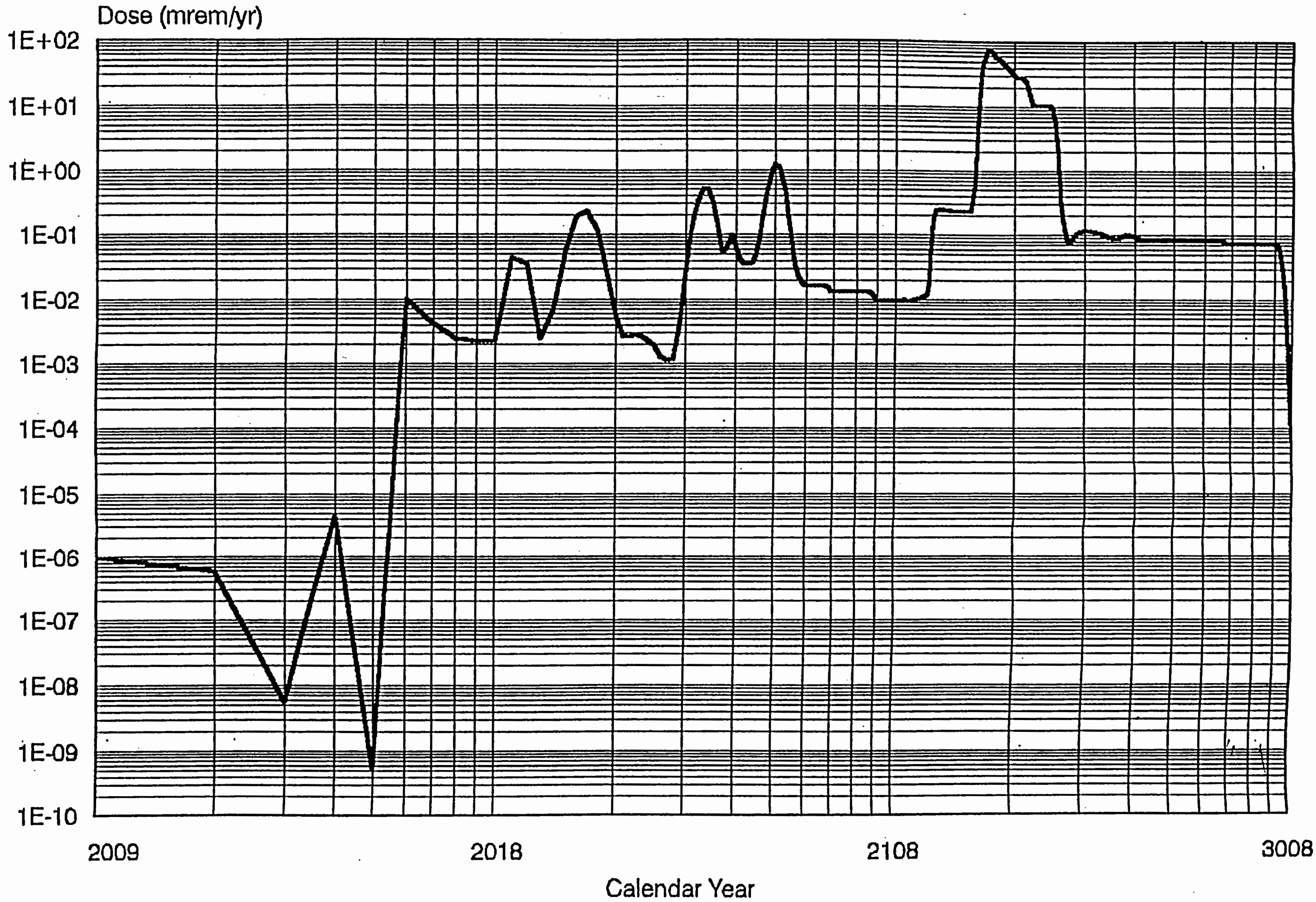


Figure D-3. **Alternative IIIA Expected Conditions (Institutional Control) Case, Groundwater Release Scenario, Cumulative Impacts for a Cattaraugus Creek Resident**

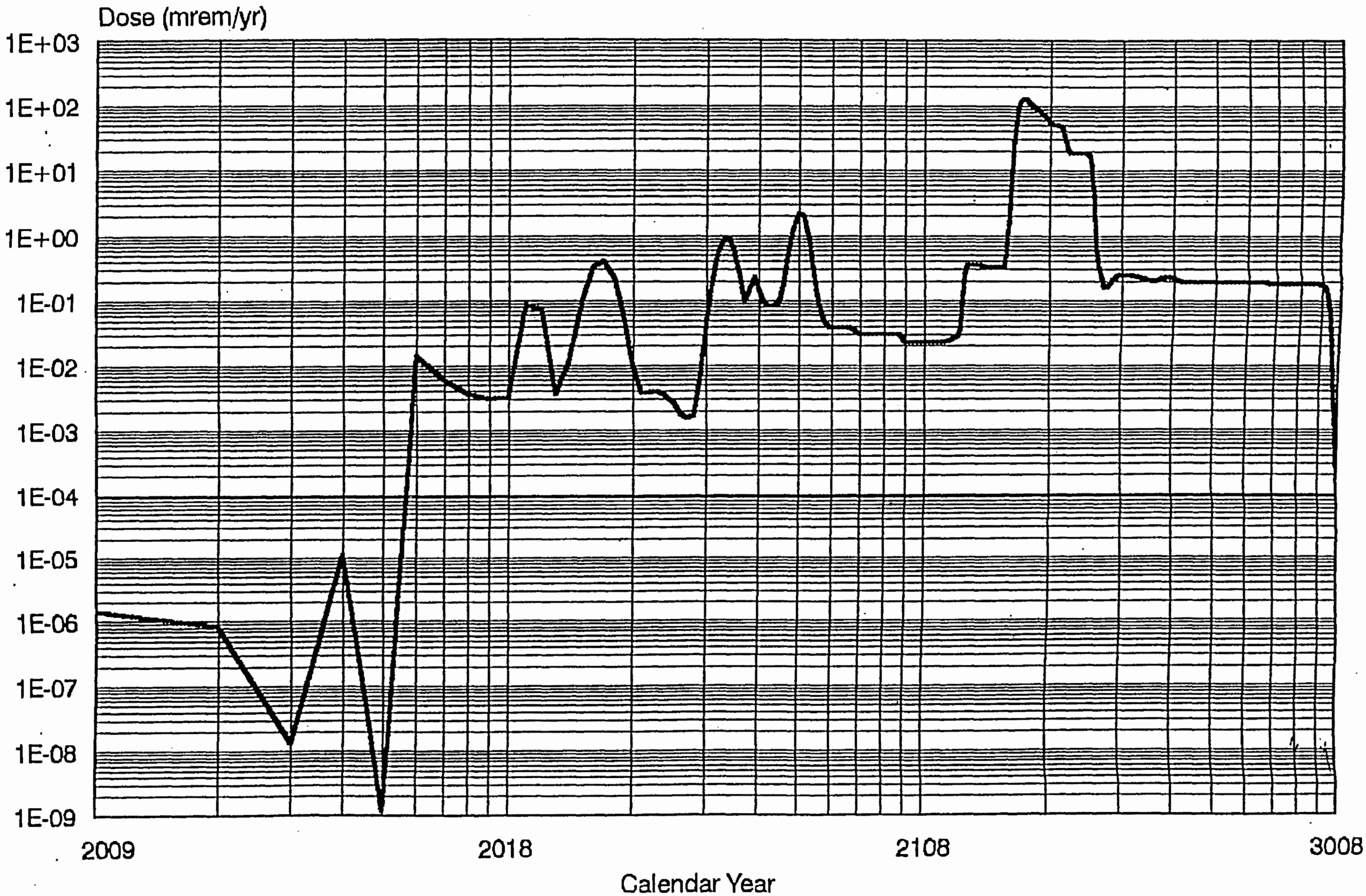


Figure D-4. Alternative IIIA Expected Conditions (Institutional Control) Case, Groundwater Release Scenario, Cumulative Impacts for a Seneca Indian Resident

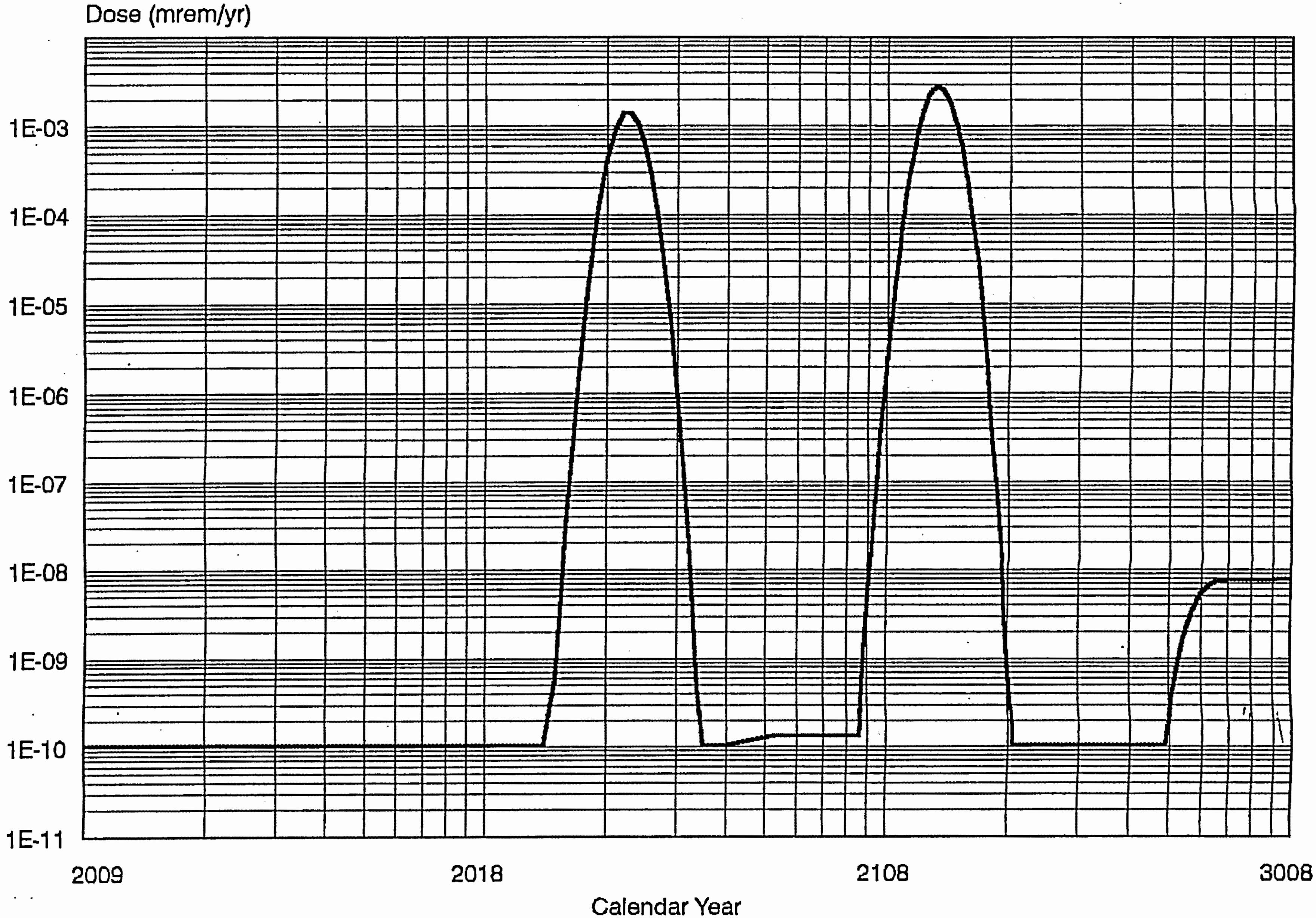


Figure D-5. Alternative IIIA Expected Conditions (Institutional Control) Case, NDA Groundwater Release Scenario, Impacts for a Cattaraugus Creek Resident

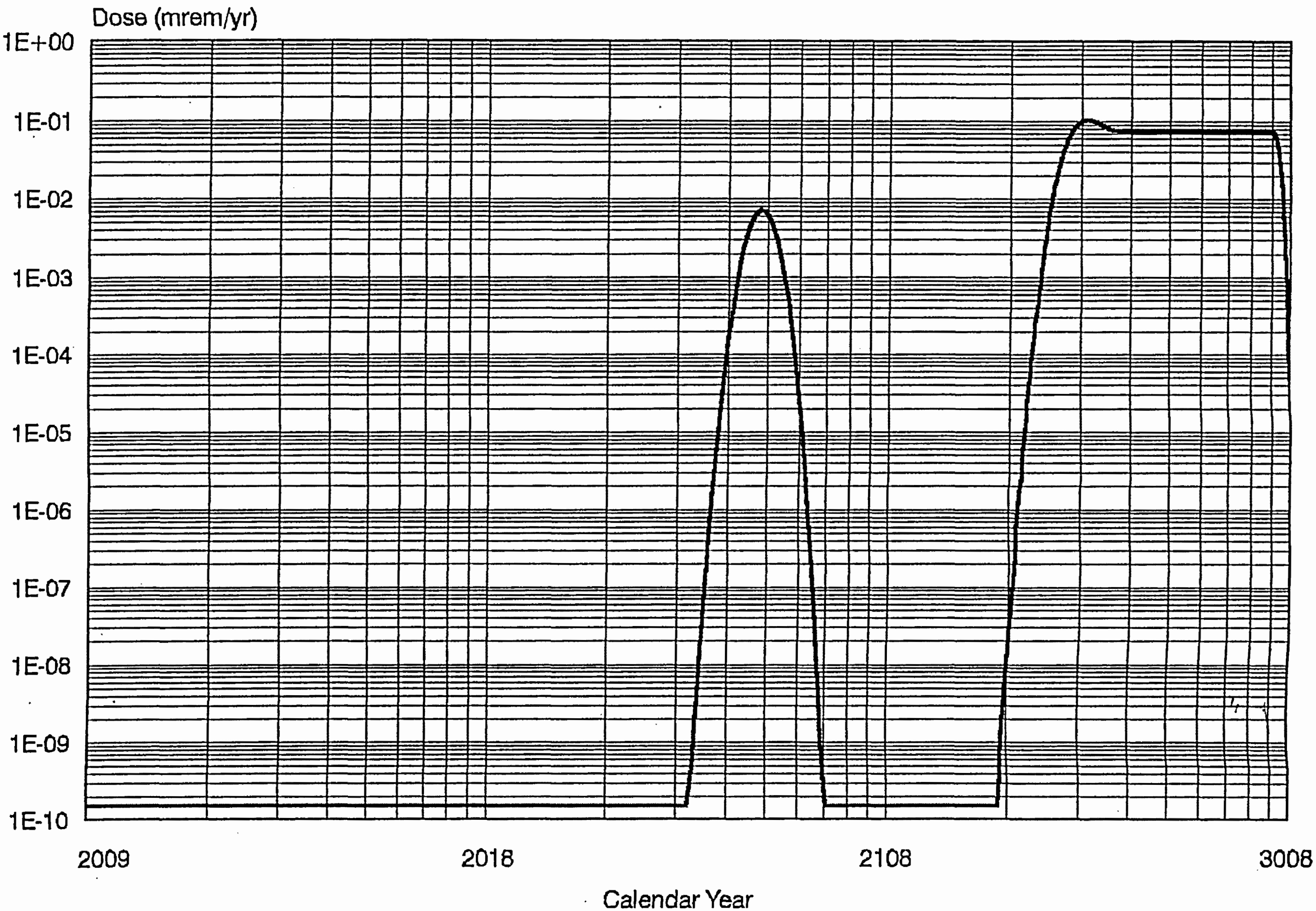


Figure D-6. Alternative III Expected Conditions (Institutional Control) Case, SDA Groundwater Release Scenario, Impacts for a Cattaraugus Creek Resident

contaminate crops. At the process building, lagoon 1 at the LLWTF, HLW tanks, and the LLW disposal facility on the north plateau, a well was assumed to be located a distance of 50 m (165 ft) from the boundary of the disposal facility. The analysis evaluated the contribution of groundwater leaching of radionuclides in disposed waste.

Table D-11 presents the intrusion scenario results for the year of maximum impact for each WMA. For the process building, HLW tanks, NDA, SDA, and RTS drum cell, the conceptual engineering designs (e.g. capping) for closure eliminate the near-surface exposure routes for the construction and discovery scenarios. Residual contamination outside the boundaries of the stabilized facilities at the LLWTF, lag storage additions, and remaining facilities in WMA 6 and WMA 10, is a potential source of exposure like Alternative I

Table D-11. Impacts to an Intruder from the Assumed Loss of Institutional Control for Alternative III (In-Place Stabilization)[a]

	Dose[a] (mrem)		
WMA/Facility (Alternative)	Agriculture/ Residential	Construction	Drilling
1—Process Building (IIIA)	3.8×10^5 [2108]	NA[b]	3.3 [2000000]
1—Process Building (IIIB)	3.8×10^5 [2123]	NA	3.3 [2000000]
2—LLWTF and Lagoons 1-5	2.2×10^5 [2127]	0.8 [2108]	0.00008 [2508]
3—HLW Tanks (IIIA)	8.9×10^7 [2108]	NA	0.4 [2508]
3—HLW Tanks (IIIB)	8.9×10^7 [2108]	NA	0.4 [2523]
5—LLW Disposal Facility (IIIB)	25.1 [33823]	NA	NA
7—NDA	NA	NA	0.05 [2508]
8—SDA	NA	NA	0.09 [2508]
9—RTS Drum Cell	29.0 [2568]	NA	0.004 [2508]
Cesium Prong On Site (IIIA)	7.3 [2108]	NA	NA
Cesium Prong On Site (IIIB)	5.1 [2123]	NA	NA
North Plateau Plume (IIIA)	840 [2108]	NA	NA
North Plateau Plume (IIIB)	590 [2123]	NA	NA

a. Doses are for year of maximum impact for that facility, the year of occurrence is provided in brackets.
b. NA = Due to the nature of the scenario and the WMA, the scenario is not applicable.

(Removal). After 500 years the concrete intruder barriers could degrade to the point where the lag storage additions and at the remaining facilities in WMA 6 and WMA 10 because inadvertent drilling could intersect disposed waste. The drilling scenario would not apply at waste is not disposed of below the surface.

Table D-12 summarizes the potential impacts to the Buttermilk Creek resident and the population in the year of maximum impact for each facility. Impacts to the off-site population under the assumed loss of institutional control case for groundwater release scenarios are the same as those reported in Table D-10 for the expected conditions case where institutional control is maintained. Impacts to residents on the north plateau on the Project Premises are large with potential for illness or fatality. The potential releases are dominated by soluble, mobile strontium-90. Impacts to Buttermilk Creek resident are dominated by large doses from the HLW tanks where strontium-90 is again the dominant radionuclide. The risk of a latent cancer fatality for the year of maximum impact for the Buttermilk Creek resident was estimated as 2.7×10^{-4}.

Table D-12. Impacts to the Public from an Assumed Loss of Institutional Control for Alternative III (In-Place Stabilization) (Groundwater Release Scenario)[a]

WMA/Facility (Alternative)	Buttermilk Creek Individual Dose (mrem)	Off-Site Population: Collective Dose (person-rem)	Off-Site Population: Latent Cancer Fatalities
1—Process Building (IIIA)	4.8 [2182]	0.4 [2182]	0.0002
1—Process Building (IIIB)	1.1 [2196]	0.1 [2196]	6.0×10^{-5}
2—LLWTF and Lagoons 1-5	0.14 [2387]	0.7 [2050]	0.0004
3—HLW Tanks (IIIA)	541.0 [2181]	43.1 [2181]	0.02
3—HLW Tanks (IIIB)	541.0 [2196]	43.1 [2181]	0.02
5—LLW Disposal Facility (IIIB)	0.002 [33823]	0.006 [2051]	3.0×10^{-6}
7—NDA	0.02 [2141]	0.002 [2141]	9.0×10^{-7}
8—SDA	0.80 [2321]	0.06 [2321]	3.2×10^{-5}
9—RTS Drum Cell	1.1 [2156]	0.08 [2156]	4.2×10^{-5}
North Plateau Plume (IIIA)	0.26 [2108]	0.27 [2000]	0.0001
North Plateau Plume (IIIB)	0.18 [2123]	0.27 [2000]	0.0001

a. Doses are for year of maximum impact for that facility, the year of occurrence is provided in brackets.

If institutional control of the site were lost, the selected erosion control strategy (either local or global) would no longer be maintained, the structures could deteriorate, and lose their effectiveness. The erosion analysis (described in Appendix L) concluded that the LLWTF, NDA, SDA, and RTS drum cell could be eroded within 1,000 years after the onset of active erosion (i.e. maintenance is lost). The design life for the global and local erosion control strategies are 1,000 and 50 years, respectively. For the purpose of analysis, it was assumed that after 1,000 years the global erosion control structures were no longer functional, the original site drainage pattern was re-established, and erosion preceded at a rate expected to be exceeded 10 percent of the time under current conditions [i.e., 0.15 m/yr (0.5 ft/yr)]. A similar sequence of events was assumed for the local erosion control structures after the 100-year institutional control period. The impact from waste structures collapsing into the stream were evaluated using the erosional collapse model described in Appendix E. Tables D-13 and D-14 summarize the potential impact to the Buttermilk Creek resident and the surrounding population for the erosional collapse scenarios given the global and local erosion control strategies, respectively. Figures D-7 and D-8 present the time histories of the impact from all facilities for the Buttermilk Creek resident under the global and local erosion control strategies, respectively. The impact for the Buttermilk Creek resident is large in each case. The annual risk of a latent cancer fatality for the average member of the population in the year of maximum impact were estimated as 7.6×10^{-6} and 3.1×10^{-5} for the global and local erosion control strategies, respectively.

Table D-13. Impacts to the Public from an Assumed Loss of Institutional Control for Alternative III (In-Place Stabilization) (Global Erosion Control Strategy: Erosional Collapse Scenario)[a]

WMA/Facility	Buttermilk Creek Individual Dose (mrem)	Off-Site Population: Collective Dose (person-rem)	Off-Site Population: Latent Cancer Fatalities
2—LLWTF	200 [3688]	8.1 [3688]	0.004
7—NDA	9,400 [3298]	742.6 [3298]	0.37
8—SDA	6.7×10^4 [3228]	5,300 [3228]	2.7
9—RTS Drum Cell	900 [3108]	71.1 [3108]	0.04

a. Doses are for year of maximum impact for that facility, the year of occurrence is provided in brackets.

Table D-14. Impacts to the Public from an Assumed Loss of Institutional Control for Alternative III (In-Place Stabilization) (Local Erosion Control Strategy: Erosional Collapse Scenario)[a]

WMA/Facility	Buttermilk Creek Individual Dose (mrem/yr)	Off-Site Population: Collective Dose (person-rem/yr)	Off-Site Population: Latent Cancer Fatalities
2—LLWTF	520 [2780]	41 [2788]	0.02
7—NDA	4.7×10^4 [2390]	3,700 [2398]	1.9
8—SDA	2.8×10^5 [2320]	2.2×10^4 [2328]	11.1
9—RTS Drum Cell	4,500 [2200]	360 [2208]	0.18

a. Doses are for year of maximum impact for that facility, the year of occurrence is provided in brackets.

D.3.3.4 Alternative IV: No Action: Monitoring and Maintenance

Alternative IV (No Action: Monitoring and Maintenance) presumes that closure activities are limited in nature; lagoon 3 at the LLWTF would be stabilized and contaminated groundwater on the north plateau would be managed. Monitoring and maintenance workers were assumed to be present to maintain site control so that intrusion and groundwater contamination scenarios would not be applicable. Alternative IV assumes that the process building, HLW tanks, lag storage additions, and RTS drum cell are maintained in their present condition and therefore do not contribute to potential releases that could affect on-site or off-site individuals. Thus, the only long-term scenarios evaluated were groundwater leaching of sediments and waste buried in the LLWTF, NDA, and SDA. Under conditions considered unlikely, it was assumed that institutional control of the site was lost and the existing facilities abandoned.

Expected Conditions Case

Under the expected conditions case, groundwater infiltrating buried sediments and waste at the LLWTF, NDA, and SDA could dissolve radionuclides and transport the contamination to surface water that is used by off-site residents. At the LLWTF, horizontal flow could transport contaminants to surface water in Erdman Brook where it ultimately would flow to Buttermilk Creek. At the NDA and SDA, horizontal flow of groundwater through the weathered Lavery till could transport dissolved radionuclides to Erdman Brook and Franks Creek where they would be discharged and ultimately flow to Buttermilk Creek. Downward flow to the Kent recessional unit could also transport dissolved radionuclides to Buttermilk Creek. For the expected conditions case where institutional control is maintained, the maximally exposed individuals are a resident located on Cattaraugus Creek near the Center boundary and a Seneca Indian resident on the Cattaraugus Reservation located on Cattaraugus Creek west of the Center. The analysis also evaluated potential impacts to the

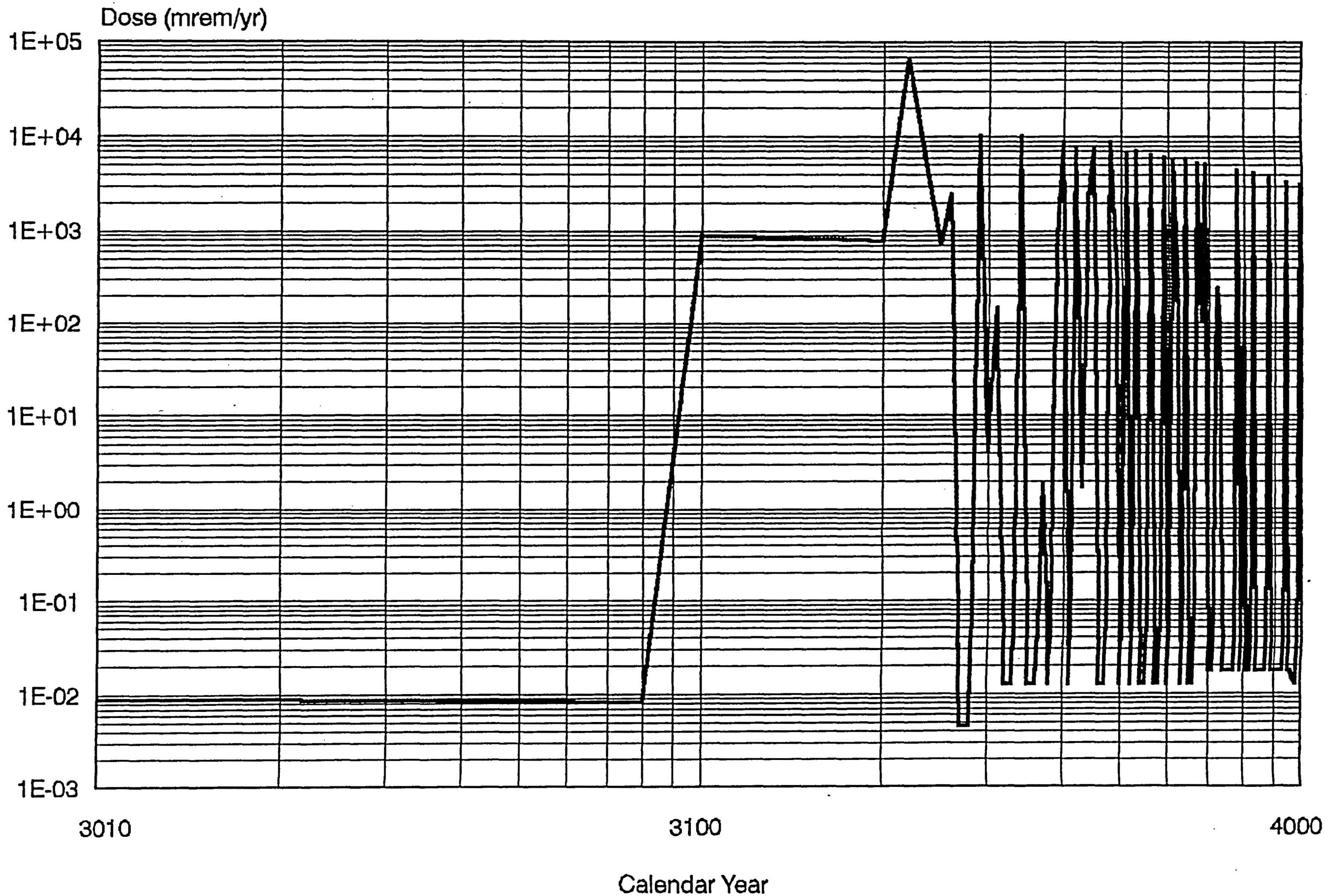


Figure D-7. Alternative III Assumed Loss of Institutional Control Case, Global Erosion Control Strategy: Erosion Collapse Scenario, Cumulative Impacts for a Buttermilk Creek Resident

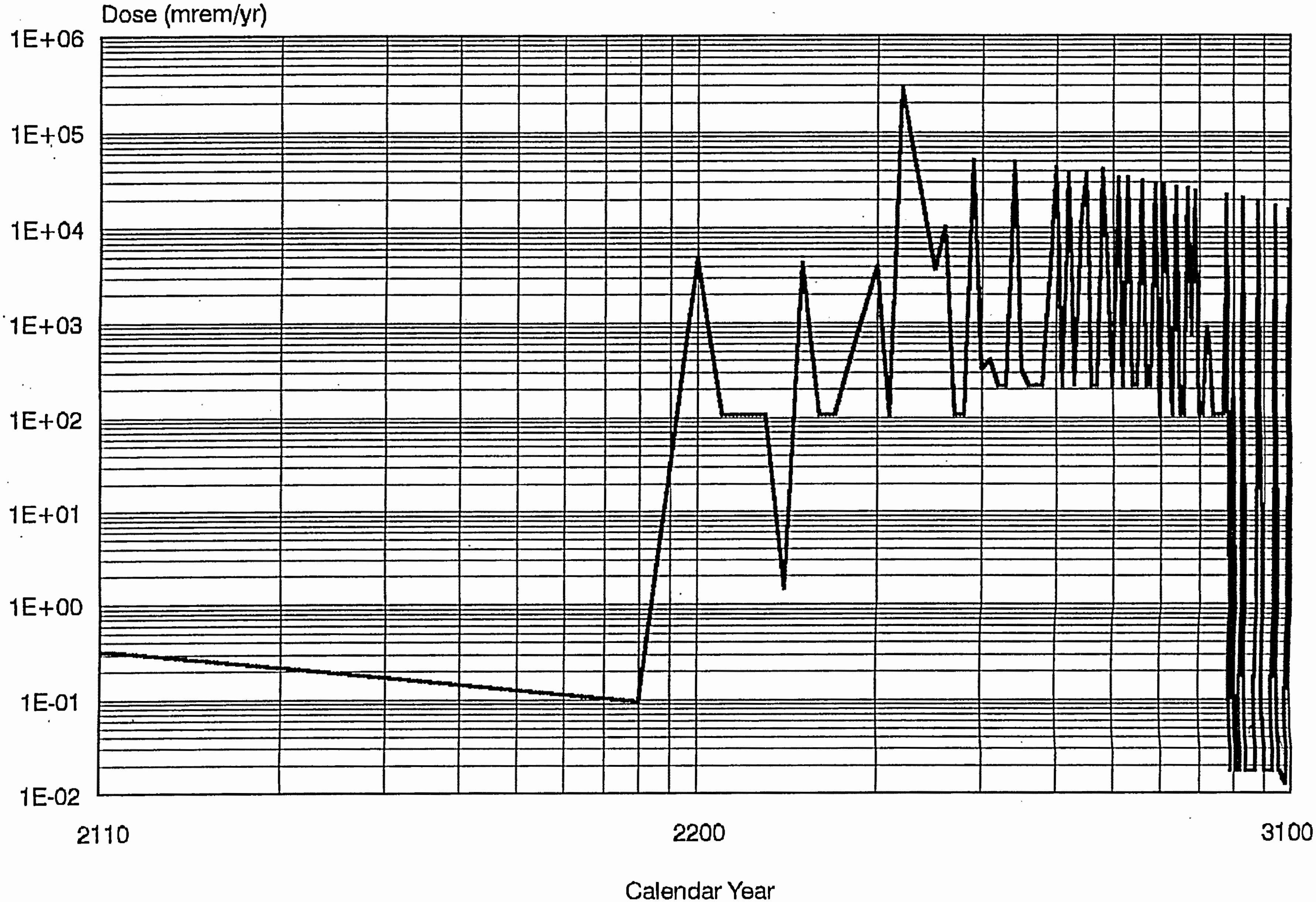


Figure D-8. Alternative III Assumed Loss of Institutional Control Case, Local Erosion Control Strategy: Erosion Collapse Scenario, Cumulative Impacts for a Buttermilk Creek Resident

surrounding population. Each affected individual was assumed to obtain fish, drinking water, and crop irrigation water from potentially contaminated surface water. Table D-15 presents the dose estimates for the year of maximum impact. The peak dose, approximately 1.2 mrem, is from release of strontium-90 from lagoon 1 sediments. The dose time histories for the Cattaraugus Creek and Seneca Indian residents are presented in Figures D-9 and D-10, respectively. In the year of maximum impact for the combined releases from all facilities, the annual risks of a latent cancer fatality were estimated as 6.0×10^{-7}, 1.1×10^{-6}, and 2.7×10^{-10} for the Cattaraugus Creek resident, Seneca Indian resident, and average member of the population, respectively.

Table D-15. Impacts to the Public from Expected Conditions for Alternative IV (No Action: Monitoring and Maintenance) (Groundwater Release Scenario)[a]

			Off-Site Population	
WMA/Facility	Cattaraugus Creek Individual Dose (mrem)	Seneca Indian Individual Dose (mrem)	Collective Dose (person-rem)	Latent Cancer Fatalities
2—LLWTF and Lagoons 1-5	1.2 [2050]	2.1 [2050]	0.72 [2050]	0.0004
7—NDA	0.005 [2068]	0.01 [2068]	0.003 [2068]	0.000002
8—SDA	0.1 [2248]	0.3 [2248]	0.06 [2248]	0.00003

a. Doses are for year of maximum impact for that facility, the year of occurrence is provided in brackets.

Loss of Institutional Control Case

Under conditions considered unlikely; it was assumed that site security and monitoring and maintenance functions would be lost. For the purposes of analysis, institutional control was assumed to be lost 100 years after the end of the implementation phase. At that time, facilities containing waste could be exposed to the elements and natural processes. Erosion could undermine the storage capability of the facilities. Individuals could establish residences and gardens on the Project Premises or directly intrude into the waste. An intruder on the Project Premises and SDA, water infiltration, and erosional collapse scenarios were used to evaluate the risk from the loss of institutional control.

For the water infiltration scenario, the containment integrity of the buildings was assumed to be lost and water percolates through the waste, dissolving radionuclides and contaminating groundwater and surface water. A resident on the Project Premises was assumed to grow crops that become contaminated by contact with the contaminated groundwater. Intruders could enter the abandoned facilities and attempt to drill wells through buried waste. Table D-16 summarizes the potential impact to the intruder on the Project Premises for the year of maximum impact by facility. In most cases the impacts are severe, potentially including illness or fatality. Individuals using stream water recharged by contaminated groundwater could also be adversely affected. The maximally exposed

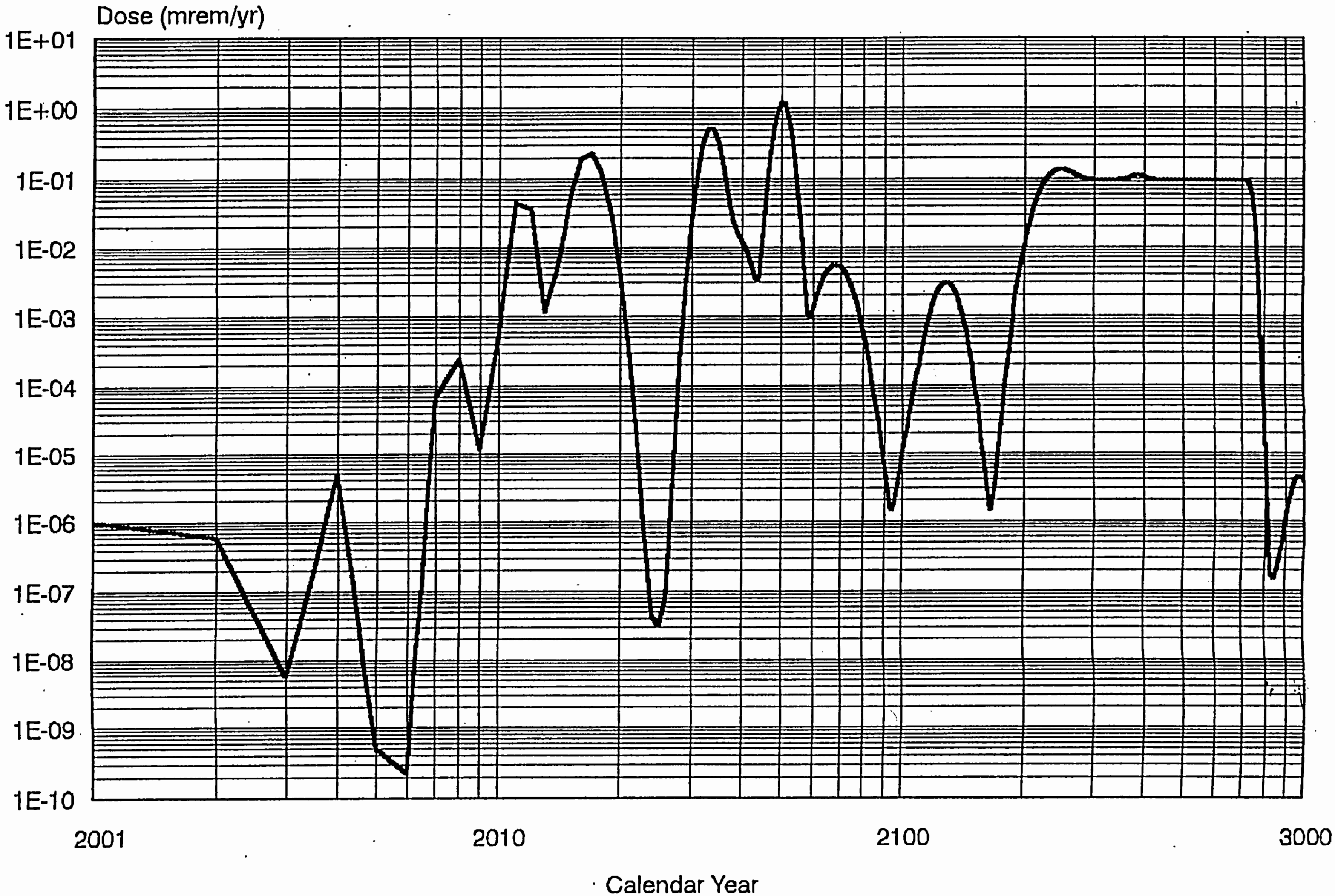


Figure D-9. **Alternative IV Expected Conditions (Institutional Control) Case, Groundwater Release Scenario, Cumulative Impacts for a Cattaraugus Creek Resident**

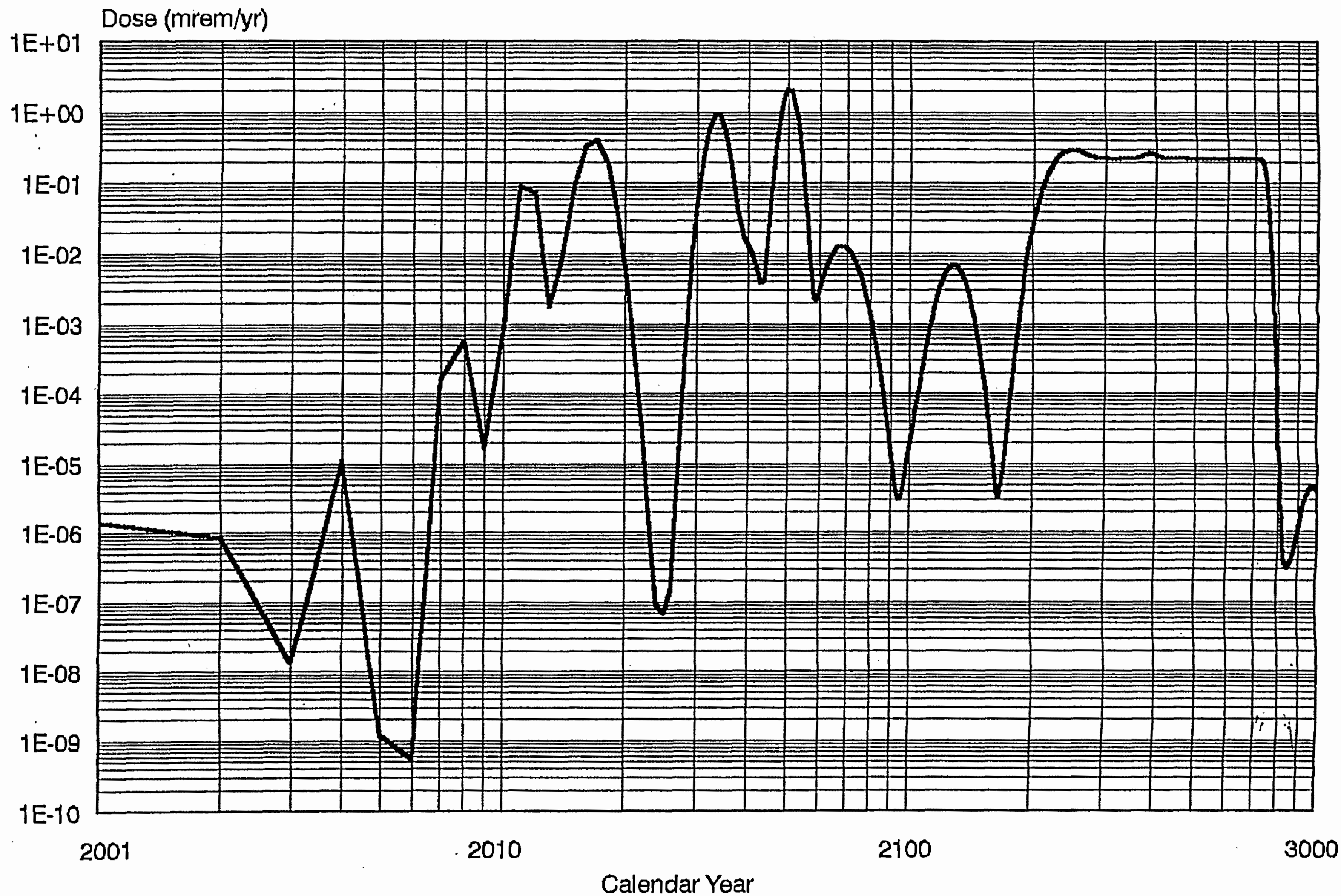


Figure D-10. **Alternative IV Expected Conditions (Institutional Control) Case, Groundwater Release Scenario, Cumulative Impacts for a Seneca Indian Resident**

individual for this case was a Buttermilk Creek resident who obtained fish, drinking water, and crop irrigation water from the creek. The surrounding population could be affected in the same manner. The potential impacts from this scenario are summarized in Table D-17. Potential releases from the process building and the HLW tanks dominate the impacts, producing potentially high doses.

Table D-16. Impacts to an Intruder from the Assumed Loss of Institutional Control Case for Alternative IV (No Action: Monitoring and Maintenance)[a]

	Dose (mrem)			
WMA/Facility	Agriculture/ Residential	Construction	Discovery	Drilling
1—Process Building	5.8×10^6 [2117]	NA	4,000 [2100]	NA
2—LLWTF and Lagoons 1-5	2.2×10^5 [2127]	0.8 [2100]	NA	0.17 [2100]
3—HLW/Vitrification Facility	1.1×10^9 [2117]	NA	8,000 [2100]	NA
5—Lag Storage Building/ Additions	1.6×10^6 [2117]	0.3 [2100]	1,000 [2100]	NA
6,10—Balance of Site	0.9 [2100]	1.5 [2100]	NA	NA
7—NDA	6.5×10^6 [2100]	4.1×10^5 [2100]	7,000 [2100]	2.1 [2100]
8—SDA	3.1×10^5 [2108]	260 [2100]	2.6×10^4 [2100]	0.56 [2100]
9—RTS Drum Cell	440 [2100]	NA	0.0001	NA
Cesium Prong On Site	8.8 [2100]	NA	NA	NA
North Plateau Plume	1,000 [2100]	NA	NA	NA

a. Doses are for the year of maximum impact for that facility, the year of occurrence is provided in brackets.
b. NA = Due to nature of the scenario and the WMA, the scenario is not applicable for this case.

Under Alternative IV (No Action: Monitoring and Maintenance), a local erosion control strategy would be implemented. Since the local erosion control strategy requires maintenance and periodic replacement, the loss of institutional control could result in active erosion. For this scenario, erosion was assumed to begin 100 years after the end of the implementation phase. Stream bank widening proceeds at a rate expected to be exceeded 10 percent of the time under current conditions [i.e., 0.15 m/yr (0.5 ft/yr)]. The erosion analysis described in Appendix L showed that the LLWTF, NDA, SDA, and RTS drum cell could be eroded within 1,000 years after the onset of active erosion (i.e. no maintenance). The erosional collapse model described in Appendix E was used to evaluate the impacts of waste inventories collapsing into the creeks. Because the delay period and rate of erosion are similar, the impact from erosional collapse scenarios under Alternative IV are the same as for the local erosion control case for Alternative III as presented in Table D-14 and Figure D-8. The potential impacts are severe, and could include illness or fatality.

Table D-17. Impacts to the Public from an Assumed Loss of Institutional Control for Alternative IV (No Action: Monitoring and Maintenance) (Groundwater Release Scenario)[a]

WMA/Facility	Buttermilk Creek Individual Dose (mrem)	Off-Site Population: Collective Dose (person-rem)	Off-Site Population: Latent Cancer Fatalities
1—Process Building	66.8 [2161]	5.3 [2161]	0.003
2—LLWTF and Lagoons 1-5	0.18 [2387]	0.01 [2387]	6.9×10^{-6}
3—HLW Tanks	4,700 [2172]	371 [2172]	0.19
5—Lag Storage Building/Additions	48.5 [2161]	3.8 [2161]	0.002
7—NDA	4.4×10^{-4} [2535]	3.5×10^{-5} [2535]	1.7×10^{-8}
8—SDA	1.0 [2248]	0.08 [2248]	0.00004
9—RTS Drum Cell	6.3 [2225]	0.50 [2225]	0.0002
North Plateau Plume	0.32 [2100]	0.27 [2000]	0.0001

a. Doses are for year of maximum impact for that facility, the year of occurrence is provided in brackets.

D.3.3.5 Alternative V: Discontinue Operations

No closure activities that have long-term effectiveness are proposed for this alternative. Neither waste storage nor disposal area would stabilized or closed with engineered barriers. Monitoring and maintenance would not be provided and intruders could occupy the site after operations were discontinued. Depending on the configuration, precipitation could percolate through aboveground facilities and transport contaminants to nearby creeks. Groundwater leaching of buried sediments and waste could transport contaminants to wells for residents on the Project Premises or the SDA or to surface water used by off-site residents.

The intruder scenarios evaluated to estimate the impacts included agriculture, home construction, discovery, and drilling. In the agricultural scenario, the resident was assumed to grow crops in contaminated soil that had released radionuclides into groundwater. Table D-18 summarizes the potential impact from these scenarios. At the process building, an intruder was assumed to enter the building and visit each of 70 rooms for a period of 5

Table D-18. Impacts to an Intruder from the Assumed Loss of Institutional Control for Alternative V (Discontinue Operations)[a]

	Dose (mrem)			
WMA/Facility	Agriculture/ Residential	Construction	Discovery	Drilling
1—Process Building	5.8×10^7 [2017]	NA[b]	4.0×10^4 [2000]	NA
2—LLWTF and Lagoons 1-5	5.0×10^5 [2017]	5.2×10^5 [2001]	NA	1.8 [2001]
3—HLW/Vitrification Facility	9.2×10^9 [2017]	NA	8.0×10^4 [2000]	NA
5—Lag Storage Building/Additions	1.6×10^7 [2017]	0.6 [2000]	1.0×10^4 [2000]	NA
6,10—Balance of Site	24.0 [2000]	9.4 [2000]	NA	NA
7—NDA	5.7×10^8 [2000]	4.1×10^6 [2000]	7.0×10^4 [2000]	21.0 [2000]
8—SDA	4.4×10^7 [2016]	2,600 [2000]	2.6×10^5 [2000]	27.0 [2000]
9—RTS Drum Cell	4,400 [2000]	NA	0.001 [2000]	NA
Cesium Prong On Site	88.0 [2000]	NA	NA	NA
North Plateau Plume	1.1×10^4 [2000]	NA	NA	NA

a. Doses are for year of maximum exposure, year of occurrence is provided in brackets.
b. NA = Due to nature of the scenario and the WMA, the scenario is not applicable for this case.

minutes each. At the LLWTF, individuals were assumed to construct a home on top of lagoon 1 sediments and debris, and drill a well through lagoon 1 buried sediments and debris. At the HLW tanks, an individual was assumed to gain access to a tank 8D-2 riser and view the tank interior for 5 minutes. At the lag storage additions, an individual was assumed to establish a garden and construct a home outside the immediate area of the buildings, while spending 5 hours exploring the inside of the storage tents. At the NDA and SDA, groundwater was assumed to flow horizontally through waste disposed of in the weathered Lavery till and contaminate near-surface soil that contained crops in a garden.

Individuals were also assumed to construct homes on the weathered Lavery till and to drill wells that intersect the waste disposal horizons. In the discovery scenario, individuals were assumed to excavate directly into the buried waste and receive 5 hours direct exposure. At the RTS drum cell, an individual was assumed to explore the building interior for 5 hours. The risk estimated for these scenarios is severe, possibly resulting in immediate fatalities. Potential impacts vary over a wide range, depending on the activity levels present in the WMA, and to a lesser extent on the differences in the exposure scenarios. The exposure scenarios are described in Section D.3.

The contaminated facilities either left undisturbed by human intrusion or that were not eroded would be exposed to precipitation and groundwater leaching processes that could dissolve radionuclides and ultimately affect off-site residents. The analysis considered the surrounding population and a Buttermilk Creek resident was selected as the maximally exposed individual. Table D-19 presents the potential impacts from the occurrence of these types of scenarios. The integrity of the process building was assumed to be lost so that precipitation could percolate through the rooms, dissolve radionuclides from the building, and contaminate groundwater in the sand and gravel layer which intersects the building. At the LLWTF, groundwater flows horizontally through sediments to Erdman Brook. The exterior shell of the lag storage additions and the RTS drum cell were assumed to deteriorate, precipitation was assumed to leach radionuclides from the waste and flow in groundwater to Erdman Brook and Franks Creek. At the NDA and SDA, horizontal groundwater flow through waste buried in the weathered Lavery till was assumed to contaminate crops grown in near-surface soil while vertical flow through the unweathered till was assumed to transport dissolved radionuclides to Buttermilk Creek. It was assumed that the contaminated groundwater in the sand and gravel layer on the north plateau was not treated and well water used for drinking and irrigation purposes was assumed to be contaminated. The residual contamination in sediment in the creek beds was predicted to have a small impact. The risk from the potential occurrence of these scenarios is severe, potentially causing illness or a fatality.

Erosion is expected to affect the LLWTF on the north plateau and the NDA, SDA, and RTS drum cell on the south plateau. The erosion rate and the spatial configuration of the effects are uncertain. To identify the limits of possible impacts, the maximum rate of creek bed advance discussed in Appendix L was used in the erosional collapse model (described in Appendix E) to estimate doses to a Buttermilk Creek resident. The doses for a Buttermilk Creek resident and the surrounding populations for the year of maximum impact

Table D-19. Impacts to the Public from the Assumed Loss of Institutional Control for Alternative V (Discontinue Operations) (Groundwater Release Scenario)[a]

WMA/Facility	Buttermilk Creek Individual Dose (mrem)	Off-Site Population: Collective Dose (person-rem)	Off-Site Population: Latent Cancer Fatalities
1—Process Building	670 [2061]	5.3×10^1 [2061]	0.026
2—LLWTF and Lagoons 1-5	11.3 [2050]	0.9 [2050]	0.0004
3—HLW/Vitrification Facility	4.5×10^4 [2072]	3,600 [2072]	1.8
5—Lag Storage Building/Additions	490 [2061]	39 [2061]	0.019
7—NDA	0.04 [2068]	0.0032 [2068]	1.6×10^{-6}
8—SDA	1.0 [2248]	0.079 [2248]	4.0×10^{-5}
9—RTS Drum Cell	6.3 [2125]	0.50 [2125]	0.0002
North Plateau Plume	3.4 [2000]	0.27 [2000]	0.0001

a. Doses are for year of maximum impact for that facility, the year of occurrence is provided in brackets.

Table D-20. Impacts to the Public from an Assumed Loss of Institutional Control for Alternative V (Discontinue Operations) (Erosional Collapse Scenario)[a]

WMA/Facility	Buttermilk Creek Individual Dose (mrem)	Off-Site Population	
		Collective Dose (person-rem)	Latent Cancer Fatalities
2—LLWTF and Lagoons 1-5	520 [2680]	41 [2680]	0.02
7—NDA	4.7×10^4 [2290]	3,700 [2290]	1.9
8—SDA	3.3×10^5 [2220]	26,000 [2220]	13.0
9—RTS Drum Cell	4,500 [2100]	360 [2100]	0.18

a. Doses are for year of maximum impact for that facility, the year of occurrence is provided in brackets.

are summarized in Table D-20. Figure D-11 shows the time distribution of the impact for all facilities. The early peaks are from collapse of lagoon 3, while the peaks at about year 250 are from collapse of the near-creek portions of the NDA and SDA. The large dose peaks at the time beyond 250 years are from release of americium-241 and the plutonium isotopes. The risk from the potential occurrence of this scenario is severe and could include illness or fatality.

D.4 HUMAN HEALTH RISK ASSESSMENT OF HAZARDOUS CHEMICALS

This section describes the methods used and the results from evaluating risks to human health from exposures to hazardous chemicals potentially present at, or potentially released from the construction and demolition debris landfill (WMA 4), the NDA (WMA 7), and the SDA (WMA 8) because these are the only areas with known or suspected hazardous chemical contamination.

The purpose of the risk assessment is to evaluate potential noncancer and cancer health effects from long-term, low-level exposures to site-related hazardous contaminants. The results are used in conjunction with the radiological risk assessment results to evaluate the impact of the alternatives. The methods that were used to characterize risk are consistent with the Environmental Protection Agency (EPA) methods as contained in the following guidance documents:

- Risk Assessment Guidance for Superfund: Human Health Evaluation Manual, Part A (EPA 1989a)
- Exposure Factors Handbook (EPA 1989b)

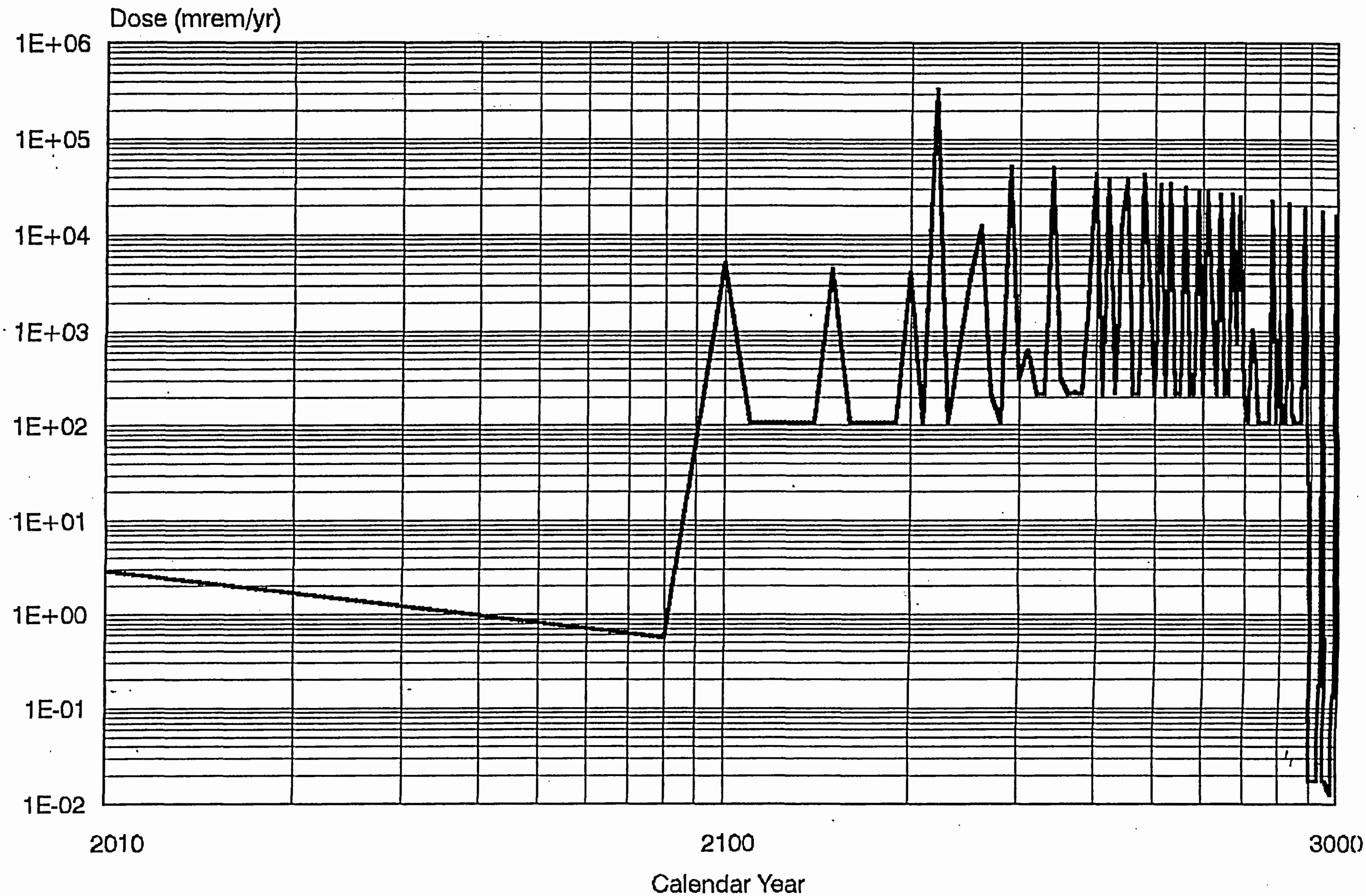


Figure D-11. **Alternative V Assumed Loss of Institutional Control Case, Erosional Collapse Scenario, Cumulative Impacts for a Buttermilk Creek Resident**

- Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors (EPA 1991a)

- Dermal Exposure Assessment: Principles and Applications (EPA 1992a)

- Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure, Preliminary Review Draft (EPA 1993a).

Other pertinent guidance documents are referenced throughout this section. The human health risk assessment of hazardous chemicals is organized in accordance with RAGS (EPA 1989a), which specifies four steps:

- Data Compilation and Evaluation (Section D.4.1)
- Exposure Assessment (Section D.4.2)
- Toxicity Assessment (Section D.4.3)
- Risk Characterization (Section D.4.4).

The risk assessment qualitatively discusses uncertainty with the risk estimates in Section D.4.5 and a summary of the results is given in Section D.4.6. Details on the nature of the waste disposed of in WMAs 4, 7, and 8 and a description of the unit are provided in Appendix C.

D.4.1 Data Evaluation

The first step in the hazardous chemical risk assessment process is to evaluate data on contaminants in the WMAs. This section gives an overview of the sample collection program and data quality assessment as it relates to the human health risk assessment, the manner in which the data are aggregated to calculate risk, and the selection of contaminants of potential concern (COPCs).

D.4.1.1 Data Collection and Management

Monitoring data are available for soils and groundwater in each of the three WMAs. Sediment samples were also collected for each of the 3 WMAs (samples collected immediately downstream of a WMA are associated with that WMA). Background samples were collected for soils in each of the 3 WMAs. For groundwater, background data are available from the sand and gravel layer (background for WMA 4) and the weathered and unweathered lavery till (background for WMAs 7 and 8). Background data are also available for sediment in Franks Creek.

However, monitoring data for chemical constituents are not available for surface water in creeks, fish tissue, or produce. Therefore, exposure point concentrations (the concentrations of chemicals available to the receptor at the point of contact) for these media were calculated using the models described in Section D.4.2.3. At WMA 4, samples were collected from surface seeps; at WMA 7, data were collected from groundwater obtained from the interceptor trench; and at WMA 8, leachate samples were collected from the disposal trenches. Seep and trench data were used to model the surface water and fish concentrations in Buttermilk Creek.

The soil, sediment, and groundwater data used in the analysis were collected, analyzed, and evaluated in accordance with the WVDP Quality Assurance Plan (WVNS 1991) which was prepared in accordance with DOE quality assurance guidelines. Under this plan, quality control procedures were implemented in the field (e.g., through the use of field duplicates, field blanks, and trip blanks) and in the laboratory (e.g., through the use of standards, laboratory spikes, and blanks). Data management and validation were performed through the Laboratory Information Management System (LIMS) which tracks the samples through collection, chain-of-custody transfer, shipping, analytical results, and final validation. However, leachate data collected from WMAs 7 and 8 were not subjected to verification and validation.

D.4.1.2 Data Aggregation

Data aggregation refers to the way sample data are combined to calculate summary statistics and to estimate the risk. For this analysis, data were aggregated as a function of exposure units, a geographic area over which a receptor is likely to average his or her exposure (both spatially and temporally) and is defined based on observed or assumed patterns of behavior and nature and extent of contamination. In general, it would not be reasonable to assume that a receptor could be simultaneously exposed to contaminants in areas that are remote or distant from one another, or that are isolated by a physical barrier.

For soils, the exposure units are the WMAs. Therefore, soil data (for both site and background) were initially aggregated into 3 separate data sets (one for each of the WMAs). Within each data set, data were further subdivided into 2 groups: surface soils 0 to 0.6 m (0 to 2 ft) below the surface and surface and subsurface soils 0 to 4.6 m (0 to 15 ft) below the surface. Soil data were aggregated by depth because some receptors were assumed to be exposed only to surface soils while other receptors could be exposed to surface and subsurface soil. This is discussed further in Section D.4.2.3.

For groundwater, site data were aggregated by WMA and geologic formation (e.g., sand and gravel layer, weathered Lavery till, and unweathered Lavery till). Monitoring wells within and immediately downgradient of a WMA were considered part of the waste management area exposure unit for the purpose of data aggregation. Background data were aggregated according to geologic formation.

Sediment data were collected in the WMAs. Sediment samples collected downstream of each WMA were used as data for that exposure unit. Background sediment data were aggregated into a single data set. Table D-21 lists the samples for each exposure unit by medium (i.e., soil, groundwater or sediment). The human health risk assessment assumed that an exposed individual visited a specific exposure unit during a given exposure event, and that the individual spent all of their time in that exposure unit.

Table D-21. Exposure Units and Associated Samples for the Project Premises and SDA

WMA 4	WMA 7		WMA 8		Background	
Groundwater						
	WT	UT	WT	UT		
802	906	904	1101A	1101B	WMA 4:	NB-1S (SG)
803	907	910	1102A	1102B		
804	908		1103A	1103B		
805	909		1104A	1104B		
86-12			1106A	1105A	WMAs 7 and 8:	1008C (WT)
			1107A	1105B		1008B (UT)
			1108A	1106B		
			1109A	1109B		
			1110A	1111A		
Soil						
SS-2	SS-7		SB1-01	SB3-02	WMA 4:	BH-30
SS-3	SS-15		SB1-02	SB3-03		BH-38
SS-4	SS-20		SB1-03	SB3-04		
BH-25	SS-21		SB1-04	SB4-01	WMA 7:	SS-7
BH-26	BH-41		SB1-05	SB4-02		BH-39
BH-27	BH-42		SB1-06	SB4-03		
BH-28			SB1-07	SB4-04	WMA 8:	SBB-01
			SB1-08			
Sediment						
ST-29	ST-21		ST-11		WMAs 4,7, and 8:	ST-6
ST-30	ST-22		ST-12			ST-18
ST-38	ST-23		ST-13			ST-26
			ST-14			
			ST-15			
			ST-16			

a. SG = sand and gravel unit
WT = weathered lavery till
UT = unweathered lavery till.

D.4.1.3 Chemicals of Potential Concern

According to RAGS (EPA 1989a), COPCs are "chemicals that are potentially site-related and whose data are of sufficient quality for use in the quantitative risk assessment." For WMAs 4, 7, and 8, the COPCs included all compounds detected above the detection limit.

D.4.2 Exposure Assessment

The objective of the exposure assessment is to identify and quantify potential human exposure to the hazardous chemicals potentially at the construction and demolition debris landfill (WMA 4), the NDA (WMA 7), and the SDA (WMA 8). The exposure assessment in conjunction with the toxicity assessment supports the characterization of potential risks to human health. The exposure assessment consists of the following components:

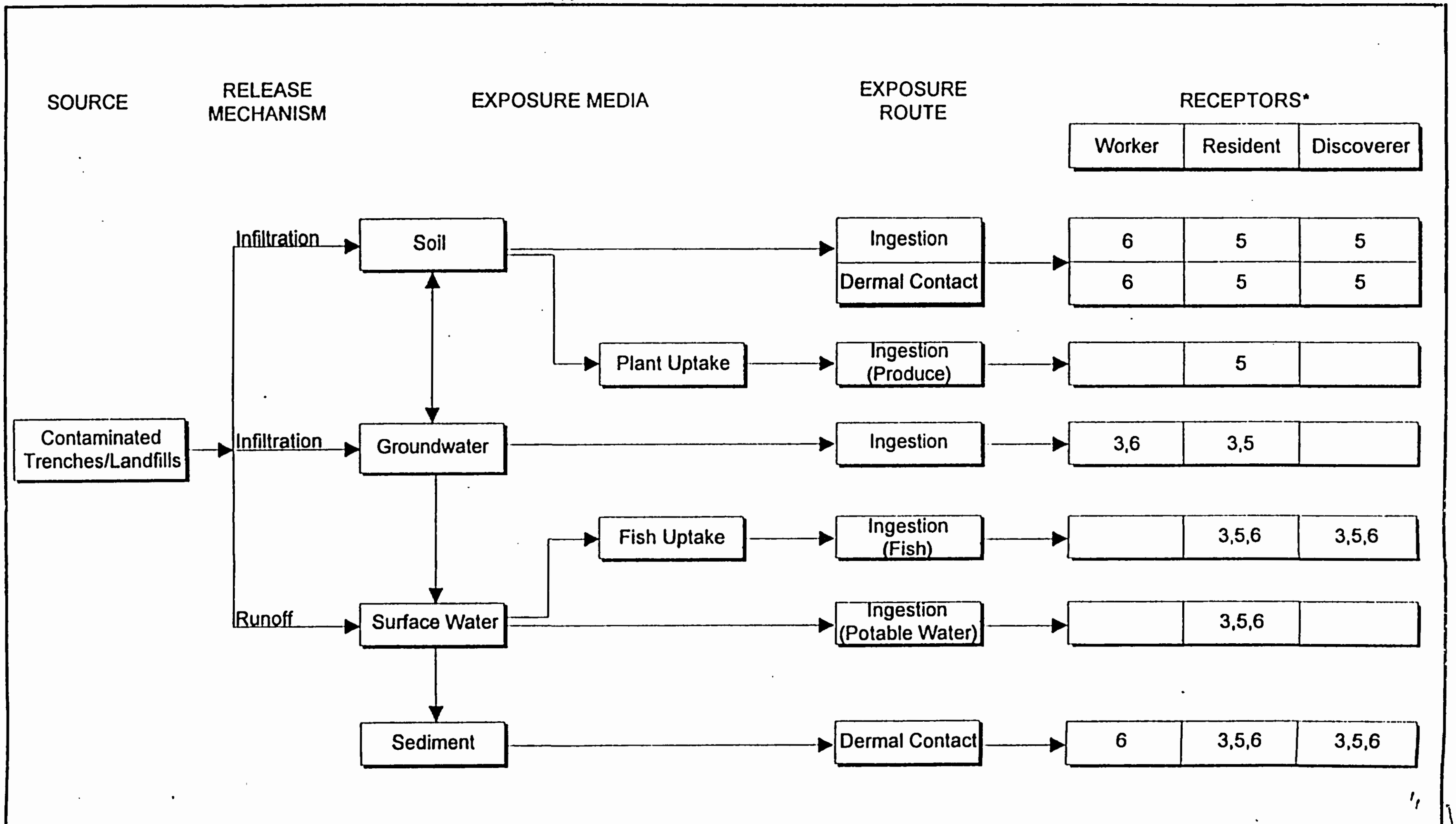
- Characterization of exposure setting and conceptual site model
- Identification of exposure pathways
- Derivation of exposure point concentrations
- Discussion of exposure assumptions used in deriving estimates of intake or dose.

In accordance with EPA guidance (EPA 1993a), the risk assessment was conducted using a reasonable maximum exposure (RME) estimate (i.e., a high-end conservative estimate). EPA defines the RME estimate as "the maximum exposure that is reasonably expected to occur at a site" (EPA 1989a). RME estimates have been developed for environmental concentrations, as well as for input variables used in the exposure assessment equations used to estimate chronic intake or dose.

D.4.2.1 Characterization of Exposure Setting and Conceptual Site Model

The conceptual site model identifies the sources and types of environmental releases and links these with receptors and activity patterns to determine the important pathways of human exposure (EPA 1989a). Figure D-12 is a graphical representation of the conceptual site model. It summarizes the exposure pathways that are evaluated in the human health risk assessment of hazardous chemicals under Alternatives III (In-Place Stabilization), IV (No Action: Monitoring and Maintenance), and V (Discontinue Operations) which all have long-term impacts from waste remaining on site.

Infiltration and runoff are the primary release mechanisms for buried contaminants in the WMAs. Contaminated soil, surface water, groundwater, sediment, fish, and produce are the media by which the receptors could be exposed. Surface water runoff, infiltration through the soil to groundwater, and groundwater flow by seeps to surface water bodies are the important transport processes in the site conceptual model.



* The number in each box corresponds to the alternative under which the indicated receptor has been evaluated. If the box is blank, the indicated receptor has not been evaluated for that pathway.

Figure D-12. Conceptual Site Model for Hazardous Chemical Releases

Groundwater Pathways

Groundwater at the site could be used as drinking water, although it presently is not. In addition, receptors could be exposed to contaminants in groundwater indirectly through exposure to surface water. Groundwater flow at the construction and demolition debris landfill (WMA 4), the NDA (WMA 7), and SDA (WMA 8) is generally towards Franks Creek (see Appendix J). At the construction and demolition debris landfill (WMA 4), wells are more likely to be installed in the sand and gravel layer than the Lavery till because the production rate of the Lavery till is very low as discussed in Section D.3.2.3. The trenches in the SDA and NDA penetrate the weathered Lavery till and the top of the unweathered Lavery till. Contaminants in the trenches could mix with the groundwater. The groundwater level fluctuates seasonally. As the water level rises, contaminated groundwater could flow through the weathered till, eventually entering the creek.

Surface Water Pathways

Field investigations indicated possible contaminant migration from the trench areas at the NDA (WMA 7) and the SDA (WMA 8) and from the construction and demolition debris landfill (WMA 4) to surface water. This migration could occur through surface runoff containing dissolved or sorbed contaminants from the surface of the disposal areas. Groundwater seepage into surface waters or sediments is also a potential pathway.

No monitoring data for hazardous constituents in surface water are available. Therefore, contaminant concentrations at points where receptors could contact the surface water have been modeled. At WMAs 7 and 8, these concentrations were modeled from leachate concentrations in the trenches, assuming that contaminants enter surface water by groundwater seepage. At WMA 4, surface water concentrations were modeled using surface seep data and by assuming that contaminants also enter the surface water as runoff.

Soil Pathways

Surface runoff and seepage of contaminants from the buried waste are two mechanisms for soil contamination in the WMAs. Surface runoff picks up dissolved or sorbed contaminants that are released from the surface of the disposal areas. Monitoring data were used for the risk assessment for soils at WMAs 4, 7, and 8.

Sediment Pathways

Sediment samples were collected from the bottom of Franks Creek. Sediment contamination is either from surface runoff of dissolved or sorbed contaminants or from groundwater seeps into surface water. Monitoring data were used in the risk assessment of exposures to sediment.

Fish and Produce Pathways

No monitoring data were available for hazardous chemicals in fish tissue or produce. For the fish ingestion scenarios, fish concentrations were computed using the modeled creek water concentrations. The concentration in the creek and either a literature value for the fish biotransfer factor for inorganic contaminants or a calculation using published linear regression equations for organic contaminants, were used to compute fish contaminant levels. A similar approach was used for the radionuclides.

Contaminant levels for the produce ingestion pathway were computed in the same way as the fish. The soil concentration was used to derive contaminant levels in produce based on a generalized soil uptake (biotransfer) factor. Literature values for soil biotransfer factors of leafy vegetables and tubers were used to estimate contaminant levels for inorganic analytes. Organic biotransfer factors were calculated from the octanol-water partition coefficient (K_{ow}) using published linear regression equations.

D.4.2.2 Identification of Exposure Pathways for Human Receptors

The exposure pathways have to be identified in the conceptual site model. However, some pathways were not evaluated for certain alternatives, WMAs, or receptors. Table D-22 presents the breakdown of exposure pathways according to alternative, WMA, and receptor.

Potential Receptors

Residents, workers in an operational setting, and discoverers in a recreational setting are the receptor groups at potential risk of exposure to hazardous chemicals. The resident receptors consist of a child (0 to 6 years in age) and an adult that may live either on the Project Premises or SDA, or on Buttermilk Creek. The residential receptors are distinct (the same resident cannot live both places simultaneously) and experience different exposures. The worker receptor is assumed to be an adult and would include, for example, grounds keepers and construction workers contacting contaminated media during maintenance activities. The worker is associated with on-site exposures at the Project Premises of the SDA. The discoverer receptor also includes an adult and a 0-to-6 year old child that may be exposed to contaminated media both from the Project Premises and the SDA and from the Buttermilk Creek (i.e., the discoverer receptor may be the same person).

The receptors vary by alternative and the medium to which they are assumed to be exposed. For example, under Alternative V (Discontinue Operations), only residents and discoverers are evaluated because the workers are assumed to have left their jobs. Under Alternative IV (No Action: Monitoring and Maintenance), no resident on the Project Premises or the SDA or discoverer exposures were evaluated because security, maintenance, and upkeep activities at the facility would continue.

Table D-22. Hazardous Chemical Exposure Pathways for the Project Premises, the SDA, and Buttermilk Creek

Alternative	WMA	Receptors (Intruders)	Surface Water Ingestion (Buttermilk Creek) Adult	Surface Water Ingestion (Buttermilk Creek) Child	Groundwater Ingestion (Project Premises and SDA) Adult	Groundwater Ingestion (Project Premises and SDA) Child	Sediment Dermal Contact (Buttermilk Creek) Adult	Sediment Dermal Contact (Buttermilk Creek) Child	Fish Ingestion (Buttermilk Creek) Adult	Fish Ingestion (Buttermilk Creek) Child	Soil (Project Premises and SDA) Ingestion Adult	Soil (Project Premises and SDA) Ingestion Child	Soil (Project Premises and SDA) Dermal Adult	Soil (Project Premises and SDA) Dermal Child	Produce Ingestion (Project Premises and SDA) Adult	Produce Ingestion (Project Premises and SDA) Child
III (In-Place Stabilization)	CDDL (WMA 4)	Residential	•	•	•	•	•	•	•	•						
		Operational			•											
		Discoverer					•	•	•	•						
	NDA (WMA 7)	Residential	•	•	•	•	•	•	•	•						
		Operational			•											
		Discoverer					•	•	•	•						
	SDA (WMA 8)	Residential	•	•	•	•	•	•	•	•						
		Operational			•											
		Discoverer					•	•	•	•						
IV (No Action: Monitoring and Maintenance)	CDDL (WMA 4)	Residential	•	•			•	•	•	•						
		Operational			•		•				•		•			
		Discoverer					•	•	•	•						
	NDA (WMA 7)	Residential	•	•			•	•	•	•						
		Operational			•		•				•		•			
		Discoverer					•	•	•	•						
	SDA (WMA 8)	Residential	•	•			•	•	•	•						
		Operational			•		•				•		•			
		Discoverer					•	•	•	•						
V (Discontinue Operations)	CDDL (WMA 4)	Residential	•	•	•	•	•	•	•	•	•	•	•	•	•	•
		Discoverer					•	•	•	•	•	•	•	•		
	NDA (WMA 7)	Residential	•	•	•	•	•	•	•	•	•	•	•	•	•	•
		Discoverer					•	•	•	•	•	•	•	•		
	SDA (WMA 8)	Residential	•	•	•	•	•	•	•	•	•	•	•	•	•	•
		Discoverer					•	•	•	•	•	•	•	•		

a. CDDL = construction and demolition debris landfill; NDA = Nuclear Regulatory Commission-licensded disposal area; SDA = New York State-licensed disposal area.

Land Use Assumptions

Exposures on Buttermilk Creek. Under Alternatives III (In-Place Stabilization), IV (No Action: Monitoring and Maintenance), and V (Discontinue Operations), off-site surface water contaminated either by runoff or from discharge of contaminated groundwater through seeps to the surface water, was evaluated as a sole source of potable water for residential receptors. Erdman Brook and Franks Creek, the creeks adjacent to the north and south plateaus into which contaminants could be deposited, are small and neither currently used nor would likely be used for drinking water. The risk assessment therefore evaluates a residential receptor living near Buttermilk Creek (a larger creek into which Franks Creek drains) using untreated creek water for drinking. Workers were excluded from the surface water exposures because they are expected to remain on the Project Premises and would not use Buttermilk Creek as their source of potable drinking water. Discoverers were also excluded because they are only visitors at the site and were assumed to obtain the majority of their drinking water from their residence, not from Buttermilk Creek.

Other exposures off the Project Premises evaluated include dermal contact with contaminated sediments and ingestion of contaminated fish tissue by residents and discoverers. Because of the lack of monitoring data for fish, and the assumptions that residents would live near Buttermilk Creek in the future, the receptors potentially exposed to contaminated fish were located on Buttermilk Creek. Direct monitoring data are available for sediment in Franks Creek; therefore, resident and discoverer exposures to sediments were evaluated on Franks Creek, rather than on Buttermilk Creek. Workers would not be exposed to fish and would only be exposed to sediments if their job required them to work in and around the creek (e.g., stabilizing the creek banks). For sediment exposures, only the dermal contact route was evaluated because residents and discoverers were assumed to be exposed while fishing and wading. Sediment ingestion while fishing and wading was considered negligible.

Exposures on the Project Premises. For purposes of analysis under Alternative III (In-Place Stabilization), the site was assumed to be available for unrestricted use after the institutional control period. Therefore, the property could be developed for residential or recreational purposes. Under a residential scenario, groundwater could be used as a source of potable water. Workers were assumed to be exposed to groundwater under Alternative III because portions of the facility may require workers to be present for maintenance or monitoring purposes. Since soils under Alternative III would be stabilized in place, no soil exposures for the Project Premises were evaluated for any of the receptors.

Under Alternative IV (No Action: Monitoring and Maintenance), the site would be monitored and maintained; therefore, only workers could be exposed to contaminants through ingestion of groundwater and through inadvertent ingestion and dermal contact with soils. It was assumed that no residents or discoverers would be allowed on the site.

Under Alternative V (Discontinue Operations), although unlikely, it is possible that the Project Premises could be developed for residential or recreational purposes. Resident receptors could be exposed to contaminated groundwater by using it as a source of potable water. Residents and discoverers could be exposed to soil contamination by inadvertent ingestion and dermal contact. Residents could also be exposed to hazardous chemicals from produce grown in contaminated soils. It was assumed that discoverer receptors would not visit the WMAs long enough or frequently enough to grow their own produce.

Exposure Pathways

The exposure pathways and receptors considered under Alternative III (In-Place Stabilization) are as follows:

- Residents and workers on the Project Premises or the SDA ingesting contaminated groundwater.
- Residents living near Buttermilk Creek on the balance of the site ingesting contaminated creek water that is used as their potable water supply.
- Residents and discoverers on the balance of the site ingesting contaminated fish caught from Buttermilk Creek.
- Residents and discoverers on the balance of the site exposed to contaminated sediments by dermal contact while fishing or wading in Buttermilk Creek.

The exposure pathways and receptors considered Alternative IV (No Action: Monitoring and Maintenance) are as follows:

- Workers on the Project Premises or the SDA ingesting contaminated groundwater.
- Residents living near Buttermilk Creek ingesting contaminated creek water which is used as their potable water supply.
- Residents and discoverers ingesting contaminated fish caught from Buttermilk Creek.
- Residents and discoverers on the balance of the site exposed to contaminated sediments through dermal contact while fishing or wading in Buttermilk Creek or workers exposed to contaminated sediments while working in and around the creek (e.g., reinforcing creek banks).
- Workers on the Project Premises and the SDA exposed to contaminants in soils through inadvertent ingestion and dermal contact.

The exposure pathways and receptors considered under Alternative V (Discontinue Operations) are as follows:

- Residents and workers on the Project Premises or the SDA ingesting contaminated groundwater.

- Residents living near Buttermilk Creek ingesting contaminated creek water that is used as their potable water supply.

- Residents and discoverers on the balance of the site ingesting contaminated fish caught from Buttermilk Creek.

- Residents and discoverers on the balance of the site exposed to contaminated sediments through dermal contact while fishing or wading in Buttermilk Creek.

- Residents and discoverers on the Project Premises or the SDA exposed to contaminants in soils through inadvertent ingestion and dermal contact.

- Residents on the Project Premises or the SDA ingesting contaminated produce grown in home gardens.

D.4.2.3 Exposure Point Concentrations

Exposure point concentrations are the concentrations of chemicals in a given medium to human receptors at the point of contact. Exposure point concentrations for the risk estimates were developed from the sample data, aggregated as discussed in Section D.4.1.2. These concentrations were calculated in accordance with EPA guidance (EPA 1992b and 1993a).

For each chemical, two concentrations were calculated: a reasonable maximum exposure (RME) exposure point concentration and a central tendency exposure (CTE) exposure point concentration. The RME exposure point concentration is the 95 percent upper confidence limit (UCL) of the arithmetic mean. The CTE exposure point concentration is the arithmetic mean.

The 95 percent UCL (RME) estimates are statistically conservative and protective of health. EPA guidance also notes that environmental concentrations are "best expressed as an estimate of the arithmetic mean regardless of the distribution of the data" [57 FR 22888 (FR 1992)]. The 95 percent UCL was therefore calculated assuming normal distribution of the data using the formula below:

$$UCL = \bar{x} + t\left(\frac{s}{\sqrt{n}}\right) \qquad \text{(D-1)}$$

where:

$\bar{x}$ = Arithmetic mean or average of the untransformed data
s = Standard deviation
t = Student-t statistic (one-tailed test)
n = Number of samples.

If the sample set is small and variable, or if values for certain nondetects have been included in the summary statistics (e.g, as one-half the limit of detection), the arithmetic mean or the UCL of the arithmetic mean may exceed the maximum value observed at the site. Under these circumstances, EPA recommends substituting the maximum observed concentration for use in the risk assessment.

"Not detected" results were treated as one-half the limit of detection and included in the calculations of the mean and UCL values. Blind field duplicates were collected to assess variability in the sampling process. They were not included in the calculation of the exposure point concentrations.

Special consideration was given to calculating the exposure point concentrations for soils. The analysis evaluates samples from two depths: surface soils from 0 to 0.6 m (0 to 2 ft) below the surface and subsurface soils from 0.6 to 4.5 m (2 to 15 ft) below the surface. Surface soils were used to calculate exposure point concentrations for the discoverer receptor. Surface and subsurface soils were used to calculate exposures for the residents and worker receptors. During construction activities (e.g., excavation of building foundations and exhuming buried waste), workers could be exposed to subsurface soils 4.5 m (15 ft) below the surface that could be brought to the surface, with the potential for exposure to what are currently subsurface soils.

Modeled Exposure Point Concentrations for Surface Water

Because environmental monitoring data for hazardous chemicals are not available for the media of concern (surface water, fish and plant tissues), modeling was done to estimate the risk from exposure to contaminants. Modeling allows a quantitative estimate of the endpoint concentrations of contaminants based on their initial concentrations at the contaminated areas.

A transport model, developed to estimate the concentration of contaminants for the surface water pathway at a given exposure point in Buttermilk Creek, was used to evaluate the migration of trench contaminants through the subsurface by groundwater and seep contaminants aboveground as runoff. The model is a simple, conservative "box" model that assumes no dispersion or degradation of chemicals over time. Data used in the model include site-specific values for:

- Concentrations of trench contents
- Groundwater flow velocities
- Surface water flow velocities for Buttermilk Creek
- Trench dimensions
- Height of the groundwater column intersecting the trenches.

The volumetric flow rate (m^3/yr) of surface water in Buttermilk Creek was measured downstream of the tributaries closest to the WMAs; therefore the flow velocity is inclusive of the tributaries.

The modeling focused on two transport scenarios that result in distinctly different contaminant levels at the exposure point (Buttermilk Creek): long-term release and catastrophic release. The major distinction between the two scenarios is the time over which the release occurs. Long-term release assumes that trench contaminants "seep" slowly out of the trench.

Long-Term Release. Contaminated water in the weathered Lavery till could carry contaminants downgradient toward the creek. The rate of release of the contaminant from the trench was estimated as the product of the concentration of the contaminant in the trench water and the volumetric flow rate through the portion of the trench intersecting the weathered till. The trench was assumed to extend 1.8 m (6 ft) into the weathered till and the groundwater velocity is the maximum horizontal velocity predicted by the site three dimensional flow model for the given area.

The concentration in surface water in Buttermilk Creek depends upon the mass rate of contaminant migration in the groundwater (and into Buttermilk Creek) over a period of time, and the surface water volumetric flow rate over the same time period.

The long-term release model is an estimate of the concentration of contaminants in surface water at the exposure point at Buttermilk Creek, and is based on the following equation:

$$C_{SW} = \frac{C \times VF_{GW}}{VF_{SW}} \qquad \text{(D-2)}$$

where:

C	=	Concentration of groundwater influenced by trench (μg/L; area and trench-specific) or surface seep
VF_{GW}	=	Groundwater volumetric flow rate (m^3/yr)
VF_{SW}	=	Surface water volumetric flow rate (m^3/yr).

The volumetric flow rate for surface water is a measured value. For groundwater, the volumetric flow rate is estimated using the following equation:

$$VF_{GW} = A \times F_{GW} \qquad \text{(D-3)}$$

where:

A	=	Cross-sectional area influenced by groundwater (m^2)
F_{GW}	=	Flow velocity for groundwater (m/yr; area-specific)

and:

$$A = L_t \times H_{GW} \tag{D-4}$$

where:

L_t = Length of trench (m; area and trench-specific)
H_{GW} = Height of groundwater column (1.83 m).

The parameters used in the above equations differ by WMA and by alternative (e.g., groundwater flow would vary after placement of a cap). At the construction and demolition debris landfill (WMA 4), the initial concentration (C) was taken from the surface seep data. At the NDA (WMA 7), groundwater data from locations near the burial holes were used for the initial concentrations. At the SDA (WMA 8), leachate data from disposal trenches were used for the initial concentrations.

Volumetric flow rates were predicted from the three-dimensional groundwater flow model described in Appendix J. For the SDA, the volumetric flow rates are trench-specific and range from 59 to 144 m^3/yr. The volumetric groundwater flow rates for the construction and demolition debris landfill and the NDA are based on the overall dimensions of the area. These flow rates are:

Construction and demolition debris landfill (WMA 4)	
Alternative III (In-Place Stabilization):	175 m^3/yr
Alternative IV (No Action: Monitoring and Maintenance) and V (Discontinue Operations):	271 m^3/yr
NRC-licensed disposal area (WMA 7)	
Alternative III (In-Place Stabilization):	26 m^3/yr
Alternative IV (No Action: Monitoring and Maintenance) and V (Discontinue Operations):	50.2 m^3/yr

Seepage from the three WMAs was assumed to simultaneously converge into Buttermilk Creek. Furthermore, contaminant movement from multiple locations near the burial holes at WMA 7 and WMA 8 were treated additively, a conservative assumption because seepage from trenches closest to Buttermilk Creek would likely arrive at the creek before trenches located further away from the creek. Concentrations entering the creek would increase with time as the contribution of each trench were added. This scenario assumes that groundwater flow has occurred over a sufficient time for the contaminants from the trenches (even the more distant trenches) to simultaneously reach Buttermilk Creek.

Catastrophic Release. The catastrophic release scenario evaluated under Alternative V (Discontinue Operations), assumes the trench contents are dumped into Franks Creek and flow into Buttermilk Creek. Erosion of the creek bank with time could produce such a release from undercutting and mass wasting as described in Appendix L. The catastrophic release scenario was applied to the SDA because it is the only facility with potentially a large volume of hazardous materials that could be "instantaneously" released under this scenario.

The south plateau was assumed to be steadily eroded into so that the trench contents would be released in series one after another. The trenches at the SDA were considered independently. Some of the SDA trenches are equidistant from the creek, and were assumed to release their contents into the creek simultaneously, and their contributions were summed. Using this approach, seven different catastrophic events were evaluated, one for each of the following trench groupings: trenches 1, 2, and 8, 3 and 9, 4 and 10, 5 and 11, trench 12, trench 13, and trench 14.

The catastrophic release model is based on the following equation:

$$C_{SW} = \frac{C \times V_t}{VF_{SW} \times CF_v \times t \times CF_t} \qquad \text{(D-5)}$$

where:

C	=	Concentration of trench contaminant (μg/L; chemical, trench-specific value)
V_t	=	Volume of trench (m^3; trench-specific value)
VF_{SW}	=	Surface water volumetric flow rate = 4.15×10^7 m^3/yr
CF_v	=	Conversion factor for volume = 1000 L/m^3
t	=	Duration of release event = 1 day
CF_t	=	Conversion factor for time = yr/365 days.

Because the exposure duration for the catastrophic scenario was assumed to be one day, only noncancer effects were evaluated.

Modeled Exposure Point Concentrations for Produce

Chemical concentration data for produce were calculated using an equilibrium partitioning model (see methods in Belcher and Travis 1989, Travis and Arms 1988, NCRP 1989). In this model, biotransfer factors were used to derive concentrations of substances in foods from measured concentrations in soil. The equation for uptake into produce is shown below:

$$C_{PRO} = C_{SO} \times BTF_{PRO} \qquad \text{(D-6)}$$

where:

CF_{PRO}	=	Chemical concentration in produce (mg/kg)
C_{SO}	=	Chemical concentration in soil (mg/kg)

BTF_{PRO}	=	Biotransfer factor from soil to plant for vegetation [mg pollutant/kg plant per (mg pollutant/kg soil)]

The biotransfer factor is a multiplier representing the uptake of contaminants into produce. For inorganic analytes, published biotransfer factors in NCRP (1989) were used. Where chemical-specific values were not available, the values presented in Baes et al. (1984) were used.

Biotransfer factors for organic substances in produce were estimated from the K_{ow} using the following equation (Travis and Arms 1988):

$$BTFo_{Vegetation} = 10^{(1.588-(0.578 \log K_{ow}))} \times 0.25 \qquad \text{(D-7)}$$

Where the 0.25 factor is a conversion factor for dry weight pasture to fresh produce (NCRP 1991).

Modeled Exposure Point Concentrations for Fish

Chemical concentration data for fish were calculated in a manner similar to the exposure point concentrations for produce. Biotransfer factors were used to derive concentrations of substances in fish from measured concentrations in surface water. The equation for uptake into fish is:

$$C_{FI} = C_{SW} \times BTF_{FI} \qquad \text{(D-8)}$$

where:

C_{FI}	=	Chemical concentration in fish (mg/kg)
C_{SW}	=	Chemical concentration in surface water (μ/L)
BTF_{FI}	=	Biotransfer factor from surface water to fish (L/kg)

For inorganic analytes, published biotransfer factors in EPA (1989c) were used. Where chemical-specific values were not available from this source, the contaminant was not evaluated. Elements considered in the hazardous chemical fish pathway analysis included arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver and zinc. Elements not considered in the hazardous chemical fish pathway analysis included barium, boron, calcium, cobalt, iron, magnesium, manganese, molybdenum, sodium, strontium, tin, titanium, and vanadium.

Biotransfer factors for organic substances in fish were estimated from the K_{ow} using the following equation (Lyman et al. 1982):

$$BTF_{FI} = 10^{(1.588-(0.578 \log K_{ow}))} \quad \text{(D-9)}$$

D.4.2.4 Intake Equations and Assumptions

This section presents the intake equations and assumptions that were used to quantitatively estimate intakes for various pathways. Two sets of exposure assumptions were developed, one representing average (CTE) estimates and the other representing high-end RMEs. The exposure assumptions are combined with the exposure point concentrations to calculate intakes expressed in milligrams of chemical per kilogram of body weight per day (mg/kg-day). The exposure assumptions and corresponding guidance or rationale used in this assessment are presented in Tables D-23 through D-27 which support the discussions below.

The oral and inhalation intakes calculated are expressed as the administered dose of a chemical (i.e., the amount of chemical at an exchange boundary, such as the skin, that is available for absorption). These intakes are not equivalent to the absorbed dose (the amount of chemical actually absorbed into the blood stream). Dermal doses are estimates of absorbed dose, however, and this discrepancy is a source of uncertainty when comparing or combining dermal doses with intakes from other exposure routes. Chemicals were not assumed to transform or degrade over the period of exposure (i.e., the concentration in the medium of concern remains the same).

Ingestion of Groundwater. Under the residential scenario, adults and children were ed to be exposed to contaminants in unfiltered groundwater. The exposure assumptions for this pathway are presented in Table D-23. Oral intake estimates for groundwater ingestion were calculated as follows:

$$Intake\ (mg/kg\text{-}day) = \frac{C_{GW} \times IR \times EF \times ED \times CF}{BW \times AT} \quad \text{(D-10)}$$

where:

C_{GW}	=	Chemical concentration in groundwater (μg/L)
IR	=	Ingestion rate (L/day)
EF	=	Exposure frequency (days/yr)
ED	=	Exposure duration (yr)
CF	=	Conversion factor (10^{-3} mg/μg)
BW	=	Body weight (kg)
AT	=	Averaging time for noncancer or cancer effects (days).

Table D-23. Exposure Assumptions for Groundwater at the Project Premises and SDA[a]

Groundwater (Project Premises and SDA) Exposure Assumptions	Units[b]	Resident				Worker (Operational) Adults		Discoverer (Recreational)			
		Children		Adults				Children		Adults	
		CTE	RME	CTE	RME	RME	CTE	RME	CTE	RME	CTE
General											
Body Weight	kg	15	15[c]	70	70[c]	70	70[c]	Not Evaluated		Not Evaluated	
Exposure Duration	years	6	6[d]	30	9[c]	25	25[e]				
Averaging Time - Noncancer	days	2,190	2,190[c]	10,950	3,285[c]	9,125	9,125[c]				
Averaging Time - Cancer	days	25,550	25,550[c]	25,550	25,550[c]	25,550	25,550[c]				
Units Conversion	(mg/µg)	1.0×10^{-3}	1.0×10^{-3}	1.0×10^{-3}	1.0×10^{-3}	1.0×10^{-3}	1.0×10^{-3}				
Alternative III (In-Place Stabilization											
Groundwater Ingestion	L/day	1	1[f]	2	1.4[c]	1	0.7[e]	Not Evaluated		Not Evaluated	
Ingestion Rate	days/year	350	350[c]	350	350[c]	250	250[c]				
Exposure Frequency											
Alternative IV (No Action: Monitoring and Maintenance)											
Groundwater Ingestion	L/day	1	1[f]	2	1.4[c]	Not Evaluated		Not Evaluated		Not Evaluated	
Ingestion Rate	days/year	350	350[c]	350	350[c]						
Exposure Frequency											
Alternative V (Discontinue Operations)											
Groundwater Ingestion	L/day	Not Evaluated		Not Evaluated		1	0.7[g]	Not Evaluated		Not Evaluated	
Ingestion Rate	days/year					52	26[h]				
Exposure Frequency											

a. CTE = central tendency exposure, RME = reasonable maximum exposure.
b. To convert kilograms to pounds, multiply by 2.205. To convert liters to gallons, multiply by 0.2642.
c. EPA (1993a), Superfund's Standard Default Exposure Factors for the RME and CTE.
d. The exposure duration for children is 6 years corresponding to a child from the ages of 0 to 6 years.
e. The RME value is from EPA (1993a); the RME value was adopted as the CTE because a CTE value was not available.
f. EPA (1989b), Exposure Factors Handbook.
g. The RME value is from EPA (1993a); the CTE value assumes that 50 percent of the daily water consumption is at the workplace.
h. The exposure frequencies for the worker under Alternative IV correspond to 1 day per week for the RME and 1 day every other week for the CTE.

Table D-24. Exposure Assumptions for Surface Water in Buttermilk Creek[a]

Surface Water (Buttermilk Creek) Exposure Assumptions	Units[b]	Resident				Worker (Operational)		Discoverer (Recreational)			
		Children		Adults		Adults		Children		Adults	
		RME	CTE	RME	CTE	RME	CTE	RME	CTE	RME	CTE
General											
Body Weight	kg	15	15[c]	70	70[c]	Not Evaluated		Not Evaluated		Not Evaluated	
Exposure Duration	years	6	6[d]	30	9[c]						
Averaging Time - Noncancer	days	2,190	2,190[c]	10,950	3,285[c]						
Averaging Time - Cancer	days	25,550	25,550[c]	25,550	25,550[c]						
	(mg/μg)	1.0×10^{-3}	1.0×10^{-3}	1.0×10^{-3}	1.0×10^{-3}						
Alternative III (In-Place Stabilization)											
Surface Water Ingestion (potable)	L/day	1	1[e]	2	1.4[c]	Not Evaluated		Not Evaluated		Not Evaluated	
Ingestion Rate	days/year	350	350[c]	350	350[c]						
Exposure Frequency											
Alternative IV (No Action: Monitoring and Maintenance)											
Surface Water Ingestion (potable)	L/day	1	1[e]	2	1.4[c]	Not Evaluated		Not Evaluated		Not Evaluated	
Ingestion Rate	days/year	350	350[c]	350	350[c]						
Exposure Frequency											
Alternative V (Discontinue Operations)											
Surface Water Ingestion (potable)	L/day	1	1[e]	2	1.4[c]	Not Evaluated		Not Evaluated		Not Evaluated	
Ingestion Rate	days/year	350	350[c]	350	350[c]						
Exposure Frequency											

a. RME = reasonable maximum exposure, CTE = central tendency exposure.
b. To convert kilograms to pounds, multiply by 2.205. To convert from liters to gallons, multiply by 0.2642.
c. EPA (1993a), Superfund's Standard Default Exposure Factors for the RME and CTE.
d. The exposure duration for children is 6 years corresponding to a child from the ages of 0 to 6 years.
e. EPA (1989b), Exposure Factors Handbook - used ingestion rates for groundwater since this pathway assumes that the surface water is potable.

Table D-25. Exposure Assumptions for Soil Ingestion at the Project Premises and the SDA[a]

Soil (Project Premises and the SDA) Exposure Assumptions	Units[b]	Resident				Worker (Operational)		Discoverer (Recreational)			
		Children		Adults		Adults		Children		Adults	
		RME	CTE	RME	CTE	RME	CTE	RME	CTE	RME	CTE
General											
Body Weight	kg	15	15[c]	70	70[c]	70	70[c]	15	15[c]	70	70[c]
Exposure Duration	years	6	2[c]	24	7[c]	25	25[e]	6	2[c]	24	7[c]
Averaging Time - Noncancer	days	2,190	730[c]	8,760	2,555[c]	9,125	9,125[c]	2,190	730[c]	8,760	2,555[c]
Averaging Time - Cancer	days	25,550	25,550[c]	25,550	25,550[c]	25,550	25,550[c]	25,550	25,550[c]	25,550	25,550[c]
Units Conversion	(kg/mg)	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}
Alternative III (In-Place Stabilization)											
Soil Ingestion		Not Evaluated		Not Evaluated		Not Evaluated		Not Evaluated		Not Evaluated	
Ingestion Rate	mg/day										
Exposure Frequency	days/year										
Alternative IV (No Action: Monitoring and Maintenance)											
Soil Ingestion						Not Evaluated					
Ingestion Rate	mg/day	200	100[c]	100	50[c]			200	100[c]	100	50[c]
Exposure Frequency	days/year	350	350[c]	350	350[c]			104	52[d]	104	52[d]
Alternative V (Discontinue Operations)											
Soil Ingestion		Not Evaluated		Not Evaluated				Not Evaluated		Not Evaluated	
Ingestion Rate	mg/day					480	50[c]				
Exposure Frequency	days/year					52	26[d]				

a. RME = reasonable maximum exposure, CTE = central tendency exposure.
b. To convert kilograms to pounds, multiply by 2.205.
c. EPA (1993a), Superfund's Standard Default Exposure Factors for RME and CTE.
d. The exposure frequencies for the discoverer correspond to 2 days per week for the RME and 1 day per week for the CTE. For the worker under Alternative IV, the exposure frequencies correspond to 1 day per week for the RME and 1 day every other week for the CTE.
e. The RME value is from EPA (1993a); the RME value was adopted as the CTE, because a CTE value was not available.

Table D-26. Exposure Assumptions for Soil Dermal Contact at the Project Premises and SDA[a]

Soil (Project Premises and SDA) Exposure Assumptions	Units[b]	Resident Children RME	Resident Children CTE	Resident Adults RME	Resident Adults CTE	Worker (Operational) Adults RME	Worker (Operational) Adults CTE	Discoverer (Recreational) Children RME	Discoverer (Recreational) Children CTE	Discoverer (Recreational) Adults RME	Discoverer (Recreational) Adults CTE
General											
Body Weight	kg	15	15[c]	70	70[c]	70	70[c]	15	15[c]	70	70[c]
Exposure Duration	years	6	2[c]	24	7[c]	25	25[e]	6	2[c]	24	7[c]
Averaging Time - Noncancer	days	2,190	730[c]	8,760	2,555[c]	9,125	9,125[c]	2,190	730[c]	8,760	2,555[c]
Averaging Time - Cancer	days	25,550	25,550[c]	25,550	25,550[c]	25,550	25,550[c]	25,550	25,550[c]	25,550	25,550[c]
Units Conversion	(kg/mg)	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}
Alternative III (In-Place Stabilization)											
Soil Dermal Contact											
Skin Surface Area	cm^2/day	Not Evaluated		Not Evaluated		Not Evaluated		Not Evaluated		Not Evaluated	
Soil-to-Skin Adherence Factor	mg/day										
Dermal Absorption Factor	unitless										
Exposure Frequency	days/year										
Alternative IV (No Action: Monitoring and Maintenance)											
Soil Dermal Contact	cm^2/day	2,010	1,750[f]	5,800	5,000[f]	Not Evaluated		21010	1,750[f]	5,800	5,000[f]
Skin Surface Area	mg/day	1	0.2[f]	1	0.2[f]			1	0.2[f]	1	0.2[f]
Soil-to-Skin Adherence Factor	unitless	chemical-specific[g]		chemical-specific[g]				chemical-specific[g]		chemical-specific[g]	
Dermal Absorption Factor	days/year	350	350[c]	350	350[c]			104	52[d]	104	52[c]
Exposure Frequency											
Alternative V (Discontinue Operations)											
Soil Dermal Contact											
Skin Surface Area	cm^2/day	Not Evaluated		Not Evaluated		5800	5000 d	Not Evaluated		Not Evaluated	
Soil-to-Skin Adherence Factor	mg/day					1	0.2 d				
Dermal Absorption Factor	unitless					chemical-specific	c				
Exposure Frequency	days/year					52	26 a				

a. RME = reasonable maximum exposure, CTE = central tendency exposure.
b. To convert kilograms to pounds, multiple by 2.205. To convert square centimeters to square inches, multiply by 0.155.
c. EPA (1993a), Superfund's Standard Default Exposure Factors for the RME and CTE.
d. The exposure frequencies for the discoverer correspond to 2 days per week for the RME and 1 day per week for the CTE. For the worker under Alternative IV, the exposure frequencies correspond to 1 day per week for the RME and 1 day every other week for the CTE.
e. The RME value is from EPA (1993a); the RME value was adopted as the CTE, because a CTE value was not available.
f. EPA (1992a), Dermal Exposure Assessment: Principles and Applications.
g. EPA (1992c), New Interim Region IV Guidance - 0.01 for organics and 0.001 for inorganics.

Table D-27. Exposure Assumptions for Sediment at the Buttermilk Creek

Sediment (Buttermilk Creek) Exposure Assumptions	Units[b]	Resident				Worker (Operational)		Discoverer (Recreational)			
		Children		Adults		Adults		Children		Adults	
		RME	CTE	RME	CTE	RME	CTE	RME	CTE	RME	CTE
General											
Body Weight	kg	15	15[c]	70	70[c]	70	70[c]	15	15[c]	70	70[c]
Exposure Duration	years	6	6[h]	30	9[c]	25	25[e]	6	6[e]	30	9[c]
Averaging Time - Noncancer	days	2,190	2,190[c]	10,950	3,285[c]	9,125	9,125[c]	2,190	2,190[c]	10,950	3,285[c]
Averaging Time - Cancer	days	25,550	25,550[c]	25,550	25,550[c]	25,550	25,550[c]	25,550	25,550[c]	25,550	25,550[c]
Units Conversion	(kg/mg)	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}
Alternative III (In-Place Stabilization)											
Sediment Dermal Contact											
Skin Surface Area	cm^2/day	2,010	1,750[f]	5,800	5,000[f]	Not Evaluated		2,010	1,750[f]	5,800	5,000[f]
Soil-to-Skin Adherence Factor	mg/day	1	0.2[f]	1	0.2[f]			1	0.2[f]	1	0.2[f]
Dermal Absorption Factor	unitless	chemical-specific[g]		chemical-specific[g]				chemical-specific[g]		chemical-specific[g]	
Exposure Frequency	days/year	52	26[d]	52	26[d]			52	26[d]	52	26[d]
Alternative IV (No Action: Monitoring and Maintenance)											
Sediment Dermal Contact	cm^2/day	2,010	1,750[f]	5,800	5,000[f]	5,800	5,000[f]	2,010	1,750[f]	5,800	5,000[f]
Skin Surface Area	mg/day	1	0.2[f]	1	0.2[f]	1	0.2[f]	1	0.2[f]	1	0.2[f]
Soil-to-Skin Adherence Factor	unitless	chemical-specific[g]		chemical-specific[g]		chemical-specific[g]		chemical-specific[g]		chemical-specific[g]	
Dermal Absorption Factor	days/year	52	26[d]	52	26[d]	52	26[d]	52	26[d]	52	26[d]
Exposure Frequency											
Alternative V (Discontinue Operations)											
Sediment Dermal Contact											
Skin Surface Area	cm^2/day	2,010	1,750[f]	5,800	5,000[f]	Not Evaluated		2,010	1,750[f]	5,800	5,000[f]
Soil-to-Skin Adherence Factor	mg/day	1	0.2[f]	1	0.2[f]			1	0.2[f]	1	0.2[f]
Dermal Absorption Factor	unitless	chemical-specific[g]		chemical-specific[g]				chemical-specific[g]		chemical-specific[g]	
Exposure Frequency	days/year	52	26[d]	52	26[d]			52	26[d]	52	26[d]

a. RME = reasonable maximum exposure, CTE = central tendency exposure.
b. To convert kilograms to pounds, multiply by 2.205. To convert square centimeters to square inches, multiply by 0.155.
c. EPA (1993a), Superfund's Standard Default Exposure Factors for the RME and CTE.
d. The exposure frequencies for the discoverer correspond to 2 days per week for the RME and 1 day per week for the CTE. For the worker under Alternative IV, the exposure frequencies correspond to 1 day per week for the RME and 1 day every other week for the CTE.
e. The RME value is from EPA (1993a); the RME value was adopted as the CTE, because a CTE value was not available.
f. EPA (1992a), Dermal Exposure Assessment: Principles and Applications.
g. EPA (1992c), New Interim Region IV Guidance - 0.01 for organics and 0.001 for inorganics.
h. The exposure duration for children is 6 years corresponding to a child from the ages 0 to 6 years.

Ingestion of Surface Water. The use of surface water as a potable source of water for residents was evaluated in the risk assessment. The exposure assumptions for this pathway are presented in Table D-24. Oral intake estimates for surface water ingestion are calculated as follows:

$$Intake\ (mg/kg\text{-}day) = \frac{C_{SW} \times IR \times EF \times ED \times CF}{BW \times AT} \quad \text{(D-11)}$$

where:

C_{SW}	=	Chemical concentration in surface water (μg/L)
IR	=	Ingestion rate (L/day)
EF	=	Exposure frequency (days/yr)
ED	=	Exposure duration (yr)
CF	=	Conversion factor (10^{-3} mg/μg)
BW	=	Body weight (kg)
AT	=	Averaging time for noncancer or cancer effects (days).

Ingestion of Soil. Soil ingestion exposures were evaluated for residents, workers, and discoverer receptors under Alternatives IV and V. The exposure assumptions for this pathway are presented in Table D-25. Intake estimates for the soil ingestion pathway were estimated using the following equation:

$$Intake\ (mg/kg\text{-}day) = \frac{C_{SO} \times IR \times EF \times ED \times CF}{BW \times AT} \quad \text{(D-12)}$$

where:

C_{SO}	=	Chemical concentration in soil (mg/kg)
IR	=	Ingestion rate (mg/day)
EF	=	Exposure frequency (days/yr)
ED	=	Exposure duration (yr)
CF	=	Conversion factor (10^{-6} kg/mg)
BW	=	Body weight (kg)
AT	=	Averaging time for noncancer or cancer effects (days).

Dermal Contact with Soil. Dermal exposure was assumed to occur simultaneously with soil ingestion exposure. The exposure assumptions for this pathway are presented in Table D-26. Intake estimates for the soil ingestion pathway were estimated as follows:

$$Absorbed\ Dose\ (mg/kg\text{-}day) = \frac{C_{SO} \times SA \times AF \times ABS \times EF \times ED \times CF}{BW \times AT} \quad \text{(D-13)}$$

where:

C_{SO}	=	Chemical concentration in soil (mg/kg)
SA	=	Skin surface area available for contact (cm^2/day)
AF	=	Soil to skin adherence factor (mg/cm^2)
ABS	=	Dermal absorption factor (unitless)
EF	=	Exposure frequency (days/yr)
ED	=	Exposure duration (yr)
CF	=	Conversion factor (10^{-6} kg/mg)
BW	=	Body weight (kg)
AT	=	Averaging time for noncancer or cancer effects (days).

Dermal Contact with Sediment. Exposure from dermal contact with sediment was evaluated for residents and discoverers and for workers under Alternative IV (No Action: Monitoring and Maintenance) while conducting maintenance activities (e.g., reinforcing creek banks). The exposure assumptions for this pathway were presented in Table D-27. These exposures were calculated as follows:

$$Absorbed\ Dose\ (mg/kg\text{-}day) = \frac{C_{SED} \times SA \times AF \times ABS \times EF \times ED \times CF}{BW \times AT} \quad \text{(D-14)}$$

where:

C_{SED}	=	Chemical concentration in sediment (mg/kg)
SA	=	Skin surface area available for contact (cm^2/day)
AF	=	Sediment to skin adherence factor (mg/cm^2)
ABS	=	Dermal absorption factor (unitless)
EF	=	Exposure frequency (days/yr)
ED	=	Exposure duration (yr)
CF	=	Conversion factor (10^{-6} kg/mg)
BW	=	Body weight (kg)
AT	=	Averaging time for noncancer or cancer effects (days).

Fish and Produce Ingestion. Exposure to chemical contaminants could occur through consumption of produce grown on the WMA and fish caught in Buttermilk Creek. The exposure assumptions for these pathways are presented in Table D-28. The estimated intake through fish and produce ingestion was calculated using the following equation:

Table D-28. Exposure Assumptions for Fish and Produce Ingestion at the Project Premises, the SDA, and Buttermilk Creek[a]

Fish (Buttermilk Creek) and Produce (Project Premises and SDA) Exposure Assumptions	Units[b]	Resident				Worker (Operational)		Discoverer (Recreational)			
		Children		Adults		Adults		Children		Adults	
		RME	CTE	RME	CTE	RME	CTE	RME	CTE	RME	CTE
General											
Body Weight	kg	15	15[c]	70	70[c]	Not Evaluated		15	15[c]	70	70[c]
Exposure Duration	years	6	6[f]	30	9[c]			6	6[f]	30	9[c]
Averaging Time - Noncancer	days	2,190	2,190[c]	10,950	3,285[c]			2,190	2,190[c]	10,950	3,285[c]
Averaging Time - Cancer	days	25,550	25,550[c]	25,550	25,550[c]			25,550	25,550[c]	25,550	25,550[c]
Fraction Ingested	unitless	1	1	1	1			1	1	1	1
Units Conversion	(kg/mg)	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}			1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}
Alternative III (In-Place Stabilization)											
Fish Ingestion	kg/day	0.048	0.048[e]	0.145	0.145[c]	Not Evaluated		0.048	0.048[e]	0.145	0.145[c]
Ingestion Fate	days/year	26	13[d]	26	13[d]			26	13[d]	26	13[d]
Exposure Frequency											
Produce Ingestion											
Ingestion Rate	kg/day	Not Evaluated		Not Evaluated		Not Evaluated		Not Evaluated		Not Evaluated	
Exposure Frequency	days/year										
Alternative IV (No Action: Monitoring and Maintenance)											
Fish Ingestion	kg/day	0.048	0.048[e]	0.145	0.145[c]	Not Evaluated		0.048	0.048[e]	0.145	0.145[c]
Ingestion Rate	days/year	26	13[d]	26	13[d]			26	13[d]	26	13[d]
Exposure Frequency											
Produce Ingestion											
Ingestion Rate	kg/day	0.084	0.054[g]	0.122	0.078[c]	Not Evaluated		Not Evaluated		Not Evaluated	
Exposure Frequency	days/year	52	26[d]	52	26[d]						
Alternative V (Discontinue Operations)											
Fish Ingestion	kg/day	0.048	0.048[e]	0.145	0.145[c]	Not Evaluated		0.048	0.048[e]	0.145	0.145[c]
Ingestion Rate	days/year	26	13[d]	26	13[d]			26	13[d]	26	13[d]
Exposure Frequency											
Produce Ingestion											
Ingestion Rate	kg/day	0.084	0.054[g]	0.122	0.078[c]	Not Evaluated		Not Evaluated		Not Evaluated	
Exposure Frequency	days/year	52	26[d]	52	26[d]						

a. RME = reasonable maximum exposure, CTE = central tendency exposure.
b. To convert kilograms to pounds, multiply by 2.205.
c. EPA (1993a), Superfund's Standard Default Exposure Factors for the RME and CTE.
d. The exposure frequencies for fish ingestion correspond to 1 day per week for 6 months for the RME and 1 day every other week for 6 months for the CTE. For produce ingestion, the exposure frequencies correspond to 1 day per week for the RME and 1 day every other week for the CTE.
e. EPA (1989b), Exposure Factors Handbook; for child fish ingestion rate, one-third of the adult ingestion rate was used—this ratio is based upon age-specific ingestion rates in EPA (1989b).
f. The exposure duration for children is 6 years corresponding to a child from the ages of 0 to 6 years.
g. For the child produce ingestion rate, approximately 70 percent of the adult ingestion rate was used—this ratio is based upon age-specific ingestion rates from Yang and Nelson (1986).

$$Intake\ (mg/kg\text{-}day) = \frac{C \times IR \times FI \times EF \times ED}{BW \times AT} \qquad \text{(D-15)}$$

where:

C	=	Chemical concentration in fish tissue or produce (mg/kg)
IR	=	Ingestion rate (kg/day)
FI	=	Fraction ingested from contaminated source (1.0) (unitless)
EF	=	Exposure frequency (days/yr)
ED	=	Exposure duration (yr)
BW	=	Body weight (kg)
AT	=	Averaging time for noncancer or cancer effects (days).

D.4.3 Toxicity Assessment

The objective of the toxicity assessment is to evaluate the inherent toxicity of the compounds being investigated and to identify and select toxicological values for use in evaluating the significance of the exposure.

Noncancer and Cancer Health Effects

EPA recommends two different approaches for evaluating noncancer and cancer health effects that reflect a fundamental difference in the proposed mechanism of toxic action for noncarcinogenic and carcinogenic compounds.

In assessing the potential for noncancer health effects, EPA assumes that there is a toxicologic threshold below which no adverse health effects occur. That is, a toxicologic threshold exists when a substance has no toxic effect at a certain level of exposure, but does have a toxic effect at a higher level. These toxicologic thresholds are represented by reference doses (RfDs) for oral exposures and reference concentrations (RfCs) for inhalation exposures. The RfDs and RfCs are levels (with uncertainty spanning an order of magnitude or greater) of daily human exposures below which adverse health effects are not anticipated, even for the most sensitive members of a population (EPA 1989a). EPA derives RfDs and RfCs based on estimates of the no-observable-adverse-effect level (NOAEL) or lowest-observable-adverse-effect level (LOAEL) in humans or test animals.

For carcinogens, however, EPA believes that the assumption of a threshold is inappropriate (EPA 1989a). An extremely low level of exposure to a carcinogen may result in chromosomal or enzyme changes leading to cancer. EPA does not, therefore, estimate a threshold for carcinogens. Instead, EPA uses a two-part evaluation in which (1) a chemical is assigned a weight-of-evidence classification and (2) a cancer slope factor is calculated for the chemical. In risk assessment, the cancer slope factor is used to estimate the probability of a cancer effect occurring in an exposed receptor over a lifetime.

The weight-of-evidence classification evaluates the evidence that a given chemical is a carcinogen to humans and animals. These ratings are as follows:

- A: Human carcinogen
- B1: Probable human carcinogen - limited human data are available
- B2: Probable human carcinogen - sufficient data in animals, and inadequate or no evidence in humans
- C: Possible human carcinogen
- D: Not classifiable as to human carcinogenicity.

EPA develops cancer slope factors for carcinogens that have been classified as A, B1, and B2 and for many that have been classified as C. The cancer slope factors are in units of inverse dose, $(mg/kg/day)^{-1}$.

For the assessment of human health risk of exposure to chemicals, the following toxicity values are of principal importance:

- RfDs for oral exposure - acceptable intake values for chronic exposure (noncancer effects)
- RfCs for inhalation exposure - acceptable intake values for chronic exposure (noncancer effects)
- Cancer slope factors for oral exposure
- Cancer slope factors for the inhalation route.

The primary source of data for toxicity values is the EPA Integrated Risk Information System (IRIS) database (EPA 1994a). IRIS is a computer-housed catalog of EPA risk assessment and risk management information for chemical substances. If toxicity values are not available on IRIS, EPA recommends use of the EPA Office of Research and Development Health Effects Assessment Summary Tables (EPA 1994b) as the second current source of information.

The oral and inhalation toxicity values used in human health risk assessment are presented in Table D-29. Priority is given to the values obtained from the IRIS database because they have been verified by the EPA RfD/RfC Work Group for noncarcinogens or by the Carcinogen Risk Assessment Verification Endeavor Work Group.

The toxicity assessment process is complicated by the fact that toxicity values are not readily available for exposure routes or for all chemicals. EPA has, however, provided guidance for the following: (1) the dermal route, (2) PAHs, and (3) chromium.

Table D-29. Toxicity Values for Ingestion and Inhalation Pathways

COMPOUND	NONCARCINOGENS Effects Oral Route (mg/kg/day) RfD-S(a)	RfD-C(a)	Uncertainty Factor Oral Route (subchronic)	Uncertainty Factor Oral Route (chronic)	Source (Oral)	Effects Inhalation Route (mg/m3) RfC-S(b)	RfC-C(b)	Effects Inhalation Route (mg/kg/day) RfD-S(b)	RfD-C(b)	Uncertainty Factor Inhal. Route (subchronic)	Uncertainty Factor Inhal. Route (chronic)	Source (Inhal.)	Noncarcinogenic Target Organ and Critical Effect
INORGANICS													
Antimony	4.00E-04	4.00E-04	1000	1000	d,c	--	--	--	--	--	--	--	whole body, blood; inc. mortality
Arsenic	3.00E-04	3.00E-04	3	3	d,c	--	--	--	--	--	--	--	skin; keratosis, hyperpigmentation
Barium	7.00E-02	7.00E-02	3	3	d,c	5.00E-03	5.00E-04	1.43E-03	1.43E-04	100	1000	d	oral-cardiovasc. sys.; inc. blood pressure. Inhal.-fetotoxicity
Beryllium	5.00E-03	5.00E-03	100	100	d,c	--	--	--	--	--	--	--	no observed effects
Boron	9.00E-02	9.00E-02	100	100	d,c	2.00E-02	2.00E-02	5.71E-03	5.71E-03	100	100	d	oral-testis; lesions, testicular atrophy. Inhal.-respir. tract, bronchus, bron
Cadmium (food)	--	1.00E-03	--	10	c	--	--	--	--	--	--	--	kidney; proteinuria
Cadmium (water)	--	5.00E-04	--	10	c	--	--	--	--	--	--	--	kidney; proteinuria
Chromium (III)	1.00E+00	1.00E+00	1000	100	d,c	--	--	--	--	--	--	n	no observed effects
Chromium (VI)	2.00E-02	5.00E-03	100	500	d,c	--	--	--	--	--	--	n	no observed effects
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	3.70E-02	3.70E-02	--	--	d,r	--	--	--	--	--	--	--	Gastrointestinal system; irritation
Cyanide	2.00E-02	2.00E-02	500	100	d,c	--	--	--	--	--	--	--	thyroid, nerve; weight loss, myelin degen
Fluoride	6.00E-02	6.00E-02	1	1	d,c	--	--	--	--	--	--	--	tooth; fluorosis
Lead	--	--	--	--	f	--	--	--	--	--	--	--	CNS, blood
Manganese (food)	1.40E-01	1.40E-01	1	1	d,c	--	5.00E-05	--	1.43E-05	--	1000	c	oral-CNS effects Inhal.-impairment of neurobehavioral function
Manganese (water)	5.00E-03	5.00E-03	1	1	d,c	--	5.00E-05	--	1.43E-05	--	1000	c	oral-CNS effects. Inhal.-impairment of neurobehavioral function
Mercury	3.00E-04	3.00E-04	1000	1000	d	3.00E-04	3.00E-04	8.57E-05	8.57E-05	30	30	n,d	oral-CNS; neurotoxicity. inhal.-kidney effects
Molybdenum	5.00E-03	5.00E-03	30	30	d,c	--	--	--	--	--	--	--	urine, joints, blood; inc. uric acid, pain
Nickel	2.00E-02	2.00E-02	300	300	d,c,o	--	--	--	--	--	--	--	dec. body and organ weight
Nickel Refinery Dust	--	--	--	--	--	--	--	--	--	--	--	--	dec. body and organ weight
Nickel Subsulfide	--	--	--	--	--	--	--	--	--	--	--	--	dec. body and organ weight
Nitrate	--	1.60E+00	--	1	c	--	--	--	--	--	--	--	blood; methemoglobinemia
Nitrite	1.00E-01	1.00E-01	10	1	d,c	--	--	--	--	--	--	--	blood; methemoglobinemia
Selenium	5.00E-03	5.00E-03	3	3	d,c	--	--	--	--	--	--	--	whole body; clinical selenosis
Silver	5.00E-03	5.00E-03	3	3	d,c	--	--	--	--	--	--	--	skin; argyria
Thallium	8.00E-04	8.00E-05	300	3000	d,c,s	--	--	--	--	--	--	--	liver, blood; inc. sgot and serum LDH
Vanadium	7.00E-03	7.00E-03	100	100	d	--	--	--	--	--	--	--	no observed effects
Zinc	3.00E-01	3.00E-01	3	3	d,c,o	--	--	--	--	--	--	--	blood; anemia
ORGANICS													
Acenaphthene	6.00E-01	6.00E-02	300	3000	d,c	--	--	--	--	--	--	--	liver; hepatotoxicity
Acenaphthylene	3.00E-01	3.00E-02	--	--	h	--	--	--	--	--	--	--	--
Acetone	1.00E+00	1.00E-01	100	1000	d,c	--	--	--	--	--	--	--	inc. liver, kidney weights, nephrotoxicity
Acetophenone	1.00E+00	1.00E-01	300	3000	d,c	--	--	--	--	--	--	--	general toxicity
Acrolein	--	2.00E-02	--	1000	n,d	--	2.00E-05	--	5.71E-06	--	1000	n,c	oral and inhal.-nasal epithelium; metaplasia, neutrophilic infiltration
Acrylonitrile	1.00E-02	1.00E-03	100	1000	d	--	2.00E-03	--	5.71E-04	--	1000	c	oral-dec. sperm counts. Inhal.-nasal epithelium; degeneration, inflamm
Aldrin	3.00E-05	3.00E-05	1000	1000	d,c	--	--	--	--	--	--	--	liver, lesions, toxicity
alpha-BHC	--	--	--	--	--	--	--	--	--	--	--	--	--
Anthracene	3.00E+00	3.00E-01	300	3000	d,c	--	--	--	--	--	--	--	no observed effects

Table D-29. Toxicity Values for Ingestion and Inhalation Pathways (continued)

COMPOUND	NONCARCINOGENS: Effects Oral Route (mg/kg/day) RfD-S(a)	RfD-C(a)	Uncertainty Factor Oral Route (subchronic)	Uncertainty Factor Oral Route (chronic)	Source (Oral)	Effects Inhalation Route (mg/m3) RfC-S(b)	RfC-C(b)	Effects Inhalation Route (mg/kg/day) RfD-S(b)	RfD-C(b)	Uncertainty Factor Inhal. Route (subchronic)	Uncertainty Factor Inhal. Route (chronic)	Source (Inhal.)	Noncarcinogenic Target Organ and Critical Effect
Aroclor-1016	--	7.00E-05	--	100	c	--	--	--	--	--	--	--	reduced birth weight
Aroclor-1248	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor-1254	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor-1260	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzene	--	4.00E-04	--	--	I	--	--	--	--	--	--	n	--
Benzo(a)anthracene	3.00E-01	3.00E-02	--	--	h	--	--	--	--	--	--	--	--
Benzo(a)pyrene	3.00E-01	3.00E-02	--	--	h	--	--	--	--	--	--	--	--
Benzo(b)fluoranthene	3.00E-01	3.00E-02	--	--	h,n	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	3.00E-01	3.00E-02	--	--	h	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	3.00E-01	3.00E-02	--	--	h	--	--	--	--	--	--	--	--
Benzoic Acid	4.00E+00	4.00E+00	1	1	d,c	--	--	--	--	--	--	--	no observed effects
beta-BHC	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-chloroethoxy)methane	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-chloroethyl)ether	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-chloroisopropyl)ether	4.00E-02	4.00E-02	1000	1000	d,c	--	--	--	--	--	--	--	erythrocytes; dec. hemoglobin
Bis(2-ethylhexyl)phthalate	--	2.00E-02	--	1000	n,c	--	--	--	--	--	--	n	liver; weight inc.
Bromacil	--	--	--	--	--	--	--	--	--	--	--	--	--
Bromodichloromethane	2.00E-02	2.00E-02	1000	1000	d,c	--	--	--	--	--	--	--	kidney; cytomegaly
Bromoform	2.00E-01	2.00E-02	100	1000	d,c	--	--	--	--	--	--	--	liver; hepatic lesions
Bromomethane	--	1.40E-03	--	1000	n,c	--	5.00E-03	--	1.43E-03	--	100	n,c	oral-forestomach; epithelial hyperplasia. Inhal.-neurotoxicity, nasal cavit
2-Butanone	2.00E+00	6.00E-01	1000	3000	d,c	1.00E+00	1.00E+00	2.86E-01	2.86E-01	3000	1000	d,c	oral and inhal.-dec. fetal birth weights
Butyl benzyl phthalate	2.00E+00	2.00E-01	100	1000	d,c	--	--	--	--	--	--	--	liver; weight changes
Carbazole	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon Disulfide	1.00E-01	1.00E-01	100	100	d,c	1.00E-02	1.00E-02	2.86E-03	2.86E-03	1000	1000	d	oral and inhal.-fetus; toxicity
Carbon Tetrachloride	--	7.00E-04	--	1000	n,c	--	--	--	--	--	--	n	liver; lesions
2-Chloroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
3-Chloroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Chloroaniline	4.00E-03	4.00E-03	3000	3000	d,c	--	--	--	--	--	--	--	spleen; proliferative lesions
Chlorobenzene	--	2.00E-02	--	1000	n,c	--	2.00E-02	--	5.71E-03	--	10000	n,d	oral-liver effects. Inhal.-liver and kidney effects
Chloroethane	--	--	--	--	--	1.00E+01	1.00E+01	2.86E+00	2.86E+00	300	300	d,c	fetus; delayed ossification
Chloroform	1.00E-02	1.00E-02	1000	1000	d,c	--	--	--	--	--	--	n	liver; lesions, fatty cyst formation
Chloromethane	--	--	--	--	--	--	--	--	--	--	--	n	--
4-Chloro-3-methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	8.00E-02	--	3000	c	--	--	--	--	--	--	--	dyspnea; abnormal appearance; liver enlargement
2-Chlorophenol	5.00E-02	5.00E-03	100	1000	d,c	--	--	--	--	--	--	--	reproductive effects
4-Chlorophenyl phenyl ether	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chlorotoluene	2.00E-01	2.00E-02	100	1000	d,c	--	--	--	--	--	--	--	dec. in body weight gain
Chlorpyrifos	3.00E-03	3.00E-03	10	10	d,c	--	--	--	--	--	--	--	blood; dec. cholinesterase activity
Chrysene	3.00E-01	3.00E-02	--	--	h	--	--	--	--	--	--	--	--
2,4-D	1.00E-02	1.00E-02	100	100	d,c	--	--	--	--	--	--	--	blood, liver, kidney; toxicity
2,4-DB	8.00E-02	8.00E-03	100	1000	d,c	--	--	--	--	--	--	--	cardiovascular sys.; hemorrhage, inc. mortality

Table D-29. Toxicity Values for Ingestion and Inhalation Pathways (continued)

	NONCARCINOGENS												
	Effects Oral Route (mg/kg/day)		Uncertainty Factor Oral Route	Uncertainty Factor Oral Route	Source	Effects Inhalation Route (mg/m3)		Effects Inhalation Route (mg/kg/day)		Uncertainty Factor Inhal. Route	Uncertainty Factor Inhal. Route	Source	Noncarcinogenic Target Organ and Critical Effect
COMPOUND	RfD-S(a)	RfD-C(a)	(subchronic)	(chronic)	(Oral)	RfC-S(b)	RfC-C(b)	RfD-S(b)	RfD-C(b)	(subchronic)	(chronic)	(Inhal.)	
4,4-DDD	--	--	--	--	--	--	--	--	--	--	--	--	--
4,4-DDE	--	--	--	--	--	--	--	--	--	--	--	--	--
4,4-DDT	5.00E-04	5.00E-04	100	100	d,c	--	--	--	--	--	--	--	liver; lesions
delta-BHC	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzo(a,h)anthracene	3.00E-01	3.00E-02	--	--	h	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibromochloromethane	2.00E-01	2.00E-02	100	1000	d,c	--	--	--	--	--	--	--	liver; hepatic lesions
Di-n-butyl phthalate	1.00E+00	1.00E-01	100	1000	d,c	--	--	--	--	--	--	--	inc. mortality
1,2-Dichlorobenzene	--	9.00E-02	--	1000	n,c	2.00E+00	2.00E-01	5.71E-01	5.71E-02	100	1000	d	oral-liver effects. inhal.-dec. body weight gain
1,3-Dichlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--
1,4-Dichlorobenzene	--	--	--	--	--	2.50E+00	8.00E-01	7.14E-01	2.29E-01	30	100	d,c	liver, kidney, effects
3,3'-Dichlorobenzidine	--	--	--	--	--	--	--	--	--	--	--	--	--
Dichlorodifluoromethane	9.00E-01	2.00E-01	100	100	d,c	2.00E+00	2.00E-01	5.71E-01	5.71E-02	1000	10000	d	oral-red. body weight. Inhal.-liver lesions
1,1-Dichloroethane	1.00E+00	1.00E-01	100	1000	d	5.00E+00	5.00E-01	1.43E+00	1.43E-01	100	1000	d	oral-no observed effects. Inhal.-kidney damage
1,2-Dichloroethane	--	--	--	--	n	--	--	--	--	--	--	n	--
1,1-Dichloroethylene	9.00E-03	9.00E-03	1000	1000	d,c	--	--	--	--	--	--	--	liver; hepatic lesions
1,2-Dichloroethylene	9.00E-03	9.00E-03	1000	1000	d	--	--	--	--	--	--	--	liver; hepatic lesions
1,2-c-Dichloroethylene	1.00E-01	1.00E-02	300	3000	d	--	--	--	--	--	--	--	blood; dec. hemoglobin and hematocrit
1,2-t-Dichloroethylene	2.00E-01	2.00E-02	100	1000	d,c	--	--	--	--	--	--	--	blood; inc. alkaline phosphatase
2,4-Dichlorophenol	3.00E-03	3.00E-03	100	100	d,c	--	--	--	--	--	--	--	immune sys.; altered immune function
Dichloroprop	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2-Dichloropropane	--	--	--	--	--	1.30E-02	4.00E-03	3.71E-03	1.14E-03	100	300	d,c	nasal mucosa; hyperplasia
1,3-Dichloropropane	--	--	--	--	--	--	--	--	--	--	--	--	--
1,3-Dichloropropene	3.00E-03	3.00E-04	1000	10000	d,c	2.00E-02	2.00E-02	5.71E-03	5.71E-03	30	30	d,c	oral-inc. organ weight. inhal.-nasal mucosa, hypertrophy, hyperplasia
Dieldrin	5.00E-05	5.00E-05	100	100	d,c	--	--	--	--	--	--	--	liver; lesions
Diethyl phthalate	8.00E+00	8.00E-01	100	1000	d,c	--	--	--	--	--	--	--	dec body growth, dec. organ weight
2,4-Dimethylphenol	2.00E-01	2.00E-02	300	3000	d,c	--	--	--	--	--	--	--	blood, nervous system effects
2,6-Dimethylphenol	6.00E-03	6.00E-04	100	1000	d,c	--	--	--	--	--	--	--	inc. body weight, liver, kidney, spleen effects
Dimethyl phthalate	1.00E+01	1.00E+01	100	100	d	--	--	--	--	--	--	--	kidney effects
2,4-Dinitrophenol	2.00E-03	2.00E-03	1000	1000	d,c	--	--	--	--	--	--	--	eye; cataracts
2,4-Dinitrotoluene	2.00E-03	2.00E-03	100	100	d,c	--	--	--	--	--	--	--	CNS, erythrocytes; neurotoxicity, Heinz bodies
2,6-Dinitrotoluene	1.00E-02	1.00E-03	300	3000	d	--	--	--	--	--	--	--	mortality, neurotoxicity, blood and kidney effects
Dinitrotoluene mixture 2,4-/2,6-	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	2.00E-02	2.00E-02	1000	1000	d	--	--	--	--	--	--	--	kidney, liver; inc. weight, inc. sgot and sgpt activity
Endosulfan	6.00E-03	6.00E-03	100	100	d	--	--	--	--	--	--	--	kidney, toxicity, lesions; dec. body weight gain
Endosulfan Sulfate	--	--	--	--	--	--	--	--	--	--	--	--	--
Endrin	3.00E-04	3.00E-04	100	100	d,c	--	--	--	--	--	--	--	CNS, liver; convulsions, lesions
Endrin Aldehyde	--	--	--	--	--	--	--	--	--	--	--	--	--
Endrin Ketone	--	--	--	--	--	--	--	--	--	--	--	--	--
EPN	--	1.00E-05	--	1000	c	--	--	--	--	--	--	--	CNS; neurotoxicity
Ethoprop	--	--	--	--	--	--	--	--	--	--	--	--	--

Table D-29. Toxicity Values for Ingestion and Inhalation Pathways (continued)

	NONCARCINOGENS												
	Effects Oral Route (mg/kg/day)		Uncertainty Factor Oral Route	Uncertainty Factor Oral Route	Source	Effects Inhalation Route (mg/m3)		Effects Inhalation Route (mg/kg/day)		Uncertainty Factor Inhal. Route	Uncertainty Factor Inhal. Route	Source	Noncarcinogenic Target Organ and Critical Effect
COMPOUND	RfD-S(a)	RfD-C(a)	(subchronic)	(chronic)	(Oral)	RfC-S(b)	RfC-C(b)	RfD-S(b)	RfD-C(b)	(subchronic)	(chronic)	(Inhal.)	
Ethylbenzene	--	1.00E-01	--	1000	n,c	--	1.00E+00	--	2.86E-01	--	300	n,c	oral-liver, kidney; toxicity. inhal.-fetus; developmental toxicity
Fensulfothion	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoranthene	4.00E-01	4.00E-02	300	3000	d,c	--	--	--	--	--	--	--	kidney, liver, blood, inc. weight, hematological changes
Fluorene	4.00E-01	4.00E-02	300	3000	d,c	--	--	--	--	--	--	--	erythrocytes; dec. counts
gamma-BHC	3.00E-03	3.00E-04	100	1000	d,c	--	--	--	--	--	--	--	liver, kidney; toxicity
gamma-Chlordane	--	--	--	--	--	--	--	--	--	--	--	--	--
Heptachlor	5.00E-04	5.00E-04	300	300	d,c	--	--	--	--	--	--	--	liver; inc. weight in males
Heptachlor Epoxide	1.30E-05	1.30E-05	1000	1000	d,c	--	--	--	--	--	--	--	liver; inc. relative weight
Hexachlorobutadiene	--	2.00E-04	--	1000	d	--	--	--	--	--	--	n	renal tubules; regeneration
Hexachlorocyclopentadiene	7.00E-02	7.00E-03	100	1000	d,c	7.00E-04	7.00E-05	2.00E-04	2.00E-05	100	1000	d	oral-stomach; lesions. inhal.-respiratory tract, lesions
Hexachloroethane	1.00E-02	1.00E-03	100	1000	d,c	--	--	--	--	--	--	--	kidney; atrophy and degen of renal tubules
Hexane	6.00E-01	6.00E-02	1000	10000	d	2.00E-01	2.00E-01	5.71E-02	5.71E-02	300	300	d,c	oral-CNS, testis; neuropathy, atrophy. inhal.-CNS; neurotoxicity
2-Hexanone	--	--	--	--	--	--	--	--	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	3.00E-01	3.00E-02	--	--	h	--	--	--	--	--	--	--	--
Isophorone	2.00E+00	2.00E-01	100	1000	d,c	--	--	--	--	--	--	--	kidney; lesions
MCPA	5.00E-04	5.00E-04	300	300	d,c	--	--	--	--	--	--	--	kidney, liver; toxicity
MCPB	1.00E-01	1.00E-02	100	1000	d,c	--	--	--	--	--	--	--	male reproductive toxicity
MCPP	1.00E-02	1.00E-03	300	3000	d,c	--	--	--	--	--	--	--	kidney; inc. weight
Methoxychlor	5.00E-03	5.00E-03	1000	1000	d,c	--	--	--	--	--	--	--	reproduction; loss of litters
2-Methyl-4,6-dinitrophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
Methylene Chloride	6.00E-02	6.00E-02	100	100	d,c	3.00E+00	3.00E+00	8.57E-01	8.57E-01	100	100	d	oral and inhal.-liver; toxicity
2-Methylnaphthalene	3.00E-01	3.00E-02	300	--	h	--	--	--	--	--	--	--	skin effects
4-Methyl-2-pentanone	8.00E-01	8.00E-02	300	3000	d	8.00E-01	8.00E-02	2.29E-01	2.29E-02	100	1000	d	oral and inhal.-liver, kidney effects
2-Methylphenol	5.00E-01	5.00E-02	100	1000	d,c	--	--	--	--	--	--	--	dec. body weight; neurotoxicity
3-Methylphenol	5.00E-01	5.00E-02	100	1000	d,c	--	--	--	--	--	--	--	dec. body weight; neurotoxicity
4-Methylphenol	5.00E-03	5.00E-03	1000	1000	d	--	--	--	--	--	--	--	maternal death, hypoactivity; respiratory system distress
N,N-Dimethylformamide	1.00E+00	1.00E-01	100	1000	d	3.00E-02	3.00E-02	8.57E-03	8.57E-03	300	300	d,c	oral-liver effects. inhal.-liver and GI system effects
Naphthalene	--	--	--	--	n	--	--	--	--	--	--	--	dec. body weight
2-Nitroaniline	--	--	--	--	--	2.00E-03	2.00E-04	5.71E-04	5.71E-05	1000	10000	d	blood; hematological effects
3-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Nitroaniline	--	--	--	--	--	--	--	--	--	--	--	--	--
Nitrobenzene	5.00E-03	5.00E-04	1000	10000	d,c	2.00E-02	2.00E-03	5.71E-03	5.71E-04	1000	10000	d	oral and inhal.-blood effects; adrenal, kidney, and liver lesions
2-Nitrophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Nitrophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
N-nitroso-di-n-propylamine	--	--	--	--	--	--	--	--	--	--	--	--	--
N-nitrosodiphenylamine	--	--	--	--	--	--	--	--	--	--	--	--	--
2,2-Oxibis-(1-chloropropane)	--	--	--	--	--	--	--	--	--	--	--	--	--
PCB	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	3.00E-02	3.00E-02	100	100	d,c	--	--	--	--	--	--	--	liver, adrenal effects, fetotoxicity
Phenanthrene	3.00E-01	3.00E-02	--	--	h	--	--	--	--	--	--	--	--
Phenol	6.00E-01	6.00E-01	100	100	d,c	--	--	--	--	--	--	--	fetus; dec. weight

Table D-29. Toxicity Values for Ingestion and Inhalation Pathways (continued)

COMPOUND	NONCARCINOGENS: Effects Oral Route (mg/kg/day) RfD-S(a)	RfD-C(a)	Uncertainty Factor Oral Route (subchronic)	Uncertainty Factor Oral Route (chronic)	Source (Oral)	Effects Inhalation Route (mg/m3) RfC-S(b)	RfC-C(b)	Effects Inhalation Route (mg/kg/day) RfD-S(b)	RfD-C(b)	Uncertainty Factor Inhal. Route (subchronic)	Uncertainty Factor Inhal. Route (chronic)	Source (Inhal.)	Noncarcinogenic Target Organ and Critical Effect
Prometon	--	1.50E-02	--	1000	c	--	--	--	--	--	--	--	no observed effects
Pyrene	3.00E-01	3.00E-02	300	3000	d,c	--	--	--	--	--	--	--	kidney; red. weight, renal tubular pathology
Stirophos	3.00E-02	3.00E-02	100	100	d,c	--	--	--	--	--	--	--	inc. liver, kidney weight; red. body weight
Styrene	--	2.00E-01	--	1000	n,c	3.00E+00	1.00E+00	8.57E-01	2.86E-01	10	30	d,c	oral-liver, erythrocytes; effects. inhal.-CNS; cerebellar dysfunction
1,1,1,2-Tetrachloroethane	3.00E-02	3.00E-02	3000	3000	d,c	--	--	--	--	--	--	--	liver,kidney; lesions
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--
Tetrachloroethylene	1.00E-01	1.00E-02	100	1000	d,c	--	--	--	--	--	--	--	liver; hepatotoxicity
Toluene	2.00E+00	2.00E-01	100	1000	d,c	--	4.00E-01	--	1.14E-01	--	300	n,c	oral-liver, kidney; altered weights. inhal.-CNS; neurological effects
Toxaphene	--	--	--	--	--	--	--	--	--	--	--	--	--
Trichloroacetic acid	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,4-Trichlorobenzene	1.00E-02	1.00E-02	1000	1000	d,c	2.00E+00	2.00E-01	5.71E-01	5.71E-02	100	1000	d	oral-adrenal; inc. weight. inhal.-liver; non-adverse weight changes
1,1,1-Trichloroethane	--	--	--	--	n	--	--	--	--	--	--	n	--
1,1,2-Trichloroethane	4.00E-02	4.00E-03	100	1000	d,c	--	--	--	--	--	--	--	blood; alterations
Trichloroethylene	--	--	--	--	--	--	--	--	--	--	--	--	--
Trichlorofluoromethane	7.00E-01	3.00E-01	1000	1000	d,c	7.00E+00	7.00E-01	2.00E+00	2.00E-01	1000	10000	d	oral-dec. body weight. inhal.-kidney and lung effects
2,4,5-Trichlorophenol	1.00E+00	1.00E-01	100	1000	d,c	--	--	--	--	--	--	--	liver, kidney; effects
2,4,6-Trichlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
Vinyl Chloride	--	1.30E-03	--	--	n,k	--	--	--	--	--	--	n	--
Xylenes	--	2.00E+00	--	100	n,c,g	--	--	--	--	--	--	--	CNS hyperactivity; dec. body weight
PCDDs and PCDFs													
2,3,7,8-TCDD	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,7,8-PeCDD	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,7,8-HxCDD	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,6,7,8-HxCDD	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,7,8,9-HxCDD	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8-HpCDD	--	--	--	--	--	--	--	--	--	--	--	--	--
OCDD	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,7,8-TCDF	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,7,8-PeCDF	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,7,8-PeCDF	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,7,8-HxCDF	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,6,7,8-HxCDF	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6,7,8-HxCDF	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,7,8,9-HxCDF	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,6,7,8-HpCDF	--	--	--	--	--	--	--	--	--	--	--	--	--
1,2,3,4,7,8,9-HpCDF	--	--	--	--	--	--	--	--	--	--	--	--	--
OCDF	--	--	--	--	--	--	--	--	--	--	--	--	--

Table D-29. Toxicity Values for Ingestion and Inhalation Pathways (continued)

	CARCINOGENS							
COMPOUND	Cancer Slope Factor (CSF): Oral Route (mg/kg/day)-1	Carcinogenic Weight-of-Evidence	Unit Risk Factor Oral Route (ug/l)-1	Source (Oral)	Cancer Slope Factor (CSF): Inhalation Route (mg/kg/day)-1	Unit Risk Factor Inhalation Route (ug/m3)-1	Carcinogenic Weight-of-Evidence	Source (Inhal.)
INORGANICS								
Antimony	--		--	--	--	--		--
Arsenic	1.75E+00	[A]	5.00E-05	c,e	5.00E+01	4.30E-03	[A]	d,c
Barium	--		--	--	--	--		--
Beryllium	4.30E+00	[B2]	1.20E-04	c	8.40E+00	2.40E-03	[B2]	d,c
Boron	--		--	--	--	--		--
Cadmium (food)	--		--	--	6.10E+00	1.80E-03	[B1]	d,c
Cadmium (water)	--		--	--	6.10E+00	1.80E-03	[B1]	d,c
Chromium (III)	--		--	--	--	--		--
Chromium (VI)	--		--	--	4.10E+01	1.20E-02	[A]	d,c
Cobalt	--		--	--	--	--		--
Copper	--	[D]	--	c	--	--		--
Cyanide	--	[D]	--	c	--	--		--
Fluoride	--		--	--	--	--		--
Lead	--	[B2]	--	c	--	--		--
Manganese (food)	--	[D]	--	c	--	--		--
Manganese (water)	--	[D]	--	c	--	--		--
Mercury	--	[D]	--	c	--	--		--
Molybdenum	--		--	--	--	--		--
Nickel	--		--	--	--	--		--
Nickel Refinery Dust	--		--	--	8.40E-01	2.40E-04	[A]	d
Nickel Subsulfide	--		--	--	1.70E+00	4.80E-04	[A]	d,c
Nitrate	--		--	--	--	--		--
Nitrite	--		--	--	--	--		--
Selenium	--	[D]	--	c	--	--		--
Silver	--	[D]	--	c	--	--		--
Thallium	--	[D]	--	c	--	--		--
Vanadium	--		--	--	--	--		--
Zinc	--	[D]	--	c	--	--		--
ORGANICS								
Acenaphthene	--		--	--	--	--		--
Acenaphthylene	--	[D]	--	c	--	--		--
Acetone	--	[D]	--	c	--	--		--
Acetophenone	--	[D]	--	c	--	--		--
Acrolein	--	[C]	--	c	--	--		--
Acrylonitrile	5.40E-01	[B1]	1.50E-05	c	2.40E-01	6.80E-05	[B1]	d,c
Aldrin	1.70E+01	[B2]	4.90E-04	c	1.70E+01	4.90E-03	[B2]	d,c
alpha-BHC	6.30E+00	[B2]	1.80E-04	c	6.30E+00	1.80E-03	[B2]	d,c
Anthracene	--	[D]	--	c	--	--		--

Table D-29. Toxicity Values for Ingestion and Inhalation Pathways (continued)

COMPOUND	CARCINOGENS Cancer Slope Factor (CSF): Oral Route (mg/kg/day)-1	Carcinogenic Weight-of-Evidence	Unit Risk Factor Oral Route (ug/l)-1	Source (Oral)	Cancer Slope Factor (CSF): Inhalation Route (mg/kg/day)-1	Unit Risk Factor Inhalation Route (ug/m3)-1	Carcinogenic Weight-of-Evidence	Source (Inhal.)
Aroclor-1016	7.70E+00	[B2]	2.20E-04	c,m	--	--		--
Aroclor-1248	7.70E+00	[B2]	2.20E-04	c,m	--	--		--
Aroclor-1254	7.70E+00	[B2]	2.20E-04	c,m	--	--		--
Aroclor-1260	7.70E+00	[B2]	2.20E-04	c,m	--	--		--
Benzene	2.90E-02	[A]	8.30E-07	c	2.90E-02	8.30E-06	[A]	d,c
Benzo(a)anthracene	7.30E-01	[B2]	--	i	--	--		--
Benzo(a)pyrene	7.30E+00	[B2]	2.10E-04	c	--	--		--
Benzo(b)fluoranthene	7.30E-01	[B2]	--	i	--	--		--
Benzo(g,h,i)perylene	--	[D]	--	c	--	--		--
Benzo(k)fluoranthene	7.30E-01	[B2]	--	i	--	--		--
Benzoic Acid	--	[D]	--	c	--	--		--
beta-BHC	1.80E+00	[C]	5.30E-05	c	1.80E+00	5.30E-04	[C]	d,c
Bis(2-chloroethoxy)methane	--		--	--	--	--		--
Bis(2-chloroethyl)ether	1.10E+00	[B2]	3.30E-05	c	1.10E+00	3.30E-04	[B2]	d,c
Bis(2-chloroisopropyl)ether	7.00E-02	[C]	2.00E-06	d	3.50E-02	1.00E-05	[C]	d
Bis(2-ethylhexyl)phthalate	1.40E-02	[B2]	4.00E-07	c	--	--		--
Bromacil	--		--	--	--	--		--
Bromodichloromethane	6.20E-02	[B2]	1.80E-06	c	--	--		--
Bromoform	7.90E-03	[B2]	2.30E-07	c	3.90E-03	1.10E-06	[B2]	d,c
Bromomethane	--	[D]	--	c	--	--		--
2-Butanone	--	[D]	--	c	--	--		--
Butyl benzyl phthalate	--	[C]	--	c	--	--		--
Carbazole	2.00E-02	[B2]	5.70E-07	c	--	--		--
Carbon Disulfide	--		--	--	--	--		--
Carbon Tetrachloride	1.30E-01	[B2]	3.70E-06	c	5.30E-02	1.50E-05	[B2]	d,c
2-Chloroaniline	--		--	--	--	--		--
3-Chloroaniline	--		--	--	--	--		--
4-Chloroaniline	--		--	--	--	--		--
Chlorobenzene	--	[D]	--	c	--	--		--
Chloroethane	--		--	--	--	--		--
Chloroform	6.10E-03	[B2]	1.70E-07	c	8.10E-02	2.30E-05	[B2]	d,c
Chloromethane	1.30E-02	[C]	3.70E-07	d	6.30E-03	1.80E-06	[C]	d
4-Chloro-3-methylphenol	--		--	--	--	--		--
2-Chloronaphthalene	--		--	--	--	--		--
2-Chlorophenol	--		--	--	--	--		--
4-Chlorophenyl phenyl ether	--		--	--	--	--		--
2-Chlorotoluene	--		--	--	--	--		--
Chlorpyrifos	--		--	--	--	--		--
Chrysene	7.30E-02	[B2]	--	i	--	--		--
2,4-D	--		--	--	--	--		--
2,4-DB	--		--	--	--	--		--

Table D-29. Toxicity Values for Ingestion and Inhalation Pathways (continued)

COMPOUND	CARCINOGENS Cancer Slope Factor (CSF): Oral Route (mg/kg/day)-1	Carcinogenic Weight-of-Evidence	Unit Risk Factor Oral Route (ug/l)-1	Source (Oral)	Cancer Slope Factor (CSF): Inhalation Route (mg/kg/day)-1	Unit Risk Factor Inhalation Route (ug/m3)-1	Carcinogenic Weight-of-Evidence	Source (Inhal.)
4,4-DDD	2.40E-01	[B2]	6.90E-06	c	--	--		--
4,4-DDE	3.40E-01	[B2]	9.70E-06	c	--	--		--
4,4-DDT	3.40E-01	[B2]	9.70E-06	c	3.40E-01	9.70E-05	[B2]	d,c
delta-BHC	--	[D]	--	c	--	--		--
Dibenzo(a,h)anthracene	7.30E+00	[B2]	--	i	--	--		--
Dibenzofuran	--	[D]	--	c	--	--		--
Dibromochloromethane	8.40E-02	[C]	2.40E-06	c	--	--		--
Di-n-butyl phthalate	--	[D]	--	c	--	--		--
1,2-Dichlorobenzene	--	[D]	--	c	--	--		--
1,3-Dichlorobenzene	--	[D]	--	c	--	--		--
1,4-Dichlorobenzene	2.40E-02	[B2]	6.80E-07	d	--	--		--
3,3'-Dichlorobenzidine	4.50E-01	[B2]	1.30E-05	c	--	--		--
Dichlorodifluoromethane	--		--	--	--	--		--
1,1-Dichloroethane	--	[C]	--	c	--	--		--
1,2-Dichloroethane	9.10E-02	[B2]	2.60E-06	c	9.10E-02	2.60E-05	[B2]	d,c
1,1-Dichloroethylene	6.00E-01	[C]	1.70E-05	c	1.20E+00	5.00E-05	[C]	d,c
1,2-Dichloroethylene	--		--	--	--	--		--
1,2-c-Dichloroethylene	--	[D]	--	c	--	--		--
1,2-t-Dichloroethylene	--		--	--	--	--		--
2,4-Dichlorophenol	--		--	--	--	--		--
Dichloroprop	--		--	--	--	--		--
1,2-Dichloropropane	6.80E-02	[B2]	1.90E-06	d	--	--		--
1,3-Dichloropropane	--		--	--	--	--		--
1,3-Dichloropropene	1.80E-01	[B2]	5.10E-06	d	1.30E-01	3.70E-05	[B2]	d
Dieldrin	1.60E+01	[B2]	4.60E-04	c	1.60E+01	4.60E-03	[B2]	d,c
Diethyl phthalate	--	[D]	--	c	--	--		--
2,4-Dimethylphenol	--		--	--	--	--		--
2,6-Dimethylphenol	--		--	--	--	--		--
Dimethyl phthalate	--	[D]	--	c	--	--		--
2,4-Dinitrophenol	--		--	--	--	--		--
2,4-Dinitrotoluene	--		--	--	--	--		--
2,6-Dinitrotoluene	--		--	--	--	--		--
Dinitrotoluene mixture 2,4-/2,6-	6.80E-01	[B2]	1.90E-05	c	--	--		--
Di-n-octyl phthalate	--		--	--	--	--		--
Endosulfan	--		--	--	--	--		--
Endosulfan Sulfate	--		--	--	--	--		--
Endrin	--	[D]	--	c	--	--		--
Endrin Aldehyde	--		--	--	--	--		--
Endrin Ketone	--		--	--	--	--		--
EPN	--		--	--	--	--		--
Ethoprop	--		--	--	--	--		--

Table D-29. Toxicity Values for Ingestion and Inhalation Pathways (continued)

	CARCINOGENS							
COMPOUND	Cancer Slope Factor (CSF): Oral Route (mg/kg/day)-1	Carcinogenic Weight-of-Evidence	Unit Risk Factor Oral Route (ug/l)-1	Source (Oral)	Cancer Slope Factor (CSF): Inhalation Route (mg/kg/day)-1	Unit Risk Factor Inhalation Route (ug/m3)-1	Carcinogenic Weight-of-Evidence	Source (Inhal)
Ethylbenzene	--	[D]	--	c	--	--		--
Fensulfothion	--		--	--	--	--		--
Fluoranthene	--	[D]	--	c	--	--		--
Fluorene	--	[D]	--	c	--	--		--
gamma-BHC	1.30E+00	[C]	3.70E-05	d	--	--		--
gamma-Chlordane	--		--	--	--	--		--
Heptachlor	4.50E+00	[B2]	1.30E-04	c	4.50E+00	1.30E-03	[B2]	d,c
Heptachlor Epoxide	9.10E+00	[B2]	2.60E-04	c	9.10E+00	2.60E-03	[B2]	d,c
Hexachlorobutadiene	7.80E-02	[C]	2.20E-06	c	7.80E-02	2.20E-05	[C]	d,c
Hexachlorocyclopentadiene	--		--	--	--	--		--
Hexachloroethane	1.40E-02	[C]	4.00E-07	c	1.40E-02	4.00E-06	[C]	d,c
Hexane	--		--	--	--	--		--
2-Hexanone	--		--	--	--	--		--
Indeno(1,2,3-cd)pyrene	7.30E-01	[B2]	--	i	--	--		--
Isophorone	9.50E-04	[C]	2.70E-08	c	--	--		--
MCPA	--		--	--	--	--		--
MCPB	--		--	--	--	--		--
MCPP	--		--	--	--	--		--
Methoxychlor	--	[D]	--	c	--	--		--
2-Methyl-4,6-dinitrophenol	--		--	--	--	--		--
Methylene Chloride	7.50E-03	[B2]	2.10E-07	c	1.65E-03	4.70E-07	[B2]	q,c
2-Methylnaphthalene	--		--	--	--	--		--
4-Methyl-2-pentanone	--		--	--	--	--		--
2-Methylphenol	--	[C]	--	c	--	--		--
3-Methylphenol	--	[C]	--	c	--	--		--
4-Methylphenol	--	[C]	--	c	--	--		--
N,N-Dimethylformamide	--		--	--	--	--		--
Naphthalene	--	[D]	--	c	--	--		--
2-Nitroaniline	--		--	--	--	--		--
3-Nitroaniline	--		--	--	--	--		--
4-Nitroaniline	--		--	--	--	--		--
Nitrobenzene	--	[D]	--	c	--	--		--
2-Nitrophenol	--		--	--	--	--		--
4-Nitrophenol	--		--	--	--	--		--
N-nitroso-di-n-propylamine	7.00E+00	[B2]	2.00E-04	c	--	--		--
N-nitrosodiphenylamine	4.90E-03	[B2]	1.40E-07	c	--	--		--
2,2-Oxibis-(1-chloropropane)	--		--	--	--	--		--
PCB	7.70E+00	[B2]	2.20E-04	c	--	--		--
Pentachlorophenol	1.20E-01	[B2]	3.00E-06	c	--	--		--
Phenanthrene	--	[D]	--	c	--	--		--
Phenol	--	[D]	--	c	--	--		--

Table D-29. Toxicity Values for Ingestion and Inhalation Pathways (continued)

	CARCINOGENS							
COMPOUND	Cancer Slope Factor (CSF): Oral Route (mg/kg/day)-1	Carcinogenic Weight-of-Evidence	Unit Risk Factor Oral Route (ug/l)-1	Source (Oral)	Cancer Slope Factor (CSF): Inhalation Route (mg/kg/day)-1	Unit Risk Factor Inhalation Route (ug/m3)-1	Carcinogenic Weight-of-Evidence	Source (Inhal.)
Prometon	--		--	--	--	--		--
Pyrene	--	[D]	--	c	--	--		--
Stirophos	2.40E-02	[C]	6.90E-07	d	--	--		--
Styrene	--		--	--	--	--		--
1,1,1,2-Tetrachloroethane	2.60E-02	[C]	7.40E-07	c	2.60E-02	7.40E-06	[C]	d,c
1,1,2,2-Tetrachloroethane	2.00E-01	[C]	5.80E-06	c	2.00E-01	5.80E-05	[C]	d,c
Tetrachloroethylene	--		--	--	--	--		--
Toluene	--	[D]	--	c	--	--		--
Toxaphene	1.10E+00	[B2]	3.20E-05	c	1.10E+00	3.20E-04	[B2]	d,c
Trichloroacetic acid	--		--	--	--	--		--
1,2,4-Trichlorobenzene	--	[D]	--	c	--	--		--
1,1,1-Trichloroethane	--	[D]	--	c	--	--		--
1,1,2-Trichloroethane	5.70E-02	[C]	1.60E-06	c	5.70E-02	1.60E-05	[C]	d,c
Trichloroethylene	--		--	--	--	--		--
Trichlorofluoromethane	--		--	--	--	--		--
2,4,5-Trichlorophenol	--		--	--	--	--		--
2,4,6-Trichlorophenol	--		3.10E-07	c	1.00E-02	3.10E-06	[B2]	d,c
Vinyl Chloride	1.90E+00	[A]	5.40E-05	d	3.00E-01	8.40E-05	[A]	d
Xylenes	--	[D]	--	c	--	--		--
PCDDs and PCDFs								
2,3,7,8-TCDD	1.50E+05	[B2]	4.50E+00	d	1.50E+05	(3.3E-05 [pg/m3]$^{-1}$)	[B2]	d
1,2,3,7,8-PeCDD	7.50E+04	--	--	j	7.50E+04	--	--	j
1,2,3,4,7,8-HxCDD	1.50E+04	--	--	j	1.50E+04	--	--	j
1,2,3,6,7,8-HxCDD	1.50E+04	--	--	j	1.50E+04	--	--	j
1,2,3,7,8,9-HxCDD	1.50E+04	--	--	j	1.50E+04	--	--	j
1,2,3,4,6,7,8-HpCDD	1.50E+03	--	--	j	1.50E+03	--	--	j
OCDD	1.50E+02	--	--	j	1.50E+02	--	--	j
2,3,7,8-TCDF	1.50E+04	--	--	j	1.50E+04	--	--	j
1,2,3,7,8-PeCDF	7.50E+03	--	--	j	7.50E+03	--	--	j
2,3,4,7,8-PeCDF	7.50E+04	--	--	j	7.50E+04	--	--	j
1,2,3,4,7,8-HxCDF	1.50E+04	--	--	j	1.50E+04	--	--	j
1,2,3,6,7,8-HxCDF	1.50E+04	--	--	j	1.50E+04	--	--	j
2,3,4,6,7,8-HxCDF	1.50E+04	--	--	j	1.50E+04	--	--	j
1,2,3,7,8,9-HxCDF	1.50E+04	--	--	j	1.50E+04	--	--	j
1,2,3,4,6,7,8-HpCDF	1.50E+03	--	--	j	1.50E+03	--	--	j
1,2,3,4,7,8,9-HpCDF	1.50E+03	--	--	j	1.50E+03	--	--	j
OCDF	1.50E+02	--	--	j	1.50E+02	--	--	j

Table D-29. Toxicity Values for Ingestion and Inhalation Pathways (continued)

a RfD-S: Reference dose for subchronic exposure, oral route. RfD-C: Reference dose for chronic (long-term) exposure, oral route

b. RfC-S: Reference concentration for subchronic (short-term) exposure, inhalation route. RfC-C: Reference concentration for chronic (long-term) exposure, inhalation route
Inhalation RfCs have been converted to inhalation RfDs by multiplying by 20m u3 /day and dividing by 70 kg.

c. EPA IRIS Data Base (August 1994).

d. USEPA ORD Health Effects Assessment Summary Tables (HEAST) FY 1994 Annual (March 1994).

e. The oral unit risk for arsenic has been proposed by EPA. The oral slope factor was calculated from the unit risk by assuming an ingestion of 2 liters of water per day by a 70 kg adult.

f. EPA has not developed a reference dose for lead. EPA recommends use of the lead biokinetic model to estimate blood lead levels for the purposes of risk assessment.

g. Toxicity measures presented are for mixed xylenes.

h. In the absence of toxicity data, the RfDs for pyrene have been adopted for this compound.

i. The cancer slope factor for this compound has been estimated by multiplying the cancer slope factor for benzo(a)pyrene by a toxicity equivalence factor (see table below).

j. The cancer slope factor for this compound has been estimated by multiplying the cancer slope facor for 2,3,7,8-TCDD by a toxicity equivalence factor (see table below).

k. The reference dose for vinyl chloride was derived from the EPA ODW longer-term drinking water health advisory.

l. The RfD for chronic exposure to a 70 kg adult was derived from the EPA ADI of 0.025 mg/day. Drinking Water Criteria Document for Benzene (USEPA 1985, EPA Office of Drinking Water).

m. In the absence of data, the cancer slope factor for PCBs as a class of compounds has been adopted for Aroclor-1016, Aroclor-1248, Aroclor-1254, and Aroclor-1260.

n. For subchronic information regarding these chemicals (and chronic information regarding napthalene [RfD] and 1,1,1-trichloroethane [RfC]), HEAST instructs the user to contact the Superfund Health Risk Technical Support Center.

o. Values are for metals in the form of soluble salts.

p. Radionuclide slope factors are from HEAST March 1994.

q. The inhalation slope factor for methylene chloride was calculated from the inhalation unit risk factor by assuming an inhalation rate of 20 m u3 /day by a 70 kg adult.

r. The EPA Office of Drinking Water MCL of 1.3 mg/L has been converted to intake estimate of 3.7E-02 mg/kg-day by assuming ingestion of 2 liters of water/day by a 70 kg adult

s. values are for thallium (I) carbonate, thallium (I) chloride, and thallium (I) sulfate

RELATIVE POTENCY OF PAHs

PAH	Relative Potency (a)	Relative Potency (b)
Benzo(a)pyrene	1.000	0.145
Benzo(a)anthracene	0.100	1.000
Benzo(b)fluoranthene	0.100	0.140
Benzo(j)fluoranthene		0.022
Benzo(k)fluoranthene	0.100	0.061
Benzo(g,h,i)perylene		0.066
Chrysene	0.010	0.004
Cyclopentadieno(cd)pyrene		0.023
Dibenzo(a,h)anthracene	1.000	1.110
Indeno(1,2,3-cd)pyrene	0.100	0.232
Pyrene		0.081

a. USEPA Region IV, Interim Guidance, February 11, 1992

b. Source Krewski,D et.al. 1989 "Carcinogenic Risk Assessment of Complex Mixtures". *Toxicology and Industrial Health* 5(5):851-867.

RELATIVE POTENCY OF DIOXINs AND FURANs

Dioxin/Furan	Relative Potency (c)
2,3,7,8-TCDD	1.000
1,2,3,7,8-PeCDD	0.500
1,2,3,4,7,8-HxCDD	0.100
1,2,3,6,7,8-HxCDD	0.100
1,2,3,7,8,9-HxCDD	0.100
1,2,3,4,6,7,8-HpCDD	0.010
OCDD	0.001
2,3,7,8-TCDF	0 100
1,2,3,7,8-PeCDF	0.050
2,3,4,7,8-PeCDF	0 500
1,2,3,4,7,8-HxCDF	0.100
1,2,3,6,7,8-HxCDF	0.100
2,3,4,6,7,8-HxCDF	0 100
1,2,3,7,8,9-HxCDF	0.100
1,2,3,4,6,7,8-HpCDF	0.010
1,2,3,4,7,8,9-HpCDF	0 010
OCDF	0.001

c. 1989 TEFs from *Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-Dioxins and -Dibenzofurans (CDDs and CDFs) and 1989 Update, Part II, March*. EPA/625/3-89/016.

Dermal Route. Toxicity values are only available for the oral and inhalation routes. In addition, most of these toxicity values are based on administered dose rather than absorbed dose. The administered dose is the amount of chemical at an exchange boundary, such as skin, that is *available* for absorption, as opposed to the amount absorbed. As discussed in Section D.4.2.4, the intake equation for the dermal contact exposures calculates absorbed dose (by incorporating a dermal absorption factor or a permeability coefficient). Thus, it is necessary to convert the administered dose toxicity value to an absorbed dose toxicity value in order to calculate risk for dermal contact exposures.

Toxicity values for dermal contact exposures were obtained by converting toxicity values based on administered dose to toxicity values based on absorbed dose. This conversion requires data from laboratory studies on gastrointestinal absorption in the species on which the toxicity measures are based. The administered-dose toxicity value is then divided (if it is a cancer slope factor) or multiplied (if it is an RfD) by the gastrointestinal absorption factor to derive the absorbed-dose toxicity value.

The gastrointestinal absorption factors used in this risk assessment were obtained from EPA guidance (EPA 1993b), the ATSDR's toxicological profiles, and other literature sources (with priority assigned in the order listed). A list of the toxicity values used to evaluate the dermal pathway, gastrointestinal absorption factors, dermal permeability coefficients, and dermal absorption factors used in this risk assessment is included in Table D-30.

Polycyclic Aromatic Hydrocarbons. Most PAHs do not have published RfDs for noncancer effects, and only benzo(a)pyrene has a published slope factor for cancer effects. Because of this lack of data, EPA has interim guidance for evaluating some PAHs that are known to cause cancer (EPA 1993c). In this interim guidance, EPA recommends using relative potency values (orders of magnitude) for seven PAHs. These values are related to the slope factor of benzo(a)pyrene and are based on reliable studies in which PAHs caused cancer after repeated exposures to mouse skin.

These relative potency values have been incorporated into the risk assessment. EPA specifies that the relative potency values "...should be applied only to assessment of carcinogenic hazard from oral exposure to PAHs" and that there is "...currently no inhalation unit risk for benzo(a)pyrene that has been found acceptable by the Carcinogen Risk Assessment Verification Endeavor" (EPA 1993c). Therefore, dermal and inhalation exposures to carcinogenic PAHs are not evaluated quantitatively in the risk assessment. This contributes to the uncertainty for the risk assessment and is discussed in Section D.4.5.

For PAHs exhibiting noncancer effects without EPA-approved RfDs, the RfD for pyrene was used as a surrogate. Naphthalene was not used for this purpose because a risk assessment for this substance is currently under review by an EPA work group and no toxicity value is available on either IRIS or the Health Effects Assessment Summary Tables.

Table D-30. Chemical Specific Values used in Evaluation of Dermal Exposure Pathways

COMPOUND	Gastrointestinal Absorption Factors (a)	Chronic Reference Dose Dermal Route (mg/kg-day)	Cancer Slope Factor (CSF): Dermal Route $(mg/kg\text{-}day)^{-1}$	Dermal Permeability Coefficient (b)		Dermal Absorption Factor (e)
INORGANICS						
Aluminum	0.05	--	--	0.001	(c)	0.01
Antimony	0.15	6.0E-05	--	0.001	(c)	0.01
Arsenic	0.95	2.9E-04	1.8E+00	0.001	(c)	0.01
Barium	0.91	6.4E-02	--	0.001	(c)	0.01
Beryllium	0.01	5.0E-05	4.3E+02	0.001	(c)	0.01
Cadmium	0.025	2.5E-05	--	0.001	(c)	0.01
Cadmium (water)	0.05	2.5E-05	--	0.001	(c)	0.01
Calcium	1	--	--	0.001	(c)	0.01
Chromium (III)	0.45	4.5E-01	--	0.001	(c)	0.01
Chromium (VI)	0.45	2.3E-03	--	0.001	(c)	0.01
Cobalt	0.45	--	--	0.001	(c)	0.01
Copper	0.6	2.2E-02	--	0.001	(c)	0.01
Iron	1	--	--	0.001	(c)	0.01
Lead	1	--	--	0.001	(c)	0.01
Magnesium	0.05	--	--	0.001	(c)	0.01
Manganese	0.03	4.2E-03	--	0.001	(c)	0.01
Manganese (water)	0.03	1.5E-04	--	0.001	(c)	0.01
Mercury	0.15	4.5E-05	--	0.001	(c)	0.01
Nickel	0.05	1.0E-03	--	0.001	(c)	0.01
Potassium	1	--	--	0.001	(c)	0.01
Selenium	0.8	4.0E-03	--	0.001	(c)	0.01
Silver	1	5.0E-03	--	0.001	(c)	0.01
Sodium	1	--	--	0.001	(c)	0.01
Thallium	1	8.0E-05	--	0.001	(c)	0.01
Vanadium	0.05	3.5E-04	--	0.001	(c)	0.01
Zinc	0.25	7.5E-02	--	0.001	(c)	0.01

Table D-30. Chemical Specific Values used in Evaluation of Dermal Exposure Pathways (continued)

COMPOUND	Gastrointestinal Absorption Factors (a)	Chronic Reference Dose Dermal Route (mg/kg-day)	Cancer Slope Factor (CSF): Dermal Route $(mg/kg\text{-}day)^{-1}$	Dermal Permeability Coefficient (b)		Dermal Absorption Factor (e)
ORGANICS						
1,2,3,4,6,7,8-HpCDD	0.5	--	3.0E+03	1.4		0.03
1,2,3,4,6,7,8-HpCDF	0.5	--	3.0E+03	1.4		0.03
1,2,3,4,7,8,9-HpCDF	0.5	--	3.0E+03	1.4		0.03
1,2,3,4,7,8-HxCDD	0.5	--	3.0E+04	1.4		0.03
1,2,3,4,7,8-HxCDF	0.5	--	3.0E+04	1.4		0.03
1,2,3,6,7,8-HxCDD	0.5	--	3.0E+04	1.4		0.03
1,2,3,6,7,8-HxCDF	0.5	--	3.0E+04	1.4		0.03
1,2,3,7,8,9-HxCDD	0.5	--	3.0E+04	1.4		0.03
1,2,3,7,8,9-HxCDF	0.5	--	3.0E+04	1.4		0.03
1,2,3,7,8-PeCDD	0.5	--	1.5E+05	1.4		0.03
1,2,3,7,8-PeCDF	0.5	--	1.5E+04	1.4		0.03
1,2-Dichlorobenzene	1	9.0E-02	--	0.061		0.3
1,2-Dichloroethylene	1	9.0E-03	--	0.01		0.3
1,3-Dichlorobenzene	1	--	--	0.087		0.3
1,4-Dichlorobenzene	1	--	2.4E-02	0.062		0.3
2,2'-oxybis(1-Chloropropane)	1	--	--			0.3
2,3,4,6,7,8-HxCDF	0.5	--	3.0E+04	1.4		0.03
2,3,4,7,8-PeCDF	0.5	--	1.5E+05	1.4		0.03
2,3,7,8-TCDD	0.5	--	3.0E+05	1.4		0.03
2,3,7,8-TCDF	0.5	--	3.0E+04	1.4		0.03
2,4,5-T	1	1.0E-02	--			0.3
2,4,5-Trichlorophenol	1	1.0E-01	--	1.4		0.3
2,4-D	1	1.0E-02	--			0.3
2,4-DB	1	8.0E-03	--			0.3
2-Butanone	0.95	5.7E-01	--	0.0011		0.3
2-Methylnaphthalene	1	3.0E-02	--			0.3
4,4-DDD	0.9	--	2.7E-01	0.28		0.3
4,4-DDE	0.9	--	3.8E-01	0.24		0.3
4,4-DDT	0.9	4.5E-04	3.8E-01	0.43		0.3
4-Methylphenol	1	5.0E-03	--			0.3
4-Nitrophenol	0.9	--	--	0.0061		0.3
Acenaphthene		--	--			0.3
Acenaphthylene		--	--			0.3
Acetone	0.83	8.3E-02	--	0.001		0.3
Aldrin	0.9	2.7E-05	1.9E+01	0.0016		0.3
alpha-BHC	0.97	--	6.5E+00	0.0316	(d)	0.3

Table D-30. Chemical Specific Values used in Evaluation of Dermal Exposure Pathways (continued)

COMPOUND	Gastrointestinal Absorption Factors (a)	Chronic Reference Dose Dermal Route (mg/kg-day)	Cancer Slope Factor (CSF): Dermal Route $(mg/kg\text{-}day)^{-1}$	Dermal Permeability Coefficient (b)	Dermal Absorption Factor (e)
alpha-Chlordane	1	--	--	0.046	0.3
Anthracene		--	--		0.3
Aroclor-1260	0.75	--	1.0E+01		0.06
Benzene	0.9	3.6E-04	3.2E-02	0.021	0.3
Benzo(a)anthracene		--	--	0.81	0.3
Benzo(a)pyrene		--	--	1.2	0.3
Benzo(b)fluoranthene		--	--	1.2 (d)	0.3
Benzo(g,h,i)perylene		--	--		0.3
Benzo(k)fluoranthene		--	--		0.3
beta-BHC	0.9	--	2.0E+00	0.0316 (d)	0.3
Bis(2-ethylhexyl)phthalate	0.9	1.8E-02	1.6E-02	0.033	0.3
Bromodichloromethane	0.9	1.8E-02	6.9E-02	0.0058	0.3
Butyl benzyl phthalate	1	2.0E-01	--		0.3
Carbazole	0.9	--	2.2E-02		0.3
Carbon Disulfide	0.9	9.0E-02	--	0.024	0.3
Carbon Tetrachloride	0.9	6.3E-04	1.4E-01	0.022	0.3
Chloroform	1	1.0E-02	6.1E-03	0.0089	0.3
Chloromethane	0.9	--	1.4E-02	0.0042	0.3
Chrysene		--	--	0.81	0.3
delta-BHC	1	--	--		0.3
Di-n-butyl phthalate	1	1.0E-01	--	0.033	0.3
Dibenzo(a,h)anthracene		--	--	2.7	0.3
Dibenzofuran	1	--	--		0.3
Dicamba	1	3.0E-02	--		0.3
Dichloroprop	1	--	--		0.3
Dieldrin	0.9	4.5E-05	1.8E+01	0.016	0.3
Diethyl phthalate	1	8.0E-01	--	0.0048	0.3
Endosulfan	0.9	5.4E-03	--	0.0316 (d)	0.3
Endosulfan I	0.9	5.4E-03	--	0.0316 (d)	0.3
Endosulfan II	0.9	5.4E-03	--	0.0316 (d)	0.3
Endosulfan Sulfate	1	--	--	0.0316 (d)	0.3
Endrin	1	3.0E-04	--	0.016	0.3
Endrin Aldehyde	1	--	--		0.3
Endrin Ketone	1	--	--		0.3
Ethylbenzene	0.92	9.2E-02	--	0.074	0.3
Fluoranthene	0.43	1.7E-02	--	0.36	0.3
Fluorene		--	--		0.3
gamma-BHC	0.99	3.0E-04	1.3E+00	0.014	0.3

Table D-30. Chemical Specific Values used in Evaluation of Dermal Exposure Pathways (continued)

COMPOUND	Gastrointestinal Absorption Factors (a)	Chronic Reference Dose Dermal Route (mg/kg-day)	Cancer Slope Factor (CSF): Dermal Route $(mg/kg\text{-}day)^{-1}$	Dermal Permeability Coefficient (b)		Dermal Absorption Factor (e)
gamma-Chlordane	1	--	--	0.046		0.3
Heptachlor	0.4	2.0E-04	1.1E+01	0.011		0.3
Heptachlor Epoxide	0.9	1.2E-05	1.0E+01	0.0316	(d)	0.3
Indeno(1,2,3-cd)pyrene		--	--	1.9		0.3
Isophorone	1	2.0E-01	9.5E-04	0.0044		0.3
MCPP	1	1.0E-03	--			0.3
Methoxychlor	0.9	4.5E-03	--	0.0316	(d)	0.3
Methylene Chloride	1	6.0E-02	7.5E-03	0.0045		0.3
N-nitroso-di-n-propylamine	0.9	--	7.8E+00			0.3
Naphthalene		--	--	0.069		0.3
OCDD	0.5	--	3.0E+02	1.4		0.03
OCDF	0.5	--	3.0E+02	1.4		0.03
p,p'-Methoxychlor	0.9	4.5E-03	--	0.0316	(d)	0.3
PCB	1	--	--	7.7		0.3
Pentachlorophenol	1	3.0E-02	1.2E-01	0.65		0.3
Phenanthrene		--	--	0.27		0.3
Pyrene		--	--			0.3
Tetrachloroethylene	0.9	9.0E-03	--	0.048		0.3
Toluene	1	2.0E-01	--	0.045		0.3
Trichloroethylene	0.98	--	--	0.016		0.3
Trichlorofluoromethane	1	3.0E-01	--	0.017		0.3
Vinyl Chloride	1	1.3E-03	1.9E+00	0.0073		0.3
Xylenes	0.9	1.8E+00	--	0.08		0.3
RADIONUCLIDES						
Radium 228	0.2		2.0E-11	0.001	(c)	0.01
Radium 228+D	0.2		2.0E-11	0.001	(c)	0.01

Table D-30. Chemical Specific Values used in Evaluation of Dermal Exposure Pathways (continued)

COMPOUND	Gastrointestinal Absorption Factors (a)	Chronic Reference Dose Dermal Route (mg/kg-day)	Cancer Slope Factor (CSF): Dermal Route $(mg/kg\text{-}day)^{-1}$	Dermal Permeability Coefficient (b)	Dermal Absorption Factor (e)

(a) Gastrointestinal absorption factors are taken from EPA Region V guidance (EPA 1993d), the ATSDR toxicological profiles, and other literature sources (with priority asigned in the order listed). If no gastrointestinal absorption factor was available, a default value of one was used.

(b) Chemical specific permeability coefficients were taken from Table 5-7 in *Dermal Exposure Assessment: Principles and Applications* (EPA 1992c).

(c) The default permeability coefficient defined in *Dermal Exposure Assessment: Principles and Applications (EPA 1992c)* was used for these metals in the absence of chemical specific coefficients.

(d) The permeability coefficients for these compounds were derived using an algorithim in Table 5-5 of *Dermal Exposure Assessment: Principles and Applications* (EPA 1992c); note that the molecular weights of these compounds were greater than 150 and the log K_{ow}s were greater than 3.5.

(e) Default dermal absorption factors for tetrachlorobiphenyl (6%), 2,3,7,8-TCDD (3%), and cadmium (1%) are presented on Table 6-3 in *Dermal Exposure Assessment: Principles and Applications* (EPA 1992c). A memorandum from Karen A. Hammerstrom to Joan Dollarhide (EPA 1993f) states that these values are recommended for all PCB congeners, dioxin/furan congeners, and inorganics. Her memo also states that default dermal absorption factors of 30% for both SVOCs and VOCs seem reasonable.

Chromium. Chromium speciation (delineation of total chromium as chromium III versus chromium IV) was not conducted. Therefore, the risk assessment has assumed that the chromium is present in its hexavalent form (chromium IV). This is a conservative assumption because hexavalent chromium is a carcinogen by inhalation (whereas the trivalent form is not) and has a more stringent (i.e., lower) RfD than trivalent chromium (chromium III).

D.4.4 Risk Characterization

This section discusses the final step in the risk assessment process, risk characterization. Section D.4.4.1 presents an overview of risk characterization methods used in this assessment, and Section D.4.4.2 shows the results of risk characterization for each alternative by WMA.

D.4.4.1 Risk Characterization Methods

Risk characterization combines the exposure and toxicity assessments by comparing estimates of intake or dose with appropriate toxicity values. Results of this comparison provide an indication of the potential for adverse health effects to exposed receptors. The objective of the risk characterization is to determine whether exposure to chemicals within the exposure units poses risks that exceed EPA target levels for human health effects. The results of the risk assessment may thus support the selection of appropriate remedial alternatives.

General EPA Methods for Risk Assessment

This risk characterization presents a separate evaluation of noncancer and cancer effects because organisms typically respond differently after exposure to noncarcinogenic or carcinogenic agents.

The cancer risk is the probability of excess (incremental) lifetime cancer risk (ELCR) for an individual that can be attributed to long-term exposure to chemicals. The terms excess and incremental imply risk that may be attributable to the site. This means that health effects resulting from exposure to chemicals at other sites have been excluded. This does not however, mean that the risk from background has been excluded.

The procedure for calculating risk for exposure to carcinogenic compounds has been established by EPA (EPA 1989a). A nonthreshold, dose-response model is used to calculate a cancer slope (potency) factor (which mathematically is the slope of the dose-response curve) for each chemical. To derive an estimate of risk, the cancer slope factor is then multiplied by the estimated chronic daily dose (intake) experienced by the exposed individual:

$$Risk = CDI \times CSF \qquad \text{(D-16)}$$

where:

Risk	=	High-end estimate of the excess lifetime cancer risk to an individual (unitless probability)
CDI	=	Chronic daily dose averaged over a 70-yr period (mg/kg body weight/day)
CSF	=	95 percent upper-bound estimate of the slope of the dose-response curve (mg/kg body weight/day)$^{-1}$.

This equation assumes that the slope factor is a constant and that risk is directly proportional to intake. In evaluating risk of exposure to more than one carcinogen, the risk measure for each compound may be summed to for an overall estimate of total risk of cancer effects (EPA 1989a):

$$Risk_T = \sum_{i=1}^{n} Risk_i \qquad \text{(D-17)}$$

where:

$Risk_T$	=	The combined excess lifetime cancer risk across chemical carcinogens
$Risk_i$	=	The risk estimate for the i^{th} chemical of n chemicals under evaluation.

The above equation assumes that the chemicals have independent actions (no chemical interactions which may increase or decrease an individual chemical's toxicity) and that the chemicals produce the same effect (i.e., cancer). The summation of risks is conducted for each source of environmental release, each associated exposure pathway, and each receptor group at risk of exposure.

The traditionally accepted practice of evaluating exposure to noncarcinogenic compounds has been to experimentally determine a NOAEL and to divide it by a safety factor to establish an acceptable human dose, for example, acceptable daily intake or RfD. The RfD is then compared to the average daily dose experienced by the exposed population to obtain a measure of concern for adverse noncancer effects:

$$HQ = \frac{Dose}{RfD} \quad \text{(D-18)}$$

where:

HQ	=	Hazard Quotient: potential for adverse noncancer effects
Dose	=	Average daily dose for subchronic or chronic exposure (mg/kg body weight/day)
RfD	=	Acceptable intake for subchronic or chronic exposure (mg/kg body weight/day).

Dose and the RfD are expressed in the same units and are based upon common exposure periods (i.e., chronic [long-term], subchronic, or shorter-term). Guidelines for evaluating exposure to mixtures of noncarcinogens are presented by EPA (1989a). Essentially, the EPA-recommended approach involves summing the hazard quotients (ratio of daily dose/RfD) for the chemicals under evaluation to obtain the hazard index (HI).

After individual pathway risks are calculated, risks or hazard indices may be combined for a receptor. The risk assessor must exercise judgment in identifying "reasonable exposure pathway combinations" and in determining "whether it is likely that the same individuals would consistently face the RME by more than one pathway" (EPA 1989a).

EPA guidelines for interpreting noncancer and cancer effects have been adopted in the risk assessment. EPA has established target risk levels for use in determining the need for site remediation. For noncancer effects, EPA has set the target HQ at 1. If the HQ is greater than 1, there is the potential for adverse health effects at the given exposure/dose level. For multiple noncarcinogens, the HQs for the chemicals under evaluation are summed, resulting in the HI. If the HI is greater than 1, the potential also exists for adverse health effects resulting from exposure to mixtures of chemicals. In cases where the HQ for individual substances is less than 1 but several HQs sum to greater than 1, EPA recommends segregating the compounds into groups with like or common toxicological effects and re-evaluating the potential for the various adverse health effects. In cases where HQs for individual substances are greater than 1, this step is not necessary or useful.

For cancer effects, the target cancer risk range has been set at 1×10^{-4} to 1×10^{-6}. Cancer risks less than 10^{-6} are not typically considered a concern. EPA guidance is not as definitive concerning risks falling within the target risk range. In a memorandum entitled "Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions" (EPA 1991b), EPA Assistant Administrator Don R. Clay states, "Where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4}, and the non-carcinogenic hazard quotient is less than 1, action generally is not warranted..." although "...a risk manager may also decide that a baseline risk level less than 10^{-4} is unacceptable due to site specific reasons."

In the risk characterization, chemicals of concern (COCs) are identified. Using guidance presented in the Clay memorandum, COCs in the human health risk assessment are defined as individual chemicals that contribute to a pathway that exceeds a 10^{-4} risk or an HI of 1. COCs may either independently exceed EPA targets or combine to exceed EPA targets.

D.4.4.2 Risk Characterization Results

The following subsections present the risk characterization results. Results for each alternative and WMA are discussed separately. A risk characterization summary is provided for each alternative in Tables D-31 through D-34. As an additional point of comparison, Tables D-35 through D-37 present hypothetical risk estimates based on background data. Background contaminant concentration data for each WMA are summarized in Table D-21, Differences in the hypothetical background risk across alternatives are determined by the differing scenario conditions summarized in Table D-22.

Each table presents quantitative results of the risk assessment and a letter designator interpreting the estimates in light of EPA targets. In the summary tables, risk estimates that are below the noncancer HI of 1 or the lower end of EPA's cancer target risk range ($<10^{-6}$) are indicated with a "B." "E" designates risk exceeding the noncancer HI of 1 or the upper end of the cancer target risk range (10^{-4}). Cancer risk estimates within the EPA target cancer risk range (10^{-6} to 10^{-4}) are designated with a "W."

EPA recommends that risk estimates be reported to one significant figure. Thus, risk estimates were rounded to one significant figure in the last step when reporting total site risk estimates. In the text, scientific notation is used when needed to avoid overstating the precision of the estimates.

Alternative III (In-Place Stabilization)

The risk characterization summary for Alternative III is presented in Table D-31. Risks are presented separately for each WMA and for the receptors at Buttermilk Creek. No soil or produce exposures were evaluated under Alternative III since soils would be stabilized in place.

WMA 4. Noncancer hazard indices for soil, sediment, and groundwater exposures for WMA 4 are below the EPA noncancer target ($HI<1$). Cancer risks for residents and discoverers (both child and adult receptors) fall below or within the EPA target cancer risk range, whereas cancer risks for the worker fall below the target range. The pathway responsible for resident and discoverer risks within the range is dermal contact with sediment. Arsenic and beryllium combined are responsible for approximately 99 percent of the sediment dermal contact risks.

Table D-31. Risk Characterization Summary for Reasonable Maximum Exposure Risks: Alternative III (In-Place Stabilization)[a]

Media	Exposure Route	Noncancer					Cancer				
		Residential		Worker (Operational)	Discoverer/Recreational		Residential		Worker (Operational)	Discoverer/Recreational	
		Child	Adult		Child	Adult	Child	Adult		Child	Adult
WMA 4:											
Soil	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Produce	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sediment	Dermal Contact	$2.41x10^{-1}$ B	$1.49x10^{-1}$ B	NA	$2.41x10^{-1}$ B	$1.49x10^{-1}$ B	$1.10x10^{-5}$ W	$3.41x10^{-5}$ W	NA	$1.10x10^{-5}$ W	$3.41x10^{-5}$ W
Groundwater	Ingestion	$1.33x10^{-3}$ B	$5.70x10^{-4}$ B	$2.03x10^{-4}$ B	NA	NA	$1.83x10^{-8}$ B	$3.93x10^{-8}$ B	$1.17x10^{-8}$ B	NA	NA
Chemical Hazards Combined Exposure:											
Hazard Index (HI):		$2x10^{-1}$ B	$1x10^{-1}$ B	$2x10^{-4}$ B	$2x10^{-1}$ B	$1x10^{-1}$ B					
Excess Lifetime Cancer Risk:							$1x10^{-5}$ W	$3x10^{-5}$ W	$1x10^{-8}$ B	$1x10^{-5}$ W	$3x10^{-5}$ W
WMA 7:											
Soil	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sediment	Dermal Contact	$3.31x10^{-2}$ B	$2.05x10^{-2}$ B	NA	$3.31x10^{-2}$ B	$2.05x10^{-2}$ B	$5.98x10^{-6}$ W	$1.85x10^{-5}$ W	NA	$5.98x10^{-6}$ W	$1.85x10^{-5}$ W
Produce	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Groundwater (Weathered Lavery Till)	Ingestion	$2.01x10^{-3}$ B	$8.60x10^{-4}$ B	$3.07x10^{-4}$ B	NA	NA	$6.23x10^{-8}$ B	$1.34x10^{-7}$ B	$3.98x10^{-8}$ B	NA	NA
Groundwater (Unweathered Lavery Till)	Ingestion	$1.37x10^{-3}$ B	$5.88x10^{-4}$ B	$2.10x10^{-4}$ B	NA	NA	$4.96x10^{-8}$ B	$1.06x10^{-7}$ B	$3.16x10^{-8}$ B	NA	NA
Chemical Hazards Combined Exposure:											
Hazard Index (HI):		$4x10^{-2}$ B	$2x10^{-2}$ B	$5x10^{-4}$ B	$3x10^{-2}$ B	$2x10^{-2}$ B					
Excess Lifetime Cancer Risk:							$6x10^{-6}$ W	$2x10^{-5}$ W	$7x10^{-8}$ W	$6x10^{-6}$ W	$2x10^{-5}$ W
WMA 8:											
Soil	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sediment	Dermal Contact	$7.13x10^{-2}$ B	$5.23x10^{-2}$ B	NA	$7.13x10^{-2}$ B	$4.41x10^{-2}$ B	$8.14x10^{-6}$ W	$2.52x10^{-5}$ W	NA	$8.14x10^{-6}$ W	$2.52x10^{-5}$ W
Produce	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Groundwater (Weathered Lavery Till)	Ingestion	$9.78x10^{-4}$ B	$4.19x10^{-4}$ B	$1.50x10^{-4}$ B	NA	NA	$1.30x10^{-8}$ B	$2.78x10^{-8}$ B	$8.26x10^{-9}$ B	NA	NA
Groundwater (Unweathered Lavery Till)	Ingestion	$5.56x10^{-4}$ B	$2.38x10^{-4}$ B	$8.50x10^{-5}$ B	NA	NA	$1.46x10^{-8}$ B	$3.13x10^{-8}$ B	$9.33x10^{-9}$ B	NA	NA
Chemical Hazards Combined Exposure:											
Hazard Index (HI):		$7x10^{-2}$ B	$5x10^{-2}$ B	$2x10^{-4}$ B	$7x10^{-2}$ B	$4x10^{-2}$ B					
Excess Lifetime Cancer Risk:							$8x10^{-6}$ W	$3x10^{-5}$ W	$2x10^{-8}$ B	$8x10^{-6}$ W	$3x10^{-5}$ W
Buttermilk Creek:											
Surface Water (WMA 4)	Ingestion	$5.46x10^{-10}$ B	$2.34x10^{-10}$ B	NA	NA	NA	$0.00x10^{0}$ B	$0.00x10^{0}$ B	NA	NA	NA
Surface Water (WMA 7)	Ingestion	$2.07x10^{-8}$ B	$8.85x10^{-9}$ B	NA	NA	NA	$1.72x10^{-14}$ B	$3.69x10^{-14}$ B	NA	NA	NA
Surface Water (WMA 8)	Ingestion	$2.78x10^{-5}$ B	$1.19x10^{-5}$ B	NA	NA	NA	$7.76x10^{-11}$ B	$1.66x10^{-10}$ B	NA	NA	NA
Fish (WMA 4)	Ingestion	$2.95x10^{-8}$ B	$1.91x10^{-8}$ B	NA	$2.95x10^{-8}$ B	$1.91x10^{-8}$ B	$0.00x10^{0}$ B	$0.00x10^{0}$ B	NA	$0.00x10^{0}$ B	$0.00x10^{0}$ B
Fish (WMA 7)	Ingestion	$1.86x10^{-4}$ B	$1.21x10^{-4}$ B	NA	$1.86x10^{-4}$ B	$1.21x10^{-4}$ B	$1.42x10^{-9}$ B	$4.61x10^{-9}$ B	NA	$1.42x10^{-9}$ B	$4.61x10^{-9}$ B
Fish (WMA 8)	Ingestion	$6.46x10^{-1}$ B	$4.18x10^{-1}$ B	NA	$6.46x10^{-1}$ B	$4.18x10^{-1}$ B	$1.02x10^{-6}$ W	$3.31x10^{-6}$ W	NA	$1.02x10^{-6}$ W	$3.31x10^{-6}$ W
Chemical Hazards Combined Exposure:											
Hazard Index (HI):		$6x10^{-1}$ B	$4x10^{-1}$ B	NA	$6x10^{-1}$ B	$4x10^{-1}$ B					
Excess Lifetime Cancer Risk:							$1x10^{-6}$ W	$3x10^{-6}$ W	NA	$1x10^{-6}$ W	$3x10^{-6}$ W

a. B = below EPA target noncancer hazard index (HI) (HI < 1) or cancer risk (ELCR < $1x10^{6}$)
W = within EPA target for cancer risk range (ELCR > = $1x10^{-6}$ and < $1x10^{-4}$)
E = exceeds EPA target for noncancer target hazard index (HI > = 1), or cancer risk (ELCR > = $1x10^{4}$)
NA = not applicable.

Table D-32. Risk Characterization Summary for Reasonable Maximum Exposure Risks: Alternative IV (No Action: Monitoring and Maintenance)[a]

Media	Exposure Route	Noncancer: Residential Child	Noncancer: Residential Adult	Noncancer: Worker (Operational)	Noncancer: Discoverer/Recreational Child	Noncancer: Discoverer/Recreational Adult	Cancer: Residential Child	Cancer: Residential Adult	Cancer: Worker (Operational)	Cancer: Discoverer/Recreational Child	Cancer: Discoverer/Recreational Adult
WMA 4:											
Soil	Ingestion	NA	NA	5.54×10^{-2} B	NA	NA	NA	NA	7.91×10^{-6} W	NA	NA
	Dermal Contact	NA	NA	3.86×10^{-2} B	NA	NA	NA	NA	1.45×10^{-5} W	NA	NA
Produce	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sediment	Dermal Contact	2.41×10^{-1} B	1.49×10^{-1} B	1.49×10^{-1} B	2.41×10^{-1} B	1.49×10^{-1} B	1.10×10^{-5} W	3.41×10^{-5} W	2.84×10^{-5} W	1.10×10^{-5} W	3.41×10^{-5} W
Groundwater	Ingestion	NA	NA	4.23×10^{-5} B	NA	NA	NA	NA	2.43×10^{-9} B	NA	NA
Chemical Hazards Combined Exposure:											
Hazard Index (HI):		2×10^{-1} B	1×10^{-1} B	2×10^{-1} B	2×10^{-1} B	1×10^{-1} B					
Excess Lifetime Cancer Risk:							1×10^{-5} W	3×10^{-5} W	5×10^{-5} W	1×10^{-5} W	3×10^{-5} W
WMA 7:											
Soil	Ingestion	NA	NA	2.69×10^{-2} B	NA	NA	NA	NA	3.22×10^{-6} W	NA	NA
	Dermal Contact	NA	NA	1.87×10^{-2} B	NA	NA	NA	NA	8.11×10^{-6} W	NA	NA
Sediment	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Produce	Dermal Contact	3.31×10^{-2} B	2.05×10^{-2} B	2.05×10^{-2} B	3.31×10^{-2} B	2.05×10^{-2} B	5.98×10^{-6} W	1.85×10^{-5} W	1.54×10^{-5} W	5.98×10^{-6} W	1.85×10^{-5} W
Groundwater (Weathered Lavery Till)	Ingestion	NA	NA	6.39×10^{-5} B	NA	NA	NA	NA	8.27×10^{-9} B	NA	NA
Groundwater (Unweathered Lavery Till)	Ingestion	NA	NA	4.37×10^{-5} B	NA	NA	NA	NA	6.58×10^{-9} B	NA	NA
Chemical Hazards Combined Exposure:											
Hazard Index (HI):		3×10^{-2} B	2×10^{-2} B	4×10^{-2} B	3×10^{-2} B	2×10^{-2} B					
Excess Lifetime Cancer Risk:							6×10^{-6} W	2×10^{-5} W	2×10^{-5} W	6×10^{-6} W	2×10^{-5} W
WMA 8:											
Soil	Ingestion	NA	NA	5.05×10^{-2} B	NA	NA	NA	NA	8.25×10^{-6} W	NA	NA
	Dermal Contact	NA	NA	2.48×10^{-2} B	NA	NA	NA	NA	1.58×10^{-5} W	NA	NA
Sediment	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Produce	Dermal Contact	7.13×10^{-2} B	5.23×10^{-2} B	4.41×10^{-2} B	7.13×10^{-2} B	4.41×10^{-2} B	8.14×10^{-6} W	2.52×10^{-5} W	2.10×10^{-5} W	8.14×10^{-6} W	2.52×10^{-5} W
Groundwater (Weathered Lavery Till)	Ingestion	NA	NA	3.11×10^{-5} B	NA	NA	NA	NA	1.72×10^{-9} B	NA	NA
Groundwater (Unweathered Lavery Till)	Ingestion	NA	NA	1.77×10^{-5} B	NA	NA	NA	NA	1.94×10^{-9} B	NA	NA
Chemical Hazards Combined Exposure:											
Hazard Index (HI):		7×10^{-2} B	5×10^{-2} B	7×10^{-2} B	7×10^{-2} B	4×10^{-2} B					
Excess Lifetime Cancer Risk:							8×10^{-6} W	3×10^{-5} W	4×10^{-5} W	8×10^{-6} W	3×10^{-5} W
Buttermilk Creek:											
Surface Water (WMA 4)	Ingestion	8.46×10^{-10} B	3.63×10^{-10} B	NA	NA	NA	0.00×10^{0} B	0.00×10^{0} B	NA	NA	NA
Surface Water (WMA 7)	Ingestion	3.99×10^{-8} B	1.71×10^{-8} B	NA	NA	NA	3.33×10^{-14} B	7.13×10^{-14} B	NA	NA	NA
Surface Water (WMA 8)	Ingestion	3.62×10^{-5} B	1.55×10^{-5} B	NA	NA	NA	1.01×10^{-10} B	2.16×10^{-10} B	NA	NA	NA
Fish (WMA 4)	Ingestion	4.57×10^{-8} B	2.96×10^{-8} B	NA	4.57×10^{-8} B	2.96×10^{-8} B	0.00×10^{0} B	0.00×10^{0} B	NA	0.00×10^{0} B	0.00×10^{0} B
Fish (WMA 7)	Ingestion	3.59×10^{-4} B	2.33×10^{-4} B	NA	3.59×10^{-4} B	2.33×10^{-4} B	2.75×10^{-9} B	8.90×10^{-9} B	NA	2.75×10^{-9} B	8.90×10^{-9} B
Fish (WMA 8)	Ingestion	8.39×10^{-1} B	5.43×10^{-1} B	NA	8.39×10^{-1} B	5.43×10^{-1} B	1.33×10^{-6} W	4.30×10^{-6} W	NA	1.33×10^{-6} W	4.30×10^{-6} W
Chemical Hazards Combined Exposure:											
Hazard Index (HI):		8×10^{-1} B	5×10^{-1} B	NA	8×10^{-1} B	5×10^{-1} B					
Excess Lifetime Cancer Risk:							1×10^{-6} W	4×10^{-6} W	NA	1×10^{-6} W	4×10^{-6} W

a. B = below EPA target noncancer hazard index (HI) (HI < 1), or cancer risk (ELCR < 1×10^{-6})
W = within EPA target for cancer risk range (ELCR >= 1×10^{-6} and < 1×10^{-4})
E = exceeds EPA target for noncancer target hazard index (HI >= 1), or cancer risk (ELCR >= 1×10^{-4})
NA = not applicable.

Table D-33. **Risk Characterization Summary for RME and CTE Risks (Catastrophic Release Scenario) for WMA 8: Alternative V (Discontinue Operations)[a]**

	RME				
	Residential		Worker	Discoverer/Recreational	
Trenches	Child	Adult	(Operational)	Child	Adult
1, 2, and 8	7.65×10^{-2} B	3.28×10^{-2} B	NA	NA	NA
3 and 9	9.85×10^{-2} B	4.22×10^{-2} B	NA	NA	NA
4 and 10	1.04×10^{-1} B	4.44×10^{-2} B	NA	NA	NA
5 and 11	4.71×10^{-2} B	2.02×10^{-2} B	NA	NA	NA
12	3.61×10^{-2} B	1.55×10^{-2} B	NA	NA	NA
13	2.66×10^{-2} B	1.14×10^{-2} B	NA	NA	NA
14	2.05×10^{-3} B	8.77×10^{-4} B	NA	NA	NA

	CTE				
	Residential		Worker	Discoverer/Recreational	
Trenches	Child	Adult	(Operational)	Child	Adult
1, 2, and 8	7.65×10^{-2} B	2.30×10^{-2} B	NA	NA	NA
3 and 9	9.85×10^{-2} B	2.96×10^{-2} B	NA	NA	NA
4 and 10	1.04×10^{-1} B	3.11×10^{-2} B	NA	NA	NA
5 and 11	4.71×10^{-2} B	1.41×10^{-2} B	NA	NA	NA
12	3.61×10^{-2} B	1.08×10^{-2} B	NA	NA	NA
13	2.66×10^{-2} B	7.99×10^{-3} B	NA	NA	NA
14	2.05×10^{-3} B	6.14×10^{-4} B	NA	NA	NA

a. RME = reasonable maximum exposure.
B = below USEPA target noncancer hazard index (HI<1).
NA = not applicable.
CTE = central tendency exposure

Table D-34. Risk Characterization Summary for Reasonable Maximum Exposure Risks: Alternative V (Discontinue Operations)[a]

		Noncancer					Cancer				
		Residential		Worker	Discoverer/Recreational		Residential		Worker	Discoverer/Recreational	
Media	Exposure Route	Child	Adult	(Operational)	Child	Adult	Child	Adult	(Operational)	Child	Adult
Soil	Ingestion	6.43×10^{-1} B	6.89×10^{-2} B	NA	2.15×10^{-1} B	2.31×10^{-2} B	2.38×10^{-5} W	1.02×10^{-5} W	NA	7.38×10^{-6} W	3.16×10^{-6} W
	Dermal Contact	2.20×10^{-1} B	1.36×10^{-1} B	NA	1.25×10^{-1} B	7.71×10^{-2} B	3.01×10^{-5} W	7.44×10^{-5} W	NA	1.13×10^{-5} W	2.78×10^{-5} W
Produce	Ingestion	3.53×10^{0} E	1.10×10^{0} E	NA	NA	NA	1.06×10^{-4} E	1.64×10^{-4} E	NA	NA	NA
Sediment	Dermal Contact	2.41×10^{-1} B	1.49×10^{-1} B	NA	2.41×10^{-1} B	1.49×10^{-1} B	1.10×10^{-5} W	3.41×10^{-5} W	NA	1.10×10^{-5} W	3.41×10^{-5} W
Groundwater	Ingestion	1.33×10^{-3} B	5.70×10^{-4} B	NA	NA	NA	1.83×10^{-8} B	3.93×10^{-8} B	NA	NA	NA
Chemical Hazards Combined Exposure:											
Hazard Index (HI):		5×10^{0} E	1×10^{0} E	NA	6×10^{-1} B	2×10^{-1} B					
Excess Lifetime Cancer Risk:							2×10^{-4} E	3×10^{-4} E	NA	3×10^{-5} W	7×10^{-5} W
WMA 7:											
Soil	Ingestion	3.81×10^{-1} B	4.08×10^{-2} B	NA	1.05×10^{-1} B	1.12×10^{-2} B	1.12×10^{-5} W	4.80×10^{-6} W	NA	3.00×10^{-6} W	1.29×10^{-6} W
	Dermal Contact	2.21×10^{-1} B	1.36×10^{-1} B	NA	6.05×10^{-2} B	3.74×10^{-2} B	2.87×10^{-5} W	7.11×10^{-5} W	NA	6.30×10^{-6} W	1.56×10^{-5} W
Produce	Ingestion	2.30×10^{0} E	7.17×10^{-1} B	NA	NA	NA	4.27×10^{-5} W	6.65×10^{-5} W	NA	NA	NA
Sediment	Dermal Contact	3.31×10^{-2} B	2.05×10^{-2} B	NA	3.31×10^{-2} B	2.05×10^{-2} B	5.98×10^{-6} W	1.85×10^{-5} W	NA	5.98×10^{-6} W	1.85×10^{-5} W
Groundwater (Weathered Lavery Till)	Ingestion	2.01×10^{-3} B	8.60×10^{-4} B	NA	NA	NA	6.23×10^{-8} B	1.34×10^{-7} B	NA	NA	NA
Groundwater (Unweathered Lavery Till)	Ingestion	1.37×10^{-3} B	5.88×10^{-4} B	NA	NA	NA	4.96×10^{-8} B	1.06×10^{-7} B	NA	NA	NA
Chemical Hazards Combined Exposure:											
Hazard Index (HI):		3×10^{0} E	9×10^{-1} B	NA	9×10^{-2} B	6×10^{-2} B					
Excess Lifetime Cancer Risk:							8×10^{-5} W	2×10^{-4} E	NA	1×10^{-5} W	3×10^{-5} W
WMA 8:											
Soil	Ingestion	1.32×10^{0} E	1.41×10^{-1} B	NA	1.96×10^{-1} B	2.10×10^{-2} B	2.93×10^{-5} W	1.26×10^{-5} W	NA	7.70×10^{-6} W	3.30×10^{-6} W
	Dermal Contact	1.16×10^{0} E	7.18×10^{-1} B	NA	8.01×10^{-2} B	4.95×10^{-2} B	4.48×10^{-5} W	1.11×10^{-4} E	NA	1.22×10^{-5} W	3.03×10^{-5} W
Produce	Ingestion	1.23×10^{1} E	3.83×10^{0} E	NA	NA	NA	1.27×10^{-4} E	1.97×10^{-4} E	NA	NA	NA
Sediment	Dermal Contact	7.13×10^{-2} B	5.23×10^{-2} B	NA	7.13×10^{-2} B	4.41×10^{-2} B	8.14×10^{-6} W	2.52×10^{-5} W	NA	8.14×10^{-6} W	2.52×10^{-5} W
Groundwater (Weathered Lavery Till)	Ingestion	9.78×10^{-4} B	4.19×10^{-4} B	NA	NA	NA	1.30×10^{-8} B	2.78×10^{-8} B	NA	NA	NA
Groundwater (Unweathered Lavery Till)	Ingestion	5.56×10^{-4} B	2.38×10^{-4} B	NA	NA	NA	1.46×10^{-8} B	3.13×10^{-8} B	NA	NA	NA
Chemical Hazards Combined Exposure:											
Hazard Index (HI):		1×10^{1} E	5×10^{0} E	NA	2×10^{-1} B	9×10^{-2} B					
Excess Lifetime Cancer Risk:							2×10^{-4} E	3×10^{-4} E	NA	2×10^{-5} W	6×10^{-5} W
Buttermilk Creek:											
Surface Water (WMA 4)	Ingestion	8.46×10^{-10} B	3.63×10^{-10} B	NA	NA	NA	0.00×10^{0} B	0.00×10^{0} B	NA	NA	NA
Surface Water (WMA 7)	Ingestion	3.99×10^{-8} B	1.71×10^{-8} B	NA	NA	NA	3.33×10^{-14} B	7.13×10^{-14} B	NA	NA	NA
Surface Water (WMA 8)	Ingestion	3.62×10^{-5} B	1.55×10^{-5} B	NA	NA	NA	1.01×10^{-10} B	2.16×10^{-10} B	NA	NA	NA
Fish (WMA 4)	Ingestion	4.57×10^{-8} B	2.96×10^{-8} B	NA	4.57×10^{-8} B	2.96×10^{-8} B	0.00×10^{0} B	0.00×10^{0} B	NA	0.00×10^{0} B	0.00×10^{0} B
Fish (WMA 7)	Ingestion	3.59×10^{-4} B	2.33×10^{-4} B	NA	3.59×10^{-4} B	2.33×10^{-4} B	2.75×10^{-9} B	8.90×10^{-9} B	NA	2.75×10^{-9} B	8.90×10^{-9} B
Fish (WMA 8)	Ingestion	8.39×10^{-1} B	5.43×10^{-1} B	NA	8.39×10^{-1} B	5.43×10^{-1} B	1.33×10^{-6} W	4.30×10^{-6} W	NA	1.33×10^{-6} W	4.30×10^{-6} W
Chemical Hazards Combined Exposure:											
Hazard Index (HI):		8×10^{-1} B	5×10^{-1} B	NA	8×10^{-1} B	5×10^{-1} B					
Excess Lifetime Cancer Risk:							1×10^{-6} W	4×10^{-6} W	NA	1×10^{-6} W	4×10^{-6} W

a. B = below EPA target noncancer hazard index (HI) (HI<1) or cancer risk (ELCR<1×10^{6})
W = within EPA target for cancer risk range (ELCR>=1×10^{6} and <1×10^{-4})
E = exceeds EPA target for noncancer target hazard index (HI>=1), or cancer risk (ELCR>=1×10^{4})
NA = not applicable.

Table D-35. Risk Characterization Summary for Reasonable Maximum Exposure Risks: Background for Alternative III (In-Place Stabilization)[a]

		Noncancer					Cancer				
		Residential		Worker	Discoverer/Recreational		Residential		Worker	Discoverer/Recreational	
Media	Exposure Route	Child	Adult	(Operational)	Child	Adult	Child	Adult	(Operational)	Child	Adult
WMA 4 (Background):											
Soil	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Produce	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sediment	Dermal Contact	$4.84x10^{-2}$ B	$2.99x10^{-2}$ B	NA	$4.84x10^{-2}$ B	$2.99x10^{-2}$ B	$5.13x10^{-6}$ W	$1.59x10^{-5}$ W	NA	$5.13x10^{-6}$ W	$1.59x10^{-5}$ W
Groundwater	Ingestion	$1.70x10^{-4}$ B	$7.28x10^{-5}$ B	$2.60x10^{-5}$ B	NA	NA	$0.00x10^{0}$ B	$0.00x10^{0}$ B	$0.00x10^{0}$ B	NA	NA
Chemical Hazards Combined Exposure:											
Hazard Index (HI):		$5x10^{-2}$ B	$3x10^{-2}$ B	$3x10^{-5}$ B	$5x10^{-2}$ B	$3x10^{-2}$ B					
Excess Lifetime Cancer Risk:							$5x10^{-6}$ W	$2x10^{-5}$ W	$0x10^{0}$ B	$5x10^{-6}$ W	$2x10^{-5}$ W
WMA 7 (Background):											
Soil	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Produce	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sediment	Dermal Contact	$4.83x10^{-2}$ B	$2.72x10^{-2}$ B	NA	$4.83x10^{-2}$ B	$2.99x10^{-2}$ B	$5.10x10^{-6}$ W	$1.58x10^{-5}$ W	NA	$5.10x10^{-6}$ W	$1.58x10^{-5}$ W
Groundwater (Weathered Lavery Till)	Ingestion	$1.73x10^{-3}$ B	$7.43x10^{-4}$ B	$2.65x10^{-4}$ B	NA	NA	$6.90x10^{-8}$ B	$1.48x10^{-7}$ B	$4.40x10^{-8}$ B	NA	NA
Groundwater (Unweathered Lavery Till)	Ingestion	$6.01x10^{-4}$ B	$2.58x10^{-4}$ B	$9.20x10^{-5}$ B	NA	NA	$0.00x10^{0}$ B	$0.00x10^{0}$ B	$0.00x10^{0}$ B	NA	NA
Chemical Hazards Combined Exposure:											
Hazard Index (HI):		$5x10^{-2}$ B	$3x10^{-2}$ B	$4x10^{-4}$ B	$5x10^{-2}$ B	$3x10^{-2}$ B					
Excess Lifetime Cancer Risk:							$5x10^{-6}$ W	$2x10^{-5}$ W	$4x10^{-8}$ W	$5x10^{-6}$ W	$2x10^{-5}$ W
WMA 8 (Background):											
Soil	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Produce	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sediment	Dermal Contact	$4.83x10^{-2}$ B	$2.99x10^{-2}$ B	NA	$4.83x10^{-2}$ B	$2.99x10^{-2}$ B	$5.10x10^{-6}$ W	$1.58x10^{-5}$ W	NA	$5.10x10^{-6}$ W	$1.58x10^{-5}$ W
Groundwater (Weathered Lavery Till)	Ingestion	$1.73x10^{-3}$ B	$7.43x10^{-4}$ B	$2.65x10^{-4}$ B	NA	NA	$6.90x10^{-8}$ B	$1.48x10^{-7}$ B	$4.40x10^{-8}$ B	NA	NA
Groundwater (Unweathered Lavery Till)	Ingestion	$6.01x10^{-4}$ B	$2.58x10^{-4}$ B	$9.20x10^{-5}$ B	NA	NA	$0.00x10^{0}$ B	$0.00x10^{0}$ B	$0.00x10^{0}$ B	NA	NA
Chemical Hazards Combined Exposure:											
Hazard Index (HI):		$5x10^{-2}$ B	$3x10^{-2}$ B	$4x10^{-4}$ B	$5x10^{-2}$ B	$3x10^{-2}$ B					
Excess Lifetime Cancer Risk:							$5x10^{-6}$ W	$2x10^{-5}$ W	$4x10^{-8}$ B	$5x10^{-6}$ W	$2x10^{-5}$ W

a. B = below EPA target noncancer hazard index (HI) (HI < 1) or cancer risk (ELCR < $1x10^{-6}$)
W = within EPA target for cancer risk range (ELCR >= $1x10^{-6}$ and < $1x10^{-4}$)
E = exceeds EPA target for noncancer target hazard index (HI >= 1), or cancer risk (ELCR >= $1x10^{-4}$)
NA = not applicable.

Table D-36. Risk Characterization Summary for Reasonable Maximum Exposure Risks: Background for Alternative IV (No Action: Monitoring and Maintenance)[a]

Media	Exposure Route	Noncancer					Cancer				
		Residential		Worker	Discoverer/Recreational		Residential		Worker	Discoverer/Recreational	
		Child	Adult	(Operational)	Child	Adult	Child	Adult	(Operational)	Child	Adult
WMA 4 (Background):											
Soil	Ingestion	5.36x10^{-1} B	5.74x10^{-2} B	NA	1.44x10^{-1} B	1.55x10^{-2} B	1.50x10^{-5} W	6.43x10^{-6} W	NA	3.97x10^{-6} W	1.70x10 W
	Dermal Contact	3.80x10^{-1} B	2.35x10^{-1} B	NA	1.10x10^{-1} B	6.79x10^{-2} B	3.24x10^{-5} W	8.01x10^{-5} W	NA	9.57x10^{-6} W	2.37x10 W
Produce	Ingestion	3.69x10^{0} E	1.15x10^{0} E	NA	NA	NA	6.02x10^{-5} W	9.37x10^{-5} W	NA	NA	NA
Sediment	Dermal Contact	4.84x10^{-2} B	2.99x10^{-2} B	NA	4.84x10^{-2} B	2.99x10^{-2} B	5.13x10^{-6} W	1.59x10^{-5} W	NA	5.13x10^{-6} W	1.59x10 W
Groundwater	Ingestion	1.70x10^{-4} B	7.28x10^{-5} B	NA	NA	NA	0.00x10^{0} B	0.00x10^{0} B	NA	NA	NA
Chemical Hazards Combined Exposure:											
Hazard Index (HI):		5x10^{0} E	1x10^{0} E	NA	3x10^{-1} B	1x10^{-1} B					
Excess Lifetime Cancer Risk:							1x10^{-4} E	2x10^{-4} E	NA	2x10^{-5} W	4x10^{-5} W
WMA 7 (Background):											
Soil	Ingestion	4.00x10^{-1} B	4.29x10^{-2} B	NA	1.18x10^{-1} B	1.27x10^{-2} B	1.48x10^{-5} W	6.34x10^{-6} W	NA	4.40x10^{-6} W	1.88x10 W
	Dermal Contact	1.78x10^{-1} B	1.10x10^{-1} B	NA	5.23x10^{-2} B	3.23x10^{-2} B	2.86x10^{-5} W	7.06x10^{-5} W	NA	8.49x10^{-6} W	2.10x10 W
Produce	Ingestion	2.68x10^{0} E	8.35x10^{-1} B	NA	NA	NA	6.10x10^{-5} W	9.49x10^{-5} W	NA	NA	NA
Sediment	Dermal Contact	4.83x10^{-2} B	2.72x10^{-2} B	NA	4.83x10^{-2} B	2.99x10^{-2} B	5.10x10^{-6} W	1.58x10^{-5} W	NA	5.10x10^{-6} W	1.58x10 W
Groundwater (Weathered Lavery Till)	Ingestion	1.73x10^{-3} B	7.43x10^{-4} B	NA	NA	NA	6.90x10^{-8} B	1.48x10^{-7} B	NA	NA	NA
Groundwater (Unweathered Lavery Till)	Ingestion	6.01x10^{-4} B	2.58x10^{-4} B	NA	NA	NA	0.00x10^{0} B	0.00x10^{0} B	NA	NA	NA
Chemical Hazards Combined Exposure:											
Hazard Index (HI):		3x10^{0} E	1x10^{0} B	NA	1x10^{-1} B	6x10^{-2} B					
Excess Lifetime Cancer Risk:							9x10^{-5} W	2x10^{-4} W	NA	1x10^{-5} W	4x10^{-5} W
WMA 8 (Background):											
Soil	Ingestion	4.09x10^{-1} B	4.38x10^{-2} B	NA	1.11x10^{-1} B	1.19x10^{-2} B	1.67x10^{-5} W	7.17x10^{-6} W	NA	3.99x10^{-6} W	1.71x10 W
	Dermal Contact	1.77x10^{-1} B	1.10x10^{-1} B	NA	4.51x10^{-2} B	2.79x10^{-2} B	3.46x10^{-5} W	8.55x10^{-5} W	NA	4.22x10^{-7} B	1.04x10 W
Produce	Ingestion	2.86x10^{0} E	8.89x10^{-1} B	NA	NA	NA	6.78x10^{-5} W	1.06x10^{-4} W	NA	NA	NA
Sediment	Dermal Contact	4.83x10^{-2} B	2.99x10^{-2} B	NA	4.83x10^{-2} B	2.99x10^{-2} B	5.10x10^{-6} W	1.58x10^{-5} W	NA	5.10x10^{-6} W	1.58x10 W
Groundwater (Weathered Lavery Till)	Ingestion	1.73x10^{-3} B	7.43x10^{-4} B	NA	NA	NA	6.90x10^{-8} B	1.48x10^{-7} B	NA	NA	NA
Groundwater (Unweathered Lavery Till)	Ingestion	6.01x10^{-4} B	2.58x10^{-4} B	NA	NA	NA	0.00x10^{0} B	0.00x10^{0} B	NA	NA	NA
Chemical Hazards Combined Exposure:											
Hazard Index (HI):		3x10^{0} B	1x10^{0} B	NA	9x10^{-2} B	6x10^{-2} B					
Excess Lifetime Cancer Risk:							1x10^{-4} E	2x10^{-4} E	NA	6x10^{-6} W	2x10^{-5} W

a. B = below EPA target noncancer hazard index (HI) (HI<1) or cancer risk (ELCR<1x10^{-6})
W = within EPA target for cancer risk range (ELCR>=1x10^{-6} and <1x10^{-4})
E = exceeds EPA target for noncancer target hazard index (HI>=1), or cancer risk (ELCR>=1x10^{-4})
NA = not applicable.

Table D-37. Risk Characterization Summary for Reasonable Maximum Exposure Risks: Background for Alternative V (Discontinue Operations)[a]

Media	Exposure Route	Noncancer: Residential Child	Noncancer: Residential Adult	Noncancer: Worker (Operational)	Noncancer: Discoverer/Recreational Child	Noncancer: Discoverer/Recreational Adult	Cancer: Residential Child	Cancer: Residential Adult	Cancer: Worker (Operational)	Cancer: Discoverer/Recreational Child	Cancer: Discoverer/Recreational Adult
WMA 4 (Background):											
Soil	Ingestion	NA	NA	3.71×10^{-2} B	NA	NA	NA	NA	4.25×10^{-6} W	NA	NA
	Dermal Contact	NA	NA	3.39×10^{-2} B	NA	NA	NA	NA	1.23×10^{-5} W	NA	NA
Produce	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sediment	Dermal Contact	4.84×10^{-2} B	2.99×10^{-2} B	2.99×10^{-2} B	4.84×10^{-2} B	2.99×10^{-2} B	5.13×10^{-6} W	1.59×10^{-5} W	1.32×10^{-5} W	5.13×10^{-6} W	1.59×10^{-5} W
Groundwater	Ingestion	NA	NA	5.41×10^{-6} B	NA	NA	NA	NA	0.00×10^{0} B	NA	NA
Chemical Hazards Combined Exposure:											
Hazard Index (HI):		5×10^{-2} B	3×10^{-2} B	1×10^{-1} B	5×10^{-2} B	3×10^{-2} B					
Excess Lifetime Cancer Risk:							5×10^{-6} W	2×10^{-5} W	NA	5×10^{-6} W	2×10^{-5} W
WMA 7 (Background):											
Soil	Ingestion	NA	NA	3.04×10^{-2} B	NA	NA	NA	NA	4.71×10^{-6} W	NA	NA
	Dermal Contact	NA	NA	1.62×10^{-2} B	NA	NA	NA	NA	1.09×10^{-5} W	NA	NA
Produce	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sediment	Dermal Contact	4.83×10^{-2} B	2.72×10^{-2} B	2.99×10^{-2} B	4.83×10^{-2} B	2.99×10^{-2} B	5.10×10^{-6} W	1.58×10^{-5} W	1.32×10^{-5} W	5.10×10^{-6} W	1.58×10^{-5} W
Groundwater (Weathered Lavery Till)	Ingestion	NA	NA	5.52×10^{-5} B	NA	NA	NA	NA	9.16×10^{-9} B	NA	NA
Groundwater (Unweathered Lavery Till)	Ingestion	NA	NA	1.91×10^{-5} B	NA	NA	NA	NA	0.00×10^{0} B	NA	NA
Chemical Hazards Combined Exposure:											
Hazard Index (HI):		5×10^{-2} B	3×10^{-2} B	5×10^{-2} B	5×10^{-2} B	3×10^{-2} B					
Excess Lifetime Cancer Risk:							5×10^{-6} W	2×10^{-5} W	NA	5×10^{-6} W	2×10^{-5} W
WMA 8 (Background):											
Soil	Ingestion	NA	NA	2.85×10^{-2} B	NA	NA	NA	NA	4.27×10^{-6} W	NA	NA
	Dermal Contact	NA	NA	1.39×10^{-2} B	NA	NA	NA	NA	5.44×10^{-7} B	NA	NA
Produce	Ingestion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sediment	Dermal Contact	4.83×10^{-2} B	2.99×10^{-2} B	2.99×10^{-2} B	4.83×10^{-2} B	2.99×10^{-2} B	5.10×10^{-6} W	1.58×10^{-5} W	1.32×10^{-5} W	5.10×10^{-6} W	1.58×10^{-5} W
Groundwater (Weathered Lavery Till)	Ingestion	NA	NA	5.52×10^{-5} B	NA	NA	NA	NA	9.16×10^{-9} B	NA	NA
Groundwater (Unweathered Lavery Till)	Ingestion	NA	NA	1.91×10^{-5} B	NA	NA	NA	NA	0.00×10^{0} B	NA	NA
Chemical Hazards Combined Exposure:											
Hazard Index (HI):		5×10^{-2} B	3×10^{-2} B	4×10^{-2} B	5×10^{-2} B	3×10^{-2} B					
Excess Lifetime Cancer Risk:							5×10^{-6} W	2×10^{-5} W	NA	5×10^{-6} W	2×10^{-5} W

a. B = below EPA target noncancer hazard index (HI) (HI < 1) or cancer risk (ELCR < 1×10^{-6})
W = within EPA target for cancer risk range (ELCR >= 1×10^{-6} and < 1×10^{-4})
E = exceeds EPA target for noncancer target hazard index (HI >= 1), or cancer risk (ELCR >= 1×10^{-4})
NA = not applicable.

WMA 7. Noncancer hazard indices for soil, sediment, and groundwater exposures for WMA 7 are below the EPA noncancer target (HI<1). Cancer risks for residents and discoverers (both child and adult receptors) fall below or within the EPA target cancer risk range (in the upper 10^{-6} and lower 10^{-5} range), whereas cancer risks for the worker fall below the target range. Risks for the resident and discoverer receptors fall within the range due to the sediment dermal contact pathway. Beryllium is responsible for approximately 95 percent of the risk attributed to this pathway.

WMA 8. Noncancer hazard indices for soil, sediment, and groundwater exposures for WMA 8 are below the EPA noncancer target (HI<1). Cancer risks for residents and discoverers (both child and adult receptors) fall below or within the EPA target cancer risk range (in the upper 10^{-6} and lower 10^{-5} range), whereas cancer risks for the worker fall below the target range. Risks for the resident and discoverer receptors fall within the range because of the sediment dermal contact pathway. Arsenic and beryllium are entirely responsible for the risk attributed to this pathway.

Buttermilk Creek. Noncancer hazard indices for surface water ingestion (as a potable water source) and fish ingestion exposures for receptors at Buttermilk Creek are below the EPA noncancer target (HI<1). Cancer risks at Buttermilk Creek fall within the EPA target cancer risk range for resident and discoverer receptors (in the lower 10^{-6} range). Cancer risks within the range are due primarily to ingestion of fish as modeled from contaminants present in WMA 8. The majority (66 percent) of this cancer risk is from benzene and vinyl chloride.

Alternative IV (No Action: Monitoring and Maintenance)

The risk characterization summary for Alternative IV is presented in Table D-32. Risks are presented separately for each WMA and for the receptors at Buttermilk Creek.

WMA 4. Noncancer hazard indices for exposures at WMA 4 are below the EPA noncancer target (HI<1). Cancer risks are within or below the target cancer risk range for all receptors. Dermal contact with soil and dermal contact with sediment are the pathways primarily responsible for risks within the EPA target cancer risk range. For both pathways, arsenic and beryllium combined are responsible for >99 percent of the pathway risk.

WMA 7. Noncancer hazard indices for exposures at WMA 7 are below the EPA noncancer target (HI<1). Cancer risks are within or below the target cancer risk range for all receptors. Dermal contact with soil and dermal contact with sediment are the pathways primarily responsible for risks within the EPA target cancer risk range. For both pathways, arsenic and beryllium combined are responsible for >99 percent of the pathway risk.

WMA 8. Noncancer hazard indices for exposures at WMA 8 are below the EPA noncancer target (HI<1). Cancer risks are within or below the target cancer risk range for all receptors. Dermal contact with soil and dermal contact with sediment are the pathways primarily responsible for risks within the EPA target cancer risk range. For both pathways, arsenic and beryllium combined are responsible for >99 percent of the pathway risk.

Buttermilk Creek. Noncancer hazard indices for surface water ingestion (as a potable water source) and fish ingestion exposures for receptors at Buttermilk Creek are below the EPA noncancer target (HI<1). Cancer risks at Buttermilk Creek fall within the EPA target cancer risk range for resident and discoverer receptors (in the lower and mid 10^{-6} range). Cancer risks within the range are primarily from ingestion of fish as modeled from contaminants present in WMA 8. The majority (66 percent) of this cancer risk is due to benzene and vinyl chloride.

Alternative V (Discontinue Operations)

The risk characterization summary for Alternative V is presented in Tables D-33 and D-34. Risks are presented separately for each WMA and for the receptors at Buttermilk Creek.

WMA 4. Noncancer hazard indices for soil, sediment, and groundwater exposures for WMA 4 are below the EPA noncancer target (HI<1). However, the noncancer hazard index for produce ingestion is above the EPA target at 4 for the residential child and one for the residential adult. Arsenic is responsible for 66 percent and vanadium is responsible for 24 percent of the noncancer HI for this pathway.

Cancer risks are above the target cancer risk range for the residents (at 2×10^{-4} for the child and 3×10^{-4} for the adult) and are within the range for the discoverer/recreational receptors. For the residents, the produce ingestion pathway is responsible for risks above the target range with arsenic the primary contributor (responsible for 99 percent of the produce ingestion risk). For the discoverer/recreational receptors, ingestion and dermal contact with soil and dermal contact with sediment are the pathways responsible for risks within the EPA target cancer risk range. For all 3 pathways, arsenic and beryllium combined are responsible for >99 percent of the pathway risk. For Alternative V arsenic and vanadium are designated as COCs in the WMA 4 for the produce ingestion pathway because these contaminants contribute to a pathway that exceeds a 10^{-4} risk or an HI of 1.

WMA 7. Noncancer hazard indices for soil, sediment, and groundwater exposures for WMA 7 are below the EPA noncancer target (HI<1). However, the noncancer hazard index for produce ingestion is above the EPA target for the residential child at 2. Arsenic is responsible for approximately 41 percent and vanadium is responsible for approximately 44 percent of the noncancer HI.

Cancer risks are above the target cancer risk range for the residential adult (at 2×10^{-4}) and are within the range for the resident child (at 8×10^{-5}) and the discoverer/recreational receptors. For the residential adult, the produce ingestion pathway and the soil dermal contact pathway are primarily responsible for risks within the target range. For the residential receptors, arsenic is responsible for 98 percent of the produce ingestion pathway and beryllium is responsible for 97 percent of the soil dermal contact pathway. For the discoverer/recreational receptors, ingestion and dermal contact with soil and dermal contact with sediment are the pathways responsible for risks within the EPA target cancer risk range. For all 3 pathways, arsenic and beryllium combined are responsible for >99 percent of the pathway risk.

For Alternative V, arsenic and vanadium are designated as COCs for the produce ingestion pathway and beryllium is a COC for the soil dermal contact pathway at WMA 7 because these contaminants contribute to a pathway that exceeds a 10^{-4} risk or an HI of 1.

WMA 8. Hazard indices for the residents are above the EPA noncancer target (at 10 for the child and 5 for the adult) at WMA 8, but are below the target for the discoverer/recreational receptors. Noncancer hazard indices for sediment and groundwater exposures for WMA 8 are below the EPA noncancer target (HI<1). However, the noncancer hazard indices for produce ingestion, soil ingestion, and soil dermal contact are above the EPA target for the residential child. For the residential adult, only the produce ingestion pathway exceeds the EPA noncancer target of one. For the produce pathway, cadmium, arsenic, thallium, and vanadium are responsible for 53 percent, 23 percent, 10 percent, and 10 percent of the noncancer HI, respectively. For the soil ingestion pathway, arsenic, barium, and cadmium are responsible for 42 percent, 18 percent, and 16 percent of the noncancer HI, respectively. For the soil dermal contact pathway, cadmium is responsible for 72 percent of the noncancer HI.

Cancer risks are above the target cancer risk range for the residents (at 2×10^{-4} for the child and 3×10^{-4} for the adult) and are within the range for the discoverer/recreational receptors. For the residential adult, the produce ingestion pathway and soil dermal contact pathways are responsible for risks above the target range. For the residential child, only the produce pathway has cancer risks above the EPA target risk range. Arsenic is the primary contributor to the produce pathway risk (responsible for 99 percent of the cancer risk). For the soil dermal contact pathway, beryllium is responsible for 94 percent of the cancer risk. For the discoverer receptors, dermal contact with soil and sediment are the pathways responsible for risks within the EPA target cancer risk range. For both pathways, arsenic and beryllium combined are responsible for 100 percent of the cancer risk.

For Alternative V, cadmium, arsenic, thallium, and vanadium are designated as COCs for the produce ingestion pathway; arsenic, barium, and cadmium are COCs for the soil ingestion pathway; and cadmium is a COC for the soil dermal contact pathway because these contaminants contribute to pathways that exceed a 10^{-4} risk level or an HI of 1.

Buttermilk Creek. Noncancer hazard indices for surface water ingestion (as a potable water source) and fish ingestion exposures for receptors at Buttermilk Creek are below the EPA noncancer target (HI<1). Cancer risks at Buttermilk Creek fall within the EPA target cancer risk range for resident and discoverer receptors (in the lower and mid 10^{-6} range). Cancer risks within the range are because of ingestion of fish as modeled from contaminants present in WMA 8. The majority (66 percent) of this cancer risk is from benzene and vinyl chloride.

Buttermilk Creek Catastrophic Release Scenario for Surface Water

The catastrophic release scenario involved exposure to surface water only for residents living near Buttermilk Creek. In addition, only short term noncancer effects were evaluated as the exposure duration was assumed to be one day. Under Alternative V (Discontinue Operations), noncancer hazard indices fall below the EPA target of one.

Background. As a comparison, risks were also calculated using data from background locations. The risks were calculated and the pathways were combined in the same manner as the risks for the site data (e.g., according to alternative and WMA). The risk characterization summary for background is presented in Tables D-26 through D-28.

Alternative III (In-Place Stabilization). Noncancer hazard indices for all 3 WMAs are below the EPA noncancer target HI of one. Cancer risk fall within the EPA target risk range due to dermal contact with sediments. Arsenic and beryllium are responsible for nearly all of this cancer risk.

Alternative IV (No Action: Monitoring and Maintenance). Noncancer hazard indices for all receptors are all below the EPA noncancer target. Cancer risks for the receptors are below or within the EPA target risk range. The pathways responsible for risks within the target range are soil ingestion, dermal contact with soils, and dermal contact with sediments. In WMAs 4 and 7, arsenic and beryllium are responsible for most of the pathway risks. In WMA 8 sediments, arsenic and beryllium are also responsible for most of the pathway risks. However, in WMA 8 soils, arsenic is entirely responsible for the risk.

Alternative V (Discontinue Operations). Noncancer hazard indices for the discoverer/recreational receptors are below the EPA noncancer target. However, for the residents (both children and adults), noncancer HIs are equal to or above the noncancer target (ranging from 1 to 5). The produce ingestion pathway is responsible for these hazard indices above 1. In WMA 4 background samples, arsenic, manganese, and vanadium are responsible for most of the noncancer HI for this pathway. In WMAs 7 and 8, arsenic and vanadium are responsible for most of the noncancer HI for this pathway. Cancer risks are within the EPA target risk range for the discoverer/recreational receptor. For the residents, however, cancer risks are above the EPA target range (in the low 10^{-4} range). These risks are primarily because of the soil dermal contact and produce ingestion pathways. Beryllium is responsible for nearly all of the soil dermal contact background risks. Arsenic is responsible for nearly all of the produce ingestion risk.

D.4.5 Uncertainty in the Risk Assessment

The sources of uncertainty in the human health risk assessment for chemicals and the relative influence of these sources on the risk assessment results are discussed in this section. Uncertainty is inherent in every step of the risk assessment process. Risk assessment of waste sites must not be viewed as yielding single-value, invariant results. Rather, the results of risk assessment are estimates that span a range of possible values and that may be understood only in light of the assumptions and methods used in the evaluation.

D.4.5.1 Data Adequacy and Model Uncertainty

Two issues are of crucial importance concerning their contribution to uncertainty in this risk assessment: data adequacy and uncertainty with the transport model.

Data Adequacy

The data used in this risk assessment are of variable quality which directly affects the level of uncertainty in the conclusions. In some cases (as discussed below), the data are unsuitable for use in a risk assessment. It is crucial to note that estimates based on such data are not valid for the purpose of remedial decision-making. Actual risks could be either greater or less than those projected using the unsuitable data. Specifically, groundwater data from the trench area at the NDA (WMA 7), and leachate data from the disposal trenches at the SDA (WMA 8) are of questionable validity.

The groundwater sample data for WMA 7 have not undergone validation, and therefore have not been subjected to basic quality control procedures. In addition, the groundwater data were collected during a single sampling event in 1990. A single sampling event is unlikely to adequately characterize groundwater subject to seasonal variations. The use of older data is also problematic in that it may not adequately represent current conditions.

Data from the WMA 8 trenches also must be regarded as low quality since they have not undergone validation. No sample data are available for Trenches 6 and 7. Risks for Trench 14 are based on two samples that were analyzed for volatile and semivolatile organic compounds only. Only one sample is available for the remaining trenches. These data are also quite old, having been collected in 1987. Some of the disposal trenches are hundreds of meters in length, and a single sample from one point in a trench is unlikely to adequately characterize the contamination.

The surface water and fish exposure pathways were based on transport models that used unvalidated data as a starting point. Because there are numerous factors involved and since quality control was not maintained, the direction of the bias (under- or overestimation) cannot be determined.

Uncertainty In The Transport Model

The transport model does not account for attenuation of the concentration of contaminants during transport. Attenuation would be expected as a result of chemical decay, volatilization, binding to soils, or binding to suspended particulate matter and sediment in the creeks. Furthermore, dispersion was not accounted for in the model. The direction of the bias in the model is toward overestimation in direct proportion to the extent of attenuation that actually occurs. The overall uncertainty of the model is overwhelmed by the uncertainty introduced by the use of unvalidated data (discussed above).

D.4.5.2 Uncertainty in Exposure Assessment

Exposure assessment may introduce considerable uncertainty in the risk assessment process. Uncertainty in elements of the exposure assessment are brought together and compounded in the estimate of intake or dose. The risk assessors and risk managers must examine and interpret a diversity of information, including (1) the nature, extent, and magnitude of contamination; (2) transport of chemicals in the environment; (3) identification of exposure routes; (4) identification of receptor groups currently at risk and potentially at risk in the future; and (5) activity patterns of receptors and receptor groups.

Types of uncertainty identified in the exposure assessment include scenario uncertainty (missing or incomplete information needed to define the exposure scenario or pathway), model uncertainty, and parameter uncertainty (inadequate information to quantify an exposure variable or assumption).

Scenario uncertainty may arise when pathways were not included in, or were eliminated from, the assessment. For example, under Alternative IV, no soil exposures were evaluated for resident and discoverer receptors because it is assumed that the property will be guarded and maintained.

Models have been used to estimate contaminant levels in fish and produce using the equations and biotransfer factors presented earlier. Uncertainty is inherent in the use of models as surrogates for actual measurements from produce grown on site or fish caught in Buttermilk Creek. In particular, the chemical-specific biotransfer factors that were used have been derived from studies that may not represent conditions at the Center. Although the equations are simple, they are uncertain since it is not possible to verify the food chain transfer on a site-specific basis.

Parameter uncertainty results because many of the exposure parameters or assumptions used in the risk assessment are default values recommended by EPA. These default parameters, which are generally conservative, do not necessarily reflect actual behavior and have been used in the absence of site-specific information. In addition, assumptions about the future land uses are speculative. In attempting to predict future exposures, assumptions must be made concerning future site activities, and receptor behavior. The uncertainty with the exposure assumptions used in the risk assessment is low to moderate and most likely overestimates the actual risks.

Each of the exposure parameters is commonly treated as a single point estimate. None of these parameters, however, is truly a single value. Instead, a range or distribution of values would more accurately represent exposures. Defining a range of values for any given parameter is actually a measure of variability in the risk assessment. Quantitative uncertainty analysis allows one to measure this variability, but is difficult to perform because of the quantity and quality of available data as well as requiring a major commitment of time and resources.

D.4.5.3 Uncertainties Related to Toxicity Information

Although EPA provides toxicity values that are point estimates, uncertainty surrounds these point estimates. Identification of the sources of this uncertainty enables the risk assessor to establish the degree of confidence with the toxicity measures.

Uncertainty is inherent within the toxicity assessment and is primarily due to differences in study design, species, sex, routes of exposure, or dose-response relationships. A major source of uncertainty involves the use of toxicity values based on experimental studies that substantially differ from typical human exposure scenarios. The derivation of the toxicity values must take into account such differences as (1) using dose-response information from animal studies to predict effects in humans, (2) using dose-response information from high-dose studies to predict adverse health effects from low doses, (3) using data from short-term studies to predict long term (chronic) effects, and (4) extrapolating from specific populations to general populations.

The cancer slope factors in particular are based on studies that may differ greatly from realistic situations. Experimental cancer bioassays typically expose animals to very high levels of chemicals (i.e., the maximum tolerated dose) for their entire lifetime. After the appropriate studies have been identified, the slope factor is calculated as the 95 percent UCL of the slope of the dose-response curve. This introduces conservatism into the risk assessment.

The derivation of reference doses generally involves the use of animal studies. Uncertainty factors ranging from 1 to 10,000 are incorporated into the reference dose to provide an extra level of public health protection. The factors used depend on the type of study from which the value has been derived (e.g., animal or human, long-term or short-term). The scientific basis for this practice is somewhat uncertain. In general, high uncertainty factors are meant to bias the results conservatively so that exposures at the reference dose level will not result in adverse health effects.

No toxicity values are available from EPA for the dermal route. Therefore, oral toxicity values have been adjusted for the dermal pathway by using chemical-specific gastrointestinal absorption factors to adjust the oral toxicity value from an administered value to an absorbed value. Once adjusted to an absorbed value, the value may then appropriately be used to evaluate dermally absorbed doses.

For some chemicals, chemical-specific gastrointestinal absorption factors were not available. In such cases, the unadjusted oral toxicity value was used to evaluate the dermal pathway (EPA 1992a). This introduces uncertainty into the risk assessment that varies for different chemicals. For chemicals that are well absorbed in the gut, the uncertainty in the adjusted toxicity value is minimal since the adjustment would be minimal. Greater uncertainty is associated with chemicals that are poorly absorbed in the gut since the toxicity value would be adjusted in direct proportion to the absorption.

In addition, no adjustments have been made for the medium of exposure (e.g., when the medium of exposure in the site differs from the medium of exposure assumed by the toxicity value). The uncertainty associated with using the absorbed dose toxicity values for the dermal pathway is moderate and the bias unknown.

There are many chemicals for which no toxicity value exists and for which little information is available. Therefore, a quantitative risk estimate cannot be calculated for these chemicals. For example, many chemicals are not evaluated for the inhalation pathway because of limited inhalation-based toxicological information. The lack of toxicity information for some chemicals may contribute to the underestimation of risks.

Cancer and noncancer risks are summed in the risk characterization process (separately for carcinogens and noncarcinogens) to estimate potential risks associated with the simultaneous exposure to multiple chemicals. In the case of carcinogens, this approach gives carcinogens with a class B or class C weight-of-evidence the same weight as carcinogens with a class A weight-of-evidence. It also equally weights cancer slope factors derived from animal data with those derived from human data. Uncertainties in the combined risks are also compounded because RfDs and cancer slope factors do not have equal accuracy or levels of confidence and are not based on the same severity of effect.

Toxicity values are not available for most of the PAHs. Only one carcinogenic PAH (benzo(a)pyrene) has a toxicity value for use in risk assessment. Benzo(a)pyrene is one of several other PAHs that were detected. When evaluating oral exposure to PAHs, the approach used in the risk assessment was to relate the toxicity of PAHs to that of benzo(a)pyrene. The factors used to relate the toxicity are called relative potency values. This approach, although currently under review by EPA, is based on scientific studies, and is thought to be more realistic than the alternative method of assuming that all carcinogenic PAHs have a potency factor equal to that of benzo(a)pyrene.

PAHs are known to be dermally active compounds. However, carcinogenic effects from dermal exposure to PAHs have not been assessed quantitatively. Without quantifying cancer risks from PAHs by the dermal route, the cancer risk for PAHs may be underestimated. Quantification of these risks may contribute to the cancer risk to the same extent or more than the oral cancer risk for PAHs. However, the exclusion of these risks is unlikely to affect the results of the risk assessment because PAHs were not responsible for risks exceeding EPA targets.

D.4.5.4 Uncertainties in Risk Characterization

Uncertainties in any phase of the risk analysis are reflected in the risk estimates. Some uncertainty is from the summation of risks and hazard quotients for multiple chemical contaminants. As stated in RAGS (EPA 1989a), "The assumption of dose additivity ignores possible synergisms or antagonisms among chemicals, and assumes similarity in mechanisms of action and metabolism." However, summing risks and hazard quotients for multiple substances in this risk assessment gives a conservative estimate.

D.4.5.5 Uncertainty in the Catastrophic Release Scenario

The catastrophic release scenario evaluated exposures that might occur if the entire contents of a trench (or several trenches) at the SDA suddenly entered Franks Creek in one day. The "slug" of surface water moving down into Buttermilk Creek was assumed not to disperse, and would thus move past any given downstream point in one day. This results in a one day exposure to the downstream receptor drinking water from Buttermilk Creek.

EPA-approved toxicity values for use in risk assessment are typically oriented toward long-term chronic exposures. There are, however, subchronic RfDs for some chemicals that are intended for use with exposure durations as brief as two weeks. Where subchronic RfDs are not available, available chronic RfDs were used in the risk assessment. Uncertainty is introduced in the use of subchronic or chronic RfDs for evaluating a one day exposure. The use of these values is likely to conservatively bias the risk estimates because shorter-term RfDs are generally equal to or greater than longer-term RfDs. The underlying rationale is that greater exposure levels may be tolerated for short periods of time, whereas the same exposure levels would not be tolerable for longer periods of time.

Cancer effects were not evaluated under the catastrophic release scenario because it is not appropriate for very short-term exposures. This is due in large part to the way doses are estimated when evaluating cancer effects. The carcinogenic dose estimate is averaged across an entire lifetime. For 1 day of exposure, the cancer dose (and risk) estimate would in every case be exceedingly small, about 3 to 4 orders of magnitude less than for the 9 to 30 years of exposure that is typically evaluated.

D.4.6 <u>Summary and Conclusions</u>

A human health risk assessment was conducted to evaluate risks from exposure to hazardous chemicals present at, or potentially released from WMAs 4, 7, and 8. Risks associated only with Alternatives III, IV, and V were evaluated. The methods used to characterize risk are consistent with EPA methods. The conclusions of this human health risk assessment are summarized by alternative.

D.4.6.1 Alternative III (In-Place Stabilization)

Noncancer risks evaluated under Alternative III were below the EPA target of one. Cancer risks fell below or within the EPA target risk range (10^{-6} to 10^{-4}). All risks for the catastrophic release scenario were below the EPA noncancer target HI.

D.4.6.2 Alternative IV (No Action: Monitoring and Maintenance)

Noncancer risks evaluated under Alternative IV were below the EPA target of one. Cancer risks fell below or within the EPA target risk range (10^{-6} to 10^{-4}). Risks for the catastrophic release scenario were below the EPA noncancer target HI.

D.4.6.3 Alternative V (Discontinue Operations)

In WMA 4, noncancer risks for residents were above the EPA target HI from ingestion of produce. Cancer risks for residents were above the EPA target risk range from produce ingestion. COCs for the produce ingestion pathway are arsenic and vanadium. For WMA 7, noncancer risk for the child resident was above the EPA target HI from ingestion of produce. Cancer risk for the adult resident was above the EPA target risk range from produce ingestion and dermal contact with soil. COCs for the produce ingestion pathway are arsenic and vanadium. Beryllium was designated as a COC for the soil dermal contact pathway. For WMA 8, noncancer risks for residents were above the EPA target HI from the produce ingestion, soil ingestion, and soil dermal contact pathways. Cancer risks for residents were above the EPA target risk range from produce ingestion and dermal contact with soil. COCs for the produce ingestion pathway are arsenic, cadmium, thallium, and vanadium. Arsenic, barium, and cadmium are COCs for the soil ingestion pathway and cadmium was designated as a COC for the soil dermal contact pathway.

D.5 CALCULATION OF RISK

Methods for calculating risk from radiation exposure are discussed in the BEIR V report (NAS 1990) and in the 1990 Recommendations of the International Commission on Radiation Protection (ICRP 1991). The factors used in calculations in this EIS are those recommended by the ICRP and are consistent with those used by the NRC. The factors apply when the dose is less than 20 rem and when the dose rate is less than 10 rem/hr.

Estimation of genetic and somatic effects in individuals and populations are determined by multiplying EDE for an individual or the collective dose equivalent for a population by the risk coefficient, i.e.,

$$risk = EDE \times risk\ coefficient \quad \text{(D-19)}$$

Different coefficients have been developed for workers and members of the general public. For example, the risk for detrimental changes for individuals receiving 0.1 rem of total body EDE would be calculated as follows:

risk for somatic effects for workers = 0.1 rem x 4 x 10^{-4} rem^{-1} = 4 x 10^{-5}

risk for somatic effects for the general public = 0.1 rem x 5 x 10^{-4} rem^{-1} = 5 x 10^{-5}

The results show that the increased risk from somatic effects for an EDE of 0.1 rem are 4 x 10^{-5} or 4 in 100,000 and for workers 4 x 10^{-5} or 5 in 100,000 for the public. The values of risk to the population presented in Chapter 5 are based on these risk coefficients.

D.6 DEVELOPMENT OF SITE CLOSURE CRITERIA

As described previously in this appendix, the public may receive radiation doses during and after site closure. During the implementation phase, individuals residing near the site may be exposed to radioactivity released to air or surface waters. After closure, additional exposure pathways to on-site occupants are possible from the residual activity in the buildings or soil.

A complete set of accepted closure criteria that apply to all exposure scenarios at the Center does not exist. Therefore, criteria have been developed based on the radiation dose guidance for the general public recommended by NRC, EPA, and NYSDEC.

The NRC recently published a proposed rule which establishes a total effective dose equivalent limit of 15 mrem/yr for residual radioactivity distinguishable from background. In addition to this limitation, licensees would be required to reduce this residual radioactivity to As-Low-As-Reasonably-Achievable (ALARA) levels.

The EPA recently released a preliminary draft regulation (10 CFR Part 196) consisting of a generally-applicable radiation standard for residual radioactivity. Similar to the NRC proposed rule, this draft standard establishes an annual effective dose equivalent limit of 15 mrem. The relevant time period over which this limitation exists is 10,000 years after the remedial action.

The NYSDEC has established guidance for a dose limit for soils contaminated with radioactive materials (NYSDEC 1993). This limit is a total effective dose equivalent to the maximally exposed member of the general public after site cleanup of 10 mrem in any one year; this dose equivalent is in addition to that received from background radiation.

Based on these proposed and existing standards, a limit of 15 mrem in the maximum year to the maximally exposed individual has been applied in this EIS. This is consistent with the basic 15 mrem limits recommended by both the NRC and EPA, and the NRC's policy to reduce residual radioactivity to ALARA levels. It should be noted that despite the selection of this criterion for use in the EIS, the criterion actually used in the cleanup of the site may be different.

An additional criterion is used in this EIS for intruders to buried waste sites or facilities containing stored waste or radioactive contamination. This criterion is necessary to evaluate Alternative V (Discontinue Operations), which assumes site abandonment without institutional control; thus, the potential exists for an individual to gain access to a site which has not been remediated. In this case the criteria established for site remediation would not be applicable. For this case, a maximum annual individual dose equivalent of 100 mrem was used as the criterion for analysis in this EIS. This criterion is consistent with the annual dose limit to members of the public from operations licensed by the NRC or 100 mrem established in 10 CFR Part 20 ("Standards for Protection Against Radiation").

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APPENDIX E

RELEASE MODELS AND SOURCE TERMS

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RELEASE MODELS AND SOURCE TERMS

Estimating the rates of release of contaminants from operating or stabilized facilities requires identifying individual contaminants of concern, estimating initial inventories of contaminants, and describing the mechanisms for release of contaminants. Section E.1 describes the screening process used to reduce the number of radionuclides considered in detail in the impact evaluations. Appendix C summarizes available data and estimates of radionuclide inventories for each waste management area (WMA). Section E.2 describes the data and methods used to estimate release rates for long-term impact assessments. Sections E.3 through E.7 describe the release models and source terms developed for each alternative.

E.1 SCREENING OF RADIONUCLIDES

Before radionuclide inventories and source terms were developed for each WMA, the radionuclides important for this Environmental Impact Statement (EIS) were identified. Many radionuclides are present at the site; they occur in waste inventories in tanks, drums, boxes, and in contaminated facilities, soil, and lagoons. Assessing the radionuclide inventories, source terms, and potential doses for each of these radionuclides would be both impractical and imprudent because (a) a large amount of data would be needed to develop site inventories, source terms, and parameters required for dose calculations, and (b) only a small fraction of the radionuclides would ultimately be important with respect to doses received by workers and the population during completion of the West Valley Demonstration Project (WVDP) and after closure or long-term management of facilities at the Western New York Nuclear Service Center (Center). Thus, many of the radionuclides present in the facilities and waste were eliminated from consideration before developing the WMA inventories and source terms. To reduce the number of radionuclides assessed for this EIS, the following procedure was used:

1. A comprehensive list of radionuclides present at the Center was compiled. This information was obtained from the waste characterization reports for each WMA.

2. Radionuclides with half-lives less than 1 year were eliminated (Short-lived radionuclides that are daughters of long-lived radionuclides are accounted for in the dose calculations).

3. Radionuclides with half-lives ranging from 1 to 3 years were eliminated if the quantities remaining at the end of WVDP high-level [radioactive] waste (HLW) solidification would be insignificant in relation to similar radionuclides. (Based on this criterion, radionuclides with half-lives between 1 and 3 years were eliminated except antimony-125 and promethium-147).

4. Radionuclides that always appear in insignificant quantities with respect to similar radioisotopes were eliminated (e.g., cesium-135 activities are always several orders of magnitude less than cesium-137 activities).

5. Radionuclides with total sitewide activities of less than 10 μCi were eliminated. This criterion was selected based on assessing the potential dose that would be received if 10 μCi of a radionuclide were introduced directly to the atmosphere or a stream.

6. Generic dose calculations were made using the RESRAD and GENII computer codes (see Appendix D for a description of these codes). The purpose of these calculations was to determine the relative contribution of each radionuclide to doses to the population, assuming equal quantities of each radionuclide were deposited directly to the air, surface water, or soil, and considering the relevant exposure pathways. Based on the results of the generic calculations, a radionuclide was eliminated from consideration if either of the following two conditions existed: (1) for both the air and water release scenarios, the resulting doses were more than four orders of magnitude lower than the doses from other radionuclides, or (2) the dose for a radionuclide was similar to or less than the dose from a radioisotope that was more abundant by two or more orders of magnitude. An example of the first case is palladium-107; the contribution of this radionuclide to doses to the population is less than 0.01 percent of the doses from other radionuclides for every pathway. An example of the second condition is uranium-236. The dose per unit activity of uranium-236 is similar to that of uranium-235 and uranium-238, which are always present in much larger quantities. Because these radioisotopes are transported together in the environment, uranium-236 was eliminated from consideration.

Using this procedure, the following 30 radionuclides were considered in this EIS (daughters of these radionuclides were accounted for in the dose assessments):

- Hydrogen-3
- Carbon-14
- Cobalt-60
- Strontium-90
- Technetium-99
- Cadmium-113m
- Antimony-125
- Tin-126
- Iodine-129
- Cesium-137
- Europium-154
- Radium-226
- Actinium-227
- Radium-228
- Thorium-229
- Protactinium-231
- Thorium-232
- Uranium-232
- Uranium-233
- Uranium-234
- Uranium-235
- Neptunium-237
- Uranium-238
- Plutonium-238
- Plutonium-239
- Plutonium-240
- Plutonium-241
- Americium-241
- Curium-243
- Curium-244.

After this list of radionuclides was established, the radionuclide inventories were developed as presented in Appendix C. The radionuclide source terms were then developed for each alternative and WMA. This process eliminated many of the listed radionuclides from consideration for some WMAs because of their relative insignificance compared to the most prominent radionuclides. Sections E.2 through E.7 present the release models considered and the WMA-specific source terms used to calculate doses to the public and to site workers.

E.2 RELEASE MODELS FOR LONG-TERM IMPACT ASSESSMENT

The rate of release of radionuclides from each WMA for each alternative is affected by the physical and chemical state of the material, the engineered confinement or barrier system, and the environmental processes acting on the confinement system. For Alternative I (Removal), stored and disposed inventories would be removed from the site and only residual contamination would remain. The rates of release of residual contamination to potential residents are estimated using the intruder scenarios described in Appendix D. Similarly for Alternative II (On-Premises Storage), buried and stored wastes would be recovered and stored in a new on-premises facility that would be continually maintained and would not be a source for release of radionuclides. The potential for release of residual contamination was evaluated as for Alternative I. For Alternative III (In-Place Stabilization), buried waste would be stabilized in place and new disposal facilities would be constructed. Flow barriers and waste solidification in concrete or grout would be the primary engineering approaches used for this alternative. Release rates would be controlled by movement of water and dissolved radionuclides through the barrier system or, if flow rates are sufficiently low, by diffusion of radionuclides through the waste form. For Alternative IV (No Action: Monitoring and Maintenance), the water infiltration, dissolution, and water transport processes would occur at the low-level waste treatment facility (LLWTF), U.S. Nuclear Regulatory Commission (NRC)-licensed disposal area (NDA), and New York State-licensed disposal area (SDA). For Alternative V (Discontinue Operations), erosion of the site would become important, and an episodic release of radionuclides to surface water would occur because of erosional collapse. For facilities unaffected by erosion, infiltration of water into the waste, dissolution, and transport in the water may occur. Another release model considered was climatic and weather changes; however, it was determined that the effects from erosion would likely bound the impacts of reglaciating the Center as described in Section E.2.1. Thus, the primary release models selected for the EIS impact evaluations are groundwater flow and solubility limited leaching, radionuclide diffusion in concrete, and erosional collapse as described in Sections E.2.2, E.2.3, and E.2.4, respectively.

E.2.1 Climatic and Weather Changes (Glaciation)

With respect to climatic and weather change, the concern is that such changes could expose the radioactive waste to the environment. With low-level waste, the goal is to contain the wastes long enough for the dominant radioisotopes to decay to acceptable levels. After a period of 500 to 1,000 years, most of the radioisotopes of human-health concern will have decayed substantially. The dominant fission products will have decayed to the point that the principal radiological concerns would be from the uranium and long-lived transuranic isotopes remaining, such as plutonium. NRC, in establishing that shallow land burial was an acceptable practice for LLW, recognized these facts and concluded that after several centuries, the risks were acceptable. High-level waste, with its higher concentration of long-lived transuranic isotopes, was determined to be unacceptable for shallow-land burial, in part because of concern over the long-term potential of climatic change to expose the waste to the surface environment.

The potential for climate changes to expose the waste to environmental transport mechanisms is considered less of a threat than the current potential for erosion. Climate changes which could expose the waste occur over tens of thousands of years. The current erosional processes could expose the waste after hundreds or thousands of years.

E.2.2 Groundwater Flow and Solubility-Limited Release Models

Groundwater flowing through buried sediments or waste can dissolve radionuclides and transport them through the environment. Estimating the rate of release requires specifying the configuration of the waste, estimating groundwater velocity, and estimating the concentration of each radionuclide in the groundwater leaving the waste disposal volume. In these evaluations, the waste is assumed to be located in a box-like volume with rectangular sides. Groundwater flows through the waste in a direction perpendicular to one of the sides of the box. For waste disposed of below the ground surface (such as at the LLWTF, NDA, and SDA), the groundwater velocities used in the evaluations were those predicted by the site three-dimensional model described in Appendix J. Representative results are presented in Table E-1, and the values reported as maximums are used in the release calculations. The velocities reported are the maximum and minimum values predicted for all points within the referenced area and may not correspond to the same location in the aquifer.

For the NDA and SDA, the minimum horizontal velocities are predicted for localized areas characterized by small horizontal hydraulic gradients. Magnitudes of vertical velocities are more uniform because of the smaller spatial variation in the vertical hydraulic gradient.

For wastes disposed of in tumuli, such as the new on-premises disposal facility and the radwaste treatment system (RTS) drum cell, it was assumed that the facility becomes saturated after closure and that the rate of influx is determined by the saturated hydraulic conductivities of the available flow paths and a unit downward hydraulic gradient. Each facility is constructed with a drainage layer designed to route infiltration away from the waste. Thus, two primary flow paths are available: (1) directly downward through the waste and (2) downward through the drainage layer around the waste. The flow through these paths is estimated based on Darcy's Law using an equivalent parallel flow network model.

For both facilities, the expected case involves proper functioning of the drainage layer with a time dependent increase in hydraulic conductivity of the cap and concrete layers. The conceptual design characteristics of tumuli proposed for the new on-premises LLW disposal

Table E-1. Groundwater Velocities for Release and Transport Modeling for Alternative IV (No Action: Monitoring and Maintenance)

	Interstitial Velocity (m/yr)[a]			
	Horizontal[b]		Vertical[c]	
WMA/Facility	Minimum	Maximum	Minimum	Maximum
1—Process Building	0.10	3.32	0.08	0.16
2—LLWTF	0.02	88.4	0.01	2.98
3—HLW Tanks/Vitrification Facility	0.14	3.38	0.10	0.12
4—CDDL	0.14	38.6	0.03	0.29
5—CPC Waste Storage Area	0.18	43.2	0.01	2.13
6—Central Project Premises	0.001	20.6	0.02	0.20
7—NDA	2.9×10^{-6}	3.00	0.06	0.43
8—SDA	2.9×10^{-6}	1.34	0.08	0.18
9—RTS Drum Cell	3.6×10^{-4}	2.87	0.06	2.36
10—Support and Services Area	0.01	11.1	0.02	0.34

a. To convert from meters per year to feet per year, multiply by 3.281.
b. Horizontal velocities are reported for the sand and gravel layer for WMAs 1, 2, 3, 4, 5, 6, and 10 and for the weathered Lavery till for WMAs 7, 8, and 9.
c. Vertical velocities are reported for the unweathered till.

facility and the RTS drum cell are summarized in Tables E-2 and E-3, respectively (WVNS 1994a, WVNS 1985). The time dependence of expected conditions is represented by assuming that after 100 years the cap degrades to conditions similar to those of the south plateau surface soil (hydraulic conductivity equal to 1×10^{-7} cm/s) and the concrete characteristics resemble those of soil (hydraulic conductivity equal to 1×10^{-3} cm/s). The volumetric flow rates through the waste estimated for these conditions are presented in Table E-4.

Table E-2. Disposal Tumulus Design Characteristics

Layer	Thickness (m)[a]	Saturated Hydraulic Conductivity (cm/s)[b]	Porosity
Compacted Soil	0.15	3.5×10^{-8}	0.25
Sand and Gravel	0.91	1.0	0.40
Clay	1.22	3.5×10^{-8}	0.25
Concrete	0.15	5.0×10^{-10}	0.50
Grouted Class A, B, and C Waste	1.0	1.0	0.50
Concrete	0.31	5×10^{-10}	0.50
Clay	1.0	3.5×10^{-8}	0.25

a. To convert meters to feet, multiply by 3.281.
b. To convert from centimeters per second to inches per second, multiply by 0.394.

Table E-3. Radwaste Treatment System Drum Cell Tumulus Design Characteristics

Layer	Thickness (m)[a]	Saturated Hydraulic Conductivity (cm/s)[b]	Porosity
Compacted Soil	1.0	3.5×10^{-8}	0.25
Rip-rap	1.0	1.0	0.40
Gravel	1.0	1.0	0.40
Clay	1.0	3.5×10^{-8}	0.25
Waste	3.4	0.001	0.29
Gravel	1.0	1.0	0.40

a. To convert meters to feet, multiply by 3.281.
b. To convert from centimeters per second to inches per second, multiply by 0.394.

Table E-4. Expected Condition Flow Rates through Waste for Tumuli on the Project Premises

Time Period (yr)	LLW Disposal Facility (m^3/yr)[a]	RTS Drum Cell (m^3/yr)[a]
T <100	3.5×10^{-4}	5.5×10^{-4}
T > 100	0.001	6.2×10^{-3}

a. To convert from cubic meters per year to cubic feet per year, multiply by 35.315.

In addition to degradation of the cap and concrete, performance of the tumuli could be affected by clogging of the drainage layer. For both facilities, maximum infiltration would occur if the drainage layer were completely clogged and the only available flow path was directly through the waste. This case was investigated by assuming that the tumuli function according to design for the first 100 years, but after 100 years, the cap and concrete degrade as in the expected case and the drainage layer becomes completely clogged. Infiltration rates predicted for this case are presented in Table E-5.

Estimates of radionuclide concentrations in groundwater are the final data needed for estimates of flow-dissolution mechanism release rates. Limited on-site measurement data are available and no site-specific experiments have been conducted to establish radionuclide concentrations in groundwater. Thus, geochemical modeling was used to supplement the existing data by estimating equilibrium solubility. Solubility is defined as the total amount of all aqueous species containing the specific element in equilibrium with a limiting solid phase. To predict the concentrations of dissolved species, the characteristics of the groundwater must be defined. Chemical analysis conducted in the site environmental monitoring program were used for this purpose. The representative analysis is presented in Table E-6. In addition, the pH and EH of the groundwater must be specified to complete the calculation. A pH value of 7.8 was selected to represent site conditions, and two EH values [corresponding to oxidizing (EH = +0.1) and reducing conditions (EH = -0.1)] were selected. The PHREEQE computer code (Parkhurst et al. 1980), developed at the U.S. Geologic Survey, was used to estimate solubilities. The results of the calculations are presented in Table E-7 along with potentially relevant site-specific data. For the conditions examined, only technicium and uranium showed strong sensitivity to redox conditions.

E.2.3 Diffusion-Limited Release Models

Concrete waste forms are proposed for use at the process building, the HLW tanks, and the RTS drum cell. The hydraulic conductivity of concrete is low enough that under most circumstances the release rate of radionuclides dissolved in the pore water is determined by diffusion of the radionuclide through the pore network. The proposed grouting of the process building and HLW tanks would produce a horizontal slab encapsulating radionuclides

Table E-5. **Flow Rates through Waste for Tumuli on the Project Premises with Clogged Drainage Layers**

Time Period (yr)	LLW Disposal Facility (m^3/yr)[a]	RTS Drum Cell (m^3/yr)[a]
T <100	3.5 x 10^{-4}	5.5 x 10^{-4}
T > 100	76	100

a. To convert from cubic meters per year to cubic feet per year, multiply by 35.315.

Table E-6. Representative Groundwater Composition

Species	Concentration (mg/L)
Cations	
Calcium	100.6
Magnesium	22.8
Sodium	20.4
Potassium	2.18
Iron	0.13
Manganese	0.49
Anions	
Chloride	4.44
Sulfate	178.2
Nitrate + Nitrite N	0.32
Ammonia	0.06
Bicarbonate Alkalinity[a]	205.7
Carbonate Alkalinity[a]	< 1

a. As mg $CaCO_3$/L

Table E-7. Concentrations of Elements in Water

Element	Tank 8D-2 Supernatant (g/m^3)	SDA Trench Water[a] (g/m^3)	NDA Leachate[b] (g/m^3)	PHREEQE Solubilities Reducing (g/m^3)	PHREEQE Solubilities Oxidizing (g/m^3)
H	2.4×10^{-6}	0.00038	NR[c]	NC[d]	NC
C	0.015	0.00012	NR	NC	NC
Co	NR[b]	6.2×10^{-8}	4.7×10^{-7}	0.30	0.30
Ni	0.0068	NR	NR	NC	NC
Se	0.27	NR	NR	NC	NC
Sr	0.0078	6.3×10^{-5}	4.5×10^{-5}	10	10
Tc	47.1	0.0052	NR	0.001	30
Cd	2.1×10^{-5}	NR	NR	0.0015	0.0015
Sn-126	0.0007	NR	NR	NC	NC
Sb	1.0×10^{-6}	NR	NR	NC	NC
I	0.59	NR	6.8	NC	NC
Cs	43	1.2×10^{-5}	0.00085	hs[e]	hs
Pm	2.9×10^{-6}	NR	NR	NC	NC
Sm	1.9×10^{-5}	NR	NR	NC	NC
Eu	9.5×10^{-6}	NR	3.4×10^{-6}	0.002	0.002
Pb	NR	NR	NR	0.2	0.2
Ac	NR	NR	NR	NC	NC
Ra-226	NR	NR	NR	0.01	0.01
Th-232	NR	NR	NR	5.0×10^{-13}	5.0×10^{-13}
Pa	NR	NR	NR	NC	NC
U	89	NR	13.4	0.0001	0.35
Np	4.6×10^{-5}	NR	NR	1.0×10^{-9}	1.0×10^{-9}
Pu	0.25	2.6×10^{-5}	NR	1.0×10^{-9}	1.0×10^{-9}
Am	0.0038	5.8×10^{-8}	0.001	0.15	0.15
Cm	NR	NR	NR	hs	hs

a. Prudic 1986
b. WVNS 1989
c. NR = not reported
d. NC = not calculated
e. hs = highly soluble

left in the facilities. The encapsulated radionuclides could diffuse downward into groundwater flowing below the slab. At the RTS drum cell, the waste form is a large number of individual drums placed in a downward moving flow field. The following paragraphs describe diffusion-controlled release models appropriate to each situation.

Release rates from slab-type waste forms were estimated assuming a one-dimensional conceptual model in which flowing groundwater maintains radionuclide concentration at one face of the slab at a low value providing a concentration gradient driving force for release of the radionuclide. Depending on the amount of radionuclide originally present, the two situations described below may develop.

In the first case (present in the process building), the amount of the radionuclide may be small enough in relation to the volume of cement and pore water that the entire inventory of radionuclides would dissolve and distribute between aqueous and cement-adsorbed phases. This situation is expected to describe conditions in the process building grout. In this case, activity balances formed around the two phases can be combined into a single differential balance, which is solved for the radionuclide concentration profile and related release rate. The differential balance may be simplified by representing the radionuclide inventory and diffusional resistances as occupying separate portions of the waste volume. This type of model is termed a shrinking-core model and is easier to evaluate than the equivalent distributed parameter model. The activity balance for a radionuclide may be stated as:

$$-eA_w \frac{D}{T} \frac{C}{H-z} - eA_w z R_d L C = eA_w R_d \frac{\partial Cz}{\partial t} \qquad \text{(E-1)}$$

where
- e = porosity of the concrete
- A_w = area of the slab perpendicular to the diffusive flux
- D = diffusivity of the radionuclide
- T = quotient of waste form constrictivity and tortuosity
- C = concentration of radionuclide in the pore water
- H = thickness of the slab
- z = thickness of the shrinking core
- R_d = retardation factor for radionuclide in concrete
- L = radionuclide decay constant
- t = time.

Because the activity concentration in the core portion changes only by decay, the equation may be solved for the thickness of the shrinking core as:

$$z = H - \sqrt{\frac{2D}{R_d T} t} \qquad \text{(E-2)}$$

The release is then calculated from the thickness of the core and the known, decay-dependent concentration of the radionuclide in the core. The adequacy of the shrinking-core approach was evaluated by comparison with a published distributed parameter model (Crank 1975) release rate for a nondecaying component. The results of the comparison are summarized in Table E-8 for a component with diffusivity of 0.065 m^2/yr (0.700 ft^2/yr), a slab thickness of 1 m (3.3 ft), and an initial concentration of 1 Ci/m^3. The results indicate that the shrinking core model gives a conservative but reasonable approximation to the more exact solution.

Table E-8. Comparison of Shrinking-Core and Distributed Parameter Diffusion Models

	Shrinking-Core Model		Distributed Parameter Diffusion Model
Time (yr)	Thickness of shrinking core (m)[a]	Release (Ci)	Release[b] (Ci)
1	0.77	0.12	0.09
2	0.68	0.16	0.13
3	0.61	0.20	0.16
4	0.54	0.23	0.18
5	0.49	0.26	0.20
6	0.44	0.28	0.22
7	0.40	0.30	0.24
8	0.36	0.32	0.26
9	0.32	0.34	0.27
10	0.28	0.36	0.29
15	0.12	0.44	0.38
20	0.00	0.50	0.41

a. To convert meters to feet, multiply by 3.281.
b. Crank (1975), Equation 4-24.

In the second case (present in the HLW tanks), the amount of initial radionuclide inventory may be large enough that the radionuclide inventory does not fully dissolve and a sludge phase remains encapsulated with the liquid in the concrete. This situation is modeled by assuming that the amount of radionuclide present in the sludge phase is much greater than the radionuclide inventory in the pore water and concrete-adsorbed phases. As in the earlier case, a shrinking-core approximation is applied to an activity balance to derive the equation:

$$- eA_w \frac{D}{T} \frac{C_l}{H-z} - A_w zLC_s = A_w \frac{\partial C_s z}{\partial t} \qquad \text{(E-3)}$$

where C_s = radionuclide concentration in the core sludge phase
C_l = radionuclide concentration in the core pore water.

The sludge concentration is referenced to total solid phase volume. Because activity concentration in the core sludge phase decreases only by decay, the thickness of the core is estimated as:

$$z = H - \sqrt{\frac{2eDC_l}{TC_{s0}L} e^{Lt}} \qquad \text{(E-4)}$$

where C_{s0} = initial radionuclide concentration in the core.

Estimates of diffusional release rates from the rectangular drums emplaced in the RTS drum cell were developed by modeling cylindrical drums of equivalent length and volume. In this case, the radionuclide inventory is low enough that a sludge phase is not expected to form and the radionuclide can distribute between the pore water and concrete phases. Applying cylindrical symmetry, combining the pore water and adsorbed phase activity balances, and the shrinking-core approximation lead to the following equation:

$$- 2\ e\ r\ L_d \frac{D}{T} \frac{C}{R-r} - R_d\ r^2\ L_d\ L\ C = R_d\ L_d \frac{\partial r^2 C}{\partial t} \qquad \text{(E-5)}$$

where r = radial thickness of the shrinking core
R = total radius of a drum
L_d = length of a drum
C = radionuclide concentration in the pore water.

Because the concentration in the core decreases only by decay, the thickness of the core is estimated as:

$$r = R - \sqrt{\frac{2D}{R_d T} t} \qquad \text{(E-6)}$$

The release rate is calculated from the known, time-dependent core concentration and the estimated core thickness.

E.2.4 Erosional Collapse Release Model

Erosional processes are changing the configuration of streams on the Center and may eventually affect the waste disposal trenches on the south plateau and the lagoons on the north plateau. The rate of movement of the stream banks toward the disposal areas is uncertain, but it has been evaluated using the methods discussed in Appendix L. Because the movement of the stream banks on a spatially distributed basis requires data that are not presently available, a simplified one-dimensional model was developed to evaluate potential dose impacts of erosional collapse. In this model, each trench is represented as a series of sections located at known initial distances from a stream bank. The initial radionuclide inventory of each section and the constant rate of advance of the stream bank toward the trench are specified. The movement of the stream bank is tracked for specified time intervals and checked against the position of the trench sections. When the stream bank position reaches a trench section, the radionuclide inventory of that section is assumed to fall into a mixing cell in the stream, dissolve in the water, and flow to an off-site resident who uses the water for domestic and irrigation purposes. Radionuclide inventories in the trench sections and the stream mixing cell are decayed at each time step. The results of application of this model to the LLWTF, NDA, SDA, and RTS drum cell are presented in Chapter 5 and Appendix D.

E.2.5 Transport Parameter Data

The primary physical parameters used in release and transport modeling are the radionuclide-specific diffusivity and distribution coefficient and the solid media-specific constrictivity, tortuosity, and dispersivity. Aqueous phase coefficients for diffusion through on-site soils have not been measured but were estimated from ionic conductivity theory (CRC 1966, Daniel and Shackelford 1988). Estimated aqueous phase diffusion coefficients are presented in Table E-9. Tortuosity in the unweathered till was estimated by fitting solutions of the dispersion equation to tritium profiles reported for soils below the SDA trenches (Prudic 1986). The derived value, 2.5, agrees with independent estimates (Prudic 1986). An estimate of the quotient of constrictivity and tortuosity for cement may be derived from reported values of the cement cesium leachability index for the WVDP (Grant et al. 1985) and the estimated cesium aqueous diffusion coefficient. The derived value for the quotient of constrictivity and tortuosity, approximately 0.01, is in agreement with published values (Atkinson and Hearne 1984). Distribution coefficients (K_d) have been measured for a limited number of radionuclides for some of the West Valley soils (WVNS 1994b). In addition, published data for representative soil types (Thibault et al. 1990) were reviewed and evaluated. Sand and clay, the principal constituents of soil on the Center were among the types for which data were reported. To provide a conservative analysis, the distribution coefficients reported for sand (Thibault et al. 1990) were used for all areas on the Project Premises and the SDA. The only exceptions were for cesium (K_d = 40) and strontium (K_d = 5, north plateau and K_d = 10, south plateau), where site derived values were used.

Table E-9. Nuclide-Specific Transport Parameters for Long-Term Analysis

Nuclide	Distribution Coefficient (mL/g)	Diffusivity (m^2/yr)[a]
H	0	0.294
C	1.0	0.0374
Co	60	0.0231
Ni	400	0.021
Se	150	0.0318
Sr	5	0.025
Tc	0.1	0.0461[b]
Cd	80	0.0227
Sn	130	0.0298[b]
Sb	45	0.0268
I	1.0	0.034
Cs	40	0.0649
Pm	240	0.0192[b]
Sm	245	0.0192
Eu	240	0.019
Pb	270	0.0298
Ra	500	0.0281
Ac	450	0.0187[b]
Th	3,100	0.0268[b]
Pa	550	0.0268[b]
U	35	0.0134
Np	5	0.0268[b]
Pu	550	0.0187[b]
Am	1,900	0.019[b]
Cm	4,000	0.0187[b]

a. To convert from square meters per year to square feet per year, multiply by 10.764.
b. Estimated from conductivity of similar ion taking into account aqueous phase speciation.

Values for aquifer dispersivity have not been measured or estimated for the Project Premises and the SDA. Literature reported values (Waldrop 1985) range from 0.1 to 100 for the type of soil at the Center. Because peak estimated concentrations decrease with increasing dispersivity, a value of 0.1 was selected as reasonably conservative for these evaluations.

E.3 ALTERNATIVE I: REMOVAL AND RELEASE TO ALLOW UNRESTRICTED USE

This alternative includes decontamination and dismantlement of site structures, excavation of disposal areas, and removal and packaging of all wastes for off-site disposal. Contaminated soil removed from the disposal areas would be treated before packaging and disposal off site to reduce the volume of waste disposed of. The disposal areas and areas where structures were located would then be backfilled, graded, revegetated, and released for unrestricted use. Much of the backfill material would consist of soil determined to be uncontaminated (or contaminated to levels less than preestablished screening criteria) during the measurement and sorting process conducted at the container management area. The associated source terms for the implementation and post-implementation periods are discussed below, including considerations specific to individual WMAs.

E.3.1 Source Terms During the Implementation Phase

During the implementation phase for Alternative I (Removal), each WMA would be decontaminated to the extent necessary for release for unrestricted use. During this period, the remediation workers would be routinely exposed to the residual contamination, and the public could be exposed to contamination from radioactive materials released routinely or accidentally. This section describes the nature of the source terms for exposures of workers and for routine releases to the off-site public. Estimates of the magnitude of exposure and release rates are presented in Chapter 3. The source terms for large, accidental releases are presented in Appendix G. An additional source term during the implementation phase for this alternative is the packaged waste transported off site, which would result in exposures to both the public and to transportation workers. The description of this source term and the method for calculating doses to the public using the RADTRAN code are described in Appendix H.

Source Terms for Public Exposures

During the closure actions, radioactivity may be released to the environment through releases to air and surface water. However, doses to the public during these activities would be limited using engineering controls (WVNS 1994c through g). For example, during excavation of disposal areas, including the NDA, SDA, and lagoons 1 and 2, containment structures would be established to contain and filter generated dust. Also, contaminated water generated during decontamination of buildings would be evaporated producing releases to the atmosphere.

Because of the presence of the containment structures and the relatively small quantities of radioactivity expected to be released to the atmosphere during decontamination of structures, the airborne source term during the implementation phase is expected to be small for each WMA under routine operations. Additionally, the releases of evaporated, contaminated liquid to the atmosphere during implementation are expected to be small because liquid waste would be treated before release.

Estimates of radioactivity releases to the atmosphere for WMAs 1, 2, 3, 5, 7, and 8 are presented in the closure engineering reports for those WMAs (WVNS 1994c through g, i, and j). The release estimate for WMA 2 (LLWTF) was developed from measured activities of lagoon 3 sediment and U.S. Environmental Protection Agency (EPA) estimates of resuspension factors. The volume of contaminated liquid to be treated was estimated in closure engineering reports for each WMA. For decontamination solutions generated in decontaminating the process building, HLW tanks, and 02 building, the radionuclide distribution was assumed to be equal to that presented in the WMA waste characterization reports. The total quantity of activity was determined by the decontamination efficiencies cited in the closure engineering reports for each WMA and alternative. For the NDA and SDA, measured distributions of radionuclides in trench water (see Appendix C) were used in the release estimates. Source terms for releases to the atmosphere are presented in Chapter 3.

The following sections identify inventories used to develop source terms for five facilities: process building, LLWTF, HLW tanks, NDA, and SDA. For all other facilities and associated WMAs, the public source terms during the implementation phase would be relatively insignificant because of the relatively small radiological inventories (see Appendix C) and the nature of the contamination (e.g., drummed waste).

Process Building (WMA 1)

The process building has many rooms and cells containing significant amounts of radioactivity, as described in Appendix C. There would be potential for radioactive material to become entrained in the air during decontamination of the process building equipment and structure. The levels of airborne activity would depend on the contamination levels in the area being decontaminated and the processes that are being applied. It is not possible to apply a single resuspension factor or set of factors to the proposed operation to determine the resultant air concentrations because adjustments would be made during the process if unacceptably high amounts of material became airborne. These adjustments might include local ventilation exhausts to collect dust near the point of generation, water mists directed at dusty jobs such as scarifying of concrete surfaces, or substitution of chemical decontamination for mechanical methods that generate unacceptable amounts of dust.

Low-Level Waste Treatment Facility and Lagoons 1-5 (WMA 2)

Alternative I (Removal) for the LLWTF has been conceptualized as decontamination and dismantlement of the 02 building and associated structures, excavation of the lagoons, and removal of wastes for off-site disposal. The radiological source term for this alternative was determined on the basis of the radiological inventories of the 02 building and lagoons 1 and 2 as presented in Appendix C.

High-Level Waste Storage Area and Vitrification Facility (WMA 3)

As described in Appendix C, the HLW tanks are the most highly contaminated areas in this WMA. Alternative I (Removal) for the HLW tanks consists of decontaminating and dismantling the tanks, and disposing of the waste off site. The radiological source term for this alternative was determined on the basis of radiological inventories of tanks 8D-1 and 8D-2 as presented in Appendix C.

U.S. Nuclear Regulatory Commission-Licensed Disposal Area (WMA 7)

Alternative I (Removal) for the NDA consists of exhuming the waste and disposing of it off site. The exhumed waste would be treated or repackaged as necessary before off-site disposal. Contaminated soil would be exhumed and processed to reduce the volume. The site would then be backfilled, graded, revegetated, and released for unrestricted use.

The radiological source term for this alternative was determined on the basis of the radiological inventories of the NDA disposal holes and trenches presented in Appendix C. The source terms of other facilities within the NDA boundaries are small relative to the disposal holes and trenches.

State-Licensed Disposal Area (WMA 8)

Alternative I (Removal) for the SDA consists of exhuming the waste and disposing of it off site. The exhumed waste would be treated or repackaged as necessary before off-site disposal. Contaminated soil would be exhumed and processed to reduce the volume. The site would then be backfilled, graded, revegetated, and released for unrestricted use.

The radiological source term for this alternative was determined on the basis of the radiological inventories of the trenches as presented in Appendix C. The source terms of other facilities within the SDA boundaries are small compared to the disposal trenches.

Sources of Occupational Exposures

For Alternative I (Removal), occupational doses would occur from the entire radionuclide inventory at the Project Premises and the SDA because it was assumed that all of the radioactivity would be removed from the WMAs, packaged, and transported off site. External doses were calculated based on the activities of gamma-emitting radionuclides. The external doses received during the handling of the radioactivity would be the product of the number of worker-hours expended multiplied by the average dose rates incurred during various operations. The method for estimating worker doses is described more fully in Appendix F. The methodology for determining doses to workers involved in off-site waste transport operations is described in Appendix H.

Internal doses could result from the inhalation or ingestion of radioactive material. The inhalation source term is the radionuclide activity that could become airborne during the implementation phase actions. However, as described in Appendix D, this exposure pathway is relatively insignificant because engineering and administrative control measures would be implemented to prevent the inhalation of airborne radioactive material by workers. Similarly, doses from ingestion of radioactive material would be minimal.

E.3.2 Public Source Terms During the Post-Implementation Phase

After the implementation actions, the remediated and backfilled areas could contain small quantities of residual radioactivity. Most of this activity would be in the soil used as backfill material or with original soil not removed during the implementation activities because of the extremely low or undetectable levels of radioactivity initially present. Members of the public residing near the Center could be exposed to the residual contamination through (a) resuspension of the contaminated soil in air and subsequent transport off site, (b) radionuclides leached from the soil by infiltrating water and subsequently discharged from the groundwater, and (c) radionuclides carried to surface waters through surface runoff. Members of the public who establish residence on top of these slightly contaminated areas could be exposed to residual activity through direct exposure, inhalation of resuspended soil, ingestion of plants grown on the contaminated soil, ingestion of meat and milk products from animals raised near the contaminated soil, and ingestion from drinking contaminated groundwater.

The residual contamination level would depend on several factors, the initial contamination levels, the efficacy of the closure actions in reducing soil contamination levels, and the residual activity contained in the soil used as backfill material. Because it is unknown how extensively the areas would be decontaminated or how much activity would be contained in the backfilled soil, the source term for Alternative I (Removal) was conservatively determined by assuming that the amount of residual soil contamination in each WMA would result in a maximum annual dose of 15 mrem to a family member who established residence on top of the former WMA site within 10,000 years after release of the site (see Appendix D, Section D.5). Thus, it was assumed that 15 mrem/yr is the established dose criterion and that soil containing the derived maximum permissible levels of contamination would be used as backfill for the WMAs as needed. Details on the assumptions regarding releases to the environment from soil and the method for performing dose calculations using the RESRAD computer code to derive the appropriate soil contamination criteria are given in Appendix D. Appendix D also describes the assumptions and methods used to translate residual soil contamination levels to doses to the public residing off site.

Based on these assumptions and methods and the isotopic distributions for each facility presented in Appendix C, source terms resulting in a maximum individual annual dose to an on-site occupant were developed for four areas: (1) process building, (2) LLWTF, (3) NDA, and (4) SDA. Each source term consisted of a 10,000 m^2 (107,600 ft^2) area containing soil uniformly contaminated to a depth of 3.6 m (11.8 ft) with the area-specific radionuclide distributions reported in Table E-9. The soil density was taken as 2.1 g/cm^3 for the north plateau and 1.68 g/cm^3 for the south plateau. Appendix D describes the other parameters required to perform the RESRAD calculations, including specific values used for north plateau and south plateau WMAs. The calculated source terms are presented in Table E-10.

Table E-10. **Distribution of Radionuclides in Soil Resulting in 15 mrem/yr Maximum Annual Dose to an Occupant in Three Areas on the Project Premises and an Occupant on the SDA**

Radionuclide	Activity Concentration (pCi/g)			
	PB/Vit[a] (WMAs 1&3)	LLWTF (WMA 2)	NDA (WMA 7)	SDA (WMA 8)
H-3	1.4×10^{-5}	0.0039	2.9×10^{5}	0.048
C-14	5.6×10^{-5}	0.00038	0.014	0.0084
Co-60	8.4×10^{-5}	0.0096	0.72	0.5
Sr-90	2.9	0.17	0.66	0.9
Tc-99	0.00072	0.0015	0.00026	0.00032
Sb-125	0.00029	0.00042	0.017	3×10^{-8}
I-129	1.4×10^{-7}	0.00021	2.3×10^{-7}	1.2×10^{-4}
Cs-137	2.9	5.1	1.1	1.2
Eu-154	0.014	0.029	0.0051	0.23
U-232	2.9×10^{-6}	0	0.0009	5.4×10^{-5}
U-233	4.2×10^{-6}	0.0017	0.0012	0.00018
U-234	1.4×10^{-6}	8.4×10^{-5}	0.00057	4.7×10^{-5}
U-235	4.2×10^{-8}	1.7×10^{-5}	1.3×10^{-5}	1.1×10^{-5}
Np-237	9.6×10^{-6}	2.1×10^{-5}	3.6×10^{-6}	1.1×10^{-6}
U-238	4.2×10^{-7}	0.00018	1.1×10^{-4}	2.4×10^{-5}
Pu-238	0.0029	0.053	0.18	0.96
Pu-239/240	0.00072	0.027	0.06	0.0054
Pu-241	2.9×10^{-6}	2.0	1.3	0.96
Am-241	0.029	0.029	0.026	0.0042
Cm-244	0.0029	0.0024	0.0011	0.00018

a. PB/Vit = process building and vitrification facility.

The source terms presented in Table E-10 are overestimated because of the conservatism in the dose calculations and the likelihood that cleanup would be performed to levels less than those presented in the table.

E.4 ALTERNATIVE II: REMOVAL, ON-PREMISES WASTE STORAGE, AND PARTIAL RELEASE TO ALLOW UNRESTRICTED USE

This alternative is similar to Alternative I (Removal), except that mixed and radioactive wastes would be placed in new retrievable storage areas on the Project Premises rather than being transported off site. Therefore, source terms for this alternative would be identical to those presented for Alternative I (Removal) in Section E.3, with the exception that waste in the retrievable storage areas would be a source of exposure to site workers. It is not anticipated that the waste in this facility would be released to the environment under normal operations. Potential doses resulting from accidental releases from this facility are addressed in Appendix G.

The source terms for atmospheric releases were developed and the source volumes for liquid release were estimated in WVNS (1994c through g). The concentration of radionuclides in the water was estimated as described for Alternative I. Source term estimates are presented in Chapter 3.

E.5 ALTERNATIVE III: IN-PLACE STABILIZATION AND ON-PREMISES LOW-LEVEL WASTE DISPOSAL

This alternative involves in-situ stabilization of site facilities. Although some decontamination and dismantlement activities would occur, most waste (including buried waste) and contamination would be stabilized in place. Low-level waste generated by implementation phase actions would be disposed of in the process building on the Project Premises [Alternative IIIA (Backfill)] or in a new LLW disposal facility [Alternative IIIB (Rubble)]; however, the volume of such wastes would be small relative to that generated in Alternatives I (Removal) or II (On-Premises Storage).

E.5.1 Source Terms During the Implementation Phase

During the implementation phase for this alternative, each WMA would be stabilized. The source terms for each facility vary because the closure activities vary depending on the facility. During the implementation phase, workers would be exposed to residual contamination, especially at facilities to be decontaminated (e.g., the 01/14 building) or removed [e.g., the chemical process cell (CPC) waste storage area] for disposal on the Project Premises. The public could be exposed to contamination from radioactive materials released routinely or accidentally during implementation phase activities. This section gives the source terms for worker exposures and for routine releases to the off-site public. The potential source terms for releases from accidents are discussed in Appendix G.

Source Terms for Public Exposures

During the closure actions, radioactivity could be released to the environment by releases to air and surface water. However, doses to the public during these actions would be avoided using engineering controls (WVNS 1994c through j). The radiological source terms developed for each WMA under Alternative III (In-Place Stabilization) are discussed below.

Process Building (WMA 1)

The source term for the process building depends on the specific actions taken for this alternative. As described in Chapter 3, two possibilities exist: (1) the building could be backfilled with low-density concrete or (2) the building could be reduced to rubble and capped. The source term is expected to be more substantial for the second option because creating rubble could generate substantial quantities of airborne contamination. Even though the airborne contamination would be controlled by engineering features such as containment structures and filtration, some of this material could be released to the environment and subsequently transported off site.

Low-Level Waste Treatment Facility and Lagoons 1-5 (WMA 2)

Alternative III (In-Place Stabilization) for the LLWTF includes decontaminating, dismantling, and demolishing the 02 building and backfilling and capping the neutralization pit, interceptors, and lagoons. Because the primary source term for the 02 building would be the contamination released during the decontamination activities, the source term was assumed to be the same as that for Alternative I (Removal). Because the closure actions for the neutralization pit, interceptors, and lagoons would not be disruptive, no source term was postulated for these facilities for public exposures during the implementation phase.

High-Level Waste Storage Area and Vitrification Facility (WMA 3)

As described in Chapter 3, Alternative III (In-Place Stabilization) for these facilities entails two general options: (1) backfilling the vitrification facility with low-density concrete, with minimum decontamination before the backfilling operations [Alternative IIIA (Backfill)] and (2) disassembly of the vitrification facility followed by in-place stabilization of the rubble [Alternative IIIB (Rubble)]. In both cases the HLW tanks would be backfilled with low-density concrete. The source term for these operations would be radioactive material that becomes airborne and is released to the environment.

Lag Storage Building and Additions and Chemical Process Cell Waste Storage Area (WMA 5)

Alternative III (In-Place Stabilization) for these facilities includes removing the stored waste and placing the waste in the process building [Alternative IIIA (Backfill)] or in a disposal facility on the Project Premises [Alternative IIIB (Rubble)]. Because the waste in these facilities is confined in drums or other containers, no source term was postulated for routine operations (source terms for accidental releases are discussed in Appendix G). Residual contamination in the facilities would be very low.

NRC-Licensed Disposal Area (WMA 7)

Because this alternative does not involve disruption of contaminated soil or buried waste, the source term for the implementation phase is limited to treated, evaporated trench water released to the atmosphere. Additionally, no source term was postulated for the interim waste storage facility (IWSF) because the waste is contained or for the slightly contaminated ancillary facilities because a source term resulting in exposure of the off-site public would be relatively insignificant.

State-Licensed Disposal Area (WMA 8)

Like the NDA, this alternative does not disrupt the buried waste; thus, the source term for public exposures during the implementation phase is limited to release of treated, evaporated trench water to the atmosphere. No source term was postulated for the slightly contaminated ancillary facilities because the source term would be relatively insignificant.

Radwaste Treatment System Drum Cell (WMA 9)

Alternative III (In-Place Stabilization) for the RTS drum cell involves converting the facility into a tumulus-type disposal facility. Because the waste in the facility has been solidified in concrete, is contained in drums, and the conversion activities would not disrupt the waste, no source term was postulated for the implementation phase.

Sources of Occupational Exposures

Alternative III (In-Place Stabilization) requires workers to handle or be in close proximity to waste and contamination in aboveground facilities. External dose rates to workers from the waste and contamination would be a function of the activities of the gamma-emitting radionuclides (notably cesium-137 and cobalt-60), the proximity of workers to the sources, the time workers spend near the sources, and the presence of shielding between the sources and the workers during the stabilization activities. As described in Appendix D and in Section E.2.1, the inhalation source term is insignificant because engineering and administrative control measures would be designed to prevent the inhalation of airborne radioactive material by workers. Similarly, doses from ingestion of radioactive material would be minimal.

E.5.2 Source Terms During the Post-Implementation Phase

During the post-implementation phase, exposures to the public residing near the Project Premises could result from ineffective waste containment and stabilization activities. Additionally, workers would receive small exposures during the routine monitoring and maintenance activities. Sources of these exposures are described below.

Source Terms for Public Exposures

The source terms for the post-implementation phase of Alternative III (In-Place Stabilization) are complex because waste would be left in place with engineering controls to prevent the release of the radioactivity to the environment. Therefore, the source term depends on the effectiveness of the engineering controls. The controls could be effective initially and then degrade over time. In some cases there would be no source term until the engineering controls fail. In other cases, the engineering design may be only partially effective in containing the contamination, and releases could begin early in the post-implementation phase. The following sections describe the postulated source terms for facilities containing radionuclide inventories other than residual soil contamination.

Process Building (WMA 1)

For Alternative IIIA [In-Place Stabilization (Backfill)], the spent fuel fines would be removed from the process building, waste would be placed in empty rooms, and the structure would be backfilled with low-density concrete. The chemical process cell and the extraction cells were assumed to be the primary rooms used for waste disposal and the final height of the grout was estimated as 10 m (33 ft). The radionuclide inventories are presented in Appendix C. Over time, the monolith was assumed to be saturated with water and radionuclides were assumed to disperse into the concrete pore water and diffuse downward to the sand and gravel layer, removing radionuclides from the concrete. For this conceptual model, release rates were estimated using the slab waste form model described in Section E.2. The cross sectional area for diffusion is approximately 500 m^2 (5,400 ft^2). Using the transport models described in Appendix D, radionuclides potentially released to the aquifer would be transported toward on-site and off-site residents. For Alternative IIIB [In-Place Stabilization (Rubble)], spent fuel fines would be removed from the process building, the building collapsed to a rubble pile, grouted, and capped. The nuclide inventory of the building would be less than that of Alternative IIIA [In-Place Stabilization (Backfill)] but concentrated at the bottom of the building in a grouted layer assumed to be 1 m (3.3 ft) thick. The belowgrade portion of the building would be backfilled with cement, and the grouted, capped, abovegrade rubble pile has been conceptualized as 7.9 m (26 ft) thick. In the scenario evaluated, the structure becomes saturated and radionuclides diffuse to the underlying sand and gravel layer. The slab diffusion release model described in Section E.2 was used to estimate release rates.

Low-Level Waste Treatment Facility and Lagoons 1-5 (WMA 2)

For Alternative III (In-Place Stabilization), sediment and buried debris would remain in place and each lagoon would be capped. Groundwater was assumed to flow horizontally through the buried sediments, dissolve radionuclides, and transport the dissolved contaminants to Erdman Brook. Thus, the flow-dissolution model described in Section E.2 was used to estimate release rates for this area.

High-Level Storage Area and Vitrification Facility (WMA 3)

For Alternative III (In-Place Stabilization), residual waste in each of the tanks would be grouted in place. The inventory of radionuclides remaining in the tank was estimated as 3 percent of the full inventory as described in Appendix C. Because movement of the waste sludge is constrained by tank internals, the inventory was assumed to be distributed into a 1-m (3.3-ft) layer at the bottom of the tank. The tank itself was assumed to degrade and to offer no resistance to the potential release of radionuclides. The gravel layer placed under the tank is saturated with water, which provides a mixing zone for radionuclides diffusing through the grout. The sludge-grout diffusion model described in Section E.2 was used to estimate the quantity of radionuclides potentially released to groundwater.

Lag Storage Building and Additions and Chemical Process Cell Waste Storage Area (WMA 5)

For Alternative IIIB [In-Place Stabilization (Rubble)], stored waste in the lag storage building and additions and CPC waste storage area would be emplaced in a new disposal facility on the Project Premises. A tumulus using concrete for stabilization and infiltration control was selected as the reference design. After closure, the facility was assumed to become saturated with water percolating through the layers. Radionuclides contacted by the water dissolve and eventually reach the underlying sand and gravel layer. Infiltration rates were estimated using the harmonic mean hydraulic conductivity, and the release rate was estimated as the product of solubility and infiltration rate.

NRC-Licensed Disposal Area (WMA 7)

Waste at the NDA is disposed of in both the weathered and unweathered till. Water percolates horizontally and vertically through the waste, dissolving radionuclides that could be transported to Erdman Brook and Buttermilk Creek. Release rates were estimated as the product of water flow rate and radionuclide solubility.

State-Licensed Disposal Area (WMA 8)

At the SDA, waste disposed of in the weathered and unweathered till could be leached by groundwater and transported to Franks Creek and Buttermilk Creek. Release rates were estimated as the product of solubility and groundwater flow rate as described in Section E.2.

Radwaste Treatment System Drum Cell (WMA 9)

At the RTS drum cell, cemented wasted in drums would be covered in a tumulus. Water infiltrating the tumulus was assumed to dissolve radionuclides diffusing out of the drums. The diffusional release rate was estimated using the cylindrical waste form approximation described in Section E.2. If the concentration of a radionuclide in the infiltrating water exceeded the solubility, the resulting release rate was estimated as the product of infiltration rate and solubility rather than as the estimated diffusional release rate.

Sources of Occupational Exposures

During the routine monitoring and maintenance period, workers would be exposed to direct radiation from the stabilized radiological contaminants. These exposures are likely to be minimal, however, because shielding (e.g., concrete for the process building and tanks and soil for the NDA and SDA would be used between the workers and waste). Annual worker doses were estimated based on the expected dose rates and the annual number of person-hours required for monitoring and maintaining the site. The dose rates would be expected to decrease each year from radiological decay, most notably from the decay of cesium-137.

E.6 ALTERNATIVE IV: NO ACTION: MONITORING AND MAINTENANCE

Because minimal implementation activities, such as contaminant stabilization, would occur under this alternative before the long-term monitoring and maintenance program begins, no radiological source terms for either public or occupational exposures were evaluated. Source terms for post-implementation phase exposures are discussed in the following sections.

E.6.1 Public Source Terms During the Post-Implementation Phase

For this alternative, facilities on the Project Premises were assumed to be maintained in their present condition. No releases were predicted for the process building, HLW tanks, lag storage building and additions, and the RTS drum cell. At the LLWTF, NDA, and SDA groundwater flow and radionuclide dissolution could occur. As in the case of Alternative III (In-Place Stabilization), release rates from each of these facilities was estimated as the product of solubility and groundwater flow rate. Erosion was not expected to affect the facilities for this alternative.

E.6.2 Sources of Occupational Exposures During the Post-Implementation Phase

During routine monitoring and maintenance, workers would receive external radiation exposures from the existing contamination and waste. These exposures would likely be minimal initially, although they could increase over time from the increased effort required to maintain the Project Premises in its present condition. However, the increases in effort could be partially or completely offset by the decreased dose rates as a result of radiological decay, most notably the decay of cesium-137.

E.7 ALTERNATIVE V: DISCONTINUE OPERATIONS

Under this alternative, operations would be discontinued and the site would be abandoned. As a result, there would be no implementation phase because no actions would occur. The source term for public exposures for the post-implementation phase is described below. Two primary release scenarios were considered. In an undisturbed site scenario, groundwater infiltrating the waste transports radionuclides to on-site and off-site residents. In the disturbed site scenario, erosional collapse occurs at the LLWTF, NDA, SDA, and RTS drum cell, releasing waste directly to surface water.

Public Source Terms After Site Abandonment

The source term for public exposures for this alternative potentially includes the sitewide inventory. Because institutional controls were assumed to discontinue at the time of abandonment, the public could gain access to the site, and in some cases, direct access to the radioactive material.

Exposures to occupants on the Project Premises and the SDA were developed based on the WMA inventories presented in Appendix C and on analysis of many potential exposure scenarios. The methodologies for determining the potential doses from these source terms and the relevant exposure scenarios are presented in Appendix D.

In addition to the potential for the public to be exposed by direct access to the contamination, members of the public residing off site could be exposed from contamination inadvertently transported off site. The subsections below describe the postulated radiological source term for facilities in each WMA.

Process Building (WMA 1)

After abandonment, the process building was assumed to degrade and lose structural integrity, allowing water to percolate through the building. Because most of the radionuclide inventory resides in rooms with floors belowgrade, the release was assumed to occur into the sand and gravel layer. The average normal infiltration rate for the north plateau [17 cm/yr (6.7 in./yr)] was assumed, and the release rate was estimated as the product of solubility and infiltration rate. The process building area is not expected to be affected by erosional processes.

Low-Level Waste Treatment Facility and Lagoons 1-5 (WMA 2)

In the undisturbed site scenario, water could percolate through the sediments, radionuclides could be dissolved and transported to Erdman Brook. Release rates were estimated as the product of solubility and groundwater flow rate. In the disturbed site scenario, the bank of Erdman Brook erodes, causing collapse of the lagoons into the creek. At the time of collapse, the remaining inventory in the affected section of the lagoon was assumed to deposit in the creek. The collapse process begins at lagoon 3 approximately 30 years after abandonment and reaches lagoon 1 after approximately 900 years.

High-Level Waste Tanks (WMA 3)

After abandonment, the tanks were assumed to fail and the contents would be exposed to flowing groundwater. Radionuclides were assumed to dissolve into the water and flow northward toward the creeks. The release rate was estimated as the product of groundwater flow and solubility. WMA 3 is not expected to be affected by erosional processes.

Lag Storage Building and Additions and Chemical Process Cell Waste Storage Area (WMA 5)

At WMA 5, stored waste would be protected by sheet metal and air-support structures. These structures have a short design life and were assumed to fail soon after abandonment. Precipitation contacting the cement form was assumed to dissolve radionuclides and flow overland to the creek. The release rate was estimated as the product of solubility and average annual precipitation rate [100 cm/yr (39 in./yr)]. The facilities in WMA 5 are not expected to be affected by erosional processes.

NRC-Licensed Disposal Area (WMA 7)

Under undisturbed conditions, the waste at the NDA would be leached by groundwater flowing horizontally through the weathered till and by water percolating downward through the unweathered till. In each case, release rates were estimated as the product of solubility and groundwater flow rate. The impacts of erosion of Erdman Brook were evaluated using the erosional collapse model described in Section E.2. The entire inventory present in a trench section or disposal hole would be deposited into the creek at the time of collapse of that section. Initial collapse has been estimated to occur after approximately 250 years and would be complete after 900 years.

State-Licensed Disposal Area (WMA 8)

In the undisturbed site scenario, horizontal and vertical groundwater flow were assumed to leach radionuclides from the buried waste. Release for both flow paths was estimated as the product of solubility and groundwater flow rate. In the erosional collapse scenario, movement of the bank of Franks Creek would cause collapse of the trenches into the creek. Initial collapse has been estimated to occur after approximately 250 years, and the trenches would be fully eroded after 900 years. The remaining inventory of the affected section would be deposited in the creek at the time of collapse.

Radwaste Treatment System Drum Cell (WMA 9)

The sheet metal structure at the RTS drum cell has a short design life and was assumed to fail soon after site abandonment. Precipitation contacting the cement waste form was assumed to dissolve radionuclides and flow overland to the creek. The release rate was estimated as the product of radionuclide solubility and annual average precipitation rate. Erosion of Franks Creek was assumed to affect the RTS drum cell. In this assumed scenario, waste drums collapse into the creek as the creek bank advances through the drum cell. The inventory remaining in a failed section could dissolve in surface water. Collapse was estimated to being after approximately 150 years and would be complete after approximately 700 years.

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[2]WVNS, 1994j. *West Valley Demonstration Project, Lag Storage Area Closure Engineering Report*, WVDP-EIS-032, Rev. 0, August.

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[1]Document is available in the public reading room.
[2]Later version of the document is available in the public reading room.

APPENDIX F

METHOD FOR CALCULATING OCCUPATIONAL INJURIES, ILLNESSES, AND FATALITIES

APPENDIX F

METHOD FOR CALCULATING OCCUPATIONAL INJURIES, ILLNESSES, AND FATALITIES

This appendix describes the method used to estimate occupational (nonradiological) injuries, illnesses, and fatalities to workers completing closure activities for the alternatives being evaluated in this Environmental Impact Statement (EIS). Implementation phase activities of the closure alternatives involve occupational risk of injury, illness, and loss of life unrelated to radiological hazards. These hazards are present in many industrial activities and are similar to those at other U.S. Department of Energy (DOE) facilities. The results of this analysis are presented in Chapter 5 of this EIS.

F.1 INTRODUCTION

The implementation phase of closure includes constructing confinement structures and waste handling and storage facilities; waste exhumation, repackaging, and storage; facility decontamination, dismantlement, and demolition; and support services, such as security, engineering, and quality assurance. Events that could result in personal injury, illness, or death include exposure to toxic materials, overexertion, falls, crushing, pinching, and mechanical impacts with machinery or vehicles. These accidents are possible as the result of routine work. Most of these hazards occur in other industries as well, and the estimated risks for the Western New York Nuclear Service Center (Center) were based on historical experience involving similar operations. In contrast, impacts from major accidents that present a risk to the public from the release of radioactive material to the environment cannot be estimated in this manner because the accident risks and radiological materials are unique to the Center. These unique accidents are addressed separately in Appendix G. However, both implementation actions and unique accidents may involve nonradiological impacts to workers. The methodology used to evaluate these impacts is presented in Section F.2 below.

F.2 METHODOLOGY

Occupational injury, illness, and fatality estimates were calculated using occupational incidence rates of major industry groups, DOE, and DOE contractors and multiplying these rates by person-hour estimates. An incidence rate is defined as the number of recordable cases of occupational injuries, illnesses, or fatalities per 100 full-time workers (200,000 worker-hours). The categories of occupational (nonradiological) injuries, illnesses, and fatalities used in this EIS are defined by the Occupational Safety and Health Administration as follows (NSC 1993a):

- **Occupational injury**—an injury, such as a cut, fracture, sprain, or amputation, that results from a work accident or from an exposure involving a single incident in the work environment.

- **Occupational illness**—an abnormal condition or disorder, other than one resulting from an occupational injury, caused by exposure to environmental factors of employment. Occupational illness includes acute and chronic illness or disease that may be caused by inhalation, absorption, ingestion, or direct contact.

- **Lost workdays**—those days that the employee would have worked but could not because of occupational injury or illness. The number of lost workdays should not include the day of injury or onset of illness. The number of days includes all days (consecutive or not) on which, because of injury or illness: (a) the employee would have worked but could not, (b) the employee was assigned to a temporary job, (c) the employee worked at a permanent job less than full time, or (d) the employee worked at a permanently assigned job but could not perform all duties normally connected with it.

- **Lost workday cases**—cases that involve days away from work or days of restricted work activity.

- **Recordable cases**—cases involving an occupational injury or occupational illness, including death. Not recordable are first aid cases that involve one-time treatment and subsequent observation of minor scratches, cuts, burns, and splinters but do not ordinarily require medical care, even though the treatment is given by a physician or registered professional personnel.

- **Nonfatal cases without lost workdays**—cases of occupational injury or illness that did not involve fatalities or lost workdays but did result in (a) transfer to another job or termination of employment, (b) medical treatment, other than first aid, (c) diagnosis of occupational illness, (d) loss of consciousness, or (e) restriction of work or motion.

For this EIS, postulated incidents for illness and injury were determined using the incidence rates for lost workdays. Calculations cover both the implementation phase and the post-implementation maintenance and monitoring period considered in the EIS.

Incidence rates are based on the type of work activity. To identify appropriate incidence rates for each closure alternative, work activities were classified into three major categories: (1) construction, (2) operations, and (3) services. Construction activities include the construction of confinement, control, and support structures; demolition of structures; and the excavation and backfilling of clean soil. Operations consist of on-site waste handling, monitoring, and transportation activities (including excavation of contaminated soil, exhumation of waste, decontamination and immobilization, removal of contaminated equipment, waste packaging/repackaging, on-site storage, monitoring, and sampling). Services include activities such as engineering, design, security, and administration. Impacts from off-site transportation are addressed in Appendix H.

All three types of work activities occur within each of the alternatives. To estimate the number of lost workday cases and fatalities that may occur during implementation of the alternatives, data regarding the lost workday case and fatality incidence rates for DOE workers were reviewed (DOE 1994). These data included detailed descriptions (by worker category) of the lost workday case and fatality incidence rates for 1993 and summaries of the rates for the 5 years before 1993.

The DOE data were sufficient to develop estimates of the lost workday cases rates for the three categories of workers identified for this EIS. It was assumed that the rates observed for 1993 represent rates for implementation of the closure alternatives.

The DOE data were not sufficient to develop estimates of the worker fatality rates for the closure alternatives, because the number of fatalities that occur at DOE facilities is variable and too low in number to derive precise estimates for the worker categories. Therefore, fatality rates for the three worker categories were developed by determining the ratio of worker fatalities to lost workday cases for similar workers at all U.S. industries as documented by the National Safety Council and the U.S. Department of Labor (NSC 1993a, NSC 1993b, DOL 1993), and by assuming that these ratios represent ratios for West Valley closure activities.

The incidence rates used to estimate the total number of lost workday cases and fatalities for each of the closure alternatives are presented in Table F-1.

Table F-1. Lost Workday Cases and Fatality Incidence Rates[a]

	Construction	Operation	Services
Lost Workday Cases	2.8	1.2	2.2
Fatalities	0.0090	0.0013	0.0015

a. Incidence rates per 100 full-time employees (i.e., 100 worker-years).

F.3 CALCULATION OF IMPACTS

Estimates of the person-hours required to implement the closure alternatives for each waste management area (WMA) were derived from the closure engineering reports, which address the (a) existing site facilities, (b) new facilities (e.g., retrievable storage area, container management area, and low-level waste disposal facility) and (c) activities not correlated to specific facilities such as erosion control and site monitoring and maintenance (WVNS 1994a through 1994m). Person-hour estimates for each alternative were assigned to one of the three general work activities; the results are presented in Table F-2 for Alternatives I, through IV. Alternative V (Discontinue Operations) was not included because there would be no occupational activities.

To compare the occupational injuries, illnesses, and fatalities that would occur during the implementation phase of an alternative with those that would occur during the post-implementation phase long-term monitoring and maintenance period, a nominal time frame of 100 years was selected to calculate impacts during the monitoring and maintenance period. In addition to the impacts of monitoring and maintaining the site during this timeframe, the

Table F-2. Labor Requirements by Type of Work Activity for Each Alternative (Worker-Years)

Alternative	1	2	3	4	5	6	7	8	9	10	11	12	Container Management Area	Retrievable Storage Area	LLW Disposal Facility	Erosion Control	Maintenance, Monitoring[a]	Site Support
	Waste Management Area/Facility/Activity																	
I. Removal and Release to Allow Unrestricted Use																		
Construction	150	15	46	6	4	4	147	28	3	10	2	23	149	NA[b]	NA	0.4	NA	0
Operations	364	9	144	1	4	0.7	321	442	9	2	0.3	4	993	NA	NA	0.1	NA	2560
Services	933	48	378	15	20	12	872	876	23	22	5	53	2001	NA	NA	1	NA	3840
Total	1447	72	568	22	28	17	1340	1346	35	34	7	80	3143	NA	NA	2	NA	6400
II. Removal, On-Premises Storage, and Partial Release to Allow Unrestricted Use																		
Construction	150	15	46	6	4	4	147	28	0	6	2	18	149	285	NA	12	0	0
Operations	364	9	144	1	4	0.7	321	442	0	0.9	0.3	3	993	390	NA	10	0[c]	2360
Services	933	48	378	15	20	12	872	876	0.6	13	5	41	2001	2079	NA	16	0[c]	3540
Total	1447	72	568	22	28	17	1340	1346	0.6	20	7	62	3143	2754	NA	38	0[c]	5900
IIIA. In-Place Stabilization (Backfill) and On-Premises LLW Disposal																		
Construction	41	9	23	0	4	4	61	133	9	6	2	11	10	NA	NA	58	0	0
Operations	32	7	11	0	4	0.7	10	20	1	0.9	0.3	2	124	NA	NA	49	2390[d]	160
Services	162	35	92	0	20	12	148	288	23	13	5	26	232	NA	NA	76	2390[d]	240
Total	235	51	126	0	28	17	219	441	33	20	7	39	366	NA	NA	183	4780[d]	400
IIIB. In-Place Stabilization (Rubble) and On-Premises LLW Disposal																		
Construction	350	9	113	0	4	4	61	133	9	6	2	11	10	NA	340	191	0	0
Operations	257	7	25	0	4	0.7	10	20	1	0.9	0.3	2	124	NA	109	37	2390[d]	440
Services	1103	35	288	0	20	12	148	288	23	13	5	26	232	NA	773	396	2390[d]	660
Total	1710	51	426	0	28	17	219	441	33	20	7	39	366	NA	1222	624	4780[d]	1100
IV. No Action: Monitoring and Maintenance																		
Construction	0.1	4	0	0	0	0.1	0	0	0	0	0	0	NA	NA	NA	58	0	NA
Operations	2	2	3	0	2	0.02	0	0	0	0	0	0	NA	NA	NA	49	9165[e]	NA
Services	17	14	13	0	5	3	0	0	0.6	0	0	0	NA	NA	NA	76	9165[e]	NA
Total	19	20	16	0	7	3	0	0	0.6	0	0	0	NA	NA	NA	183	18330[e]	NA

a. Based on estimates provided in WVNS (1994f) for an assumed 100-year period.
b. NA = Not applicable.
c. Maintenance and monitoring person-hours for this alternative are mostly attributable to the retrievable storage area; these person-hours have been included in the retrievable storage area estimates.
d. When evaluating alternatives on a WMA-specific basis, these person-hours should be attributed to the appropriate WMAs. For this alternative, there are monitoring and maintenance hours associated with WMAs 1, 2, 3, 4, 7, 8, 10, and 12.
e. When evaluating alternatives on a WMA-specific basis, these person-hours should be attributed to the appropriate WMAs. For this alternative, there are monitoring and maintenance hours associated with all WMAs.

impacts of replacing facilities that have a design life of less than 100 years were included.

Table F-2 gives person-hour estimates by WMA and by alternative. Person-hours for constructing and operating new facilities and performing activities required to support the various alternatives are also included. The person-hour estimates are presented in this manner so that occupational injury, illness and fatality rates can be properly considered when evaluating the costs and benefits of implementing the various alternatives for each facility or WMA.

Person-hour estimates for maintenance and monitoring activities over the post-implementation phase are included as a separate category in Table F-2 and were not included in the WMA-specific estimates because the estimates are provided as site-wide person-hours rather than WMA-specific person-hours in the closure engineering reports. Although the alternative wide person-hour and occupational injury/illness rates presented in Chapter 5 incorporate these additional sitewide costs, the WMA-specific estimates do not include the maintenance and monitoring person-hours when in fact some maintenance and monitoring would occur for the specific facilities within the WMAs. For example, under Alternative IV (No Action: Monitoring and Maintenance) most of the estimated monitoring and maintenance person-hours would likely be associated with the U.S. Nuclear Regulatory Commission-Licensed Disposal Area (NDA), State-Licensed Disposal Area (SDA) and process building.

Based on the closure engineering reports, some of the estimated person-hours (and associated occupational illnesses, injuries and fatalities) have been attributed to a support facility. In evaluating the alternatives on a WMA-specific basis, these person-hours should be apportioned to the relevant WMAs. For example, under Alternative II, hours listed in Table F-2 for the retrievable storage area should actually be attributed to the facilities that would supply waste to the retrievable storage area (e.g., the NDA, SDA and process building).

Fewer overall hours could be required to implement an entire alternative than is indicated by summing the estimates shown in Table F-2 for individual facilities. This could occur because of the increased efficiency of implementing a single alternative for the entire site when compared to implementing several different alternatives for different WMAs. This possibility should be considered when evaluating the costs and benefits of each alternative.

The estimated number of lost workday cases and fatalities for each alternative is obtained by multiplying the incidence rates presented in Table F-1 by the person-hour estimates presented in Table F-2 (divided by 100 to correct the units). Tables F-3 and F-4 summarize the estimated number of lost workday cases and fatalities, respectively. Numbers presented in Tables F-3 and F-4 that are significantly less than one suggest a low probability that an incident will occur.

Table F-3. Total Estimated Lost Workday Cases for Each Alternative[a]

Alternative	Waste Management Area/Facility/Activity																	
	1	2	3	4	5	6	7	8	9	10	11	12	Container Management Area	Retrievable Storage Area	LLW Disposal Facility	Erosion Control	Maintenance, Monitoring[b]	Site Support
I. Removal and Release to Allow Unrestricted Use																		
Construction	4.2	0.4	1.3	0.2	0.1	0.1	4.1	0.8	0.0	0.3	0.0	0.6	4.2	NA[d]	NA	0.0	NA	0
Operations	4.4	0.1	1.7	0.0	0.0	0.0	3.9	5.3	0.1	0.0	0.0	0.0	12	NA	NA	0.0	NA	31
Services	21	1.1	8	0.3	0.4	0.3	19	19	0.5	0.5	0.1	1.2	44	NA	NA	0.0	NA	84
Total[c]	30	1.6	11	0.5	0.5	0.4	27	25	0.6	0.8	0.1	1.8	60	NA	NA	0.0	NA	115
II. Removal, On-Premises Storage, and Partial Release to Allow Unrestricted Use																		
Construction	4.2	0.4	1.3	0.2	0.1	0.1	4.1	0.8	0	0.2	0.0	0.5	4.2	8.0	NA	0.3	0	0
Operations	4.4	0.1	1.7	0.0	0.0	0.0	3.9	5.3	0	0.0	0.0	0.0	12	4.7	NA	0.1	0	28
Services	21	1.1	8	0.3	0.4	0.3	19	19	0.0	0.3	0.1	0.9	44	46	NA	0.4	0	78
Total[c]	30	1.6	11	0.5	0.5	0.4	27	25	0.0	0.5	0.1	1.4	60	59	NA	0.8	0	106
IIIA. In-Place Stabilization (Backfill) and On-Premises LLW Disposal																		
Construction	1.1	0.3	0.6	0	0.1	0.1	1.7	3.7	0.3	0.2	0.0	0.3	0.3	NA	NA	1.6	0	0
Operations	0.4	0.0	0.1	0	0.0	0.0	0.1	0.2	0.0	0.0	0.0	0.0	1.5	NA	NA	0.6	29	1.9
Services	3.6	0.8	2.0	0	0.4	0.3	3.3	6.3	0.5	0.3	0.1	0.6	5.1	NA	NA	1.7	53	5.3
Total[c]	5.1	1.1	2.7	0	0.5	0.4	5.1	10	0.8	0.5	0.1	0.9	6.9	NA	NA	3.9	82	7.2
IIIB. In-Place Stabilization (Rubble) and On-Premises LLW Disposal																		
Construction	9.8	0.3	3.2	0	0.1	0.1	1.7	3.7	0.3	0.2	0.0	0.7	0.3	NA	9.5	5.3	0	0
Operations	3.1	0.0	0.3	0	0.0	0.0	0.1	0.2	0.0	0.0	0.0	0	1.5	NA	1.3	0.4	29	5.3
Services	24	0.8	6.3	0	0.4	0.3	3.3	6.3	0.5	0.3	0.1	0.1	5.1	NA	17	8.7	53	15
Total[c]	37	1.1	9.8	0	0.5	0.4	5.1	10	0.8	0.5	0.1	0.8	6.9	NA	28	14	82	20
IV. No Action: Monitoring and Maintenance																		
Construction	0.0	0.1	0	0	0	0.0	0	0	0	0	0	0	NA	NA	NA	1.6	0	NA
Operations	0.0	0.0	0.0	0	0.0	0.0	0	0	0	0	0	0	NA	NA	NA	0.6	110	NA
Services	0.4	0.3	0.3	0	0.1	0.0	0	0	0.0	0	0	0	NA	NA	NA	1.7	202	NA
Total[c]	0.4	0.4	0.3	0	0.1	0.0	0	0	0.0	0	0	0	NA	NA	NA	3.9	312	NA

a. An entry of 0 indicates that no lost workday cases have been estimated based on the zero person-hours estimated (see Table F-2); an entry of 0.0 indicates that the estimated lost workday cases is less than 0.1.
b. See Table F-2 and the text for a discussion of these impacts.
c. Totals may not exactly equal the sum of the numbers in the columns because of rounding.
d. NA = Not applicable.

Table F-4. Total Estimated Fatalities for Each Alternative[a]

Alternative	Waste Management Area/Facility/Activity 1	2	3	4	5	6	7	8	9	10	11	12	Container Management Area	Retrievable Storage Area	LLW Disposal Facility	Erosion Control	Maintenance, Monitoring[b]	Site Support
I. <u>Removal and Release to Allow Unrestricted Use</u>																		
Construction	0.014	0.001	0.004	0.0005	0.0004	0.0004	0.013	0.003	0.0003	0.0009	0.0002	0.002	0.013	NA[d]	NA	0.0000	NA	0
Operations	0.005	0.0001	0.002	0.0000	0.0000	0.0000	0.004	0.006	0.0001	0.0000	0.0000	0.0000	0.013	NA	NA	0.0000	NA	0.033
Services	0.014	0.0007	0.006	0.0002	0.0003	0.0002	0.013	0.013	0.0003	0.00003	0.0000	0.0008	0.030	NA	NA	0.0000	NA	0.058
Total[c]	0.033	0.002	0.012	0.0007	0.0007	0.0006	0.022	0.022	0.001	0.001	0.0002	0.003	0.056	NA	NA	0.0001	NA	0.091
II. <u>Removal, On-Premises Storage, and Partial Release to Allow Unrestricted Use</u>																		
Construction	0.014	0.001	0.004	0.0005	0.0004	0.0004	0.013	0.003	0	0.0005	0.0002	0.002	0.013	0.026	NA	0.002	0	0
Operations	0.005	0.0001	0.002	0.0000	0.0000	0.0000	0.004	0.006	0	0.0000	0.0000	0.0000	0.013	0.005	NA	0.0002	0	0.031
Services	0.014	0.0007	0.006	0.0002	0.0003	0.0002	0.013	0.013	0.0000	0.0002	0.0000	0.0006	0.030	0.031	NA	0.0002	0	0.053
Total[c]	0.033	0.002	0.012	0.0007	0.0007	0.0006	0.022	0.022	0.0000	0.0007	0.0002	0.003	0.056	0.062	NA	0.001	0	0.084
IIIA. <u>In-Place Stabilization (Backfill) and On-Premises LLW Disposal</u>																		
Construction	0.004	0.008	0.002	0	0.0004	0.0004	0.005	0.012	0.0008	0.0005	0.0002	0.001	0.009	NA	NA	0.005	0	0
Operations	0.0004	0.0000	0.0001	0	0.0000	0.0000	0.000	0.0003	0.0000	0.0000	0.0000	0.0000	0.002	NA	NA	0.0006	0.031	0.006
Services	0.002	0.0005	0.001	0	0.0003	0.0002	1 0.002	0.004	0.0003	0.0002	0.0000	0.0004	0.003	NA	NA	0.001	0.036	0.004
Total[c]	0.006	0.001	0.003	0	0.0007	0.0006	0.007	0.016	0.001	0.0007	0.0002	0.002	0.006	NA	NA	0.007	0.19	0.006
IIIB. <u>In-Place Stabilization (Rubble) and On-Premises LLW Disposal</u>																		
Construction	0.032	0.0008	0.010	0	0.0004	0.0004	0.005	0.012	0.0008	0.0005	0.0002	0.001	0.0009	NA	0.031	0.017	0	0
Operations	0.003	0.0000	0.0003	0	0.0000	0.0000	0.000	0.0003	0.0000	0.0000	0.0000	0	0.002	NA	0.001	0.0005	0.031	0.006
Services	0.017	0.0005	0.004	0	0.0003	0.0002	1 0.002	0.004	0.0003	0.0002	0.0000	0.0004	0.003	NA	0.012	0.006	0.036	0.010
Total[c]	0.052	0.001	0.017	0	0.0007	0.0006	0.007	0.016	0.001	0.0007	0.0002	0.002	0.006	NA	0.044	0.024	0.067	0.016
IV. <u>No Action: Monitoring and Maintenance</u>																		
Construction	0.0000	0.0004	0	0	0	0.0000	0	0	0	0	0	0	NA	NA	NA	0.005	0	NA
Operations	0.0000	0.0000	0.0000	0	0.0000	0.0000	0	0	0	0	0	0	NA	NA	NA	0.0006	0.12	NA
Services	0.0003	0.0002	0.0002	0	0.0000	0.0000	0	0	0.0000	0	0	0	NA	NA	NA	0.001	0.14	NA
Total[c]	0.0003	0.0006	0.0002	0	0.0001	0.0000	0	0	0.0000	0	0	0	NA	NA	NA	0.007	0.26	NA

a. An entry of 0 indicates that no fatalities have been estimated based on the zero person-hours estimated (see Table F-2); an entry of 0.0000 indicates that the estimated fatalities is less than 0.0001.
b. See Table F-2 and the text for a discussion of these impacts.
c. Totals may not exactly equal the sum of the numbers in the columns because of rounding.
d. NA = Not applicable.

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APPENDIX G

RADIATION DOSES TO THE PUBLIC FROM ACCIDENTS

APPENDIX G

RADIATION DOSES TO THE PUBLIC FROM ACCIDENTS

Implementation of the alternatives evaluated in this Environmental Impact Statement (EIS) will involve actions with radioactively contaminated materials both during the implementation and post-implementation phase. Accidents could occur during both phases that result in radiological doses greater than those expected from normal operations. The purpose of this appendix is to identify the general nature and potential consequences of such accidents.

This information supports the selection of a closure or long-term site management alternative by providing information on the risk that could result from actions implemented under the various alternatives. Precise risk estimates cannot be developed at this time because only conceptual engineering designs of facilities are available. Still, potential accident scenarios that could occur and their expected likelihood can be developed based on experience at similar or related facilities. The identified accident scenarios are expected to be considered in the design basis for facilities actually built and features incorporated into the design and operation to make such accidents highly unlikely.

G.1 TECHNICAL APPROACH

The appendix focuses on identifying and evaluating accidents that would result in radiological doses to individuals and populations. It does not evaluate implementation phase accidents involving liquid releases because these types of accidents were not expected to release as much material to the environment as accidents involving gaseous releases. Liquid releases during the post-implementation phase are analyzed in Appendix D, which addresses the long-term performance assessment of the storage and disposal facilities.

Two general types of initiators may lead to accidents in processing facilities. The first type of accident is internally initiated, which could be caused by equipment failure, operator error, or a combination of both. The second type of accident is externally initiated, where either external human activities (e.g., airplane crashes) or natural phenomena (e.g., earthquakes) could threaten the ability of the facility and its equipment and operations to control the radiological material. This accident analysis evaluates both internally and externally initiated accidents.

For internally initiated accidents, the estimates of material released were developed considering the facilities, its operations, and the materials used within the facility. This information was acquired from the facility waste characterization reports (WVNS 1994a through 1994h) and the closure engineering reports (WVNS 1994i through 1994r). The waste inventory information was projected from data in the waste characterization reports and is presented in Appendix C. Assumptions regarding the spatial distribution of the radioactivity are consistent with the information provided in the facility characterization reports. The scenario parameters used in the analysis were based on engineering judgement, using the DOE handbook for release and respirable fractions (Mishima 1994). Situations were identified where both large amounts of material would be at risk and there would be a mechanism for transporting the material to the environment. The transporting mechanism could be the result of equipment failure (e.g., filters or vessels) or energetic reactions (e.g., fires and explosions).

For externally initiated accidents, the estimates of material released were developed from an understanding of both the potential external initiators as well as the facility, operations, and materials that would be impacted by these external events. There are no surrounding industrial facilities that could affect the site facilities. After reviewing the design criteria for the proposed facilities, the only external events examined in this appendix were seismic events. The focus on seismic initiators is consistent with previous evaluations of existing structures (NRC 1982, NRC 1991) that concluded while it is very unlikely that there would be serious off-site consequences as a result of a seismic event, it was even more unlikely there would be serious off-site consequences as a result of either straight-line high winds or high winds from tornadoes. In addition, releases because of high winds or tornadoes would be widely dispersed, producing much lower doses compared to similar or smaller releases under less severe meteorological conditions.

For each action performed as part of an alternative, the possible release mechanisms were identified and events were postulated that could initiate the release. The magnitude of the release was estimated from the primary barrier that confined or contained the material and the effects of mitigating features or processes were considered. For airborne releases, source terms were calculated as the product of the material-at-risk, damage ratio, airborne release fraction or airborne release rate, respirable fraction, and leak path factor as described in Mishima (1994).

There is uncertainty in these estimated consequences because of the limited characterization of the existing contamination, of the processing facilities, and of the processing operations. The estimates are believed to be conservative.

Doses from the resulting releases were calculated for the exposed off-site individual and the population using site specific X/Q dispersion factors and GENII computer code dose conversion factors for inhalation (see Appendix D for a discussion of the GENII computer code). For purposes of this analysis, the exposed population was assumed to be that living within 80 km (50 mi) of the Western New York Nuclear Service Center (Center). The population and other demographic parameters used in this analysis are those reported in Section 4.8 of this EIS. Key parameters were based on conservative assumptions so that the impacts from the postulated accidents were overestimated. Atmospheric dispersion factors calculated from meteorology data collected at the Center (summarized in Appendix K) were used to determine the air concentration and deposition of radioactive material at various off-site locations. To determine the maximum impact, dispersion factor values that are exceeded only 5 percent of the time were used. In other words, 95 percent of the time, the consequences of the particular release would be equal to or less than the estimate given. The use of 95 percent meteorology results in an estimated dose over an order of magnitude higher than that estimated using 50 percent meteorology. This approach provides a conservative estimate of impacts.

To eliminate inconsequential accidents from the analysis, radionuclide inventories for individual facilities were compared to DOE-STD-1027-92, Table A.1, "Threshold Quantities for Category 3 Facilities" (DOE 1992). If a facility did not meet the criteria for Category 3 facilities, "hazard analysis shows the potential for only significant localized consequences," no accident analysis was performed for that facility.

In the accidents postulated in Sections G.2 through G.6, the atmospheric pathway dominates the doses received by the population. Although the implementation actions of closure and remaining stabilized facilities with contamination could potentially release radioactive materials to the surface or groundwaters, the contribution from water pathways would be minor in most cases. Inhalation from an airborne plume is the most direct pathway to humans and results in higher individual and population doses per unit activity released than the surface or groundwater pathways for the postulated accidents and radionuclides of concern. Doses from the eventual subsurface transport of buried waste [e.g., U.S. Nuclear Regulatory Commission-licensed disposal area (NDA), New York State-licensed disposal area (SDA) and lagoons] from erosion and containment degradation processes were addressed as part of the long-term performance assessment in Appendix D.

Population and individual dose estimates were developed for the maximum credible accident scenarios identified for each waste management area (WMA) and alternative. Accident releases were assumed to be of short duration, typically lasting 1 hour or less. After a quantity of radioactive material was released to the atmosphere, it was assumed to be carried off site by prevailing winds, where members of the public could be exposed to external radiation from the cloud passage and could inhale some radioactive material in the cloud. Residents could receive external radiation doses from the radioactive material deposited on the ground, inhale resuspended radioactive material, and ingest radioactive material that is transported to drinking water and foodstuffs for the radionuclides of concern. But inhalation of radioactive material entrained in the plume is the predominant dose contributor.

Doses were calculated to the maximally exposed off-site individual and to the population by using GENII inhalation dose factors.

In addition to the members of the public located off site, workers could receive radiation doses from the accidents postulated in Sections G.2 through G.6. The individuals doses received by workers from these accidents would likely be higher than those to the public because of both the proximity of workers to the accident location and the possibility that workers could be involved in accident mitigation, assessment, and recovery activities.

Workers near the accident are likely to receive the highest doses; these workers are considered primary workers. They may be working in the facilities or structure or with the systems or components involved in the accident. The radiation doses received by the workers during an accident would depend on a variety of facility-specific factors, including the

- Exact distance between the workers and the release point

- Amount of material released per unit time

- Time required to evacuate the area, which depends on other factors, including whether the workers were injured or attempted to mitigate the accident

- Availability and type of protective equipment worn by the workers, such as respirators.

This EIS does not estimate maximum individual doses to primary workers because of the uncertainties associated with these factors and the lack of detailed design information necessary to predict specific event sequences and conditions. The actual doses received by workers could vary by many orders of magnitude depending on the specific accident sequences, conditions, and responses. Nonetheless, it is possible to estimate qualitatively the risks to workers directly involved in the postulated accidents.

As discussed previously, the doses that workers could receive if there was an accident depend on several factors including the amount of radioactive material released, the time period over which the material was released, the distance between the workers and the release, the presence of shielding or mitigating factors, and the specific responses of the workers to the accident. Each of the postulated accidents in this appendix was assessed qualitatively to determine the potential impacts to the workers directly involved in the accident. This assessment evaluates factors that determine potential doses for each accident for three dose categories: < 5 rem, 5 - 25 rem, and > 25 rem.

- An accident resulting in a < 5-rem dose would have low impacts to workers. A dose of 5 rem corresponds to the annual dose limit to DOE and DOE contractor workers under normal operations as promulgated in 10 CFR Part 835, "Occupational Radiation Protection."

- An accident resulting in a 5 to 25-rem dose could have moderate impacts to workers. Although the doses would be higher than the normal occupational limits, they would not be high enough to cause acute radiological injuries. The estimated probability of a fatal cancer arising from the exposures would be 0.02 for a dose of 25 rem based on currently accepted risk factors. The upper limit of 25 rem corresponds to the maximum guideline for exposures to workers involved in emergency situations as promulgated in 10 CFR Part 835. Additionally, 25 rem is commonly used in DOE safety analysis when developing facility designs to define acceptable doses consistent with the guidelines in DOE-STD-3009-94, "Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports" (DOE 1994).

- An accident resulting in a dose of > 25 rem could have high impacts to workers, because they could experience acute radiation effects in addition to a very significant potential for induced cancer. At doses only slightly above 25 rem, effects would be minor and may not be noticeable. At doses over 100 rem, however, serious illnesses could occur; doses exceeding 500 rem could result in death.

Most of the accidents postulated in this appendix would likely result in doses < 5 rem to the maximally exposed worker. Combined with the low probability of the accidents (as discussed later in this appendix), the overall risk to workers is very low.

Depending on factors, such as worker response and distance from the source, several of the postulated accidents could result in doses between 5 and 25 rem to the maximally exposed workers. These include the accidents presented in Sections G.2.3, G.2.7, G.2.8, G.2.10 and G.5.1. In each case, no more than a few workers (i.e., approximately 10 or less) could receive doses in this range. At a dose of 25 rem, the average probability that a worker would incur a fatal cancer following the accidental exposure would be approximately 0.02. The overall risk when considering both the probability of a fatal cancer and the probability that the accident would occur is less than the annual risk of a fatality incurred by the average U.S. worker (approximately 5×10^{-5}, see Appendix F). For example, if the annual probability of the accident were 1×10^{-4} (the highest value in the range of the relevant postulated accidents), the overall annual fatality risk to a worker on site would not exceed 2×10^{-6}. Thus, the overall risk to workers would not be significantly increased by the radiological risks associated with the postulated accidents.

No credible accidents would be likely to result in worker doses exceeding 25 rem. Although some postulated accident scenarios could result in doses exceeding this value, the combination of events necessary to result in such doses were not considered credible for this accident assessment. Doses of this magnitude would be prevented by mitigating design features, such as using remote handling equipment to exhume high-activity waste or to decontaminate highly contaminated facilities, and using controls on ventilation with appropriate safety features.

Application of the requirements in DOE Order 5480.23, "Nuclear Safety Analysis Reports" would ensure that sufficient mitigating features would be incorporated into facility designs and site activities to establish radiological accident risks that are less than the risks from nonradiological industrial accidents observed in relatively safe industries and are as low as reasonably achievable.

DOE recognizes that protecting workers against consequences from potential accidents is of paramount importance when designing facilities and systems. Therefore, it provides explicit requirements and guidance (DOE Order 5480.23 and associated implementation documents) to ensure that worker risks are maintained within acceptable levels when designs are developed, reviewed, approved, and implemented. These requirements ensure that the risks to primary workers from the accidents postulated in Appendix G would be minimized and maintained within acceptable levels. If an accident that design improvements would be required to reduce the risks to acceptable levels. These improvements would be reviewed and approved by DOE before the designs could be implemented.

Other workers on site could be impacted by an accident. Workers that could be affected but are not in the immediate vicinity of the accident are considered collocated workers. Similar to primary workers, many variables affect the specific radiation doses that could be received, and specific maximum individual doses are not calculated in this EIS for each postulated accident. However, it is possible to estimate the approximate doses to collocated workers that could be received compared to the doses received by the maximally exposed off-site individual. Assuming that a collocated worker was 100 m (330 ft) from the release point [rather than 1000 m (3,300 ft) assumed for the maximally exposed offsite individual], the collocated worker could receive doses as much as an order of magnitude higher than those received off site. This general estimate is based on an approximate factor of 40 or 50 increase in air concentrations from a ground-level release at the 100-m (330-ft) distance compared to the 1000-m (3,300-ft) distance and a factor of approximately 5 decrease in dose because of factors such as more rapid awareness by the worker (and the resulting reduced exposure time), and emergency response training to minimize exposure. The numerous variables and the associated uncertainties do not permit a more accurate measure of potential doses to collocated workers because of the conceptual nature of the available design information. As discussed previously, DOE requirements for designing and implementing facilities and systems ensure that the risks from accidents to collocated workers would be minimized because designs would reduce the risks to acceptable levels.

The risk from an accident is determined not only by the potential doses received as a result of the accident but also by the probability that the accident will occur. To determine the overall risk associated with the accidents postulated in this EIS, each of the accidents was assigned a probability range based on the estimated annual likelihood that all of the events postulated would occur together and result in the postulated release. The probability range was based on an assessment of the annual probability that additional events would occur to cause the postulated release (such as a filter failure).

Based on the accidents described below, each postulated accident for which off-site doses were estimated was assigned an annual probability range of either 10^{-4} to 10^{-6} or 10^{6} to 10^{-8}. These ranges correspond to accidents that are considered within the design basis and beyond the design basis, respectively. However, there could be exceptions to these ranges for specific accident sequences (such as those initiated by a beyond design basis earthquake, which may occur with an annual probability greater than 10^{-6}). These estimated probability ranges identify differences in impacts among alternatives and, therefore, identify reasonable choices among alternatives. The estimates do not represent precise assessments of the accident probabilities; the lack of detailed design information does not permit precise assessments. Accident probabilities will be examined in more detail during the safety analysis process mandated by DOE to ensure that facility and system designs result in acceptable accident risks.

The likelihood of seismic events of a specific severity was estimated using the site seismic hazard curve, which is the product of multiple experts. The curve is presented in Figure G-1 and shows the estimated frequency range for a specific horizontal ground acceleration and the general nature of the effects from that specific acceleration. The information presented in the figure is drawn from Murray et al. (1977), NRC (1982a), Trifunac and Brady (1975), and WVNS (1992a). Appendix M provides a more detailed discussion of the site seismic characteristics.

G.2 DESCRIPTION OF ACCIDENTS FOR ALTERNATIVE I (REMOVAL)

Alternative I (Removal and Release to Allow Unrestricted Use) involves removal of the radioactive material and contaminated equipment, complete decontamination of the structures, removal of the waste to off-site disposal locations, demolition of the structures, and release of the Center to allow unrestricted use.

A variety of operations and activities would be required to close the Center. To identify the bounding accidents, each conceptual engineering design step in the closure engineering reports was analyzed for the accident potential implicit in the operation. The location (e.g., room, tank, system, or trench) or specific operation that could lead to the largest release was then identified.

In general, the postulated accidents that result in the highest potential consequences during decontamination and removal of the site facilities would take place during the implementation phase because more radioactivity would still be present and subject to release. Also, vacuum cleaning, mechanical disassembly, and chemical decontamination processes used to remove the radioactive material would make it more mobile and vulnerable to accidental release.

Most decontamination activities would occur inside the intact buildings or specially built containment enclosures with ventilation exhaust filtered through two high-efficiency particulate air stages. Handling of decontamination wastes was assumed to occur within the ventilation envelope, before the waste packages were sealed.

Because there is little residual radioactivity in WMAs 4, 6, 10, 11, and 12, no accidents were postulated for these WMAs. The postulated bounding accidents for WMAs 1, 2, 3, 5, 7, 8, and 9 are described in the following sections. In addition, potential accidents resulting from operation of the container management area, which would be an integral part of this alternative, were postulated. Alternative I (Removal) does not have post-implementation phase actions; therefore, no post-implementation accidents were postulated.

G.2.1 Process Building Postulated Accident: Failure of Building Ventilation System Confinement during Decontamination Operations

The suspended particulate activity generated by mechanical cleaning, cutting, or other decontamination activity would stress the high-efficiency particulate air filters in the

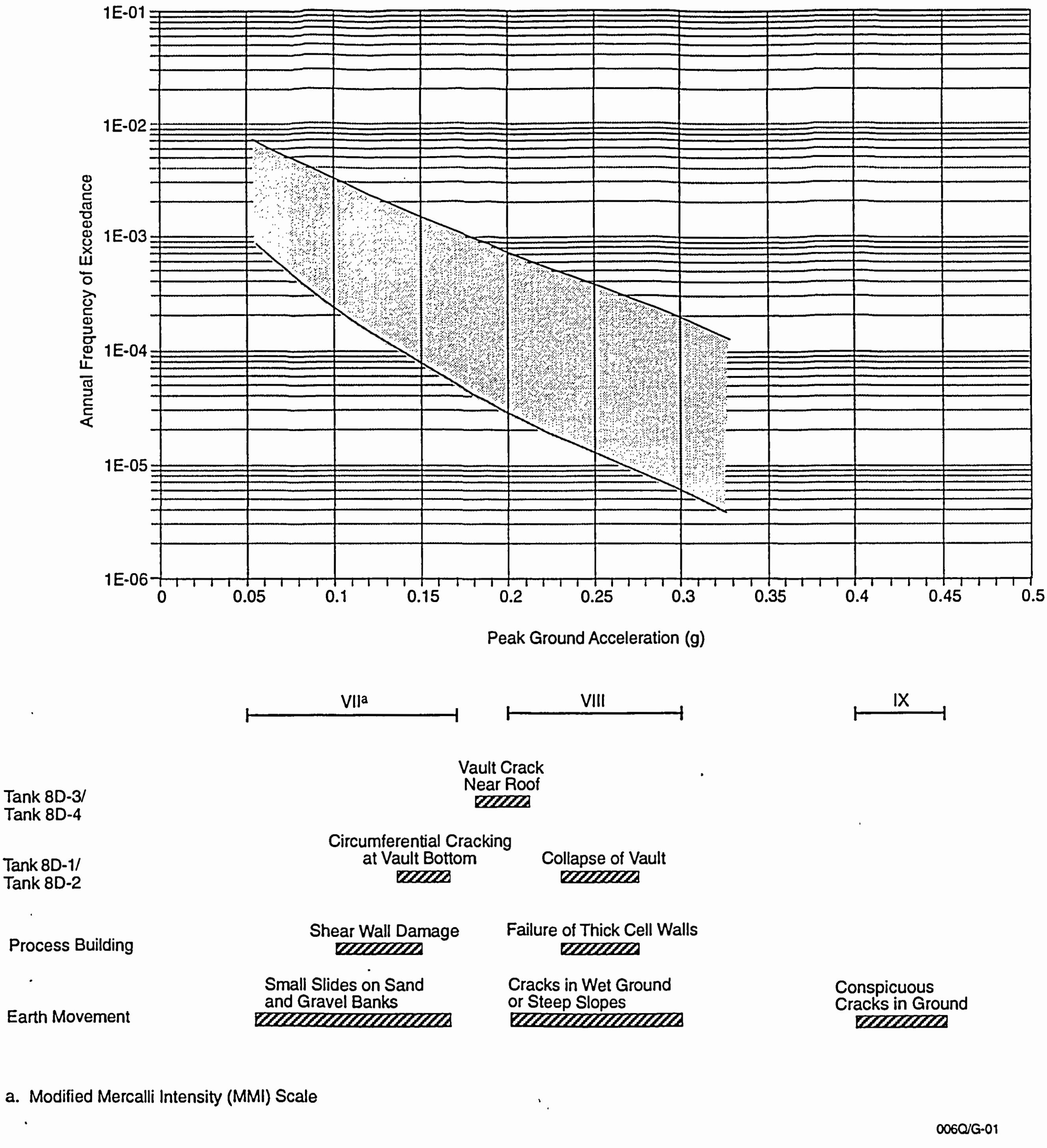

Figure G-1. Summary of Potential Seismic Effects on Facilities at the Western New York Nuclear Service Center.

ventilation and filtration system whose integrity is particularly important to the safety of the operation. If either one or both stages of high-efficiency particulate air filtration were compromised or the ventilation duct failed in some critical areas, exhaust air could be released unfiltered to the environment and more radioactive materials would be transported off site.

A brief release of radioactive aerosols was postulated to occur during process building decontamination. For EIS analysis, high-pressure spray washing was assumed to be used for decontamination. This process generates airborne aerosols that normally are collected and filtered by the ventilation system. Although the decontamination operations would involve other methods as well, this method would produce a high concentration of aerosols. This scenario assumes that, because of either a ventilation duct failure before filtration or a filter failure, unfiltered effluent aerosols would be exhausted to the environment during a 1-hour period. The 1-hour limitation assumes that the failure would be detected by either the effluent monitors or the filter differential pressure monitors and that mitigating actions (e.g., shutdown of exhaust fans or isolation of the ducts) would be taken.

To determine the source term, it was assumed that 50 percent of all activity in the process mechanical cell would be removed by 40 hours of spraying. If 1 percent of the material removed became airborne, the fraction of the activity in the process mechanical cell that could escape the process building if there were no filtration would be 0.0001 (0.5 x 0.01 x 1/40). On the basis of the process mechanical cell inventory information in Appendix C, the quantities in Table G-1 could potentially be released to the environment from this event.

Table G-1. Estimated Activity Released to the Atmosphere from a Breach of the Process Building Ventilation System during Decontamination Activities

Radionuclide	Released Activity (Ci)
Sr-90	0.1
Cs-137	0.1
Pu-238	0.009
Pu-239/240	0.004
Pu-241	0.06
Am-241	0.003

Failure of ventilation system confinement could result from a fabrication flaw, improper installation, fire or explosion, excessive loading or differential pressure, natural phenomena, or some combination of two or more of these factors. Complete failure of a high-efficiency particulate air filter stage or ductwork during normal operation is highly unlikely, and simultaneous failure of more than one component would be less likely. Thus, because a common-cause failure mechanism is the only credible process, it represents the most severe operational failure of the ventilation envelope and was analyzed as a bounding accident condition. The estimated annual probability for this accident is 10^{-6} to 10^{-8}.

G.2.2 Process Building Postulated Accident: Dust Reentrainment in the Process Mechanical Cell with Partial Ventilation System Failure

The process mechanical cell contains contaminated dust and debris. This accident scenario assumes a heavy piece of equipment drops to the floor of the cell and resuspends contaminated dust. Based on the information in WVNS 1993(c), floor dust was assumed to represent no more than 10 percent of the radioactivity in the room. If dust on 1 m^2 (11 ft^2) of floor surface is expected to become airborne out of a 58 m^2 (624 ft^2) floor area, the airborne fraction would be (1 m^2/58 m^2 x 0.1 = 0.002). If one of the two high-efficiency particulate air filters fails concurrently, the fraction of airborne material released to the atmosphere would be 5 x 10^{-4}. Based on these estimates, the total release fraction would be 1 x 10^{-6}. The source term for this postulated accident is provided in Table G-2.

Table G-2. Estimated Activity Released to the Atmosphere from a Dust Reentrainment Accident in the Process Mechanical Cell with Partial Filter Failure

Radionuclide	Released Activity (Ci)
Sr-90	0.001
Cs-137	0.001
Pu-238	0.00009
Pu-239/240	0.00004
Pu-241	0.0006
Am-241	0.00003

A comparison of the postulated releases in Tables G-1 and G-2 shows that complete failure of the ventilation filtration system produces a larger release from the process building. Accordingly, only this postulated accident was analyzed for potential off-site impacts. No probability was estimated for this less severe accident.

G.2.3 Low-Level Waste Treatment Facility Postulated Accident: Fire/Explosion Destroys Temporary Containment Structure during Excavation of Lagoon 1 with Subsequent Burning of Debris

As described in Appendix C, lagoon 1 will contain most of the residual contamination in the low-level waste treatment facility (LLWTF) at the end of West Valley Demonstration Project (WVDP) high-level [radioactive] waste (HLW) solidification. Decontamination of the LLWTF lagoon 1 would entail building a containment structure around the work area, excavating the lagoon soil and contents, and packaging the soil and contents for shipment to a waste site. Some of the contaminated lagoon debris could consist of very fine particulate matter, which is unlikely to become airborne as long as it remains wet. However, if allowed to dry, the material could be easily resuspended, especially if the particles are small. In this condition, the material could be a source term for atmospheric transport. The postulated accident involves a fire or explosion that damages or destroys the temporary containment structure. The explosion could occur from petroleum-based fuels used in excavation equipment, such as hydraulic fluid or natural gas. If constructed of common combustibles, such as plastic and wood, the confinement structure could burn. The primary factors in this scenario are the loss of the confinement; the exposure of excavated soil and debris to the drying effects of sun, wind, and possibly heat from a fire; and the failure to recognize the significance of this drying or inability to take action to mitigate the release because of radiological or other hazard conditions. A secondary factor for the explosion scenario would be creating an aerosol and dispersing some of the material over a larger surface area, therefore increasing the drying and resulting resuspension rates. Based on the information and methodology of Mishima (1994), it was assumed that a maximum of 1 percent of the lagoon 1 material could become airborne based on inventory information (WVNS 1994f) and as reported in Appendix C of this EIS. The resulting activity that would be released to the atmosphere from the postulated accident is summarized in Table G-3. The estimated annual probability for this accident is 10^{-6} to 10^{-8}.

Table G-3. Estimated Activity Released to the Atmosphere from Dried Lagoon 1 Soil and Breach of Containment System

Radionuclide	Released Activity (Ci)
Sr-90	0.2
Cs-137	7
Pu-238	0.07
Pu-239/240	0.04
Pu-241	3
Am-241	0.04

G.2.4 High-Level Waste Tanks Postulated Accident Number 1: Partial Collapse of Tank 8D-2 during Decontamination

During the decontamination and demolition of HLW tank 8D-2, cutting equipment would be lowered into the tank to remove portions of the interior structure and shell. It was postulated that removing the structural members out of sequence or positioning the cutting equipment incorrectly could lead to a partial collapse of the tank shell. If the tank were being exhausted directly to the containment building ventilation system, the collapse of the tank could cause a pressure pulse on the high-efficiency particulate air filters, damaging or destroying the filters and resulting in a release to the atmosphere. Although the tank would already have been flushed of residual sludge, radioactive contamination would remain on the interior surfaces, and the ongoing cutting work could produce airborne particulate matter.

At the end of WVDP HLW solidification, the total activity on the interior of the tank (excluding the tank sludge) is estimated to be approximately 200 Ci, most of which is attributable to strontium-90 and cesium-137 (WVNS 1994a). The cutting process is postulated to release contamination on 1,613 cm² (250 in.²) of surface per hour. With a ventilation flow rate in the tank of 0.25 air changes per hour, the radioactivity concentration in the tank air would average 2 x 10^{-4} Ci/m³. Assuming that one-third of the 2,810 m³ (99,400 ft³) of air in the tank is released during the collapse, the total radioactivity released from this accident would be approximately 0.2 Ci. A breakdown by radionuclide is given in Table G-4. No probability was estimated for this less severe accident.

Table G-4. Estimated Activity Released to the Atmosphere from a Partial Collapse of Tank 8D-2 during Decontamination Activities

Radionuclide	Released Activity (Ci)
Sr-90	0.1
Cs-137	0.1
Pu-238	0.0001
Pu-239/240	0.00005
Pu-241	0.0001
Am-241	0.041
Cm-244	0.0001

G.2.5 High-Level Waste Tanks Postulated Accident Number 2: Failure of Piping During Sludge Removal

The residual sludge remaining in HLW tank 8D-2 after HLW vitrification would amount to approximately 3 percent of the pre-vitrification radioactivity (WVNS 1994a). The conceptual sludge removal process involves a liquid lance and vacuum extraction system (WVNS 1994q). The system would be used to hydraulically lance and loosen the radioactive material remaining at the tank bottom and suction the loosened material into a coupled exhaust system. Water use would be conserved through a recycle system; it has been estimated that the system would use 7,600 L (20,000 gal) of water. The water would be pumped through a smooth pore filter to remove entrained particulate matter before being recirculated to the tank.

Radioactive material could be released to the tank containment through a pipe break or pump seal failure, which could result in contaminated water being sprayed into the containment, a small fraction of which could be in the form of aerosoled droplets. If the tank ventilation filtration system were concurrently breached by an explosion or some other mechanism, the airborne material could be released directly to the environment.

Based on WVNS (1994q), it was estimated that approximately 75 percent of the tank sludge material would be removed during the initial 1,000 hours of system operation. Assuming that the lancing and vacuum cycle is repeated hourly, this implies that an average of 0.075 percent of the sludge material would be removed per hour. If a breach were to occur during one of these cycles, it was estimated that up to 10 percent of the water could be released from the system, and 1 percent of that amount could become airborne in the tank containment in the form of aerosoled droplets. Thus, the fraction of the tank inventory that could become airborne in this accident scenario is approximately 8×10^{-7}. Assuming that the ventilation system filtration is inoperative, all of the airborne radioactivity could be released to the environment. Table G-5 presents the activities of the significant radionuclides potentially released, calculated based on the HLW tank 8D-2 residual inventory presented in Appendix C.

Table G-5. Estimated Activity Released to the Atmosphere from a Piping Failure during Removal of Tank 8D-2 Sludge with Complete Filter Failure

Radionuclide	Released Activity (Ci)
Sr-90	0.2
Cs-137	0.2
Pu-238	0.0002
Pu-239/240	0.00007
Pu-241	0.0002
Am-241	0.002
Cm-244	0.0002

A comparison of the postulated releases in Tables G-4 and G-5 shows that a piping system failure and complete failure of the ventilation filtration system during removal of the sludge would produce the larger release from the HLW tanks. Accordingly, only this postulated accident was analyzed for potential off-site impacts. The estimated annual probability for this accident is 10^{-6} to 10^{-8}.

G.2.6 Waste Management Area 5 Postulated Accident: Drum Handling Accident Results in Breach of Drums and Exposes Class C Waste to the Environment

The worst-case accident for Alternative I (Removal) for this WMA is based on an accident assessment in the safety analysis report for a drum handling accident in the lag storage additions (WVNS 1993a). The accident involves dropping a pallet containing six maximally loaded drums during operations. This accident could occur while removing drums from the lag storage additions for processing at the container management area. The worst-case accident involving the chemical process cell (CPC) waste storage area was not evaluated because many more Class C drums are stored in the lag storage additions and the boxes in the CPC waste storage area contain pieces of equipment for which the release fractions would be small. For these reasons, a worst-case accident involving the CPC waste storage area would be both less likely and no more severe than a worst-case accident involving the lag storage additions.

Each of the six drums dropped were assumed to have a maximum surface exposure rate of 200 mR/hr. The safety analysis report assumed that 10 percent of the contents were released from the drums and exposed to the atmosphere. Of this 10 percent, 0.1 percent of the radioactivity was assumed to have been suspended in air and transported off site. This assumption was based on information contained in Mishima (1994). Table G-6 presents the total activity assumed in the safety analysis report to be released from this event. Although radioactive decay would reduce the radioactivity in the drums by the year 2000 (the date at which this EIS assumes that decontamination and decommissioning would begin, this consideration was ignored and the source term in the safety analysis report was adopted. The estimated annual probability for this accident is 10^{-4} to 10^{-6}.

Table G-6. Estimated Activity Released to the Atmosphere from a Drum Handling Accident during Removal of Drums for the Lag Storage Facilities

Radionuclide	Released Activity (Ci)
Sr-90	0.00001
Cs-137	0.00001
Pu-238	0.0000008
Pu-239/240	0.0000004
Pu-241	0.00001
Am-241	0.0000006

G.2.7 NRC-Licensed Disposal Area Postulated Accident: Combustion of Exposed Contaminated Waste Breaches Containment Structure and Disperses Contamination

In exhuming the contents of the NDA, it was postulated that a container of flammable solvent becomes exposed, broken, and ignited. The solvent fire spreads to 0.3 m^3 (11 ft^3) of exposed contaminated organic waste and produces contaminated smoke. The fire compromises the integrity of the containment structure and generates convection flows within the burning material; 40 percent of the contaminated waste becomes airborne (Mishima 1994). The burned material was assumed to have the same activity concentrations as that reported for the "lag storage area general waste" category (WVNS 1994b). The estimates of the activity potentially released for this postulated accident are given in Table G-7. Accidents involving the release of material from the high-activity waste forms in the NDA, such as the reactor hulls or fuel, were not considered credible in this analysis. The estimated annual probability for this accident is 10^{-6} to 10^{-8}.

Table G-7. Estimated Activity Released to the Atmosphere from a Maximum Credible Accident Involving a Fire in the NRC-Licensed Disposal Area

Radionuclide	Released Activity (Ci)
Sr-90	6
Cs-137	6
Pu-238	0.4
Pu-239/240	0.2
Pu-241	2
Am-241	0.1

G.2.8 State-Licensed Disposal Area Postulated Accident: Combustion of Exposed Contaminated Waste Breaches Containment Structure and Disperses Contamination

This postulated accident is identical to the accident described for the NDA except for the composition of the airborne radioactivity. In this scenario, combustion of 0.3 m^3 (11 ft^3) of contaminated material exhumed from trench 10 was assumed. The activity concentration of the material involved in the fire was assumed to be the same as the average activity concentration of the trench as reported in Appendix C. Trench 10 was selected on the basis of dose calculations, which indicated that the dose per unit volume of radioactivity released to the atmosphere would be the highest for trench 10 because of its relatively high concentration of plutonium-238. The estimates of the activity released for this postulated accident are given in Table G-8. The estimated annual probability for this accident is 10^{-6} to 10^{-8}.

Table G-8. Estimated Activity Released to the Atmosphere from a Maximum Credible Accident Involving a Fire in SDA Trench 10

Radionuclide	Released Activity (Ci)
Sr-90	0.2
Cs-137	0.2
Pu-238	1.0
Pu-239/240	0.005
Pu-241	0.02
Am-241	0.003

G.2.9 Radwaste Treatment System Drum Cell Postulated Accident: Design Basis Earthquake Results in Breach of Drums and Exposes Uncontained Waste to the Environment

The waste stored in the drum cell would be removed for off-site disposal, and the radwaste treatment system (RTS) drum cell would be dismantled and completely removed. The drum removal operations would be similar to the drum handling activities evaluated in the RTS drum cell safety analysis report (WVNS 1993b). This safety analysis report addressed three accident scenarios during the handling and storage of the Class B/C drum cell waste: a design basis tornado passing over the site, a design basis earthquake involving the collapse of the temporary weather structure and the shield walls, and a crane failure that ruptures two 270-L (71-gal) drums. Of these events, the design basis earthquake would lead to the greatest release of radioactivity and the greatest dose to a maximally exposed off-site individual. The total activity estimated to be released to the atmosphere was 5.0 μCi of cesium-137 and lesser amounts of other radionuclides. This estimated activity assumed that the maximum permissible volume of free liquid (0.5 percent of the drum volume) was released from eight drums and that 0.1 percent of the radioactivity in the liquid became airborne. Table G-9 presents the total activity assumed in the safety analysis report to be released from this event. Although radioactive decay would reduce the radioactivity in the drums by the year 2000 (the date at which this EIS assumes that the closure alternatives would be implemented), this decay was ignored, and the source term in the safety analysis report was adopted. The estimated annual probability for this accident is 10^{-4} to 10^{-6}.

Table G-9. Estimated Activity Released to the Atmosphere from a Design Basis Earthquake during Removal of Drums from the Radwaste Treatment System Drum Cell

Radionuclide	Released Activity (Ci)
Sr-90	0.000006
Cs-137	0.00004
Pu-238	0.000002
Pu-239/240	0.0000005
Pu-241	0.00002

G.2.10 <u>Container Management Area Postulated Accident: Design Basis Earthquake Causes Breach of Waste Containment and Loss of High-Efficiency Particulate Air Filtration</u>

The container management area would process waste from the WMAs for the purposes of assay, volume reduction, treatment, and repackaging. Because this facility is in the preconceptual design phase, it is not possible to postulate specific accidents on the basis of facility component failures. However, an upper bound on the potential impacts from an accident can be estimated on the basis of two primary considerations: (1) the amount of waste projected to be processed and (2) existing safety requirements that must be met before the container management area could be operated, which reduce the likelihood of a potential accident. These considerations are discussed below.

The magnitude of a potential release from the container management area can be estimated based on the likely facility inventory and standard accident release fractions typical of nuclear facilities. The container management area is expected to process up to 42 m^3 (1500 ft^3) of waste per day (WVNS 1994j). Data in Appendix C indicates that the radioactivity concentrations in much of the waste processed in the container management area would be approximately 0.02, 0.1 and 0.1 Ci/ft^3 of cesium-137, strontium-90 and plutonium-238, respectively, for SDA waste and 0.1, 0.1 and 0.02 Ci/ft^3 of cesium-137, strontium-90 and plutonium-238, respectively, for NDA waste. For NDA values, these concentrations translate to daily activities of approximately 200, 200 and 30 Ci of cesium-137, strontium-90 and plutonium-238, respectively. It is unlikely that more than 0.1 percent of the radioactive material would be released in a design basis accident unless a large fire or explosion were involved (Mishima 1994). For this amount of material to be released, the material would need to bypass the high-efficiency particulate air filtration system or the system would need to become inoperable. If the facility design precluded a large fire or explosion, approximately 0.2, 0.2 and 0.03 Ci of cesium-137, strontium-90 and plutonium-238, respectively, could be released. The estimated annual probability for this accident is 10^{-4} to 10^{-6}. If a large fire or explosion were possible and would represent an unacceptable risk to either workers or the public, it is expected the design would be modified during the design review process. Potential liquid releases have not been evaluated because (a) the facility would have been designed to meet 40 CFR Part 264 ["Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities"] containment requirements, which would reduce the likelihood of liquid releases and (b) doses per unit activity released would be less for liquid releases.

The other consideration in estimating the potential impacts from an accident is the existence of standard safety requirements and the fact that the facility cannot be operated unless these requirements are met. One requirement that must be met is the preparation and approval of a safety analysis report; in addition, many other safety-related reviews would be necessary, including an operational readiness review. A safety analysis report (and other assessments) would include a detailed accident assessment of the proposed facility design, inventory, and operations. Operation of the facility would not be permitted until the associated safety documentation had been approved. One component of this approval would be assurance that minimum acceptable accident safety standards (limitations on the risks that operation of the facility could pose to the public) had been met or exceeded. For example, the DOE Nuclear Safety Policy goal states that the cancer fatality risk to the population within 1.6 km (1 mi) of the site boundary of a DOE nuclear facility should not exceed 0.1 percent of the sum of all cancer fatality risks resulting from ill other causes. This goal translates to an annual risk of approximately 5×10^{-6} (DOE 1991). On the assumption of a return period of 2000 years as the design basis for this accident, the maximum individual effective dose equivalent would need to be less than 20 rem to result in an annual risk less than 5×10^{-6} (if the cancer risk factor is 5×10^{-4} per rem; see Appendix D).[a]

For this EIS, dose calculations were performed on the basis of the conservative release estimates presented above and were compared to the criterion calculated on the basis of the DOE Nuclear Safety Policy goal (20 rem). The maximum individual effective dose equivalent was less than 20 rem for the container management area as shown in Section G.8. This approach was taken in this EIS for new facilities and operations that would be required to implement the alternatives. In cases where the calculated annual effective dose equivalent exceeds 20 rem (one case each for Alternatives I, II, III, and IV; see Section G.7), modifications to the assumptions would be necessary to meet the Nuclear Safety Policy Goal. If such modifications were not warranted, modifications to the facility design or operations could be required before the alternative were implemented.

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[a] Using this approach, an accident having an annual probability of significantly less than 1 in 2,000 would have a correspondingly higher allowable effective dose equivalent. However, it is unlikely that a facility would be permitted to operate if the effective dose equivalent to the maximally exposed individual would be greater than 20 rem for any credible accident because at dose equivalents above this level the occurrence of deterministic as opposed to stochastic effects begins to predominate. Therefore, for this accident assessment an effective dose equivalent greater than 20 rem for any postulated accident suggests that additional safety design or accident mitigation features would need to be incorporated before the alternative could be considered viable for that facility.

G.3 DESCRIPTION OF ACCIDENTS FOR ALTERNATIVE II (ON-PREMISES STORAGE)

Alternative II (Removal, On-Premises Waste Storage, and Partial Release to Allow Unrestricted Use) is similar to Alternative I with two exceptions: (1) all radioactive wastes, except RTS drum cell waste, would be stored in retrievable storage areas on the Project Premises rather than being disposed of off site, and (2) the RTS drum cell would be managed as a storage facility on the Project Premises. The accidents postulated for each WMA for this alternative are identical to those postulated for Alternative I (Removal) except for an additional accident addressing the long-term storage of waste in the RTS drum cell and accidents addressing the retrievable storage areas for both the implementation and post-implementation phases.

G.3.1 Radwaste Treatment System Drum Cell Postulated Accident: Earthquake Results in Breach of Drums and Exposes Uncontained Waste to the Environment

The drum cell would be managed as-is for an indefinite period, with a long-term continuous maintenance and monitoring program. Because this alternative would involve few operational activities for the RTS drum cell, no operational accidents were postulated.

During the post-implementation long-term monitoring and maintenance period, the potential exists for an accident initiated by natural phenomena. Since it was assumed that storage would be indefinite, the possibility exists that an accident more severe than designed for the facility could occur. To evaluate this occurrence, the postulated accident is a beyond design basis earthquake with a peak ground acceleration of 0.33 g. The earthquake was assumed to completely destroy the facility, and the drums were assumed to be breached. Based on information in Mishima (1994), 0.2 percent of the radioactivity in the drums was assumed to become airborne.

The radionuclide activities postulated to be released from this event are given in Table G-10. These values were derived by multiplying the radionuclide inventories presented in Appendix C by a release fraction of 0.002 and by assuming a plutonium isotopic ratio similar to that given in Table G-9. The estimated annual probability for this accident is 10^{-4} to 10^{-6}.

Table G-10. Estimated Activity Released to the Atmosphere from a Beyond Design Basis Earthquake during Long-Term Monitoring and Maintenance of the Radwaste Treatment System Drum Cell

Radionuclide	Released Activity (Ci)
Sr-90	1
Cs-137	1
Pu-238	0.4
Pu-239/240	0.08
Pu-241	4

G.3.2 Retrievable Storage Area Postulated Accident: Drum Handling Accident or Design Basis Earthquake Causes Release of Radioactive Material

The retrievable storage areas would be used for storage of the radioactive waste generated by the closure actions under Alternative II, including waste generated as a result of facility decontamination, waste currently stored in facilities on the Project Premises, and waste exhumed from disposal areas. Because the retrievable storage areas would be used exclusively as a storage facility, potential bounding accidents are likely to be similar to those postulated for existing storage facilities such as the lag storage building and additions and the RTS drum cell. However, the potential releases of radioactivity would be greater for the retrievable storage areas than for those facilities because it would store a larger radionuclide inventory. For this reason, additional safety features would have to be incorporated into the engineering design of the facilities to ensure that the radioactivity would be contained during an accident such as a severe earthquake.

Preconceptual facility design information for the retrievable storage areas was obtained from WVNS (1994j, 1994s). As currently conceptualized, the retrievable storage areas would contain safety features because of the large inventory and the various waste types, concentrations, and matrices and it would be designed to withstand severe natural phenomena. Based on the conceptual design information, it was postulated that the bounding accident during the implementation phase would be a drum handling accident resulting in the breach of several waste packages; the bounding accident during the post-implementation long-term monitoring and maintenance period would be a beyond design basis earthquake. The conceptual designs have not been sufficiently developed to accurately project the fraction of material that could be released from these postulated accidents. Estimates were made on the basis of similar postulated accidents for other facilities and by assuming that minimum safety standards would be met before the facility could accept waste.

For the implementation phase, it was assumed that a waste handling accident results in the breach of packages arriving from the container management area. Because the waste would be in a more stable form than when it arrived at the container management area, it was assumed that the releases from such an accident would be no worse than the releases from the bounding accident for the container management area.

For the post-implementation long-term monitoring and maintenance period, the bounding accident was assumed to be a beyond design basis earthquake with a peak ground acceleration of 0.33 g, because the period during which the waste remains in storage is indefinite. The potential release from this event has not been postulated. However, as with the container management area, the upper bound on the potential impacts can be estimated on the basis of the existing safety requirements that must be met to ensure that the probabilities of an accident will be reduced. The estimated annual probability for this accident is 10^{-4} to 10^{-6}. The maximum individual effective dose equivalent from the accident would need to be less than 20 rem to meet the DOE Nuclear Safety Policy goal as described in Section G.2.10.

G.4 DESCRIPTION OF ACCIDENTS FOR ALTERNATIVE IIIA [IN-PLACE STABILIZATION (BACKFILL)]

Alternative IIIA (In-Place Stabilization and On-Premises Low-Level Waste Disposal) involves the in-situ stabilization of contaminated facilities and low-level [radioactive] waste (LLW) disposal on the Project Premises, with minimal decontamination performed. This section describes source terms for the postulated bounding accidents that could occur during these activities. Disruptive events that could affect the integrity of belowground disposal facilities (e.g., erosional processes that could result in the potential release of contaminants from the SDA) have not been postulated. The impacts from the eventual transport of these materials have been addressed in Appendix D in the analysis of long-term impacts.

Because WMAs 4, 6, 10, 11, and 12 contain little or no radioactive contamination, no accidents were postulated for them. Additionally, unlike Alternative I (Removal), closure activities under Alternative IIIA [In-Place Stabilization (Backfill)] for the lagoons, NDA, and SDA would not remove or handle the buried waste but would contain and immobilize them. Thus, no accidents were postulated for WMAs 2, 7, and 8 for this alternative. The postulated bounding accidents for WMAs 1, 3, 5, and 9 and for supporting facilities are described in the following sections.

G.4.1 Process Building Postulated Accident: Failure of Building Ventilation System during Vacuuming of Spent Fuel Fines

Minimal decontamination of the process building has been conceptualized. Decontamination actions would be to vacuum the spent fuel fines. During this operation, it is unlikely that contamination other than the spent fuel fines would contribute to potential releases. Backfilling of the process building rooms and cells would not likely result in releases in the event of an accident.

The postulated accident involves failure of the building ventilation system during the vacuuming operation. It was assumed that the operations are being performed in the process mechanical cell when the ventilation system fails and that 0.1 percent of the spent fuel fines become airborne during 40 hours of vacuuming. Unfiltered effluent aerosols were assumed to be exhausted to the atmosphere during a 1-hour period (see Section G.2.1). It was conservatively assumed that spent fuel fines consist of all radioactive material classified as particles (WVNS 1993c), and that this represents 50 percent of the activity in the process mechanical cell. The source term for this postulated accident was calculated as shown in Table G-11 on the basis of the radiological inventory in the process mechanical cell as given in Appendix C. The estimated annual probability for this accident is 10^{-4} to 10^{-6}.

Table G-11. Estimated Activity Released to the Atmosphere from a Breach of the Process Building Ventilation System during Vacuuming of the Spent Fuel Fines

Radionuclide	Released Activity (Ci)
Sr-90	0.01
Cs-137	0.01
Pu-238	0.0009
Pu-239/240	0.0004
Pu-241	0.006
Am-241	0.0003

G.4.2 Process Building Postulated Accident: Earthquake Affects Integrity of Entombed Waste

After the process building was backfilled, it would be monitored and maintained for an indefinite period. No credible accidents were identified that would result in releases to the environment over a short period. Although a beyond design basis earthquake could initiate fractures or failures in the concrete monolith, it is not expected that potential short-term releases would be less than those considered before. Mitigation activities would be performed in conjunction with the monitoring and maintenance program to ensure that the public is adequately protected from releases over the long term. The impacts from an earthquake would be similar to those resulting from the long-term degradation of the entombed structure and the eventual contact of the radioactive material with groundwater; these impacts are addressed in Appendix D as part of the long-term performance assessment. The estimated annual probability for this accident is 10^{-4} to 10^{-6}.

G.4.3 High-Level (Radioactive) Waste Tanks Postulated Accident: Ventilation System Failure During Backfilling of Tank 8D-2

Under Alternative IIIA [In-Place Stabilization (Backfill)] and IIIB [In-Place Stabilization (Rubble)], the HLW tanks would be stabilized by backfilling with low-density concrete. The postulated accident assumes that the radionuclides entrained in venting gas streams would be released unfiltered to the atmosphere by either the failure of both high-efficiency particulate air filters or by bypassing of the high-efficiency particulate air filters to a containment system breach. An unmitigated release was assumed to last 1 hour if the ventilation system failure were detected by either the effluent monitors or the filter differential pressure monitors and mitigating actions (e.g., shutdown of exhaust fans or isolation of the ducts) were assumed to be taken.

To determine the source term, 0.1 percent of the sludge was assumed to become airborne during solidification and to be transported through the ventilation system. It was assumed that solidification activities would take a 40-hour period and that the ventilation flow rate represents at least several tank volumes per hour, resulting in an unfiltered 1-hour release of a maximum of 0.0025 percent of the radioactivity in the sludge potentially being released to the environment. Table G-12 summarizes the radioactivity that could potentially be released to the environment from this event on the basis of the HLW tank 8D-2 inventory given in Appendix C. Impacts from accidents at the vitrification facility would be bounded by the postulated accidents for the process building. The estimated annual probability for this accident is 10^{-6} to 10^{-8}.

Table G-12. Estimated Activity Released to the Atmosphere from a Containment System Failure during Backfilling of Tank D-2

Radionuclide	Released Activity (Ci)
Sr-90	5
Cs-137	5
Pu-238	0.005
Pu-239/240	0.002
Pu-241	0.05
Am-241	0.05
Cm-244	0.005

G.4.4 High-Level (Radioactive) Waste Tanks Postulated Accident: Earthquake Affects Integrity of Entombed Waste

The potential accident identified for the HLW tank after it has been entombed was a beyond design basis earthquake resulting in the accelerated release of radioactive material from the tank. However, as postulated for the potential accident at the process building (see Section G.4.2), a potential release to the atmosphere would be unlikely. Additionally, mitigation activities could be performed in conjunction with the monitoring and maintenance program to contain a potential release to the soil. The impacts from an earthquake would not be significantly different from those resulting from the long-term degradation of the entombed structure and the eventual contact of the sludge in the HLW tanks with the groundwater. These impacts were addressed in Appendix D as part of the long-term performance assessment. The estimated annual probability for this accident is 10^{-4} to 10^{-6}.

G.4.5 Waste Management Area 5 Postulated Accident: Drum Handling Accident Results in Breach of Drums and Exposes Class C Waste to the Environment

Waste would be removed from the WMA 5 storage areas as in Alternatives I (Removal) and II (On-Premises Storage); except it would be sent directly to the process building for entombment rather than to the container management area. Thus, the postulated accident for this alternative is identical to that described in Section G.2.6. The estimated annual probability for this accident is 10^{-4} to 10^{-6}.

G.4.6 Radwaste Treatment System Drum Cell Postulated Accident: Earthquake Results in Breach of Drums

The RTS drum cell would be converted into a tumulus for disposal of the Class B and C waste as originally planned when the facility was constructed. Because Alternative IIIA [In-Place Stabilization (Backfill)] would not involve drum handling activities, the worst-case accident during implementation would be a design basis earthquake similar to that described in Section G.2.9 for Alternative I (Removal). Therefore, the source term was postulated to be identical to Alternative I.

Like Alternative II (On-Premises Storage), there is potential for an accident initiated by natural phenomena during the post-implementation long-term monitoring and maintenance period. A severe earthquake could dislodge and breach some of the drums in the facility. However, unlike Alternative II, the tumulus would be designed to prevent releases to the atmosphere from this event. Additionally, mitigation activities performed in conjunction with the monitoring and maintenance program could contain a potential release to the soil. The impacts from an earthquake would not be significantly different from those that would result from the long-term degradation of the waste containers and tumulus with eventual contact of the radioactive material with groundwater. These impacts are addressed in Appendix D as part of the long-term performance assessment. The estimated annual probability for this accident is 10^{-4} to 10^{-6}.

G.4.7 Wastewater Treatment Area Postulated Accident: Worst-Case Implementation Phase Accident for Alternative III

A stand-alone wastewater treatment area would be built for Alternative III (In-Place Stabilization). The system would treat liquid generated by decontamination as facilities were being stabilized or from pumping leachate and groundwater during watering of the disposal areas.

The wastewater treatment area sequential batch reactor has been conceptualized as processing up to 11,360 L/day (3,000 gal/day) of wastewater (WVNS 1994j). Holding tanks would likely store wastewater to be processed continuously for several days. The bounding accident postulated was an earthquake-induced direct release of 113,600 L (30,000 gal) of untreated SDA leachate flowing from a collapsed holding tank to Erdman Brook. The impacts were calculated using the GENII liquid pathway exposure model described in Appendix D. The untreated leachate was assumed to have radionuclide concentrations similar to those from SDA trench 9 (NYSERDA 1989). The postulated radioactivities potentially released are presented in Table G-13. The estimated annual probability for this accident is 10^{-4} to 10^{-6}.

Table G-13. Estimated Activity Released to Surface Water from an Earthquake-Induced Breach of a Wastewater Treatment Facility Holding Tank

Radionuclide	Released Activity (Ci)
H-3	20
C-14	10
Sr-90	0.002
Tc-99	0.04
I-129	0.01
Cs-137	0.002
Np-237	0.002
Pu-238, 239, 240	0.001

G.5 DESCRIPTION OF ACCIDENTS FOR ALTERNATIVE IIIB [IN-PLACE STABILIZATION (RUBBLE)]

The closure actions under Alternative IIIB (In-Place Stabilization and On-Premises Low-Level Waste Disposal in a new facility) would be identical to those performed under Alternative IIIA [In-Place Stabilization (Backfill)] for most facilities except the process building and the vitrification facility. Radioactive waste removed from the waste storage facilities (e.g., the lag storage additions and building) would be placed in the process building for entombment under Alternative IIIA [In-Place Stabilization (Backfill)], but they would be placed in a new radioactive waste disposal facility on the Project Premises under Alternative IIIB [In-Place Stabilization (Rubble)]. Thus, most of the accidents postulated for Alternative IIIA are applicable to Alternative IIIB. The postulated accidents for the process building are different because it would be disassembled, grouted, and capped under Alternative IIIB rather than entombed in concrete as under Alternative IIIA. No separate accident was postulated for the vitrification facility because it was assumed the vitrification facility would be stabilized the same way as the process building; therefore, accidents postulated for the process building would bound the accidents postulated for the vitrification facility. Accidents were also postulated for the LLW disposal facility.

G.5.1 Process Building Postulated Accident: Failure of Containment Structure during Demolition of the Process Mechanical Cell

The conceptual design for the process building includes minimal decontamination (e.g., vacuuming) of the process mechanical cell before demolition and rubble activities. Demolition would be performed by a high-pressure water-cutting system that could generate radioactive aerosols in the highly contaminated areas. The postulated accident involves failure of the building ventilation system during the cutting operations. This scenario is similar to the accident postulated for the process building for Alternative I (Section G.2.1) because high-pressure water spraying was the assumed decontamination method. However, this scenario assumed that higher-pressure water would be used to perform the cutting. Thus, all of the process mechanical cell inventory was assumed to be removed by the cutting operations (it was conservatively assumed that vacuuming the process mechanical cell before demolition would not remove significant amounts of material), and that 1 percent of the inventory became airborne at the time of ventilation system failure and was released to the atmosphere. The releases to the environment from this postulated accident are given in Table G-14. The estimated annual probability for this accident is 10^{-6} to 10^{-8}.

Table G-14. Estimated Activity Released to the Atmosphere from a Failure of the Process Building Ventilation System

Radionuclide	Released Activity (Ci)
Sr-90	10
Cs-137	10
Pu-238	0.09
Pu-239/240	0.04
Pu-241	6
Am-241	0.3

G.5.2 Process Building Postulated Accident: Earthquake Undermines Integrity of Capped Rubble Pile

After the process building is dismantled, the rubble pile would be capped and monitored and maintained indefinitely. As with Alternative IIIA [In-Place Stabilization (Backfill)], no credible accidents were identified that could result in potential releases to the environment over a short period. Although a beyond design basis earthquake could initiate fractures or failures in the capped pile, a short-term release is unlikely. Mitigation activities could be performed in conjunction with the monitoring and maintenance program to ensure that the public was adequately protected from potential releases over the long term. The impacts from an earthquake would be similar to those resulting from the long-term degradation of the capped rubble pile and the eventual contact of the radioactive material with groundwater. These impacts are addressed in Appendix D as part of the long-term performance assessment. The estimated annual probability for this accident is 10^{-4} to 10^{-6}.

G.5.3 Low-Level Waste Disposal Facility Postulated Accident: Drum Handling Accident Results in Breach of Drums

Under Alternative IIIB [In-Place Stabilization (Rubble)], a LLW disposal facility would be built on the Project Premises to dispose of the waste currently stored in the lag storage additions and in the CPC waste storage area. The postulated bounding accident was a drum handling accident like that postulated for removing drums from the lag storage additions for Alternative I (Removal). The facility design would minimize the potential of an accident occurring while placing waste into the facility (WVNS 1994k); thus, no accidents more severe than that postulated for removing the drums were postulated. The estimated releases from the drum handling accident are presented in Table G-15. The estimated annual probability for this accident is 10^{-4} to 10^{-6}.

Table G-15. Estimated Activity Released to the Atmosphere from a Drum Handling Accident during Transfer of Drums to the Low-Level Radioactive Waste Disposal Facility

Radionuclide	Released Activity (Ci)
Sr-90	0.00001
Cs-137	0.00001
Pu-238	0.0000008
Pu-239/240	0.0000004
Pu-241	0.00001
Am-241	0.0000006

G.5.4 Radioactive Waste Disposal Facility Postulated Accident: Earthquake Undermines Integrity of Tumulus

After boxes and drums were placed in the disposal facility, the facility would be converted to a tumulus-type facility, like an earth-mounded concrete bunker (WVNS 1994k). The worst-case accident postulated for the indefinite disposal period was a beyond design basis earthquake with a peak ground acceleration of 0.33 g that could topple and breach waste boxes or drums. However, like the RTS drum cell tumulus, the facility would be designed to minimize the potential release to the atmosphere from this type of event. For this reason, it was assumed that this accident would not have the potential to significantly impact the off-site public. Mitigation activities performed in conjunction with the monitoring and maintenance program could contain a potential release to soil. The impacts from an earthquake would not be different from those that would result from the long-term degradation of the waste containers and tumulus. These impacts are addressed in Appendix D as part of the long-term performance assessment. The estimated annual probability for this accident is 10^{-4} to 10^{-6}.

G.6 DESCRIPTION OF ACCIDENTS FOR ALTERNATIVE IV (NO ACTION: MONITORING AND MAINTENANCE)

Under Alternative IV (No Action: Monitoring and Maintenance), the facilities would be monitored and maintained indefinitely. Because minimal decontamination and stabilization would take place, no accidents were postulated during the implementation phase. During the post-implementation monitoring and maintenance period, the potential exists for disrupting the aboveground facilities from severe natural phenomena. The postulated bounding accidents are discussed in this section. Impacts from the disruption of the belowground disposal areas from erosion are addressed in Appendix D.

G.6.1 Process Building Postulated Accident: Earthquake Results in Release of Radioactive Material from General Purpose Cell, Process Mechanical Cell and Extraction Cell 1

The process building general purpose cell could fail given a seismic event of approximately 0.1 g having a return period of approximately 1,000 years (NRC 1982), although a potential release of radioactivity to the atmosphere is unlikely because the cell is embedded in the building. The process mechanical cell and chemical process cell are postulated to withstand an event of 0.15 g (return period of approximately 2,000 years) or greater. However, because the post-implementation long-term monitoring and maintenance period is indefinite, a beyond design basis earthquake with a 0.33 g peak ground acceleration was assumed to occur and destroy these three cells, which contain the majority of the radioactivity in the process building. A more severe seismic event could not reasonably be expected to occur at the Center (NRC 1982, Murray et al. 1977). Because the ventilation system was assumed to fail completely, it would be a direct, unfiltered leakpath for the contamination. An airborne release fraction of up to 0.002 could occur from this event (Mishima 1994). Thus, the source term for this event (see Table G-16) is postulated to be 0.2 percent of the inventory present in the general purpose cell, process mechanical cell, and extraction cell 1 (these cells combined contain most of the radioactivity present in the process building) as reported in Appendix C. Although the radioactivity would be decaying at the time such an earthquake could occur (thousands of years in the future), no radioactive decay was conservatively assumed when the earthquake occurred. The estimated annual probability for this accident is 10^{-4} to 10^{-6}.

Table G-16. Estimated Activity Released to the Atmosphere from a 0.33 g Earthquake Results in Failure of the Process Building General Purpose Cell, Process Mechanical Cell, and Extraction Cell 1

Radionuclide	Released Activity (Ci)
Sr-90	6
Cs-137	6
Pu-238	2
Pu-239/240	1
Pu-241	20

G.6.2 High-Level (Radioactive) Waste Tanks Postulated Accident: Beyond Design Basis Earthquake Results in Ventilation System Failure and Release of Airborne Radioactivity

Like Alternative IIIA [In-Place Stabilization (Backfill)] and Alternative IIIB [In-Place Stabilization (Rubble)], the bounding accident was a beyond design basis earthquake (0.33 g peak ground acceleration) resulting in the accelerated release of radioactive material from the tank. The release to the surrounding soil could be greater than releases under Alternatives IIIA and IIIB because under Alternative IV (No Action: Monitoring and Maintenance) the tank would not have been filled with concrete. An earthquake of this magnitude would be unlikely to result in immediate doses to the off-site public because of the soil surrounding the tank (NRC 1982). Mitigation activities performed in conjunction with the post-implementation monitoring and maintenance program could control a potential release. The impacts from an earthquake would be similar to those from the long-term degradation of the HLW tank and vault caused by the tank sludge material contacting groundwater. These impacts are addressed in Appendix D as part of the long-term performance assessment.

On the basis of the above, the postulated bounding accident was a beyond design basis earthquake resulting in complete ventilation system failure and the release of gases contained in the tank. A maximum of 0.2 percent of the tank 8D-2 sludge activity as reported in Appendix C was assumed to become airborne at the time of the event (Mishima 1994). The activity postulated to be released from this event is presented in Table G-17. The estimated annual probability for this accident is 10^{-4} to 10^{-6}.

Table G-17. Estimated Activity Released to the Atmosphere from a Beyond Design Basis Earthquake Resulting in Failure of the Tank 8D-2 Ventilation System

Radionuclide	Released Activity (Ci)
Sr-90	10
Cs-137	10
Pu-238	0.01
Pu-239/240	0.004
Pu-241	0.1
Am-241	0.1
Cm-244	0.01

G.6.3 Waste Management Area 5 Postulated Accident: Severe Winds Destroy Storage Facilities

The lag storage safety analysis report (WVNS 1993a) states that the lag storage structures are designed to withstand a wind loading of 45 m/s (100 mph); no discussion of tornado design loadings is provided. Because there is an indefinite period of long-term monitoring and maintenance, it is reasonable to assume that a tornado or windstorm could destroy the facilities. Similarly, the CPC waste storage area could be destroyed by severe winds. A maximum of 1 percent of the activity reported in Appendix C and in Table 5 of WVNS (1994d) were assumed to be released (Mishima 1994). These activities are presented in Table G-18. The estimated annual probability for this accident is 10^{-4} to 10^{-6}.

Although this event would result in significantly greater dispersion of the potentially released radionuclides than the 95 percent maximum meteorology assumed for the off-site exposure calculations, the lower standard was ignored, and the greater impacts were assumed in calculating impacts. Thus, the postulated impacts from this event have likely been significantly overestimated.

Table G-18. Estimated Activity Released to the Atmosphere from Destruction of the Waste Management Area 5 Storage Facilities Because of Severe Winds

Radionuclide	Released Activity (Ci)
Sr-90	5
Cs-137	5
Pu-238	0.1
Pu-239/240	0.08
Pu-241	2
Am-241	0.05

G.6.4 Radwaste Treatment System Drum Cell Postulated Accident: Earthquake Results in Breach of Drums and Exposes Uncontained Waste to the Environment

The activities performed would be identical to those performed under Alternative II. The postulated releases would be the same as those in Section G.3.1. The estimated annual probability for this accident is 10^{-4} to 10^{-6}.

G.7 CALCULATION OF DOSES FROM POSTULATED ACCIDENTS

Maximum potential doses were estimated for each postulated accident described in Sections G.2 through G.6. For accidents postulated to occur during the implementation phase, the dose calculations were performed by calculating the amount of radioactive material inhaled by the reasonably maximally exposed individual and by the population out to a distance of 80 km (50 mi) from the Center. The maximally exposed individual was assumed to be continuously 1000 m (3300 ft) from the point of release for the duration of the release and during plume passage. A distance of 1000 m (3300 ft) was selected because it is the approximate distance to the present site boundary from the major facilities on the Project Premises, and it is less than the current distance to the nearest resident. The choice of this distance for dose calculations, in combination with the assumption of continuous exposure, is likely to result in higher estimated doses than would actually occur in the event of an accident. A more precise distance was not derived for the dose calculations because of the uncertainty of many variables such as the actual site boundary in the future, the location of the nearest resident in the future, the many different potential release locations, and the exact location of some potential new facilities (such as the retrievable storage areas).

The radionuclide intakes were calculated by multiplying the quantity of material released by the 95th percentile X/Q parameter relevant to the distance being evaluated and a standard breathing rate of 3.3×10^{-4} m^3/s (0.012 ft^3/s). Doses were calculated from the resulting intakes by using the GENII dose conversion factors for inhalation as discussed in Appendix D. The population distribution used to determine collective population doses was the projected population for the year 2000 (WVNS 1992b), and the wind direction was assumed to be toward the north-northwest, resulting in the maximum potential collective population doses relative to other wind directions. For accidents postulated to occur over the long term, doses to the maximally exposed individual and to the population were calculated in a similar manner. However, these dose estimates should be viewed with discretion because the postulated accidents for the long term involve highly improbable accident scenarios that would be highly unlikely even in the near term, if at all. Because the associated dose estimates are based on radioactivity levels and population distributions estimated to exist in the year 2000, the dose estimates for these accidents are highly uncertain and the postulated accidents are not likely to occur. The results of the dose calculations are shown in Tables G-19 through G-24.

Table G-19. Doses Resulting from Postulated Accidents during the Implementation Phase of Alternative I (Removal)

Waste Management Area	Description of Upper-Bound Accident	Maximum Individual Dose Commitment (rem)	Population Dose Commitment (rem)
1	Process building ventilation system confinement fails during decontamination operations	0.6	7,000
2	Fire/explosion destroys containment structure during lagoon 1 excavation	7	90,000
3	Piping failure during removal of tank 8D-2 sludge	0.1	1,000
5	Drum handling accident results in breach of lag storage addition drums	0.00007	0.8
7	Exposed waste in NRC-Licensed Disposal Area burns and breaches containment structure	20	300,000
8	Exposed waste in State-Licensed Disposal Area burns and breaches containment structure	30	400,000
9	Design basis earthquake results in breach of drums	0.00009	1
Container Management Area	Operational accident releases radioactive material	0.9	10,000

Table G-20. Impacts from Severe Natural Phenomena during the Long Term for Alternative II (On-Premises Storage)

Waste Management Area	Description of Upper-Bound Accident	Maximum Individual Dose Commitment (rem)	Population Dose Commitment (rem)
9	Beyond design basis earthquake destroys Radwaste Treatment System drum cell	20	200,000
Retrievable Storage Areas	Beyond design basis earthquake causes breach of waste containment	20	200,000

Table G-21. Doses Resulting from Postulated Accidents during the Implementation Phase of Alternative II (On-Premises Storage)

Waste Management Area	Description of Upper-Bound Accident	Maximum Individual Dose Commitment (rem)	Population Dose Commitment (rem)
1	Process building ventilation system confinement fails during decontamination operations	0.6	7,000
2	Fire/explosion destroys containment structure during lagoon 1 excavation	7	90,000
3	Piping failure during removal of tank 8D-2 sludge	0.1	1000
5	Drum handling accident results in breach of lag storage addition drums	0.00007	0.8
7	Exposed waste in NRC-Licensed Disposal Area burns and breaches containment structure	20	300,000
8	Exposed waste in State-Licensed Disposal Area burns and breaches containment structure	30	400,000
Container Management Area	Operational accident releases radioactive material	0.9	10,000
Retrievable Storage Areas	Drum handling accident breaches drums arriving from the container management area	0.9	10,000

Table G-22. **Doses from Postulated Accidents during the Implementation Phase of Alternative III (In-Place Stabilization)**

Waste Management Area	Description of Upper-Bound Accident	Maximum Individual Dose Commitment (rem)	Population Dose Commitment (rem)
1	Ventilation system fails in process building during vacuuming of spent fuel fines[a]	0.06	700
1	Containment structure fails during demolition of the process mechanical cell[b]	60	700,000
3	Ventilation system fails during backfilling of tank 8D-2	2	30,000
5	Drum handling accident results in breach of lag storage addition drums	0.00007	0.8
9	Design basis earthquake results in breach of drums	0.00009	1
Container Management Area	Tank failure releases untreated leachate to creek	0.0001	0.09
Low-Level (Radioactive) Waste Disposal Facility	Drum handling accident results in breach of drums[b]	0.00007	0.8

a. Accident postulated for Alternative IIIA.
b. Accident postulated for Alternative IIIB.

Table G-23. **Doses Resulting from Postulated Accidents during the Long Term for Alternative III (In-Place Stabilization)**

Waste Management Area	Description of Upper-Bound Accident	Maximum Individual Dose Commitment (rem)	Population Dose Commitment (rem)
1	Earthquake affects integrity of entombed waste[a]	0[b]	0[b]
1	Earthquake affects integrity of capped rubble pile[c]	0[b]	0[b]
3	Earthquake affects integrity of entombed waste in tank 8D-2	0[b]	0[b]
9	Earthquake breaches drums in Radwaste Treatment System drum cell tumulus	0[b]	0[b]
Low Level (Radioactive) Waste Disposal Facility	Earthquake affects integrity of tumulus	0[b]	0[b]

a. Bounding accident postulated for Alternative IIIA [In-Place Stabilization (Backfill)].
b. No large releases to the atmosphere have been postulated. Releases as a result of long-term degradation of the integrity of the waste containment with eventual contact of radioactive material with groundwater have been addressed as part of the long-term performance assessment in Appendix D.
c. Bounding accident postulated for Alternative IIIB [In-Place Stabilization (Rubble)].

Table G-24. Doses from Postulated Accidents during the Long-Term for Alternative IV (No Action: Monitoring and Maintenance)

Waste Management Area	Description of Upper-Bound Accident	Maximum Individual Dose Commitment (rem)	Population Dose Commitment (rem)
1	Beyond design basis earthquake results in failure of Process Building and release of radioactive material	100	1,000,000
3	Beyond design basis earthquake results in ventilation system failure and release of airborne radioactivity	5	60,000
5	Severe winds destroy waste storage facilities	9	100,000
9	Beyond design basis earthquake destroys RTS drum cell	20	200,000

The tables show there are risks from accidents for all the alternatives. The risk derives from the contained radionuclides and the potential for equipment failures, human errors, or natural phenomena to result in the release of some of the contained radionuclides. This comparison does not suggest that any of the alternatives are more favorable or less favorable because of the potential accident risks.

Some of the postulated accidents could result in doses greater than 5 rem under the postulated conditions as shown in the tables. These accidents generally involve complete ventilation system or containment system failures during scenarios in which large inventories are upset during decontamination activities or by severe natural phenomena. However, several factors should be considered when evaluating the significance of the calculated doses:

1. The postulated accident conditions, including accident initiators, release fractions, and meteorological conditions, are extremely conservative. Taken together, the conservative assumptions used to derive the dose estimates are sufficient to ensure that the actual doses in the event of accidents like those postulated would likely be much less than estimated, and the postulated accidents would be extremely unlikely to occur.

2. In some cases, the postulated doses were developed on the basis of preliminary, preconceptual design information. Conservative assumptions were necessary to derive accident source terms because of the lack of detailed design information. It is likely that an accident assessment on the basis of actual design information would result in lower estimated doses.

3. None of the alternatives could be implemented until required safety assessments, which would include detailed accident assessments on the basis of actual design information, were completed and approved. Approval would not occur until the postulated doses to both the workers and the public were within preestablished criteria. If the postulated impacts from credible accidents were not acceptable, then additional safety features would need to be incorporated.

On the basis of these considerations, potential accidents could be caused by major decontamination and excavation operations, and contamination could not be left in place without risk from severe natural phenomena. However, the estimates indicate that sufficient safety features should be incorporated into engineering designs for Alternatives I, II, and III for each WMA to meet DOE Nuclear Safety Policy Goals. Except for Alternative IV (No Action: Monitoring and Maintenance), the process building may be unable to achieve the safety goal. It is possible that a more rigorous safety assessment could show that an event severe enough to result in the postulated off-site doses is not credible. Otherwise, monitoring and maintenance would be needed to ensure that such a postulated event would not result in the estimated doses for Alternative IV (No Action: Monitoring and Maintenance) to be considered acceptable.

G.8 PRICE-ANDERSON ACT

The Price-Anderson Act, as amended (42 U.S.C. §2210), governs liability and compensation in the event of a nuclear incident arising from activities of DOE. A "nuclear incident" is defined under the Atomic Energy Act as

> "any occurrence, including an extraordinary nuclear occurrence, within the United States causing, within or outside the United States, bodily injury, sickness, disease, or death, or loss of or damage to property, or loss of use of property, arising out of or resulting from the radioactive, toxic, explosive, or other hazardous properties of source or special nuclear or byproduct material...." [42 U.S.C. §2014(q)]

In the unlikely event that a nuclear incident were to occur during WVDP implementation or post-implementation activities, the affected people could be eligible for reimbursement under the provisions of the Price-Anderson Act.

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APPENDIX H

TRANSPORTATION ANALYSIS

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APPENDIX H

TRANSPORTATION ANALYSIS

H.1 INTRODUCTION

This appendix summarizes the methods and results of analysis for determining the environmental impacts of transporting radioactive materials on public highways and railroads. The impacts are presented by alternative in the Environmental Impact Statement (EIS) and include doses and health effects.

H.2 TRANSPORTATION REGULATIONS

The regulatory standards for packaging and transporting radioactive materials are designed to achieve four primary objectives:

- Protect persons and property from radiation emitted from packages during transportation, by specific limitations on the allowable radiation levels
- Contain radioactive material in the package (achieved by packaging design requirements based on performance-oriented packaging integrity tests and environmental criteria)
- Prevent nuclear criticality (an unplanned nuclear chain reaction that may occur as a result of concentrating too much fissile material in one place)
- Assure physical protection against theft and sabotage during transit.

The U.S. Department of Transportation regulates the transportation of hazardous materials in interstate commerce by land, air, and water. As outlined in a 1979 Memorandum of Understanding with the U.S. Nuclear Regulatory Commission (NRC), the Department of Transportation specifically regulates the carriers of radioactive materials and the conditions of transport, such as routing, handling and storage, and vehicle and driver requirements. The Department of Transportation also regulates the labeling, classification and marking of radioactive material packages.

The NRC regulates the packaging and transporting of radioactive material for its licensees, which includes commercial shippers of radioactive materials. In addition, under an agreement with the Department of Transportation, the NRC sets the standards for packages containing fissile materials and Type B packages.

The Department of Energy (DOE), through its management directives, orders, and contractual agreements, ensures the protection of public health and safety by imposing on its transportation activities standards equivalent to those of the Department of Transportation and the NRC. According to 49 CFR Part 173.7(d), packages made by or under the direction of the DOE may be used for transporting Class 7 materials when the packages are evaluated, approved, and certified by the DOE against packaging standards equivalent to those specified in 10 CFR Part 71 ("Packaging and Transportation of Radioactive Material").

The Department of Transportation also has requirements that help to reduce transportation impacts. Some requirements affect drivers, packaging, labeling, marking, and placarding. Others specifying the maximum dose rate from radioactive material shipments help to reduce incident-free transportation doses.

The Federal Emergency Management Agency is responsible for establishing policies for, and coordinating civil emergency management, planning, and interaction with, federal executive agencies that have emergency response functions in the event of a transportation incident. The Federal Emergency Management Agency coordinates federal and state participation in developing emergency response plans and is responsible for the development of the interim federal Radiological Emergency Response Plan. This plan is designed to coordinate federal support to state and local governments, upon request, during the event of a transportation incident.

The Interstate Commerce Commission is responsible for the regulation of the economic aspects of overland shipments of radioactive materials. The commission issues operating authorities to carriers and also monitors and approves freight rates.

Radioactive materials are transported in strong, tight packages; Type A packages; or Type B packages. The amount of radioactive material determines which package must be used. Strong, tight packages are expected to retain their contents without leakage during normal transport, but performance criteria are not quantified. Type A packages are designed to retain their radioactive contents in normal transport. Under normal conditions, a Type A package must withstand:

- Temperatures ranging from -40°C (-40°F) to 70°C (158°F)
- External pressures ranging from 0.25 to 1.4 kg/cm^2 (3.5 to 20 lb/in.^{2})
- Normal vibration experienced during transportation
- Simulated rainfall of 5 cm (2 in.) per hour for 1 hour
- Free fall from 0.3 to 1.2 m (1 to 4 ft), depending on the package weight
- Water immersion-compression tests
- Impact of a 6 kg (13 lb) steel cylinder with rounded ends dropped from 1 m (40 in.) onto the most vulnerable surface.

Type B packages are designed to retain their radioactive contents in both normal and accident conditions. In addition to the normal conditions outlined above, under accident conditions, a Type B package must withstand:

- Free drop for 9.1 m (30 ft) onto an unyielding surface in a way most likely to cause damage

- Free drop from 1 m (3.3 ft) onto the end of a 15-cm (6-in.) diameter vertical steel bar

- Exposure to temperatures of 800°C (1475°F) for at least 30 minutes

- Immersion in at least 0.91 m (3 ft) of water for 8 hours in an orientation most likely to result in leakage.

Compliance with these requirements is demonstrated by using a combination of simple calculational methods, computer modeling techniques, or scale-model or full-scale testing of casks.

Radioactive materials shipped in Type A containers are subject to specific radioactivity limits, identified as A_1 and A_2 values in 49 CFR Part 173.435 ("Table of A_1 and A_2 values for radionuclides"). In addition, external radiation limits as prescribed in 49 CFR Part 173.441 (Radiation Level Limitations") must be met. If the A_1 or A_2 limits are exceeded, the material must be shipped in a Type B container unless it can be demonstrated that the material meets the definition of "low specific activity." If the material qualifies as low specific activity as defined in 10 CFR Part 71 ("Packaging and Transportation of Radioactive Material"), it may be shipped in an approved low specific activity shipping container. If the material exceeds A_1 or A_2 limits and does not qualify as low specific activity, the material must be shipped in a certified Type B container. Type B containers are subject to the radiation limits in 49 CFR Part 173.393, but no quantity limits are imposed except in the case of fissile materials and plutonium. Special packaging requirements are imposed for plutonium in excess of 20 curies by 10 CFR Part 71.63 ("Special Requirements for Plutonium Shipments").

H.3 TRANSPORTATION MODES AND ROUTES

H.3.1 Transportation Routing Models

To assess incident-free and transportation accident impacts, route characteristics were determined for shipments from the Center to the Hanford Site and the Nevada Test Site. Representative highway and rail routes were analyzed by using the routing computer codes HIGHWAY (Johnson et al. 1993a) and INTERLINE (Johnson et al. 1993b). The routes were calculated on the basis of current routing practices and applicable routing regulations and guidelines. Route characteristics include total shipment distance between each origin and destination and the fractions of travel in rural, suburban, and urban population density zones (see Table H-1). The HIGHWAY and INTERLINE routing computer codes are described below.

Table H-1. Transportation Distances between Facilities

Route	Miles	Rural (%)	Suburban (%)	Urban (%)
Truck Routes				
WNYNSC to Hanford Site	2556.0	84.6	13.7	1.7
WNYNSC to Nevada Test Site	2373.0	83.7	14.3	2.0
Rail Routes				
WNYNSC to Hanford Site	2654.0	78.3	18.0	3.7
WNYNSC to Nevada Test Site	2554.0	80.8	15.1	4.0

a. To convert miles to kilometers, multiply by 1.609.

The HIGHWAY computer code predicts highway routes for transporting radioactive materials within the United States. The HIGHWAY database is a computerized road atlas that currently describes approximately 390,000 km (240,000 mi) of roads. A complete description of the Interstate Highway System, United States highways, most of the principal state highways, and a number of local and community highways are identified in the database. The HIGHWAY computer code calculates routes that maximize the use of interstate highways. This feature allows the user to predict routes for shipment of radioactive materials that conform to Department of Transportation regulations (as specified in 49 CFR Part 177, "Carriage by Public Highway"). The routes calculated, in conforming to applicable guidelines and regulations, represent routes that could be used but may not be the actual routes used in the future. The code is updated periodically to reflect current road conditions, and it has been benchmarked against reported mileage and observations of commercial truck firms.

The INTERLINE computer code is designed to simulate routing of the United States rail system. The INTERLINE database consists of 94 separate subnetworks and represents various competing railroads in the United States. The database used by INTERLINE was originally based on Federal Railroad Administration data and reflected the United States railroad system in 1974. The database has since been expanded and modified over the past two decades. The routes in this study used the standard assumptions in the INTERLINE computer code that simulates the selection process that railroads use to direct shipments of radioactive material. Currently, there are no specific routing regulations for transporting radioactive material by rail. INTERLINE is updated periodically to reflect current track conditions, and it has been benchmarked against reported mileage and observations of commercial rail firms.

H.3.2 Radioactive Materials Shipments

Radioactive material shipments for the EIS alternatives were assumed to be transported by either truck or rail. At this time, insufficient data exist to determine what fraction of shipments would be shipped by either transport mode. Therefore, the transportation analysis assumed that radioactive materials are shipped 100 percent by truck or 100 percent by rail to bound potential impacts.

To determine the number of shipments required to transport radioactive materials under alternatives evaluated in this EIS, each radioactive waste category was evaluated with respect to radiological and physical characteristics to determine the appropriate shipping container. The concentration of cesium-137 is the dominant gamma-emitting radionuclide and was used to estimate does rates outside the shipping containers. The following shipping containers were assumed for purposes of evaluation; the identification of a shipping container from a specific manufacturer is not meant to indicate a preference for that company's container but is identified for analytical purposes only:

- 208-L (55-gal) drum (Type A)
- B-96 box (Type A)
- NUPAC 14-210H cask (Type A - low specific activity)
- NUPAC 10-142 cask (Type B)
- NUPAC 72B cask (Type B - remote-handled transuranic waste).
- TRUPACT-II cask (Type B - contact-handled transuranic waste).

The number of shipping containers per shipment was estimated on the basis of dimensions and weight of the shipping containers, the Transportation Index, and the transport vehicle dimensions and weight limits. Drums and boxes were assumed to be shipped on standard truck semi-trailers or railcars in a single stack. A truck shipment would contain 84 drums or 10 B-96 boxes; a railcar would contain 120 drums or 12 B-96 boxes. NUPAC 14-210H, 10-142, and 72B casks would be shipped one to a truck or two to a railcar. TRUPACT-II casks would be shipped three to a truck or six to a railcar.

The types of radioactive wastes, and, therefore, the number of shipments varies by alternative. Radioactive wastes are shipped off site under Alternatives I and III. Under Alternative I, waste from all waste management areas (WMAs) would be shipped off site. Alternative I evaluates two cases. Under case 1, the contaminated soil volumes are treated, which reduces the volume of waste shipped off site. Under case 2, soil treatment is assumed to not be effective and a large volume of radioactive waste would be shipped off site.

Under Alternative II, no radioactive waste is shipped off site. Under Alternative III, off site shipments are limited to waste category 4 from WMA 1, waste category 9 from WMA 3, and a portion of waste category 4 from WMA 5. Table H-2 gives data on the waste categories. Table H-3 summarizes the number of radioactive waste shipments for Alternatives I, II, and III.

Table H-2. Radioactive Waste Categories

WMA	Waste Category	Description	Waste Volume[a] (ft^3)	Void Fraction	Cs-137 (Ci/ft^3)
1	WC-1	Size-reduced equipment/piping A	162,000	0.7	0.03
	WC-2	Size-reduced equipment/piping B	1,620	0.7	1.25
	WC-3	Size-reduced equipment/piping C	4,850	0.7	130
	WC-4	Spent fuel fines	415	0.9	13,000
	WC-5	Contaminated soil	100,000[b]	0.9	8.5×10^{-9}
2	WC-1a	Neutralization pit concrete	121[b]	0.7	1.3×10^{-9}
	WC-1b	Neutralization pit liner and baffles	4	0.7	3.8×10^{-4}
	WC-2	Old interceptor rubble	3,500[b]	0.7	2.9×10^{-9}
	WC-3	New interceptor liner	30	0.7	4.3×10^{-4}
	WC-4a	Lagoon 1 sediment	62,000[b]	0.9	0.071
	WC-4b	Lagoon 1 debris and clay cap	46,000[b]	0.7	7.8×10^{-4}
	WC-5	Lagoon 2 sediment	42,000	0.9	1.5×10^{-4}
	WC-6	Lagoon 3 sediment	23,000	0.9	7.4×10^{-6}
	WC-7	02 building pipes, etc.	5,800[b]	0.7	1.9×10^{-3}
	WC-8	Lagoons 4 & 5 sediments and liners	1730[b]	0.7	5.2×10^{-6}
	WC-9	Contaminated soil	700,000[b]	0.9	1.8×10^{-3}
	WC-10	Plume sediments	4,000,000[b]	0.9	1.6×10^{-6}
3	WC-1	8D-2 decon resin	12,000	0.9	16.83
	WC-2	8D-2 tank & internals—size-reduced	3,500	0.7	0.015
	WC-3	8D-1 decon resin	12,000	0.9	21.42
	WC-4	8D-1 tank & internals—size-reduced	3,500	0.7	8.6×10^{-5}
	WC-5	Vault concrete rubble	70,000	0.7	3.9×10^{-5}
	WC-6	D 8-3 & D 8-4 tanks—size-reduced	350	0.7	5.7×10^{-4}
	WC-7	Vitrification Facility size-reduced equipment	500	0.7	0.47
	WC-8	Vitrification Facility melter - dismantled/size-reduced	760	0.7	9.16
	WC-9	HLW glass canisters	9,000	NA[c]	935
5	WC-1a	Lag storage area drums	96,700	NA	6.0×10^{-4}
	WC-1b	Lag storage area boxes	356,700	NA	4.0×10^{-4}
	WC-2a	CPC waste storage area drums	7,000	NA	7.0×10^{-5}
	WC-2b	CPC waste storage area low activity boxes	5,600	NA	3.4×10^{-4}
	WC-2c	CPC waste storage Area CPC boxes	15,000	NA	0.013
	WC-3	Contaminated soil	60,000[b]	0.9	1.0×10^{-5}
	WC-4	Cesium Prong soil	1,400,000[b]	0.9	2.3×10^{-6}
6 & 10	WC-1	Rail spur dirt	1,200[b]	0.9	0.03
	WC-2	Lag Storage Addition-2 foundation dirt	2,600[b]	0.9	0.03
	WC-3	Laundry room dirt	60[b]	0.9	0.03
	WC-4	Contaminated soil	4,500[b]	0.9	8.5×10^{-7}
7	WC-1a	NFS GTCC hulls & hardware	7,000	0.7	2.86
	WC-1b	NFS GTCC spent fuel	13	0.7	615
	WC-1c	NFS GTCC ion exchange resins & sludge	3,200	0.9	0.31
	WC-1d	NFS GTCC degraded extractant	400	0.9	1.3×10^{-3}
	WC-1e	NFS GTCC filters	12,600	0.7	0.32
	WC-1f	NFS GTCC failed & discarded equipment	12,200	0.7	0.74

Table H-2. Radioactive Waste Categories (Continued)

WMA	Waste Category	Description	Waste Volume[a] (ft^3)	Void Fraction	Cs-137 (Ci/ft^3)
7	WC-1g	NFS GTCC compactible trash	1,700	0.7	0.024
	WC-1h	NFS GTCC non-compactible trash	500	0.7	0.08
	WC-1i	(see WMA 7 WC-2)			
	WC-1j	NFS GTCC special	6,000	0.7	3.3×10^{-3}
	WC-1k	NFS GTCC low specific activity general	18,400	0.7	0.16
	WC-2	NFS dirt	40,000[b]	0.9	5.0×10^{-4}
	WC-3a	NFS 73-81 ion exchange resins & sludge	3,600	0.9	0.28
	WC-3b	NFS 73-81 degraded extractant	500	0.9	1.0×10^{-3}
	WC-3c	NFS 73-81 filters	14,200	0.7	0.28
	WC-3d	NFS 73-81 failed & discarded equipment	13,800	0.7	0.65
	WC-3e	NFS 73-81 compactible trash	1,900	0.7	0.021
	WC-3f	NFS 73-81 non-compactible trash	600	0.7	0.07
	WC-3g	NFS 73-81 special	6,800	0.7	2.9×10^{-3}
	WC-3h	NFS 73-81 low specific activity general	20,700	0.7	0.145
	WC-4	WVNS trench	180,000[b]	0.7	7.4×10^{-4}
	WC-5	Contaminated soil	4,300,000[b]	0.9	2.6×10^{-5}
8	WC-1a	SDA trench 2 LLW	80,700	0.7	0.025
	WC-1b	SDA trench 3	178,400	0.7	0.022
	WC-1c	SDA trench 5 LLW	248,400	0.7	0.008
	WC-1d	SDA trench 8 LLW	216,100	0.7	9.3×10^{-3}
	WC-1e	SDA trench 9 LLW	150,600	0.7	6.6×10^{-3}
	WC-1f	SDA trench 10 LLW	154,200	0.7	0.013
	WC-1g	SDA trench 11 LLW	155,100	0.7	0.013
	WC-1h	SDA trench 12 LLW	123,700	0.7	0.024
	WC-1i	SDA trench 13 LLW	186,500	0.7	0.016
	WC-1j	SDA trench 14	206,200	0.7	0.019
	WC-2a	SDA trench 1	55,000	0.7	0.04
	WC-2b	SDA trench 4	274,000	0.7	0.029
	WC-3	(see WMA 8, WC-4c and WC-4d)			
	WC-4a	SDA trench 2 TRU	24,000	0.7	NA
	WC-4b	SDA trench 5 TRU	1,000	0.7	NA
	WC-4c	SDA trench 6	460	0.7	10.9
	WC-4d	SDA trench 7	2,500	0.7	1.2×10^{-3}
	WC-4e	SDA trench 8 TRU	11,000	0.7	NA
	WC-4f	SDA trench 9 TRU	8,000	0.7	NA
	WC-4g	SDA trench 10 TRU	14,000	0.7	NA
	WC-4h	SDA trench 11 TRU	10,000	0.7	NA
	WC-4i	SDA trench 12 TRU	59,000	0.7	NA
	WC-5	Contaminated soil	6,800,000	0.9	1.1×10^{-5}
9	WC-1	RTS drum cell 71-gallon drums	207,310	NA	4.9×10^{-3}

a. Waste volumes without treatment by soil treatment.
b. Waste volumes reduced by factor of 4 by soil treatment.
c. NA = Not applicable.

Sources: WVNS (1993a through f)

Table H-3. **Radioactive and Industrial Materials Shipments for Alternatives I (Removal), II (On-Premises Storage), and III (In-Place Stabilization)**

		Alternative I (Removal)			Alternative II (On-Premises Storage)			Alternative III (In-Place Stabilization)		
WMA	Category	Duration (years)	Truck	Rail	Duration (years)	Truck	Rail	Duration (years)	Truck	Rail
WMA 1	Rad Case 1[a]	15	1,612	816	0[b]	0	0	24	20	10
	Rad Case 2[c]	15	1,698	888	0	0	0	24	20	10
	Industrial	15	1,703	1,192	15	1,703	1,192	24	72	50
WMA 2	Rad Case 1	2.5	1,599	1,262	0	0	0	0	0	0
	Rad Case 2	2.5	6,342	5,007	0	0	0	0	0	0
	Industrial	2.5	96	67	2.5	96	67	2	34	24
WMA 3	Rad Case 1	9	625	354	0	0	0	11.5	300	150
	Rad Case 2	9	625	354	0	0	0	11.5	300	150
	Industrial	9	1,188	831	9	1,188	831	11.5	119	83
WMA 4	Rad Case 1	d	d	d	d	d	d	d	d	d
	Rad Case 2	d	d	d	d	d	d	d	d	d
	Industrial	1.5	829	580	1.5	829	580	1	108	75
WMA 5	Rad Case 1	2	1,057	826	0	0	0	2	23	19
	Rad Case 2	2	2,320	1,878	0	0	0	2	23	19
	Industrial	2	155	108	2	155	108	2	155	108
WMAs 6 & 10	Rad Case 1	4.67	6	4	0	0	0	0	0	0
	Rad Case 2	4.67	26	15	0	0	0	0	0	0
	Industrial	4.67	4,930	3,451	4	3,137	2,196	3.33	4,481	3,137
WMA 7	Rad Case 1	11.5	6,595	3,713	0	0	0	0	0	0
	Rad Case 2	11.5	12,527	7,865	0	0	0	0	0	0
	Industrial	11.5	336	235	11.5	336	235	5	47	33
WMA 8	Rad Case 1	23	7,430	5,242	0	0	0	0	0	0
	Rad Case 2	23	16,318	11,464	0	0	0	0	0	0
	Industrial	23	15	10	23	15	10	6.5	15	10
WMA 9	Rad Case 1	4.25	2,150	1,075	0	0	0	0	0	0
	Rad Case 2	4.25	2,150	1,075	0	0	0	0	0	0
	Industrial	4.25	717	502	1	717	502	1.67	8	5
Totals	Rad Case 1		21,074	13,292		0	0		343	179
	Rad Case 2		42,006	28,546		0	0		343	179
	Industrial		9,968	6,977		8,175	5,723		5,037	3,526

a. Rad Case 1 = radioactively contaminated soil is treated.
b. Radioactive waste may be generated but would not be shipped off site.
c. Rad Case 2 = all radioactively contaminated soil remains contaminated after soil treatment.
d. Shipments for the radioactive waste from WMA 4 are included in the shipments for WMA 2, because WMA 4 contains some of the contaminated groundwater plume from the north plateau.

H.3.3 Nonradioactive Industrial Waste Shipments

In addition to the radioactive material shipments discussed in Section H.3.2, non-radioactive industrial wastes would also be shipped off site for disposal under Alternatives I, II, and III. Because of limited characterization data for these wastes, it was assumed that industrial wastes would be shipped in 208-L (55-gal) drums. This assumption gives a conservative estimate of the number of shipments because it is likely that some of these materials could be shipped in cargo containers or other configurations that would accommodate slightly larger volumes per shipment. The number of industrial waste shipments for Alternatives I, II, and III is summarized in Table H-3.

H.4 INCIDENT-FREE TRANSPORTATION RISKS

H.4.1 Methodology

Radiological dose during incident-free transportation of radioactive materials results from exposure to the external radiation field that surrounds the shipping containers. The population dose is a function of the number of people exposed, their proximity to the containers, their length of time of exposure, and the intensity of the radiation field surrounding the containers.

Radiological impacts were determined for crew workers and the general population during incident-free transportation. For truck shipments, the crew were the drivers of the shipment vehicle. For rail shipments, the crew were workers in close proximity to the shipping containers during inspection or classification of railcars. The general population were persons within 800 m (2,625 ft) of the road or railway (off-link), persons sharing the road or railway (on-link), and persons at stops. Exposures to workers who would load and inspect the shipments are not included in this analysis but are included in the occupational estimates for plant workers.

Collective doses for the crew and general population were calculated by using the RADTRAN 4 computer code (Neuhauser and Kanipe 1992). The radioactive material shipments were assigned a dose rate based on their radiological characteristics (see Table H-4).

To calculate the collective dose, a unit risk factor is developed to estimate the impact from transporting one shipment of radioactive material over a unit distance of travel in a given population density zone. The unit risk factors may be combined with routing information, such as the shipment distances in various population density zones, to determine the risk for a single shipment (a shipment risk factor) between a given origin and destination (Cashwell et al. 1986).

Unit risk factors were developed on the basis of travel within rural, suburban, and urban population zones by using RADTRAN 4 and default data (see Neuhauser and Kanipe 1992). The unit risk factors for a dose rate of 1 millirem per hour at 1 m (3.3 ft) from the shipping container for truck and rail shipments are itemized in Table H-5.

Table H-4. Dose Rates at 1 m (3.3 ft) from the Shipping Container[a]

WMA	Dose Rate (mR/hr)
208-LITER (55-GALLON) DRUMS	
WMA 2 WC-9	4.3
WMA 5 WC-1a/2a	3.1
WMA 7 WC-1j	4.8
WMA 7 WC-2	1.2
WMA 7 WC-3g	4.3
WMA 7 WC-4	1.1
WMA 7 WC-5	0.078
WMA 8 WC-1a-b/1e-j	14
WMA 8 WC-2b	14
WMA 8 WC-5	0.033
B-96 BOXES	
WMA 1 WC-6	2.8×10^{-5}
WMA 2 WC-1-3/7	6.8
WMA 2 WC-4b-6/8	0.67
WMA 2 WC-10	0.0052
WMA 3 WC-2/4-6	14
WMA 5 WC-1b	3.1
WMA 5 WC-3/4	0.034
WMA 8 WC-1c/1d	14
WMA 8 WC-2a	14
WMA 8 WC-4d	14
WMA 6-10 WC-4	0.0028
NUPAC 14-210H CASK	
WMA 1 WC-1	0.042
WMA 2 WC-4a	0.099
WMA 3 WC-7	0.66
WMA 5 WC-2b/2c	0.018
WMA 9 WC-1	0.0070
WMA 6-10 WC-1-3	0.042
NUPAC 10-142 CASK	
WMA 3 WC-1/3	0.064
WMA 3 WC-8	0.028
WMA 7 WC-1b	2.4
WMA 7 WC-1d/g/h/k	0.0010
WMA 7 WC-3b/e/f/h	0.0010
WMA 8 WC-4c	14
TRUPACT II CASK	
WMA 8 WC-4a/b/e-i	6.6×10^{-6}
NUPAC 72B CASK	
WMA 1 WC-2/3	0.80
WMA 1 WC-4	0.19
WMA 3 WC-9	13
WMA 7 WC-1a/c/e/f	0.0058
WMA 7 WC-3a/c/d	0.0051

a. Refer to Table H-2 for waste categories.

Table H-5. **Incident-Free Unit Risk Factors for a Dose Rate of 1 Millirem per Hour at 1 m (3.3 ft) from the Shipping Container for Truck and Rail Shipments**

		Unit risk factors (person-rem per kilometer)[a]		
Mode	Exposure group	Rural	Suburban	Urban
Truck				
	Occupational	4.2×10^{-5}	9.3×10^{-5}	1.5×10^{-4}
	General population			
	Off-link[b]	4.6×10^{-8}	6.1×10^{-6}	4.0×10^{-5}
	On-link[c]	1.9×10^{-6}	5.4×10^{-6}	5.6×10^{-5}
	Stops	4.5×10^{-5}	4.5×10^{-5}	4.5×10^{-5}
	General population total	4.7×10^{-5}	5.6×10^{-5}	1.4×10^{-4}
Rail				
	Occupational[d]	1.6×10^{-6}	1.6×10^{-6}	1.6×10^{-6}
	General population			
	Off-link[b]	6.3×10^{-8}	1.2×10^{-5}	1.1×10^{-4}
	On-link[c]	2.5×10^{-8}	3.2×10^{-7}	8.7×10^{-7}
	Stops[e]	1.8×10^{-6}	1.8×10^{-6}	1.8×10^{-6}
	General population total	1.9×10^{-6}	1.4×10^{-5}	1.1×10^{-4}

a. The methodology, equations, and data used to develop the unit risk factors are discussed in Madsen et al. (1986) and Neuhauser and Kanipe (1992). Cashwell et al. (1986) contains a detailed explanation of the use of unit risk factors.
b. Off-link general population were persons within 800 meters (2,625 feet) of the road or railway.
c. On-link general population were persons sharing the road or railway.
d. The nonlinear component of incident-free rail dose for crew workers because of railcar inspections and classifications is 0.0018 person-rem per shipment. Ostmeyer (1986) contains a detailed explanation of the rail exposure model.
e. The nonlinear component of incident-free rail dose for the general population because of railcar inspections and classifications is 0.0032 person-rem per shipment. Ostmeyer (1986) contains a detailed explanation of the rail exposure model.

Incident-free nonradiological fatalities were also evaluated by using unit risk factors (Rao et al. 1982). These nonradiological unit risk factors are applicable to radioactive and industrial material shipments. The nonradiological unit risk factor for truck transport used in this analysis was 1.0×10^{-7} fatalities per kilometer; for rail transport, the nonradiological unit risk factor was 1.3×10^{-7} fatalities per kilometer. These unit risk factors account for the fatalities from emission of particulates and sulfur dioxide, but they are applicable only to the urban population zone (Rao et al. 1982). The distance used in the nonradiological analyses must be doubled to reflect the round trip distance because these impacts occur whether or not the shipment contains radioactive material. The radiological material shipments assumed the urban fractions presented in Table H-5. The industrial material shipments conservatively assumed all of the shipment was in an urban area, when in fact, within a 640-km (400-mi) radius of the Center, travel through rural areas would be required.

H.4.1.1 Maximally Exposed Individual Exposure Scenarios

Maximum individual doses were calculated by using the RISKIND computer code (Yuan et al. 1993). The maximum individual doses for the routine transportation off site were estimated for transportation workers, as well as members of the general population. For railcar shipments, the doses to three hypothetical members of the general population were evaluated to determine the maximally exposed individual. The three scenarios were (a) a railyard worker working at a distance of 10 m (33 ft) from the shipping container for 2 hours, (b) a resident living 30 m (98 ft) from the rail line where the shipping container was being transported, and (c) a resident living 200 m (656 ft) from a rail stop where the shipping container was sitting for 20 hours. For rail shipments, the maximum exposed transportation worker was an individual in a railyard who spent a time- and distance-weighted average of 0.16 hours inspecting, classifying, and repairing railcars (Wooden 1986).

For truck shipments, the three scenarios were also evaluated to determine the maximally exposed individual in the general population. These scenarios were: (a) a person caught in traffic and located 1 m (3.3 ft) away from the surface of the shipping container for one-half hour, (b) a resident living 30 m (98 ft) from the highway used to transport the shipping container, and (c) a service station worker working at a distance of 20 m (66 ft) from the shipping container for 2 hours. The hypothetical maximum exposed individual doses were accumulated over a single year. However, for the situation involving an individual caught in traffic next to a truck, the radiological exposures were calculated for only one event because it was considered unlikely that the same individual would be caught in traffic next to all containers for all shipments. For truck shipments, the maximum exposed transportation worker is the driver who was assumed to drive shipments for up to 2,000 hours per year.

H.4.2 Results of Calculations

This section summarizes the results of the incident-free transportation analyses for radioactive and industrial materials shipments. Tables H-6 and H-7 contain the detailed results of the analyses. This section discusses the results on an annual basis; the cumulative radiation doses and risks are also presented in Tables H-6 and H-7.

For Alternative I, the shipment of radioactive material by truck was estimated to result in 0.059 to 0.063 cancer fatalities per year for workers (with soil treatment) and 0.10 to 0.11 cancer fatalities per year for workers (without soil treatment). For the general population, the shipment of radioactive material by truck was estimated to result in 0.39 to 0.42 cancer fatalities per year (with soil treatment) and 0.56 to 0.60 cancer fatalities per year (without soil treatment). The estimated annual number of nonradiological fatalities was 0.31 (with soil treatment) and 0.35 (without soil treatment).

Table H-6. Doses and Health Effects from the Incident-Free Transport of Radioactive and Industrial Material by Truck

WMA		Alternative I (Removal)		Alternative II (On-Premises Storage)		Alternative III (In-Place Stabilization)	
		Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site
Annual Occupational Collective Dose from Transport of Radioactive Material (person-rem/yr)							
1	Case 1[a]	5.2	4.9	—[b]	—	0.062	0.058
	Case 2[c]	5.2	4.9	—	—	0.062	0.058
2	Case 1	32	30	—	—	—	—
	Case 2	120	120	—	—	—	—
3	Case 1	11	10	—	—	5.9	5.5
	Case 2	11	10	—	—	5.9	5.5
4	Case 1	d	d	—	—	—	—
	Case 2	d	d	—	—	—	—
5	Case 1	62	58	—	—	0.15	0.14
	Case 2	66	62	—	—	0.15	0.14
6 & 10	Case 1	0.0094	0.0088	—	—	—	—
	Case 2	0.039	0.037	—	—	—	—
7	Case 1	5.9	5.6	—	—	—	—
	Case 2	21	19	—	—	—	—
8	Case 1	42	39	—	—	—	—
	Case 2	44	42	—	—	—	—
9	Case 1	0.73	0.68	—	—	—	—
	Case 2	0.73	0.68	—	—	—	—
Total	Case 1	160	150	—	-	6.1	5.7
	Case 2	270	260	-	-	6.1	5.7

Table H-6. Doses and Health Effects from the Incident-Free Transport of Radioactive and Industrial Material by Truck (Continued)

WMA		Alternative I (Removal) Hanford Site	Alternative I (Removal) Nevada Test Site	Alternative II (On-Premises Storage) Hanford Site	Alternative II (On-Premises Storage) Nevada Test Site	Alternative III (In-Place Stabilization) Hanford Site	Alternative III (In-Place Stabilization) Nevada Test Site
Cumulative Occupational Collective Dose from Transport of Radioactive Material (person-rem)							
1	Case 1	78	73	—	—	1.5	1.4
	Case 2	78	73	—	—	1.5	1.4
2	Case 1	80	75	—	—	—	—
	Case 2	310	290	—	—	—	—
3	Case 1	99	93	—	—	68	63
	Case 2	99	93	—	—	68	63
4	Case 1	d	d	—	—	—	—
	Case 2	d	d	—	—	—	—
5	Case 1	120	120	—	—	0.30	0.28
	Case 2	130	120	—	—	0.30	0.28
6 & 10	Case 1	0.044	0.041	—	—	—	—
	Case 2	0.18	0.17	—	—	—	—
7	Case 1	68	64	—	—	—	—
	Case 2	240	220	—	—	—	—
8	Case 1	960	900	—	—	—	—
	Case 2	1000	960	—	—	—	—
9	Case 1	3.1	2.9	—	—	—	—
	Case 2	3.1	2.9	—	—	—	—
Total	Case 1	1400	1300	—	—	69	65
	Case 2	1900	1800	—	—	69	65

Table H-6. Doses and Health Effects from the Incident-Free Transport of Radioactive and Industrial Material by Truck (Continued)

		Alternative I (Removal)		Alternative II (On-Premises Storage)		Alternative III (In-Place Stabilization)	
WMA		Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site
Annual Public Collective Dose from Transport of Radioactive Material (person-rem/yr)							
1	Case 1	5.1	4.7	—	—	0.033	0.030
	Case 2	5.1	4.7	—	—	0.033	0.030
2	Case 1	120	110	—	—	—	—
	Case 2	450	420	—	—	—	—
3	Case 1	110	100	—	—	66	62
	Case 2	110	100	—	—	66	62
4	Case 1	d	d	—	—	—	—
	Case 2	d	d	—	—	—	—
5	Case 1	170	160	—	—	0.079	0.074
	Case 2	170	160	—	—	0.079	0.074
6 & 10	Case 1	0.0092	0.0086	—	—	—	—
	Case 2	0.039	0.036	—	—	—	—
7	Case 1	7.6	7.1	—	—	—	—
	Case 2	22	21	—	—	—	—
8	Case 1	430	400	—	—	—	—
	Case 2	430	400	—	—	—	—
9	Case 1	0.72	0.67	—	—	—	—
	Case 2	0.72	0.67	—	—	—	—
Total	Case 1	840	780	—	—	67	62
	Case 2	1200	1100	—	—	67	62

Table H-6. Doses and Health Effects from the Incident-Free Transport of Radioactive and Industrial Material by Truck (Continued)

WMA		Alternative I (Removal) Hanford Site	Alternative I (Removal) Nevada Test Site	Alternative II (On-Premises Storage) Hanford Site	Alternative II (On-Premises Storage) Nevada Test Site	Alternative III (In-Place Stabilization) Hanford Site	Alternative III (In-Place Stabilization) Nevada Test Site
Cumulative Public Collective Dose from Transport of Radioactive Material (person-rem)							
1	Case 1	76	71	—	—	0.78	0.73
	Case 2	76	71	—	—	0.78	0.73
2	Case 1	290	270	—	—	—	—
	Case 2	1100	1000	—	—	—	—
3	Case 1	1000	940	—	—	760	710
	Case 2	1000	940	—	—	760	710
4	Case 1	d	d	—	—	—	—
	Case 2	d	d	—	—	—	—
5	Case 1	340	310	—	—	0.16	0.15
	Case 2	340	320	—	—	0.16	0.15
6 & 10	Case 1	0.043	0.040	—	—	—	—
	Case 2	0.18	0.17	—	—	—	—
7	Case 1	87	81	—	—	—	—
	Case 2	250	240	—	—	—	—
8	Case 1	199009	200	—	—	—	—
	Case 2	10000	9300	—	—	—	—
9	Case 1	3.0	2.8	—	—	—	—
	Case 2	3.0	2.8	—	—	—	—
Total	Case 1	12000	11000	—	—	760	710
	Case 2	13000	12000	—	—	760	710

Table H-6. Doses and Health Effects from the Incident-Free Transport of Radioactive and Industrial Material by Truck (Continued)

WMA		Alternative I (Removal)		Alternative II (On-Premises Storage)		Alternative III (In-Place Stabilization)	
		Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site
Annual Occupational Cancer Fatalities from Transport of Radioactive Material							
1	Case 1	0.0021	0.0019	—	—	2.5×10^{-5}	2.3×10^{-5}
	Case 2	0.0021	0.0019	—	—	2.5×10^{-5}	2.3×10^{-5}
2	Case 1	0.013	0.012	—	—	—	—
	Case 2	0.050	0.047	—	—	—	—
3	Case 1	0.0044	0.0041	—	—	0.0024	0.0023
	Case 2	0.0044	0.0041	—	—	0.0024	0.0023
4	Case 1	d	d	—	—	—	—
	Case 2	d	d	—	—	—	—
5	Case 1	0.025	0.023	—	—	6.0×10^{-5}	5.6×10^{-5}
	Case 2	0.026	0.025	—	—	6.0×10^{-5}	5.6×10^{-5}
6 & 10	Case 1	3.7×10^{-6}	3.5×10^{-6}	—	—	—	—
	Case 2	1.6×10^{-5}	1.5×10^{-5}	—	—	—	—
7	Case 1	0.0024	0.0022	—	—	—	—
	Case 2	0.0083	0.0077	—	—	—	—
8	Case 1	0.017	0.016	—	—	—	—
	Case 2	0.018	0.017	—	—	—	—
9	Case 1	2.9×10^{-4}	2.7×10^{-4}	—	—	—	—
	Case 2	2.9×10^{-4}	2.7×10^{-4}	—	—	—	—
Total	Case 1	0.063	0.059	—	—	0.0024	0.0023
	Case 2	0.11	0.10	—	—	0.0024	0.0023

Table H-6. **Doses and Health Effects from the Incident-Free Transport of Radioactive and Industrial Material by Truck (Continued)**

		Alternative I (Removal)		Alternative II (On-Premises Storage)		Alternative III (In-Place Stabilization)	
WMA		Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site
Cumulative Occupational Cancer Fatalities from Transport of Radioactive Material							
1	Case 1	0.031	0.029	—	—	5.9×10^{-4}	5.5×10^{-4}
	Case 2	0.031	0.029	—	—	5.9×10^{-4}	5.5×10^{-4}
2	Case 1	0.032	0.030	—	—	—	—
	Case 2	0.12	0.12	—	—	—	—
3	Case 1	0.040	0.037	—	—	0.027	0.025
	Case 2	0.040	0.037	—	—	0.027	0.025
4	Case 1	d	d	—	—	—	—
	Case 2	d	d	—	—	—	—
5	Case 1	0.049	0.046	—	—	1.2×10^{-4}	1.1×10^{-4}
	Case 2	0.053	0.050	—	—	1.2×10^{-4}	1.1×10^{-4}
6 & 10	Case 1	1.8×10^{-5}	1.6×10^{-5}	—	—	—	—
	Case 2	7.4×10^{-5}	6.9×10^{-5}	—	—	—	—
7	Case 1	0.027	0.026	—	—	—	—
	Case 2	0.095	0.089	—	—	—	—
8	Case 1	0.38	0.36	—	—	—	—
	Case 2	0.41	0.38	—	—	—	—
9	Case 1	0.0012	0.0012	—	—	—	—
	Case 2	0.0012	0.0012	—	—	—	—
Total	Case 1	0.56	0.53	—	—	0.028	0.026
	Case 2	0.75	0.71	—	—	0.028	0.026

Table H-6. Doses and Health Effects from the Incident-Free Transport of Radioactive and Industrial Material by Truck (Continued)

WMA		Alternative I (Removal) Hanford Site	Alternative I (Removal) Nevada Test Site	Alternative II (On-Premises Storage) Hanford Site	Alternative II (On-Premises Storage) Nevada Test Site	Alternative III (In-Place Stabilization) Hanford Site	Alternative III (In-Place Stabilization) Nevada Test Site
Annual Public Cancer Fatalities from Transport of Radioactive Material							
1	Case 1	0.0025	0.0024	—	—	1.6×10^{-5}	1.5×10^{-5}
	Case 2	0.0025	0.0024	—	—	1.6×10^{-5}	1.5×10^{-5}
2	Case 1	0.058	0.054	—	—	—	—
	Case 2	0.22	0.21	—	—	—	—
3	Case 1	0.056	0.052	—	—	0.033	0.031
	Case 2	0.056	0.052	—	—	0.033	0.031
4	Case 1	d	d	—	—	—	—
	Case 2	d	d	—	—	—	—
5	Case 1	0.084	0.078	—	—	4.0×10^{-5}	3.7×10^{-5}
	Case 2	0.086	0.080	—	—	4.0×10^{-5}	3.7×10^{-5}
6 & 10	Case 1	4.6×10^{-6}	4.3×10^{-6}	—	—	—	—
	Case 2	1.9×10^{-5}	1.8×10^{-5}	—	—	—	—
7	Case 1	0.0038	0.0035	—	—	—	—
	Case 2	0.011	0.010	—	—	—	—
8	Case 1	0.22	0.20	—	—	—	—
	Case 2	0.22	0.20	—	—	—	—
9	Case 1	3.6×10^{-4}	3.3×10^{-4}	—	—	—	—
	Case 2	3.6×10^{-4}	3.3×10^{-4}	—	—	—	—
Total	Case 1	0.42	0.39	—	—	0.033	0.031
	Case 2	0.60	0.56	—	—	0.033	0.031

Table H-6. **Doses and Health Effects from the Incident-Free Transport of Radioactive and Industrial Material by Truck (Continued)**

WMA		Alternative I (Removal)		Alternative II (On-Premises Storage)		Alternative III (In-Place Stabilization)	
		Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site
Cumulative Public Cancer Fatalities from Transport of Radioactive Material							
1	Case 1	0.038	0.036	—	—	3.9×10^{-4}	3.7×10^{-4}
	Case 2	0.038	0.036	—	—	3.9×10^{-4}	3.7×10^{-4}
2	Case 1	0.14	0.13	—	—	—	—
	Case 2	0.56	0.52	—	—	—	—
3	Case 1	0.51	0.47	—	—	0.38	0.36
	Case 2	0.51	0.47	—	—	0.38	0.36
4	Case 1	d	d	—	—	—	—
	Case 2	d	d	—	—	—	—
5	Case 1	0.17	0.16	—	—	7.9×10^{-5}	7.4×10^{-5}
	Case 2	0.17	0.16	—	—	7.9×10^{-5}	7.4×10^{-5}
6 & 10	Case 1	2.1×10^{-5}	2.0×10^{-5}	—	—	—	—
	Case 2	9.1×10^{-5}	8.4×10^{-5}	—	—	—	—
7	Case 1	0.044	0.041	—	—	—	—
	Case 2	0.13	0.12	—	—	—	—
8	Case 1	5.0	4.6	—	—	—	—
	Case 2	5.0	4.6	—	—	—	—
9	Case 1	0.0015	0.0014	—	—	—	—
	Case 2	0.0015	0.0014	—	—	—	—
Total	Case 1	5.9	5.5	—	—	0.38	0.36
	Case 2	6.4	5.9	—	—	0.38	0.36

Table H-6. Doses and Health Effects from the Incident-Free Transport of Radioactive and Industrial Material by Truck (Continued)

		Alternative I (Removal)		Alternative II (On-Premises Storage)		Alternative III (In-Place Stabilization)	
WMA		Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site
Cumulative Cancer Fatalities from Emissions from Transport of Radioactive Material							
1	Case 1	0.0200	0.0200	—	—	0.0003	0.0003
	Case 2	0.0200	0.0200	—	—	0.0003	0.0003
2	Case 1	0.0179	0.0189	—	—	—	—
	Case 2	0.0709	0.0739	—	—	—	—
3	Case 1	0.0060	0.0060	—	—	0.0036	0.0036
	Case 2	0.0060	0.0060	—	—	0.0036	0.0036
4	Case 1	d	d	—	—	0.0008	0.0008
	Case 2	d	d	—	—	0.0008	0.0008
5	Case 1	0.0122	0.0122	—	—	0.0002	0.0002
	Case 2	0.0262	0.0272	—	—	0.0002	0.0002
6 & 10	Case 1	0.0030	0.0030	—	—	—	—
	Case 2	0.0030	0.0030	—	—	—	—
7	Case 1	0.0771	0.0771	—	—	—	—
	Case 2	0.1371	0.1471	—	—	—	—
8	Case 1	0.0831	0.0871	—	—	—	—
	Case 2	0.1781	0.1881	—	—	—	—
9	Case 1	0.0276	0.0276	—	—	0.0001	0.0001
	Case 2	0.0276	0.0276	—	—	0.0001	0.0001
Total	Case 1	0.2469	0.2519	—	—	0.0050	0.0050
	Case 2	0.4689	0.4929	—	—	0.0050	0.0050

Table H-6. **Doses and Health Effects from the Incident-Free Transport of Radioactive and Industrial Material by Truck (Continued)**

		Alternative I (Removal)		Alternative II (On-Premises Storage)		Alternative III (In-Place Stabilization)	
WMA		Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site
Cumulative Cancer Facilities from Emissions from Transport of Industrial Material							
1	Case 1	0.2200	0.2200	0.2200	0.2200	0.0091	0.0091
	Case 2	0.2200	0.2200	0.2200	0.2200	0.0091	0.0091
2	Case 1	0.0121	0.0121	0.0121	0.0121	0.0044	0.0044
	Case 2	0.0121	0.0121	0.0121	0.0121	0.0044	0.0044
3	Case 1	0.1540	0.1540	0.1540	0.1540	0.0154	0.0154
	Case 2	0.1540	0.1540	0.1540	0.1540	0.0154	0.0154
4	Case 1	0.1067	0.1067	0.1067	0.1067	0.0132	0.0132
	Case 2	0.1067	0.1067	0.1067	0.1067	0.0132	0.0132
5	Case 1	0.0198	0.0198	0.0198	0.0198	0.0198	0.0198
	Case 2	0.0198	0.0198	0.0198	0.0198	0.0198	0.0198
6 & 10	Case 1	0.6270	0.6270	0.4070	0.4070	0.5720	0.5720
	Case 2	0.6270	0.6270	0.4070	0.4070	0.5720	0.5720
7	Case 1	0.0429	0.0429	0.0429	0.0429	0.0061	0.0061
	Case 2	0.0429	0.0429	0.0429	0.0429	0.0061	0.0061
8	Case 1	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019
	Case 2	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019
9	Case 1	0.0924	0.0924	0.0924	0.0924	0.0009	0.0009
	Case 2	0.0924	0.0924	0.0924	0.0924	0.0009	0.0009
Total	Case 1	1.2768	1.2768	1.0568	1.0568	0.6428	0.6428
	Case 2	1.2768	1.2768	1.0568	1.0568	0.6428	0.6428

a. Case 1 = radioactively contaminated soil is treated.
b. — = Radioactive waste may be generated but would not be shipped off-site, so there would be no dose or health effects.
c. Case 2 = all radioactively contaminated soil remains contaminated after soil treatment.
d. Values for WMA 4 are included in those for WMA 2, because WMA 4 contains some of the contaminated groundwater plume from the north plateau.

Table H-7. Doses and Health Effects from the Incident-Free Transport of Radioactive and Industrial Material by Rail

WMA		Alternative I (Removal) Hanford Site	Alternative I (Removal) Nevada Test Site	Alternative II (On-Premises Storage) Hanford Site	Alternative II (On-Premises Storage) Nevada Test Site	Alternative III (In-Place Stabilization) Hanford Site	Alternative III (In-Place Stabilization) Nevada Test Site
Annual Occupational Collective Dose from Transport of Radioactive Material (person-rem/yr)							
1	Case 1[a]	0.11	0.11	—[b]	—	7.0×10^{-4}	7.2×10^{-4}
	Case 2[c]	0.11	0.11	—	—	7.0×10^{-4}	7.2×10^{-4}
2	Case 1	3.5	3.6	—	—	—	—
	Case 2	14	14	—	—	—	—
3	Case 1	2.9	3.0	—	—	1.3	1.4
	Case 2	2.9	3.0	—	—	1.3	1.4
4	Case 1	d	d	—	—	—	—
	Case 2	d	d	—	—	—	—
5	Case 1	5.7	5.9	—	—	0.0028	0.0029
	Case 2	5.9	6.1	—	—	0.0028	0.0029
6 & 10	Case 1	2.4×10^{-4}	5×10^{-4}	—	—	—	—
	Case 2	8.7×10^{-4}	9.1×10^{-4}	—	—	—	—
7	Case 1	0.22	0.23	—	—	—	—
	Case 2	0.66	0.68	—	—	—	—
8	Case 1	13	14	—	—	—	—
	Case 2	13	14	—	—	—	—
9	Case 1	0.015	0.016	—	—	—	—
	Case 2	0.015	0.016	—	—	—	—
Total	Case 1	26	27	—	—	1.3	1.4
	Case 2	36	38	—	—	1.3	1.4

Table H-7. Doses and Health Effects from the Incident-Free Transport of Radioactive and Industrial Material by Rail (Continued)

WMA		Alternative I (Removal) Hanford Site	Alternative I (Removal) Nevada Test Site	Alternative II (On-Premises Storage) Hanford Site	Alternative II (On-Premises Storage) Nevada Test Site	Alternative III (In-Place Stabilization) Hanford Site	Alternative III (In-Place Stabilization) Nevada Test Site
Cumulative Occupational Collective Dose from Transport of Radioactive Material (person-rem)							
1	Case 1	1.6	1.7	—	—	0.017	0.017
	Case 2	1.6	1.7	—	—	0.017	0.017
2	Case 1	8.7	9.0	—	—	—	—
	Case 2	34	35	—	—	—	—
3	Case 1	26	27	—	—	15	16
	Case 2	26	27	—	—	15	16
4	Case 1	d	d	—	—	—	—
	Case 2	d	d	—	—	—	—
5	Case 1	11	12	—	—	0.0056	0.0058
	Case 2	12	12	—	—	0.0056	0.0058
6 & 10	Case 1	0.0011	0.0012	—	—	—	—
	Case 2	0.0041	0.0042	—	—	—	—
7	Case 1	2.6	2.7	—	—	—	—
	Case 2	7.6	7.8	—	—	—	—
8	Case 1	310	320	—	—	—	—
	Case 2	310	320	—	—	—	—
9	Case 1	0.065	0.067	—	—	—	—
	Case 2	0.065	0.067	—	—	—	—
Total	Case 1	360	370	—	—	15	16
	Case 2	390	400	—	—	15	16

Table H-7. **Doses and Health Effects from the Incident-Free Transport of Radioactive and Industrial Material by Rail (Continued)**

		Alternative I (Removal)		Alternative II (On-Premises Storage)		Alternative III (In-Place Stabilization)	
WMA		Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site
Annual Public Collective Dose from Transport of Radioactive Material (person-rem/yr)							
1	Case 1	0.42	0.37	—	—	0.0027	0.0024
	Case 2	0.42	0.37	—	—	0.0027	0.0024
2	Case 1	13	12	—	—	—	—
	Case 2	52	46	—	—	—	—
3	Case 1	11	9.7	—	—	5.1	4.5
	Case 2	11	9.7	—	—	5.1	4.5
4	Case 1	d	d	—	—	—	—
	Case 2	d	d	—	—	—	—
5	Case 1	22	19	—	—	0.011	0.0094
	Case 2	23	20	—	—	0.011	0.0094
6 & 10	Case 1	9.2×10^{-4}	8.0×10^{-4}	—	—	—	—
	Case 2	0.0034	0.0030	—	—	—	—
7	Case 1	0.87	0.76	—	—	—	—
	Case 2	2.5	2.2	—	—	—	—
8	Case 1	51	45	—	—	—	—
	Case 2	52	45	—	—	—	—
9	Case 1	0.059	0.052	—	—	—	—
	Case 2	0.059	0.052	—	—	—	—
Total	Case 1	99	87	—	—	5.1	4.5
	Case 2	140	120	—	—	5.1	4.5

Table H-7. Doses and Health Effects from the Incident-Free Transport of Radioactive and Industrial Material by Rail (Continued)

WMA		Alternative I (Removal) Hanford Site	Alternative I (Removal) Nevada Test Site	Alternative II (On-Premises Storage) Hanford Site	Alternative II (On-Premises Storage) Nevada Test Site	Alternative III (In-Place Stabilization) Hanford Site	Alternative III (In-Place Stabilization) Nevada Test Site
Cumulative Public Collective Dose from Transport of Radioactive Material (person-rem)							
1	Case 1	6.3	5.5	—	—	0.065	0.057
	Case 2	6.3	5.5	—	—	0.065	0.057
2	Case 1	34	29	—	—	—	—
	Case 2	130	110	—	—	—	—
3	Case 1	100	87	—	—	59	51
	Case 2	100	87	—	—	59	51
4	Case 1	d	d	—	—	—	—
	Case 2	d	d	—	—	—	—
5	Case 1	44	39	—	—	0.022	0.019
	Case 2	45	40	—	—	0.022	0.019
6 & 10	Case 1	0.0043	0.0038	—	—	—	—
	Case 2	0.016	0.014	—	—	—	—
7	Case 1	10	8.7	—	—	—	—
	Case 2	29	26	—	—	—	—
8	Case 1	1200	1000	—	—	—	—
	Case 2	1200	1000	—	—	—	—
9	Case 1	0.25	0.22	—	—	—	—
	Case 2	0.25	0.22	—	—	—	—
Total	Case 1	1400	1200	—	—	59	51
	Case 2	1500	1300	—	—	59	51

Table H-7. **Doses and Health Effects from the Incident-Free Transport of Radioactive and Industrial Material by Rail (Continued)**

WMA		Alternative I (Removal) Hanford Site	Alternative I (Removal) Nevada Test Site	Alternative II (On-Premises Storage) Hanford Site	Alternative II (On-Premises Storage) Nevada Test Site	Alternative III (In-Place Stabilization) Hanford Site	Alternative III (In-Place Stabilization) Nevada Test Site
Annual Occupational Cancer Fatalities from Transport of Radioactive Material							
1	Case 1	4.3×10^{-5}	4.5×10^{-5}	—	—	2.8×10^{-7}	2.9×10^{-7}
	Case 2	4.3×10^{-5}	4.5×10^{-5}	—	—	2.8×10^{-7}	2.9×10^{-7}
2	Case 1	0.0014	0.0014	—	—	—	—
	Case 2	0.0054	0.0056	—	—	—	—
3	Case 1	0.0011	0.0012	—	—	5.3×10^{-4}	5.5×10^{-4}
	Case 2	0.0011	0.0012	—	—	5.3×10^{-4}	5.5×10^{-4}
4	Case 1	d	d	—	—	—	—
	Case 2	d	d	—	—	—	—
5	Case 1	0.0023	0.0024	—	—	1.1×10^{-6}	1.2×10^{-6}
	Case 2	0.0024	0.0024	—	—	1.1×10^{-6}	1.2×10^{-6}
6 & 10	Case 1	9.5×10^{-8}	9.9×10^{-8}	—	—	—	—
	Case 2	3.5×10^{-7}	3.6×10^{-7}	—	—	—	—
7	Case 1	9.0×10^{-5}	9.3×10^{-5}	—	—	—	—
	Case 2	2.6×10^{-4}	2.7×10^{-4}	—	—	—	—
8	Case 1	0.0053	0.0055	—	—	—	—
	Case 2	0.0054	0.0055	—	—	—	—
9	Case 1	6.1×10^{-6}	6.3×10^{-6}	—	—	—	—
	Case 2	6.1×10^{-6}	6.3×10^{-6}	—	—	—	—
Total	Case 1	0.010	0.011	—	—	5.3×10^{-4}	5.5×10^{-4}
	Case 2	0.015	0.015	—	—	5.3×10^{-4}	5.5×10^{-4}

Table H-7. Doses and Health Effects from the Incident-Free Transport of Radioactive and Industrial Material by Rail (Continued)

WMA		Alternative I (Removal) Hanford Site	Alternative I (Removal) Nevada Test Site	Alternative II (On-Premises Storage) Hanford Site	Alternative II (On-Premises Storage) Nevada Test Site	Alternative III (In-Place Stabilization) Hanford Site	Alternative III (In-Place Stabilization) Nevada Test Site
Cumulative Occupational Cancer Fatalities from Transport of Radioactive Material							
1	Case 1	6.5×10^{-4}	6.7×10^{-4}	—	—	6.7×10^{-6}	6.9×10^{-6}
	Case 2	6.5×10^{-4}	6.7×10^{-4}	—	—	6.7×10^{-6}	6.9×10^{-6}
2	Case 1	0.0035	0.0036	—	—	—	—
	Case 2	0.014	0.014	—	—	—	—
3	Case 1	0.010	0.011	—	—	0.0061	0.0063
	Case 2	0.010	0.011	—	—	0.0061	0.0063
4	Case 1	d	d	—	—	—	—
	Case 2	d	d	—	—	—	—
5	Case 1	0.0046	0.0047	—	—	2.2×10^{-6}	2.3×10^{-6}
	Case 2	0.0047	0.0049	—	—	2.2×10^{-6}	2.3×10^{-6}
6 & 10	Case 1	4.4×10^{-7}	4.6×10^{-7}	—	—	—	—
	Case 2	1.6×10^{-6}	1.7×10^{-6}	—	—	—	—
7	Case 1	0.0010	0.0011	—	—	—	—
	Case 2	0.0030	0.0031	—	—	—	—
8	Case 1	0.12	0.13	—	—	—	—
	Case 2	0.12	0.13	—	—	—	—
9	Case 1	2.6×10^{-5}	2.7×10^{-5}	—	—	—	—
	Case 2	2.6×10^{-5}	2.7×10^{-5}	—	—	—	—
Total	Case 1	0.14	0.15	—	—	0.0061	0.0063
	Case 2	0.16	0.16	—	—	0.0061	0.0063

Table H-7. Doses and Health Effects from the Incident-Free Transport of Radioactive and Industrial Material by Rail (Continued)

		Alternative I (Removal)		Alternative II (On-Premises Storage)		Alternative III (In-Place Stabilization)	
WMA		Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site
Annual Public Cancer Fatalities from Transport of Radioactive Material							
1	Case 1	2.1×10^{-4}	1.8×10^{-4}	—	—	1.3×10^{-6}	1.2×10^{-6}
	Case 2	2.1×10^{-4}	1.8×10^{-4}	—	—	1.3×10^{-6}	1.2×10^{-6}
2	Case 1	0.0067	0.0059	—	—	—	—
	Case 2	0.026	0.023	—	—	—	—
3	Case 1	0.0055	0.0048	—	—	0.0026	0.0022
	Case 2	0.0055	0.0048	—	—	0.0026	0.0022
4	Case 1	d	d	—	—	—	—
	Case 2	d	d	—	—	—	—
5	Case 1	0.011	0.0097	—	—	5.4×10^{-6}	4.7×10^{-6}
	Case 2	0.011	0.0099	—	—	5.4×10^{-6}	4.7×10^{-6}
6 & 10	Case 1	4.6×10^{-7}	4.0×10^{-7}	—	—	—	—
	Case 2	1.7×10^{-6}	1.5×10^{-6}	—	—	—	—
7	Case 1	4.3×10^{-4}	3.8×10^{-4}	—	—	—	—
	Case 2	0.0013	0.0011	—	—	—	—
8	Case 1	0.026	0.023	—	—	—	—
	Case 2	0.026	0.023	—	—	—	—
9	Case 1	2.9×10^{-5}	2.6×10^{-5}	—	—	—	—
	Case 2	2.9×10^{-5}	2.6×10^{-5}	—	—	—	—
Total	Case 1	0.050	0.043	—	—	0.0026	0.0022
	Case 2	0.070	0.062	—	—	0.0026	0.0022

Table H-7. Doses and Health Effects from the Incident-Free Transport of Radioactive and Industrial Material by Rail (Continued)

		Alternative I (Removal)		Alternative II (On-Premises Storage)		Alternative III (In-Place Stabilization)	
WMA		Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site
Cumulative Public Cancer Fatalities from Transport of Radioactive Material							
1	Case 1	0.0031	0.0028	—	—	3.2×10^{-5}	2.8×10^{-5}
	Case 2	0.0031	0.0028	—	—	3.2×10^{-5}	2.8×10^{-5}
2	Case 1	0.017	0.015	—	—	—	—
	Case 2	0.065	0.057	—	—	—	—
3	Case 1	0.050	0.044	—	—	0.029	0.026
	Case 2	0.050	0.044	—	—	0.029	0.026
4	Case 1	d	d	—	—	—	—
	Case 2	d	d	—	—	—	—
5	Case 1	0.022	0.019	—	—	1.1×10^{-5}	9.4×10^{-6}
	Case 2	0.023	0.020	—	—	1.1×10^{-5}	9.4×10^{-6}
6 & 10	Case 1	2.1×10^{-6}	1.9×10^{-6}	—	—	—	—
	Case 2	7.9×10^{-6}	6.9×10^{-6}	—	—	—	—
7	Case 1	0.0050	0.0044	—	—	—	—
	Case 2	0.015	0.013	—	—	—	—
8	Case 1	0.59	0.52	—	—	—	—
	Case 2	0.59	0.52	—	—	—	—
9	Case 1	1.3×10^{-4}	1.1×10^{-4}	—	—	—	—
	Case 2	1.3×10^{-4}	1.1×10^{-4}	—	—	—	—
Total	Case 1	0.69	0.60	—	—	0.029	0.026
	Case 2	0.75	0.66	—	—	0.029	0.026

Table H-7. **Doses and Health Effects from the Incident-Free Transport of Radioactive and Industrial Material by Rail (Continued)**

WMA		Alternative I (Removal) Hanford Site	Alternative I (Removal) Nevada Test Site	Alternative II (On-Premises Storage) Hanford Site	Alternative II (On-Premises Storage) Nevada Test Site	Alternative III (In-Place Stabilization) Hanford Site	Alternative III (In-Place Stabilization) Nevada Test Site
Cumulative Cancer Fatalities from Emissions from Transport of Radioactive Material							
1	Case 1	0.0300	0.0210	—	—	0.0004	0.0003
	Case 2	0.0320	0.0230	—	—	0.0004	0.0003
2	Case 1	0.0460	0.0330	—	—	—	—
	Case 2	0.1800	0.1300	—	—	—	—
3	Case 1	0.0130	0.0092	—	—	0.0055	0.0039
	Case 2	0.0130	0.0092	—	—	0.0055	0.0039
4	Case 1	d	d	—	—	—	—
	Case 2	d	d	—	—	—	—
5	Case 1	0.0300	0.0210	—	—	0.0007	0.0005
	Case 2	0.0680	0.0490	—	—	0.0007	0.0005
6 & 10	Case 1	0.0002	0.0001	—	—	—	—
	Case 2	0.0006	0.0004	—	—	—	—
7	Case 1	0.1400	0.0970	—	—	—	—
	Case 2	0.2900	0.2000	—	—	—	—
8	Case 1	0.1900	0.1400	—	—	—	—
	Case 2	0.4200	0.3000	—	—	—	—
9	Case 1	0.0390	0.0280	—	—	—	—
	Case 2	0.0390	0.0280	—	—	—	—
Total	Case 1	0.4882	0.3493	—	—	0.0066	0.0047
	Case 2	1.0426	0.7396	—	—	0.0066	0.0047

Table H-7. **Doses and Health Effects from the Incident-Free Transport of Industrial Radioactive and Material by Rail (Continued)**

WMA		Alternative I (Removal) Hanford Site	Alternative I (Removal) Nevada Test Site	Alternative II (On-Premises Storage) Hanford Site	Alternative II (On-Premises Storage) Nevada Test Site	Alternative III (In-Place Stabilization) Hanford Site	Alternative III (In-Place Stabilization) Nevada Test Site
Cumulative Cancer Fatalities from Emissions from Transport of Industrial Material							
1	Case 1	0.2000	0.2000	0.2000	0.2000	0.0083	0.0083
	Case 2	0.2000	0.2000	0.2000	0.2000	0.0083	0.0083
2	Case 1	0.0110	0.0110	0.0110	0.0110	0.0040	0.0040
	Case 2	0.0110	0.0110	0.0110	0.0110	0.0040	0.0040
3	Case 1	0.1400	0.1400	0.1400	0.1400	0.0140	0.0140
	Case 2	0.1400	0.1400	0.1400	0.1400	0.0140	0.0140
4	Case 1	0.0970	0.0970	0.0970	0.0970	0.0120	0.0120
	Case 2	0.0970	0.0970	0.0970	0.0970	0.0120	0.0120
5	Case 1	0.0180	0.0180	0.0180	0.0180	0.0180	0.0180
	Case 2	0.0180	0.0180	0.0180	0.0180	0.0180	0.0180
6 & 10	Case 1	0.5700	0.5700	0.3700	0.3700	0.5200	0.5200
	Case 2	0.5700	0.5700	0.3700	0.3700	0.5200	0.5200
7	Case 1	0.0390	0.0390	0.0390	0.0390	0.0055	0.0055
	Case 2	0.0390	0.0390	0.0390	0.0390	0.0055	0.0055
8	Case 1	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017
	Case 2	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017
9	Case 1	0.0840	0.0840	0.0840	0.0840	0.0008	0.0008
	Case 2	0.0840	0.0840	0.0840	0.0840	0.0008	0.0008
Total	Case 1	1.1607	1.1607	0.9607	0.9607	0.5843	0.5843
	Case 2	1.1607	1.1607	0.9607	0.9607	0.5843	0.5843

Table H-7. **Doses and Health Effects from the Incident-Free Transport of Radioactive and Industrial Material by Rail (Continued)**

WMA		Alternative I (Removal) Hanford Site	Alternative I (Removal) Nevada Test Site	Alternative II (On-Premises Storage) Hanford Site	Alternative II (On-Premises Storage) Nevada Test Site	Alternative III (In-Place Stabilization) Hanford Site	Alternative III (In-Place Stabilization) Nevada Test Site
Annual Occupational Collective Dose from Transport of Radioactive Material (person-rem/yr)							
1	Case 1	0.11	0.11	—	—	7.0×10^{-4}	7.2×10^{-4}
	Case 2	0.11	0.11	—	—	7.0×10^{-4}	7.2×10^{-4}
2	Case 1	3.5	3.6	—	—	—	—
	Case 2	14	14	—	—	—	—
3	Case 1	2.9	3.0	—	—	1.3	1.4
	Case 2	2.9	3.0	—	—	1.3	1.4
4	Case 1	d	d	—	—	—	—
	Case 2	d	d	—	—	—	—
5	Case 1	5.7	5.9	—	—	0.0028	0.0029
	Case 2	5.9	6.1	—	—	0.0028	0.0029
6 & 10	Case 1	2.4×10^{-4}	2.5×10^{-4}	—	—	—	—
	Case 2	8.7×10^{-4}	9.1×10^{-4}	—	—	—	—
7	Case 1	0.22	0.23	—	—	—	—
	Case 2	0.66	0.68	—	—	—	—
8	Case 1	13	14	—	—	—	—
	Case 2	13	14	—	—	—	—
9	Case 1	0.015	0.016	—	—	—	—
	Case 2	0.015	0.016	—	—	—	—
Total	Case 1	26	27	—	—	1.3	1.4

a. Case 1 = radioactively contaminated soil is treated.
b. — = radioactive waste may be generated but would not be shipped off-site, so there would be no dose or health effects.
c. Case 2 = all radioactively contaminated soil remains contaminated after soil treatment.
d. Values for WMA 4 are included in those for WMA 2, because WMA 4 contains some of the contaminated groundwater plume from the north plateau.

For Alternative II, no radioactive material was shipped. The shipment of industrial (nonradioactive) material by truck was estimated to result in 0.31 nonradiological fatalities per year.

For Alternative III, the shipment of radioactive material by truck was estimated to result in 0.0023 to 0.0024 cancer fatalities per year for workers. For the general population, the shipment of radioactive material by truck was estimated to result in 0.031 to 0.033 cancer fatalities per year. The estimated number of nonradiological fatalities was 0.20.

For Alternative I, the shipment of radioactive material by rail was estimated to result in 0.010 to 0.011 cancer fatalities per year for workers (with soil treatment) and 0.015 cancer fatalities per year for workers (without soil treatment). For the general population, the shipment of radioactive material by rail was estimated to result in 0.043 to 0.050 cancer fatalities per year (with soil treatment) and 0.062 to 0.070 cancer fatalities per year (without soil treatment). The estimated number of annual nonradiological fatalities was 0.30 to 0.32 (with soil treatment) and 0.37 to 0.42 (without soil treatment).

For Alternative II, no radioactive material was shipped. The shipment of industrial (nonradioactive) material by rail was estimated to result in 0.28 nonradiological fatalities (with or without soil treatment).

For Alternative III, the shipment of all radioactive and industrial (nonradioactive) material by rail was estimated to result in 0.00053 to 0.00055 cancer fatalities per year for workers (with or without soil treatment). For the general population, the shipment of radioactive and industrial (nonradioactive) material by rail was estimated to result in 0.0022 to 0.0026 cancer fatalities per year (with or without soil treatment). The estimated number of nonradiological fatalities was 0.18 (with or without soil treatment).

For Alternative I, the shipment of radioactive material by truck was estimated to result in an occupational dose to the maximally exposed individual of 4 rem/yr (with or without soil treatment). For the general population, the shipment of radioactive material by truck was estimated to result in a maximally exposed individual dose of 0.097 rem/yr (with soil treatment) or 0.13 rem/yr (without soil treatment).

For Alternative II, no radioactive material was shipped. For Alternative III, the shipment of radioactive material by truck was estimated to result in an occupational dose to the maximally exposed individual of 4 rem/yr (with or without soil treatment). For the general population, the shipment of radioactive material by truck was estimated to result in a maximally exposed individual dose of 0.0091 rem/yr (with or without soil treatment).

For Alternative I, the shipment of radioactive material by rail was estimated to result in an occupational dose to the maximally exposed individual of 0.53 rem/yr (with soil treatment) or 0.73 rem/yr (without soil treatment). For the general population, the shipment of radioactive material by rail was estimated to result in a maximally exposed individual dose of 0.26 rem/yr (with soil treatment) or 0.36 rem/yr (without soil treatment).

For Alternative II, no radioactive material would be disposed of. For Alternative III, the shipment of all radioactive material by rail was estimated to result in an occupational dose to the maximally exposed individual of 0.035 rem/yr (with or without soil treatment). For the general population, the shipment of all radioactive material by truck was estimated to result in a maximally exposed individual dose of 0.017 rem/yr (with or without soil treatment).

H.5 TRANSPORTATION ACCIDENT RISKS AND MAXIMUM REASONABLY FORESEEABLE CONSEQUENCES

H.5.1 Methodology

The off-site transportation accident analysis examines the impact of accidents during the transportation of waste by truck or rail. Under accident conditions, impacts to human health and the environment could result from the release and dispersal of radioactive material. Transportation accident impacts have been assessed by using accident analysis methodology developed by the NRC. This section overviews the methodology; detailed description is found in the referenced report (NRC 1977). Accidents that could potentially breach the shipping container are represented by a spectrum of accident severities and radioactive release conditions. Historically, most transportation accidents involving radioactive materials have resulted in little or no release of radioactive material from the shipping container. Consequently, the analysis of accident risks takes into account a spectrum of accidents ranging from high-probability accidents of low severity to hypothetical high-severity accidents that have a correspondingly low probability of occurrence. The accident analysis calculates the probabilities and consequences from this spectrum of accidents.

Two types of analyses were performed in order to assess radioactive waste transportation accident impacts. First, an accident risk assessment took into account the probabilities and consequences of a spectrum of potential accident severities by using methodology developed by the NRC (NRC 1977). For the spectrum of accidents considered in the analysis, accident consequences in terms of collective dose to the population within 80 km (50 mi) were multiplied by the accident probabilities to yield collective dose risk by using the RADTRAN 4 computer code (Neuhauser and Kanipe 1992). Second, radiological consequences were calculated for an accident of maximum credible severity in each population zone in order to represent the maximum reasonably foreseeable impacts to individuals and populations should an accident occur. An accident is considered credible if its probability of occurrence is greater than 1×10^{-7} per year. The accident consequence assessment for maximally exposed individuals and population groups was performed by using the RISKIND computer code (Yuan et al. 1993).

The impacts for specific alternatives were calculated in units of dose (person-rem). Impacts are further expressed as health risks in terms of estimated latent cancer fatalities in exposed populations. The health risk conversion factors used were derived from International Commission on Radiological Protection (ICRP) Publication 60 (ICRP 1991).

H.5.1.1 Accident Rates

For calculating accident shipment-risk factors, national average accident rates were taken from data in Saricks and Kvitek (1994) for heavy combination trucks and rails. For truck transportation, separate accident rates were used for rural, suburban, and urban population density zones and accident fatality risks were based on national rates for interstate highways in urban and rural areas (Saricks and Kvitek 1994). For rail transportation, one average accident rate was used, and accident fatality risks were calculated on the basis of a national average rate of 2.64×10^{-8} fatalities per rail-kilometer (Cashwell 1986).

H.5.1.2 Accident Severity Categories and Conditional Probabilities

Accident severity categories for potential radioactive waste transportation accidents are described in two NRC reports: NUREG-0170 (NRC 1977) for radioactive waste in general, and a report commonly referred to as the Modal Study (Fischer et al. 1987) for spent nuclear fuel. The Modal Study represents a refinement of the NUREG-0170 methodology, with application to spent nuclear fuel transportation only. However, because the transportation of spent nuclear fuel is outside the scope of this EIS, the discussion of accident severity categories presented here focuses on the NUREG-0170 classification scheme.

The NUREG-0170 accident severity classification schemes for truck and rail transportation is shown in Figure H-1. Severity is described as a function of the magnitudes of the mechanical forces (impact) and thermal forces (fire) to which a shipping container may be subjected during an accident. Because all accidents can be described in these terms, severity is independent of the specific accident sequence. In other words, a sequence of events resulting in an accident in which a shipping container is subjected to forces within a certain range of values is assigned to the accident severity category in that range. The accident severity scheme is designed to take into account credible transportation accidents, including accidents with low probability but high consequences and those with high probability but low consequences.

The accident severity categories represent a set of scenarios defined by a combination of mechanical and thermal forces. A conditional probability is assigned in each category as shown in Table H-8. For example, Category I accidents are the least severe but most frequent, whereas Category VIII accidents are very severe but very infrequent. The product of the severity category conditional probability and the baseline accident rate represents the expected frequency of each accident severity category. Each population density zone has a distinct baseline accident rate and distribution of accident severities related to differences in average vehicle velocity, traffic density, and other factors, including rural, suburban, or urban location.

For the accident risk assessment, accident risk was generically defined as the product of the consequences of an accident and the probability of the occurrence of that accident, an approach consistent with the methodology used by the RADTRAN 4 computer code. The

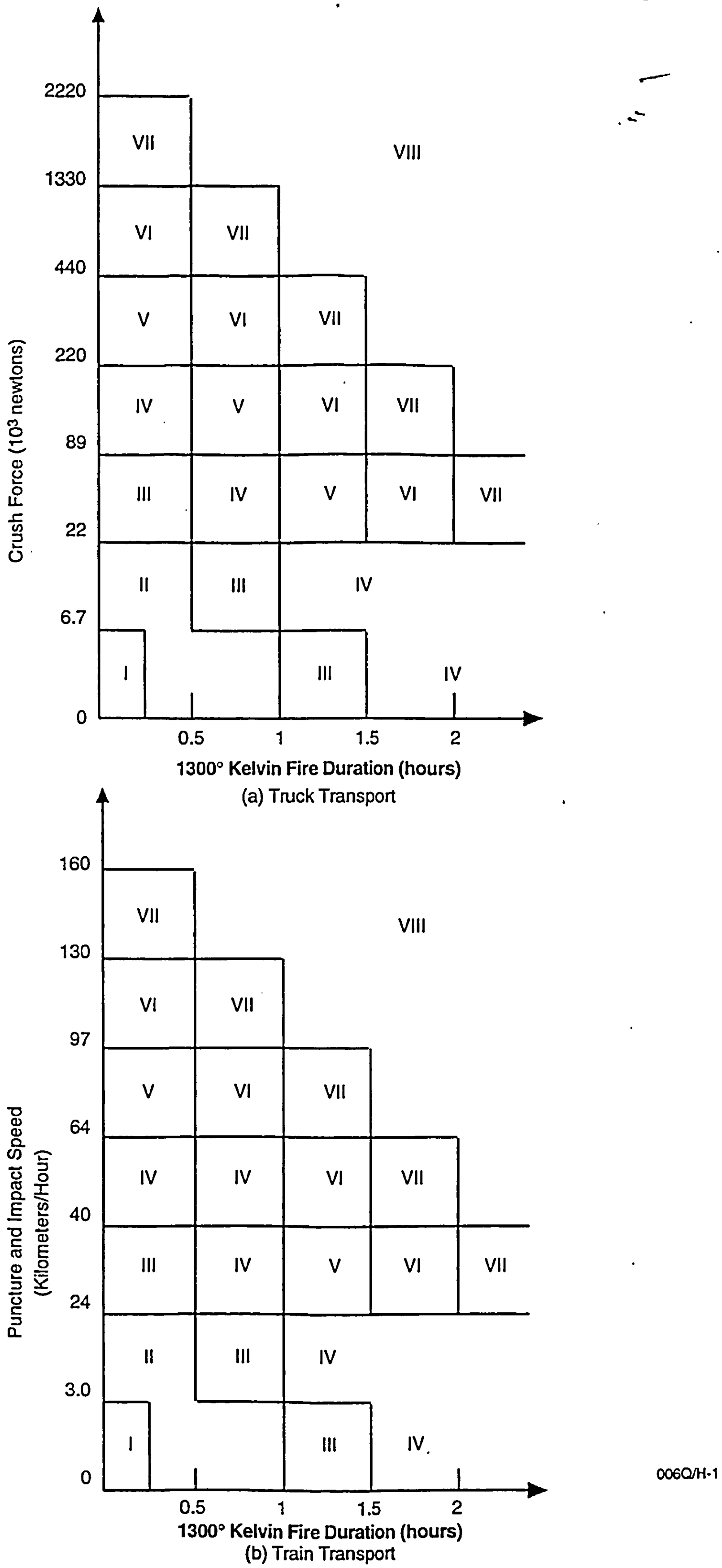

Figure H-1. Accident Severity Category Classification for (a) Truck Transport and (b) Rail Transport (modified from NRC 1977).

Table H-8. Fraction of Truck and Rail Accidents Expected within Each Severity Category, Assuming an Accident Occurs[a]

Severity Category	Population Zone		
	Rural	Suburban	Urban
Truck			
I	0.462	0.435	0.583
II	0.302	0.285	0.382
III	0.176	0.221	0.0278
IV	0.0403	0.0506	0.00636
V	0.0118	0.00664	7.42×10^{-4}
VI	0.00647	0.00174	1.46×10^{-4}
VII	5.71×10^{-4}	6.72×10^{-5}	1.13×10^{-5}
VIII	1.13×10^{-4}	5.93×10^{-6}	9.94×10^{-7}
Rail			
I	0.666	0.313	0.572
II	0.241	0.188	0.343
III	0.384	0.451	0.0772
IV	0.0384	0.0451	0.00772
V	0.0064	0.00338	5.14×10^{-4}
VI	6.50×10^{-4}	1.60×10^{-4}	1.86×10^{-5}
VII	3.42×10^{-4}	3.76×10^{-5}	8.57×10^{-6}
VII	6.41×10^{-5}	3.13×10^{-6}	7.15×10^{-7}

a. The accident severity fractions were derived from NUREG-0170 (NRC 1977).

RADTRAN 4 code sums the product of consequences and probability over the eight accident severity categories to obtain a probability-weighted risk value referred to in this appendix as dose risk, which is expressed in units of person-rem. This methodology calculated unit risk factors on the basis of one curie of a radionuclide for each origin-destination pair, each shipping container type, and each transport mode. The unit risk factors were input to a spreadsheet containing the radionuclide inventory for each waste category and shipping container type to yield shipment risk factors. Multiplying the shipment risk factors by the number of shipments yields the total accident risk for the shipping campaign.

These results do not give information on the magnitude of accident consequences should an accident actually occur. To develop this information, calculations were also performed to assess the consequences of maximum reasonably foreseeable accidents. Maximum consequence doses were calculated for populations and individuals on the assumption of the most severe accident scenario with a probability greater than 1 x 10^{-7} per year. In terms of the radioactivity released to the environment, the most severe credible accident could be represented by one or more of the eight accident severity categories. That is, depending on the type of shipping container, the maximum release of radioactivity may occur in more than one severity category. For example, with a Type A container, accident severity categories IV through VIII result in the same total release of radioactive material. However, each accident severity category has a different probability of occurrence. That is, the maximum reasonably foreseeable accident has consequences based on the maximum release scenario, but the probability of the accident is the sum of the probabilities for accident severity categories IV through VIII. Accidents of this severity are extremely rare, occurring approximately once per 100,000 truck or 10,000 rail accidents involving a radioactive waste shipment.

H.5.1.3 Atmospheric Conditions

Because it is impossible to predict the specific location of an off-site transportation accident, generic atmospheric conditions were selected for the risk and consequence assessments. On the basis of observations from National Weather Service surface meteorological stations at over 300 locations in the United States, on an annual average, neutral conditions (Pasquill Class C and D) occur 50 percent of the time, and stable (Pasquill Class E and F) and unstable (Pasquill Class A and B) conditions occur 33 percent and 17 percent of the time, respectively (Doty et al. 1976). The neutral category predominates in each season, but most frequently in the winter (nearly 60 percent of the observations).

For accident risk assessment, neutral weather conditions (Pasquill Stability Class D) were assumed because neutral meteorological conditions compose the most frequently occurring atmospheric stability condition in the United States and are thus most likely to be present in the event of an accident involving a radioactive waste shipment. Neutral weather conditions are typified by moderate windspeeds, vertical mixing within the atmosphere, and good dispersion of atmospheric contaminants. Stable weather conditions are typified by low windspeeds, very little vertical mixing within the atmosphere, and poor dispersion of atmospheric contaminants.

For the accident consequence assessment, doses were assessed under both neutral (Class D with 4 m/s [13 ft/s] windspeed) and stable (Class F with 1 m/s [3.3 ft/s] windspeed) atmospheric conditions. Such stable Class F conditions generally occur no more than 5 percent of the time. Results calculated for neutral conditions represent the most likely consequences, and the results for stable conditions represent a worst-case weather situation.

H.5.1.4 Population Density Zones

Three population density zones (rural, suburban, and urban) were used for the off-site population risk assessment. These zones respectively correspond to mean population densities of 6, 719, and 3,861 persons/km^2 (16, 1,862 and 10,000 persons/mi^2), respectively (Neuhauser and Kanipe 1992). The three population density zones are based on an aggregation of the 12 population density zones given in the HIGHWAY and INTERLINE output.

H.5.1.5 Exposure Pathways

Radiological doses were calculated for an individual located near the scene of the accident and for populations within 80 km (50 mi) of the accident. Rural, suburban, and urban population densities were assessed. Dose calculations considered a variety of exposure pathways, including inhalation and direct exposure (cloudshine) from a passing cloud of radiological contaminants, ingestion from contaminated crops, direct exposure (groundshine) from radioactivity deposited on the ground, and inhalation of radioactive dust particles.

H.5.1.6 Health Risk Conversion Factors

The health risk conversion factors used to estimate latent cancer fatalities from radiological exposures were derived from ICRP Publication 60 (ICRP 1991) for exposures of less than 20 rem: 5.0×10^{-4} and 4.0×10^{-4} latent fatal cancer cases per person-rem for members of the public and workers, respectively. Although latent cancer fatalities are the predominant health risk from low-level radiation doses (i.e., doses below the thresholds for acute effects), they are not the only potential detrimental health effects; others include non-fatal cancers and hereditary effects. The total risk of detrimental health effects are estimated as 7.3×10^{-4} and 5.6×10^{-4} total detrimental health effects per person-rem for members of the public and workers, respectively.

H.5.2 Waste Characterization and Radioactive Release Characteristics

H.5.2.1 Characterization of Radioactive Wastes

Radioactive wastes have been identified in nine of the WMAs for evaluation of off site transportation impacts under Alternatives I, II, and III. Characterization data for these wastes were derived from waste characterization reports cited within this appendix. To expedite the transportation analysis, reported radionuclide distributions were limited to those radionuclides that account for at least 95 percent of the total dose from accidental release to the environment. Thus, waste categories are represented by various combinations of the following eight radionuclides and radionuclide parent/daughter pairs: cobalt-60, strontium/yttrium-90, cesium-137/barium-137m, plutonium-238, plutonium-239, plutonium-240, plutonium-241, and americium-241. Also, similar waste categories were combined where possible to further simplify the analysis. When waste categories were combined, the combined waste category was assigned the highest radioactivity concentration (based on curies per cubic foot of waste) from among the individual waste categories combined to preserve conservatism in the analysis.

The individual waste categories by WMA are listed in Table H-2. A unique identification code was assigned to each waste category within a WMA. The table also gives a brief description of the waste, waste volume, estimated void fraction, cesium-137 concentration (the major contributor to incident-free impacts), and reference sources for radionuclide data. The representative shipping container inventories estimated for each waste category are shown in Tables H-9 through H-14. Section H.3.2 of this appendix discusses the methodology used to assign appropriate shipping containers to the various waste categories.

Table H-9. Representative Radionuclide Inventories for Wastes Shipped in 55-Gallon Drums

55-Gallon Drums - Ci per Container										
Nuclide	WMA 2 WC-9	WMA 5 WC-1a/2a	WMA 7 WC-1j	WMA 7 WC-2	WMA 7 WC-3g	WMA 7 WC-4	WMA 7 WC-5	WMA 8 WC-1a-b/ 1e-j	WMA 8 WC-2b	WMA 8 WC-5
Co-60	0.00	0.00	2.63×10^{-5}	6.87×10^{-6}	2.35×10^{-5}	6.58×10^{-6}	9.69×10^{-6}	0.00258	0.078	4.57×10^{-6}
Sr/Y-90	3.9×10^{-4}	0.00437	0.0175	0.00343	0.0156	0.00395	1.60×10^{-4}	0.129	0.155	6.62×10^{-5}
Cs-137	0.0124	0.00460	0.0175	0.00343	0.0156	0.00395	1.78×10^{-4}	0.103	0.155	7.37×10^{-5}
Pu-238	1.27×10^{-4}	2.25×10^{-4}	8.76×10^{-4}	3.43×10^{-4}	7.83×10^{-4}	2.63×10^{-4}	8.90×10^{-4}	5.15×10^{-4}	7.76×10^{-4}	3.68×10^{-4}
Pu-239	6.47×10^{-5}	5.98×10^{-5}	2.63×10^{-4}	6.87×10^{-5}	2.35×10^{-4}	6.58×10^{-5}	1.78×10^{-6}	1.29×10^{-4}	3.88×10^{-4}	7.33×10^{-7}
Pu-240	0.00	4.55×10^{-5}	1.75×10^{-4}	5.15×10^{-5}	1.56×10^{-4}	5.26×10^{-5}	1.78×10^{-6}	1.03×10^{-4}	1.94×10^{-6}	7.33×10^{-7}
Pu-241	0.00479	0.00304	0.00701	0.00172	0.00627	0.00132	1.78×10^{-5}	0.00155	0.00194	7.33×10^{-6}
Am-241	6.76×10^{-5}	0.00	2.63×10^{-4}	6.87×10^{-5}	2.35×10^{-4}	7.88×10^{-5}	1.78×10^{-6}	1.55×10^{-4}	1.94×10^{-4}	7.33×10^{-7}

Table H-10. Representative Radionuclide Inventories for Wastes Shipped in B-96 Boxes

B-96 boxes - Ci per Container											
Nuclide	WMA 1 WC-6	WMA 2 WC-1-3/7	WMA 2 WC-4b-6/8	WMA 2 WC-10	WMA 3 WC-2/4-6	WMA 5 WC-1b	WMA 5 WC-3/4	WMA 8 WC-1c/1d	WMA 8 WC-2a	WMA 8 WC-4d	WMA 6&10 WC-4
Co-60	0.00	9.40×10^{-5}	0.00	6.94×10^{-9}	0.00	0.00	0.00	0.244	1.1	0.108	0.00
Sr/Y-90	7.00×10^{-7}	0.063	0.012	1.47×10^{-4}	0.337	0.037	8.40×10^{-4}	0.271	0.123	2.70×10^{-5}	6.87×10^{-5}
Cs-137	7.37×10^{-7}	0.13	0.013	1.36×10^{-4}	0.337	0.039	8.84×10^{-4}	0.543	2.45	0.0811	7.24×10^{-5}
Pu-238	3.61×10^{-8}	2.20×10^{-4}	1.10×10^{-4}	1.11×10^{-6}	0.00	0.00133	4.33×10^{-5}	0.00	9.80×10^{-6}	0.00	3.55×10^{-6}
Pu-239	9.58×10^{-9}	3.10×10^{-4}	8.90×10^{-5}	9.35×10^{-7}	0.00	3.50×10^{-4}	1.15×10^{-5}	0.00	2.45×10^{-6}	0.00	9.42×10^{-7}
Pu-240	7.29×10^{-9}	2.20×10^{-4}	0.00	0.00	0.00	2.66×10^{-4}	8.75×10^{-6}	0.00	2.45×10^{-6}	0.00	7.17×10^{-7}
Pu-241	4.86×10^{-7}	0.0094	0.0056	5.87×10^{-5}	0.00	0.0182	5.83×10^{-4}	0.00	4.90×10^{-4}	1.89×10^{-6}	4.76×10^{-5}
Am-241	0.00	9.40×10^{-4}	1.10×10^{-4}	1.15×10^{-6}	0.00	0.00	0.00	0.00	4.90×10^{-7}	1.35×10^{-7}	0.00

Table H-11. Representative Radionuclide Inventories for Wastes Shipped in NUPAC 14-210H Casks

NUPAC 14-210H Casks - Ci per Container						
Nuclide	WMA 1 WC-1	WMA 2 WC-4a	WMA 3 WC-7	WMA 5 WC-2b/2c	WMA 9 WC-1	WMA 6&10 WC-1-3
Co-60	0.00	0.00	0.0045	0.00	0.00	0.00
Sr/Y-90	3.99	0.38	54.4	0.12	0.465	5.04
Cs-137	4.20	13.0	58.8	0.12	0.465	5.3
Pu-238	0.206	0.13	0.0707	0.008	0.127	0.26
Pu-239	0.0546	0.067	0.0142	0.00213	0.0337	0.069
Pu-240	0.0416	0.00	0.0104	0.0016	0.0257	0.0525
Pu-241	2.77	4.9	0.609	0.108	1.4	3.5
Am-241	0.00	0.07	0.467	0.00307	0.00	0.00

Table H-12. Representative Radionuclide Inventories for Wastes Shipped in NUPAC 10-142 Casks

NUPAC 10-142 Casks - Ci per Container						
Nuclide	WMA 3 WC-1/3	WMA 3 WC-8	WMA 7 WC-1b[a]	WMA 7 WC-1d/g/h/k	WMA 7 WC-3b/e/f/h	WMA 8 WC-4c
Co-60	0.16	0.07	2.82	0.027	0.024	1,400
Sr/Y-90	1,990	805	564	16.1	14.4	0.4
Cs-137	2,730	870	7,520	16.1	14.4	1,000
Pu-238	2.62	1.05	6.58	1.07	0.958	0.00
Pu-239	0.53	0.21	9.4	0.269	0.24	0.00
Pu-240	0.004	0.15	7.52	0.215	0.192	0.00
Pu-241	8.74	9.03	282	5.37	4.8	0.02
Am-241	16.8	6.91	28.2	0.322	0.288	0.002

a. Waste is classified as reactor fuel elements and is exempt from 10 CFR Part 71.63 requirements for plutonium in excess of 20 curies per package.

Table H-13. Representative Radionuclide Inventories for Wastes Shipped in NUPAC 72B Casks

	NUPAC 72B Casks - Ci per Container				
Nuclide	WMA 1 WC-2/3	WMA 1 WC-4	WMA 3 WC-9	WMA 7 WC-1a/c/e/f	WMA 7 WC-3a/c/d
Co-60	0.00	0.00	3.2	0.009	0.008
Sr/Y-90	1,960	475	27,000	5.06	4.52
Cs-137	2,070	500	29,000	5.06	4.52
Pu-238	101	24	27	7.58	6.77
Pu-239	27	7	6.8	2.53	2.26
Pu-240	20	5	15	1.26	1.13
Pu-241	1,360	330	300	50.6	45.2
Am-241	0.00	0.00	340	0.085	0.076

Table H-14. Representative Radionuclide Inventories for Wastes Shipped in TRUPACT-II Casks

	TRUPACT-II Casks - Ci per Container
Nuclide	WMA 8 WC-4a/b/e-i
Pu-238	52.9
Pu-239	0.16
Pu-240	0.11
Pu-241	1.06
Am-241	0.16

H.5.2.2 Characterization of Non-Radioactive Industrial Wastes

Nonradioactive industrial wastes are included in the transportation accident analysis in order to assess impacts from traffic accidents involving them. For purposes of this analysis, industrial waste is characterized in terms of volume only. The industrial waste volumes by WMA expected to be shipped under Alternatives I, II, and III are summarized in Table H-15.

Table H-15. Industrial Waste Volumes

WMA	Alternative I (ft^3)	Alternative II (ft^3)	Alternative III (ft^3)
1	827,000	827,000	102,000
2	43,000	43,000	15,000
3	457,000	457,000	53,000
4	374,000	374,000	0
5	69,000	69,000	69,000
6 & 10	2,220,000	1,490,000	956,000
7	150,000	150,000	21,000
8	6,500	6,500	6,500
9	320,000	0	3,400
Container Management Area/Wastewater Treatment Area	667,000	667,000	44,200
Erosion	400	400	1,140,000
Total[a]	5,130,000	4,080,000	2,400,000

a. Values in columns may not add up to totals due to rounding.

H.5.2.3 Radioactive Release Characteristics

Radiological consequences were calculated by assigning radionuclide release fractions on the basis of the type of waste, the type of shipping container, and the accident severity category. The release fraction is defined as the fraction of the radioactivity in the container that could be released to the atmosphere in a given severity of accident. Release fractions vary according to waste type and the physical or chemical properties of the radioisotopes. Most solid radionuclides are nonvolatile and are, therefore, relatively nondispersible.

Representative release fractions were developed for each container type on the basis of NRC and DOE reports (NRC 1977; Elder et al. 1986; DOE 1990). For Type A containers (208-L [55-gal] drums, B-96 boxes, NUPAC 14-210H low specific activity casks) and Type B containers such as the NUPAC 10-142 cask, estimates of the fraction of radioactive material released from the shipping container were based on recommended values from NUREG-0170 (NRC 1977). The NUREG-0170 values must be multiplied by an aerosolized fraction to estimate the amount of material dispersed into the atmosphere. For this analysis, an aerosolized fraction of 0.01 was assigned on the basis of the recommendations of Elder et al. (1986) for non-volatile solids. The release fractions used for standard Type A and Type B containers as a function of accident severity category are summarized in Table H-16.

Table H-16. Radioactive Release Fractions for Standard Type A and Type B Containers[a]

Accident Severity Category	Type A Containers		Type B Containers	
	Truck	Rail	Truck	Rail
I	0.00	0.00	0.00	0.00
II	1.0×10^{-4}	1.0×10^{-4}	0.00	0.00
III	0.001	0.001	0.00	0.00
IV	0.01	0.01	0.00	0.00
V	0.01	0.01	0.00	0.00
VI	0.01	0.01	1.0×10^{-4}	1.0×10^{-4}
VII	0.01	0.01	5.0×10^{-4}	5.0×10^{-4}
VIII	0.01	0.01	0.001	0.001

a. Release fraction = fraction released from shipping container times aerosolized fraction (1 percent).

Sources: NUREG-0170 (NRC 1977) and Elder et al. (1986)

Release fractions for contact-handled transuranic wastes shipped in TRUPACT-II casks and remote-handled transuranic wastes shipped in NUPAC 72B casks were developed in the EIS for the Waste Isolation Pilot Plant (DOE 1990). The same release fractions were used in this analysis and are summarized in Table H-17.

Table H-17. Radioactive Release Fractions for TRUPACT-II and NUPAC 72B Shipping Containers

Accident Severity Category	TRUPACT-II		NUPAC 72B	
	Truck	Rail	Truck	Rail
I	0.00	0.00	6.0×10^{-9}	0.00
II	0.00	0.00	2.0×10^{-7}	0.00
III	8.0×10^{-9}	2.0×10^{-8}	6.0×10^{-9}	2.0×10^{-8}
IV	2.0×10^{-7}	7.0×10^{-7}	2.0×10^{-7}	7.0×10^{-7}
V	8.0×10^{-5}	8.0×10^{-5}	1.0×10^{-4}	1.0×10^{-4}
VI	2.0×10^{-4}	2.0×10^{-4}	1.0×10^{-4}	1.0×10^{-4}
VII	2.0×10^{-4}	2.0×10^{-4}	2.0×10^{-4}	2.0×10^{-4}
VIII	2.0×10^{-4}	2.0×10^{-4}	2.0×10^{-4}	2.0×10^{-4}

Source: DOE (1990)

H.5.3 Impacts from Waste Shipments

H.5.3.1 Impacts from Radioactive Waste Shipments

The results of the accident risk assessment for radioactive waste shipments are summarized in Tables H-18 and H-19 for truck and rail, respectively. There is little difference in impacts based on waste destination, i.e., the Hanford Site versus the Nevada Test Site. Risks are marginally lower for transport to Nevada Test Site. Under Alternative I, the probability of a latent cancer fatality as a result of truck transportation accidents ranges from about 0.0013 to 0.0019 per year depending on the waste treatment option selected. The corresponding risk for Alternative III is about 0.00006 per year. The greatest risk from truck transportation is for fatalities from traffic accidents. Under Alternative I, about 0.41 to 0.98 traffic fatality per year would be expected as a result of truck accidents. The corresponding risk for Alternative III is about 0.01 traffic fatality per year.

The probability of a latent cancer fatality as a result of rail transportation accidents ranges from about 0.0002 to 0.0003 per year for Alternative I depending on the waste treatment option selected. The corresponding risk for Alternative III is about 0.000004 per year. As in the case of truck transport, the greater risks are from fatalities from traffic accidents. Under Alternative I, about 0.39 to 1.01 traffic fatality per year would be expected as a result of rail accidents. The corresponding risk for Alternative III is about 0.005 traffic fatality per year.

In the event that an accident occurred, the consequences would be bounded by the results of the maximum reasonably foreseeable transportation accidents summarized in Table H-20. Under Alternative I, the maximum reasonably foreseeable accident in an urban population zone has a probability of 3.05×10^{-7} per year and could result in 41 latent cancer fatalities if the accident occurred with stable weather conditions. The accident involves a rail shipment of remote-handled transuranic waste. The probability of this accident occurring in a suburban population zone is about 1.39×10^{-6} per year and could result in 8 latent cancer fatalities under stable weather conditions. The accident probability for the rural zone is 6.16×10^{-6} per year and the likelihood of a single latent cancer fatality in the exposed population is about 4 out of 10.

Table H-18. Accident Risks in Transporting Radioactive Waste by Truck for Alternatives I (Removal), II (On-Premises Storage) and III (In-Place Stabilization)

		Alternative I (Removal)		Alternative II (On-Premises Storage)		Alternative III (In-Place Stabilization)	
WMA	Treatment[a]	Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site
		General Population Collective Dose (person-rem/yr)					
WMA 1	Case 1	0.354	0.346	NA[b]	NA	2.27 x 10^{-4}	2.20 x 10^{-4}
	Case 2	0.354	0.346	NA	NA	2.27 x 10^{-4}	2.20 x 10^{-4}
WMA 2	Case 1	0.213	0.208	NA	NA	NA	NA
	Case 2	0.822	0.806	NA	NA	NA	NA
WMA 3	Case 1	0.167	0.161	NA	NA	0.118	0.114
	Case 2	0.167	0.161	NA	NA	0.118	0.114
WMA 4	Case 1	c	c	NA	NA	NA	NA
	Case 2	c	c	NA	NA	NA	NA
WMA 5	Case 1	0.096	0.094	NA	NA	1.01 x 10^{-4}	9.92 x 10^{-5}
	Case 2	0.101	0.099	NA	NA	1.01 x 10^{-4}	9.92 x 10^{-5}
WMAs 6 & 10	Case 1	0.006	0.006	NA	NA	NA	NA
	Case 2	0.024	0.023	NA	NA	NA	NA
WMA 7	Case 1	0.162	0.158	NA	NA	NA	NA
	Case 2	0.553	0.540	NA	NA	NA	NA
WMA 8	Case 1	0.413	0.400	NA	NA	NA	NA
	Case 2	0.536	0.521	NA	NA	NA	NA
WMA 9	Case 1	1.15	1.13	NA	NA	NA	NA
	Case 2	1.15	1.13	NA	NA	NA	NA
Totals	Case 1	2.56	2.51	NA	NA	0.119	0.115
	Case 2	3.71	3.63	NA	NA	0.119	0.115

Table H-18. Accident Risks in Transporting Radioactive Waste by Truck for Alternatives I (Removal), II (On-Premises Storage), and III (On-Site Stabilization) (Continued)

		Alternative I (Removal)		Alternative II (On-Premises Storage)		Alternative III (In-Place Stabilization)	
WMA	Treatment[a]	Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site
		Estimated General Population Cancer Fatalities Per Year					
WMA 1	Case 1	1.77×10^{-4}	1.73×10^{-4}	NA	NA	1.14×10^{-7}	1.10×10^{-7}
	Case 2	1.77×10^{-4}	1.73×10^{-4}	NA	NA	1.14×10^{-7}	1.10×10^{-7}
WMA 2	Case 1	1.07×10^{-4}	1.04×10^{-4}	NA	NA	NA	NA
	Case 2	4.11×10^{-4}	4.03×10^{-4}	NA	NA	NA	NA
WMA 3	Case 1	8.35×10^{-5}	8.05×10^{-5}	NA	NA	5.90×10^{-5}	5.70×10^{-5}
	Case 2	8.35×10^{-5}	8.05×10^{-5}	NA	NA	5.90×10^{-5}	5.70×10^{-5}
WMA 4	Case 1	c	c	NA	NA	NA	NA
	Case 2	c	c	NA	NA	NA	NA
WMA 5	Case 1	4.80×10^{-5}	4.70×10^{-5}	NA	NA	5.05×10^{-8}	4.96×10^{-8}
	Case 2	5.05×10^{-5}	4.95×10^{-5}	NA	NA	5.05×10^{-8}	4.96×10^{-8}
WMAs 6 & 10	Case 1	3.00×10^{-6}	3.00×10^{-6}	NA	NA	NA	NA
	Case 2	1.20×10^{-5}	1.15×10^{-5}	NA	NA	NA	NA
WMA 7	Case 1	8.10×10^{-5}	7.90×10^{-5}	NA	NA	NA	NA
	Case 2	2.77×10^{-4}	2.70×10^{-4}	NA	NA	NA	NA
WMA 8	Case 1	2.07×10^{-4}	2.00×10^{-4}	NA	NA	NA	NA
	Case 2	2.68×10^{-4}	2.61×10^{-4}	NA	NA	NA	NA
WMA 9	Case 1	5.75×10^{-4}	5.65×10^{-4}	NA	NA	NA	NA
	Case 2	5.75×10^{-4}	5.65×10^{-4}	NA	NA	NA	NA
Total	Case 1	1.28×10^{-3}	1.26×10^{-3}	NA	NA	5.95×10^{-5}	5.75×10^{-5}
	Case 2	1.86×10^{-3}	1.82×10^{-3}	NA	NA	5.95×10^{-5}	5.75×10^{-5}

Table H-18. Accident Risks in Transporting Radioactive Waste by Truck for Alternatives I (Removal), II (On-Premises Storage), and III (On-Site Stabilization) (Continued)

WMA	Treatment[a]	Alternative I (Removal) Hanford Site	Alternative I (Removal) Nevada Test Site	Alternative II (On-Premises Storage) Hanford Site	Alternative II (On-Premises Storage) Nevada Test Site	Alternative III (In-Place Stabilization) Hanford Site	Alternative III (In-Place Stabilization) Nevada Test Site
		Estimated Traffic Accident Fatalities Per Year					
WMA 1	Case 1	0.017	0.016	NA	NA	1.33×10^{-4}	1.23×10^{-4}
	Case 2	0.018	0.017	NA	NA	1.33×10^{-4}	1.23×10^{-4}
WMA 2	Case 1	0.102	0.095	NA	NA	NA	NA
	Case 2	0.403	0.375	NA	NA	NA	NA
WMA 3	Case 1	0.011	0.010	NA	NA	0.004	0.004
	Case 2	0.011	0.010	NA	NA	0.004	0.004
WMA 4	Case 1	c	c	NA	NA	NA	NA
	Case 2	c	c	NA	NA	NA	NA
WMA 5	Case 1	0.084	0.078	NA	NA	0.002	0.002
	Case 2	0.184	0.172	NA	NA	0.002	0.002
WMAs 6 & 10	Case 1	2.04×10^{-4}	1.90×10^{-4}	NA	NA	NA	NA
	Case 2	8.85×10^{-4}	8.24×10^{-4}	NA	NA	NA	NA
WMA 7	Case 1	0.091	0.085	NA	NA	NA	NA
	Case 2	0.173	0.161	NA	NA	NA	NA
WMA 8	Case 1	0.051	0.048	NA	NA	NA	NA
	Case 2	0.113	0.105	NA	NA	NA	NA
WMA 9	Case 1	0.080	0.075	NA	NA	NA	NA
	Case 2	0.080	0.075	NA	NA	NA	NA
Totals	Case 1	0.437	0.407	NA	NA	0.006	0.006
	Case 2	0.984	0.916	NA	NA	0.006	0.006

a. Case 1 = contaminated soil is treated.
Case 2 = contaminated soil remains contaminated after soil treatment.
b. NA = Not applicable because radioactive waste would not be transported off site.
c. Values for WMA 4 are included in those for WMA 2, because WMA 4 contains some of the contaminated groundwater plume from the north plateau.

Table H-19. Accident Risks in Transporting Radioactive Waste by Rail for Alternatives I (Removal), II (On-Premises Storage), and III (In-Place Stabilization)

		Alternative I (Removal)		Alternative II (On-Premises Storage)		Alternative III (In-Place Stabilization)	
WMA	Treatment[a]	Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site
General Population Collective Dose (person-rem/yr)							
WMA 1	Case 1	0.059	0.051	NA	NA	1.59×10^{-5}	1.37×10^{-5}
	Case 2	0.059	0.051	NA	NA	1.59×10^{-5}	1.37×10^{-5}
WMA 2	Case 1	0.038	0.032	NA	NA	NA	NA
	Case 2	0.144	0.124	NA	NA	NA	NA
WMA 3	Case 1	0.012	0.011	NA	NA	0.008	0.007
	Case 2	0.012	0.011	NA	NA	0.008	0.007
WMA 4	Case 1	c	c	NA	NA	NA	NA
	Case 2	c	c	NA	NA	NA	NA
WMA 5	Case 1	0.017	0.014	NA	NA	1.75×10^{-5}	1.51×10^{-5}
	Case 2	0.018	0.015	NA	NA	1.75×10^{-5}	1.51×10^{-5}
WMAs 6 & 10	Case 1	0.001	0.001	NA	NA	NA	NA
	Case 2	0.004	0.004	NA	NA	NA	NA
WMA 7	Case 1	0.026	0.022	NA	NA	NA	NA
	Case 2	0.094	0.081	NA	NA	NA	NA
WMA 8	Case 1	0.070	0.061	NA	NA	NA	NA
	Case 2	0.091	0.079	NA	NA	NA	NA
WMA 9	Case 1	0.202	0.174	NA	NA	NA	NA
	Case 2	0.202	0.174	NA	NA	NA	NA
Total	Case 1	0.424	0.366	NA	NA	0.008	0.007
	Case 2	0.625	0.539	NA	NA	0.008	0.007

Table H-19. Accident Risks in Transporting Radioactive Waste by Rail for Alternatives I (Removal), II (On-Premises Storage), and III (In-Place Stabilization) (Continued)

		Alternative I (Removal)		Alternative II (On-Premises Storage)		Alternative III (In-Place Stabilization)	
WMA	Treatment[a]	Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site
Estimated General Population Cancer Fatalities Per Year							
WMA 1	Case 1	2.95×10^{-5}	2.55×10^{-5}	NA	NA	7.95×10^{-9}	6.85×10^{-9}
	Case 2	2.95×10^{-5}	2.55×10^{-5}	NA	NA	7.95×10^{-9}	6.85×10^{-9}
WMA 2	Case 1	1.90×10^{-5}	1.60×10^{-5}	NA	NA	NA	NA
	Case 2	7.20×10^{-5}	6.20×10^{-5}	NA	NA	NA	NA
WMA 3	Case 1	6.00×10^{-6}	5.50×10^{-6}	NA	NA	4.00×10^{-6}	3.50×10^{-6}
	Case 2	6.00×10^{-6}	5.50×10^{-6}	NA	NA	4.00×10^{-6}	3.50×10^{-6}
WMA 4	Case 1	c	c	NA	NA	NA	NA
	Case 2	c	c	NA	NA	NA	NA
WMA 5	Case 1	8.50×10^{-6}	7.00×10^{-6}	NA	NA	8.75×10^{-9}	7.55×10^{-9}
	Case 2	9.00×10^{-6}	7.50×10^{-6}	NA	NA	8.75×10^{-9}	7.55×10^{-9}
WMAs 6 & 10	Case 1	5.00×10^{-7}	5.00×10^{-7}	NA	NA	NA	NA
	Case 2	2.00×10^{-6}	2.00×10^{-6}	NA	NA	NA	NA
WMA 7	Case 1	1.30×10^{-5}	1.10×10^{-5}	NA	NA	NA	NA
	Case 2	4.70×10^{-5}	4.05×10^{-5}	NA	NA	NA	NA
WMA 8	Case 1	3.50×10^{-5}	3.05×10^{-5}	NA	NA	NA	NA
	Case 2	4.55×10^{-5}	3.95×10^{-5}	NA	NA	NA	NA
WMA 9	Case 1	1.01×10^{-4}	8.70×10^{-5}	NA	NA	NA	NA
	Case 2	1.01×10^{-4}	8.70×10^{-5}	NA	NA	NA	NA
Totals	Case 1	2.12×10^{-4}	1.83×10^{-4}	NA	NA	4.00×10^{-6}	3.50×10^{-6}
	Case 2	3.13×10^{-4}	2.70×10^{-4}	NA	NA	4.00×10^{-6}	3.50×10^{-6}

Table H-19. Accident Risks in Transporting Radioactive Waste by Rail for Alternatives I (Removal), II (On-Premises Storage), and III (In-Place Stabilization) (Continued)

		Alternative I (Removal)		Alternative II (On-Premises Storage)		Alternative III (In-Place Stabilization)	
WMA	Treatment[a]	Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site	Hanford Site	Nevada Test Site
		Estimated Traffic Accident Fatalities Per Year					
WMA 1	Case 1	0.012	0.012	NA	NA	9.38×10^{-5}	9.04×10^{-5}
	Case 2	0.013	0.013	NA	NA	9.38×10^{-5}	9.04×10^{-5}
WMA 2	Case 1	0.114	0.110	NA	NA	NA	NA
	Case 2	0.451	0.435	NA	NA	NA	NA
WMA 3	Case 1	0.009	0.009	NA	NA	0.003	0.003
	Case 2	0.009	0.009	NA	NA	0.003	0.003
WMA 4	Case 1	c	c	NA	NA	NA	NA
	Case 2	c	c	NA	NA	NA	NA
WMA 5	Case 1	0.093	0.090	NA	NA	0.002	0.002
	Case 2	0.211	0.204	NA	NA	0.002	0.002
WMAs 6 & 10	Case 1	1.93×10^{-4}	1.86×10^{-4}	NA	NA	NA	NA
	Case 2	7.23×10^{-4}	6.97×10^{-4}	NA	NA	NA	NA
WMA 7	Case 1	0.073	0.070	NA	NA	NA	NA
	Case 2	0.154	0.148	NA	NA	NA	NA
WMA 8	Case 1	0.051	0.050	NA	NA	NA	NA
	Case 2	0.112	0.108	NA	NA	NA	NA
WMA 9	Case 1	0.057	0.055	NA	NA	NA	NA
	Case 2	0.057	0.055	NA	NA	NA	NA
Totals	Case 1	0.409	0.394	NA	NA	0.005	0.005
	Case 2	1.01	0.972	NA	NA	0.005	0.005

a. Case 1 = contaminated soil is treated.
Case 2 = contaminated soil remains contaminated after soil treatment.
b. NA = Not applicable because radioactive waste would not be transported off site.
c. Values for WMA 4 are included in those for WMA 2 because WMA 4 contains some of the contaminated groundwater plume from the north plateau.

Table H-20. Doses and Health Effects for the Maximum Reasonably Foreseeable Radioactive Waste Transportation Accident for Alternatives I (Removal), II (On-Premises Storage), and III (In-Place Stabilization)

	General Population							
	Urban		Suburban		Rural		Maximally Exposed Individual	
Alternative I (Removal)								
Annual Probability	3.05×10^{-7}[a]		1.39×10^{-6}[a]		6.16×10^{-6}[a]		7.71×10^{-6}[a]	
Weather[c]	Neutral	Stable	Neutral	Stable	Neutral	Stable	Neutral	Stable
Dose[d]	10,300	82,500	1,920	15,400	106	851	10	32
LCFs[e]	5	41	1	8	0.05	0.4	0.01	0.02
Alternative II								
(None because there would be no radioactive shipments)								
Alternative III								
Annual Probability	1.82×10^{-6}[b]		8.85×10^{-6}[b]		3.98×10^{-7}[a]		3.98×10^{-7}[a]	
Weather[c]	Neutral	Stable	Neutral	Stable	Neutral	Stable	Neutral	Stable
Dose[d]	0.5	3.7	0.09	0.69	106	851	10	32
LCFs[e]	0.0003	0.0019	0.00005	0.0003	0.05	0.4	0.01	0.02

a. Rail shipment of remote-handled transuranic waste.
b. Rail shipment of contaminated soil.
c. Meteorological conditions at time of accident.
d. Dose in person-rem for the general population; rem for the maximally exposed individual.
e. Estimated latent cancer fatalities (LCFs) based on risk factor of 5.0×10^{-4} LCF/person-rem (ICRP 1991).

For Alternative II, there are no radioactive shipments and, thus, no maximum reasonably foreseeable transportation accident. For Alternative III, the maximum reasonably foreseeable transportation accident for the urban and suburban population zones involves a rail shipment of radioactively contaminated soil. The probability of this accident occurring in an urban population zone is 1.82×10^{-6} per year and the likelihood of a single latent cancer fatality in the exposed population is about 3 out of 10,000. The probability of this accident occurring in a suburban population zone is 8.85×10^{-6} per year with a likelihood of about 19 in 10,000 of a single latent cancer fatality in the exposed population. The maximum reasonably foreseeable transportation accident in a rural population zone is the same accident with the same consequences described for the rural population zone under Alternative I, but the accident probability under Alternative III is reduced to 3.98×10^{-7} per year. Under Alternative III, this accident is not reasonably foreseeable in urban or suburban population zones because the accident probability for those zones is less than 1×10^{-7} per year.

H.5.3.2 Impacts from Industrial Waste Shipments

The only estimated impact from transportation accidents involving industrial waste are traffic fatalities. For purposes of analysis, the location of the disposal facility was not identified, but its distance from the WVDP was assumed to be within 640 km (400 mi). The results of the analysis for both truck and rail shipments is summarized in Table H-21. Under Alternative I, the probability of a truck traffic fatality is about 0.05 per year with a comparable risk for rail transport. The traffic fatality risk increases for Alternative II to about 0.06 for both truck and rail. The annual traffic fatality risk is lowest for Alternative III with a risk of about 0.04 for both truck and rail.

H.6 MITIGATION

The impacts of transportation for the alternatives may be mitigated in a number of different ways. For example, the routes used for truck shipments may be chosen by using Department of Transportation routing guidelines, which are designed to reduce the radiological impacts from transportation. The guidelines consider as primary factors (a) the radiation exposure from incident-free transport, (b) the risk to general population from an accidental release of radioactive material, and (c) the economic risk from an accidental release of radioactive material. The guidelines consider as secondary factors (a) emergency response effectiveness, (b) evacuation capabilities, (c) location of special facilities such as schools or hospitals, and (d) traffic fatalities and injuries unrelated to the radioactive nature of the cargo. Potential mitigation is also made possible by using approved shipment containers.

H.7 CUMULATIVE IMPACTS

DOE conducted a comprehensive cumulative transportation impacts analysis (DOE 1995). The cumulative impacts of radioactive materials transportation consisted of impacts from (a) historical shipments, (b) the alternatives evaluated, (c) other reasonably foreseeable actions that include transportation of radioactive material, and (d) general radioactive materials transportation not related to a particular action. The collective dose to the general population and workers was the measure used to quantify cumulative transportation

Table H-21. Estimated Annual Traffic Fatalities from the Transportation of Nonradioactive Industrial Wastes for Alternatives I (Removal), II (On-Premises Storage), and III (In-Place Stabilization)[a]

	Alternative I (Removal)		Alternative II (On-Premises Storage)		Alternative III (In-Place Stabilization)	
WMA	Truck	Rail	Truck	Rail	Truck	Rail
1	0.00285	0.0027	0.00285	0.0027	7.49×10^{-5}	7.11×10^{-5}
2	9.66×10^{-4}	9.17×10^{-4}	9.66×10^{-4}	9.17×10^{-4}	4.21×10^{-4}	4.00×10^{-4}
3	0.00331	0.00314	0.00331	0.00314	2.59×10^{-4}	2.46×10^{-4}
4	0.0139	0.0132	0.0139	0.0132	0.0027	0.00256
5	0.00194	0.00184	0.00194	0.00184	0.00194	0.00184
6 & 10	0.0265	0.0251	0.0197	0.0187	0.0337	0.032
7	7.33×10^{-4}	6.96×10^{-4}	7.33×10^{-4}	6.96×10^{-4}	2.36×10^{-4}	2.24×10^{-4}
8	1.59×10^{-5}	1.51×10^{-5}	1.59×10^{-5}	1.51×10^{-5}	5.62×10^{-5}	5.33×10^{-5}
9	0.00423	0.00402	0.018	0.0171	1.14×10^{-4}	1.09×10^{-4}
Total	0.054	0.052	0.061	0.058	0.040	0.038

a. Based on shipping route of 640 km (400 mi) (1,280 km [800 mi] round trip).

impacts. This measure of impact was chosen because it can be directly related to cancer fatalities by using a cancer risk coefficient and because it is difficult to identify a maximally exposed individual for shipments throughout the United States spanning long periods of time (the analyses covered 93 years, 1943 through 2035).

The total estimated number of cancer fatalities was 130 for transportation workers and 160 for the general population (DOE 1995). The largest number of cumulative cancer fatalities estimated for radioactive material shipments from West Valley, 0.75 for transportation workers and 6.4 for the general population, occurred under Alternative I, with its approximately 42,000 shipments. When the impacts from the West Valley shipments are added to the impacts estimated in DOE (1995), 130 cancer fatalities were estimated for transportation workers and 160 cancer fatalities were estimated for the general population. Over the same 93-year period, 47,000,000 people would die from cancer, at the assumed rate of 500,000 cancer deaths per year (U.S. Bureau of the Census, 1993). The transportation-related cancer fatalities would be indistinguishable from other cancer fatalities and would be 0.0006 percent of the total number of cancer fatalities occurring in that period.

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[2]WVNS, 1993c. *West Valley Demonstration Project, Chemical Process Cell Waste Storage Area Waste Characterization Report*, WVDP-EIS-023, Rev. 0, July.

[2]WVNS, 1993d. *West Valley Demonstration Project, Characterization Report for the NRC Licensed Disposal Area*, WVDP-EIS-021, Rev. 0, June.

[1]WVNS, 1993e. *West Valley Demonstration Project, New York State Licensed Disposal Area Waste Characterization Report*, WVDP-EIS-022, Rev. 0, August.

[2]WVNS, 1993f. *West Valley Demonstration Project, Radwaste Treatment System Drum Cell Characterization Study*, WVDP-EIS-027, Rev. 0, May.

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[1]Later version of the document is available in the public reading room.
[2]Document is available in the public reading room.

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APPENDIX I

METHOD OF SOCIOECONOMIC IMPACT ANALYSIS

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METHOD OF SOCIOECONOMIC IMPACT ANALYSIS

This appendix describes the methodology used to assess the socioeconomic impacts of the alternatives evaluated in this Environmental Impact Statement (EIS). Section I.1 explains the methodology and baseline characteristics used for the socioeconomic analysis, Sections I.2 through I.7 give the analyses for each of the five alternatives.

I.1 INTRODUCTION

Assessing socioeconomic impact requires (a) defining the area(s) of assessment, (b) establishing the baseline characteristics for that area(s), and (c) evaluating the expected changes over time resulting from implementing an alternative.

Two areas were defined for analysis purposes: the region of influence (ROI) for the socioeconomic analysis is the two county area comprising Cattaraugus and Erie counties and the primary impact area ("local" area) is within a 20-km (12-mi) radius of the Center. Erie County includes the 2 greater metropolitan Buffalo area. The primary impact area is that portion of Cattaraugus and Erie Counties most likely to experience the local impact of an alternative. The local area is primarily rural in nature and is within the ROI.

The baseline socioeconomic characteristics include employment, housing, and population within the two defined areas. Projected trends for population, employment, income and housing were obtained using the U.S. Bureau of Economic Analysis statistics provided in Section 4.8 of the EIS and is summarized in the following paragraphs.

I.1.1 Region of Influence

The 1990 population in the ROI was about 1.2 million and is projected to grow at an annual rate of about 0.2 percent during the 1990s and at an annual rate of about 0.13 percent from 2000 to 2030 (the implementation time frame for the five alternatives). Employment in the ROI is about 580,000 workers and projected to increase at an average annual rate of 0.67 percent during the 1990s and then decrease at an annual rate of 0.16 percent from 2000 to 2030.

Unemployment rates have historically been about a point higher than the New York State rate, which has been near the national average. The recent regional unemployment rate has been about 5.5 to 7.5 percent from 1970 to 1993.

Housing stock has increased faster than the population and the vacancy rates in the region were about 2 percent in 1970 and about 6 percent in 1990.

Public services are adequate to meet the current demands of the region.

I.1.2 Primary Impact Area

The population in the primary impact area is about 28,000 people. This population is projected to grow at an annual rate of 0.16 percent during the 1990s and at 0.11 percent from 2000 to 2030. Employment in the primary impact area is about 14,000 workers and the employment trend is projected to be very similar to that for the ROI increasing at an average annual rate of 0.63 percent during the 1990s and then decreasing annually at a rate of 0.17 percent from 2000 to 2030.

The West Valley Demonstration Project (WVDP) is the largest employer in the primary impact area with direct site employment of about 950 people for the WVDP high-level [radioactive] waste (HLW) solidification. Employment is expected to decrease starting in 1998 and decline to a minimal staffing level by 2004. Housing stock and vacancy rates in the primary impact area are similar to the ROI.

Public services are adequate to meet the current demands of the area.

Expected Baseline Changes

The Regional Input-Output Modeling System (RIMS II) developed by the Bureau of Economic Analysis was used to estimate the impact of project and program expenditures by industry on regional output, earnings, and employment. The model uses linear employment and expenditure multipliers to predict indirect employment. Patterns of regional economic activity and employment can be estimated. The RIMS II model is adaptable to specific analysis using the U.S. Bureau of Economic Analysis county-specific statistics on employment, industries, and household earnings. Reliability tests of RIMS II have been conducted by the U.S. Bureau of Economic Analysis and have been found to overstate actual surveyed estimates by under 10 percent. Therefore, the RIMS II analysis is conservative. (DOC 1981)

The evaluation of the socioeconomic impact of each alternative using the county-specific RIMS II model relies on the estimated expenditures for direct labor and purchased goods and services. Cost estimates for each alternative were obtained from the *Overall Site-Wide Closure Engineering Report* WVNS (1994) and translated into annual expenditures assuming that expenditures would follow the same distribution over time as the employment levels for each year. The four expenditure categories: labor, materials, equipment, and contingency given in WVNS (1994) were converted to annual values and then translated into three elements in the ROI final demand vector: wholesale trade, business services, and households. Labor costs represent payments to households; equipment and materials are assumed to be purchased from the wholesale trade industry; and contingency expenditures are assumed to be represented by expenditures in the business services industry.

Methodology and Assumptions

The estimate of actual shares of project expenditures going to local firms within the ROI is important for the analysis. The labor dollars in WVNS (1994) reflect fully-burdened labor costs to the firm, so it was assumed that two-thirds of the labor dollars would be distributed as wages and that 90 percent of wages would be spent in the local area. The 90 percent assumption derives from the estimate of personnel consumption expenditures compared to net gross domestic product, currently at 89 percent (Survey of Current Business 1994) and probably reflects an upper-bound estimate on indirect employment resulting from direct employment.

Each alternative includes expenditures for materials and equipment. It was assumed that purchases would be made at the national wholesale level and that 20 percent of the expenditures for equipment and materials would go to local firms, based on recent statistics on the share of direct expenditures for inputs in the wholesale industry with an adjustment for the ratio of the ROI output multiplier divided by the national output multiplier. The share of direct expenditures for the national wholesale industry is 29.7 percent. When adjusted, the local share of the direct expenditures was estimated to be 20.7 percent.

The contingency expenditures were assumed to purchase services with only 0.5 percent of these expenditures actually going to firms within the region, based on the expectation that these expenditures would be for specialized services not likely to be found within the ROI.

Table I-1 gives the ROI RIMS II earnings multipliers for the three industry categories (households, wholesale trade and business services) used to convert local expenditures into economic activity. Table I-2 presents average wage rates by two-digit Standard Industrial Classification industry categories used to estimate indirect ROI employment.

Table I-1. Western New York Nuclear Service Center Region of Influence RIMS II Earning Multipliers for Wholesale Trade, Business Services, and Households

Industry Group	Wholesale Trade	Business Services	Households
Agriculture & Mining	0.0016	0.0020	0.0030
Maintenance & Repair	0.0066	0.0071	0.0074
Manufacturing	0.0315	0.0397	0.0387
Transportation & Utilities	0.0229	0.0265	0.0245
Wholesale Trade	0.4229	0.0142	0.0170
Retail Trade	0.0274	0.0346	0.0557
Finance, Insurance & Real Estate	0.0194	0.0231	0.0299
Services	0.0896	0.6495	0.1258
Total	0.6219	0.7967	0.3020

Source: DOC (1993a)

Table I-2. Western New York Nuclear Service Center Region of Influence Average Earnings, 1992

Industry Group	Number Employed	Annual Earnings ($1,000)	Average Annual Earnings ($)
Agriculture & Mining	4,001	64,004.0	15,997
Maintenance & Repair	22,551	664,059.3	29,447
Manufacturing	80,242	3,172,367.5	39,535
Transportation & Utilities	24,426	901,099.6	36,891
Wholesale Trade	28,004	820,349.2	29,294
Retail Trade	106,757	1,458,834.4	13,665
Finance, Insurance & Real Estate	39,717	999,676.9	25,170
Services	174,929	3,732,673.4	21,337

Source: DOC (1994a and b)

Employment was used to estimate the number of new households that could result from implementing an alternative. The maximum number of immigrating households was calculated by dividing total employment by 1.34, the average number of jobs held per household, based on national averages for 1993 (DOC 1994c). Population increases within the ROI were calculated by multiplying household increases by 2.59, the average 1990 household size for the ROI (U.S. Bureau of Census 1993).

Employment levels in the primary impact area were estimated based on the fact approximately 7 percent of the employees in the ROI were employed in Cattaraugus County in 1992. The residential population within the primary impact area shows that 17.6 percent live in Cattaraugus County and 1.3 percent live in Erie County (WVNS 1992). Using these values, an estimated 2.44 percent of indirect employment would be based in the primary impact area (calculated as 0.07*0.176 + 0.93*0.013). Based on the current pattern of employment at the WVDP, it was assumed that 35 percent of primary impact area employees would live in Cattaraugus County, with the remaining 65 percent of the employees living in Erie County. For people residing in Cattaraugus County, 75 percent would live within the primary impact area; of those living in Erie County, 50 percent were assumed to live in the primary impact area. Based on these values, approximately 59 percent of employee households would be located in the primary impact area (calculated as 0.35*0.75 + 0.65*0.50). The average household size in the primary impact area was slightly larger than the ROI at 2.68 people per occupied unit (DOC 1993b).

I.2 ALTERNATIVE I: REMOVAL AND RELEASE TO ALLOW UNRESTRICTED USE

The evaluation of the incremental socioeconomic impact from implementing Alternative I (Removal) requires estimates of the direct employment (WVNS 1994).

Table I-3 shows the estimated expenditure levels by year during the implementation phase for Alternative I. Implementation of Alternative I would start in the year 2000 and continue through 2025.

Table I-3. Estimated Expenditures for Implementing Alternative I (Removal)

	Expenditures (thousands of 1996 dollars)				
Year	Materials	Equipment	Labor	Contingency	Total
2000	166	158	2,219	1,272	3,815
2001	249	238	3,328	1,908	5,723
2002	2,100	1,996	28,066	16,081	48,243
2003	2,614	2,486	34,943	20,022	60,065
2004	3,594	3,417	48,033	27,522	82,566
2005	4,382	4,166	58,572	33,560	100,680
2006	5,826	5,540	77,874	44,620	133,860
2007	6,416	6,101	85,750	49,134	147,401
2008	6,598	6,274	88,191	50,532	151,595
2009	6,872	6,534	91,851	52,629	157,886
2010	6,989	6,645	93,404	53,519	160,557
2011	7,030	6,684	93,959	53,837	161,510
2012	6,964	6,620	93,072	53,328	159,984
2013	6,914	6,574	92,406	52,947	158,841
2014	6,697	6,369	89,522	51,294	153,882
2015	6,482	6,163	86,637	49,641	148,923
2016	5,960	5,665	79,649	45,637	136,911
2017	5,627	5,350	75,212	43,095	129,284
2018	5,079	4,830	67,889	38,899	116,697
2019	4,631	4,404	61,900	35,468	106,403
2020	4,640	4,411	62,010	35,531	106,592
2021	3,976	3,779	53,137	30,446	91,338
2022	3,943	3,747	52,693	30,192	90,575
2023	2,963	2,817	39,601	22,691	68,072
2024	2,282	2,171	30,504	17,479	52,436
2025	1,137	1,081	15,196	8,707	26,121

Source: Calculated from WVNS (1994)

Table I-4 presents the estimated levels of direct and indirect regional employment and the associated population and housing for the ROI. Table I-5 presents comparable information for the primary impact area.

Implementing Alternative I would result in an increase of employment, starting in the year 2000 and peaking in the year 2011. With total employment of around 1,700, this represents about a 0.3 percent (1,700/608,000) of the expected employment in the two county region. Employment would gradually decrease and be eliminated in the year 2025.

Total employment in the local, primary impact area is estimated to peak at 868 which would represent about 6 percent of the local area employment at the time. Implementing of Alternative I would provide employment for personnel who otherwise could be unemployed as a result of completing the WVDP HLW solidification. For this reason, there would be a positive impact from implementing the alternative.

There would be layoffs near the completion of the implementation phase for Alternative I, producing a negative impact. Eliminating these jobs would result in employment loss on a scale similar to that which would have occurred had decontamination and decommissioning of the WVDP not started. Because the WVDP employment represents a fraction of the regional employment, the elimination of these jobs is not expected to have a substantial impact on the region. For the 20-km (12-mi) area of primary impact, the situation would be different. In 2011, the peak year of employment, employment at the Center has been projected to represent about 6 percent of the total local employment (DOC 1992). The gradual rampdown in employment until the year 2025 would result in a local employment rate decrease of about 0.5 to 1 percent per year, producing a negative but not substantial local impact.

No housing shortages would be expected to result from implementing Alternative I because there is an oversupply of housing and many employees currently supporting the WVDP HLW solidification would be expected to support the decontamination and decommissioning of the WVDP. For the same reason, no noticeable change in demand for local public services would be expected from implementing Alternative I. If people leave the area following completion of the alternative, there would be additional houses on the market and a reduced demand for public services.

I.3 ALTERNATIVE II: REMOVAL, ON-PREMISES WASTE STORAGE, AND PARTIAL RELEASE TO ALLOW UNRESTRICTED USE

Table I-6 shows the estimated expenditure levels by year [from implementing Alternative II (On-Premises Storage)], which is assumed to start in 2000 and continue through 2026. Table I-7 shows the estimated levels of direct and indirect regional employment resulting from implementing Alternative II. Direct and indirect employment levels for the primary impact area were estimated using the factors given in Table I-8. These tables also show the expenditures and employment for the site monitoring and maintenance period during the post-implementation phase.

Table I-4. Employment, Population, and Housing Impacts in the Region of Influence for Alternative I (Removal)[a]

Year	Direct Employment	Indirect Employment	Total Employment	Population	Occupied Housing
2000	20	20.1	40.1	78	30
2001	30	30.2	60.2	117	45
2002	253	254.7	507.7	982	379
2003	315	317.1	632.1	1,222	472
2004	433	435.8	868.8	1,678	648
2005	528	531.5	1,059.5	2,049	791
2006	702	706.6	1,408.6	2,722	1,051
2007	773	778.1	1,551.1	2,999	1,158
2008	795	800.2	1,595.2	3,082	1,190
2009	828	833.4	1,661.4	3,212	1,240
2010	842	847.5	1,689.5	3,266	1,261
2011	847	852.5	1,699.5	3,284	1,268
2012	839	844.5	1,683.5	3,253	1,256
2013	833	838.5	1,671.5	3,230	1,247
2014	807	812.3	1,619.3	3,129	1,208
2015	781	786.1	1,567.1	3,028	1,169
2016	718	722.7	1,440.7	2,784	1,075
2017	678	682.4	1,360.4	2,629	1,015
2018	612	616.0	1,228.0	2,372	916
2019	558	561.7	1,119.7	2,165	836
2020	559	562.7	1,121.7	2,168	837
2021	479	482.1	961.1	1,857	717
2022	475	478.1	953.1	1,841	711
2023	357	359.3	716.3	1,386	535
2024	275	276.8	551.8	1,067	412
2025	137	137.9	274.9	531	205

a. Number of full-time equivalents, people, or units.

Source: Calculated from WVNS (1994)

Table I-5. **Employment, Population, and Housing Impacts in the Primary Impact Area for Alternative I (Removal)[a]**

Year	Direct Employment	Indirect Employment	Total Employment	Population	Occupied Housing
2000	20	0.5	20.5	24	9
2001	30	0.7	30.7	38	14
2002	253	6.2	259.2	311	116
2003	315	7.7	322.7	386	144
2004	433	10.6	443.6	531	198
2005	528	13.0	541.0	646	241
2006	702	17.3	719.3	860	321
2007	773	19.0	792.0	946	353
2008	795	19.5	814.5	973	363
2009	828	20.3	848.3	1,013	378
2010	842	20.7	862.7	1,032	385
2011	847	20.8	867.8	1,037	387
2012	839	20.6	859.6	1,026	383
2013	833	20.5	853.5	1,021	381
2014	807	19.8	826.8	989	369
2015	781	19.2	800.2	957	357
2016	718	17.6	735.6	879	328
2017	678	16.7	694.7	831	310
2018	612	15.0	627.0	750	280
2019	558	13.7	571.7	683	255
2020	559	13.7	572.7	683	255
2021	479	11.8	490.8	587	219
2022	475	11.7	486.7	582	217
2023	357	8.8	365.8	437	163
2024	275	6.8	281.8	338	126
2025	137	3.4	140.4	169	63

a. Number of full-time equivalents, people, or units.

Source: Calculated from WVNS (1994)

Table I-6. Estimated Expenditures for Implementing Alternative II (On-Premises Storage)

Year	Expenditures (thousands of 1996 dollars)[a]				
	Materials	Equipment	Labor	Contingency	Total
2000	168	106	1,489	882	2,645
2001	334	214	2,977	1,763	5,288
2002	2,501	1,594	22,231	13,163	39,489
2003	4,587	2,925	40,790	24,151	72,453
2004	6,552	4,177	58,259	34,494	103,482
2005	7,701	4,911	68,481	40,547	121,640
2006	8,929	5,693	79,397	47,010	141,029
2007	11,117	7,087	98,850	58,527	175,581
2008	11,172	7,123	99,347	58,821	176,463
2009	11,329	7,223	100,736	59,644	178,932
2010	11,451	7,302	101,827	60,290	180,870
2011	9,643	6,149	85,749	50,771	152,312
2012	9,643	6,149	85,749	50,771	152,312
2013	9,732	6,206	86,543	51,241	153,722
2014	9,443	6,020	83,963	49,713	149,139
2015	9,509	6,063	84,559	50,066	150,197
2016	8,828	5,630	78,504	46,481	139,443
2017	8,037	5,123	71,458	42,309	126,927
2018	7,757	4,946	68,977	40,840	122,520
2019	6,507	4,149	57,862	34,259	102,777
2020	6,597	4,205	58,655	34,729	104,186
2021	5,915	3,771	52,601	31,144	93,431
2022	5,525	3,523	49,127	29,088	87,263
2023	5,079	3,237	45,158	26,737	80,211
2024	3,292	2,100	29,278	17,335	52,005
2025	3,382	2,156	30,072	17,805	53,415
2026	1,328	847	11,813	6,994	20,982
Monitoring and Maintenance Phase	190.6	121.6	1,233.3	386.4	1931.9

a. Labor costs represent payments to households; equipment and materials purchased from the wholesale trade industry; and contingency expenditures are assumed to be represented by expenditures in the business services industry.

Source: Calculated from WVNS (1994)

Table I-7. **Employment, Population, and Housing Impacts in the Region of Influence for Alternative II (On-Premises Storage)[a]**

Year	Direct Employment	Indirect Employment	Total Employment	Population	Occupied Housing
2000	15	13.8	28.8	54	21
2001	30	27.5	57.5	111	43
2002	224	205.7	429.7	831	321
2003	411	377.5	788.5	1,523	588
2004	587	539.1	1,126.1	2,176	840
2005	690	633.7	1,323.7	2,559	988
2006	800	734.7	1,534.7	2,966	1,145
2007	996	914.8	1,910.8	3,693	1,426
2008	1,001	919.3	1,920.3	3,711	1,433
2009	1,015	932.2	1,947.2	3,763	1,453
2010	1,026	942.3	1,968.3	3,805	1,469
2011	864	793.5	1,657.5	3,204	1,237
2012	864	793.5	1,657.5	3,204	1,237
2013	872	800.9	1,672.9	3,232	1,248
2014	846	777.0	1,623.0	3,136	1,211
2015	852	782.5	1,634.5	3,160	1,220
2016	791	726.5	1,517.5	2,932	1,132
2017	720	661.3	1,381.3	2,670	1,031
2018	695	638.3	1,333.3	2,577	995
2019	583	535.5	1,118.5	2,163	835
2020	591	542.8	1,133.8	2,161	834
2021	530	486.8	1,016.8	1,966	759
2022	495	454.6	949.6	1,836	709
2023	455	417.9	872.9	1,686	651
2024	295	270.9	565.9	1,093	422
2025	303	278.3	581.3	1,124	434
2026	119	109.3	228.3	440	170
Monitoring and Maintenance Phase	31.5	11.7	43.2	83	32

a. Number of full-time equivalents, people, or units.

Source: Calculated from WVNS (1994)

Table I-8. **Employment, Population, and Housing Impacts in the Primary Impact Area for Alternative II (On-Premises Storage)[a]**

Year	Direct Employment	Indirect Employment	Total Employment	Population	Occupied Housing
2000	15	0.3	15.3	19	7
2001	30	0.7	30.7	38	14
2002	224	5.0	229.0	273	102
2003	411	9.2	420.2	501	187
2004	587	13.2	600.2	716	267
2005	690	15.5	705.5	842	314
2006	800	17.9	817.9	976	364
2007	996	22.3	1,018.3	1,214	453
2008	1,001	22.4	1,023.4	1,222	456
2009	1,015	22.8	1,037.8	1,238	462
2010	1,026	23.0	1,049.0	1,252	467
2011	864	19.4	883.4	1,053	393
2012	864	19.4	883.4	1,053	393
2013	872	19.6	891.6	1,064	397
2014	846	19.0	865.0	1,032	385
2015	852	19.1	871.1	1,040	388
2016	791	17.7	808.7	965	360
2017	720	16.1	736.1	879	328
2018	695	15.6	710.6	847	316
2019	583	13.1	596.1	710	265
2020	591	13.3	604.3	721	269
2021	530	11.9	541.9	646	241
2022	495	11.1	506.1	603	225
2023	455	10.2	465.2	555	207
2024	295	6.6	301.6	359	134
2025	303	6.8	309.8	370	138
2026	119	2.7	121.7	145	54
Monitoring and Maintenance Phase	31.5	0.3	31.8	38	14

a. Number of full-time equivalents, people, or units.

Source: Calculated from WVNS (1994)

Implementing Alternative II results in direct and indirect employment totaling 1,970 persons, starting in 2000, peaking in 2010, and gradually declining during the post-implementation period to a total of 43. The peak year total employment would represent about 0.3 percent (1970/608,800) of the expected employment in the ROI. Within the 20-km (12-mi) primary impact area, total employment is estimated to peak at 1,049 estimated to represent about 7.5 percent of the area employment at the time. Creation of these jobs is expected to produce a positive socioeconomic impact as described for Alternative I; implementing the alternative could provide employment for personnel who otherwise would be unemployed after completing the WVDP HLW solidification.

Employment would decrease at the end of the implementation phase in both the ROI and the primary impact area, producing a negative impact. Because the WVDP employment represents only 0.3 percent of the total employment in the ROI, the elimination of these jobs would not be expected to produce a substantial impact on regional employment. In the peak year of employment within the primary impact area, employment is expected to represent about 7 percent of the total employment (DOC 1992). The local employment rate would gradually decline from the peak to about 0.5 to 1 percent per year, producing a negative local impact.

Impacts to housing supply and demand for public services in the ROI and the primary impact area are expected to be similar to that described for Alternative I.

I.4 ALTERNATIVE IIIA: IN-PLACE STABILIZATION (BACKFILL) AND ON-PREMISES LOW-LEVEL WASTE DISPOSAL

Table I-9 shows the annual estimated expenditures by year for Alternative IIIA [In-Place Stabilization (Backfill)], expected to start in 2000 and continue through 2010 (WVNS 1994). The estimated expenditure levels for the monitoring and maintenance phase of the alternative are also shown in Table I-9.

Table I-10 presents the estimated levels of direct and indirect regional employment resulting from implementing Alternative IIIA. Indirect levels of employment for the primary impact area were estimated using the factors presented in Table I-11. The tables address both the implementation phase and the post-implementation (monitoring and maintenance) phase of Alternative IIIA.

Implementing Alternative IIIA would result in substantial employment starting in the year 2000, peaking in the year 2006 with almost 700 workers, and then gradually decreasing to a monitoring and maintenance staffing level (Table I-10). The peak year total employment represents about 0.1 percent (683/603,800) of the expected employment in the ROI. The total employment in the 20-km (12-mi) local primary impact area is estimated to peak at 335 which would represent about 2.4 percent of the expected local area employment (DOC 1992). Creating these jobs would produce a positive socioeconomic impact because it would provide employment for personnel who could otherwise be laid off following completion of the HLW solidification.

Table I-9. Estimated Expenditures for Implementing Alternative IIIA [In-Place Stabilization (Backfill)]

Year	Expenditures (thousands of 1996 dollars)[a]				
	Materials	Equipment	Labor	Contingency	Total
2000	168	109	1,149	357	1,783
2001	1,329	863	9,075	2,817	14,084
2002	1,985	1,290	13,555	4,208	21,038
2003	3,853	2,502	26,305	8,165	40,825
2004	4,946	3,213	33,772	10,483	52,414
2005	5,417	3,520	36,988	11,481	57,406
2006	5,501	3,574	37,562	11,659	58,296
2007	4,828	3,137	32,968	10,233	51,166
2008	4,222	2,743	28,833	8,950	44,748
2009	2,305	1,497	15,737	4,885	24,424
2010	303	196	2,066	642	3,207
Monitoring and Maintenance Phase	4,016	2,610	1,233	386	1,932

a. Labor costs represent payments to households; equipment and materials are assumed to be purchased from the wholesale trade industry; and contingency expenditures are assumed to be represented by expenditures in the business services industry.

Source: Calculated from WVNS (1994)

Table I-10. Employment, Population, and Housing Impacts in the Region of Influence for Alternative IIIA [In-Place Stabilization (Backfill)][a]

Year	Direct Employment	Indirect Employment	Total Employment	Population	Occupied Housing
2000	10	10.9	20.9	41	16
2001	79	85.9	164.9	319	123
2002	118	128.3	246.3	477	184
2003	229	249.1	478.1	925	357
2004	294	319.8	613.8	1,186	458
2005	322	350.2	672.2	1,300	502
2006	327	355.7	682.7	1,318	509
2007	287	312.2	599.2	1,158	447
2008	251	273.0	524.0	1,013	391
2009	137	149.0	286.0	552	213
2010	18	19.6	37.6	73	28
Monitoring and Maintenance Phase	51.5	67.7	119.2	231	89

a. Number of full-time equivalents, people, or units.

Source: Calculated from WVNS (1994)

Table I-11. Employment, Population, and Housing Impacts in the Primary Impact Area for Alternative IIIA [In-Place Stabilization (Backfill)][a]

Year	Direct Employment	Indirect Employment	Total Employment	Population	Occupied Housing
2000	10	0.3	10.3	13	5
2001	79	2.1	81.1	96	36
2002	118	3.1	121.1	145	54
2003	229	6.1	235.1	281	105
2004	294	7.8	301.8	362	135
2005	322	8.5	330.5	397	148
2006	327	8.7	335.7	402	150
2007	287	7.6	294.6	354	132
2008	251	6.7	257.7	308	115
2009	137	3.6	140.6	169	63
2010	18	0.5	18.5	21	8
Monitoring and Maintenance Phase	49.2	64.2	113.4	220	85

a. Number of full-time equivalents, people, or units.

Source: Calculated from WVNS (1994)

Employment would decrease near the end of the implementation phase under Alternative IIIA, producing a negative impact. Because the peak site employment represents 0.1 percent of the ROI employment, eliminating these jobs is not expected to affect regional employment. Employment would decrease at an annual rate of 0.5 to 1 percent from the peak year until the year 2025, producing a slight negative, local impact.

No housing shortages are expected to result from implementing Alternative IIIA because of the housing surplus (see Table 4-21) and because it is anticipated that current employees would remain to support implementation of this alternative. The WVDP employment for Alternative IIIA are less than current employment levels and more houses could be put on the market if people leave the area. Should people leave the area, there would be a reduced demand for local public services.

I.5 ALTERNATIVE IIIB: IN-PLACE STABILIZATION (RUBBLE) AND ON-PREMISES LOW-LEVEL WASTE DISPOSAL

Table I-12 presents the estimated expenditures by year for Alternative IIIB [In-Place Stabilization (Rubble)], which is expected to start in 2000 and continue through 2026. Table I-13 presents the estimated levels of direct and indirect regional employment that would result from implementing Alternative IIIB. Table I-14 presents comparable information for the primary impact area. Both tables present information for the implementation and the post-implementation (monitoring and maintenance) phase.

Table I-12. **Estimated Expenditures for Implementing Alternative IIIB [In-Place Stabilization (Rubble)]**

Year	Expenditures (thousands of 1996 dollars)[a]				
	Materials	Equipment	Labor	Contingency	Total
2000	170	103	916	297	1,486
2001	3,169	1,919	17,041	5,532	27,661
2002	2,947	1,785	15,850	5,146	25,728
2003	4,106	2,486	22,081	7,168	35,841
2004	6,406	3,878	34,450	11,184	55,918
2005	8,177	4,951	43,978	14,277	71,383
2006	8,586	5,199	46,176	14,990	74,951
2007	6,866	4,156	36,923	11,986	59,931
2008	5,383	3,260	28,952	9,399	46,994
2009	3,799	2,301	20,431	6,633	33,164
2010	3,747	2,271	20,156	6,544	32,718
2011	3,747	2,271	20,156	6,544	32,718
2012	3,747	2,271	20,156	6,544	32,718
2013	3,646	2,208	19,607	6,365	31,826
2014	2,896	1,753	15,576	5,056	25,281
2015	2,590	1,568	13,926	4,521	22,605
2016	2,641	1,598	14,201	4,610	23,050
2017	2,606	1,578	14,018	4,551	22,753
2018	2,521	1,527	13,560	4,402	22,010
2019	2,521	1,527	13,560	4,402	22,010
2020	2,606	1,578	14,018	4,551	22,753
2021	2,641	1,598	14,201	4,610	23,050
2022	2,419	1,464	13,010	4,223	21,116
2023	2,164	1,310	11,636	3,778	18,888
2024	2,504	1,516	13,468	4,372	21,860
2025	2,231	1,352	12,003	3,897	19,483
2026	377	226	2,016	655	3,274
Monitoring and Maintenance Phase	4,015.8	2,432.3	4,085	2,633.3	13,166.4

Source: Calculated from WVNS (1994)

Table I-13. **Employment, Population, and Housing Impacts in the Region of Influence for Alternative IIIB [In-Place Stabilization (Rubble)][a]**

Year	Direct Employment	Indirect Employment	Total Employment	Population	Occupied Housing
2001	10	8.9	18.9	36	14
2000	186	165.9	351.9	681	263
2001	173	154.3	327.3	632	244
2002	241	215.0	456.0	881	340
2003	376	335.4	711.4	1,375	531
2004	480	428.1	908.1	1,756	678
2005	504	449.5	953.5	1,844	712
2006	403	359.4	762.4	1,474	569
2007	316	281.9	597.9	1,155	446
2008	223	198.9	421.9	816	315
2009	220	196.2	416.2	805	311
2010	220	196.2	416.2	805	311
2011	220	196.2	416.2	805	311
2012	214	190.9	404.9	782	302
2013	170	151.6	321.6	622	240
2014	152	135.6	287.6	557	215
2015	155	138.2	293.2	567	219
2016	153	136.5	289.5	559	216
2017	148	132.0	280.0	541	209
2018	148	132.0	280.0	541	209
2019	153	136.5	289.5	559	216
2020	155	138.2	293.2	567	219
2021	142	126.6	268.6	518	200
2022	127	113.3	240.3	464	179
2023	147	131.1	278.1	539	208
2024	131	116.8	247.8	479	185
2025	22	19.6	41.6	80	31
Monitoring and Maintenance Phase	49.2	64.2	113.4	220	85

a. Full-time equivalents, people, or units.

Source: Calculated from WVNS (1994)

Table I-14. Employment, Population, and Housing Impacts in the Primary Impact Area for Alternative IIIB [In-Place Stabilization (Rubble)][a]

Year	Direct Employment	Indirect Employment	Total Employment	Population	Occupied Housing
2000	10	0.2	10.2	13	5
2001	186	4.0	190.0	228	85
2002	173	3.8	176.8	212	79
2003	241	5.2	246.2	295	110
2004	376	8.2	384.2	458	171
2005	480	10.5	490.5	584	218
2006	504	11.0	515.0	614	229
2007	403	8.8	411.8	490	183
2008	316	6.9	322.9	386	144
2009	223	4.9	227.9	271	101
2010	220	4.8	224.8	268	100
2011	220	4.8	224.8	268	100
2012	220	4.8	224.8	268	100
2013	214	4.7	218.7	260	97
2014	170	3.7	173.7	206	77
2015	152	3.3	155.3	185	69
2016	155	3.4	158.4	188	70
2017	153	3.3	156.3	188	70
2018	148	3.2	151.2	180	67
2019	148	3.2	151.2	180	67
2020	153	3.3	156.3	188	70
2021	155	3.4	158.4	188	70
2022	142	3.1	145.1	174	65
2023	127	2.8	129.8	155	58
2024	147	3.2	150.2	180	67
2025	131	2.9	133.9	161	60
2026	22	0.5	22.5	27	10
Monitoring and Maintenance Phase	49.2	1.6	50.8	62	23

a. Full-time equivalents, people, or units.

Source: Calculated from WVNS (1994)

Implementing Alternative IIIB would result in increased employment starting in the year 2000 and peaking in the year 2005 with total employment of about 1,000 workers. Employment would gradually decrease to the monitoring and maintenance level. The peak year total employment represents about 0.16 percent (953/603,400) of the expected employment in the two-county region. The total employment in the primary impact area is estimated to peak at 515 which represents about 3.7 percent of the local employment. Creation of these jobs would produce a positive socioeconomic impact by providing employment opportunities for personnel.

Employment would decrease near the completion of the implementation phase of Alternative IIIB producing a negative impact. However, site employment represents a small fraction of the regional employment in the two-county area and the staff reduction is not expected to have a substantial impact on regional employment. The gradual rampdown in employment would decrease local employment at a rate of about 1 percent per year or less from the peak year until the year 2025, producing a small negative impact.

No housing shortages are expected to result from implementing Alternative IIIB.

I.6 ALTERNATIVE IV: NO ACTION: MONITORING AND MAINTENANCE

Table I-15 shows the annual estimated expenditures by year for Alternative IV (No Action: Monitoring and Maintenance), which is expected to start in 2000 and continue through 2005. The table shows the expenditures for site stabilization (the years 2000 through 2005) and for the (monitoring and maintenance) phase thereafter.

Table I-16 presents the estimated levels of direct and indirect regional employment resulting from implementing Alternative IV. Table I-17 presents comparable information for the primary impact area. Both tables present information for the implementation phase and the post-implementation (monitoring and maintenance) phase that follows.

Implementing Alternative IV would result in employment starting in the year 2000 sustaining 20 to 30 workers until the year 2006, when employment would increase to a monitoring and maintenance level of 381 workers. This represents a small percentage (0.1 percent) of the expected regional employment at the time. Within the 20 km (12.4 mi) primary impact area the monitoring and maintenance phase employment is estimated to be less than 200 workers which represents about 1.5 percent of the local area employment (DOC 1992). The creation of these jobs is expected to produce a positive socioeconomic impact and to offset the negative impact from completing the WVDP HLW solidification. Because there is no projected staffing reduction for this alternative, there would be no negative impact on regional and area employment.

No housing shortages or increased demand for local services are expected to result from implementing Alternative IV.

Table I-15. Estimated Expenditures for Implementing Alternative IV (No Action: Monitoring and Maintenance)

Year	Expenditures (thousands of 1996 dollars)[a]				
	Materials	Equipment	Labor	Contingency	Total
2000	589	320	2,116	756	3,781
2001	471	257	1,693	605	3,026
2002	627	343	2,257	807	4,034
2003	707	385	2,538	908	4,538
2004	510	277	1,833	655	3,275
2005	941	514	3,384	1,210	6,049
Monitoring and Maintenance Phase	9,981	5,451	14,556	7,497	37,485

a. Labor costs represent payments to households; equipment and materials are assumed to be purchased from the wholesale trade industry; and contingency expenditures are assumed to be represented by expenditures in the business services industry.

Source: Calculated from WVNS (1994)

Table I-16. Employment, Population, and Housing Impacts in the Region of Influence for Alternative IV (No Action: Monitoring and Maintenance)[a]

Year	Direct Employment	Indirect Employment	Total Employment	Population	Occupied Housing
2000	15	21.9	36.9	73	28
2001	12	17.5	29.5	57	22
2002	16	23.4	39.4	75	29
2003	18	26.3	44.3	85	33
2004	13	19.0	32.0	62	24
2005	24	35.0	59.0	114	44
Monitoring and Maintenance Phase	187.1	193.5	380.6	736	284

a. Number of full-time equivalents, people, or units.

Source: Calculated from WVNS (1994)

Table I-17. **Employment, Population, and Housing Impacts in the Primary Impact Area for Alternative IV (No Action: Monitoring and Maintenance)[a]**

Year	Direct Employment	Indirect Employment	Total Employment	Population	Occupied Housing
2000	15	0.5	15.5	19	7
2001	12	0.4	12.4	16	6
2002	16	0.6	16.6	19	7
2003	18	0.6	18.6	21	8
2004	13	0.5	13.5	16	6
2005	24	0.9	24.9	29	11
Monitoring and Maintenance Phase	187.1	4.7	191.8	230	86

a. Number of full-time equivalents, people, or units.

Source: Calculated from WVNS (1994)

I.7 ALTERNATIVE V: DISCONTINUE OPERATIONS

Implementing Alternative V means that the site would be abandoned after completing the WVDP HLW solidification; operations would be discontinued. A negative socioeconomic impact in the local area of primary impact would occur similar to that for Alternatives I and II, but it would be more severe because it would occur over a shorter time period. The impact would result from completing vitrification with no subsequent employment to mitigate or offset these effects.

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[1]Document is available in the public reading room.

APPENDIX J

HYDROGEOLOGIC MODELS USED TO CALCULATE GROUNDWATER FLOW AND TRANSPORT

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APPENDIX J

HYDROLOGIC MODELS USED TO CALCULATE GROUNDWATER FLOW AND TRANSPORT

This appendix discusses the conceptual and numerical models used in this Environmental Impact Statement (EIS) to simulate groundwater flow behavior and the migration of radionuclides and hazardous constituents in formations under the Project Premises and the New York State-licensed disposal area (SDA). The approach to and results of development of a calibrated groundwater model are presented. Where data are uncertain (e.g., the hydraulic conductivity of the till sand), values were used that produce conservative results. The description of stratigraphy and hydrogeology is presented, the criteria and basis for selection of the numerical models is discussed, the modeling results for the six alternatives are presented, and the sensitivity of model predictions to variation of model parameters and boundary conditions is evaluated.

J.1 BACKGROUND

The Western New York Nuclear Service Center (Center) is located within a U-shaped, northwest trending bedrock valley filled with approximately 150 m (500 ft) of Pleistocene glacial deposits that form a till plain (WVNS 1993a). A cross-section view of the buried valley, perpendicular to the northwest-trending centerline, is presented in Figure J-1. The Project Premises and the SDA which comprise the modeled area for this study are located on the western edge of the till plain in Buttermilk Creek Valley at an elevation of 420 m (1,400 ft) above mean sea level (Figure J-2). Because bedrock outcrops along the margins of the valley and has low permeability, hydraulic communication of the buried valley with water-bearing sediments in adjacent glacial valleys is limited. Adjacent glacial valleys are Connoissarauley to the west and Broadleaf to the north. Recharge of the groundwater system within the bedrock valley is primarily from precipitation within the watershed and not from subsurface flow from regional drainages. Erdman Brook divides the Project Premises into a north and south plateau.

Section 4.1 of this EIS describes the geologic units and structure near the Project Premises and the SDA and Sections 4.3.2 and 4.3.3 summarize the hydrogeologic conditions within the unsaturated and saturated zones. Table 4-1 gives a description and the thickness for each of the geologic units that underlie the north and south plateaus.

The main process area and most of the other facilities are located on the north plateau. Hence, much of the north plateau is covered with impermeable surfaces such as roads and buildings. The shallow groundwater system under the north plateau is locally affected by lagoons 2 and 3, a french drain, and other man-made subsurface features. On the south plateau, the groundwater system is affected by disposal holes and trenches in the Nuclear Regulatory Commission-licensed disposal area (NDA) and trenches in the SDA.

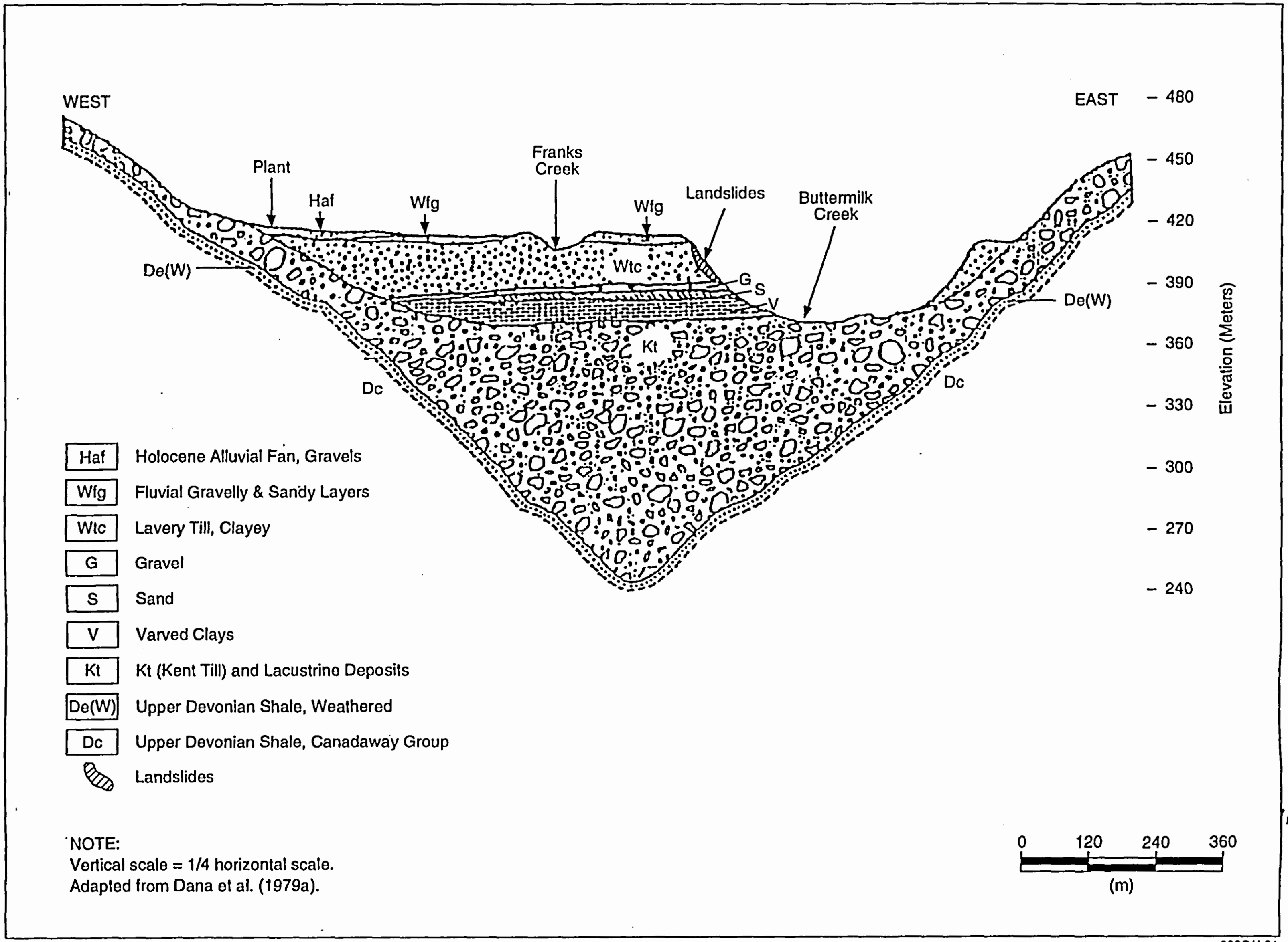

Figure J-1. Cross-section of the Buried Bedrock Valley (modified from Dana et al. 1979).

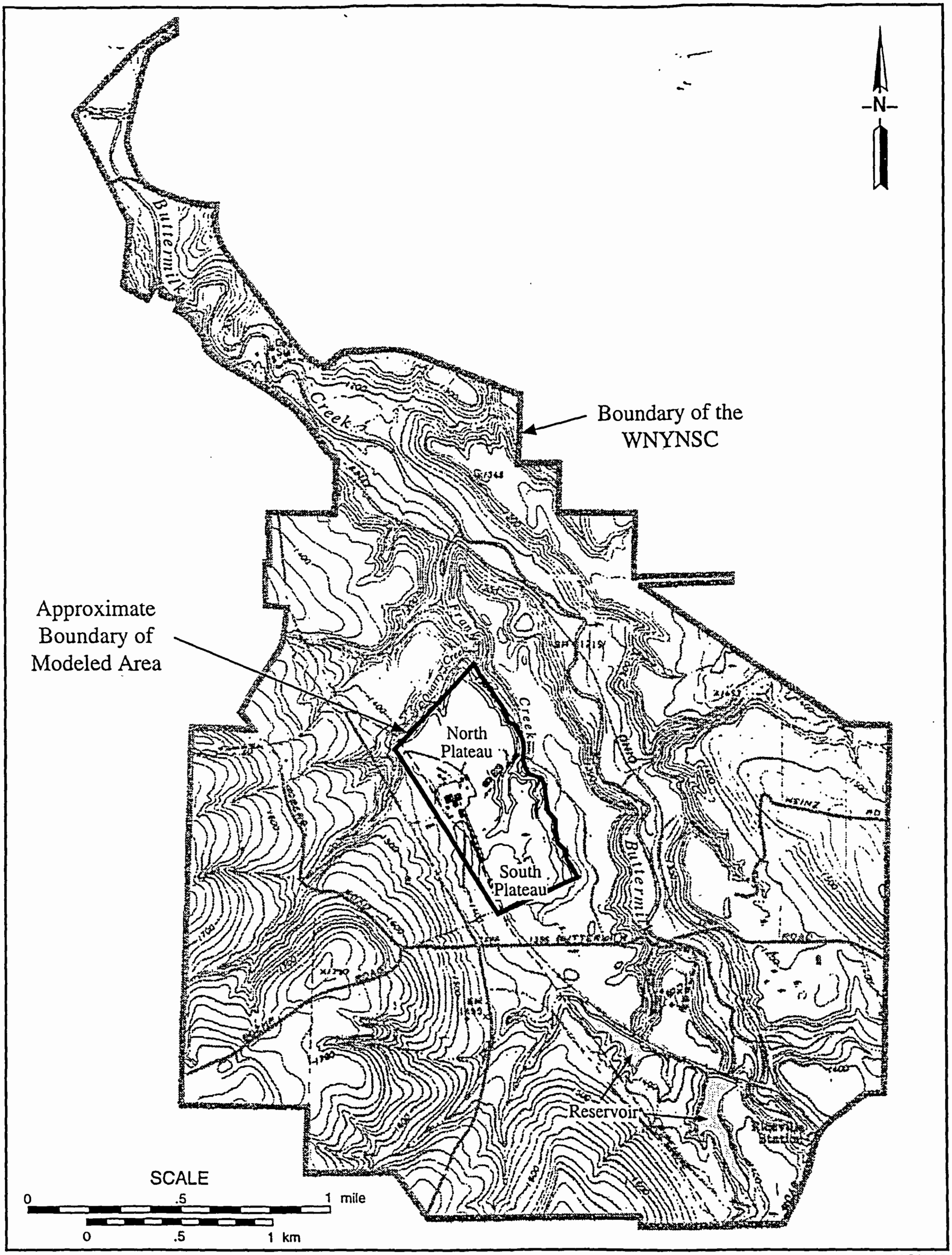

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Figure J-2. Approximate Boundary of the Modeled Area at the Western New York Nuclear Service Center.

J.2 PURPOSE AND OBJECTIVES OF MODELING

The purpose of developing a site-specific model is to gain insight into the hydrogeochemical processes occurring in the subsurface in order to predict the flow of groundwater and the transport of contaminants from potential sources. The objectives of this modeling study are listed below:

- To establish baseline conditions at the start of closure; for purposes of analysis, the West Valley Demonstration Project (WVDP) decontamination and decommissioning activities and closure or long-term management of the Center were assumed to start in the year 2000. Baseline conditions include the distribution of hydraulic heads and groundwater velocities and the spatial distribution of groundwater concentration of radiological contamination in the model area.

- To simulate groundwater flow and contaminant transport for the five alternatives being evaluated in this EIS.

- To provide data to support the long-term performance assessment including identification of potential subsurface flow paths and groundwater velocities along these flow paths.

The following conditions apply to the numerical modeling:

- Changes in the hydrogeological system caused by erosion were not considered in the groundwater modeling. Erosion modeling is discussed in Appendix L and incorporated into the radiological and hazardous chemical risk assessments discussed in Appendix D.

- To estimate the baseline distribution of contaminants in the year 2000, the distribution of contaminants in 1991 was used for the initial condition. For radionuclide transport, the model considers the spatial distribution of contaminants without the contaminant source. The leach rate, contaminant leaching, and time since the leaching started were unavailable. Quantifying the contaminant source in the absence of the above information is not rigorous. However, detailed information on contaminant concentrations in groundwater and soil was used for groundwater modeling. A conservative estimate of the source for the north plateau groundwater plume was developed for the long-term performance assessment as discussed in Appendix D.

- The model assumes water and media are incompressible.

- The three-dimensional groundwater flow model considers individual radionuclides and simulates their decay, but does not simulate ingrowth of daughter radionuclides. Ingrowth of daughter radionuclides is evaluated in the risk assessment models as discussed in Appendix D and E.

J.3 SITE DESCRIPTION AND MODEL CONCEPTUALIZATION

This section describes the physical system and its features that were incorporated into the conceptual model. The study (modeled) area is a subset of the bedrock valley described in Section J.1 and represented in Figure J-1 and of the Center as represented in Figure J-2. The topography of the model area is presented in Figure J-3. A conceptual model is a simplified description of the site hydrogeology and of the physical and chemical phenomena affecting contaminant migration in the model area. The conceptual model focuses on groundwater flow in the four uppermost hydrogeologic units under the Project Premises and the SDA. The configuration of the hydrogeologic units for the north and south plateaus are presented in Figures 4.4 and 4.5, respectively. Section J.3.1 summarizes the hydrogeologic setting for the study area and Section J.3.2 gives the model conceptualization.

J.3.1 Hydrogeologic Setting

The discussion of the hydrogeology of each unit describes the physical characteristics of the unit, the recharge and discharge areas for each unit, and the direction of flow within the unit. The hydrogeology of the individual units is described in ascending order from the bedrock (deepest) to the sand and gravel layer (shallowest).

J.3.1.1 Bedrock

The bedrock underlying the area consists of shale and sandstone and the depth to bedrock is less than 1 m (3 ft) along the hillsides of Buttermilk Creek valley west of the plant. Bedrock is exposed in the upland stream channels along Quarry Creek northwest of the site, in hill tops west and south of the site, and in the steep-walled gorges cut by Cattaraugus Creek to the north and by Connoissarauley Creek to the west (Bergeron et al. 1987). The upper 3 m (10 ft) of bedrock has been both mechanically and chemically weathered and contains abundant fractures and decomposed rock, allowing this layer to transmit more groundwater than the underlying competent (i.e., less weathered and fractured) bedrock. Recharge to bedrock is from precipitation on the upland areas west of the Project Premises (outside the model area). Subsurface groundwater flow in the weathered bedrock follows the buried topography toward the northwest. Some groundwater flow from weathered bedrock into the sand and gravel layer and weathered till may occur upgradient (west) of the Project Premises but outside the modeled area. Other than the sand and gravel layer, the weathered bedrock is the only other major water-bearing unit on the north plateau.

J.3.1.2 Kent Recessional Unit

The Kent recessional unit is a sequence of laminated silt and clay that grades upward into sand and silt at the top. This unit outcrops along the west bank of Buttermilk Creek (LaFleur 1979). The upper part of the recessional sequence is unsaturated (Prudic 1986), with 2 out of 13 wells completed in this formation on the south plateau consistently dry and 4 out of 5 wells on the north plateau dry (WVNS 1993b). The unsaturated conditions result from the very low vertical permeability of and slow recharge rate through the overlying layer (the unweathered till). In contrast, the recessional sequence has a high horizontal conductivity.

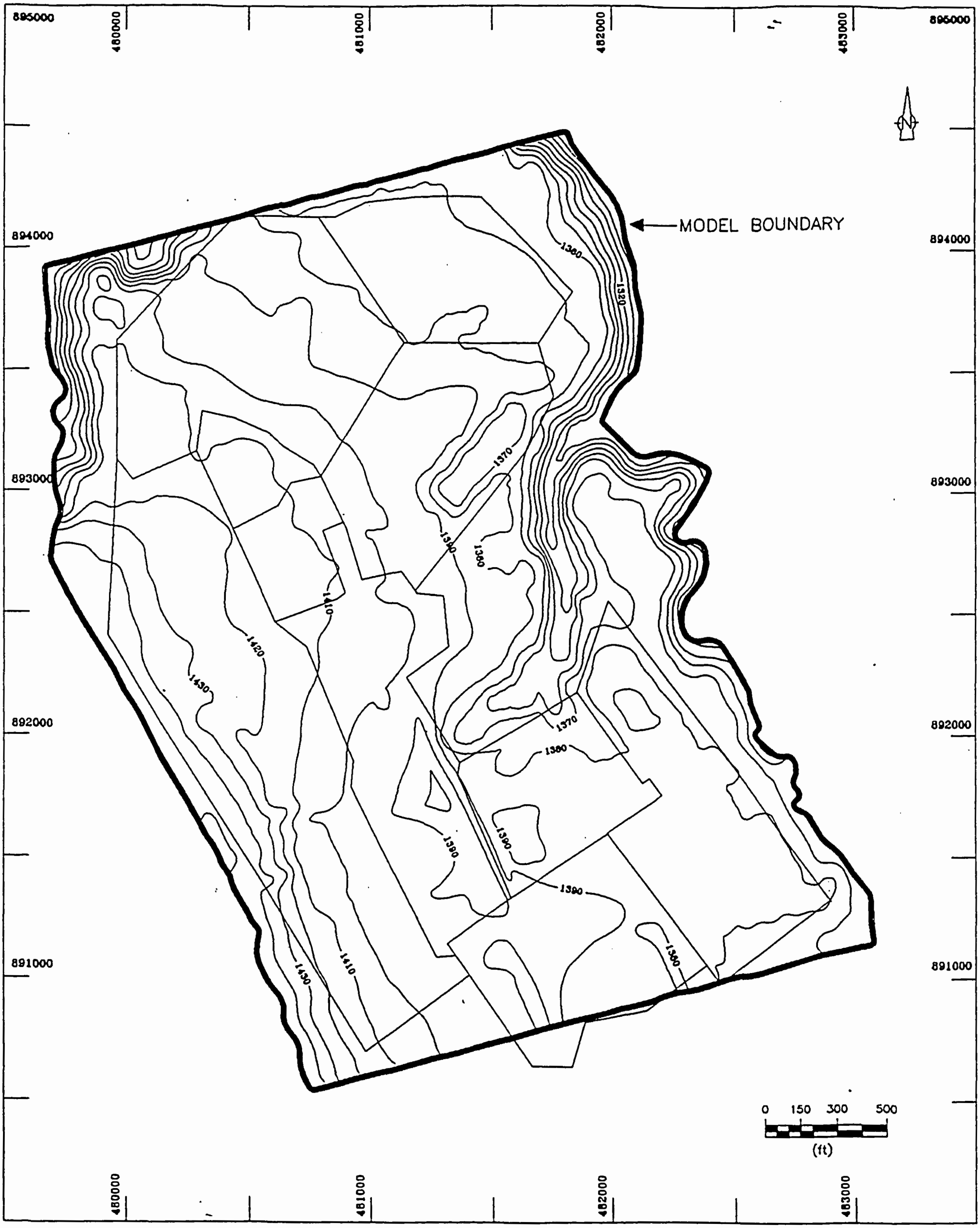

Figure J-3. Topography of the Model Area (elevations in ft above mean sea level).

The direction of groundwater flow is east toward Buttermilk Creek. Although moist zones indicating seepage are present, they occur outside the modeled area. No major springs are evident in outcrops along Buttermilk Creek (WVNS 1993b) although some discharge to the creek may occur (Prudic 1986).

J.3.1.3 Unweathered Lavery Till

The unweathered Lavery till (unweathered till) underlies both the north and south plateau and is a silty clay that contains minor amounts of discontinuous, randomly oriented lenses or masses of stratified sand, gravel, silt, and rhythmic clay-silt lamination (Albanese et al. 1983). Piezometers screened at shallower depths show seasonal variations in water levels; piezometers installed at deeper levels show little or no variation in water levels throughout the year (WVNS 1993b). The groundwater flow direction in the unweathered till is directed downward to the underlying Kent recessional unit.

J.3.1.4 Till Sand

The till sand unit is a sand deposit on the north plateau within the upper 6.1 m (20 ft) of the unweathered Lavery till on the north plateau. Although isolated lenses and stringers of fine to coarse sand are common within the Lavery till, borehole data suggest that this till sand unit is continuous beneath the process building and adjacent facilities. The majority of the unit; however, lies east of the process building and is under confined conditions. Groundwater in the till sand flows southeast toward Erdman Brook after the topography. Recharge to the till sand from overlying units has not been observed based on available well control. No significant discharge zones have been observed in the field (WVNS 1993b).

J.3.1.5 Weathered Lavery Till

The weathered Lavery till (weathered till) is located on the south plateau, contains numerous root tubes, and is highly desiccated, resulting in intersecting horizontal and vertical fractures. These factors indicate that the weathered till has a higher permeability than the underlying unweathered till. The contact between the unweathered and weathered till can be distinct or gradual. Vertical fractures have been observed from the ground surface to a depth of 8 m (26 ft) below ground surface, extending into the unweathered till. The thickness of the weathered till across the south plateau varies from 0.9 to 4.9 m (3 to 15 ft) and averages about 3 m (10 ft). The general direction of flow is controlled by topography (Figure J-3). Some groundwater within the weathered till discharges to the local marshes and stream valleys that border the south plateau and to the underlying unweathered till.

J.3.1.6 Sand and Gravel Layer

The surficial sand and gravel layer is found only on the north plateau. Unconfined groundwater flow in the sand and gravel layer is primarily horizontal, because the low hydraulic conductivity of the underlying unweathered till prevents significant downward flow. The water levels are typically highest in April and lowest in July and groundwater flow is controlled by topography, which generally slopes from the southwest to the northeast toward

Franks Creek (Figure 4-11). Recharge to groundwater is from precipitation, subsurface flow from bedrock located upslope of the Project Premises, and leakage from plant operations. Groundwater is discharged from the sand and gravel layer via several pathways, including evapotranspiration; seepage to streams, springs, and stream faces above the sand and gravel/unweathered till contact along the periphery of the north plateau; the french drain adjacent to lagoons 2 and 3; and downward flow to the underlying Lavery till.

J.3.2 Previous Modeling

There have been several previous modeling studies of the hydrogeologic system under the Project Premises and the SDA. The United States Geological Survey (USGS) modeled groundwater flow conditions under the north plateau (Yager 1987) and the south plateau (Prudic 1986). Kool and Wu (1991), the New York State Geological Survey (Albanese et al. 1983), DOE (1986), and Dames and Moore (1987) have modeled groundwater flow on the south plateau. Table J-1 summarizes the previous modeling. These models were either one- or two-dimensional, either in cross sectional or planar view. The previous modeling did not consider multiple lithological units (i.e., the sand and gravel layer, the weathered till, the unweathered till, and the till sand) at the site or evaluate both the north and south plateaus as an integrated hydrogeologic system.

Table J-1. Summary of Modeling Investigations of the West Valley Demonstration Project Premises and the SDA

Reference	Hydrogeologic Unit Modeled	Location	Processes Modeled	Model
Bergeron and Bugliosi (1988)	Weathered Till Unweathered Till	South Plateau	Flow	FEMWATER
Albanese et al. (1983)			Simple water budget	
U.S. Department of Energy (1986)	Weathered Till Unweathered Till	South Plateau	Flow and Transport	FEMWATER PRESTO
Dames and Moore (1987)	Weathered Till	South Plateau RTS Drum Cell Building	Uncalibrated	CREAMS
Kool and Wu (1991)	Weathered Till Unweathered Till	South Plateau NDA Interceptor Trench and NDA Trenches	Flow and Transport	VAM2D
Prudic (1986)	Weathered Till Unweathered Till	South Plateau SDA	Flow and Transport	FEMWATER Analytical Solution
Yager (1987)	Sand and Gravel Layer	North Plateau	Flow	MODFLOW
Current Study	Sand and Gravel Layer Weathered Till Unweathered Till Till Sand	North Plateau South Plateau	Flow and Transport	3DFEMWATER 3DLEWASTE

J.3.3 Model Conceptualization

In the current conceptual model of the site, the hydrogeological system is modeled as multilayered, consisting of a sand and gravel layer, a weathered till layer, an unweathered till layer, and till sand lenses. Figure J-4 is a conceptualization of the groundwater flow system for the north and south plateaus. Not all of the layers are continuous across the model area. The sand and gravel layer is only on the north plateau and the weathered till is only on the south plateau, both layers are underlain by unweathered till. The unweathered till has sand lenses, which may or may not be connected to each other. The layers vary in thickness across the site. The water table represents the upper extent of the unconfined hydrogeologic system. Water flow in the sand and gravel layer is predominantly horizontal. Fluctuations in the water table are high in the weathered till compared to the sand and gravel layer. The base of the model in the study area is the contact between the Kent recessional unit and the overlying unweathered Lavery till. The lower boundary is modeled as a constant head surface, consistent with existing well data.

The spatial and temporal variability in hydrogeological properties and microclimate play an important role in determining the hydrologic response of the groundwater system. The thickness of both the vadose zone and the unconfined aquifer varies, depending on the spatial variability of the geologic deposits, the elevation of the land surface, and the elevation of the low-permeability porous or fractured layers that form the hydrologic base of the unconfined aquifer varies. The water table fluctuates with changes in precipitation and with human-induced factors (e.g., infiltration from ponds, ditches, irrigation). These factors demonstrate that the hydrogeology of the sand and gravel layer and of the Lavery till (weathered and unweathered) is a dynamic, three-dimensional system.

J.3.4 Data Base

For more than 10 years, various field investigations have been conducted at the Project Premises and the SDA to gain better insight into the subsurface stratigraphy and groundwater flow in the study area. During 1989 and 1990 a network of 107 monitoring wells was installed to monitor groundwater quality. The hydraulic conductivity, water quality, and water level data used to model the formations underlying the study area are summarized in Table J-2. Table J-2 also identifies the number of wells screened in a particular unit.

The majority of the hydrogeologic data used as input for the model are in the following reports or data files:

- West Valley Nuclear Services, Inc. (WVNS), 1993a. *Environmental Information Document, Vol. I, Geology,* WVDP-EIS-004, Rev. 0.

- WVNS, 1993c. *Environmental Information Document, Vol. III, Hydrology: Part 4, Vadose Zone Hydrology*, WVDP-EIS-009, Rev. 0.

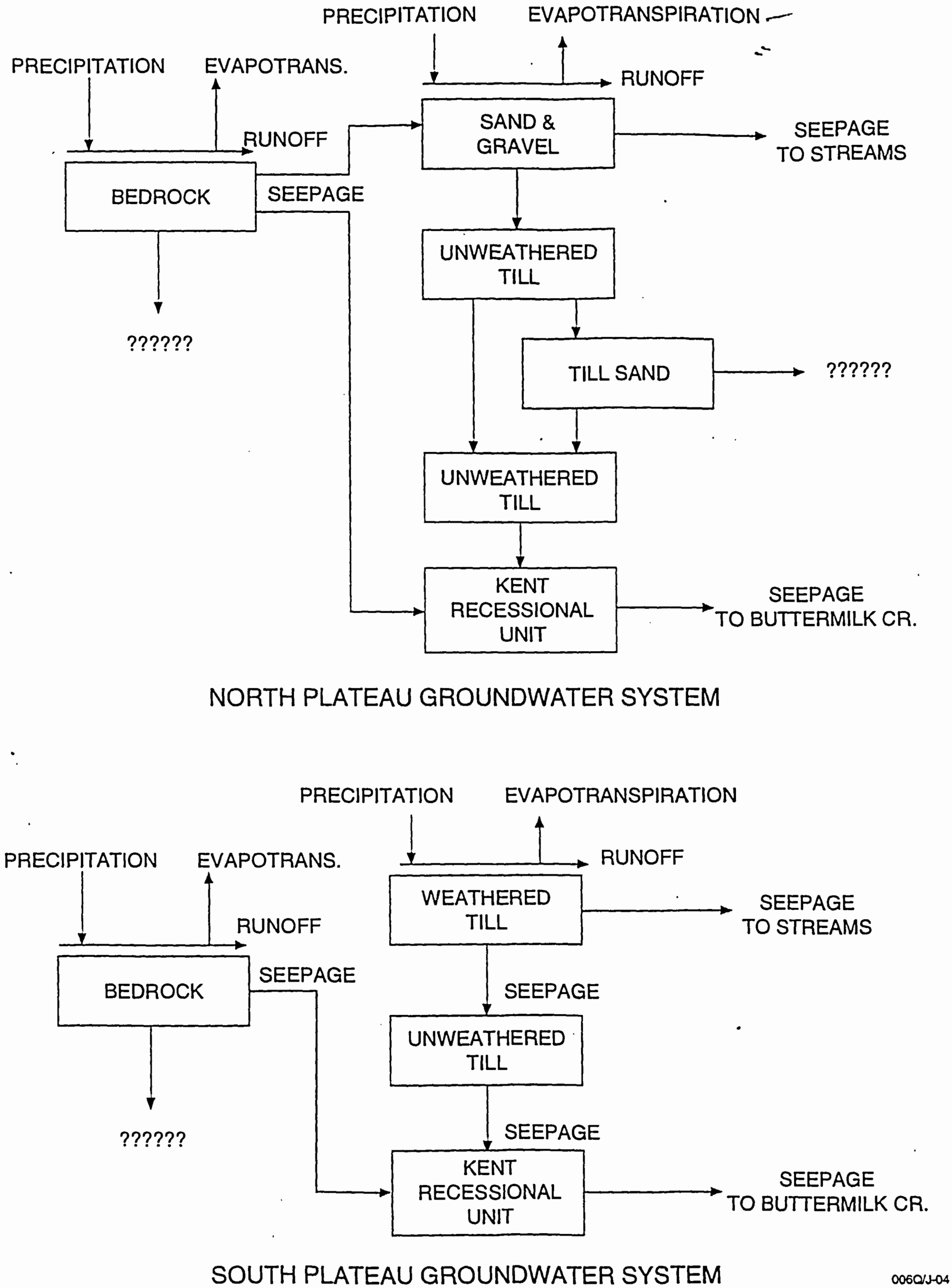

Figure J-4. **Conceptual Model for the Hydrogeologic System on the North and South Plateaus.**

Table J-2. Summary of Data Used in the Modeling

	No. Wells Screened	Hydraulic Conductivity[a]	Water-Quality[b]	1991 Water Level
Sand and Gravel Layer	49	26	40	36
Weathered Till	17	8	17	14
Unweathered Till	47	40	24	21
Till Sand Unit	9	1	9	9
Kent Recessional Unit	23	8	13	18[c]
Bedrock	7	NA[d]	NA	NA

a. Hydraulic conductivity value calculated from field measurements (i.e., slug tests).
b. Number of wells that monitor tritium, gross alpha, and gross beta.
c. Thirteen wells located on the south plateau (2 are dry). Five wells located on the north plateau (4 are dry).
d. NA = Not available.

- WVNS, 1993b. *Environmental Information Document, Vol. III, Hydrology: Part 4, Groundwater Hydrology and Geochemistry*, WVDP-EIS-009, Rev. 0.
- 1991 water-level data files (used for model calibration).

J.3.5 Model Area

The model area used in this study is shown in Figure J-5. The location of the model boundaries is important for accurate simulation of the hydrogeological conditions at the site. For this reason, model boundaries were extended to the natural (physical) boundaries of the site as much as possible. The following physical features define the model boundaries. The eastern boundary lies within Franks Creek, a discharge area; the northern portion of the western boundary is defined by Quarry Creek, a discharge area; the southern portion of the western boundary lies on the 435 m (1,450 ft) topographic contour; and the northern and southern boundaries are defined by swamps on the north and south plateaus. The base of the unweathered till forms the lower boundary of the model and the ground surface is the top boundary. The west-to-east and south-to-north dimensions of the model area are approximately 730 m (2,400 ft) and 1,020 m (3,350 ft), respectively. The thickness of the modeled volume is approximately 6 m (20 ft) along the western boundary and varies from 20 to 30 m (66 to 100 ft) along the eastern boundary.

J.3.6 Factors Affecting Groundwater Flow

Groundwater flow on the Project Premises and the SDA is controlled by natural and man-made features. Natural features controlling groundwater movement include fractures and hydraulic conductivity. Man-made features affecting flow include such things as the storage

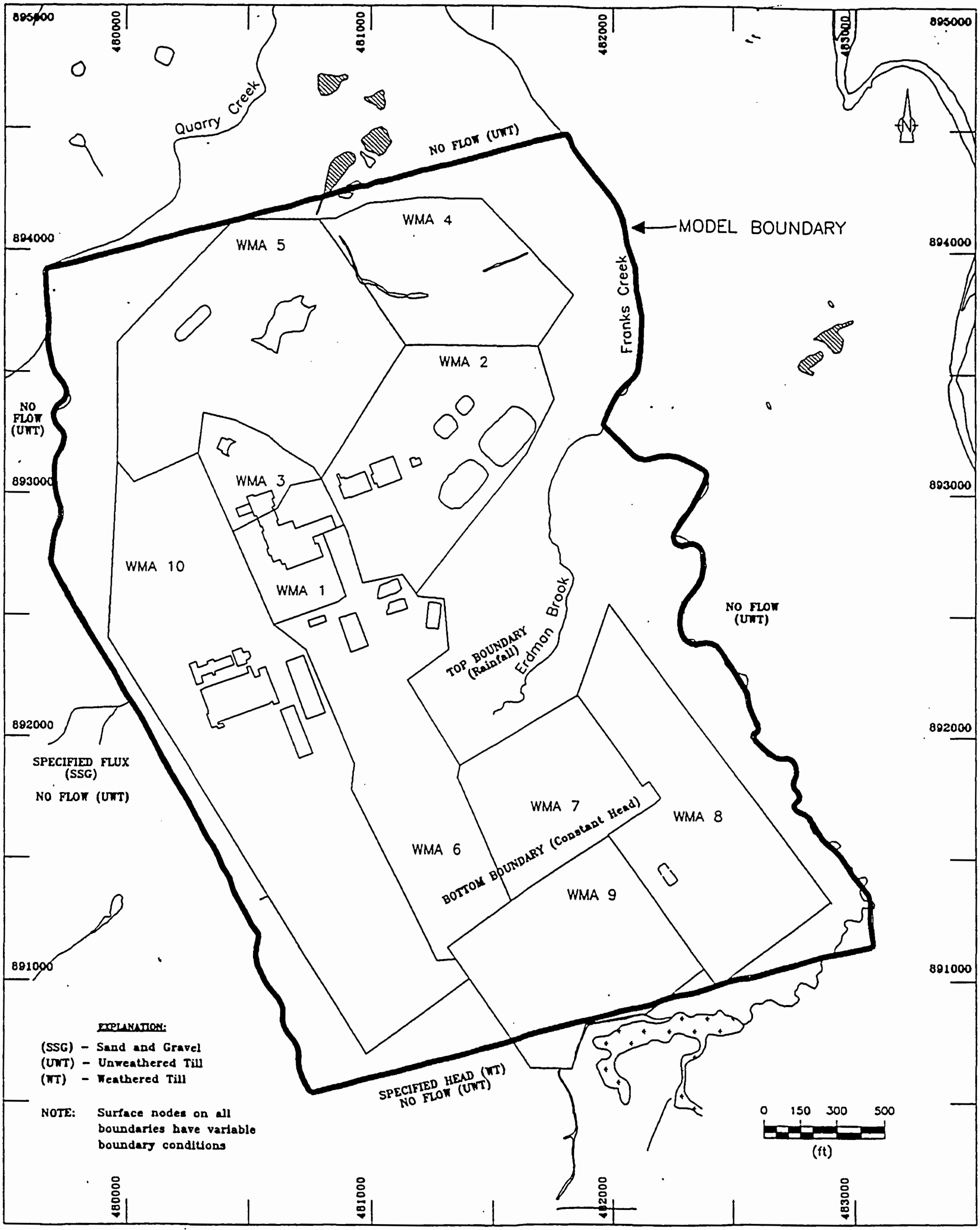

Figure J-5. Physical Boundaries and Boundary Conditions for the Flow Model.

lagoons, the trench interceptor and paved parking lots. These phenomena affecting flow are described below.

J.3.6.1 Flow Under Undisturbed Conditions

Variability in Hydraulic Conductivity. Hydraulic conductivity is the major controlling factor for the movement of groundwater. Variation in the hydraulic conductivity can alter flow paths and groundwater velocities along those flow paths. Laboratory and field tests have been performed at the site to characterize the hydraulic conductivity of the formations. Results from these tests are based on different assumptions and scales. Field tests are more reliable than laboratory tests since they account for the effects of fractures and compaction. Laboratory analysis tests a smaller and potentially less representative portion of the formation than hydraulic well tests.

The hydraulic conductivity of the sand and gravel layer determined by slug tests varies greatly and ranges from 1.8×10^{-5} to 4.2×10^{-3} cm/s (0.05 to 12.0 ft/day). Figure J-6 shows the spatial variability of the hydraulic conductivity in the sand and gravel layer as determined from slug tests of monitoring wells. Near the process building, the high-level liquid waste complex, and the low-level waste treatment facility the hydraulic conductivity is lower (WVNS 1993b) because of backfilling and compaction of soil during construction activity.

Limited data (eight slug tests) are available for the hydraulic conductivity of the fractured weathered till. The measured hydraulic conductivity of the weathered till ranges from 2×10^{-8} to 6×10^{-6} cm/s (6×10^{-5} to 2×10^{-2} ft/day). The unweathered till does not show significant spatial variation in the hydraulic conductivity. Measured values range from 2.1×10^{-8} to 7.5×10^{-7} cm/s (6.0×10^{-5} to 2.1×10^{-3} ft/day) based on data from 40 wells.

Laboratory tests have been conducted on six core samples of the unweathered till to determine the effect of increased confining pressures on hydraulic conductivity (Prudic 1981). Vertical hydraulic conductivity decreased about 40 percent as confining pressures increased from near atmospheric to 7 kg/cm^2 (14 to 100 lb/in.^{2}) (a pressure equivalent to a depth of 30 m [100 ft]). These results suggest that increased overburden pressure reduces the hydraulic conductivity. About half of this decrease occurred between confining pressures near atmospheric and 1 kg/cm^2 (14 lb/in.^{2}). At pressures between 1 and 7 kg/cm^2 (14 to 100 lb/in.^{2}), vertical conductivity decreased linearly (Prudic 1981).

Five core samples of the unweathered till were reacted with simulated trench water to determine if leachate contained in the disposal trenches would affect hydraulic conductivity. Three samples showed a three- to seven-fold decrease in permeability compared to values obtained from earlier tests with formation water only; the other two samples showed little or no effect. The results of these laboratory tests suggest that geochemical reactions between trench water and the till may reduce the hydraulic conductivity (Prudic 1986).

Fractures. Fractures in the weathered till play an important role in groundwater flow on the south plateau. They may either be intrinsic or could develop in response to construction activities. Data on fracture characteristics such as aperture width, orientation, and density are

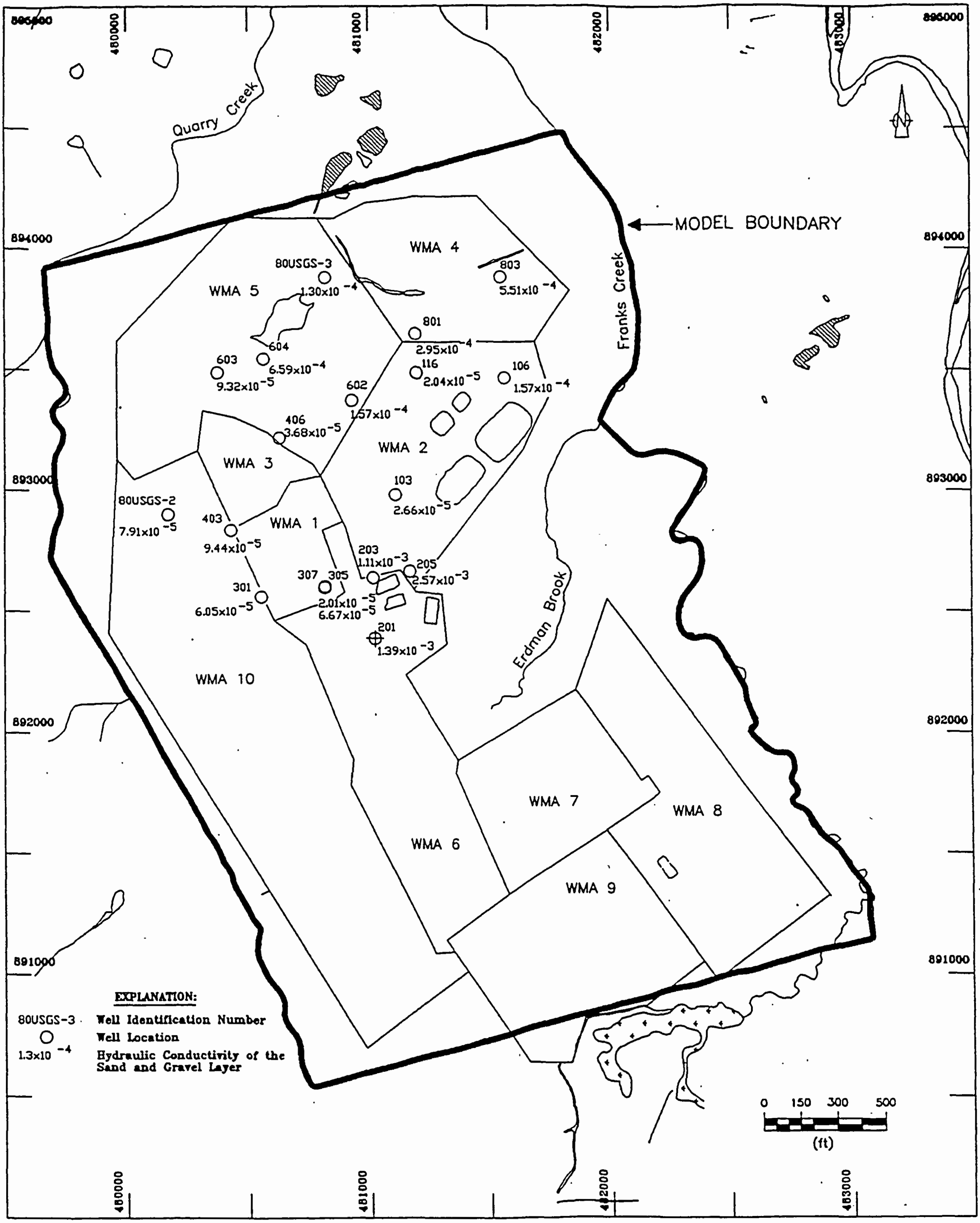

Figure J-6. Distribution of Hydraulic Conductivity in the Sand and Gravel Layer from Slug Tests (cm/s) (modified from WVNS 1993c).

not available for every area within the Project Premises. However, the following statements summarize observations on fractures within the study area:

- The density of fractures within a formation is controlled by moisture content and soil development in the till. The more weathered the soil and drier the till, the more prevalent the fractures. The orientation and spacing of most fractures is determined by the internal fabric of the till (WVNS 1993c).

- Calculations based on the engineering properties of the moist till at depth indicate that, due to its plasticity, the unweathered till will not accommodate open fractures at depths greater than 15 m (50 ft) (WVNS 1993c). A test trench excavated to a depth greater than 13 m (43 ft) did not detect fractures in the moist, unweathered till even after the walls had been exposed for several hours (WVNS 1993c).

- Tritium measurements in water from a water-bearing gravel lens at 13 m (43 ft) indicated that groundwater at this location had not been affected by infiltration of modern (post-1952) surface water (WVNS 1993c), indicating that fractures had not penetrated to 13 m (43 ft) in the tested area.

- The calculated maximum depth for open fractures in the Lavery till is 15 m (50 ft). Fractures have been observed to a depth of 8 m (26 ft) (WVNS 1993c).

- Oxidized fractures decrease in number and width with depth and were absent below about 5 m (16 ft) in the walls of a research trench located 200 m (660 ft) from the SDA (Dana et al. 1979).

- Computer simulations of groundwater flow in the till indicate that the weathered till is as much as 10 times more permeable than the unweathered till to a depth of 5 m (16 ft), presumably because of fractures (Prudic 1986).

- Infiltration and percolation affect the piezometric levels at depth. The lag time between precipitation events and their effect on the piezometric level of the Kent recessional unit was approximately 6 months (WVNS 1993a).

- Deep penetrating fractures could potentially act as conduits for the migration of contaminants to deeper units; however, no such fractures have been documented.

J.3.6.2 Flow Under Disturbed Conditions

This section describes how flow is influenced by various man-made features on both the north and south plateaus (Figure J-7).

On the north plateau, the plant facilities have altered the natural groundwater flow pattern by obstructing flow in some areas and providing preferential discharge points in others. These effects are discussed by waste management area (WMA). In WMAs 1 and 3, the fuel receiving and storage pool and the liquid high-level waste tank complex, respectively,

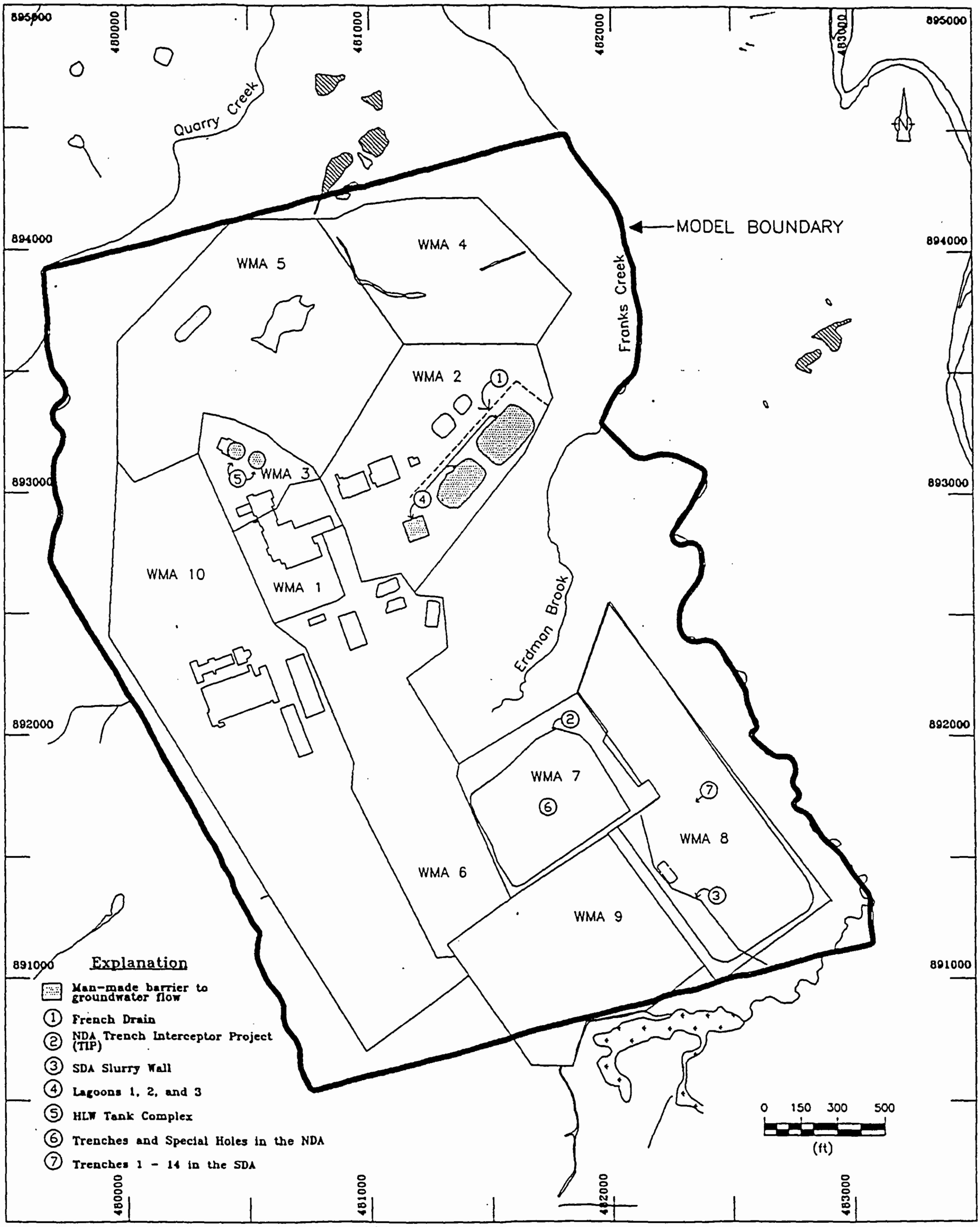

Figure J-7. Man-made Barriers to Groundwater Flow.

fully penetrate the sand and gravel layer and prevent groundwater flow through portions of these areas. The backfill surrounding these structures is less permeable than the native formations, which impedes groundwater flow.

The drainage structures and wastewater lagoons in WMA 2 have also affected the natural groundwater flow. Two drainage structures (the french drain adjacent to lagoons 2 and 3 and the ditch connecting the woodland to the stream channel above station NP-3) installed to remove groundwater from parts of the north plateau discharge groundwater throughout the year and tend to act as a sink, that is, flow is toward these areas. Lagoons 4 and 5 were built above the land surface in 1971. Although their bases were sealed with silty clay till, wastewater may have leaked to the sand and gravel layer. In 1974, the lagoons were lined with a synthetic material to prevent further leakage. Lagoons 2 and 3 were both excavated into the underlying till below the sand and gravel layer; however, wastewater can leak into the sand and gravel layer whenever the water level in the lagoons rises above the contact between the till and the sand and gravel layer. The french drain described above has reduced seepage to lagoons 2 and 3, but seepage still occurs along the southwest side of lagoon 2. In 1984, lagoon 1 was backfilled and decommissioned from the low-level waste treatment system.

On the south plateau, disposal holes and trenches in the NDA and SDA modify groundwater flow in the weathered till layer. Flow across the NDA is presumed to be discontinuous and limited because of the numerous disposal trenches and special holes that could act as hydraulic sinks. The trench interceptor project modifies flow downgradient of the NDA. Horizontal flow within the interior of the SDA is limited because the water levels are maintained below the contact of the weathered till by the presence of partially saturated trenches. A slurry wall in the weathered till located along a portion of the western edge of the SDA prevents groundwater movement into the SDA.

J.3.7 Vadose Zone

The vadose zone occurring between the land surface and the water table contains water at pressures below atmospheric pressure and voids containing both air and water. Under the unsaturated conditions observed in the vadose zone, hydraulic conductivity is a strong, non-linear function of water content, decreasing several orders of magnitude as water content decreases from the saturation level. This functional relationship plays a role in establishing infiltration and evaporation rates and the related elevation of the water table. During storm events, infiltration creates a wetting front which moves downward through the vadose zone under the influence of gravitational and capillary forces. During the dry season, evaporation occurs and an upward flux of water develops under the influence of capillary forces.

In the sand and gravel layer of the north plateau, the water table is located approximately 2 m (6 ft) below the ground surface near the process building and slopes downward to the northeast, intersecting the ground surface at the swamps and seeps north of the construction and demolition debris landfill (CDDL). Annual average fluctuation of the water table on the north plateau is approximately 0.77 m (3 ft) (WVNS 1993c). On the south plateau, the water table is located approximately 2 m (7 ft) below the ground surface during the dry season (summer) and at the ground surface during the wet season (winter). Water budget analysis indicates that annual average recharge to the sand and gravel layer on the north plateau is 17 cm/yr (6.7 in./yr) while recharge to the Lavery till on the south plateau is approximately 7 cm/yr (2.8 in./yr) (WVNS 1993c). Yager (1987) estimated that influx to the sand and gravel layer from bedrock on the western boundary of the Project Premises is 10 cm/yr (4 in./yr). Flow within the sand and gravel layer is predominately horizontal with limited leakage to the underlying unweathered till. On the south plateau, approximately 6 cm/yr (2.4 in./yr) of recharge flows horizontally through the weathered till, leaving 1 cm/yr (0.4 in./yr) of vertical percolation to the unweathered till (WVNS 1993c).

J.3.8 Solute Transport

Contaminant migration in groundwater is controlled by several factors, including advection, diffusion, and dispersion of dissolved contaminants, geochemical reactions with the formation, and chemical and radiological transformation of the contaminants.

Solute transport occurs in three dimensions. In the sand and gravel layer and weathered till, horizontal transport by advection dominates with mechanical dispersion playing a secondary role. In the unweathered till, the primary transport mechanism is molecular diffusion as indicated by the very low velocities. The radionuclide and organic source terms decrease over time through radiological and biological decay; therefore, the contaminant transport decreases over time. Contaminants may also be retarded by adsorption onto soil particles and, therefore, are not transported as fast as the groundwater. Laboratory adsorption measurements conducted with samples of sand and gravel, weathered till, and unweathered till (WVNS 1994) indicate that all units adsorb cobalt, strontium, cesium, iodine, and americium and that technitium is not readily bound to the soil phase.

J.4 NUMERICAL MODEL SELECTION

This section describes the selection of a numerical model appropriate to the site. Subsequent use of the term "model" refers to the selected numerical model unless otherwise specified. The use of a model with simplifying assumptions is justified because it allows meaningful predictions in a complex hydrogeological system. The selected model must be able to incorporate the factors (advection and dispersion) and processes (decay and adsorption) that control contaminant transport and transformation. For this study, the selected models had to be capable of simulating the following conditions:

- Confined or unconfined conditions
- Steady state or transient conditions

- Three-dimensional behavior of the aquifer (horizontal and vertical flow) and non-uniform distribution of the contaminant plume

- Variably saturated conditions

- Spatial and temporal variability in the hydrologic properties

- Spatial and temporal variations in boundary conditions

- Variable grid size and time step

- Minimum or negligible numerical dispersion

- Spatial (point and areal) and temporal variations in contaminant sources

- Transformation of contaminants

- Irregular geometry of the site.

In addition, the model should preferably be in the public domain.

Two models were identified that met the above criteria: 3DFEMWATER (A Three-dimensional Finite Element Model of WATER Flow through Saturated-Unsaturated Media, Yeh and Chang 1993; EPA 1992) for flow and 3DLEWASTE (A Three-dimensional Finite Element Model of WASTE Transport through Saturated-Unsaturated Media, Yeh and Chang 1993; EPA 1992) for contaminant transport. Both the models (source codes) are publicly available and can be used on DOS and UNIX-based platforms. The special features of 3DFEMWATER and 3DLEWASTE are flexibility and versatility in modeling a wide range of problems. 3DFEMWATER cannot explicitly account for fractured media; however, since it meets other site-specific requirements (e.g., surface infiltration, seepage, heterogeneity) and detailed quantitative data on fracture properties (e.g., fracture aperture, depth and direction) are not available, the use of 3DFEMWATER is justified for the site. It was assumed that the weathered till is so highly fractured that it behaves as a continuous porous medium. Data collected at a research trench excavated on the south plateau (WVNS 1993c) indicating a density of hundreds of fractures per model element supports use of the equivalent porous media approach. The effect of fractures is implicitly accounted for in the hydraulic parameters.

The flow and transport models have the capabilities described below:

- Treat heterogeneous and anisotropic media consisting of as many geologic formations as desired

- Consider both distributed and point sources/sinks that are spatially and temporally dependent

- Accept the prescribed initial conditions or obtain them by simulating a steady state version of the system under consideration

- Address a transient head and concentration distributed over the Dirichlet boundary

- Handle time-dependent total fluxes due to a pressure gradient varying along the Neumann boundary

- Treat time-dependent total fluxes distributed over the Cauchy boundary

- Automatically determine variable boundary conditions of evaporation, infiltration, or seepage at the soil-air interface

- Include the off-diagonal hydraulic conductivity components in the modified Richards equation for dealing with cases when the coordinate system does not coincide with the principal directions of the hydraulic conductivity tensor

- Automatically reset time step size when boundary conditions or source/sinks change abruptly

- Check the mass balance computation over the entire region for every time step.

Additionally, 3DLEWASTE:

- Completely eliminates numerical oscillation due to advection terms

- Can be applied to the mesh Peclet number, ranging from 0 to infinity (conventional finite element or finite difference models typically impose unduly severe restrictions on the mesh Peclet number)

- Can use very large time steps to greatly reduce numerical dispersion

- Includes three adsorption models—the linear isotherm and the nonlinear Freundlich and Langmuir isotherms

- Includes the conventional Eulerian approach as an option.

Moreover, the 3DLEWASTE model incorporates the hybrid Lagrangian-Eulerian finite element approach, which is superior to and will never be worse than its corresponding upstream finite element method. The mathematical details of the model are given in Yeh and Chang (1993).

J.5 DESCRIPTION OF NUMERICAL MODEL

This section describes the flow and transport models and discusses the input parameters used for the modeling study.

J.5.1 Flow Model

3DFEMWATER is designed to solve the following system of governing equations along with initial and boundary conditions, which describe flows through saturated-unsaturated media. Derivation of these equations are contained in Yeh (1987).

Governing Equation

$$F \frac{\partial h}{\partial t} = \nabla \cdot [K_s K_r \cdot (\nabla h + \nabla z)] + q \tag{J-1}$$

where h is the pressure head, t is time, K_s is the saturated hydraulic conductivity tensor, K_r is the relative hydraulic conductivity, z is the elevation head, q is the source or sink, and F is the water capacity given by ignoring water and formation compressibility. In equation J-2, θ is the volumetric moisture content.

$$F = \frac{d\theta}{dh} \tag{J-2}$$

Initial Conditions

$$h = h_i\ (x,y,z) \quad in\ R, \tag{J-3}$$

where R is the region of interest and h_i is the prescribed initial condition, which can be obtained by either field measurements or by solving the steady state version of equation J-1. Section J.5.4 describes how the various boundary conditions were incorporated into the model.

Boundary Conditions

Dirichlet Conditions:

$$h = h_d(x_b,y_b,z_b,t) \quad on \quad B_d \tag{J-4}$$

Neumann Conditions:

$$-n \cdot K_s K_r \cdot \nabla h = q_n(x_b,y_b,z_b,t) \quad on\ B_n, \qquad \text{(J-5)}$$

Cauchy Conditions:

$$-n \cdot (K_s K_r \cdot \nabla h + K_s K_r \cdot \nabla z) = q_c(x_b,y_b,z_b,t) \quad on\ B_c, \qquad \text{(J-6)}$$

Variable Conditions - During Precipitation Period:

$$h = h_p(x_b,y_b,z_b,t) \quad on\ B_v \qquad \text{(J-7)a}$$

or

$$-n \cdot (K_s K_r cdt \nabla h + K_s K_r \cdot \nabla z) = q_p(x_b,y_b,z_b,t) \quad on\ B_v, \qquad \text{(J-7b)}$$

Variable Conditions - During Nonprecipitation Period:

$$h = h_p(x_b,y_b,z_b,t) \quad on\ B_v, \qquad \text{(J-7c)}$$

or

$$h = h_m(x_b,y_b,z_b,t) \quad on\ B_v, \qquad \text{(J-7d)}$$

or

$$-n \cdot (\nabla h + \nabla z) = q_e(x_b,y_b,z_b,t) \quad on\ B_v, \qquad \text{(J-7e)}$$

where (x_b, y_b, z_b) is the spatial coordinate on the boundary; n is an outward unit vector normal to the boundary; h_d, q_n, and q_c are the prescribed Dirichlet functional value, Neumann flux, and Cauchy flux, respectively; B_d, B_n, and B_c are the Dirichlet, Neumann, and Cauchy boundary, respectively; B_v is the variable boundary; h_p is the allowed ponding depth and q_p is the infiltration of precipitation, respectively, on the variable boundary; h_m is the allowed minimum pressure on the variable boundary; and q_e is the allowed maximum evaporation rate on the variable boundary, which is the potential evaporation. Only the equations J.7a through J.7e are used at any point on the variable boundary at any time.

<u>*Soil Property Function Specifications*</u>

Analytical functions are used to describe the dependence of water content, water capacity, and relative hydraulic conductivity on pressure head. The relationships between water content, water capacity, relative hydraulic conductivity, and pressure head are given by van Genuchten (1980) as:

$$\theta = \theta_r + \frac{\theta_s - \theta_r}{[1 + (\alpha h)^n]^m} \tag{J-8}$$

in which

$$\frac{d\theta}{dh} = \alpha(n - 1)\ [1 - f(\theta)]^m\ [f(\theta)]\ (\theta_s - \theta_r) \tag{J-9}$$

$$K_r = [\ (\theta - \theta_s) \ /\ (\ \theta_s - \theta_r\ )\ ]^{1/2} \{\ 1 - [1 - f(\theta)\ ]^m\ \}^2 \tag{J-10}$$

and

$$f(\theta) = [\theta - \theta_r] \ /\ [\theta_s - \theta_r]^{1/m} \qquad m = 1 - \frac{1}{n} \tag{J-11}$$

where θ_r and θ_s are the residual and saturated volumetric water content, respectively; m, n, α are empirical parameters; and h is the piezometric pressure (head).

The model used in this study simulates unsaturated, as well as saturated, conditions. Therefore, the three functions presented above are needed to compute the water content, water capacity, and relative hydraulic conductivity based on the pressure head.

J.5.2 Transport Model

3DLEWASTE is designed to solve the following system of governing equations along with initial and boundary conditions, which describe the material transport through groundwater systems. The equations are derived based on the continuity of mass and flux laws. The major processes are advection, dispersion/diffusion, adsorption, decay, and source/sink.

Governing Equations

$$\theta\frac{\partial C}{\partial t} + \rho_b\frac{\partial S}{\partial t} + V\cdot\nabla C = \nabla\cdot\ (\theta D\cdot\nabla C)\ - \lambda(\theta C + \rho_b S)\ + QC_{in} \tag{J-12}$$

where

$$S = K_d C \quad \textit{for linear isotherm} \tag{J-13}$$

or

$$S = \frac{S_{max}\, KC}{1 + KC} \quad \textit{for Langmuir isotherm} \tag{J-14}$$

or

$$S = KC^n \quad \textit{for Freundlich isotherm} \tag{J-15}$$

where θ is the volumetric moisture content, ρ_b is the bulk density of the solid medium (M/L^3), C is the material concentration in aqueous phase (M/L^3), S is the material concentration in solid phase (M/M), t is time, **V** is the specific discharge (L/T), ∇ is the del operator, **D** is the dispersion coefficient tensor, λ is the decay constant (T^{-1}), Q is the source rate of water (L^3/T), C_{in} is the material concentration in the source (M/L^3), K_d is the distribution coefficient (L^3/M), S_{max} is the maximum concentration allowed in the medium in the Langmuir nonlinear isotherm (M/L^3), n is the power index in the Freundlich nonlinear isotherm, and K is the coefficient in the Langmuir or Freundlich nonlinear isotherm.

The dispersion coefficient tensor **D** in equation J.1 is given by

$$\theta D = a_T |V| \delta + (a_L - a_T)\, VV / |V| + \theta a_m \tau \delta \tag{J-16}$$

where $|\mathbf{V}|$ is the magnitude of **V**, δ is the Kronecker delta tensor, a_T is transverse dispersivity, a_L is the longitudinal dispersivity, a_m is the molecular diffusion coefficient, and τ is the tortuosity.

Initial Conditions

$$C = C_i(x,y,z) \; in \; R \tag{J-17}$$

Prescribed Concentration (Dirichlet) Boundary Conditions (specified concentration)

$$C = C_d(x_b,y_b,z_b,t) \; on \; B_d \tag{J-18}$$

Variable Boundary Conditions

$$n \cdot (VC - \theta D \cdot \nabla C) = n \cdot VC_v(x_b,y_b,z_b,t) \text{ if } n \cdot V \leq 0 \qquad \text{(J-19)}$$

$$n \cdot (-\theta D \cdot \nabla C) = 0 \text{ if } n \cdot V > 0$$

Cauchy Boundary Conditions (general boundary condition)

$$n \cdot (VC - \theta D \cdot \nabla C) = q_c(x_b,y_b,z_b,t) \text{ on } B_c \qquad \text{(J-21)}$$

Neumann Boundary Conditions (specified flux)

$$n \cdot (-\theta D \cdot \nabla C) = q_n(x_b,y_b,z_b,t) \text{ on } B_n \qquad \text{(J-22)}$$

where C_i is initial concentration; R is the region of interest; (X_b, Y_b, Z_b) is the spatial coordinate on the boundary; **n** is an outward unit vector normal to the boundary; C_d and C_v are the prescribed concentration on the Dirichlet boundary and the specified concentration of water through the variable boundary, respectively; B_d and B_v are the Dirichlet and variable boundaries, respectively; q_c and q_n are the prescribed total flux and gradient flux through the Cauchy and Neumann boundaries B_c and B_n, respectively.

Because the hybrid Lagrangian-Eulerian approach is used to simulate equation J-1, it is written in the Lagrangian-Eulerian form as

$$(\theta + \rho_b \frac{dS}{dC}) \frac{DC}{Dt} = \nabla \cdot (\theta D \cdot \nabla C) - \lambda(\theta C + \rho_b S) + QC_{in} - QC , \qquad \text{(J-23)}$$

$$V^* = \frac{V}{\theta + \rho_b K_d} \text{ for Linear isotherm model} \qquad \text{(J-24)}$$

$$\theta \frac{DC}{Dt} + \rho_b \frac{dS}{dC} \frac{\partial C}{\partial t} = \nabla \cdot (\theta D \cdot \nabla C) - \lambda(\theta C + \rho_b S) + QC_{in} - QC \qquad \text{(J-25)}$$

$$V^* = \frac{V}{\theta} \text{ for Freundlich and Langumir models} \qquad \text{(J-26)}$$

J.5.3 Model Grid Description

The finite-element grid used in this modeling study is shown in Figure J-8. The grid coordinates illustrate the dimensions of the grid blocks. The grid blocks vary in size from a minimum of 13 m (43 ft) to a maximum of 36 m (118 ft). The irregular shape of the grid results from the prescribed boundary conditions described in Section J.3.5. The grid consists of 29 x 43 x 19 (x,y,z) grid blocks (elements) and has a much finer grid at the lagoons in WMA 2 on the north plateau and with the NDA (WMA 7) and SDA (WMA 8) on the south plateau. Each grid-block has six sides and eight nodes (corners). Thus, the 3-dimensional mesh has 26,400 nodes and 23,693 elements.

For the vertical discretization of the grid, the topographic surface is the upper boundary and the base of the unweathered till is the lower boundary. The formations between these two boundaries vary in thickness, increasing from west to east to a maximum of 30.5 m (100 ft) below the south plateau. On the western side, the maximum thickness is 6.1 m (20 ft). The site is divided into 19 blocks in the vertical direction (Z-direction) which vary in thickness from 0.3 to 1.5 m (1 to 5 ft). The ratio in the Z-dimension between two adjacent blocks was never more than 1.5 to avoid convergence problems in the simulations.

J.5.4 Model Input Parameters

The major parameters used in simulation of groundwater flow are the unsaturated and saturated hydraulic conductivities. Additional supporting data include the amount of water entering the model area as precipitation and the boundary and initial conditions of hydraulic head and groundwater fluxes. This sub-section identifies the magnitudes of hydraulic conductivities used in the simulations while the following two sub-sections describe the boundary conditions and contaminant transport parameters used in the simulations.

J.5.4.1 Soil Characteristic Curves and Hydraulic Conductivity

To solve the variably saturated flow problem, it is necessary to specify the relationships between unsaturated hydraulic conductivity and moisture content and pressure head and water content. The van Genuchten (1980) relationship, given in equations J-9 and J-10, was used in conjunction with site specific data (WVNS 1993c) to define soil characteristic curves. The values of the empirical constants, α and n, were determined for each soil type by least squares fitting of the experimental data to the van Genuchten relationship. Parameter data for the soil characteristic curves are given in Table J-3. The complete data set and a complete description of the curve fitting procedure is presented in WVNS (1993c).

The saturated hydraulic conductivity values used in the model were calculated from field measurements and adjusted during model calibration. The hydraulic conductivity measurements used in model simulations are summarized in Table J-3. Although each element in the model was assigned an individual hydraulic conductivity value, significant spatial variation was represented only in the sand and gravel layer.

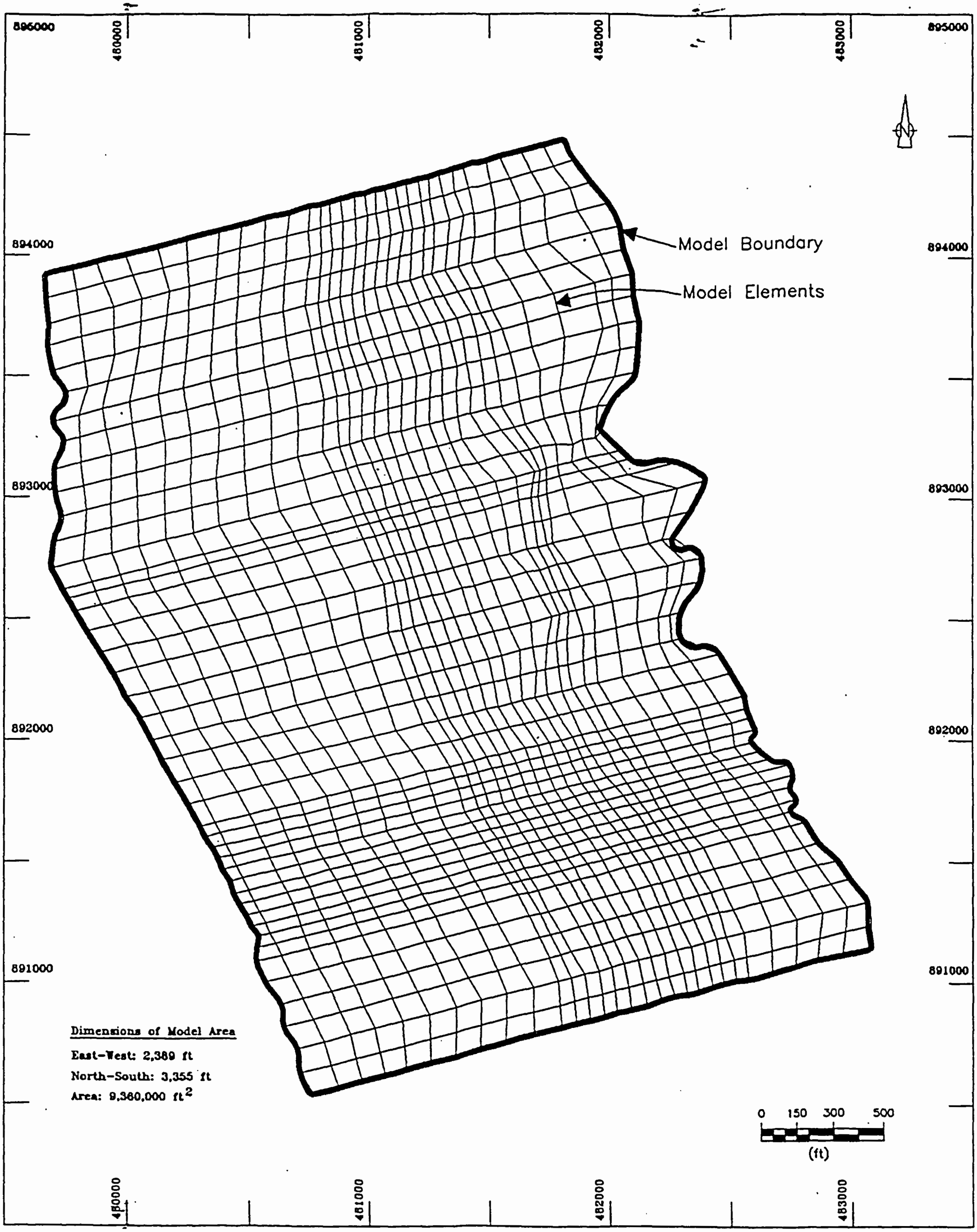

Figure J-8. Plan View of the 3-Dimensional Grid for the Project Premises and the SDA.

Table J-3. Hydrological Parameters for Soil Characteristic Curves and Hydraulic Conductivity

Hydrogeologic Units	Hydraulic Conductivity (ft/day)			Soil Characteristics			
	K_x[a]	K_y[a]	K_z[a]	(Θ_r)[b]	(Θ_s)[c]	α[d]	n[d]
Sand and Gravel Layer	0.05 - 12.0	0.05 - 12.0	0.005 - 1.2	0.135	0.27 - 0.35	.01 - 0.1	1.135 - 1.157
Weathered Till	8.5×10^{-3}	8.5×10^{-3}	8.5×10^{-3}	0.135	0.328	0.0215	1.142
Unweathered Till	1.6×10^{-4}	1.6×10^{-4}	1.6×10^{-4}	0.135	0.3	0.0634	1.1026
Till-sand Unit	0.4	0.4	0.04	0.135	0.27	0.01	1.135

a. K_x, K_y, K_z=Hydraulic conductivity in the x, y, and z directions
b. Θ_r=Residual saturation
c. Θ_s=100% Water saturation
d. Empirically-derived constants

For the model simulations, the saturated hydraulic conductivity of the weathered till was estimated to be more than an order of magnitude higher than that of the unweathered till (Prudic 1986). This increase in observed hydraulic conductivity reflects the presence of discontinuous sand lenses and the weathering and fracturing of the weathered till unit. The volume of the unit affected by the hydraulic testing was large enough to give an average contribution of the clay and sand. The clayey matrix of the unweathered till does not show significant spatial variation in the hydraulic conductivity. For the model simulations, the unweathered till was treated as isotropic consistent with Prudic's (1982) observations. To evaluate the significance of the till sand unit, two conceptual representations of the unweathered till were considered. In the first conceptual view, the till sand unit was modeled as a spatially continuous layer of elevated hydraulic conductivity within the unweathered till on the north plateau. In the second conceptual view, the till sand was absent from the model and the unweathered till was considered homogeneous and isotropic below both the north and south plateaus.

J.5.4.2 Precipitation

The daily rainfall rate was used as an input for determining the groundwater recharge in the model. Infiltration is calculated from the rainfall rate using equation J-1, using moisture characteristic relationships. The model calculates three discharge parameters—evapotranspiration, drainage, and seepage. The rainfall event used for the steady-state simulation of expected conditions was 5 cm (2 in.), equivalent to the 2-yr, 24-hour rainfall event.

J.5.4.3 Initial Conditions

Groundwater levels vary depending on location and the formation. The variation in groundwater levels create both horizontal and vertical gradients. Vertical gradient data for the site are presented in Table J-4 and Figure J-9. The vertical gradient map indicates that vertical flow is predominantly downward but that localized upward flow is possible. For the

Table J-4. Vertical Gradients from the Monitoring Wells[a]

Number	Well ID	Unit Screened	Water Levels May 1991	Gradient
1	201	SG[b]	1395.5	0.065
	202	TS[c]	1394.2	
2	203	SG	1393.1	0.000
	204	TS	1393.1	
3	205	SG	1392.2	-0.026
	206	TS	1392.9	
4	207	SG	1389.2	0.18
	208	TS	1387.0	
5	301	SG	1408.2	0.64
	302	TS	1398.5	
6	409	UWT[d]	1355.6	0.98
	86-08	SG	1391.8	
7	701	TS	1382.2	1.03
	706	SG	1399.8	
8	702	UWT	1363.8	1.50
	705	UWT	1393.8	
9	901	KR[e]	1285.1	0.76
	908	WT[f]	1373.7	
10	903	KR	1263.9	0.90
	904	UWT	1358.6	
11	1001	KR	1294.0	0.93
	1005	WT	1383.5	
12	1002	KR	1285.7	1.04
	1006	KR	1379.6	
13	1003	KR	1276.7	0.77
	1007	WT	1365.2	
14	1008B	KR	1376.2	0.58
	1008C	WT	1397.2	
15	1101A	WT	1371.6	0.99
	1101B	UT	1356.0	
	1101C	KR	1281.9	
16	1102A	WT	1373.9	1.92
	1102B	UT	1366.2	
17	1103A	WT	1378.4	0.78
	1103B	UT	1364.4	
	1103C	KR	DRY	
18	1104A	WT	1369.9	1.07
	1104B	UT	1353.8	
	1104C	KR	1253.5	
19	1105A	UT	1350.8	1.23
	1105A	UT	1336.0	
20	1106A	WT	1366.6	0.65
	1106B	UT	1356.9	

a. Heads in feet relative to atmospheric pressure and mean sea level.
b. SG=Sand and gravel layer.
c. TS=Till sand unit.
d. UWT=Unweathered Lavery till.
e. KR=Kent recessional unit.
f. WT=Weathered Lavery till.

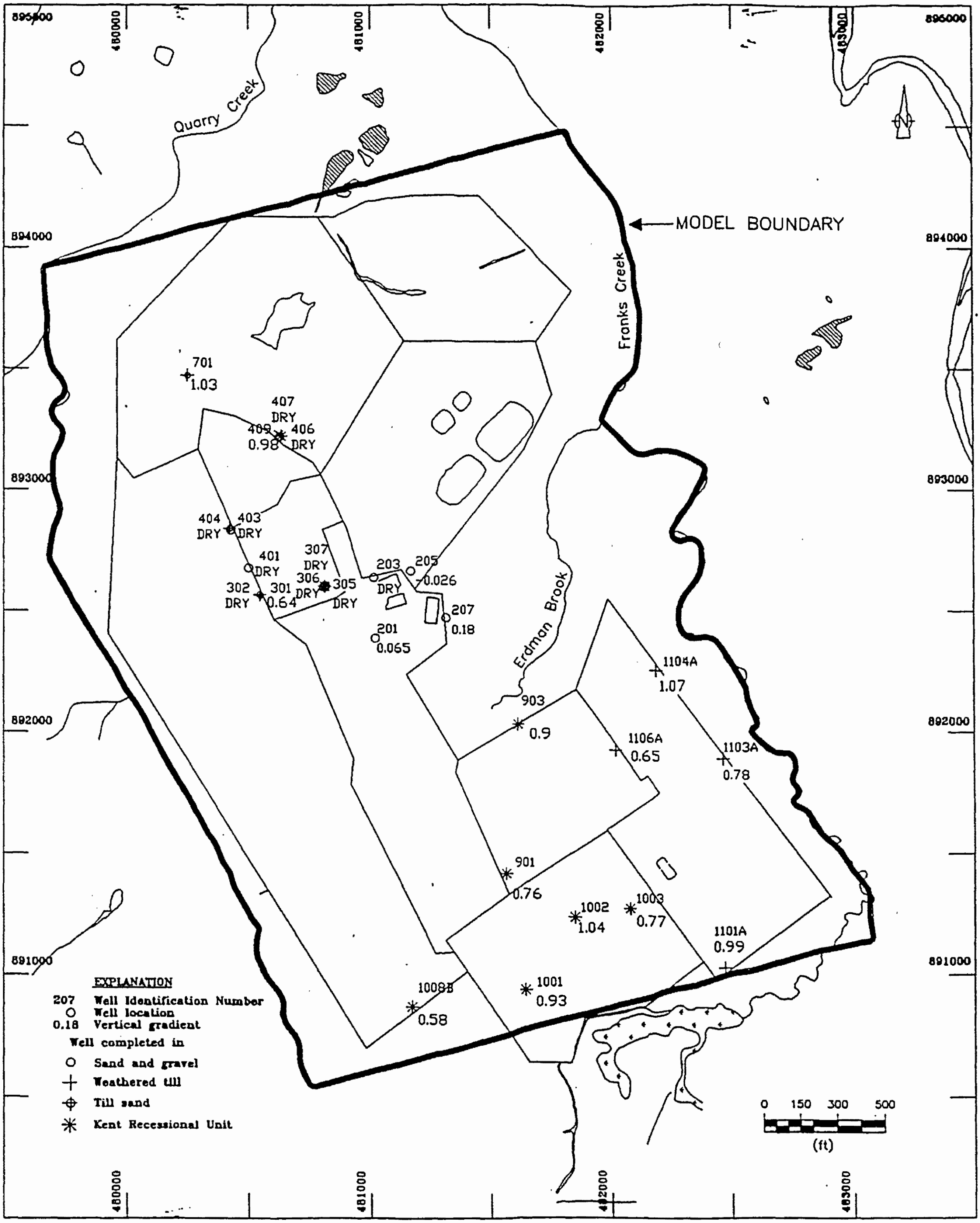

Figure J-9. Vertical Gradient Map.

steady state simulations, the water levels observed in January 1991 were used as initial conditions. For transient simulations, the initial conditions were the piezometric heads predicted in the steady state simulations.

J.5.5 Boundary Conditions

To accurately simulate the hydrogeological conditions, the boundary conditions have to be properly defined. The numerical model uses Dirichlet (specified head), Neumann (specified flux), and Cauchy (variable) boundary conditions to simulate groundwater flow into or out of the modeled area. The heads and fluxes can be specified to vary with time or remain constant over time. For both steady state and transient simulations, boundary conditions are specified for the top, bottom, and four sides of the model volume. For transient simulations, initial conditions are specified for each node of the model based on the results of steady state simulations.

For the upper surface of the model volume, the code computes infiltration through consideration of hydraulic conductivity and a specified precipitation rate. Initially infiltration is treated as flux into the soil at the same rate as the rainfall. When the rainfall rate exceeds the saturated hydraulic conductivity of the soil, the boundary condition changes to a specified head condition and runoff begins when the soil surface becomes saturated. When rainfall reduces or stops, the boundary condition reverts back to a flux boundary. Therefore, runoff is equal to the difference between rainfall and infiltration. This relationship is useful for when runoff and infiltration data are unavailable and only rainfall data are available. A constant head boundary condition is specified for the bottom of the model volume, based on the observation of unsaturated conditions in the top of the Kent recessional unit.

Specified head boundaries include the northern boundary at the swamps in the sand and gravel layer, the southern boundary at the surface and in the weathered till, the base of the model (base of the unweathered till), and along the southeastern boundary (Figure J-5).

The specified flux boundaries of the model include a no flow boundary at the unweathered till over the whole site, based on Prudic's (1986) observation that the hydraulic gradient in the unweathered till is essentially vertical, the western boundary where fluxes are calculated by the steady-state model along the 442 m (1,450 ft) topographic contour at the surface and in the sand and gravel layer, and a no flow boundary for the western part of the southern boundary based on the topographic control of groundwater flow direction.

Rainfall/seepage/evapotranspiration boundaries are special types of specified head and specified flux boundaries that vary with time in response to storm events. The ground surface is the infiltration boundary except in areas covered by man-made features (e.g., buildings). A seepage boundary occurs along the creeks and is a special flux boundary where the flux occurs in only one direction, into the creeks.

J.5.6 Solute Transport Parameters

An important consideration in the analysis of radionuclide migration is the applicability of 3DLEWASTE to the site, especially for the fractured media. Because the weathered till is highly fractured, it was assumed to be porous. Also, proper selection of transport parameters can reflect the effective transport characteristics of the fractured medium. Site-specific parameters were used for the model where possible. If site-specific parameters were not available, then literature values were used. Table J-5 summarizes the initial transport parameters used in the model.

Colloids may be present in groundwater either from direct release from a waste form or from the interaction between leached soluble radionuclides and native colloids in groundwater. Colloids can migrate faster or slower than non-colloidal contaminants depending on the hydrogeologic conditions and the processes (i.e., filtration, solubilization, and complexation) involved. In the first process, filtration, colloidal retention may reduce the porosity and permeability of a formation, therefore reducing the potential for migration and isolating the formation from further contact with groundwater. The second process, solubilization and complexation, facilitates radionuclide migration because colloids have low ionic charges and are less likely to be sorbed (Avogadro and de Marsily 1984).

The rate determining step in colloidal migration is governed by the radionuclide leaching rate from the waste form and the solubilization rate in the porous media. If the leach rate from the waste form is greater than the solubilization rate, collides will accumulate around an emplacement zone. If the leach rate is slower than the solubilization rate, then colloids will be of less importance. At the Project Premises and the SDA, the release rate from different sources and the dominate mechanism of colloidal radionuclide migration has not been experimentally determined. Therefore, for the purposes of establishing the year 2000 baseline, colloidal flow has not been addressed.

A constant coefficient of distribution (K_d) and thus a constant retardation value can be used for data analysis in simplified form. However, radionuclide adsorption is influenced by many variables and can vary significantly depending on the Eh-pH of the environment and chemical equilibria between solid and liquid phases. Therefore, in nature a constant K_d would be expected only in homogeneous material, where all the attributes of the rock, sediments, groundwater, colloids and dissolved radionuclides remain constant (Serene and Muller 1987).

For the modeling of the study area, the formations were divided into 4 homogenous materials (the sand and gravel layer, the weathered till, the unweathered till, and the till sand unit). Each formation has a unique K_d value, thereby reducing the uncertainty of this value. The K_d values were taken from both site-specific data and from literature. Strontium-90 values are site-specific and neptunium-237 values are from literature as reported in WVNS (1993a). Care was taken to select literatures values from similar lithologies. For example, for the sand and gravel layer, the K_d values for sand were used. The K_d measurement of strontium-85 was substituted for strontium-90. Strontium-85 is short-lived and is readily available as a surrogate for the longer-lived strontium-90. However, the derived K_d's from

Table J-5. Parameters Used in the Transport Model

Property	Hydrogeologic Unit: Sand and Gravel Layer	Weathered Till	Unweathered Till	Reference
	Tritium			
K_d (mL/g)	0	0	0	Site-Specific (WVNS 1993a)
Bulk Density (g/cm^3)	2.1	1.6	1.6	Site-Specific (WVNS 1993b)
α_L (ft)	70[c]	10[b]	.03[b]	b, c
α_T[a] (ft)	0.69[c]	0.30[b]	.03[b]	b, c
Dm (cm^2/yr)	59	59	59	Prudic 1986
Tortuosity	2.5	2.5	2.5	Prudic 1986
Decay Constant (1/day)	1.5×10^{-4}	1.5×10^{-4}	1.5×10^{-4}	
	Sr-90			
K_d	14.75	40.4	19.5	Site-Specific (WVNS 1993b)
Bulk Density (g/cm^3)	2.1	1.6	1.6	Site-Specific (WVNS 1993b)
α_L (ft)	70[c]	10[b]	0.03[b]	b, c
α_T (ft)	.69[c]	0.3[b]	0.03[b]	b, c
Dm (cm^2/yr)	39	39	39	Prudic 1986
Tortuosity	2.5	2.5	2.5	Prudic 1986
Decay Constant (1/day)	6.55×10^{-5}	6.55×10^{-5}	6.55×10^{-5}	
	Np-237			
K_d (mL/gm)	5	5	5	Site-Specific (WVNS 1993b)
Bulk Density (g/cm^3)	2.1	1.6	1.6	Site-Specific (WVNS 1993b)
α_L (ft)	70[c]	10[b]	0.03[b]	b, c
α_T (ft)	0.69[c]	0.3[b]	0.03[b]	b, c
Dm (cm^2/yr)	59	59	59	Prudic 1986
Tortuosity	2.5	2.5	2.5	Prudic 1986
Decay Constant (1/day)	8.87×10^{-10}	8.87×10^{-10}	8.87×10^{-10}	

a. α_T is the vertical dispersivity.
b. Kool and Wu 1991
c. EPRI 1985

strontium-85 are directly applicable to the strontium-90 isotope since the physiochemical behavior of the element is independent of the nuclear properties of the specific isotopes.

J.6 APPLICATION OF NUMERICAL MODELS TO THE ALTERNATIVES

The five alternatives evaluated in this EIS represent a wide range of options from extensive removal to discontinuing operations. Chapter 3 describes the alternatives in detail. This section discusses the modeling approach for each alternative.

J.6.1 Alternative I: Removal and Release to Allow Unrestricted Use

The goal of this alternative is to remediate the site to allow unrestricted use. Implementation would require removing contaminated building structures, soils, and sediments and backfilling with native soil. Backfilling of exhumed areas would affect the hydrological behavior at the Project Premises. Some of the man-made features affecting groundwater flow (described in J.3.2.3) would be removed and the contaminated groundwater at the site would be removed.

For the modeling study, the infiltration rate in the backfilled areas were modified from the values used in the base case as representative of the developed areas on the site. Modified boundary conditions and hydraulic conductivities were used to generate the steady-state flow field. Groundwater flow conditions for this alternative are discussed in the sensitivity analysis of Section J.7.4.

J.6.2 Alternative II: Removal, On-Premises Waste Storage, and Partial Release to Allow Unrestricted Use

This alternative is similar to Alternative I (Removal), except that wastes would be stored on-premises instead of shipped off site. During the storage period, access to the storage facility would be restricted. The balance of the Center would be released for unrestricted use. The hydrological conditions for Alternative II (On-Premises Storage) would be similar to that of Alternative I.

J.6.3 Alternative III: In-Place Stabilization and On-Premises LLW Disposal

Implementing Alternative III (In-Place Stabilization) would allow unrestricted use of the Center, except for portions of the Project Premises. In this alternative, contaminated buildings and structures would be backfilled with low-density concrete. Below-grade structures would be backfilled and capped. Buried areas and lagoons would be stabilized. The hydraulic conductivity in these areas would change because of the engineering measures. For this alternative, the base year (2000) contamination levels were used as initial values. Since the engineering actions implemented under this alternative would reduce infiltration, the groundwater system in the saturated and unsaturated zones would be affected. Groundwater flow conditions for this alternative are discussed in Section J.7.3.

J.6.4 Alternative IV: No Action: Monitoring and Maintenance

Under Alternative IV (No Action: Monitoring and Maintenance), the Center would be monitored and maintained. The year 2000 was the baseline for the model projections. Groundwater flow conditions for this alternative are discussed in Section J.7.3.

J.6.5 Alternative V: Discontinue Operations

Alternative V (Discontinue Operations) assumes the site is abandoned and there would be no institutional control in the year 2000 or beyond. This alternative is conceptually similar to Alternative IV described above. Therefore, separate simulations were not performed.

J.7 MODEL RESULTS AND DISCUSSIONS

Numerical models for the simulation of hydrogeologic systems require the specification of system parameters developed from the field data as described in Section J.5.4 and calibration of the model through the systematic comparison of computed and measured groundwater head data. This section describes the calibration and validation of the site model. For the flow model, both steady state and transient simulations were performed. Steady state simulations were conducted to describe the three-dimensional flow field (head distribution). The heads from the steady-state simulation were input as initial conditions for the transient simulations. Transient flow simulations were conducted to evaluate the sensitivity of the model to variations in hydraulic properties and to gain insight into the fluctuating groundwater levels primarily on the south plateau.

The model may fail to converge to an acceptable error criteria if the moisture content and unsaturated hydraulic conductivity versus pressure head relationships are highly non-linear or if large changes in saturated hydraulic conductivity occur over short distances. A large contrast in saturated hydraulic conductivity occurred at the contact between the unweathered till and the sand and gravel layer on the north plateau where a three order of magnitude difference in the hydraulic conductivity exists between the two formations. Because the vadose zone is relatively thin and nearly saturated over most of the model area, convergence problems related to non-linearity of the soil property relationships were not encountered. To avoid convergence problems because of the difference in hydraulic conductivity a finer mesh at the contact between the sand and gravel layer and the unweathered till was used.

J.7.1 Model Calibration and Validation

A necessary step in the development and use of the numerical model is refinement of the conceptual and parameter bases of the model and comparison of model predictions with observed conditions. This section describes the process of calibration and validation used in developing this site model.

J.7.1.1 Calibration

In the calibration procedure, model parameters are varied in a systematic, iterative manner and model predictions are compared with field data to identify the set of model parameters and features that give the best representation of the known groundwater flow distribution. Steady state simulations were used to calibrate the model with a measured hydraulic head distribution serving as the basis for comparative evaluation. Progress in the calibration procedure was measured by the cumulative absolute difference of the observed and predicted hydraulic heads. Model parameters which were varied in the calibration procedure were the hydraulic conductivities of the sand and gravel, weathered and unweathered, and till sand units. Model features which were varied in the calibration procedure were the extent of the till sand unit and the flux into the sand and gravel layer on the southwestern boundary of the model area. The range of values of the hydraulic conductivity established for the calibrated model, presented in Table J-6, were close to the selected initial conditions. A set of simulations conducted to define the characteristics of the till sand unit varied both lateral extent and thickness of the unit. The best fit corresponded to a till sand unit whose properties were the same as the surrounding unweathered till.

Table J-6. Hydraulic Conductivity (K) Values for the Steady-State Simulation

Formation	Initial K (ft/d)	Calibrated K (ft/d)
Unweathered Till	1.6×10^{-4}	2×10^{-4}
Weathered Till	8.5×10^{-3}	9×10^{-3}
Till Sand Unit	0.3	-
Sand and Gravel Layer	0.05 - 12.0	1.0 - 12.0

The simulated head distribution was compared with 1991 groundwater levels measured in 81 monitoring wells located throughout the model area. The mean absolute difference between the observed and simulated hydraulic heads is 0.6 m (2 ft) as shown in Table J-7, which is less than two percent of the 41 m (135 ft) difference between hydraulic head measured at the highest and the lowest points at the site. Simulated hydraulic heads were within 0.9 m (3 ft) of the 1991 water levels measured in 72 wells. The most noticeable difference between the observed and simulated water levels was in 9 wells screened above or in the till sand unit. The difference is attributed to the poorly defined thickness and areal extent of the till sand unit. A plot of the predicted steady-state water table contour for the sand and gravel layer and the weathered till units is presented in Figure J-10.

J.7.1.2 Transient State Model and Model Validation

Transient-state simulations of flow were conducted to determine the effect of temporal variations in rainfall on the water table level and to reproduce the fluctuating water table conditions seen in the monitoring wells. The success in predicting the transient conditions corroborates or validates the model. For the transient simulations, the initial time step taken was 0.001 day and the maximum time step was 1 day.

Table J-7. Comparison of Observed and Simulated Heads for the Steady-State[a]

Well ID	Model Layer	Node	Observed	Simulated	Error
NB-1S	SG[b]	1426	1436.68	1438.25	1.57
1008C	WT[c]	3594	1399.62	1398.99	0.63
705	UWT[d]	4317	1394.74	1395.37	0.63
701	TS[e]	5152	1384.06	1383.59	0.47
706	SG	5157	1402.29	1403.90	1.60
703	UWT	4356	1380.61	1382.10	1.49
707	UWT	4358	1389.15	1389.44	0.28
302	TS	5810	1401.33	1399.22	2.00
301	SG	5816	1410.18	1414.75	4.57
402	TS	5850	1401.20	1402.31	1.11
401	SG	5853	1410.42	1411.70	1.28
403	SG	5895	1408.90	1411.70	2.80
404	TS	5891	1401.59	1400.87	0.72
405	UWT	6899	1401.06	1399.99	1.07
603	SG	6035	1392.19	1392.46	0.27
704	UWT	6959	1391.00	1392.52	1.52
305	SG	7570	1395.06	1399.80	4.72
307	SG	7576	1401.97	1408.63	6.66
409	UWT	7706	1370.77	1367.01	3.76
406	SG	7755	1392.91	1395.00	2.08
8608	SG	7756	1393.11	1395.00	1.89
8607	SG	7756	1391.88	1395.00	3.45
604	SG	7819	1391.68	1390.52	1.16
1005	WT	7976	1383.68	1385.48	1.80
204	TS	9351	1395.29	1387.41	7.88
202	TS	9272	1397.21	1396.50	0.71
201	SG	9276	1396.22	1400.63	4.41
8609	SG	8615	1392.93	1394.50	1.57
908	WT	8974	1372.65	1375.29	2.64
203	SG	9356	1395.74	1401.01	5.27
408	SG	9433	1397.06	1402.28	5.22
907	WT	10038	1379.57	1382.05	2.48
501	SG	11233	1396.10	1398.93	2.83
905	TS	16237	1372.02	1366.92	5.10
906	WT	10037	1378.58	1376.68	1.90
205	SG	11096	1393.49	1396.83	3.34
8606	SG	11096	1393.11	1396.83	3.72
602	SG	11278	1387.74	1385.80	1.96
601	SG	12237	1377.24	1376.35	0.89
904	UWT	14476	1364.61	1362.72	1.89
1006	WT	11535	1378.63	1381.45	2.82

a. Heads in feet relative to atmospheric pressure and mean sea level.
b. SG=Sand and gravel layer.
c. WT=Weathered Lavery till.
d. UWT=Unweathered Lavery till.
e. TS=Till sand unit.

Table J-7. Comparison of Observed and Simulated Heads for the Steady-State[a] (Continued)

Well ID	Model Layer	Node	Observed	Simulated	Error
605	SG	12238	1376.87	1380.56	3.69
208	TS	12816	1388.24	1389.67	1.43
207	SG	12818	1389.50	1394.40	4.90
502	SG	13017	1388.87	1391.60	2.73
8004	SG	14838	1378.18	1380.61	2.43
1007	WT	15033	1367.01	1366.12	0.89
111	SG	15517	1383.40	1381.89	1.51
104	SG	15635	1385.88	1386.54	0.66
115	UWT	15673	1372.28	1370.46	1.82
116	SG	15678	1381.98	1379.70	1.28
801	SG	15697	1380.63	1380.61	0.02
8604	SG	16535	1384.31	1384.18	0.13
109	UWT	17294	1359.98	1368.06	1.92
1108A	WT	17697	1370.27	1369.25	1.02
110	UWT	18178	1378.01	1378.24	0.23
108	UWT	18212	1357.08	1356.74	3.34
8603	SG	18317	1379.98	1381.64	1.66
1109B	UWT	18774	1366.18	1364.22	1.96
103	SG	12054	1391.81	1388.94	2.87
105	SG	19194	1374.19	1375.42	1.23
1101A	WT	19377	1374.43	1372.33	2.10
1101B	UWT	19374	1358.25	1357.08	1.17
1106B	UWT	19695	1359.07	1359.83	0.76
1106A	WT	19698	1371.62	1372.99	1.37
106	SG	20936	1372.09	1374.44	2.35
1105B	UWT	21591	1337.66	1337.65	0.01
1105A	UWT	21595	1353.16	1355.54	2.38
114	UWT	21877	1369.03	1370.55	1.52
107	UWT	22674	1359.17	1359.40	0.23
804	SG	22717	1370.33	1369.52	0.81
803	SG	22777	1366.17	1368.50	2.33
1110A	WT	23235	1366.97	1366.57	0.40
1104B	UWT	23295	1363.68	1362.48	1.20
1104A	WT	23298	1374.91	1377.24	2.33
8612	SG	23657	1365.41	1364.08	1.33
1102B	UWT	23836	1367.46	1367.30	0.16
1102A	WT	23839	1378.72	1380.47	1.75
1111A	UWT	23897	1377.94	1376.11	1.83
1103B	UWT	24035	1366.48	1367.38	0.90
1103A	WT	24039	1379.75	1380.41	0.66

a. Heads in feet relative to atmospheric pressure and mean sea level.
b. SG=Sand and gravel layer.
c. WT=Weathered Lavery till.
d. UWT=Unweathered Lavery till.
e. TS=Till sand unit.

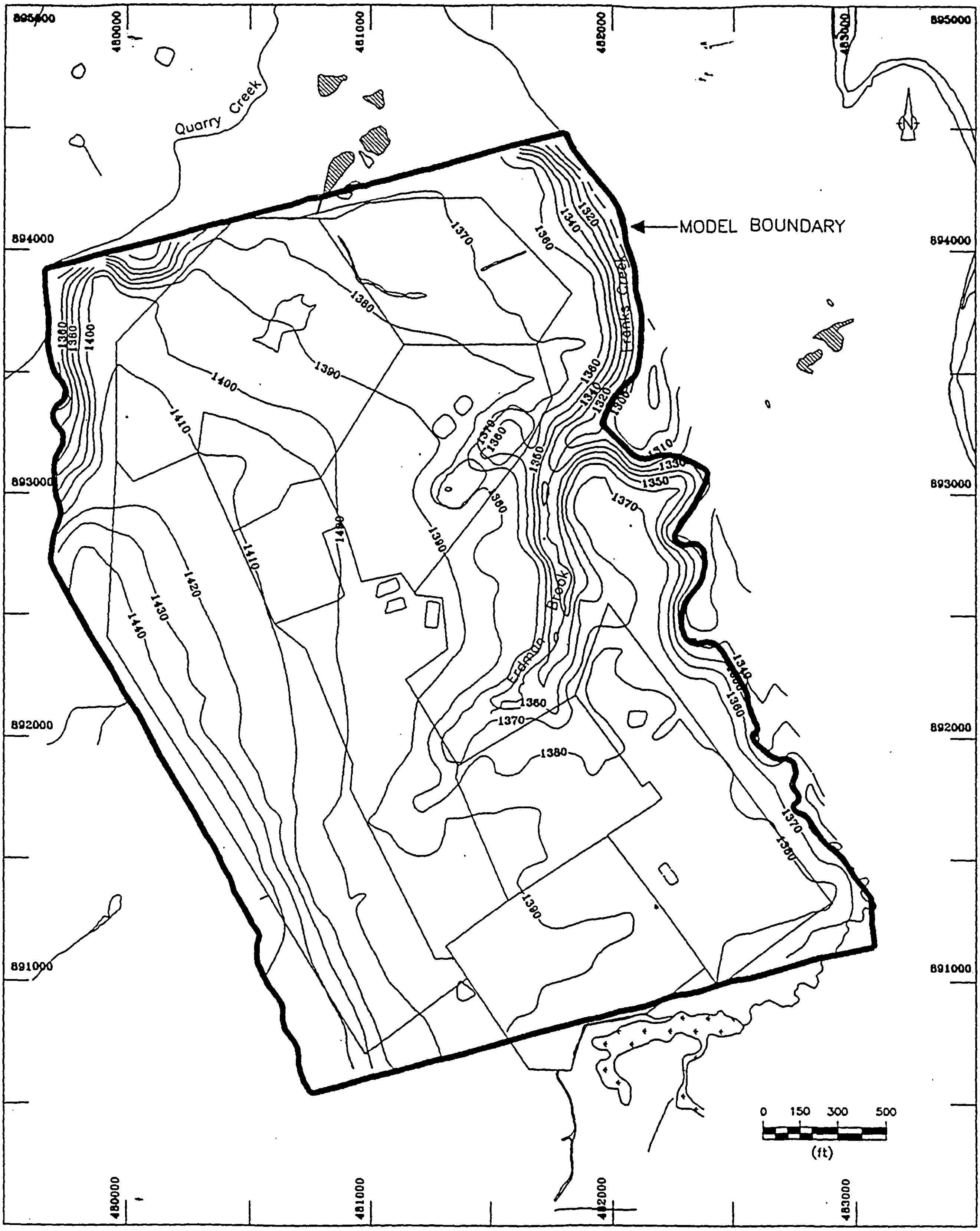

Figure J-10. Predicted Steady-State Water Table Contour Map for 1991 for the Sand and Gravel Layer and Weathered Lavery Till (elevations in feet above mean sea level).

For the transient simulations, only the surface boundary condition differed from the conditions specified for the steady-state simulation. If the steady-state model is a realistic representation of the actual physical hydrogeological system, then it should reasonably simulate the site when used in a transient mode. The calibrated hydraulic conductivity and the calculated hydraulic heads from the steady-state model were used as input parameters for the transient simulations. For the surface boundary, the observed rainfall for the period from February 1991 to April 1992 was used as input and the hydraulic heads in the 81 monitoring wells were predicted. One hundred thirty two precipitation events occurred during the study period.

The simulated hydraulic heads were compared with the observed heads as shown in Table J-8. Figure J-11 shows the simulated water level contours for April 1992. The overall transient results compare well with the observed data.

Model validation entails running a model as a predictive tool and comparing the predicted data with the observed data other than the base data. In this study, the heads were simulated for the year 1991 and compared with the observed hydraulic heads.

J.7.2 <u>Base Line Estimate</u>

The year 2000 was the base line for making flow and transport predictions since the WVDP decontamination and decommissioning and Center closure or long-term management are estimated to start about that time. The 1991 flow field generated by the calibrated steady-state model gives the flow field for the year 2000. The water table contour plot for the sand and gravel layer and the weathered Lavery till is presented in Figure J-10. The results indicate that on the north plateau, flow is generally to the northeast towards Franks Creek with interstitial velocities ranging from 5 to 20 m/yr (16 to 66 ft/yr). At the NDA on the south plateau, groundwater flow though the weathered till is predicted to be to the northeast with interstitial velocities ranging from 3×10^{-6} to 3.0 m/yr (1×10^{-5} to 10 ft/yr). At the SDA, the subsurface barrier on the southwest side restricts flow across the area. Flow through the weathered till at the SDA is predicted to be towards both Franks and Erdman Brook with interstitial velocities ranging from 3×10^{-6} to 1.3 m/yr (1×10^{-5} to 4 ft/yr). Vertical flow downward through the unweathered till at the NDA and SDA is predicted with maximum fluxes of the order 2×10^{-2} m/yr (7×10^{-2} ft/yr). On the north plateau, the water table is approximately 2 m (7 ft) below the surface near the process building and close to the surface in the north near the swamps. On the south plateau, the water table is predicted to be near the ground surface.

The distribution of radiological contamination in groundwater is an element of the baseline characteristics. The initial distributions of gross beta and tritium contamination were established using the 1991 monitoring data and are presented in Figures J-12 and J-13, respectively. Since gross alpha concentrations are at background levels at most locations, they were not presented. Given these initial condition distributions, the transport model was used

Table J-8. Comparison of Observed and Predicted Hydraulic Heads for a Transient-State Simulation[a]

Well ID	Model Layer	Node	Observed	Simulated
NB-1S	SG[b]	1426	1436	1438
1008C	WT[c]	3592	1399	1400
705	UWT[d]	4317	1394	1394
701	TS[e]	5152	1384	1384
706	SG	5157	1402	1405
703	UWT	4356	1380	1380
707	UWT	4358	1389	1388
302	TS	5810	1401	1402
301	SG	5816	1410	1414
402	TS	5850	1401	1402
401	SG	5853	1410	1415
403	SG	5895	1408	1414
404	TS	5891	1401	1405
405	UWT	6899	1401	1400
603	SG	6035	1392	1393
704	UWT	6959	1391	1392
305	SG	7570	1395	1400
307	SG	7576	1401	1408
409	UWT	7706	1370	1370
406	SG	7755	1392	1400
8608	SG	7756	1393	1400
8607	SG	7756	1391	1400
604	SG	7819	1391	1390
1005	WT	7976	1383	1385
204	TS	9351	1395	1394
202	TS	9272	1397	1401
201	SG	9276	1396	1401
8609	SG	8615	1392	1394
908	WT	8974	1372	1378
203	SG	9356	1395	1400
408	SG	9433	1397	1400
907	WT	10038	1379	1382
501	SG	11233	1396	1395
905	TS	16237	1372	1367
906	WT	10037	1378	1377
206	UWT	11091	1395	1393
205	SG	11096	1393	1396
8606	SG	11096	1393	1396
602	SG	11278	1387	1392
601	SG	12237	1377	1380
904	UWT	14476	1364	1366

a. Heads in feet relative to atmospheric pressure and mean sea level.
b. SG=Sand and gravel layer.
c. WT=Weathered Lavery till.
d. UWT=Unweathered Lavery till.
e. TS=Till sand unit.

Table J-8. Comparison of Observed and Predicted Hydraulic Heads for a Transient-State Simulation (Continued)[a]

Well ID	Model Layer	Node	Observed	Simulated
1006	WT	11535	1378	1380
605	SG	12238	1376	1380
208	TS	12816	1388	1394
207	SG	12818	1389	1394
502	SG	13017	1388	1391
8004	SG	14838	1378	1380
1007	WT	15033	1367	1371
111	SG	15517	1383	1387
104	SG	15635	1385	1387
115	UWT	15673	1372	1373
116	SG	15678	1381	1385
801	SG	15697	1380	1380
8604	SG	16535	1384	1384
109	UWT	17294	1359	1369
1108A	WT	17697	1370	1372
110	UWT	18178	1378	1378
108	UWT	18212	1357	1356
8603	SG	18317	1379	1380
1109B	UWT	18774	1366	1366
103	SG	12054	1391	1396
105	SG	19194	1374	1378
1101A	WT	19377	1374	1374
1101B	UWT	19374	1358	1357
1106B	UWT	19695	1359	1358
1106A	WT	19698	1371	1373
106	SG	20936	1372	1377
1105B	UWT	21591	1337	1337
1105A	UWT	21595	1353	1357
114	UWT	21877	1369	1370
107	UWT	22674	1359	1361
804	SG	22717	1370	1372
803	SG	22777	1366	1368
1110A	WT	23235	1366	1366
1104B	UWT	23295	1363	1362
1104A	WT	23298	1374	1377
8612	SG	23657	1365	1366
1102B	UWT	23836	1367	1367
1102A	WT	23839	1378	1380
1111A	UWT	23897	1377	1380
1103B	UWT	24035	1366	1365
1103A	WT	24039	1379	1380

a. Heads in feet relative to atmospheric pressure and mean sea level.
b. SG=Sand and gravel layer.
c. WT=Weathered Lavery till.
d. UWT=Unweathered Lavery till.
e. TS=Till sand unit.

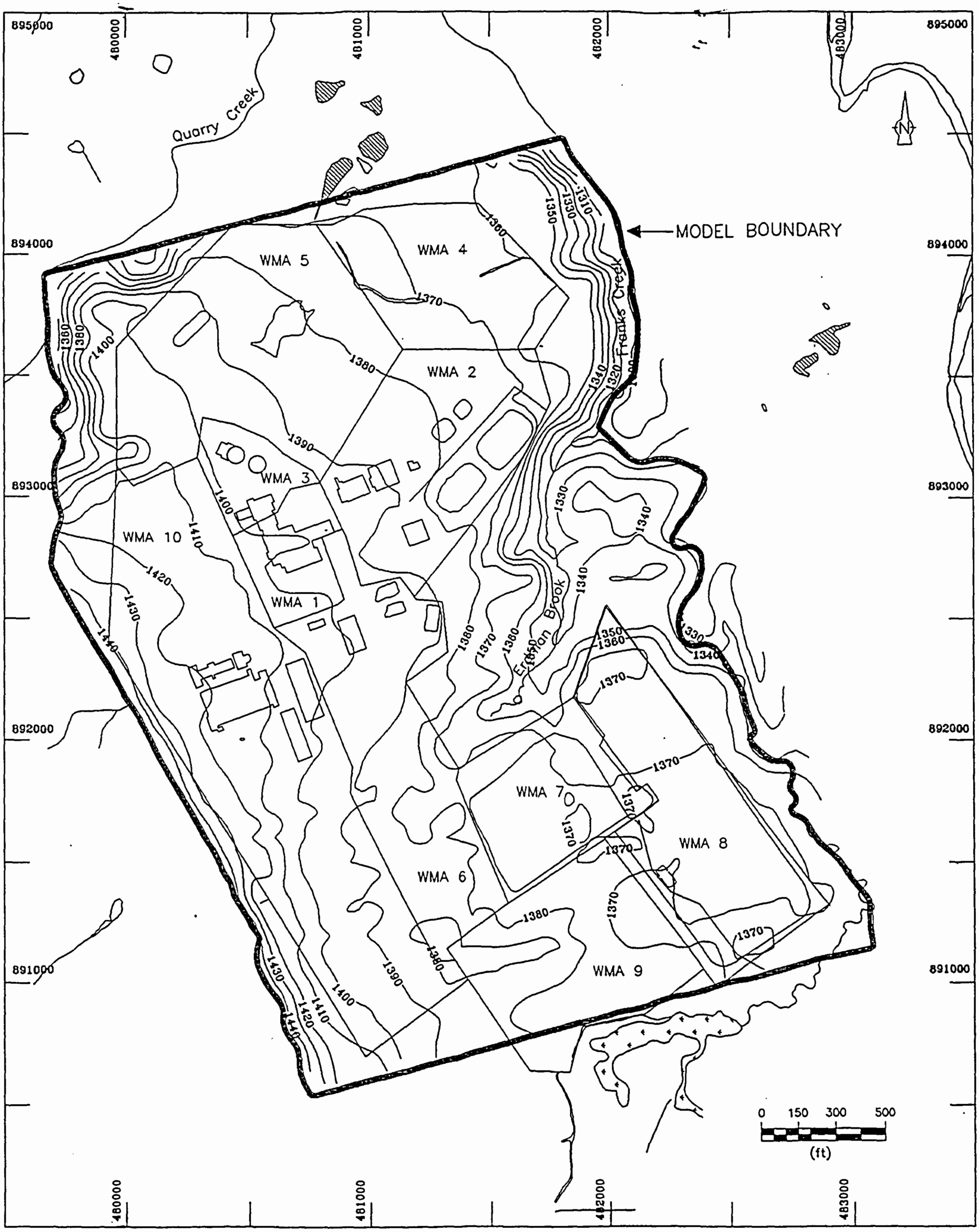

Figure J-11. Predicted Transient Water Table Contour Map for 1992.

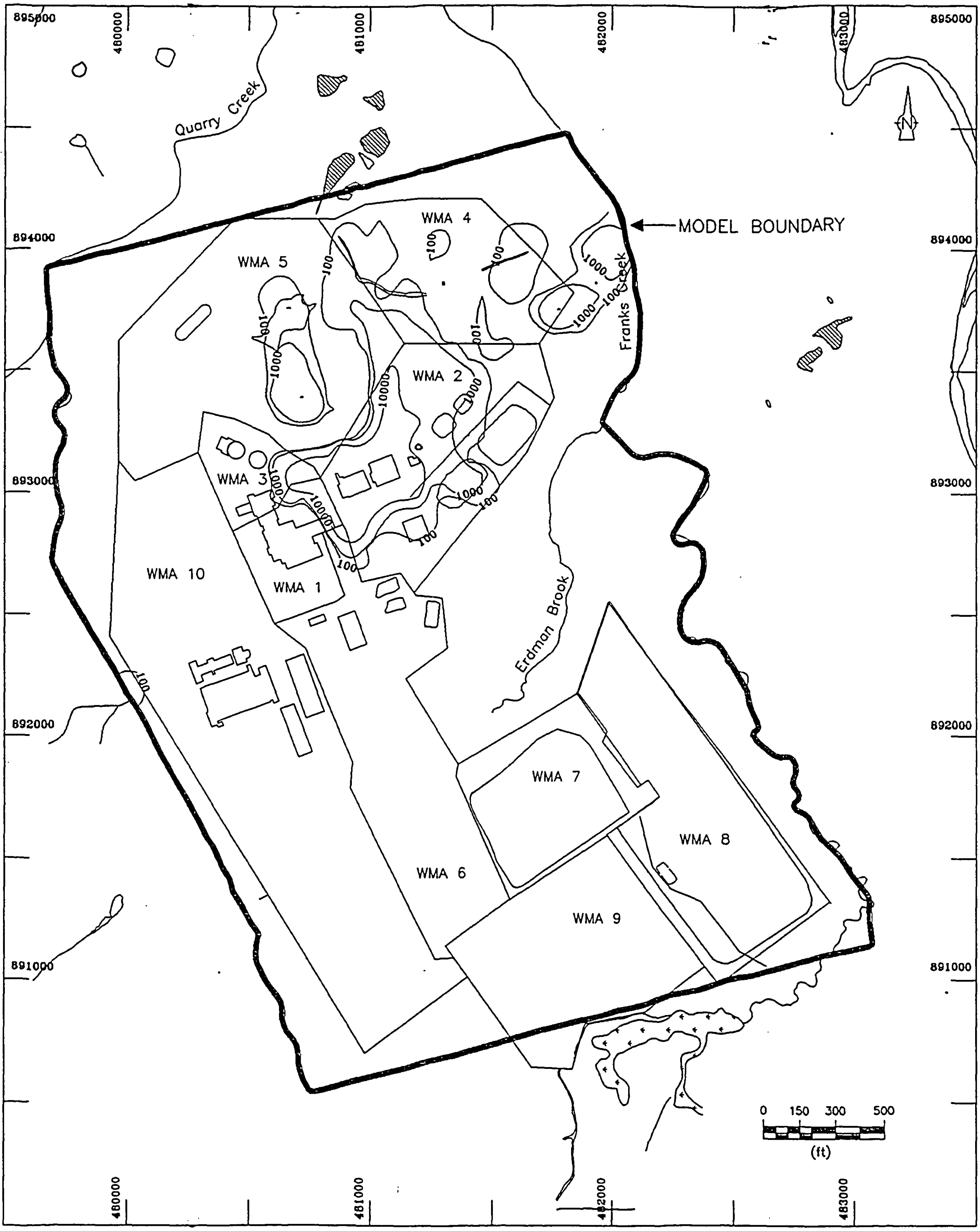

Figure J-12. Measured Beta Activity in the Sand and Gravel Layer for 1991.

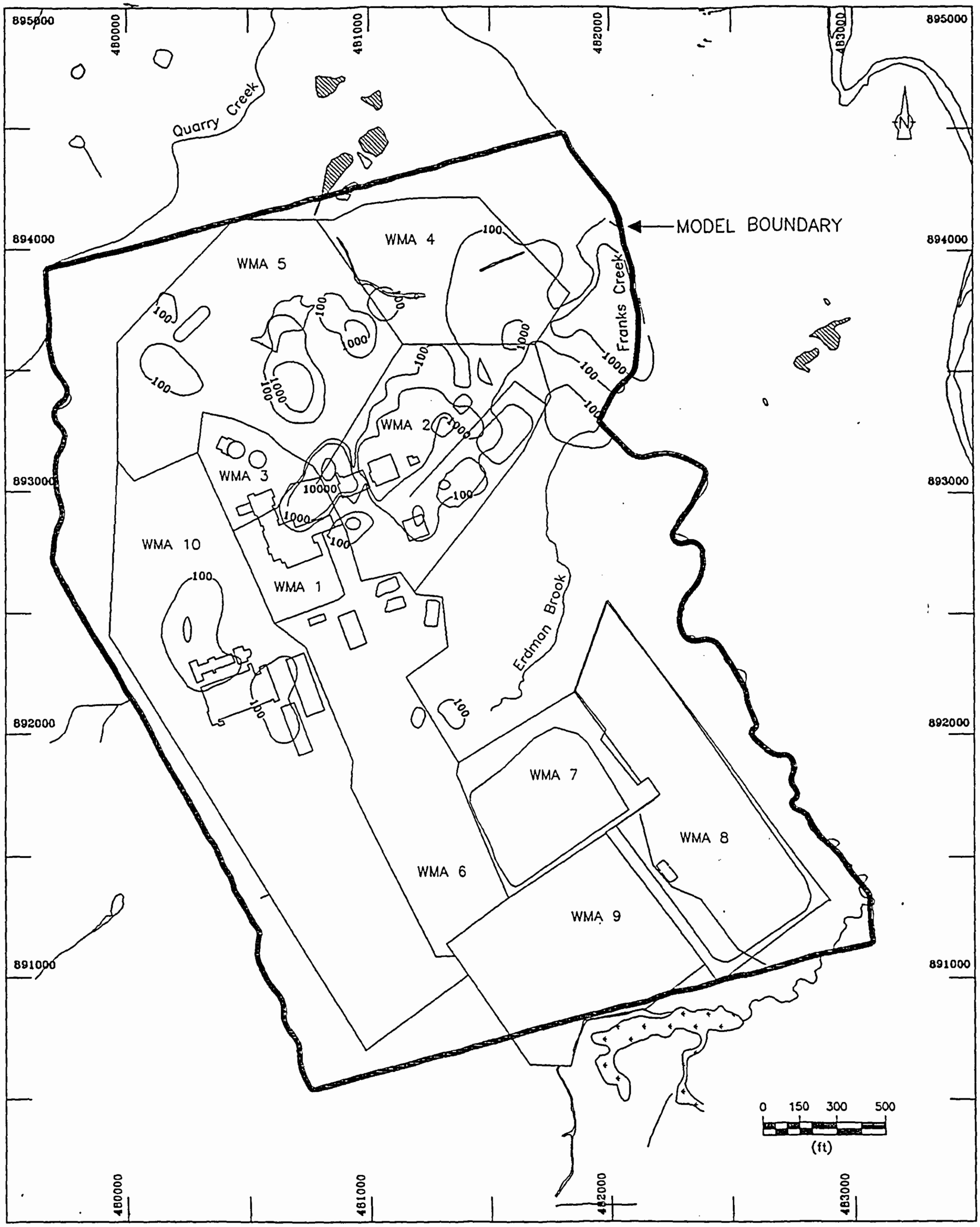

Figure J-13. Measured Tritium Activity in the Sand and Gravel Layer for 1991.

to predict the contaminant distribution for the year 2000. The results of this simulation are presented in Figures J-14 and J-15 for gross beta and tritium, respectively. The contaminant concentrations are low and decrease from 1991 to 2000; however, the actual field data measured in wells located adjacent to the fuel pool show increases in tritium, gross alpha, and gross beta. This discrepancy can be explained by two reasons: first, the steady-state flow model covers more saturated area which dilutes the contaminant concentrations and second, the initial model condition is a distributed plume without a contaminant source. Therefore, decay and dilution of dissolved contaminants results in decreased concentrations from 1991 to 2000.

J.7.3 Flow Distribution for Alternatives I, II, IV, and V

The simulations for Alternatives I (Removal) and II (On-Premises Storage) differed from the base case because building restrictions of infiltration specified for the north plateau in the base case were removed. The resulting predicted hydraulic head distribution was very similar to the base case with the exception that the water table was approximately 0.3 m (1 ft) higher in the vicinity of the process building (WMA 1). Flow directions and velocities were also similar to the base case. Base line flow conditions for Alternatives IV (No Action: Monitoring and Maintenance) and V (Discontinue Operations) are the same as that described in Section J.7.2, since the hydrogeological regime for these two alternatives does not change.

J.7.4 Steady State Flow for Alternative III

Alternative III includes stabilizing the facilities, which could include backfilling, capping, grading and closing them in place. These activities would change the topography and hydraulic conductivity of the native materials on the Project Premises and the SDA. The areas that would be affected by these actions are shown in Figure J-16.

The hydraulic conductivity of cap material, backfill material and compacted soil was quantified to model this alternative. Table J-9 summarizes the model values.

The material used to stabilize the disposal areas was assumed to have a hydraulic conductivity similar to that of the unweathered till. The lower hydraulic conductivity would affect infiltration. Since the topography would change, the model grid had to be redrawn as shown on the shaded areas in Figure J-16. Outside of the shaded regions on Figure J-16, the balance of the hydraulic conductivity field is the same as that used in the calibrated steady-state model described in Section J.7.1.1. The other input parameters were the same as those described for the steady-state model.

No calibration was done for this simulation. The steady-state water table contours are presented in Figure J-17. Table J-10 shows the difference in the hydraulic heads between the Alternative III and Alternative IV steady-state simulations to show the difference from the change in infiltration. On the north plateau, water levels increase because the process building has been removed and a cap is installed. At the NDA and SDA on the south plateau, water levels decrease because of the less permeable cap.

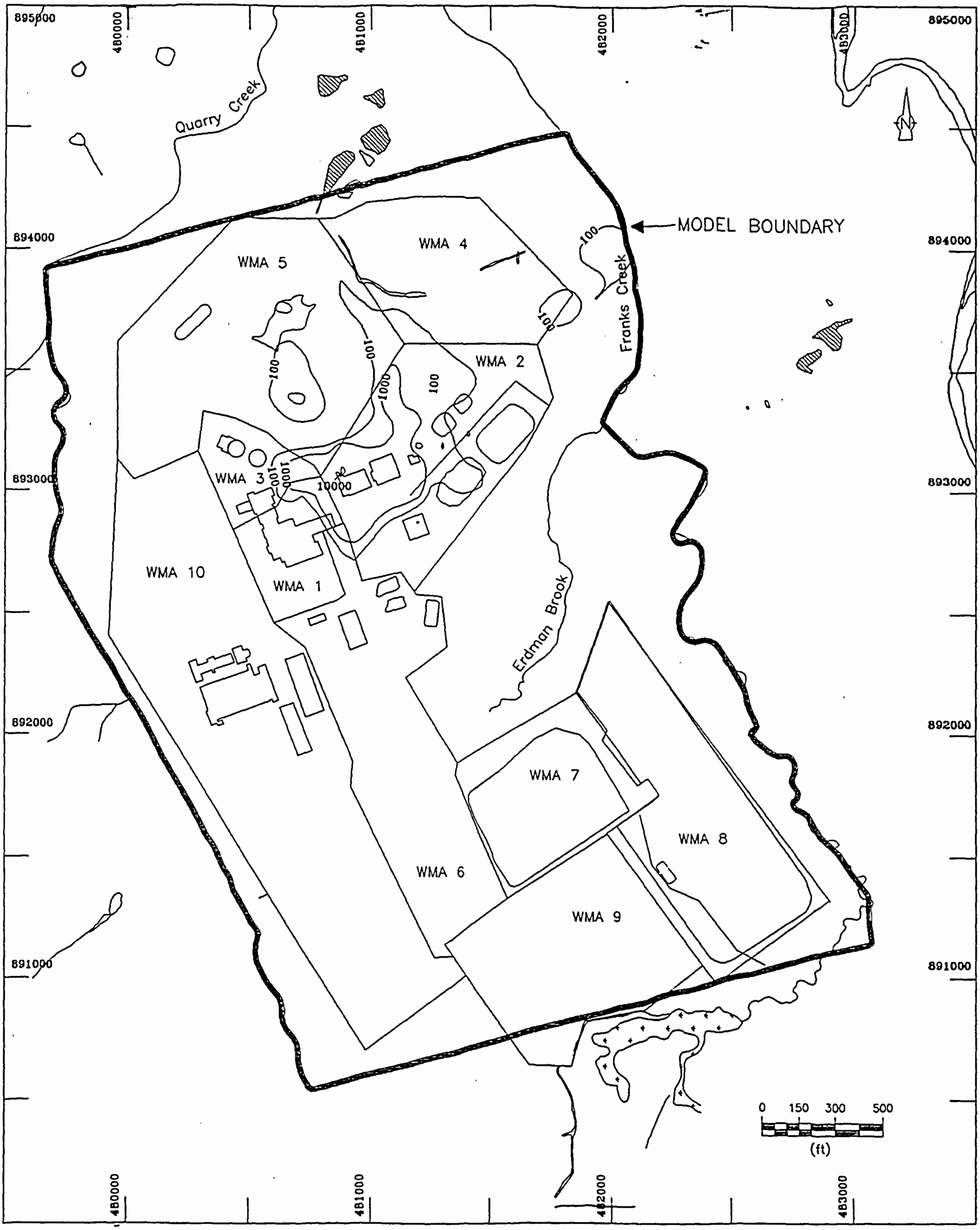

Figure J-14. Predicted Beta Activity in the Sand and Gravel Layer for 2000.

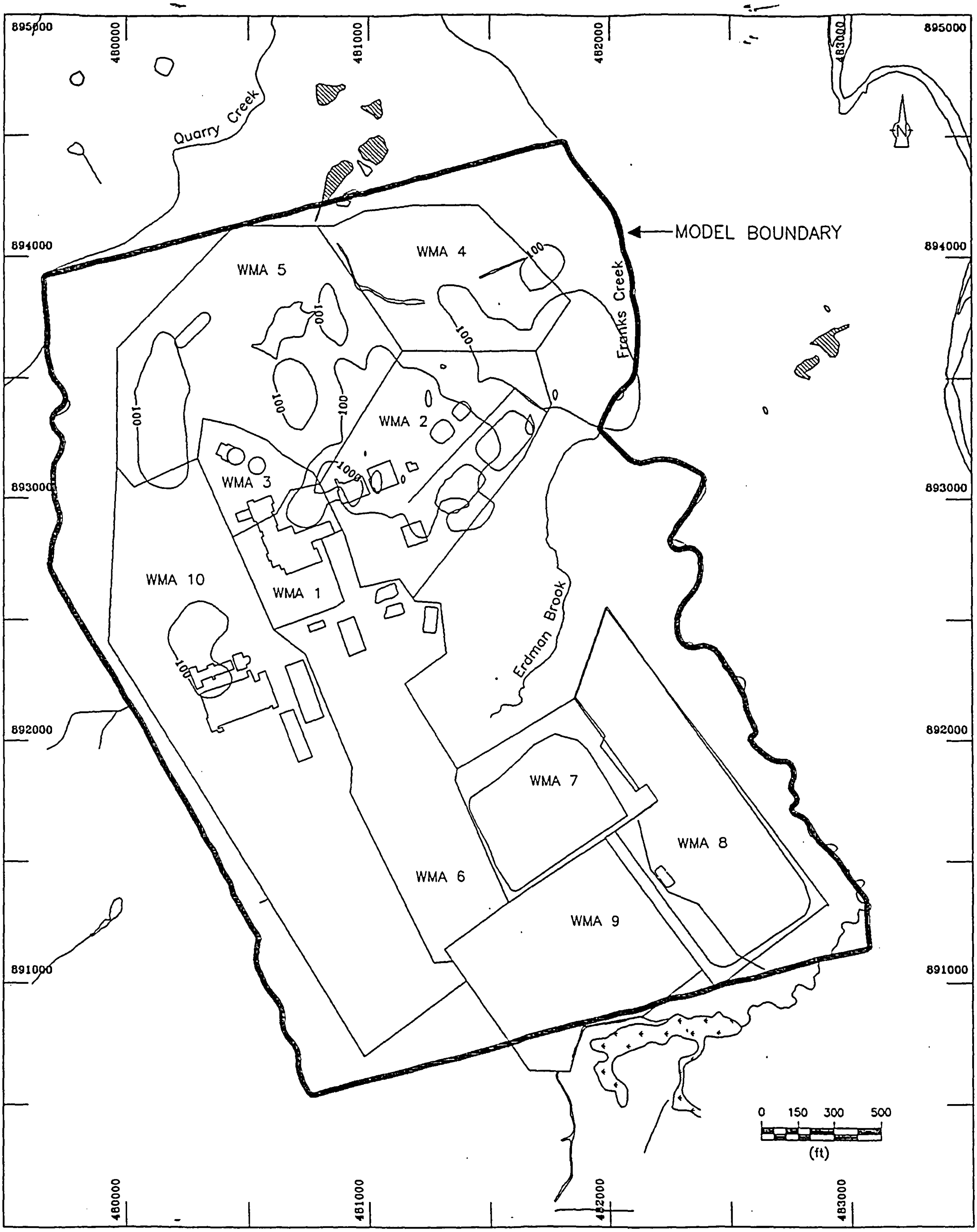

Figure J-15. Predicated Tritium Activity in the Sand and Gravel Layer for 2000.

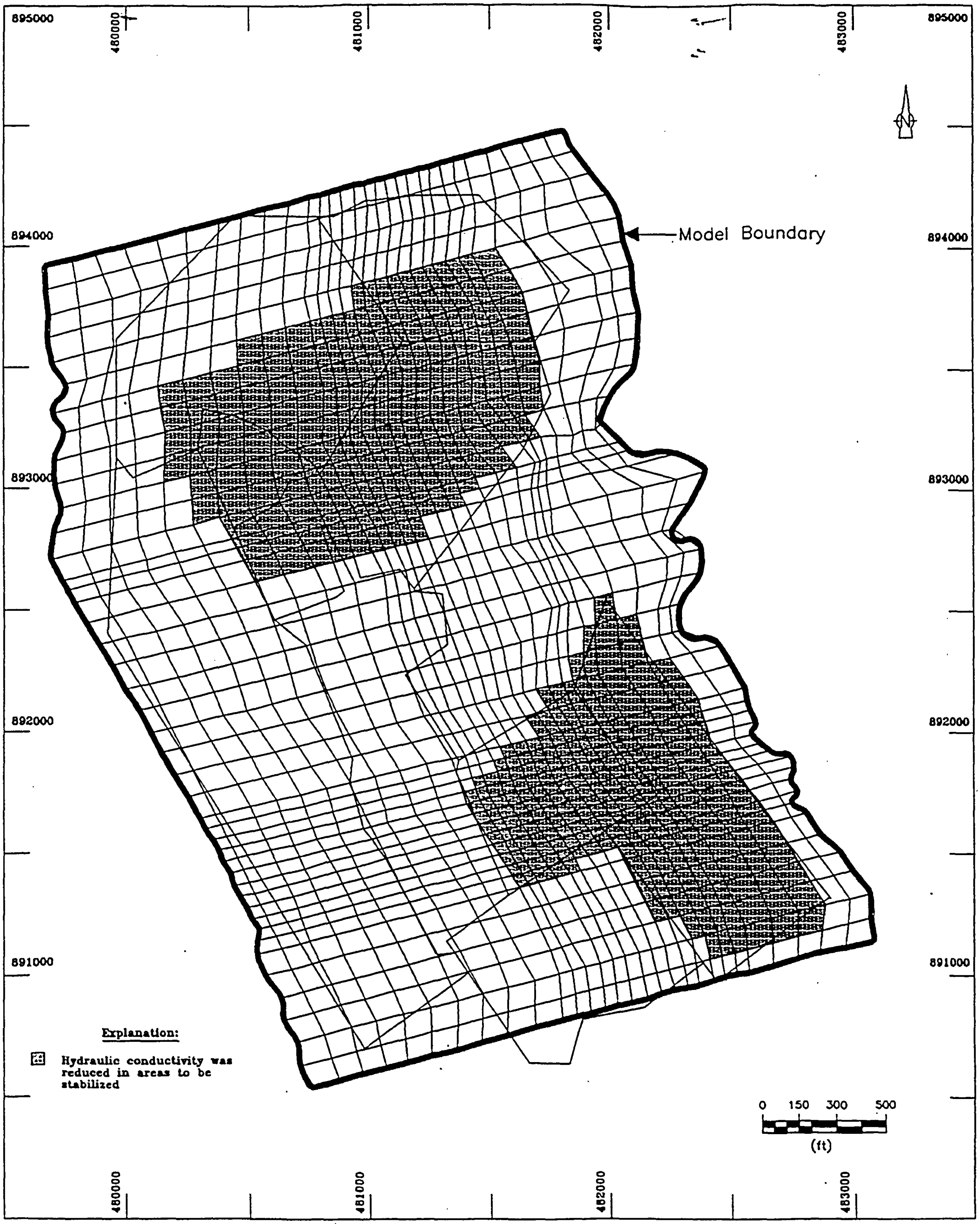

Figure J-16. Spatial Distribution of Near-Surface Hydraulic Conductivity for Alternative III.

Table J-9. Hydraulic Conductivity of Stabilization Materials for Alternative III (In-Place Stabilization)

Material	Hydraulic Conductivity (ft/day)	Reference
Cap Material	1 x 10^{-4}	DOE 1986
Backfill	0.056	WVNS 1993c
Compacted Soil	1.0 x 10^{-4}	DOE 1986

J.7.5 Sensitivity Analyses

A set of steady-state simulations were conducted to evaluate the sensitivity of the model results to variations in hydrologic parameters and modeling assumptions. The features and parameters which were varied included boundary conditions, hydraulic conductivity of the sand and gravel layer, precipitation rate, and areal extent of the till sand unit. For each simulation, one parameter was changed while the others were unchanged.

J.7.5.1 Variation in Boundary Conditions

An initial set of simulations was performed with a no flow condition specified for the east, west, north, and south boundaries. This contrasts with the specified head condition imposed for portions of these boundaries for the base case. The no-flow simulation investigates the influence of the external flow field on model area conditions. The cumulative absolute deviation between observed and simulated heads for this case was 164, which is nearly equal to the calibrated model value (i.e., 163.7). The results indicate that most of the water exits the system through nodes along the creeks where variable conditions are applied rather than along the north or south areas where constant head conditions were specified for the base case.

A second simulation was performed with constant head conditions on all boundaries except the upper surface. Again the cumulative absolute deviation was close to that of the base case indicating that flow through the variable condition (infiltration and seepage) nodes controls model performance.

A third simulation investigated the effect of applying a no flow rather than constant head condition on the bottom boundary. This case showed a greater deviation of observed and predicted heads than the base case indicating that some downward leakage through the unweathered till is consistent with prevailing head conditions.

J.7.5.2 Variation in Hydraulic Conductivity in the Sand and Gravel Layer

An initial trial investigated the impact of increasing the hydraulic conductivity of the sand and gravel layer by a factor of ten. The hydraulic conductivity of the other units were unchanged from the base case. The cumulative absolute error (170) was slightly larger than that of the base case indicating a small sensitivity to the value of the hydraulic conductivity.

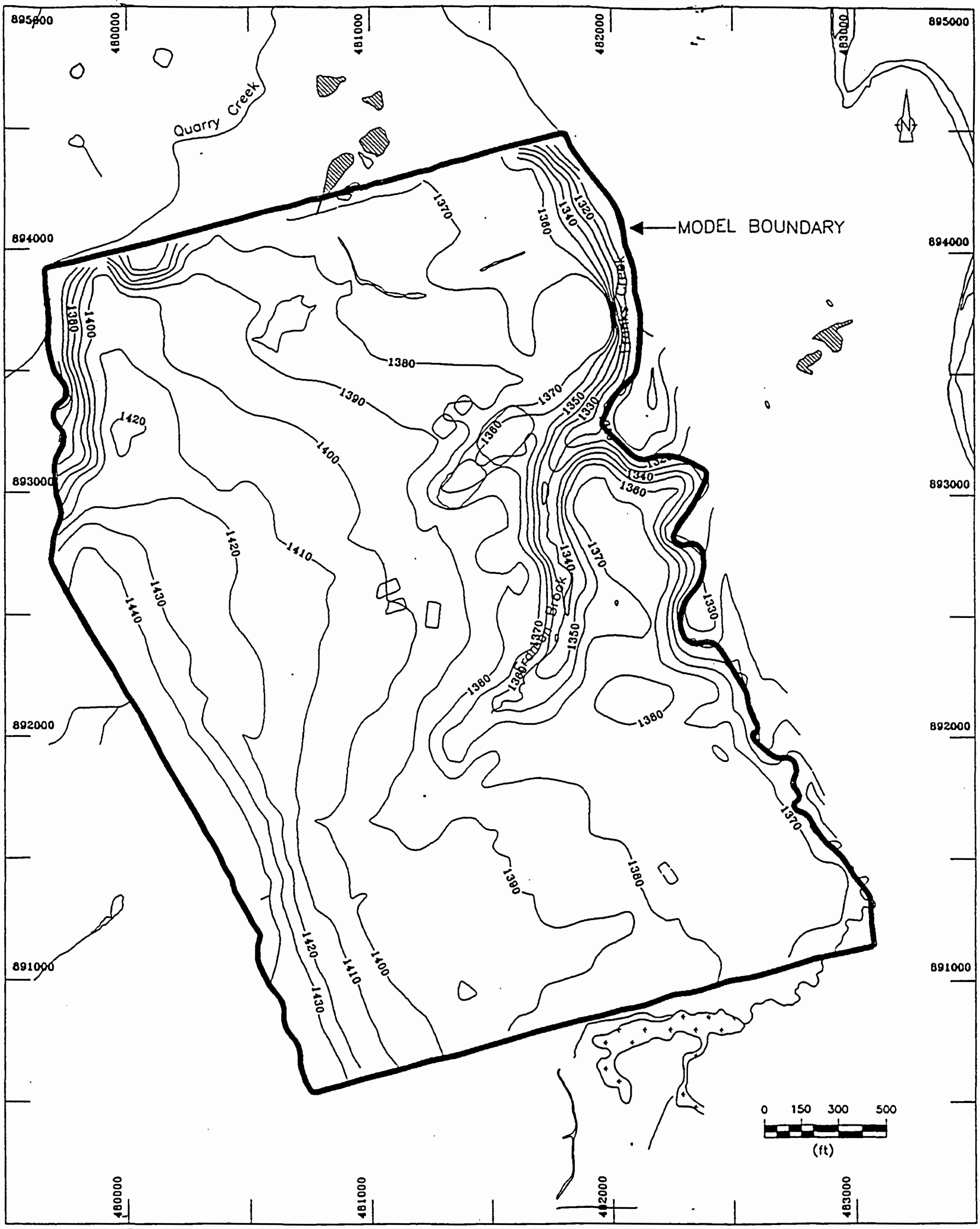

Figure J-17. Predicted Steady-State Water Table Contour Map for Alternative III.

Table J-10. Comparison of Predicted Steady-State Water Levels for the Base Case and Alternative III (In-Place Stabilization)[a]

Well ID	Model Layer	Node	Base Water Level (ft)	Simulated Water Level (ft)
NB-1S	SG[b]	1426	1438.25	1438.26
1008C	WT[c]	3594	1398.99	1401.61
705	UWT[d]	4317	1395.37	1394.64
701	TS[e]	5152	1383.59	1378.80
706	SG	5157	1403.90	1397.96
703	UWT	4356	1382.10	1382.34
707	UWT	4358	1389.44	1389.70
302	TS	5810	1399.22	1415.19
301	SG	5816	1414.75	1415.30
402	TS	5850	1402.31	1417.89
401	SG	5853	1411.70	1418.81
403	SG	5895	1411.70	1420.35
404	TS	5891	1400.87	1408.19
405	UWT	6899	1399.99	1396.96
603	SG	6035	1392.46	1382.98
704	UWT	6959	1392.52	1392.67
305	SG	7570	1399.80	1406.06
307	SG	7576	1408.63	1408.75
409	UWT	7706	1367.01	1358.55
406	SG	7755	1395.00	1382.97
8608	SG	7756	1395.00	1386.68
8607	SG	7756	1395.00	1386.68
604	SG	7819	1390.52	1384.84
1005	WT	7976	1385.48	1386.15
204	TS	9351	1387.41	1375.35
202	TS	9272	1396.50	1395.11
201	SG	9276	1400.63	1405.31
8609	SG	8615	1394.50	1384.94
908	WT	8974	1375.29	1379.64
203	SG	9356	1401.01	1401.41
408	SG	9433	1402.28	1379.58
907	WT	10038	1382.05	1382.12
501	SG	11233	1398.93	1373.53
905	TS	16237	1366.92	1360.96
906	WT	10037	1376.68	1376.91
206	UWT	11091	1372.15	1372.24
205	SG	11096	1396.83	1396.98
8606	SG	11096	1396.83	1396.98
602	SG	11278	1385.80	1385.10
601	SG	12237	1376.35	1372.13
904	UWT	14476	1362.72	1366.34

a. Heads in feet relative to atmospheric pressure and mean sea level.
b. SG: Sand and gravel layer.
c. WT: Weathered Lavery till.
d. UWT: Unweathered Lavery till.
e. TS: Till sand unit.

Table J-10. Comparison of Predicted Steady-State Water Levels for the Base Case and Alternative III (In-Place Stabilization)[a] (Continued)

Well ID	Model Layer	Node	Base Water Level (ft)	Simulated Water Level (ft)
1006	WT	11535	1381.45	1381.71
605	SG	12238	1380.56	1375.56
208	TS	12816	1389.67	1393.81
207	SG	12818	1394.40	1394.18
502	SG	13017	1391.60	1382.37
8004	SG	14838	1380.61	1373.00
1007	WT	15033	1366.12	1371.62
111	SG	15517	1381.89	1387.25
104	SG	15635	1386.54	1373.94
115	UWT	15673	1370.46	1359.53
116	SG	15678	1379.70	1378.07
801	SG	15697	1380.61	1369.38
8604	SG	16535	1384.18	1371.94
109	UWT	17294	1368.06	1372.65
1108A	WT	17697	1369.25	1369.37
110	UWT	18178	1378.24	1378.77
108	UWT	18212	1356.74	1352.61
8603	SG	18317	1381.64	1371.28
1109B	UWT	18774	1364.22	1359.16
103	SG	12054	1388.94	1376.24
105	SG	19194	1375.42	1359.15
1101A	WT	19377	1372.33	1374.63
1101B	UWT	19374	1357.08	1361.96
1106B	UWT	19695	1359.83	1360.40
1106A	WT	19698	1372,99	1371.86
106	SG	20936	1374.44	1370.51
1105B	UWT	21591	1337.65	1333.90
1105A	UWT	21595	1355.54	1350.92
114	UWT	21877	1370.55	1366.78
107	UWT	22674	1359.40	1356.48
804	SG	22717	1369.52	1357.06
803	SG	22777	1368.50	1355.31
1110A	WT	23235	1366.57	1356.16
1104B	UWT	23295	1362.48	1358.57
1104A	WT	23298	1377.24	1370.45
8612	SG	23657	1364.08	1364.95
1102B	UWT	23836	1367.30	1364.84
1102A	WT	23839	1380.47	1376.22
1111A	UWT	23897	1376.11	1369.02
1103B	UWT	24035	1367.38	1355.07
1103A	WT	24039	1380.41	1369.47

a. Heads in feet relative to atmospheric pressure and mean sea level.
b. SG=Sand and gravel layer.
c. WT=Weathered Lavery till.
d. UWT=Unweathered Lavery till.
e. TS=Till sand unit.

The role of anisotropy in the sand and gravel layer was investigated by decreasing the ratio of horizontal to vertical hydraulic conductivity by factors of ten and one hundred. A ratio of 100 was specified for the base case. In each of these cases, the cumulative absolute error increased significantly, indicating that the base case value best represented the head data.

The role of spatial variation in the hydraulic conductivity in the sand and gravel layer was investigated by specifying a single value (ft/day) for this parameter for all nodes (homogeneous case). In the base case, spatial variation was determined by field measured values. The resulting cumulative absolute error for the single value case was slightly smaller than the base case using field-measured values. This indicates that the observed spatial variation of hydraulic conductivity is not large enough to significantly alter flow directions for the model area.

J.7.5.3 Variation in Precipitation

The role of varying precipitation was investigated by doubling the assigned value of this parameter. The cumulative absolute error remained unchanged, possibly due to the water table being near the surface over much of the model area. Additional precipitation results in added run-off rather than added recharge to the flow system.

Increasing the available recharge area increased the mean absolute error in heads. In the base case, no infiltration conditions were imposed for developed areas. Removal of this restriction is expected to result in a less realistic prediction of conditions.

J.7.5.4 Variation of Areal Extent of the Till Sand Unit

The areal extent of the till sand unit is poorly defined. A set of simulations investigated the significance of representing this unit as a separate formation. The best results were obtained when the unit was absent from the model. The smallest cumulative absolute error obtained with an extensive area for the till sand unit was 227, significantly larger than the base case error. This result indicates that, within the sensitivity of the model representation, the thickness and extent of the till sand unit does not have a significant influence on the flow system.

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APPENDIX K

METHOD FOR ESTIMATING NONRADIOLOGICAL AIR QUALITY IMPACTS

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This appendix presents the methodology used to estimate the nonradiological air quality impacts potentially generated by the implementation phase of each of the five alternatives being evaluated in this Environmental Impact Statement (EIS). These impacts are estimated for predicted on- and off-site concentrations of the criteria pollutants of environmental concern and compare the concentrations to national health-based air quality standards. The sources for potential air quality impacts include generating dust from on-site activities and releasing combustion products from operating equipment and vehicles. Air emissions because of transporting waste from the Western New York Nuclear Service Center (Center) to off-site disposal facilities are discussed in Appendix H. The extent of the activities and modeled results vary among the alternatives, with the highest modeled emission values resulting from Alternative I (Removal) and the lowest modeled emissions resulting from Alternative IV (No Action: Monitoring and Maintenance).

Ambient air quality monitoring is conducted. This monitoring is to demonstrate that air emissions in an area do not violate the National Ambient Air Quality Standards set by the U. S. Environmental Protection Agency (EPA) for short- and long-term protection of public health. The Center and surrounding area in Cattaraugus County are in attainment as described in Chapter 4. The city of Buffalo, located about 48 km (30 mi) from the Center is not in attainment for ozone. The National Ambient Air Quality Standards are health-based and generally require that short (1 to 24 hour) and annual average concentrations of certain common criteria pollutants not exceed specified levels. These levels were established at concentrations that the EPA has determined are "necessary, with an adequate margin of safety, to protect the public health" (40 CFR Part 50.2, "National Primary and Secondary Ambient Air Quality Standards"). These standards were used as a basis for comparing the nonradiological air impacts from implementing an alternative. Although compliance with the National Ambient Air Quality Standards is useful for comparison, it is not determinative of significance.

Four nonradiological pollutants are of potential concern during implementation actions: (1) oxides of nitrogen (NO_x), (2) sulfur dioxide (SO_2), (3) anhydrous ammonia (NH_3), and (4) particulate matter less than 10 microns in size (PM-10). The other criteria pollutants, lead and ozone, would be produced in such small quantities by the implementation phase of closure that they were not considered in this analysis. Modeling of the effect of current plant operations on ambient air quality has been conducted, and the results show that current plant operations have not degraded air quality to exceed National and New York State ambient air quality standards at the Center boundary. To evaluate the effect of the implementation phase activities on ambient air quality, the following criteria pollutants were modeled using an EPA-approved dispersion model (COMPLEX-I): PM-10, carbon monoxide (CO), SO_2 and nitrogen dioxide (NO_2). The modeling results presented in this appendix are derived from emissions estimates for the alternatives based on information in the closure engineering reports and regional and site-specific meteorological data. The emissions reported in the closure engineering reports represent a conservative (worst-case) estimate for compiling implementation phase emissions during closure because it was assumed that no mitigative measures to control emissions would be used. Generally, the use of mitigative control measures during mining, excavation, grading, and construction can reduce fugitive dust and PM-10 emissions by as much as 80 percent (Pechan 1994a). The modeled emissions inventory included fugitive dust as particulate matter. Twenty- two percent of total suspended particulates were considered PM-10 based on Pechan (1994b). Therefore, the fugitive dust component of the emissions inventory in the closure engineering reports was reduced by 78 percent to reflect the portion of these emissions covered under the PM-10 National Ambient Air Quality Standards.

For the modeling effort, partial credit was given for mitigative measures, and the emission rates were reduced 65 percent rather than 80 percent. It was assumed that conventional engineering practices would be used to control the release of particulate matter. Exhumation of the disposal areas would be conducted under an inflatable structure, so releases to the atmosphere would be filtered. Roads and construction sites would be periodically wet down with water to reduce wind erosion and soil disruption from heavy equipment operations. Contaminated soil would be transported in covered trucks to reduce and prevent spillage and wind erosion during transport.

K.1 MODEL DESCRIPTION

A dispersion modeling protocol using COMPLEX-I was designed to estimate nonradiological criteria pollutants (i.e., CO, NO_2, PM-10 and SO_2) impacts within a 80-km (50-mi) radius of the Center. Relative dispersion values (χ/Q) computed using unit emission rates were used in conjunction with a radiological transport model to determine the radiological effects from implementation phase activities. COMPLEX-I is an EPA-approved screening dispersion model applied to areas of complex terrain. The model uses the same plume impaction algorithm originally developed for the VALLEY model (EPA 1994). For this analysis, U.S. Geological Survey 1:250,000 topographic maps [contour interval of 30.5 m (100 ft)] were used to determine receptor elevations at 16 different compass points (0°, 22.5°, 45°, 67.5°, etc.) at 10 different radial distances [1.6, 3.2, 4.8, 6.4, 8, 16, 32, 48, and 80 km (1, 2, 3, 4, 5, 10, 20, 30, 40 and 50 mi)] from the geographic center of the Project Premises and the New York state-licensed disposal area (SDA). The receptor elevations were determined for the following map quadrants:

- Toronto (43078-A1)
- Rochester (43076-A1)
- Buffalo (42078-A1)
- Elmira (42076-A1)
- Warren (41078-A1)
- Williamsport (41076-A1).

Table K-1 summarizes the direction, distance, and elevation of each modeled receptor location. Maximum average concentrations at the Project Premises fenceline, nearest the public access (i.e., Rock Springs Road, Buttermilk Road, and the Baltimore and Ohio Railroad) were also calculated. Fenceline elevations and distances were computed from a detailed site map. The emissions generated by implementation phase actions would not be released through a stack; therefore, the calculations were made for a near surface release [3 m (9 ft)], using a nominal exit velocity of 1 m/s (3.3 ft/s) and an ambient release temperature of 297 degrees K.

The input parameters for COMPLEX-I include hourly meteorological, upper air, receptor location, local terrain elevation, and emission rate data. Both site-specific and regional meteorological data were obtained from the Buffalo National Weather Service Office. Processed hourly meteorological data from the 10-m (33-ft) tower on the Project Premises for the period January 1, 1987, through December 31, 1991, were used and upper air data for the Buffalo National Weather Service for the period 1984 through 1989 were used to determine the hourly mixing heights (e.g., planetary boundary layer height) for the model domain. The 1988 data were not usable to model, so site-specific surface data were used in conjunction with the upper air data collected at the Buffalo National Weather Service office for 1988. Periodic gaps (<2 hours) in the site-specific meteorological data were filled in using the comparable surface data from the Buffalo National Weather Service surface data file. The combined data sets were preprocessed using an EPA code, PCRAMMET, and formatted for use in COMPLEX-I. Because site-specific data were used, only 1 year of data was required (EPA 1994).

The value for total emissions by alternative was generated using data from the closure engineering reports (WVNS 1994a through k). These emission estimates were generated using standard EPA techniques (e.g., AP-42) (EPA 1985). Emission values were annualized determining emission rates (in grams per second) by alternative. The work assumptions for determining the emission rate included a 24-hour workday, 7-day workweek, and, 52-weeks per year. The total emissions by alternative used as input to the modeling are summarized in Table K-2. To conservatively estimate the impacts, it was assumed that all implementation actions would occur simultaneously. As is evident from the discussion and schedule in Chapter 3, not all implementation phase actions occur simultaneously. Because no National Ambient Air Quality Standards violations occurred under this assumption, it is unlikely that National Ambient Air Quality Standards violations would occur given an actual staggered work schedule. The preprocessed 1988 meteorological files were used to estimate dispersion.

K.2 SUMMARY OF MODEL RESULTS

K.2.1 χ/Q Analyses

The relative dispersion values (e.g., χ/Q) for the surface release scenario using the 1988 meteorological data are summarized in Table K-3. The results of this analysis agreed with the earlier findings (NRC 1987), where the maximum potential for highest concentrations was located in the WNW to N sector of the region. This result is not entirely unexpected, as the combined effects of the terrain, which gently slopes lakeward in a northwesterly direction,

Table K-1. Elevations at Receptor Grid Locations for the COMPLEX-I Modeling (elevations are in feet)[a]

Compass Orientation					Downwind Distance (mi)									
Heading	Direction	Project Premises Fenceline	Nearest Public Access	1,350-Hectare (3,340-Acre) Fenceline	1	2	3	4	5	10	20	30	40	50
22.5°	NNE	1,365	1,210[b]	1,343	157.9	167.2	167.2	176.5	157.9	139.4	120.8	139.4	92.9	69.7
45.0°	NE	1,340	1,225[b]	1,492	157.9	167.2	176.5	185.8	171.9	144.0	157.9	148.7	134.7	83.6
67.5°	ENE	1,345	1,235[b]	1,375	148.7	176.5	185.8	176.5	167.2	171.9	195.1	130.1	83.6	120.8
90.0°	E	1,370	1,255[b]	1,513	157.9	185.8	176.5	167.2	157.9	181.2	148.7	167.2	176.5	139.4
112.5°	ESE	1,379	1,265[b]	1,400	157.9	185.8	185.8	167.2	185.8	148.7	185.8	139.4	185.8	213.7
135.0°	SE	1,380	1,375[c]	1,330	157.9	185.8	181.2	167.2	167.2	195.1	139.4	213.7	195.1	213.7
157.5°	SSE	1,385	1,388[c]	1,625	157.9	157.9	176.5	176.5	171.9	167.2	185.8	204.4	162.6	157.9
180.0°	S	1,395	1,425[d]	1,608	157.9	185.8	176.5	157.9	190.4	185.8	167.2	185.8	185.8	176.5
202.5°	SSW	1,430	1,440[d]	1,730	157.9	185.8	185.8	185.8	181.2	185.8	139.4	185.8	185.8	176.5
225.0°	SW	1,445	1,450[d]	1,848	167.2	176.5	167.2	195.1	185.8	176.5	148.7	157.9	130.1	176.5
247.5°	WSW	1,415	1,460[d]	1,770	157.9	184.9	157.9	176.5	148.7	130.1	167.2	167.2	167.2	153.3
270.0°	W	1,435	1,400[d]	1,725	157.9	167.2	167.2	148.7	157.9	134.7	130.1	120.8	65.0	52.9
292.5°	WNW	1,421	1,440[d]	1,555	176.5	157.9	167.2	157.9	153.3	120.8	46.5	52.9	52.9	52.9
315.0°	NW	1,495	1,450[d]	1,470	157.9	139.4	139.4	153.3	139.4	134.7	111.5	52.9	52.9	55.7
337.5°	NNW	1,370	1,250[b]	1,230	130.1	130.1	130.1	130.1	130.1	139.4	83.6	65.0	52.9	55.7
360.0°	N	1,365	1,210[b]	1,250	139.4	167.2	157.9	178.5	144.0	148.7	130.1	74.3	65.0	55.7

a. To convert feet to meters, multiply by 0.0348. To convert miles to kilometers, multiply by 1.609.
b. Baltimore and Ohio Railroad
c. Buttermilk Road
d. Rock Springs Road

Table K-2. Total Emissions in Tons During the Implementation Phase for the Alternatives[a]

WMA/Facility	Fugitive Dust and PM-10					Carbon Monoxide					Nitrogen Dioxide					Sulfur Dioxide				
	Alternative[b]					Alternative					Alternative					Alternative				
	I	II	IIIA	IIIB	IV	I	II	IIIA	IIIB	IV	I	II	IIIA	IIIB	IV	I	II	IIIA	IIIB	IV
1—Process Building	138.8	138.8	5.4	715.4	0.0	34.9	34.9	7.2	32.6	0.0	39.3	39.3	0.2	26.0	0.0	2.5	2.5	0.8	1.7	0.0
01/14 Building	0.8	0.8	0.8	0.8	0.0	3.5	3.5	3.5	3.5	0.0	2.1	2.1	2.1	2.1	0.0	0.1	0.1	0.1	0.1	0.0
2—LLWTF and Lagoons 1-5	37.8	37.8	48.1	48.1	20.5	3.3	3.3	2.5	2.5	2.3	17.5	17.5	14.0	14.0	13.1	1.1	1.1	0.8	0.8	0.8
3—HLW/Vitrification Facility	269.0	269.0	48.0	48.0	0.0	11.8	11.8	2.3	3.9	0.0	59.3	59.3	6.2	15.3	0.0	3.7	3.7	0.4	1.0	0.0
4—CDDL and MSUs	79.5	79.5	1.2	1.2	0.0	1.3	1.3	0.2	0.2	0.1	0.3	0.3	0.1	0.1	0.1	0.9	0.9	0.1	0.1	0.1
5—CPC Waste Storage Area	0.5	0.5	0.5	0.5	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.0
Lag Storage Building and Additions	28.5	28.5	28.5	28.5	0.0	0.1	0.1	0.1	0.1	0.0	0.5	0.5	0.5	0.5	0.0	0.1	0.1	0.1	0.1	0.0
7—NDA	15.8	15.8	16.2	16.2	0.0	34.1	34.1	140.9	140.9	0.0	55.1	55.1	24.7	24.7	0.0	3.6	3.9	1.7	1.7	0.0
8—SDA	446.2	446.2	129.9	129.9	0.0	22.6	22.6	46.0	46.0	0.0	16.3	16.3	22.4	22.4	0.0	1.1	1.1	1.8	1.8	0.0
9—RTS Drum Cell	0.3	0.0	1.6	1.6	0.0	3.5	0.0	5.4	5.4	0.0	5.2	0.0	22.0	22.0	0.0	0.3	0.0	1.5	1.5	0.0
—Other Facilities including WMAs 6, 10, 11 and 12	3,489.0	3,150.0	277.0	298.0	21.3	223.0	243.0	263.0	345.0	4.9	567.0	798.0	334.0	346.0	25.2	36.0	50.0	18.0	38.0	1.6

a. Without mitigative measures.
b. Alternative I: Removal and Release to Allow Unrestricted Use
Alternative II: Removal, On-Premises Waste Storage, and Partial Release to Allow Unrestricted Use
Alternative IIIA: In-Place Stabilization (Backfill) and On-Premises Low-Level Waste Disposal
Alternative IIIB: In-Place Stabilization (Rubble) and On-Premises Low-Level Waste Disposal
Alternative IV: No Action: Monitoring and Maintenance
Alternative V: Discontinue Operations

Table K-3. **Relative Dispersion Characteristics (χ/Q) for a Near Surface Release at the Western New York Nuclear Service Center (concentrations in 10^{-6} s/m^3)**[a]

Compass Orientation				1,350-Hectare (3,340-Acre)	Downwind Distance (mi)									
Degree	Heading	Project Premises Fenceline	Nearest Public Access	Fenceline	1	2	3	4	5	10	20	30	40	50
22.5°	NNE	17.63	1.71[b]	2.34	2.10	0.68	0.37	0.22	0.18	0.08	0.03	0.02	0.008	0.004
45.0°	NE	22.89	2.16[b]	2.07	1.68	0.54	0.28	0.17	0.13	0.06	0.02	0.01	0.01	0.005
67.5°	ENE	20.18	1.65[b]	0.96	0.97	0.29	0.15	0.10	0.07	0.03	0.009	0.008	0.003	0.004
90.0°	E	8.71	1.52[b]	0.70	1.08	0.31	0.18	0.12	0.09	0.03	0.01	0.007	0.005	0.005
112.5°	ESE	9.33	1.70[b]	0.82	1.36	0.40	0.21	0.15	0.10	0.05	0.01	0.01	0.006	0.004
135.0°	SE	6.36	4.70[c]	1.27	2.40	0.70	0.38	0.26	0.18	0.06	0.03	0.01	0.009	0.006
157.5°	SSE	10.79	4.08[c]	0.71	1.44	0.47	0.30	0.15	0.11	0.04	0.01	0.01	0.006	0.005
180.0°	S	2.21	1.21[d]	0.23	0.41	0.12	0.07	0.04	0.03	0.01	0.004	0.003	0.002	0.001
202.5°	SSW	1.52	2.36[d]	0.12	0.21	0.06	0.03	0.02	0.02	0.006	0.003	0.002	0.001	0.001
225.0°	SW	2.00	2.54[d]	0.14	0.25	0.08	0.04	0.02	0.02	0.006	0.003	0.002	0.001	0.001
247.5°	WSW	3.43	0.61[d]	0.17	0.20	0.06	0.03	0.02	0.02	0.006	0.002	0.001	0.001	0.001
270.0°	W	2.10	1.66[d]	0.24	0.23	0.07	0.04	0.03	0.02	0.008	0.003	0.002	0.001	0.001
292.5°	WNW	24.20	1.19[d]	0.97	0.26	0.10	0.05	0.03	0.03	0.01	0.001	0.001	0.001	0.001
315.0°	NW	21.68	1.35[d]	1.14	1.01	0.40	0.22	0.13	0.10	0.04	0.01	0.002	0.002	0.001
337.5°	NNW	24.08	1.81[b]	1.03	4.46	1.59	0.88	0.58	0.42	0.15	0.02	0.007	0.004	0.003
360.0°	N	21.60	1.79[b]	0.46	4.59	1.30	0.78	0.42	0.41	0.15	0.07	0.01	0.006	0.004

a. To convert miles to kilometers, multiply by 1.609.
b. Baltimore and Ohio Railroad
c. Buttermilk Road
d. Rock Springs Road

and the surface wind patterns (Figure 4-16 shows a significant south-southeast component) tend to disperse atmospheric pollutants along this general corridor.

K.2.2 Alternative I: Removal and Release to Allow Unrestricted Use

Under Alternative I (Removal), the structures on the Project Premises and SDA would be decontaminated, demolished, and removed off site. Buried waste would be exhumed and disposed of off site. Upon completion of this alternative, the area could be released for unrestricted use.

The criteria pollutant emissions were compiled for the activities occurring under Alternative I to determine total emissions during the construction activities of the implementation phase. The particulate emissions were divided in two categories: particulate releases from operation of heavy duty equipment and fugitive dust. The particulate emissions were further processed to reduce the emissions to only that portion in the PM-10 size fraction and to apply a control efficiency of 65 percent to the total PM-10 emissions estimate as described in the introduction. Using a receptor grid identical to that described for the dispersion calculations, COMPLEX-I was initialized using the criteria pollutant emission rates to determine the downwind ground-level concentration values for each of the four modeled criteria pollutants.

The modeling results for Alternative I are presented in Table K-4 for downwind distances less than or equal to 4.8 km (3 mi) because there were no National Ambient Air Quality Standards violations at this point. The highest concentrations for all four criteria pollutants were observed at the northwest quadrant of the Project Premises fenceline. These concentrations are one to two orders of magnitude less than the National Ambient Air Quality Standards even if background concentrations are added to the modeled results. This location is within the Center; therefore, there would be no impact on the public. Because no National Ambient Air Quality Standards violations occurred within a 4.8-km (3-mi) radius, no downwind violations from implementation phase actions would be expected. Therefore, the concentration of criteria pollutants at long-range downwind distances were not modeled.

K.2.3 Alternative II: Removal, On-Premises Waste Storage, and Partial Release to Allow Unrestricted Use

Alternative II (On-Premises Storage) is similar to Alternative I (Removal) and requires essentially the same implementation phase activities described in Section K.2.2. The major distinction between these alternatives is that under Alternative II radioactive waste is not transported off site; instead, it is stored on premises.

The criteria pollutant emissions for Alternative II were compiled in the same way as for Alternative I. The modeling results for Alternative II are presented in Table K-5 for the same downwind distances as Alternative I. The results show no violations of the National Ambient Air Quality Standards for each of the criteria pollutants considered. The highest concentrations for all four criteria pollutants were observed at the northwest quadrant of the Project Premises fenceline. However, these values are one to two orders of magnitude less

Table K-4. Concentration of Criteria Pollutants for Alternative I (Removal)

Criteria Pollutant	Primary Standard (μg/m³)	Regional Background (μg/m³)[c]	Location[a]: Project Premises Fenceline Concentration (μg/m³)	Project Premises Fenceline Direction	Nearest Public Access Concentration (μg/m³)	Nearest Public Access Direction	1 mi[b] Concentration (μg/m³)	1 mi[b] Direction	2 mi[b] Concentration (μg/m³)	2 mi[b] Direction	3 mi[b] Concentration (μg/m³)	3 mi[b] Direction
PM-10												
Maximum Average Annual	50[d]	23	5.03	NW	0.73	SE	2.68	NNE	2.76	N	1.64	N
Maximum 24-hour Average	150[e]	72	74.43	NW	19.72	SSW	26.14	NNE	16.54	N	8.40	N
Carbon Monoxide												
8-hour Maximum	10,000[f]	4.6	275.6	NW	49.0	SSW	80.0	NNE	42.0	N	22.9	N
1-hour Maximum	40,000[g]	6.6	1,000.4	WNW	227.9	SSW	192.4	N	65.8	NW	39.4	NW
Nitrogen Dioxide												
Maximum Average Annual	100[d]	0.019	12.95	NW	1.87	SE	6.90	NNE	7.10	N	4.22	N
Sulfur Dioxide												
Maximum Average Annual	80[d]	0.009	0.86	NW	0.12	SE	0.46	NNE	0.47	N	0.28	N
Maximum 24-hour Average	365[e]	0.036	12.78	NW	3.39	SSW	4.49	NNE	2.84	N	1.44	N

a. Distance from the center of the Project Premises.
b. To convert miles to kilometers, multiply by 1.609.
c. Regional background as measured near Buffalo, New York, about 48 km (30-mi) from the Center.
d. Annual arithmetic mean.
e. Twenty-four-hour average.
f. Eight-hour average.
g. One-hour average.

Table K-5. Concentration of Criteria Pollutants for Alternative II (On-Premises Storage)

Criteria Pollutant	Primary Standard (µg/m³)	Regional Background (µg/m³)[c]	Location[a]: Project Premises Fenceline Concentration (µg/m³)	Project Premises Fenceline Direction	Nearest Public Access Concentration (µg/m³)	Nearest Public Access Direction	1 mi[b] Concentration (µg/m³)	1 mi[b] Direction	2 mi[b] Concentration (µg/m³)	2 mi[b] Direction	3 mi[b] Concentration (µg/m³)	3 mi[b] Direction
PM-10												
Maximum Average Annual	50[d]	23	4.63	NW	0.67	SE	2.47	NNE	2.54	N	1.51	N
Maximum 24-hour Average	150[e]	72	68.51	NW	18.15	SSW	24.06	NNE	15.23	N	7.74	N
Carbon Monoxide												
8-Hr Maximum	10,000[f]	4.6	218.4	NW	38.8	SSW	63.4	NNE	33.3	N	18.11	N
1-Hr Maximum	40,000[g]	6.6	792.8	WNW	180.6	SSW	152.5	N	52.2	NW	31.2	NW
Nitrogen Dioxide												
Maximum Average Annual	100[d]	0.019	14.08	NW	2.03	SE	7.51	NNE	7.73	N	4.59	N
Sulfur Dioxide												
Maximum Average Annual	80[d]	0.009	0.94	NW	0.14	SE	0.50	NNE	0.52	N	0.31	N
Maximum 24-hour Average	365[e]	0.036	13.92	NW	3.69	SSW	4.89	NNE	3.09	N	1.57	N

a. Distance from the center of the Project Premises.
b. To convert miles to kilometers, multiply by 1.609.
c. Regional background as measured near Buffalo, New York, about 48-km (30-mi) from the Center.
d. Annual arithmetic mean.
e. Twenty-four-hour average.
f. Eight-hour average.
g. One-hour average.

than the National Ambient Air Quality Standards, even if substantial background concentrations are added into the modeled concentrations. This location is within the Center; therefore, there would be no impact on the public. Because no National Ambient Air Quality Standards violations occurred inside of the 4.8-km (3-mi) radius, it is very unlikely that downwind violations of this location would occur. The long-range distances downwind of the Center were not modeled for Alternative II.

K.2.4 Alternative III: In-Place Stabilization and On-Premises Low-Level Waste Disposal

Alternative IIIA [In-Place Stabilization (Backfill)] involves in-place stabilization of contaminated facilities. Under Alternative IIIA, the process building, high-level [radioactive] waste (HLW) tank farm and the vitrification facility would be backfilled with concrete. Currently stored waste in the chemical process cell (CPC) waste storage area, lag storage building, and lag storage additions would be disposed of in the process building before backfilling. The Nuclear Regulatory Commission-licensed disposal area (NDA) and SDA would be stabilized and remain in place.

Under Alternative IIIB [In-Place Stabilization (Rubble)], the process building and the vitrification facility would be disassembled, stabilized, and capped. A confinement structure would be constructed to prevent the spread of contamination during the implementation phase. The NDA and SDA would be stabilized in-place, while low-level [radioactive] waste (LLW) generated by implementing Alternative IIIB and stored waste in WMA 5 would be disposed of in a new on-premises LLW disposal facility.

The criteria pollutant emissions for Alternatives IIIA and IIIB were compiled the same way as for Alternative I (Removal). The modeling results for Alternatives IIIA and IIIB are presented in Tables K-6 and K-7, respectively, for downwind distances less than or equal to 4.8 km (3 mi). The results for both Alternatives IIIA and IIIB show no National Ambient Air Quality Standards violation for any of the criteria pollutants. The particulate emissions for Alternative IIIB are slightly higher than those for Alternative IIIA because there are more construction activities associated with Alternative IIIB (e.g., building a containment structure for disassembly and stabilization activities). The highest concentrations for all four criteria pollutants were observed at a the northwest quadrant of the Project Premises fenceline. However, these values are one to two orders of magnitude less than the National Ambient Air Quality Standards, even if substantial background concentrations are added into the modeled concentrations. This location is within the Center; therefore, there would be no impact on the public. Given that no violations occurred inside of the 4.8-km (3-mi) radius, it is very unlikely that National Ambient Air Quality Standards violations would occur downwind of this location. The long-range distances downwind of the Center were not modeled for Alternatives IIIA or IIIB, because there was no impact at the 4.8-km (3-mi) radius.

K.2.5 Alternative IV: No Action: Monitoring and Maintenance

Alternative IV (No Action: Monitoring and Maintenance) involves monitoring and maintaining the Center. The criteria pollutant emissions for Alternative IV were compiled the

Table K-6. Concentration of Criteria Pollutants for Alternative IIIA [In-Place Stabilization (Backfill)]

			Location[a]									
			Project Premises Fenceline		Nearest Public Access		1 mi[b]		2 mi[b]		3 mi[b]	
Criteria Pollutant	Primary Standard (μg/m^3)	Regional Background (μg/m^3)[c]	Concentration (μg/m^3)	Direction	Concentration (μg/m^3)	Direction	Concentration (μg/m^3)	Direction	Concentration (μg/m^3)	Direction	Concentration (μg/m^3)	Direction
PM-10												
Maximum Average Annual	50[d]	23	1.01	NW	0.15	SE	0.54	NNE	0.55	N	0.33	N
Maximum 24-hour Average	150[e]	72	14.96	NW	3.96	SSW	5.25	NNE	3.32	N	1.69	N
Carbon Monoxide												
8-Hr Maximum	10,000[f]	4.6	348.6	NW	61.9	SSW	101.1	NNE	53.1	N	28.9	N
1-Hr Maximum	40,000[g]	6.6	1,265.5	WNW	288.3	SSW	243.4	N	83.3	NW	49.8	NW
Nitrogen Dioxide												
Maximum Average Annual	100[d]	0.019	15.90	NW	2.30	SE	8.48	NNE	8.72	N	5.18	N
Sulfur Dioxide												
Maximum Average Annual	80[d]	0.009	1.05	NW	0.15	SE	0.56	NNE	0.57	N	0.34	N
Maximum 24-hour Average	365[e]	0.036	15.48	NW	4.10	SSW	5.44	NNE	3.44	N	1.75	N

a. Distance from the center of the Project premises.
b. To convert miles to kilometers, multiply by 1.609.
c. Regional Background as measured near Buffalo, New York, about 48-km (30-mi) from the Center.
d. Annual arithmetic mean.
e. Twenty-four-hour average.
f. Eight-hour average.
g. One-hour average.

Table K-7. Concentration of Criteria Pollutants for Alternative IIIB [In-Place Stabilization (Rubble)]

Criteria Pollutant	Primary Standard (μg/m³)	Regional Background (μg/m³)[c]	Location[a]: Project Premises Fenceline Concentration (μg/m³)	Project Premises Fenceline Direction	Nearest Public Access Concentration (μg/m³)	Nearest Public Access Direction	1 mi[b] Concentration (μg/m³)	1 mi[b] Direction	2 mi[b] Concentration (μg/m³)	2 mi[b] Direction	3 mi[b] Concentration (μg/m³)	3 mi[b] Direction
PM-10												
Maximum Average Annual	50[d]	23	1.26	NW	0.18	SE	0.67	NNE	0.69	N	0.41	N
Maximum 24-hour Average	150[e]	72	18.71	NW	4.96	SSW	6.57	NNE	4.16	N	2.11	N
Carbon Monoxide												
8-Hr Maximum	10,000[f]	4.6	418.1	NW	74.3	SSW	121.3	NNE	63.7	N	34.7	N
1-Hr Maximum	40,000[g]	6.6	1,517.5	WNW	345.8	SSW	291.8	N	99.8	NW	59.7	NW
Nitrogen Dioxide												
Maximum Average Annual	100[d]	0.019	16.47	NW	2.38	SE	8.78	NNE	9.04	N	5.36	N
Sulfur Dioxide												
Maximum Average Annual	80[d]	0.009	1.36	NW	0.20	SE	0.73	NNE	0.75	N	0.44	N
Maximum 24-hour Average	365[e]	0.036	20.20	NW	5.35	SSW	7.09	NNE	4.49	N	2.28	N

a. Distance from the center of the Project Premises.
b. To convert miles to kilometers, multiply by 1.609.
c. Regional background as measured near Buffalo, New York, about 48-km (30-mi) from the Center.
d. Annual arithmetic mean.
e. Twenty-four-hour average.
f. Eight-hour average.
g. One-hour average.

same way as for Alternative I (Removal). Modeling results for downwind distances less than or equal to 4.8 km (3 mi), presented in Table K-8, show no National Ambient Air Quality Standards violations for any of the modeled criteria pollutants. The highest concentrations for all four criteria pollutants were observed at the northwest quadrant of the Project Premises fenceline. However, these values are two to four orders of magnitude less than the National Ambient Air Quality Standards, even if background concentrations are added to the modeled concentrations. This location is within the Center; therefore, there would be no impact on the public. Because no violations occurred inside of the 4.8-km (3-mi) radius, it is very unlikely that National Ambient Air Quality Standards violations would occur downwind of this location. Therefore the long-range distances downwind of the Center were not modeled.

K.2.6 Alternative V: Discontinue Operations

Because operations at the Center would be discontinued and the site would be abandoned, there would be no implementation phase. Therefore, there would be no impact.

K.3 COMPARISON OF MODEL RESULTS

Table K-9 summarizes model results for each alternative (from Tables K-4 through K-8), along with the regional background concentration measured at urban and suburban sites in Buffalo, New York, about 48 km (30 mi) northwest of the Center, and National Ambient Air Quality Standards standard for each modeled criteria pollutant. For comparison, the highest average values are presented for PM-10, CO, and SO_2 (see footnote "a" for Table K-9). For each alternative, only the highest Project Premises fenceline and off site results are listed for comparison.

The regional background concentrations are less than the National Ambient Air Quality Standards for all four modeled criteria pollutants. The model results with the highest values for all alternatives are all located on the Project Premises and the SDA. The on-premises concentrations are above regional background but below the National Ambient Air Quality Standards. These effects would be temporary and of short duration. The sum of the background concentrations and the modeled results for all pollutants at all locations is less than the National Ambient Air Quality Standards. Therefore, because the National Ambient Air Quality Standard levels were established to ensure, with an adequate margin of safety, that public health would be protected, the modeling results show that public health would not likely be impacted because of airborne releases of those pollutants during the implementation phase of the alternatives.

Alternatives I (Removal) and II (On-Premises Storage) have essentially the same results for PM-10, NO_2, and SO_2, with an 8 percent difference for all three pollutants shown in Table K-9. Results for CO are also comparable between these alternatives with a difference of 23 percent. Results for Alternatives IIIA [In-Place Stabilization (Backfill)] and IIIB [In-Place Stabilization (Rubble)] are comparable, with the closest results observed for NO_2 (within 4 percent) and the widest difference between SO_2 results (30 percent). For all pollutants, results for Alternatives I and II are within the same order of magnitude as the results for Alternatives IIIA and IIIB.

Table K-8. Concentration of Criteria Pollutants for Alternative IV (No Action: Monitoring and Maintenance)

Criteria Pollutant	Primary Standard (μg/m³)	Regional Background (μg/m³)[c]	Location[a]: Project Premises Fenceline Concentration (μg/m³)	Project Premises Fenceline Direction	Nearest Public Access Concentration (μg/m³)	Nearest Public Access Direction	1 mi[b] Concentration (μg/m³)	1 mi[b] Direction	2 mi[b] Concentration (μg/m³)	2 mi[b] Direction	3 mi[b] Concentration (μg/m³)	3 mi[b] Direction
PM-10												
Maximum Average Annual	50[d]	23	0.13	NW	0.02	SE	0.07	NNE	0.07	N	0.04	N
Maximum 24-hour Average	150[e]	72	1.96	NW	0.52	SSW	0.69	NNE	0.44	N	0.22	N
Carbon Monoxide												
8-Hr Maximum	10,000[f]	4.6	6.01	NW	1.07	SSW	1.74	NNE	0.92	N	0.50	N
1-Hr Maximum	40,000[g]	6.6	21.8	WNW	5.0	SSW	4.2	N	1.4	NW	0.9	NW
Nitrogen Dioxide												
Maximum Average Annual	100[d]	0.019	0.72	NW	0.10	SE	0.38	NNE	0.39	N	0.23	N
Sulfur Dioxide												
Maximum Average Annual	80[d]	0.009	0.05	NW	0.01	SE	0.03	NNE	0.03	N	0.02	N
Maximum 24-hour Average	365[e]	0.036	0.70	NW	0.19	SSW	0.25	NNE	0.16	N	0.08	N

a. Distance from the center of the Project Premises.
b. To convert miles to kilometers, multiply by 1.609.
c. Regional background as measured near Buffalo, New York, about 48-km (30-mi) from the Center.
d. Annual arithmetic mean.
e. Twenty-four-hour average.
f. Eight-hour average.
g. One-hour average.

Table K-9. Comparison of Nonradiological Air Quality Model Results[a]

Standards and Alternatives	PM-10[b]	Carbon Monoxide[c]	Nitrogen Dioxide[d]	Sulfur Dioxide[b]
Standards				
Buffalo Regional Background	72	6.6	0.019	0.036
National Ambient Air Quality Standards (Primary Standard)	150	40,000	100	365
Alternative I (Removal)				
Project Premises Fenceline	74.43	1,000.4	12.95	12.78
Highest Offsite	26.14[e]	227.9[f]	7.10[g]	4.49[e]
Alternative II (On-Premises Storage)				
Project Premises Fenceline	68.51	792.8	14.08	13.92
Highest Offsite	24.06[e]	180.6[f]	7.73[g]	4.89[e]
Alternative IIIA [In-Place Stabilization (Backfill)]				
Project Premises Fenceline	14.96	1,265.5	15.90	15.48
Highest Offsite	5.25[e]	788.3[f]	8.72[g]	5.44[e]
Alternative IIIB [In-Place Stabilization (Rubble)]				
Project Premises Fenceline	18.71	1,517.5	16.47	20.20
Highest Offsite	6.57[e]	345.8[f]	9.04[g]	7.09[e]
Alternative IV (No Action: Monitoring and Maintenance)				
Project Premises Fenceline	1.96	21.8	0.72	0.70
Highest Offsite	0.69[e]	5.0[f]	0.39[g]	0.25[e]

a. Standards and results were selected from Tables K-4 through K-8 to compare the highest Project Premises Fenceline and Offsite concentrations (ug/m^3) for each pollutant.
b. Maximum 24-hour average.
c. One-hour maximum.
d. Maximum average annual.
e. Location 1.6 km (1 mi) downwind (NNE) of model center.
f. Location = Nearest Public Access (SSW of model center).
g. Location 3.2 km (2 mi) downwind (N) of model center.

For Alternative IV (No Action: Monitoring and Maintenance), the results are either below regional background or between the background and National Ambient Air Quality Standards. Because Alternative IV involves monitoring and maintenance of the Center, the model results are considerably lower when compared to Alternatives I, II, or III.

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WVNS, 1994e. *West Valley Demonstration Project, State Licensed Disposal Area Closure Engineering Report*, WVDP-EIS-036, Rev. 0, September.

[1]Document is available in the public reading room.
[2]Later version of the document is available in the public reading room.

[2]WVNS, 1994f. *West Valley Demonstration Project, Low Level Waste Treatment Facility Closure Engineering Report*, WVDP-EIS-037, Rev. 0, September.

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[2]WVNS, 1994h. *West Valley Demonstration Project, Lag Storage Area Closure Engineering Report*, WVDP-EIS-032, Rev. 0, August.

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[2]Later version of the document is available in the public reading room.

APPENDIX L

EROSION STUDIES

APPENDIX L

EROSION STUDIES

Erosional processes are actively changing the landscape in the vicinity of the Project Premises and the New York State-licensed disposal area (SDA). The north and south plateaus are being modified through sheet and rill erosion, stream downcutting, slope movement, and gully migration. The rate at which the plateaus are eroding has been the subject of numerous studies at the Western New York Nuclear Service Center (Center) over the last 15 years (WVNS 1993a). The objective of the erosion studies has been to use experimental observations and predictive modeling to relate the effects and rates of erosional processes to the isolation capability of the site. This appendix summarizes these studies and predicts the long-term erosion rate for the configuration of the current site drainage and for what could occur if a global erosion strategy were implemented. For the purposes of long-term performance assessment with implementation of either a local or global erosion control strategy, it was assumed that if maintenance activities were terminated, the current stream configuration would be reestablished and erosion would proceed at the rate estimated for current conditions.

L.1 OVERVIEW OF EROSIONAL PROCESSES AT THE WESTERN NEW YORK NUCLEAR SERVICE CENTER

Erosion is the loosening and removal of soil by running water, moving ice, or wind. At Center, running water is the predominate mechanism that causes erosion. During precipitation events, surface water runoff creates sheet and rill flow. Sheet flow is a continuous film of water moving over the smooth soil surfaces and rill flow is a series of tiny rivulets connecting one water-filled hollow with another on the rougher terrain. When soil particles are removed by the sheet and rill flow, the process of sheet and rill erosion occurs.

In addition, the three small ephemeral streams (Erdman Brook, Quarry Creek, and Franks Creek), which drain the Project Premises and SDA, are currently at a relatively young stage of development with profiles that are steep, with little or no floodplains, and valley walls that are V-shaped in cross section. These streams exist in glacial till material which is highly erodible. These characteristics cause the streams to move quantities of sediment and thus erode their channels. As the downcutting progresses, the base of the stream valley slopes are undercut which results in localized slope failures (i.e. slumps and landslides) at the outside of the meander loops and ultimately results in a widening of the stream valley rim.

Gully formation and advancement is another type of erosion that results from local runoff and soil characteristics. Gullies are most likely to form in areas along stream banks where slumps and deep fractures are present, seeps are flowing, and the toe of the slope intersects the outside of the meander loop. The gully propagation process occurs during thaws and after thunderstorms in the areas where a concentrated stream of water flows over the side of a plateau and when groundwater movement, referred to as the hydraulic gradient, becomes great enough for seepage to promote the grain-by-grain entrainment and removal of soil particles from the base of the gully scarp—a process referred to as sapping. Sapping causes small tunnels (referred to as pipes) to form in the soil at the base of the gully, thus, undermining and weakening the scarp until it collapses. Surface water runoff into the gully contributes to gully growth by removing fallen debris at the base of the scarp. Thus, the three predominate erosional processes at the Center are sheet and rill erosion, stream valley rim widening, and gully advance.

L.2 SUMMARY OF SITE EROSION MEASUREMENTS

The rates at which the three predominate erosion processes are eroding the Project Premises and the SDA have been measured. Sheet and rill erosion was directly measured using erosion frames at 23 locations along the stream valley banks adjacent to the Project Premises. The stream valley rim widening was indirectly measured by two methods. The first method used carbon-14 age dating and longitudinal profile techniques to predict a stream downcutting rate which was then translated into a rim widening rate by assuming a stable slope angle for the stream valley. The second method measured the rate of slope movement on active slump areas which was translated into a rim widening rate by taking into account the angle of the slopes. The gully migration rates were calculated using aerial photographs and the Soil Conservation Services Technical Report-32 method (DOA 1976). These methods for predicting the rate of erosion provide estimates based on data that are spatially localized and relevant for short-term estimates except the carbon-14 age dating technique. Therefore, the measurements provide a useful perspective on the rate of erosion that occurs throughout the stream valley, but does not provide a complete basis for long-term estimates.

L.2.1 Measurement of Sheet and Rill Erosion

Field measurements of sheet and rill erosion were taken at 23 locations along Erdman Brook, Franks Creek, and Quarry Creek using erosion frames (WVNS 1993a). Each erosion frame was composed of a triangular steel structure designed to detect changes in soil depth at the point of installation. The frames were installed in September 1990 and initially monitored every month, subsequently at two to three month intervals until April 1992 (19 months). The results showed that soil buildup (aggradation) ranging from 0.003 to 0.35 m (0.01 to 1.19 ft) was occurring at seven locations along Erdman Brook and one location along Quarry Creek (WVNS 1993a). Soil depletion (degradation) ranging from -0.003 to -0.02 m (-0.01 to -0.06 ft) was observed at three locations along Erdman Brook, three locations on Franks Creek and one location along Quarry Creek. While there were areas with soil buildup, the measured rate of erosion in areas with soil loss was up to 1.1 cm/yr (0.4 in./yr). To date, these field measurements are too small and of too short a time period to determine a confirmable aggrading or degrading trend. Additional data are being collected.

L.2.2 Measurement of Stream Valley Rim Widening

The stream valley rim widening rate was measured indirectly by two approaches. The first approach calculated a stream downcutting rate using both the carbon-14 age dating and longitudinal profile techniques. The carbon-14 age dating technique measures the activity of carbon-14 in a sample of once living material (i.e., wood, peat) that has been assimilated into the stream terrace and the time elapsed since death is determined. The rate of channel downcutting is estimated by measuring the height of the terrace above the present channel and the age of the organic matter buried in the terraces. The longitudinal profile technique gives a short-term projection of the downcutting rate by surveying a section of the stream channel and comparing it to an equivalent survey taken at a later date. The resulting downcutting rates are translated into rim widening rates by assuming a stable slope angle for the stream valley. The rate of slope movement on several active slump areas was measured by surveying post movement over a period of time and translating the measurements into a rim widening rate by taking into account the angle of the slopes.

L.2.2.1 Rim Widening Estimates Based on Stream Downcutting Measurements

LaFleur and Boothroyd predicted a stream downcutting rate (approximately 6 m/1,000 yr) based on the carbon-14 age dating of one wood fragment sample that was collected from the highest of 14 terrace levels on the west side of Buttermilk Creek (LaFleur 1979). The sample was extracted from a trench where wood fragments were buried 50 cm (20 in.) below the surface of the river gravel, and was determined to have an age of "9920 ± 240 BP (before present) (uncorrected carbon-14 years, dated by Richard Pardi, Queens College)" (Boothroyd et al. 1979). This age was assumed to be close to the time of initial incision and downcutting of Buttermilk Creek. Because Buttermilk Creek has eroded to a depth of 55 m (180 ft) at the Bond Road Bridge near the confluence with Cattaraugus Creek, a stream downcutting rate of 0.0055 m (0.018 ft)/yr was determined by dividing 55 m by 10,000 years. This rate results in a rim widening rate of 14.3 m (47 ft)/1000 yrs.

Boothroyd et al. (1982) relied on the carbon-14 age dating of the same sample to infer the time of initial incision of Franks Creek. Using an average gradient of 6.76 m/km (22 ft/0.6 mi.), Boothroyd concluded that Buttermilk Creek would have to erode 6 m (20 ft) at the Bond Road Bridge to reach the Franks Creek confluence. At a downcutting rate of 0.0055 m (0.018 ft)/yr, this would indicate initial downcutting of Franks Creek at 1,090 years after the initial downcutting of Buttermilk Creek or 8,910 years ago. With the depth of erosion at the lower portion of Franks Creek currently equal to 51.5 m (169 ft), the stream downcutting rate was calculated by dividing 51.5 m (169 ft) by 8,910 years, resulting in a value of 0.0057 m (0.018 ft)/yr, which was rounded up to 6 m/1,000 yrs. This rate results in a rim widening rate of 15.6 m (51 ft)/1000 yrs.

In 1980, a longitudinal profile survey was conducted by Dames and Moore (WVNS, 1993b) on a section of Franks Creek starting at the Quarry Creek confluence and proceeding upstream to a point on the east side of the SDA. In 1990, a second survey was completed along the same section of Franks Creek and a comparison of the resulting data indicated a downcutting rate of approximately 0.6 m (2 ft)/10 yr period which is equivalent to 60 m (200 ft)/1,000 yrs. This rate results in a rim widening rate of 156 m (513 ft)/1000 yrs. The 0.6 m (2 ft)/10-yr estimate of downcutting rate is a direct measurement of the change in thalweg, the locus of the lowest points in a stream or valley, depth over a 10-yr period; and therefore, represents the current downcutting rate along Franks Creek. Because this rate is based on a short (10-yr) projection and relies heavily on the current status of land use in the watershed and surface water runoff, it cannot be expected to be reliable for projections beyond 50 years. The current downcutting rate for Erdman Brook has not been measured but is believed to be greater than the 0.6 m (2 ft)/10 yr estimate because it has a higher gradient, urbanized watershed, and concentrated discharges from the low-level waste treatment facility. Likewise, the current downcutting rate for Quarry Creek has not been measured but is believed to be less than the estimate for Franks Creek because the watershed is less urbanized and there is more armoring of the clay stream bed.

Dames & Moore studied the angle at which the ravine slopes within the Buttermilk Creek drainage basin would be stable by measuring 21 cross sections along Quarry Creek, Franks Creek, and Erdman Brook using the 2-ft contour interval on a 1989 topographic map (WVNS 1993b). The cross sections were taken in areas having relatively stable stream valley walls (no evidence of active landsliding) and an average slope angle was calculated. The slope angle was approximately 21 degrees and is assumed to be representative of an "at-rest" slope condition, meaning the valley walls have reached equilibrium. Slopes with angles greater than 21 degrees were viewed as potentially unstable.

L.2.2.2 Estimates of Rim Widening Based on Measurement of Slope Movement

The rate of slope movement was measured on active slump areas along Buttermilk Creek and Erdman Brook. In 1978, Boothroyd, Timson, and Dana (1979) analyzed the movement of a slump block on the Buttermilk Creek ravine, referred to as the "BC-6" landslide, approximately 426 m (1,400 ft) east of the lagoons in WMA 2. Thirty-five steel posts were surveyed at locations on the slump block complex and adjoining slopes. Two years later, the posts were resurveyed to estimate an average downslope movement rate of 7.9 m (26 ft) per year which corresponds to a stream valley rim widening rate of 4.9 to 5.9 m (16 to 19 ft) per year by taking into account the steep angle of the slope. This rate of movement is believed to represent an upper estimate of the annual mass movement that has occurred on the slope because a severe storm (recurrence interval of 10 to 20 years) was recorded during the measurement period and a 4.6 m (15-ft) thick sand layer was identified near the top of the landslide.

In the area along the section of Erdman Brook that is referred to as the "North Slope of the SDA," Edwards and Moncreiff surveyed the movement of 34 posts that were installed on the slope over a 9-yr period (1982 to 1991). Albanese et al. (1984) reported the rate of downslope till movement for the first year (1982 to 1983) to be 0.2 m (0.66 ft)/yr which is equivalent to a stream valley rim widening rate of approximately 0.15 m (0.49 ft)/yr. WVNS (1993b) reported the rate of downslope till movement for the 9-yr period to be between 0.03 and 0.05 m (0.09 and 0.16 ft)/yr which is equivalent to a stream valley rim widening rate of approximately 0.02 to 0.04 m (0.07 to 0.12 ft)/yr.

The measurements of currently active slopes provide an upper bound on the rate of slope movement that is likely to occur within the stream valley; however, the rate is not sustainable over the long term because the slope movement slows down as it evolves toward a stable slope angle and eventually stops moving as it attains equilibrium. Over the course of a 1,000-yr period, many localized areas throughout the stream valley would develop unstable slopes which would move rapidly over a short time and then stabilize.

L.2.3 Measurement of Gully Advance Rates

Several existing gullies in the Buttermilk drainage basin are migrating into the edge of the north and south plateaus. Concern exists that the gully heads could cut into the disposal areas causing waste material to be released or allowing leachate to flow into the streams. To address this concern, studies were initiated to determine the rate of gully migration.

The rate of headward advance of three major existing gullies was calculated in WVNS (1993b) using the Soil Conservation Services Technical Report-32 method (DOA 1976). Aerial photographs taken in 1955, 1961, 1968, 1977, 1978, 1980, 1984, and 1989 were reviewed in support of the calculation. The results indicated that the SDA gully is advancing toward SDA disposal Trench 1 at a rate of 0.4 m (1.2 ft)/yr which means that it would reach the SDA fence in approximately 25 years and the trench in about 200 years. The NP3 gully is advancing toward the construction and demolition debris landfill at a rate of 0.7 m (2.2 ft)/yr and would encroach upon it in about 100 years. The 006 gully is migrating toward the area between the construction and demolition debris landfill and the lagoon at a rate of 0.7 m (2.3 ft)/yr and is predicted to reach this area in approximately 150 years; however, based on the present surface water drainage course, this gully head is not likely to affect the two facilities. Major gullies including the SDA, NP3, and 006 gullies are shown on Figure L-1.

Other major gullies on the Project Premises have not shown sufficient visible movement of the gully heads to calculate migration rates by the Soil Conservation Services Technical Report-32 method. However, based on the gully head advancement rates that were estimated for the SDA, NP3, and 006 gullies, the existing gullies in the Project Premises are considered a threat to the integrity of the existing facilities over the next 1,000-yr period (WVNS 1993b).

L.3 METHODS FOR PREDICTING THE LONG-TERM RATE OF EROSION

Numerical modeling and empirical equations were used to predict the long-term rate of erosion caused by sheet and rill erosion and stream downcutting. To predict the sheet and rill erosion rates, the Sedimot II model and the Universal Soil Loss Equation were used. The stream downcutting rate was predicted using the HEC-6 model and translated into a rim widening rate by assuming a stable slope angle of 21 degrees. Methods for predicting the long-term erosion rates of gullies are not available; therefore, gully advance for the 1,000-yr period was not predicted.

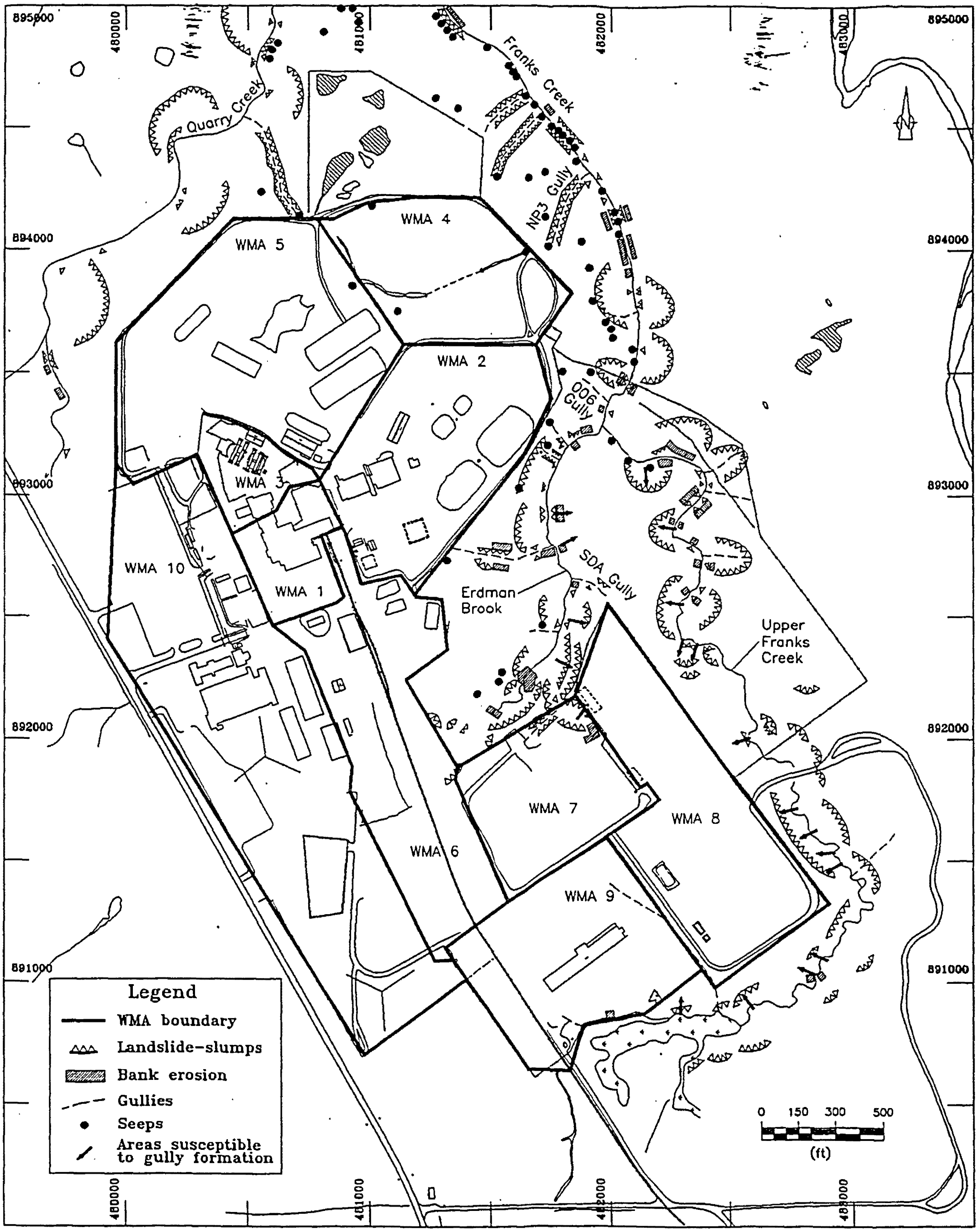

Figure L-1. Areas Susceptible to Gully Formation.

L.3.1 Predicting the Rate of Sheet and Rill Erosion

Two methods were used to predict the long-term sheet and rill rate of erosion at the Center. First, the Universal Soil Loss Equation was used to predict the volume of soil likely to be removed from the site over a typical 1-yr period. The Sedimot II model was used to account for the erosion that would occur during major storm events with recurrence intervals of greater than one year. The soil losses predicted by using the soil loss equation and the modeling results were combined to predict the cumulative soil loss over the 1,000-yr period.

The Universal Soil Loss Equation computed the soil loss based on the quantity of rainfall, the length and steepness of the slopes, the type of soil, and the type of soil cover (i.e., forest, grass, bare soil, etc.). The evaluated area was divided into subareas with similar physical properties (WVNS 1993a). Site-specific precipitation data from the meteorological tower on the Project Premises for March 1, 1990, to February 28, 1991, were used in the analysis (WVNS 1993a). The results indicated that the areas with the highest volume of calculated soil loss were within the Quarry Creek drainage basin west and northwest of the Project Premises and within the Erdman Brook-Franks Creek drainage basin west and east of the Project Premises. The computed soil loss varied from 0.002 to 0.529 metric tons/ha (0.001 to 0.236 tons/acre) which is equivalent to an average soil depth of 0.00002 cm/yr (0.000008 in./yr) to 0.004 cm/yr (0.0015 in./yr).

The quantity of sheet and rill erosion occurring during major storm events was estimated using the SEDIMOT II surface erosion model (WVNS 1993a). Four 24-hr design storms were modeled: 2-, 10-, 100-yr, and the probable maximum precipitation event, which is the maximum rainfall that could conceivably occur. The model simulates the intensity and depth of rainfall over a given time period, the resulting volume of surface water runoff, and the volume of soil washed from the ground surface. The same watershed boundaries and input parameters used in the surface water modeling analysis were used in the SEDIMOT II simulations.

The results of the SEDIMOT II simulations are consistent with the results from the analysis with the Universal Soil Loss Equation. The predicted erosion rate of soil was greatest in an area of the Franks Creek-Erdman Brook basin with disturbed or insufficient ground cover. The cumulative soil loss in this area over a 1,000-yr period having 500 2-yr storms, 100 10-yr storms, 10 100-yr storms, and 1 probable maximum precipitation event would be equivalent to 10.7 cm (4.2 in.) in depth. In other subareas, the depth of soil loss would be less than 2.5 cm (1 in.) over a 1,000-yr period, an average annual rate of 0.0025 cm/yr (0.001 in./yr).

The predictions for the rate of sheet and rill erosion are small and would have no effect on the long-term performance of the Project Premises and the SDA as waste confinement systems during either the implementation or post-implementation phase of closure.

L.3.2 Predicting the Rate of Gully Advance

New gullies will form over the next 1,000 years; however, methods for predicting the long-term erosion rates are unavailable. The gullies are most likely to form in areas along the stream banks where slumps are present, fractures are oriented perpendicular to the stream bed, seeps are flowing, and where the slope intersects the outside of a meander loop. Using these criteria, locations where gullies would be most likely to form and potentially undermine the confining ability of the disposal areas or lagoons were identified as shown with arrows on Figure L-1. The gully locations will change with time because of the influence of human-induced (i.e., building parking lots) and natural events (major storms) that modify the drainage patterns on the plateaus. Human-induced changes to the surface water drainage can, to a large extent, be controlled, thus slowing the detrimental effects of some gullies. However, as in the case of Alternative V (Discontinue Operations), other natural events that would occur over the next 1,000 years, such as animal trails developing or treefalls, could preferentially induce the formation of a gully. These natural events cannot be predicted or controlled.

L.3.3 Prediction of Long Term Stream Valley Rim Widening

Measurements and predictions of downcutting from Boothroyd (1982) and LaFleur (1979) provided an estimate of long-term rim widening; however, these estimates were not based on evaluating physical aspects of the erosion process. No widely accepted models exist for predicting long-term erosion, but it is recognized that erosion occurs following storm events. Computer models that use rainfall predictions and stream flow characteristics have been used to predict changes in stream channel profile. Thus, models for predicting the channel downcutting rate were used in conjunction with probability estimates for storm events to estimate the rate of long-term erosion at the Project Premises and SDA.

The analysis was conducted for two drainage conditions. The first condition was that the current drainage pattern could be maintained with or without local control measures. The conceptual engineering design for the local erosion control strategy includes (1) a storm water collection system to divert runoff from the paved areas to water control structures for discharge to Erdman Brook, Franks Creek, and Quarry Creek, (2) water control structures in four existing gullies, (3) three diversion dikes, (4) an interceptor channel, and (5) five concrete drop structures. The second drainage condition assumed the drainage pattern was modified. The conceptual engineering design for the global erosion control strategy includes (1) a large diversion channel with a grade stabilization structure to divert surface water from the Erdman Brook and Franks Creek watersheds into the north reservoir, (2) filling Erdman Brook and Franks Creek, grading the area, and installing an underdrain so the SDA and Nuclear Regulatory Commission-licensed disposal area (NDA) would become the top of a new, smaller watershed, (3) a grade stabilization structure in Franks Creek just before its confluence with Quarry Creek (WVNS 1994).

Six different storm events were evaluated to determine the downcutting rate in both Franks Creek and Erdman Brook. The method was not applied to Quarry Creek because the potential facilities would be located in areas where the bedrock is shallow and close to the ground surface. The storm events considered in the analysis were those with return intervals of 2, 5, 10, 20, and 100 years and the probable maximum precipitation event (estimated to have a return interval of more than 1000 years). However, the analysis assumed the return interval for the probable maximum precipitation event was 500 years to be conservative. The individual storm downcutting rate was predicted using the HEC-6 code which uses stream cross section geometry, flow rates and elevations at each section, and a sediment transport function. The stream cross section, flow rates, and elevations for the current drainage system were taken from HEC-2 runs performed by Dames & Moore (WVNS 1993c). Stream cross sections and elevations for the drainage system after implementing the global erosion control strategy were estimated from conceptual engineering designs (WVNS 1994). The sediment transport correlation is important for the HEC-6 analysis. To identify the proper correlation, the Hydraulic Design Package for Channels (SAM) developed by the Waterways Experiment Station (WES 1993) was used. This code evaluated correlations for the stream conditions evaluated by HEC-6. The correlation used for both conditions was the Laursen (Madden) function recommended by the SAM package, which provides the best correlation with measured sediment load data. The downcutting rate was converted to a rim widening rate using the stable slope estimate presented in Section L.2.2.1.

The estimates for rim widening for the six reference storms are presented in Table L-1. The results in Table L-1 show minimal change in rim widening for the storms with the higher frequency of occurrence and there is little difference in rim widening rates between Erdman Brook and Franks Creek. The greatest differences result from whether the existing drainage pattern is maintained or whether the drainage pattern is modified by a global erosion control strategy. The global erosion control design reduces water flow through Erdman Brook and Franks Creek, changing the channel cross section, with the result being much less erosion from this set of storms.

The estimates of storm frequency (return interval) and the estimate of rim widening were combined to develop probabilistic estimates for the rate of long-term rim widening from erosion. The probabilistic method estimated the probability of a specific storm combination (e.g., 20 2-year storms and five 100-year storms) and combined it with the estimate for the total rim widening for all storms in the specific combination (e.g., 20 times the 2-year storm rim widening plus five times the 100-year storm rim widening estimate). Nearly all (99.94 percent) possible storm combinations were considered. The sets of estimates for storm combination probability and total rim widening were arranged in order of increasing total rim widening. The ordered listing was used to estimate the likelihood of a specific rim widening rate. Selecting a rim widening rate and summing the probabilities for all rim widening rates less than the selected rate, gives an estimate of the likelihood of the rate being the same as, or less than the selected rate.

The probability of a specific number of storms having the same recurrence interval over a given time was estimated using the Poisson distribution. The probability of storm combinations for storms with different recurrence intervals is the product of the probabilities for storms with the same recurrence interval as estimated by the Poisson distribution.

Table L-1. **Estimates of Channel Downcutting on Erdman Brook and Franks Creek from Single Storm Events**

Frequency of Occurrence per year (Storm Event)	Current Drainage Pattern (Local Erosion Control)		Modified Drainage Pattern (Global Erosion Control)	
	Erdman Brook (m)[a]	Franks Creek (m)	Erdman Brook (m)	Franks Creek (m)
0.50 (2-year storm)	-0.20[b]	-0.14	-0.005	+0.007[c]
0.20 (5-year storm)	-0.21	-0.19	-0.007	-0.004
0.10 (10-year storm)	-0.22	-0.20	-0.012	-0.004
0.05 (20-year storm)	-0.30	-0.23	-0.054	+0.006
0.01 (100-year storm)	-0.32	-0.23	-0.191	-0.014
0.002 (PMP)[d]	-4.10	-3.50	——[e]	——

a. To convert meters to feet, multiply by 3.2808.
b. Negative number means degradation and the area is being scoured.
c. Positive number means aggradation and sediment is accumulating in the area.
d. PMP = Probable maximum precipitation event with an estimated return interval of 500 years.
e. —— = Not analyzed because not important contributor to estimating the long-term rate of rim widening.

This methodology was used to estimate the rate of long-term rim widening on Erdman Brook and Franks Creek for the current drainage condition and for a modified drainage condition from implementing the global erosion control strategy described in the *Erosion Control Engineering Report* (WVNS 1994). Table L-2 presents the probabilistic rim widening rates for the existing drainage basin. The results show that the 90 percent quantile for Erdman Brook is 0.158 m/yr (0.518 ft/yr) while the 90 percent quantile for Franks Creek is 0.153 m/yr (0.502 ft/yr), meaning that 90 percent of the erosion rates would be expected to be equal to or less than the respective 90 percent quantile values. A narrow distribution for the rim widening rate is shown because the major determinant in the probabilistic rim widening rate is the large number of low frequency storms. This observation is consistent with the results in Table L-1. As indicated in Table L-1, an increase in recurrence interval is not accompanied by a comparable increase in downcutting, and therefore rim widening rate.

Figure L-2 shows the rim widening that would occur after 1,000 years at the 90 percent quantile rate, assuming the current drainage pattern. The figure shows that most of the south plateau has eroded. The erosion from along Quarry Creek is expected to be less than shown in the figure because bedrock is closer to the surface.

Table L-2. Estimate of Long-Term Rim Widening for Erdman Brook and Franks Creek Assuming Current Drainage Conditions

Quantile (%)	Erdman Brook Rim (m/yr)[a]	Franks Creek Rim (m/yr)[a]
10	0.138	0.134
20	0.140	0.137
30	0.143	0.139
40	0.145	0.141
50	0.147	0.143
60	0.149	0.145
70	0.151	0.147
80	0.154	0.149
90	0.158	0.153

a. To convert meters to feet, multiply by 3.2808.

Table L-3 presents the results for probabilistic rim widening assuming a global erosion control strategy were implemented. The 90 percent quantile result for Erdman Brook is 0.0095 m/yr (0.03 ft/yr) while the 90 percent quantile for Franks Creek is 0.0011 m/yr (0.0004 ft/yr), meaning that 90 percent of the time, rates of erosion would be expected to be equal to or less than the 90 percent quantile rate. Like the distribution shown in Table L-2 for the current drainage pattern, there is a narrow distribution for the rim widening rate. There is a dramatic reduction in the rate of erosion on Erdman Brook and Franks Creek under the global erosion control strategy because of the reduced flow through the channels and the reconfigured channel geometry.

Table L-3. Estimate of Long-Term Rim Widening for Erdman Brook and Franks Creek Assuming Global Erosion Control Strategy

Quantile	Erdman Brook (m/yr)[a]	Franks Creek (m/yr)[a]
10	0.00669	0.00095
20	0.00729	0.00099
03	0.00769	0.00102
40	0.00805	0.00104
50	0.00831	0.00107
60	0.00856	0.00108
70	0.00880	0.00110
80	0.00907	0.00113
90	0.00947	0.00117

a. To convert meters to feet, multiply by 3.2808.

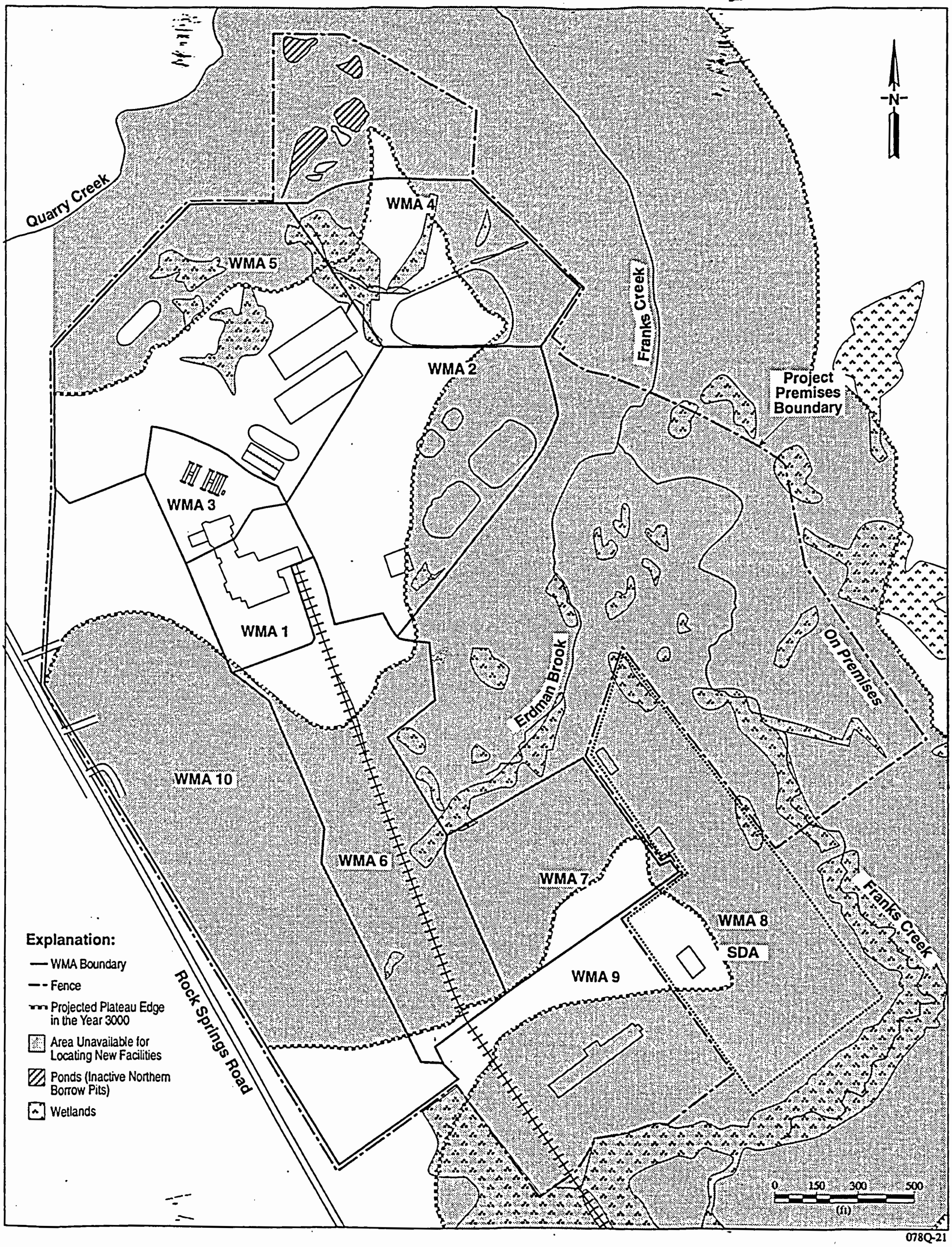

Figure L-2. Projected Erosion Front After 1,000 Years at 90 Percent Quantile Rate.

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[1]Document is available in the public reading room.

APPENDIX M

EVALUATION OF NATURAL PHENOMENA

APPENDIX M

EVALUATION OF NATURAL PHENOMENA

This appendix assesses natural phenomena that could occur during the long-term period evaluated in this Environmental Impact Statement (EIS). Seismic risk (i.e., the hazard curve) is presented in Section M.1, and high winds and tornadoes are evaluated in Section M.2. The effect of an earthquake on the structural integrity of the process building [waste management area (WMA) 1] and on the high-level (radioactive) waste (HLW) tanks and the vitrification facility (WMA 3) is evaluated in Appendix O. Accidents involving earthquakes are evaluated in Appendix G.

M.1 SEISMIC HAZARD ASSESSMENT

Earthquakes, some of them classed as major events, have occurred within several hundred kilometers of the Western New York Nuclear Service Center (Center) (see Chapter 4 of this EIS). Therefore, earthquakes are a potential hazard at the site. Estimates of peak horizontal ground acceleration have been made by different organizations during the past 23 years for recurrence intervals of 1,000 years or less, these range from 0.04 g to 0.14 g, including the effect of amplification in the soil cover at the Center. The most recent and extensive assessment was conducted by Dames and Moore in 1992 (WVNS 1992) and was based on the Electric Power Research Institute probabilistic methodology that incorporates the range of expert opinion of six independent teams of earth scientists. Results of this assessment are given in Figures M-1 and M-2, and are used as the basis for the earthquake hazard analysis discussed in Appendix O, Appendix G and for the analysis in Chapter 5. Figure M-2 presents the peak horizontal ground acceleration calculated by the six independent teams.

The approach used to generate the curves in Figures M-1 and M-2 is based on the methodology developed by the Seismic Owners Group and Electric Power Research Institute (EPRI 1988) to quantify the probability that specified levels of ground motion would be exceeded at a site in a given period of time. The methodology was specifically developed to evaluate ground motion with low probability of occurrence (less than 10^{-3} per year) at sites in the central eastern U.S. The unique feature of the Seismic Owners Group/Electric Power Research Institute method is the use of procedures to quantify the uncertainty in hazard estimates that is attributable to uncertainty in the current knowledge of tectonic processes that generate events in the central and eastern U.S. and in key analysis parameters such as rate of earthquake occurrences, maximum magnitudes of ground motion, and ground motion attenuation models. The Seismic Owners Group/Electric Power Research Institute method incorporates the range of scientific opinion and technical uncertainty of these types of estimates by using the scientific opinions and assumptions of six independent earth sciences teams in selecting and quantifying key parameters. The methodology has the ability to display, as in Figure M-2, the range in the estimates that result from using the approaches and assumptions of each of the six teams.

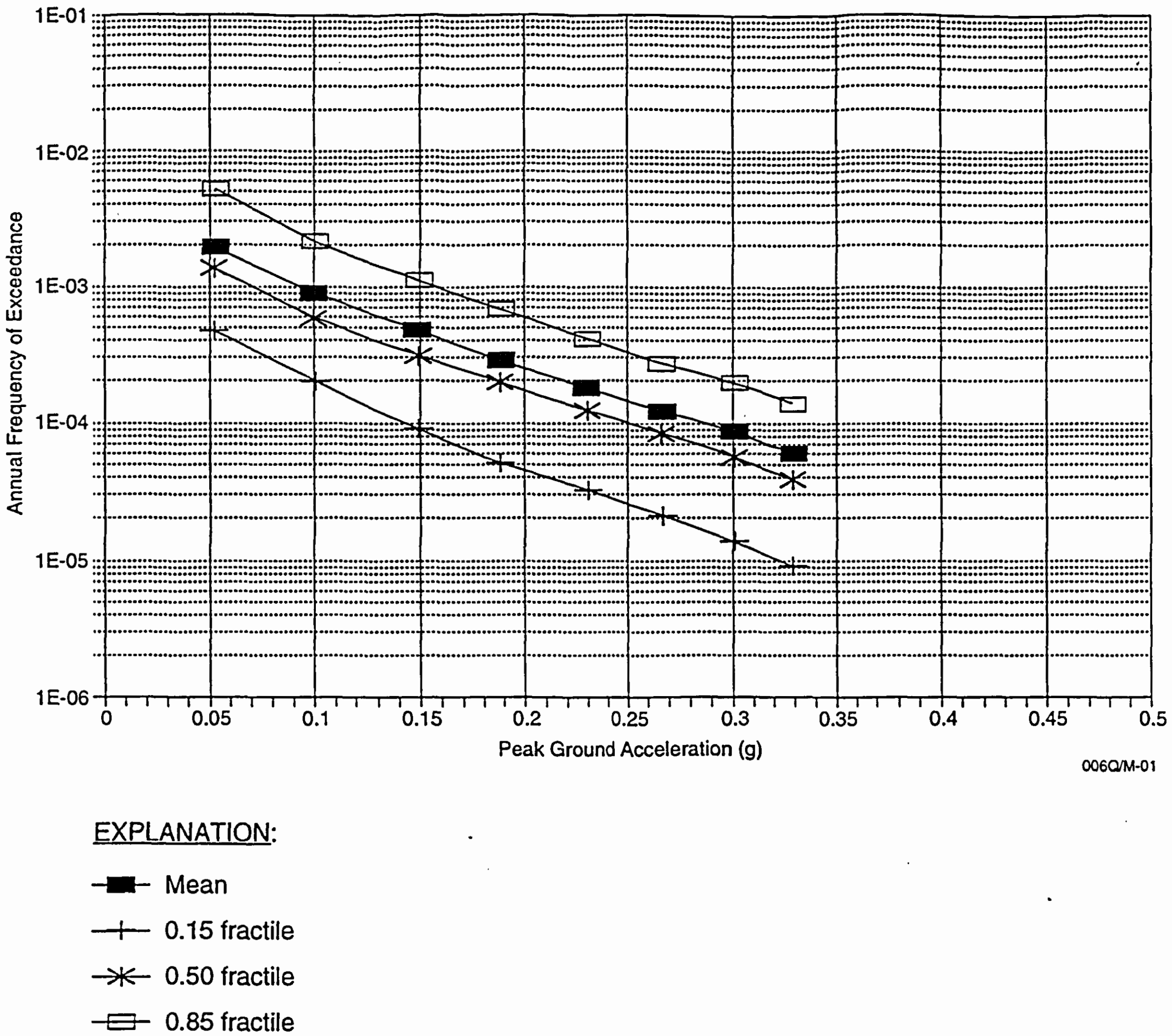


Figure M-1. Peak Ground Acceleration Fractile Hazard with Site Amplification (modified from WVNS 1992).

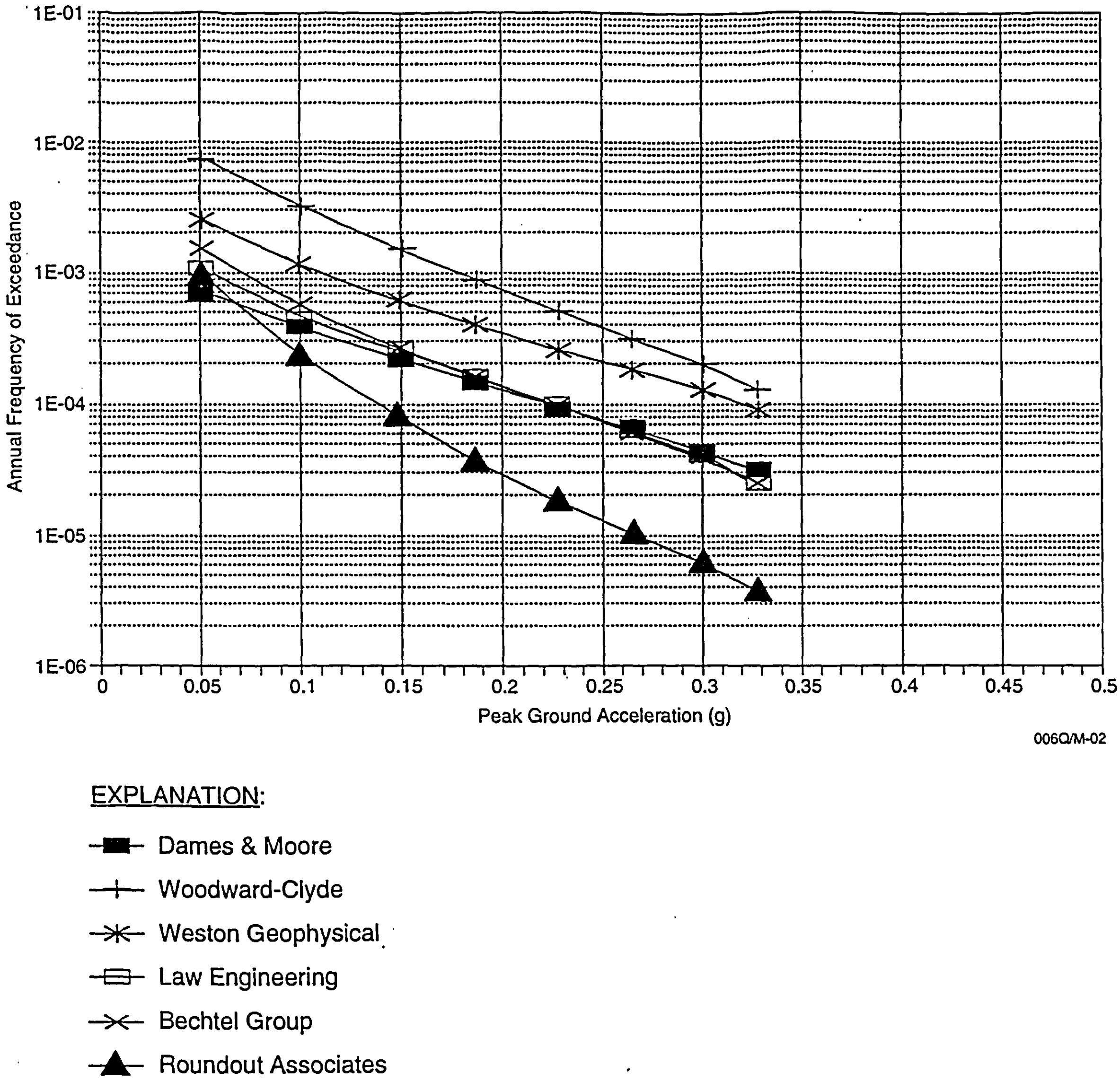


Figure M-2. Median Peak Ground Acceleration with Site Amplification Using the Approach of Six Independent Teams (modified from WVNS 1992).

The U.S. Nuclear Regulatory Commission (NRC) and the U.S. Geological Survey performed a safety evaluation review of the Seismic Owners Group/Electric Power Research Institute Seismic Hazard Methodology (EPRI 1988) and determined it was an acceptable methodology for use in calculating the seismic hazard in the central and eastern U.S. This methodology is now used extensively for license submittals to the NRC.

For most of the approaches of the expert earth science teams, the main contributor to the seismic hazard at the Center was the Clarendon-Linden fault acting in combination with a background source, variously defined by the different teams. The results presented in Figures M-1 and M-2 include the amplification effects of the various Center-specific soils.

The specific effects of the shape of the soil-bedrock interface on soil amplification of seismic waves and the resulting peak ground accelerations were investigated (Romney 1995). This investigation applied computer-generated synthetic seismograms to a two-dimensional model of the subsurface structure to simulate the buried bedrock channel that extends the length of the Center. The thickness changes in the glacial till across the buried channel and the shape of the till-bedrock formation contact would affect the behavior of seismic waves if there were an earthquake. The results from this investigation showed that soil amplification factors in the glacial till vary from west to east across the Center from about 1.0 to 1.6, with the greatest amplification occurring at the base of the channel. The modeled estimates are within the range used in the Seismic Owners Group/Electric Power Research Institute methodology (WVNS 1992).

Figure M-1 presents the annual frequency of exceeding various peak ground accelerations at the Center for four probability fractiles which indicate the confidence level of each curve. For example, the upper curve (the 0.85 fractile) represents 85 percent confidence level estimates of the peak ground acceleration and recurrence interval. Given all the uncertainties, the estimated peak ground acceleration and recurrence intervals would be expected to be exceeded only 15 percent of the time. The spread in the curves quantifies the variability in the hazard results from modeling uncertainties, limited historical data, and the range of opinions and approaches of the six expert teams. For the highest peak ground acceleration evaluated, 0.33 g, the indicated range is from 9.01×10^{-6} for the 15 percent fractile (confidence) estimate to 1.37×10^{-4} for the 85 percent fractile (confidence) estimate. As shown in Figure M-1, the mean and median (50 percent) estimates are 5.93×10^{-5} and 3.74×10^{-5}, respectively. The mean estimate peak ground acceleration for 1,000 years is 0.095 g, with an estimate of 0.16 g at the 85 percent confidence level.

Figure M-2 illustrates the range in the frequency versus acceleration estimates using the approaches of six expert teams for the median (50 percent) fractile case. It illustrates that there is a wide range in frequency estimates for a specified peak ground acceleration with the various expert approaches. For example, for the maximum peak ground acceleration evaluated, 0.33 g, the annual frequency of exceedance ranged from 1.36×10^{-4} to 4.00×10^{-6}.

M.2 SEVERE WEATHER

Severe weather at the Center is primarily restricted to straight-line winds and tornadoes. WVNS (1993) indicated that remnants of tropical systems can occasionally affect the western New York State region, but the effects are generally limited to localized increases in rainfall and not damaging wind. Thus, this discussion focuses on the potential impacts of damage at the Center as caused by straight line winds and tornadoes. Studies by McDonald (1981) and Fujita (1981) examined in great detail the specifics of these systems relative to the Center. The results of their studies are similar. However, since Fujita (1981) used a longer data record, the discussion below references his results.

M.2.1 Straight Line Winds

Because a long-term wind monitoring station at the Center does not exist, data collected at the National Weather Service office in Buffalo, New York, [located approximately 48 km (30 mi) north of the site] were used as surrogates for the high-wind probability analyses. Monthly peak wind speeds and directions were analyzed by Fujita (1981) for a 31-yr period (January, 1950, through December, 1980). Anemometer heights at the National Weather Service office varied over this time period from 29.3 m (96 ft) to the current standard elevation of 10 m (33 ft). Thus, the data were reduced to a standard nominal elevation of 10 m (33 ft), using the logarithmic wind profile relationship before performing the probability of occurrence analyses.

The dominant straight line high-wind directions are from the southwest (67 percent) and the west (23 percent). This finding is not unexpected, given the orientation of Lake Erie, which provides minimal flow retardation for a southwesterly wind regime in the vicinity of Buffalo. Table M-1 summarizes the fastest-mile wind speeds observed at the Buffalo National Weather Service office for the 31-yr period 1950-1980. The National Weather Service defines the fastest-mile wind speed as the greatest speed (in miles per hour) of any "mile" of wind occurring over the 24-hr observational period. This value is different from the peak gust, which is defined as the highest "instantaneous" wind speed recorded at a station during the normal 24-hr observational period (AMS 1959). In the analyses performed by Fujita (1981), the peak wind gust was determined to be 1.25 times the observed fastest-mile wind speed. Thus, the peak wind gust data are a linear estimation based on the observed fastest-mile wind information and is not a second wind observation. Higher wind speeds from frontal passages tend to occur in winter and early spring months. As the jet stream migrates northward into Canada during summer, maximum wind speeds are reduced and occur with localized convective thunderstorms (Fujita 1981).

Table M-2 summarizes the annual thunderstorm record for Buffalo, New York. The majority of thunderstorm activity (68 percent) is confined to the summer from June through September. NOAA (1980) indicates that due to the stabilizing influence of Lake Erie, a slight increase in thunderstorm frequency could be expected at inland locations north and south of Buffalo (e.g., the Center).

Table M-1. Monthly Variations of the Mean, Maximum and Minimum Fastest-Mile Wind Speed, 1950-1980 Values for Buffalo, New York[a]

	Mean		Maximum		Minimum	
Month	m/s	mph	m/s	mph	m/s	mph
January	20	45	35	78	13	28
February	18	41	30	67	12	27
March	19	43	27	60	13	28
April	18	41	25	57	15	33
May	17	37	24	54	13	28
June	16	36	21	48	11	25
July	16	36	23	51	9	21
August	15	33	23	51	12	27
September	16	36	23	51	12	27
October	17	37	24	54	12	27
November	18	41	25	55	14	31
December	19	43	27	60	14	31
Annual	17	39	35	78	9	21

a. Adjusted to 10 m (33 ft) above ground level.

Source: Fujita (1981)

Given the fastest-mile wind speed data for the 31-yr period (1950-1980), the probability of a specific wind speed occurring as either a straight-line high wind or tornado was calculated. Figure M-3 graphs the probability of the fastest-mile wind speed for any given month and year, and Table M-3 summarizes this information. The best-fit equation for the data in Figure M-3 is:

$$V_{fm} = 51.1 - 13.5 \log P \tag{M-1}$$

where V_{fm} represents the fastest-mile wind speed expected to occur with probability P per year. The subsequent equation for peak gust data (not shown in Figure M-3) is:

$$V_{pg} = 63.9 - 16.9 \log P \tag{M-2}$$

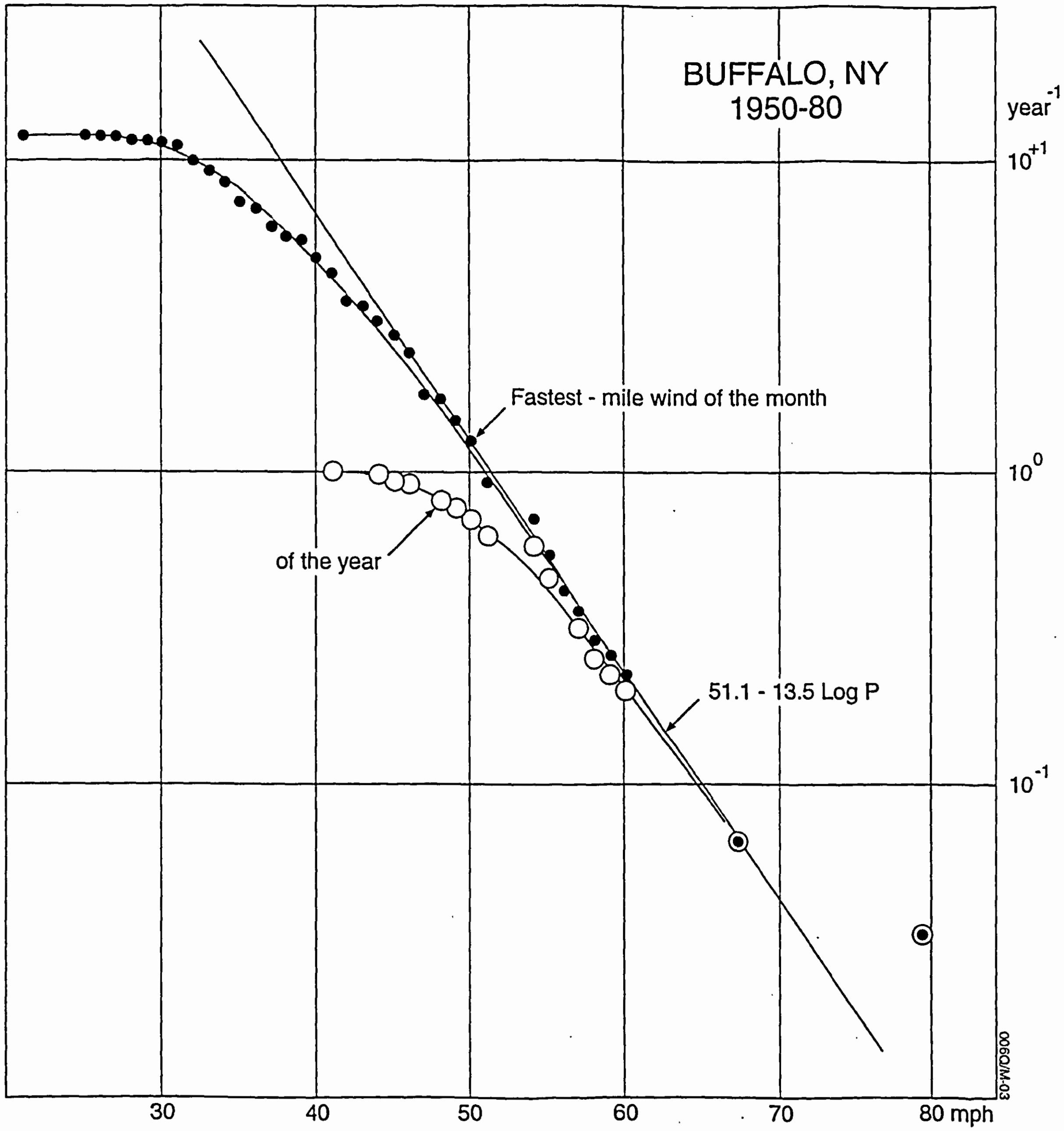
Table M-2. Mean Number of Thunderstorm Days for Buffalo, New York, 1944-1981

Month	Mean Number of Thunderstorm Days
January	a
February	a
March	1
April	2
May	3
June	5
July	6
August	6
September	4
October	2
November	1
December	a
Annual	31

a. Less than one-half.

Source: NOAA (1981)

where V_{pg} is the peak gust wind speed expected to occur with probability P per year. Thus, the maximum straight line wind that could be expected is 28.9 m/s (64.6 mph), 34.9 m/s (78.1 mph) and 40.9 m/s (91.6 mph) over ten, 100 and 1,000 years, respectively. These probabilities are based on the fastest-mile wind speed data from Buffalo, New York. However, according to Fujitas (1981), the peak gust wind speeds for these same recurrence intervals would be 1.25 times greater than those described above. The probability of an 89.4 m/s (200 mph) straight-line wind (i.e., the original Nuclear Fuel Services [NFS] design criteria wind speed) occurring at the Center is extremely small (i.e., less than 10^{-7} per year). However, such wind speeds are common in tornadoes. Thus, to determine the maximum wind speed for damage potential at the Center, tornado strike probabilities and straight-line winds were considered (Fujita 1981).



Source: Fujita (1981)

Figure M-3.—**Probabilities of the Fastest-Mile Wind Speed of the Month and the Year at Buffalo, New York [best-fit equation is based on wind speed data which has been reduced to 10 m (33 ft) height].**

Table M-3. Fastest-mile and Peak Gust Wind Speeds at Buffalo, New York (1950-1980), as a Function of Recurrence Interval

Wind Speed	Recurrence Interval (Years)					
	10	100	1,000	10,000	100,000	1,000,000
Fastest Mile						
m/s	28.9	34.9	40.9	47.0	53.0	59.1
mph	64.6	78.1	91.6	105.1	118.6	132.1
Peak Gust						
m/s	36.1	43.7	51.2	58.8	66.3	81.5
mph	80.8	97.7	114.6	131.5	148.4	182.2

Source: Fujita (1981)

M.2.2 Tornadoes

The complexity of the surrounding terrain must be considered to determine the tornado strike probability. Fujita (1981) accomplished this by dividing the area within a 167-km (100-mi) radius of the Center into four geographic regions, shown in Figure M-4 and described as follows:

Region A: Low elevation plain between 83 and 167 km (50 and 100 mi) from the site, south of Lake Erie; 10,225 km^2 (4,090 mi^2).

Region B: Low elevation plain within a 83-km (50-mi) range of the site; 9,250 km^2 (3,700 mi^2).

Region C: Low elevation plain between 83 and 167 km (50 and 100 mi) from the site, south of Lake Ontario; 11,000 km^2 (4,400 mi^2).

Region D: High elevation hills to the southeast of the site; 28,800 km^2 (9,760 mi^2).

The University of Chicago Tornado Tape (formerly referred to as the DAPPLE Tornado Tape) was used as the data source for the subsequent analyses, which covered the 65-yr period 1916-1980. During this period, a total of 83 tornadoes were reported within the study area. The peak tornado season in western New York occurs in July. These tornadoes form in association with the strong thunderstorms that occur in this region, resulting from warm Gulf of Mexico moisture being transported northward into the Great Lakes region.

Table M-4 summarizes the tornado strike probability analyses for the Center using the Fujita tornado scale described in Table M-5 for all tornadoes occurring in the regions shown on Figure M-4. The recurrence interval substantially increases for more intense tornadoes, reaching approximately 0.36 billion years (or an annual probability of 2.74 x 10^{-9} per year) for a tornado with wind speeds of 134 m/s (300 mph).

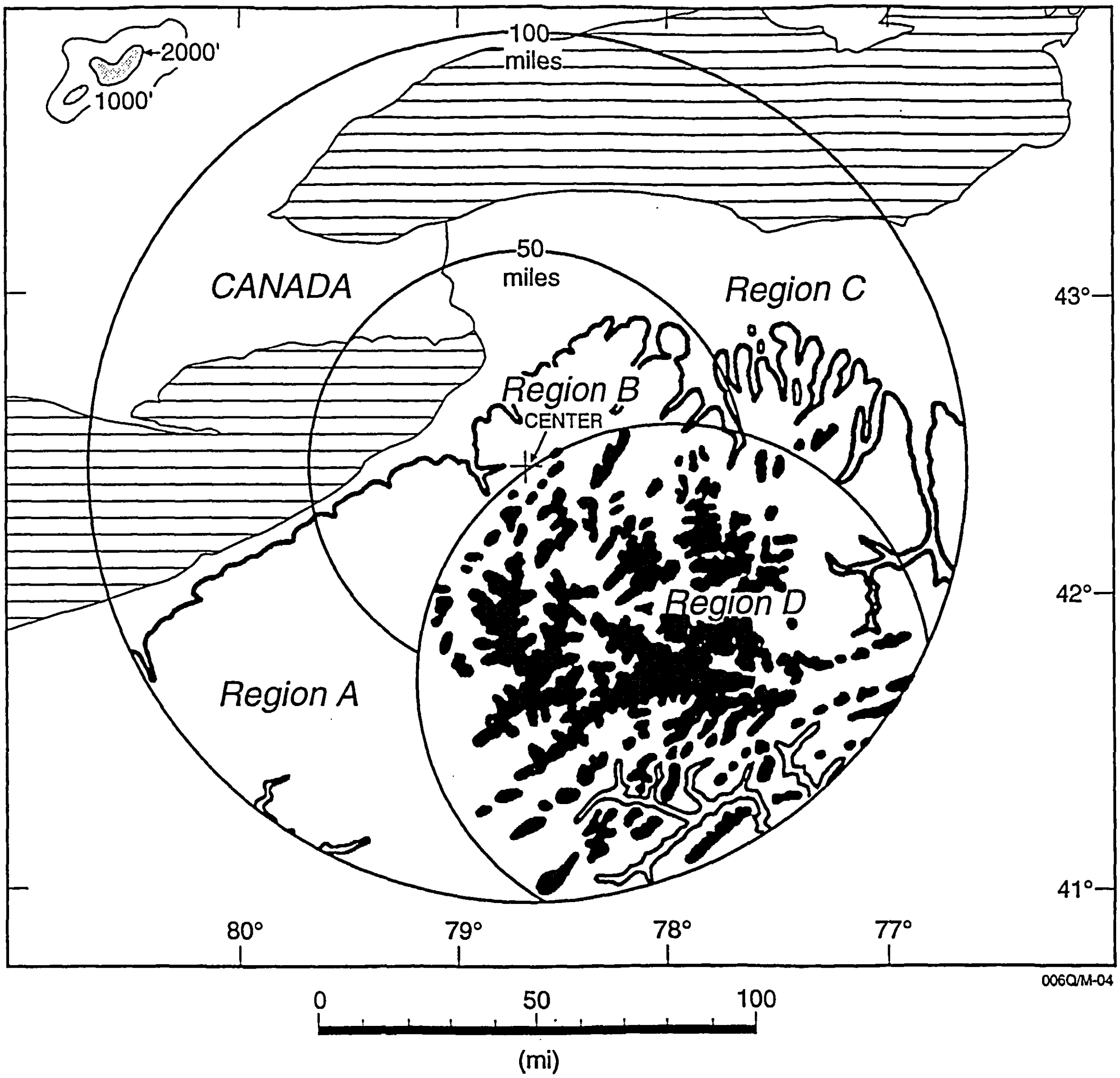


Figure M-4. Regions within a 167-km (100-mi) Radius of the Center [modified from Fujita (1981)].

Table M-4. Estimated Tornado Strike Probabilities for Western New York[a,b]

Tornado Category (F-Scale)	Maximum Wind Speed, m/s (mph) 22.4 (50)	44.7 (100)	67.1 (150)	89.4 (200)	111.8 (250)	134.1 (300)
F0 - Weak	1.2×10^{-7}	1.92×10^{-10}	1.07×10^{-13}	2.77×10^{-17}	3.82×10^{-21}	3.09×10^{-25}
F1 - Weak	1.52×10^{-5}	3.84×10^{-7}	5.29×10^{-9}	4.44×10^{-11}	2.61×10^{-13}	1.12×10^{-15}
F2 - Strong	2.54×10^{-5}	2.87×10^{-6}	2.11×10^{-7}	1.15×10^{-8}	4.86×10^{-10}	1.66×10^{-11}
F3 - Strong	9.92×10^{-5}	2.41×10^{-6}	4.36×10^{-7}	6.34×10^{-8}	7.69×10^{-9}	7.94×10^{-10}
F4 - Violent	1.04×10^{-5}	3.12×10^{-6}	6.91×10^{-7}	1.19×10^{-7}	1.66×10^{-8}	1.93×10^{-9}
Total	6.10×10^{-5}	8.78×10^{-6}	1.39×10^{-6}	1.94×10^{-7}	2.48×10^{-8}	2.74×10^{-9}

a. Results are based on the University of Chicago tornado tape data for the period 1916-1980.
b. Probability values are per year per square mile.

Source: Fujita (1981)

Table M-5. The Fujita Tornado Scale (F-Scale)

F0 *Gale Tornado* **(17.9 - 32.2 m/s, 40 - 72 mph): Light Damage**

Some damage to chimneys; break branches off trees; push over shallow-rooted trees; damage sign boards.

F1 *Moderate Tornado* **(32.6 - 50.1 m/s, 73 - 112 mph): Moderate Damage**

The lower limit (32.6 m/s, 73 mph) is the beginning of hurricane-force wind speeds; peel surface off roofs; mobile homes pushed off foundations or overturned; moving automobiles pushed off roads.

F2 *Significant Tornado* **(50.5 - 70.2 m/s, 113 - 157 mph): Considerable Damage**

Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light-object missiles generated.

F3 *Severe Tornado* **(70.6 - 92.1 m/s, 158 - 206 mph): Severe Damage**

Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off ground and thrown.

F4 *Devastating Tornado* **(92.5 - 116.2 m/s, 207 - 260 mph): Devastating Damage**

Well constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.

F5 *Incredible Tornado* **(116.7 - 142.1 m/s, 261 - 318 mph): Incredible Damage**

Strong frame houses lifted off foundations and carried considerable distance to disintegrate; automobile-sized missiles fly through the air in excess of 100 m (328 ft); trees debarked; incredible phenomena will occur.

F6-F12 **(≥142.6 m/s, ≥319 mph):**

The maximum wind speeds of tornadoes are not expected to reach the F6 category.

Source: NOAA (1991)

The NRC concluded that the design criteria for buildings at the Center should be based on a 71.5 m/s (160 mph) tornado, rather than their initial estimate of 89.4 m/s (200 mph) (NRC 1987). Based on Fujita (1981), this magnitude event would have a recurrence interval of approximately 1.4 million years (or a probability of 0.71×10^{-6} per year) at the Center. Figure M-5 shows the relationship between straight line winds and tornadoes for the Center, and the same information is summarized in Table M-6. From this data, it is apparent that straight-line wind events rather than tornadoes are more likely to generate high winds at the Center for probabilities of occurrence greater than 10^{-6} per year (for fastest-mile wind speeds) and 10^{-7} per year (for peak gust wind speeds). Thus, based on the fastest-mile wind speed and tornado analyses of Fujita (1981), for wind speeds less than approximately 53.2 m/s (119 mph), straight-line winds are the most likely event, whereas for higher wind speeds, tornadoes are the more probable event.

The intersection of the peak gust wind speed calculations and tornado analyses, occurs at 73.8 m/s (165 mph). However, given that the peak gust calculations are simply a linear adjustment (i.e., 1.25 times the fastest-mile data), it is more realistic to accept the results of the fastest-mile wind speed analyses as the basis for determining straight-line wind probabilities. Thus, straight-line winds are the governing atmospheric process for wind events with recurrence intervals of 100,000 years or less. For recurrence intervals greater than 100,000 years, tornadoes are the dominant atmospheric process for generating high wind speeds at the Center. The maximum predicted wind speed of 120.3 m/s (269 mph) at the Center has a probability of occurrence of 10^{-8} per year. The probability of a tornado generating winds of 22.4 m/s (50 mph) is of the order 10^{-4} per year. Thus, a relatively weak tornado (e.g., an F0 storm) is anticipated to have a recurrence interval of approximately 10,000 years for any square mile within the region evaluated by Fujita (1981).

Table M-6. Maximum Straight Line (Fastest-Mile and Peak Gust) and Tornadic Wind Speeds as a Function of Recurrence Interval

	Recurrence Interval (Years)							
Event Types	10	100	1,000	10,000	100,000	1,000,000	10,000,000	100,000,000
Fastest-Mile								
m/s	29.1	34.9	41.1	46.9	53.2	59.0	65.3	-
mph	65	78	92	105	119	132	146	-
Peak Gust								
m/s	36.2	43.8	51.4	59.0	66.2	73.8	81.4	-
mph	81	98	115	132	148	165	182	-
Tornado								
m/s	-	-	-	17.9	42.9	70.6	96.6	120.3
mph	-	-	-	40	96	158	216	269

-=Not computed.

Source: Fujita (1981)

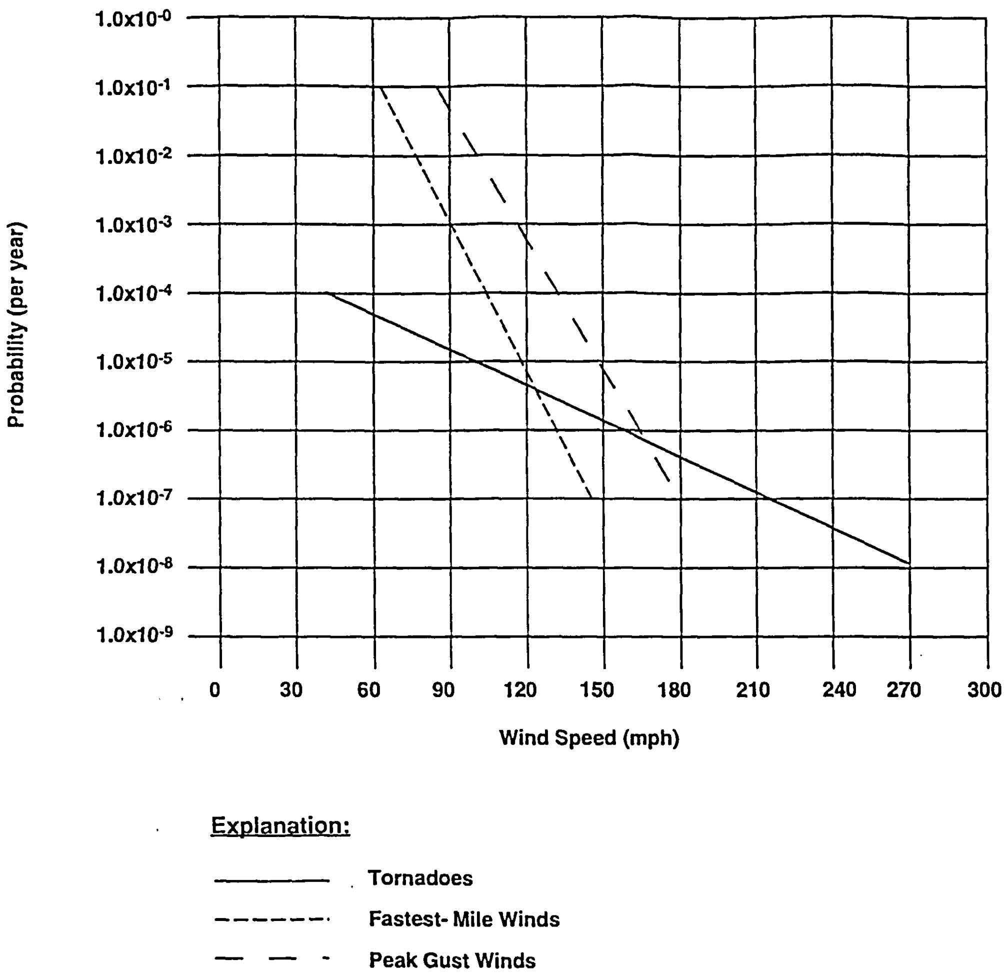


Figure M-5. Tornado and High-Wind Probabilities per Square Mile at the Center [modified from Fujita (1981)].

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[1]WVNS (West Valley Nuclear Services Company, Inc.), 1992. *Environmental Information Document, Vol. II, Seismology*, WVDP-EIS-005, Rev. 0.

[1]WVNS, 1993. *Environmental Information Document, Vol. VIII, Air Resources, Part 1*, WVDP-EIS-015, Rev. 0.

[1]Document available in the public reading room.

APPENDIX N

POTENTIAL LOCATIONS FOR NEW FACILITIES

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POTENTIAL LOCATIONS FOR NEW FACILITIES

N.1 INTRODUCTION

Implementing several of the alternatives for closure or long-term management of facilities at the Western New York Nuclear Service Center (Center) could require new processing, storage, or disposal facilities. This appendix evaluates the available area and potential locations for the new facilities on the Project Premises and the New York State-Licensed Disposal Area (SDA) because these locations offer many advantages. The Project Premises and SDA have already been disturbed or industrialized; they contain the facilities and environmental contamination that would be the source of the waste being processed, stored, or disposed of (which would allow the shortest transportation distance from the point of generation to the new facilities).

To determine the available area for new facilities, factors expected to be similar to those used in a siting process were selected. To determine potentially acceptable available areas for new facilities, factors similar to some of those that would be used in a siting process were evaluated. To determine the area required for new facilities, the estimated facility dimensions from the closure engineering reports (WVNS 1994a and 1994b) were used. This evaluation is not intended, however, to support the ultimate siting of new facilities. Should an alternative be selected that requires new facilities, it is anticipated that further analysis will be required. This evaluation is intended solely as a first level screening to determine the potential feasibility of siting new facilities.

Section N.2 discusses the factors that were used to estimate the available area for potential new facilities on the Project Premises and SDA. Section N.3 identifies the number of facilities and area required under both design basis and worst-case conditions. Section N.4 evaluates the practicality of finding available area for the new facilities and discusses potential locations for the facilities, and Section N.5 summarizes the conclusions from the evaluation.

The evaluation focuses on Alternatives II (On-Premises Storage) and IIIB [In-Place Stabilization (Rubble)] because these two alternatives require constructing the largest number of new facilities and, therefore, are more restrictive than the other alternatives. Conclusions about locating potential new facilities for the other alternatives can be easily drawn from the evaluation of Alternatives II and IIIB.

N.2 DETERMINATION OF AVAILABLE AREA

New facilities for implementing the alternatives include treatment, storage, and disposal facilities. Under Alternative II (On-Premises Storage), a container management area, comprising a volume reduction area, a wastewater treatment area, and a soil treatment area (refer to Section 3.3.2.2), would be required with an operating life of about 20 years. Alternative II would also require a retrievable storage area, comprising a shielded retrievable storage area and a contact retrievable storage area (refer to Section 3.4.2.2) that would have an active monitoring and maintenance program and a design life of about 100 years. Under Alternative IIIB [In-Place Stabilization (Rubble)], a low-level [radioactive] waste (LLW) disposal facility, consisting of separate modules (refer to Section 3.5.2.2), would be required to isolate waste from the environment for several hundreds of years. Alternatives I (Removal), IIIA [In-Place Stabilization (Backfill)], and IV (No Action: Monitoring and Maintenance) would have fewer restrictions because they would require fewer new facilities. Under Alternative I, only the container management area would be built and then dismantled. Under Alternative IIIA, a wastewater treatment area would be built and then dismantled. Under Alternative IV, a wastewater treatment area would be built and would remain on the Project Premises indefinitely.

Location requirements would vary with the type of facility. Table N-1 summarizes the factors that were considered to locate potential areas on the Project Premises and SDA.

Table N-1. Factors Considered for Locating New Facilities

	Type of New Facility		
Location Factors	Treatment Facility (Container Management Area)	Storage Facilities (Retrievable Storage Areas)	Disposal Facility (LLW Disposal Facility)
Location Relative to Floodplains	Outside the 100-year floodplain	Outside the 100-year floodplain	Outside the 100-year floodplain
Location Relative to Wetlands	Outside wetlands	Outside wetlands	Outside wetlands
Location Relative to Unmitigated Erosion Fronts	No restriction because facility would be dismantled after its operating life	Outside the 500-year unmitigated erosion front	Outside the 1,000-year unmitigated erosion front
Distance from Rock Springs Road	30 m (100 ft)	30 m (100 ft)	30 m (100 ft)
Distance from Other Facilities	20 m (65 ft)	20 m (65 ft)	20 m (65 ft)

All new facilities would be located outside the 100-year floodplain. This is a typical requirement for building construction to prevent flooding and to promote drainage and is also required under 10 CFR Part 61.50 ("Subpart D-Technical Requirements for Land Disposal Facilities") for land disposal facilities. A map showing the 100-year floodplain near the Project Premises and the SDA is given in Figure N-1. The floodplain closely parallels the creeks, and the only places (other than stream channels) on the Project Premises within it are small areas on the west side of the rail spur in waste management area (WMA) 6 and on the southwest side of WMA 9.

In accordance with 10 CFR Part 1022 ("Compliance with Floodplain/Wetlands Environmental Review Requirements"), the U.S. Department of Energy (DOE) would try to avoid the destruction of wetland areas. Therefore, potential locations for new facilities were selected outside of wetland areas. Wetlands on the Project Premises and the SDA are shown

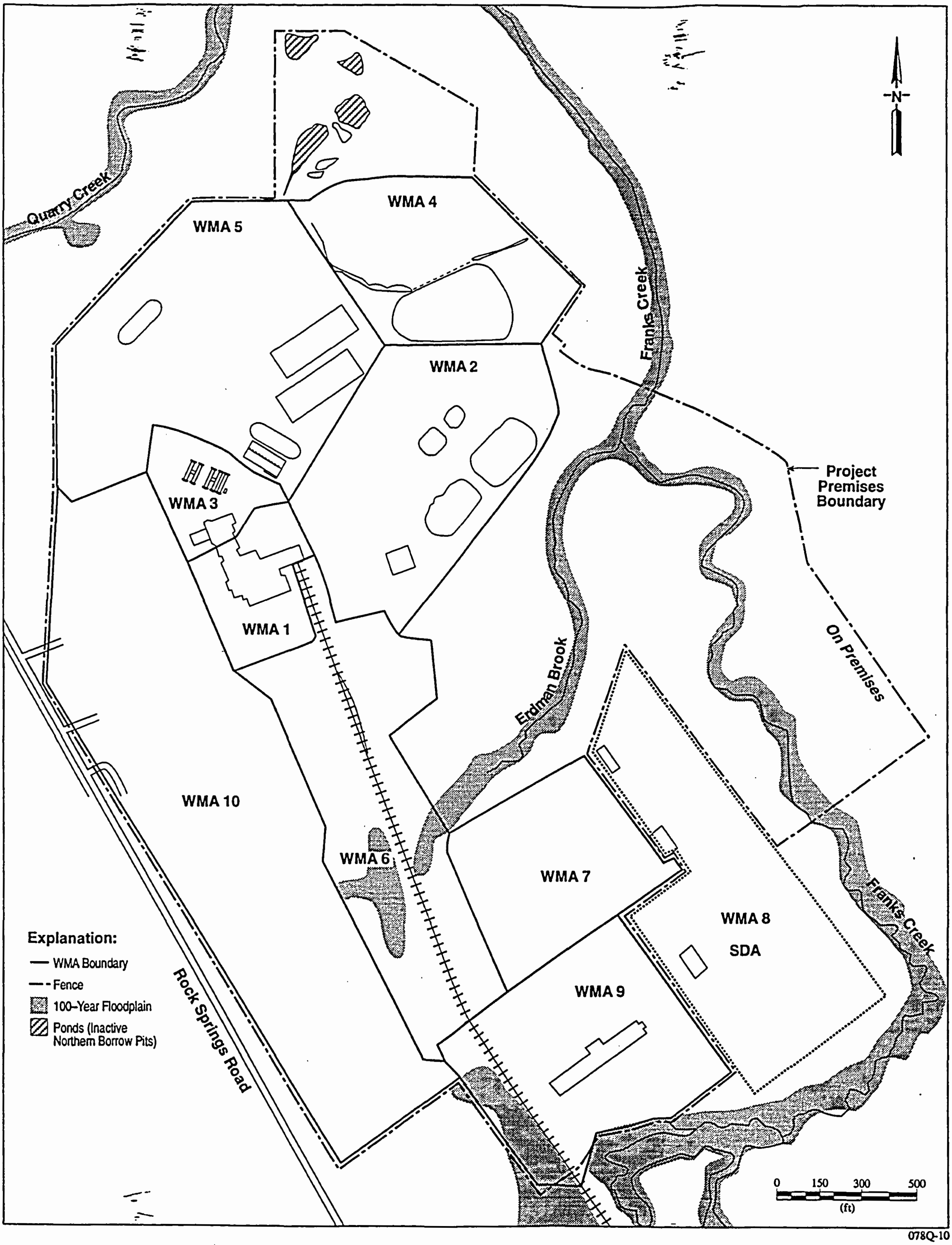

Figure N-1. 100-Year Floodplain Near the Project Premises (modified from WVNS 1993).

in Figure N-2. The largest wetlands on the developed portions of the Project Premises and SDA are located in WMAs 4 and 5 on the north plateau and in WMA 9 on the south plateau. Smaller wetlands occur in WMAs 2, 6, and 8. Other wetlands are located in the undeveloped portion of the Project Premises along Erdman Brook and Franks Creek.

New facilities should be located to avoid areas of active erosion. The restrictions for distance from unmitigated erosion fronts would vary with the type of facility. Based on the analysis of erosion processes described in Appendix L, a valley widening rate of 0.15 m (0.50 ft) per year was adopted for the purposes of long-term impact assessment. This estimate of the erosion rate is thought to be conservative because the probabilistic modeling predicts that there is only a 10 percent probability that this erosion rate would be exceeded. Moreover, erosion would not be unmitigated because there would be active maintenance and monitoring, including maintaining erosion control structures, at the Project Premises and SDA. For a treatment facility with an operating life of about 20 years that is then dismantled (such as the container management area built under Alternative II), there would be few constraints with regard to the distance from erosion fronts. In the year 2025, when the container management area would be dismantled under Alternative II, the creeks would have widened less than 2 m (7 ft) on each side if there were no mitigating measures. For this analysis, the container management area would be potentially located at least 2 m (7 ft) from the creeks.

As required by 10 CFR Part 61.50, erosion processes should be considered when locating disposal facilities, but no specific guidance is given. For this analysis, the retrievable storage areas and the LLW disposal facility modules should be located outside of the 500- and 1,000-yr erosion fronts, respectively. The LLW disposal facility uses the 1,000-yr erosion front because it is expected to remain on the Project Premises. The storage facilities require a shorter time frame because these facilities would have active monitoring, inspection, and maintenance programs. At the end of its design life, a storage facility could be rebuilt in a different location. Using a valley widening rate of 0.15 m (0.50 ft) per year and assuming no erosion controls, the 500- and 1,000-year erosion fronts were estimated and are shown in Figure N-3. As is evident from this figure, most of the southern portion of the Project Premises and the SDA would be eroded within 500 years, assuming no mitigation. The areas outside of the unmitigated eroded areas would include WMAs 1 through 5 and about one-half of WMAs 6 through 10. For projected stream valley growth over 1,000 years, the areas outside the unmitigated eroded areas would include WMAs 1 and 3; about one-half of WMAs 2, 4, and 5; and a very small portion of WMAs 6 through 10.

It was assumed that all new facilities should be at least 30 m (100 ft) away from Rock Springs Road to provide a buffer for security, environmental monitoring, and a safe distance for the public. It was also assumed that new facilities should be constructed at least 20 m (65 ft) from other facilities to allow room for construction equipment, vehicles, and security and monitoring measures.

Using the location factors given in Table N-1, the available area for the storage facilities under Alternative II and for the new disposal facilities under Alternative IIIB are shown in Figures N-4 and N-5, respectively. More area would be available for the container management area under Alternative I (Removal) and the wastewater treatment area under

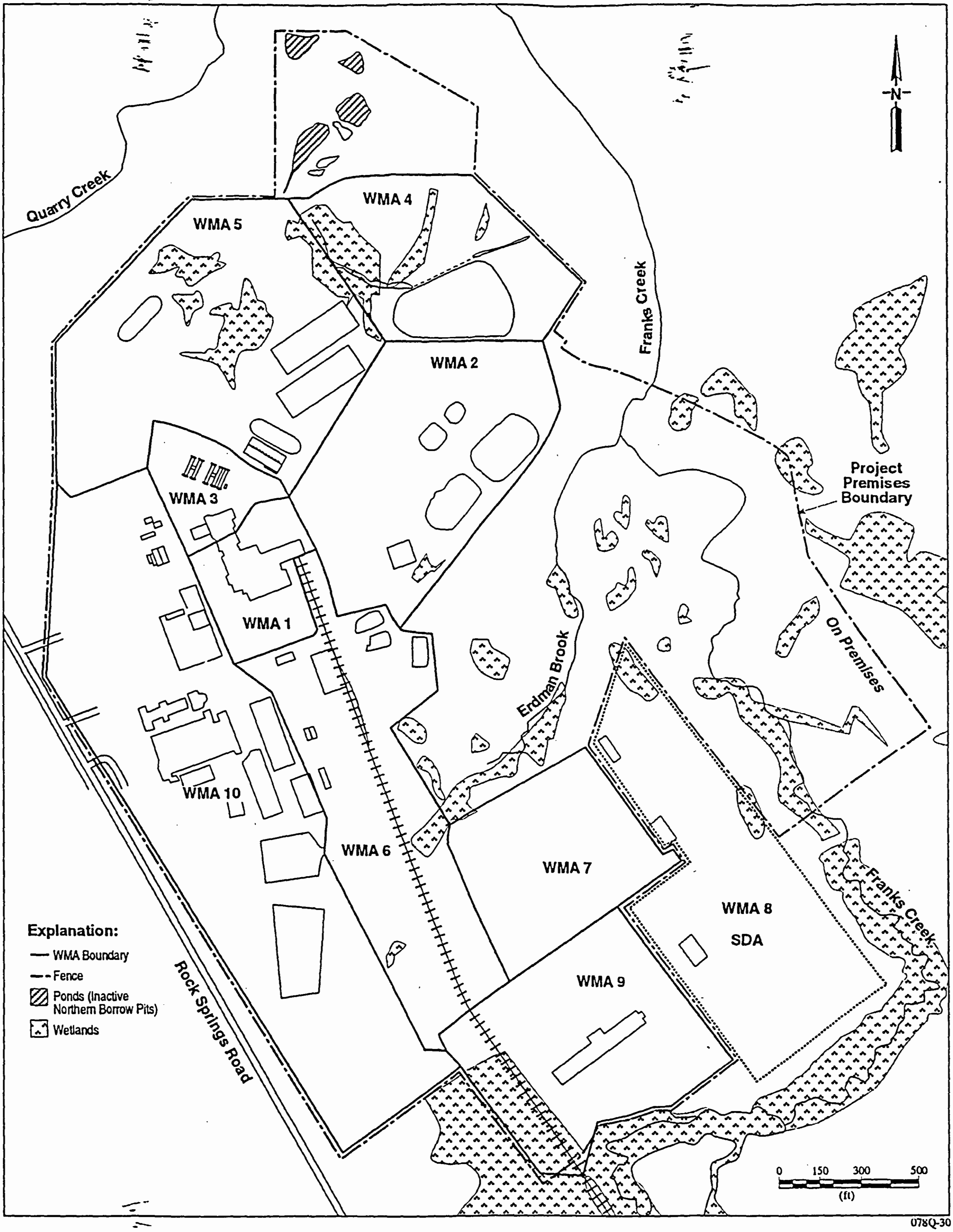

Figure N-2. Wetlands on the Project Premises and the SDA (modified from Dames & Moore 1993).

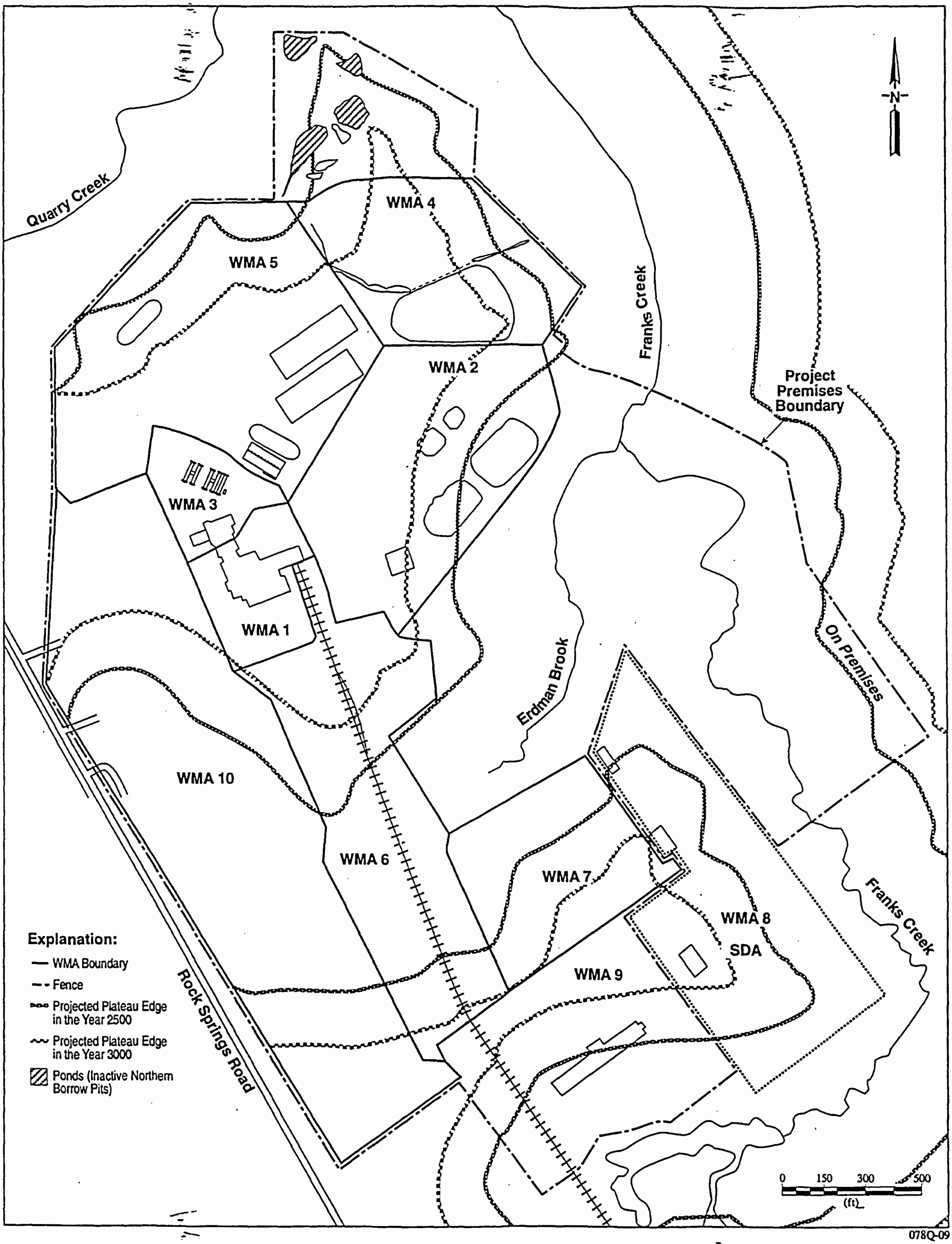

Figure N-3. Projected Stream Valley Growth to the Year 2500 (500 years) and 3000 (1,000 years)

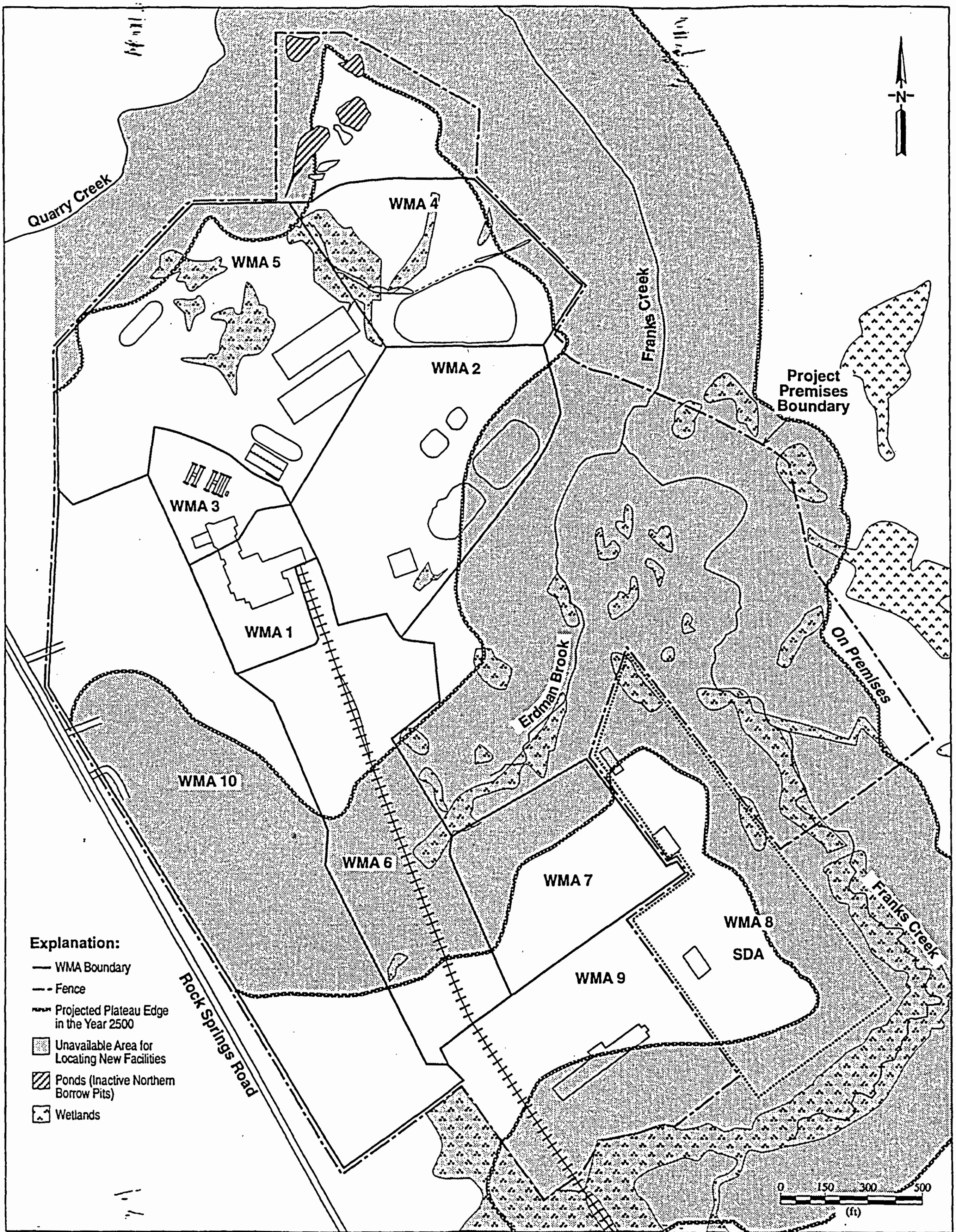

Figure N-4. Available Areas for New Facilities under Alternative II.

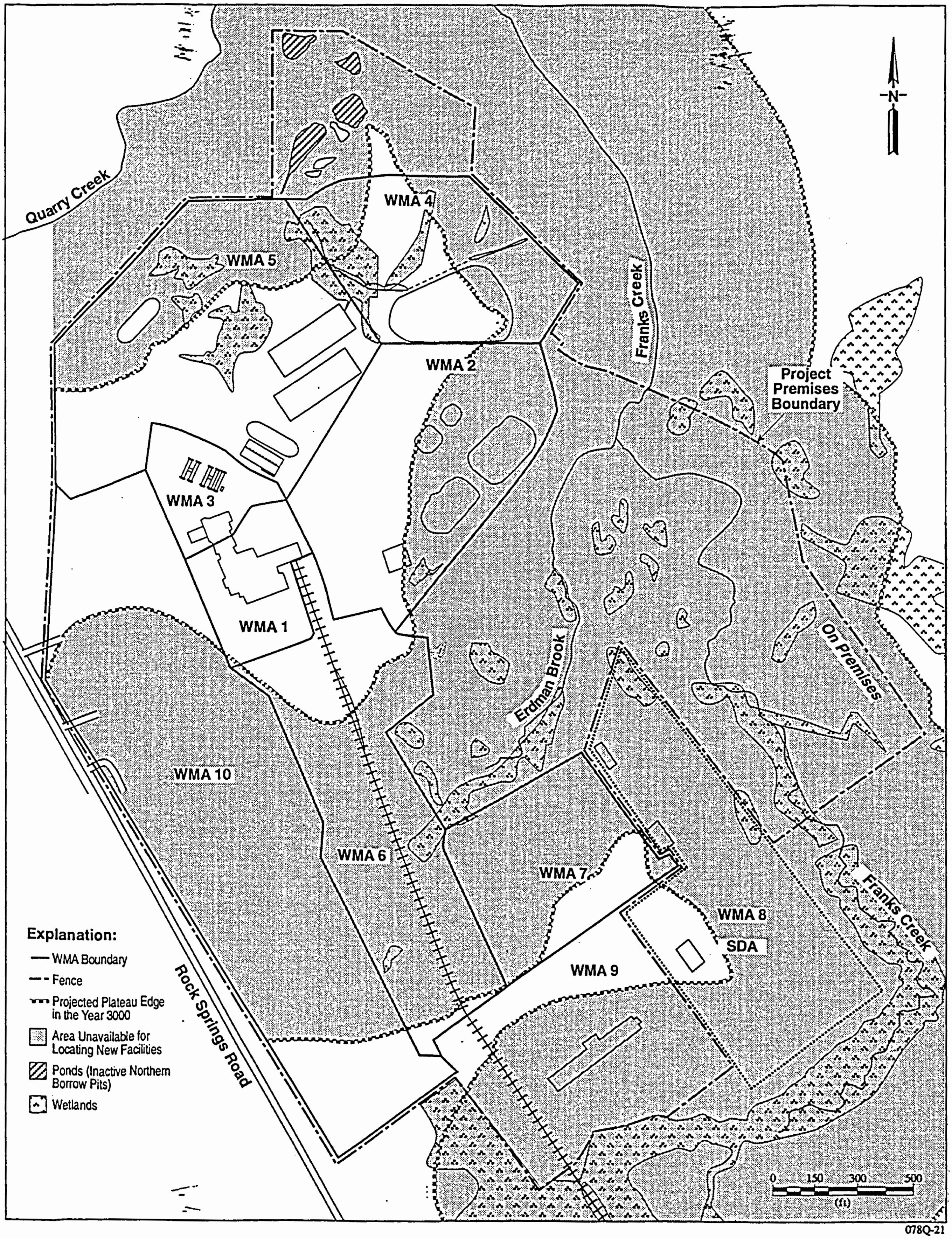

Figure N-5. Available Areas for New Facilities under Alternative IIIB.

Alternatives IIIA [In-Place Stabilization (Backfill)] and IV (No Action: Monitoring and Maintenance). The shaded areas would be unavailable for locating new facilities because they are subject to erosion, in the 100-year flood plain, wetlands, or within 30 m (100 ft) of Rock Springs Road. The only difference between Figures N-4 and N-5 is the unmitigated erosion fronts. Comparing Figures N-1 through N-4 indicates that erosion is the dominant constraint.

Other unavailable areas would include areas occupied by another facility or that has contaminated soil that would be excavated while implementing the alternative. However, after a facility had been removed or soil had been excavated, the cleared or remediated area could be used for new construction.

N.3 NUMBER OF NEW FACILITIES AND AREA REQUIRED

The number of facilities (and therefore the area) required for Alternatives II (On-Premises Storage) and III (In-Place Stabilization) depends on the success of specific design basis assumptions. If design basis assumptions are met, then a smaller area on the Project Premises and the SDA area would be required for either storage under Alternative II, or disposal under Alternative III. If design basis assumptions are not met, then a larger footprint on the Project Premises and SDA would be required. The number of new facilities and area that could be required are discussed in this section.

The number and area required for the contact retrievable storage areas under Alternative II and for the LLW disposal facility modules under Alternative IIIB was estimated using a design basis and a reasonable worst-case condition. For Alternative II, the design basis assumption was that soil treatment would result in 25 percent of the contaminated soil volume remaining contaminated and being stored on the Project Premises. The industrial waste volumes estimated in Chapter 3 for Alternative II [116,000 m^3 (4,080,000 ft^3)] would not have to be stored on the Project Premises. The worst-case assumption was that soil treatment was not practical or feasible, all contaminated soil would have to be stored on the Project Premises, and waste that had been classified as industrial (except for waste generated by dismantling remaining facilities in WMAs 6, 10, 11, and 12 and by installing erosion controls) would instead be classified as LLW [73,300 m^3 (2,590,000 ft^3)] and have to be stored on the Project Premises. (Both the contaminated soil and LLW would be stored in the contact retrievable storage areas, not in the shielded retrievable storage area.)

For Alternative IIIB [In-Place Stabilization (Rubble)], the design basis assumption was that the estimated volumes of industrial waste in Chapter 3 [maximum of 68,500 m^3 (2,420,000 ft^3)] would not have to be disposed of on the Project Premises. The worst-case assumption was that waste that had been estimated to be industrial waste in Chapter 3, except for waste generated by dismantling minor facilities in WMAs 6, 10, 11, and 12 and by installing erosion controls, would be classified as LLW instead [9,090 m^3 (321,000 ft^3)] and have to be disposed of on the Project Premises. Because no soil treatment area would be built for Alternative IIIB, the same volume of contaminated soil would have to be disposed of on the Project Premises for both the design basis and worst-case conditions. Table N-2 shows the number of contact retrievable storage areas and LLW disposal facility modules required for both the design basis and worst-case assumptions. A packing efficiency of 0.58 for some of the LLW and contaminated soil was used to derive the waste volumes shown in Table N-2.

For Alternative II (On-Premises Storage), under the design basis condition, four contact retrievable storage areas would be required for storing LLW and contaminated soil. However, for the worst-case condition, an additional 450,000 m^3 (16 million ft^3) of soil and 85,000 m^3 (3 million ft^3) of waste would require storage. For this case, 10 contact retrievable storage areas would be needed. For Alternative IIIB [In-Place Stabilization (Rubble)], under the design basis condition, three LLW disposal facility modules would be required for disposing of LLW and contaminated soil. However, for the worst-case condition, the volume of contaminated soil would remain the same as for the design basis condition, but an additional 7,300 m^3 (258,000 ft^3) of waste would require disposal. For this case, five LLW disposal modules would be required.

The determination of which set of assumptions would be more likely would be done after an alternative has been selected. For example, if either Alternative I (Removal) or II (On-Premises Storage) was selected, then bench scale testing would be initiated to determine whether soil treatment would be effective on site-specific soils. The results of this testing would show whether the design basis or worst-case assumptions for treatment of contaminated soil were appropriate.

Two conditions would affect assumptions about industrial waste volumes: (1) if generated waste could not be classified as industrial as was assumed, and (2) if off-site sanitary landfills would not accept industrial waste generated from decontamination and decommissioning of a nuclear facility. After selecting an alternative, more detailed surveys of contamination and engineering estimates would be developed to accurately estimate the actual industrial waste volumes. Moreover, the volumes could change when actual dismantlement and exhumation activities occur. Only after an alternative is selected would specific sanitary landfills be identified. If off-site landfills would not accept industrial waste from the Center, then the volume of industrial waste remaining on the Project Premises would increase.

N.4 EVALUATION OF AVAILABLE AREA AND POTENTIAL LOCATIONS FOR NEW FACILITIES

Under Alternative II (On-Premises Storage), a container management area comprising three areas would be constructed: a volume reduction area [59 x 46 m (194 x 150 ft)], a wastewater treatment area [28 x 28 m (92 x 92 ft)], and a soil treatment area [39 x 39 m (127 x 127 ft)]. These facilities would not be constructed at the location of an existing facility, and the location would not have distance constraints to accommodate the postulated erosion fronts. A potential location for these areas would be in the central portion of WMA 6 and WMA 10 because it is central to the most contaminated facilities (see Figure N-6). It would be useful to have the wastewater treatment area located near the U.S. Nuclear Regulatory Commission-licensed disposal area (NDA) and SDA because it would treat leachate from these areas. It would also be advantageous to have the soil treatment area

Table N-2. Number of New Facilities and Area Required for Design Basis Condition and Worst-Case Condition[a]

Type of Facility	Alternative II — Contact Retrievable Storage Area: Design Basis Condition	Alternative II — Contact Retrievable Storage Area: Worst-Case Condition	Alternative IIIB — LLW Disposal Facility Module: Design Basis Condition	Alternative IIIB — LLW Disposal Facility Module: Worst-Case Condition
Volume Needed to Store/Dispose of LLW and Contaminated Soil (ft^3)[b]	13,700,000	29,200,000	580,000	580,000
Volume Needed to Store/Dispose of LLW that had been Assumed to be Industrial Waste (ft^3)[b]	0	3,320,000	0	258,000
Total Volume Needed to Store/Dispose of Waste and Contaminated Soil (ft^3)	13,700,000	32,500,000	580,000	838,000
Design Capacity of a Single Facility (ft^3)	3,470,000	3,470,000	186,000	186,000
Number of Facilities Required	4	10	3	5
Dimensions of a Single Facility (ft x ft)	342 x 374	342 x 374	90 x 270	90 x 270
Area of a Single Facility (ft^2)	128,000	128,000	24,300	24,300
Total Area Required (ft^2)	512,000	1,280,000	72,900	122,000

a. To convert cubic feet to cubic meters, multiply by 0.02832. To convert feet to meters, multiply by 0.3048. To convert square feet to square meters, multiply by 0.0929. All values rounded to three significant figures.
b. A storage efficiency of 0.58 for packaged waste was used for facilities based on conceptual engineering designs.

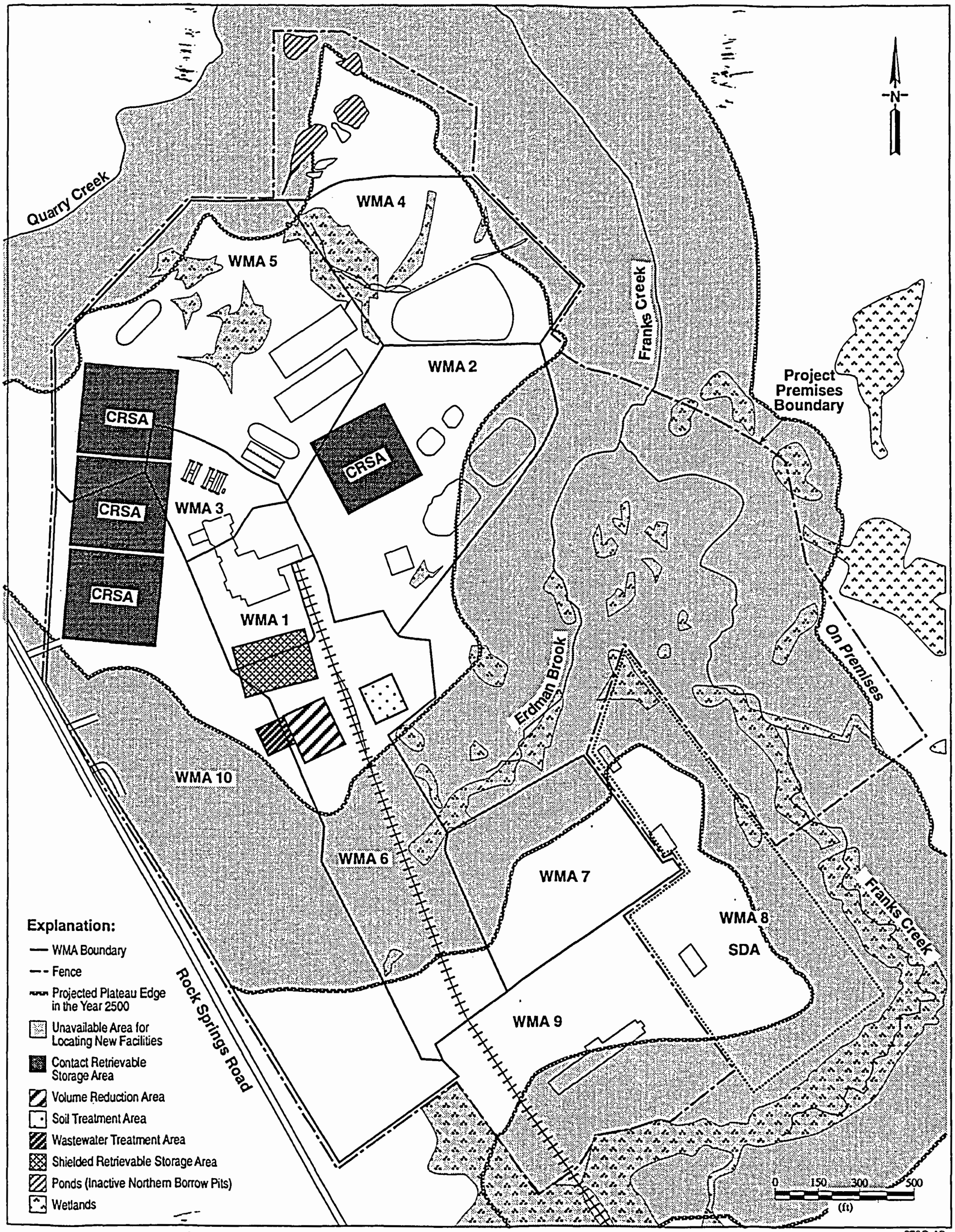

Figure N-6. Potential Locations for New Facilities under Design Basis Condition for Alternative II.

near the NDA and SDA because most of the contaminated soil would be exhumed from these areas. This facility would be dismantled after its operating life.

Potential locations for the four contact retrievable storage areas [each measuring 114 x 104 m (374 x 342 ft)] and one shielded retrievable storage area [87 x 55 m (287 x 181 ft)] under the design basis conditions are also shown in Figure N-6. Like the container management area, construction of these facilities would start at the beginning of the implementation phase, and construction of the individual contact retrievable storage areas would occur sequentially thereafter. The shielded retrievable storage area could not be built at the location of an existing facility. One potential location for this facility is in the central Project Premises, near the WMA 1 and WMA 6 boundary. Potential locations that avoid existing facilities for the four contact retrievable storage areas are the northern end of WMA 10, the southwest corner of WMA 5, and an area in WMA 2. The construction and demolition debris landfill (CDDL) would be exhumed, and the storage facilities in WMA 5 would be dismantled near the start of the implementation phase so these areas could also be used as new construction sites for the contact retrievable storage areas. Locating these facilities would not be difficult.

Finding available areas for constructing new facilities would be difficult under the worst-case condition. Potential locations for the container management area, shielded retrievable storage area, and the 10 contact retrievable storage areas required for the worst-case condition are shown in Figure N-7. The container management area could be located in the same place as described above. A potential location for the shielded retrievable storage area is in WMA 9, adjacent to the radwaste treatment system (RTS) drum cell. For the worst-case condition, constructing the contact retrievable storage areas would have to be coordinated with the removal of existing structures. The two contact retrievable storage areas at the southern end of WMAs 6 and 10 could be constructed first, followed by construction of one in the northern portion of WMA 10 because these areas would be essentially unoccupied. By the time the first three contact retrievable storage areas were constructed, the CDDL in WMA 4 would be exhumed and the storage facilities in WMA 5 would be dismantled allowing for construction of three more contact retrievable storage areas: one in WMA 4, one in WMA 5, and one at the northern end of WMA 6. The next three contact retrievable storage areas could be constructed after the vitrification facility and high-level [radioactive] waste (HLW) tanks in WMA 3 and the process building in WMA 1 were removed; the northern end of WMA 10, the western edge of WMA 5, and WMA 1 are locations that could be used for construction. These three contact retrievable storage areas could be constructed as additions to the existing storage areas in the WMAs. After the LLW treatment facility in WMA 2 was removed, the last contact retrievable storage area could be built as an addition to the existing storage area on the southeast side of WMA 5. The new facilities would be constructed near wetlands and close to the unmitigated 500-yr plateau edge.

For Alternative IIIB [In-Place Stabilization (Rubble)], a wastewater treatment area [28 x 28 m (92 x 92 ft)] would first be constructed where there was no existing facility and no distance constraints from plateau edges for erosion. A potential location for this facility could be near WMA 1 because decontamination liquids from the process building would have to be treated. This facility could be located along the western edge of WMA 1, adjacent to

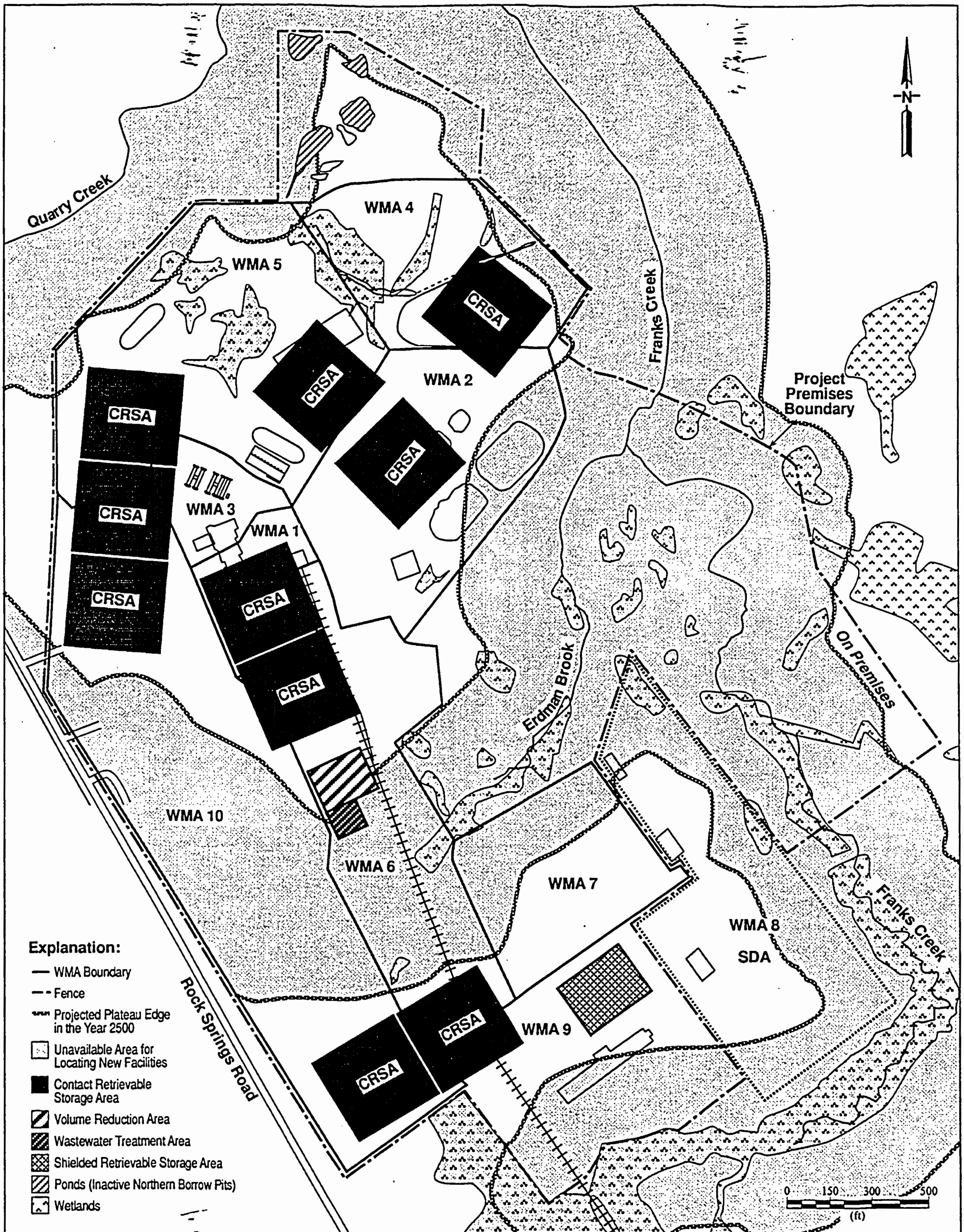

Figure N-7. Potential Locations for New Facilities under Worst-Case Condition for Alternative II.

the process building (see Figure N-8). Like the wastewater treatment area, the LLW disposal facility modules [each 82 x 27 m (270 x 90 ft)] would be constructed at the start of the implementation phase, and the individual modules would be constructed simultaneously. Therefore, these facilities could not be located in an area where there was an existing facility. Potential locations for the three LLW disposal facility modules needed for the design basis conditions are in the northern end of WMA 10 and southwestern corner of WMA 5 as shown in Figure N-8. It was considered advantageous to locate the LLW disposal facility modules on the western edge of the Project Premises where bedrock is closer to the surface and facility foundations could be in bedrock. Other areas that would not have existing facilities would include WMA 5, along the border of WMAs 2 and 5, at the northern end of WMA 6, at the southern end of WMA 10, and in WMA 9, adjacent to the RTS drum cell.

For the worst-case condition under Alternative IIIB, the wastewater treatment area could be in the same location described above. Potential locations for the five LLW disposal facility modules are shown in Figure N-9. The modules would be close together and could be converted into five individual tumuli or a single tumulus. Other areas where the LLW disposal facility modules could be constructed are the same as described for the design-basis condition.

Available areas for constructing the new LLW disposal facility modules on the Project Premises would not be difficult to locate for both the design basis and worst-case conditions. However, the potential locations would be close to wetlands or near the projected 1,000-yr eroded plateau edge as shown in Figures N-8 and N-9.

Locating available area for constructing new facilities would be most difficult under Alternative II and IIIB because they require the largest number of new facilities for either storing or disposing of waste. Locating available area for new facilities under the other alternatives would not be difficult.

- Under Alternative I (Removal), the container management area would be the only new facility built, and it would be dismantled after its useful life. There would be no distance constraints for locations relative to the plateau edges. The most advantageous location for the container management area would be in the center of the Project Premises and SDA as described for Alternative II (On-Premises Storage) and shown in Figures N-6 and N-7.

- Under Alternative IIIA [In-Place Stabilization (Backfill)], the wastewater treatment area would be the only new facility built, and it would be dismantled after its useful life. Because the process building would not be decontaminated under Alternative IIIA, the wastewater treatment area would not need to be located near WMA 1. A potential location for the wastewater treatment area could be near the NDA and SDA for treating leachate from these areas. A potential location for the wastewater treatment area could be in the northeast corner of WMA 9.

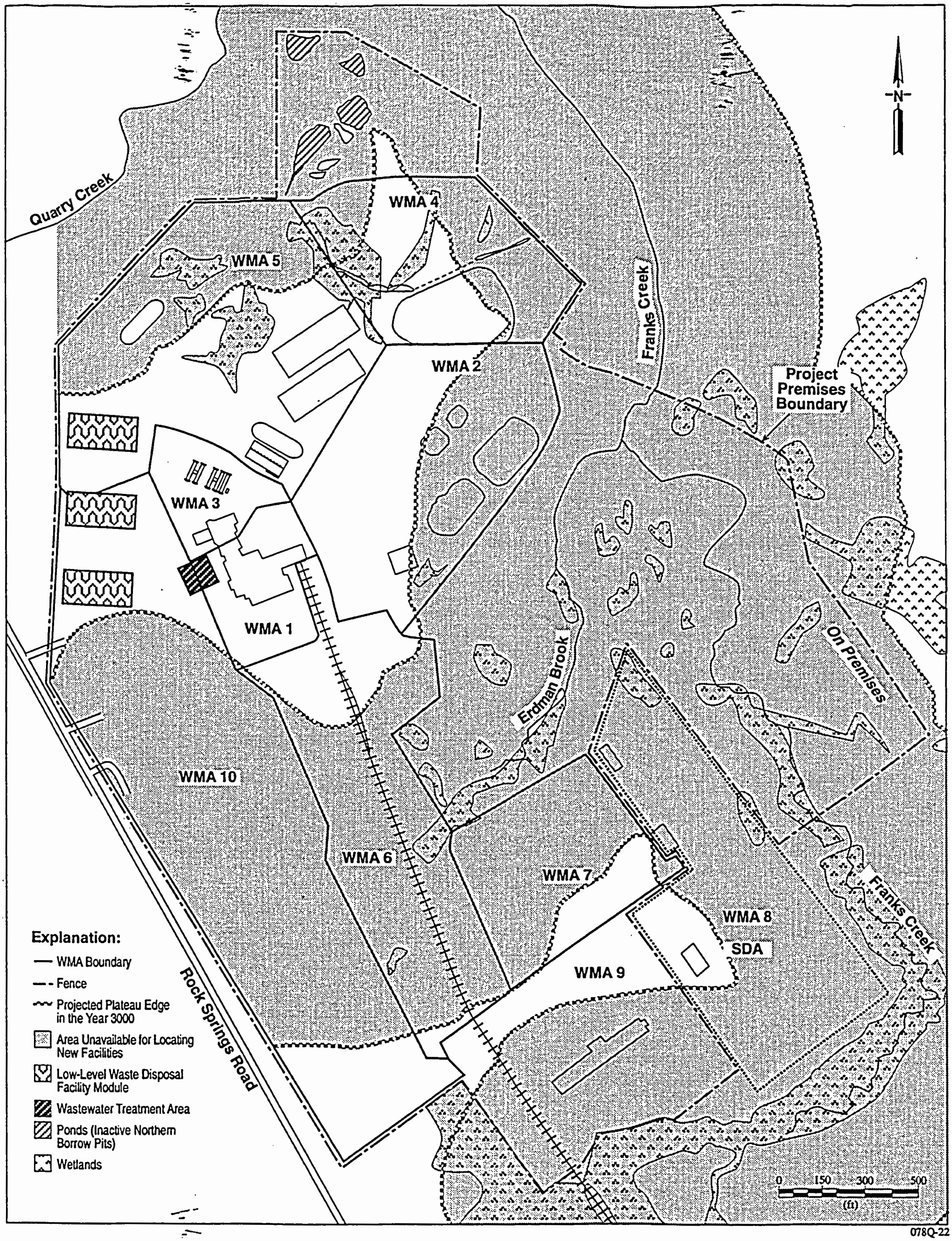

Figure N-8. Potential Locations for New Facilities under Design Basis Condition for Alternative IIIB.

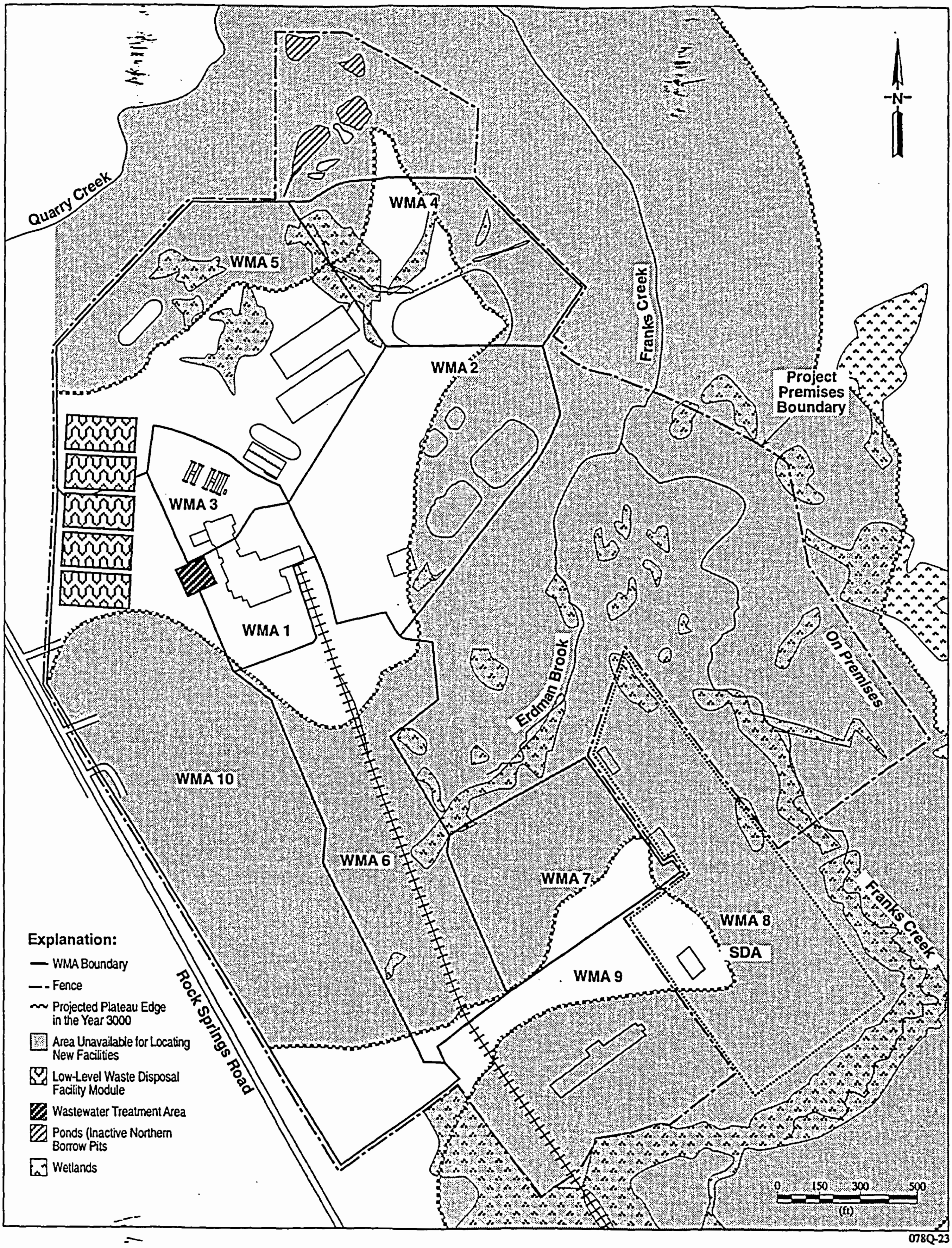

Figure N-9. Potential Locations for New Facilities under Worst-Case Condition for Alternative IIIB.

- Under Alternative IV (No Action: Monitoring and Maintenance), the wastewater treatment area would remain on the Project Premises indefinitely to treat leachate from the SDA. Like Alternative IIIA, one potential location for the wastewater treatment area could be the northeast corner of WMA 9, near the NDA and SDA.

N.5 CONCLUSIONS

Reasonable and worst-case (conservative) factors were considered to potentially locate and construct new facilities on the Project Premises and SDA that would be required for implementing the alternatives. New facilities could be located on the Project Premises for the expected or design-basis condition for all alternatives. For the worst-case condition, new facilities could also be located in the available area under all alternatives. For the worst-case condition under Alternative II, the required new facilities could be located on the Project Premises, but there would be little unused area remaining after construction.

Because conservative factors were used to estimate waste volumes and evaluate the worst-case condition, it is concluded that adequate area would be available on the Project Premises to construct the proposed new facilities evaluated under the alternatives.

REFERENCES

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[1]WVNS (West Valley Nuclear Services Company, Inc.), 1993. *Environmental Information Document. Vol. III, Hydrology: Part 2, Surface Water Hydrology*, WVDP-EIS-009, Rev. 0.

WVNS, 1994a. *West Valley Demonstration Project, Container Management and Retrievable Storage Areas Engineering Report*, WVDP-EIS-039, Rev. 0, September.

WVNS, 1994b. *West Valley Demonstration Project, Modular Low-Level Radioactive Waste Disposal Facility Engineering Evaluation*, WVDP-EIS-044, Rev. 0, July.

[1]Document is available in the public reading room.

APPENDIX O

LONG-TERM STRUCTURAL PERFORMANCE OF SELECTED REINFORCED CONCRETE STRUCTURES AT THE WESTERN NEW YORK NUCLEAR SERVICE CENTER

APPENDIX O

LONG-TERM STRUCTURAL PERFORMANCE OF SELECTED REINFORCED CONCRETE STRUCTURES AT THE WESTERN NEW YORK NUCLEAR SERVICE CENTER

This appendix presents the current understanding of the degradation processes affecting (a) the process building process cells, (b) the vaults that contain high-level [radioactive] waste (HLW) tanks 8D-1 and 8D-2, and (c) the vitrification facility cells and gives an estimate of time when collapse would be expected to occur. These structures are radiologically contaminated and would be left in place under Alternative IV (No Action: Monitoring and Maintenance) and Alternative V (Discontinue Operations). The assumption was made that equipment and waste would be removed from the facilities.

The nature of certain information in this appendix is subjective because of uncertainties in knowledge of both material behavior and structural loading mechanisms. The knowledge of the long-term behavior of reinforced concrete structures is limited by the lack of historical data; reinforced concrete has been in use for only 150 years. Historical records of earthquake damage have not provided a clear correlation between earthquake design provisions and observed damage: earthquake mechanisms and their relationship to structural response and damage is still poorly understood (D'Appolonia and Shaw 1981).

O.1 FACILITY LIFE AND POTENTIAL FOR COLLAPSE

The facilities are constructed of reinforced concrete, which is made up of concrete (a solid material formed by mixing cement, water, and aggregate under controlled conditions) and an internal lattice of steel. The concrete provides compressive strength, while the imbedded steel lattice provides tensile strength.

The tank vaults and process building were constructed of reinforced concrete according to the requirements of American Concrete Institute (ACI) Standard 318-56, which was the concrete code in effect at the time the structures were designed (ACI 1956). Under the requirements of this code, the total structural design load is computed, and a factor of 0.45 is applied as a reduction factor to obtain the allowable compressive stress in the concrete for flexure [i.e., design ultimate strength = (dead load + live load)/0.45]. An equivalent reduction factor is applied to obtain the tensile strength of the reinforcing bar.

For the process building, the critical structural members are expected to be the process cell ceilings. These ceilings were also floors for operations above the process cells and are estimated to have been designed for a live load of 732 kg/m^2 (150 lb/ft^2). The dead load of the 0.6-m (2-ft) thick floors is estimated to be 1,465 kg/m^2 (300 lb/ft^2), using a density of 2,400 kg/m^3 (150 lb/ft^3) for reinforced concrete. The design load of the floor can then be estimated to be the live load plus the dead load, or 2,197 kg/m^2 (450 lb/ft^2). The estimated floor design capacity is 450/0.45 or 4,882 kg/m^2 (1,000 lb/ft^2). Because the live load in the abandoned building would be zero, the ratio of the existing load (the dead weight of the floor) to the design capacity is approximately 3 to 10 (assuming no equipment or waste). The inverse of this ratio, 3.3, is the safety factor against collapse of the floor above a process cell. Therefore, the ceiling of a process cell would collapse because of dead load when that ceiling's flexural capacity had been reduced to 30 percent of its original strength.

The tank vaults are buried under several feet of soil, and the design live load for the tank roofs has been assumed to be negligible. As such, the safety factor against collapse is the inverse of the ACI design factor of 0.45, or 2.2. Therefore, the roof of the tank vault would collapse when the flexural capacity had been reduced to 45 percent of its original strength. During construction of the tank vaults, groundwater caused flotation of the vaults, and tank 8D-1 was left with a residual tilt of 0° 51' after remedial work was performed. In a report dated December 18, 1965, by Nuclear Safety Associates (NSA 1965), the effects of the residual tilt were evaluated, and it was concluded that, "there are no mechanical effects which will affect the lifetime of the tanks." Damage to the vaults during construction was determined to have been repaired so that the structure was in a condition equivalent to its designed condition (Schneider 1966).

The vitrification facility was constructed in the 1980s according to an ACI code from which some of the conservatism of the 1956 code had been removed. The ultimate strength under the 1971 and later codes is required to be 1.4 times the dead load plus 1.7 times the live load. For conservative estimates of failure, the safety factor against collapse is assumed to be the inverse of 1.4 or 71 percent. Therefore, the vitrification facility would not collapse before its flexural capacity had been reduced to approximately 70 percent of its original strength.

For the process building and vitrification facility, it is assumed that the failure mode would be a collapse of the concrete roof because of flexural failure. This failure would be attributed to the effects of freeze-thaw cycles on the concrete and corrosion of the reinforcing as discussed in the following sections. No collapse is expected to occur for at least 500 years, with 1,000 to 2,000 years being the probable time scale.

The tank vaults are currently buried under 1.8 to 3 m (6 to 10 ft) of soil. Because the frost line extends to a depth of approximately 1.2 m (4 ft), the freeze-thaw cycles would have a minimal effect. There are no postulated damage mechanisms comparable to those causing damage to the process building, so the failure mode of the tank vaults is less certain. The vaults are expected to last for at least 500 years, with 1,000 to 2,000 years being the probable time scale.

U.S. Nuclear Regulatory Commission (NRC)-sponsored studies on concrete degradation reached conclusions consistent with the expected time scales presented above. Clifton and Knab (1989) examined the feasibility of a 500-year service life for low-level radioactive waste placed in buried concrete vaults. The study examined the major degradation processes of sulfate attack, corrosion of reinforcing steel, alkali-aggregate reactions, groundwater leaching, freeze-thaw damage, microbiological attack, and salt crystallization. These processes involve water or aqueous solutions as the agents of concrete penetration. The study concluded that a 500-year service life can be obtained if good construction practices are followed.

Walton et al. (1990) reviewed mathematical models for estimating concrete degradation rates in environments subject to sulfate attack, reinforcement corrosion, calcium leaching, carbonation, and freeze-thaw effects. For a low sulfate environment (SO_4—of 6.33 ppm) such as found in the northeast U.S., degradation of less than 1 cm (0.4 in.) was predicted for a period of 1,000 years. For a soil chloride concentration of 1 ppm and a 5-cm (2-in.) cover of concrete over rebar, corrosion was estimated to start at 1,000 years. Calcium leaching was predicted to be less than 0.1 cm (0.04 in.) in 1,000 years, and depth of carbonization attack was estimated at less than 0.3 cm (0.12 in.) for 1,000 years. The annual rate of concrete loss was estimated at 3 cm (1.2 in.) for 100 freeze-thaw cycles annually. Neglecting the effects of freeze-thaw action and summing the other effects, total concrete degradation was expected to be less than 2 cm (0.8 in.) for a 1,000-year period (Walton et al. 1990).

Collapse of the structures would occur when the applied loads exceed the capacity. Capacity decreases over time from degradation. The analysis of data on reinforced concrete structures indicates slow degradation from corrosion, temperature cycling, freeze-thaw cycling, erosion, and plant growth as discussed below. When the structures do ultimately collapse, the immediate cause of the failure could be applying a natural hazard phenomena load, such as seismic activity, to the sufficiently degraded structure.

O.2 DAMAGING EVENTS

This section discusses conditions causing long-term degradation, such as corrosion, concrete degradation, erosion, and plant growth. The effects of natural phenomena, such as earthquakes, snow loading and wind/tornado effects, are also discussed.

O.2.1 Long-Term Degradation

Prediction of long-term degradation of reinforced concrete structures is limited because reinforced concrete has only been in use for tension load less than 150 years. The most common degradation of reinforced concrete occurs with road and bridge construction where corrosive chemicals that attack the concrete matrix, freeze-thaw cycles, and dynamic (moving) loads combine to break up the structures. In the case of the Western New York Nuclear Service Center (Center) structures, there are no corrosive chemicals attacking the concrete matrix and no dynamic loads. The degradation mechanisms that are expected to occur are discussed in the following sections.

O.2.1.1 Corrosion

Carbon steel reinforcing bar in concrete is subject to corrosion. The corrosion rate is expected to be low because the calcium in the concrete results in mildly basic internal moisture that is not very corrosive to carbon steel. The corrosion rate is estimated to be on the order of 0.3 mil/yr, which, for rebar of the size used in these facilities, results in an annual loss of strength of about 0.1 percent/year (Larrabee 1953).

O.2.1.2 Concrete Degradation

Concrete is also subject to mechanical degradation mechanisms, mainly temperature cycling, freeze-thaw cycles, erosion, and plant growth. Temperature cycling can result in cracking because of volume changes and shrinkage from drying. During freezing and thawing of concrete, either the cement paste or the aggregate, or both, may be damaged by dilation. In this process, stresses beyond the proportional limit may be produced with the possible result of permanent enlargement or actual disintegration. Literature and discussions with professionals indicate that good concrete, of the type used at the Center, has virtually no change in the modulus of elasticity after 200 freeze-thaw cycles (Waddell 1974). Therefore, degradation from temperature and freeze-thaw cycling is expected to occur very slowly.

O.2.1.3 Erosion

Erosion of the HLW tank vaults is unlikely because the tanks are located underground and are not physically located in an area on the Project Premises that is actively eroding. For the process building and vitrification facility, there is the potential for erosion of the abovegrade portions of the buildings. However, the erosion is expected to be minimal.

O.2.1.4 Plant Growth

If a structure has openings to the atmosphere, airborne debris and seeds may collect in crevices and corners, then deteriorate and become a medium for plant growth. The plant roots can cause cracks to grow in the concrete, causing further deterioration. The tank vaults would not be subject to this process, but the exterior of the process building and vitrification facility could be. However, on the basis of engineering judgment, deterioration from this process is expected to be minimal.

O.2.2 Natural Hazard Phenomena

The effects of natural hazard phenomena, such as earthquakes, snow loading, and wind/tornado effects, are discussed below. The probability of tornadoes and earthquakes at the site are discussed in Appendix M.

O.2.2.1 Collapse from Earthquakes

Earthquakes have been a historical issue at the site, and their potential and consequences have been studied. The potential for specific earthquakes are presented in the hazard curve as shown in Figure M-1 (Appendix M). Using this hazard curve, the probability of occurrence of a given earthquake acceleration occurring within a particular time period, Δt, can be estimated as presented in Table O-1. The table was obtained using the Poisson frequency distribution where the probability for an earthquake with a return period, N, occurring during a particular time period can be expressed as

$$P\ (\Delta t)\ =\ 1\ -\ e^{-(\Delta t/N)} \qquad \text{(O-1)}$$

Table O-1. Probability of Earthquake Acceleration

Return Period (years)	Maximum Peak Acceleration (g)	Time Period (years)				
		10	100	500	1,000	2,000
500	0.05	0.02	0.18	0.63	0.86	0.98
2,000	0.1	0.005	0.05	0.22	0.39	0.63
8,500	0.2	0.001	0.01	0.06	0.11	0.21
20,000	0.3	0.0005	0.005	0.03	0.05	0.10
80,000[a]	0.4	0.0001	0.001	0.006	0.01	0.03

a. Extrapolation from the hazard curve (Figure M-1, Appendix M).

The NRC safety evaluation report (NRC 1982) for the process building indicates that damage to the concrete block walls could occur at accelerations as low as 0.03 g, that onset of failure of reinforced concrete walls could occur at approximately 0.1 g, and that large portions of the structure could approach the onset of failure at 0.2 g. These conclusions were based on independent seismic analyses of the facilities performed by Lawrence Livermore National Laboratory (Murray et al. 1977) and by the Nathan M. Newmark Consulting Engineering Services. Because the term failure in these studies was used in a structural analysis sense (i.e., by comparing maximum stresses with limits in building codes), it is possible that a failure might not even be observable in the actual structure. The likelihood of gross collapse of the structure was, thus, estimated to occur at accelerations of 0.3 g.

Data from the Supernatant Treatment System Confinement Barrier Vulnerability Assessment of Extreme Natural Hazards (WVNS 1992) indicated local wall cracking at

0.2 g, shearing of walls at the foundation mat at 0.4 g, and collapse of the roof and columns at 0.6 g for the HLW tank vaults 8D-1 and 8D-2.

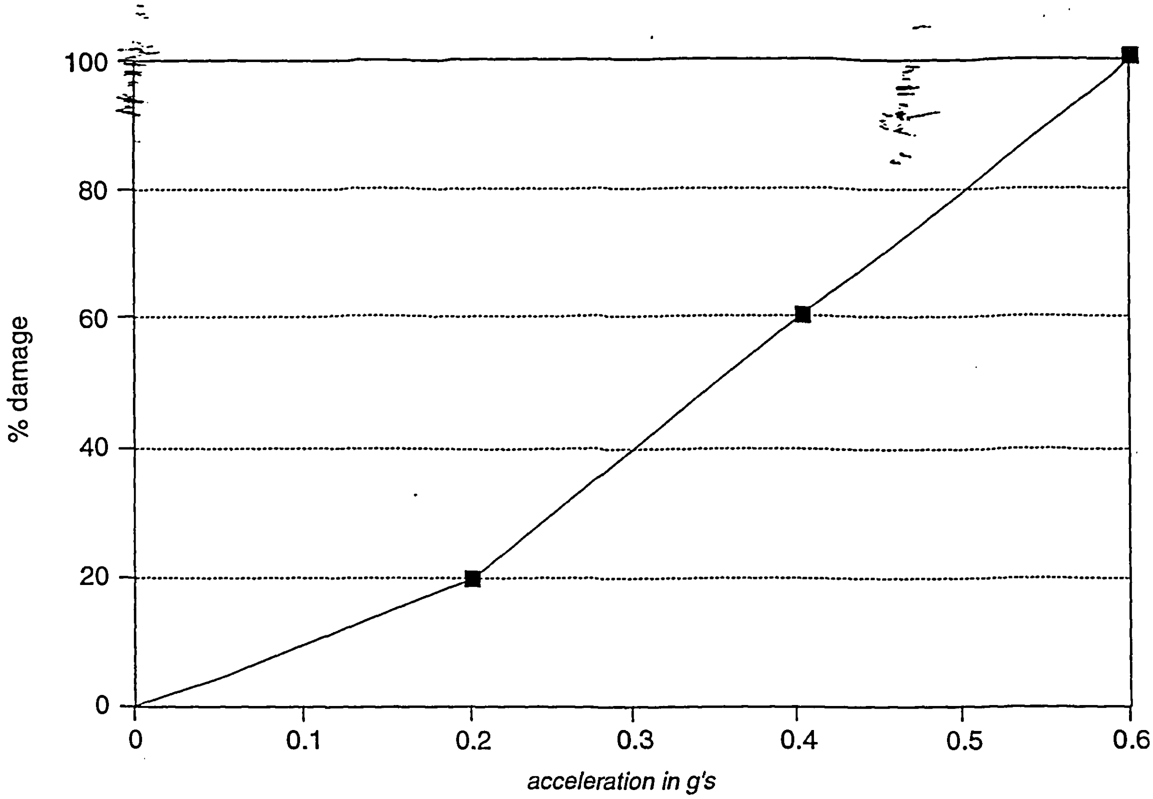
There is a significant margin of safety between the seismic demands of the vitrification facility and the capacity of the structure. Collapse of the roof, based on engineering judgment and experience, was estimated to occur at 5 or 6 times the design basis earthquake of 0.1 g; thus, ultimate collapse would be expected for an earthquake peak acceleration of 0.5 to 0.6 g (Gates 1989).

Damage curves for the process building process cells and HLW tank vaults 8D-1 and 8D-2 are shown in Figure O-1.

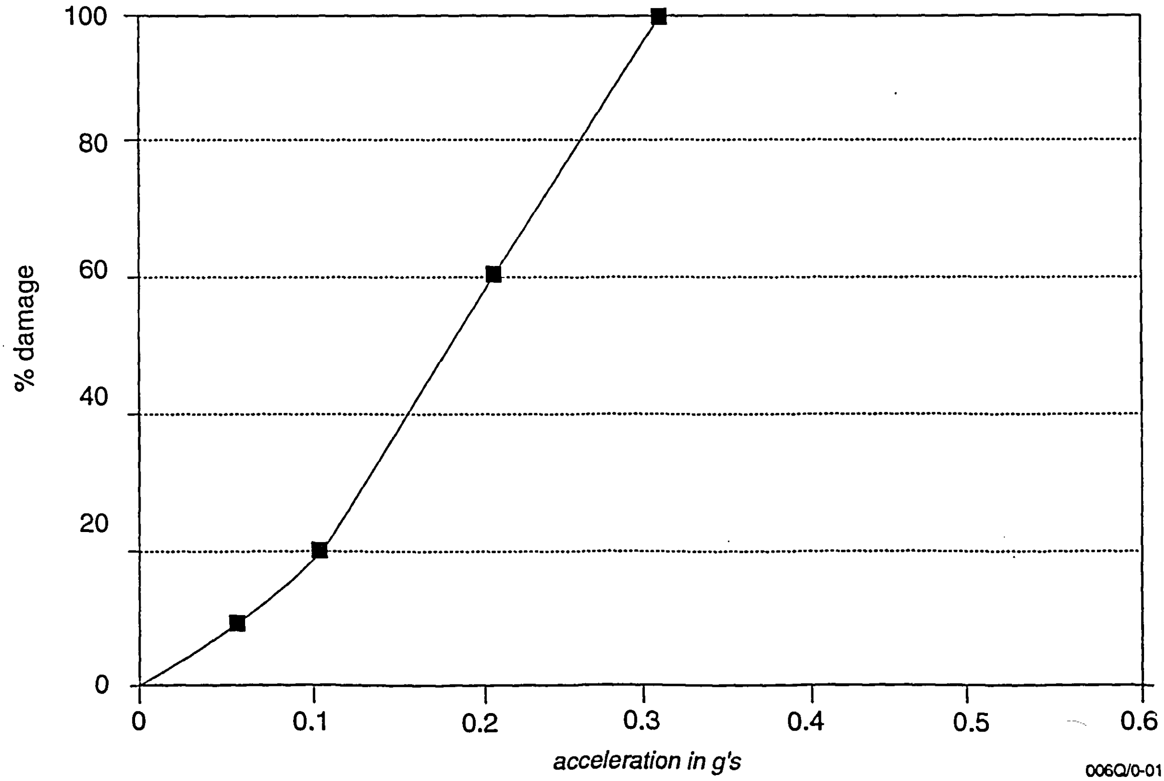
The probability that a given structure will sustain a given amount of damage as a result of a given seismic loading is referred to as structural fragility and can be derived and presented in several ways. Existing analytical studies and expert opinion were used to determine damage factors as a function of acceleration for this appendix. The damage factor is defined as a random variable with values from 0 to 1.0, where 0 represents no damage and 1.0 represents total collapse. For purposes of this appendix, light damage has a value of 0.1, moderate damage has a value of 0.2, heavy damage has a value of 0.4, and major damage has a value of 0.6. The determination of light, moderate, heavy, and major collapse damage is subjective and is based on experience and available data (Rojahn et al. 1986, Malik and Scholl 1986).

Using Table O-1 and damage curves for the facilities, seismic risk estimates as a function of exposure were calculated. Using the vaults as an example, the probability of a 0.05 g earthquake occurring in the next 100 years is 0.18; the damage would be 5 percent. The product of the two terms results in a seismic risk to the tank vaults of 0.9 percent damage. Repeating these steps for earthquakes of 0.1, 0.2, 0.3, and 0.4 g results in seismic risks of 0.5, 0.2, 0.2 and 0.06 percent damage, respectively. Therefore, the total seismic risk is 1.86 percent damage and is dominated by the 0.9 percent damage of the 0.05 g earthquake. The results of this analysis indicate that, of the acceleration levels investigated, the greatest amount of damage to the vaults in the next 100-year interval would be because of the 0.05 g acceleration that would result in less than 1 percent damage. Table O-1 shows that the probability for higher acceleration earthquakes decreases by a factor greater than three, while the amount of damage caused by increasing accelerations is only doubled. That is, the probability of occurrence of more severe earthquakes decreases more rapidly than the damage caused by the same earthquake increases.

Similar calculations were performed for intervals of 200, 400, and 1,000 years. These calculations show that the damage is dominated by smaller, more likely earthquakes. For a 1,000-year period, seismic events are expected to result in less than 10 percent damage to the structures. For a seismic event to cause major damage, such as 60 percent, the required ground acceleration would have to exceed 0.2 g. Table O-1 indicates that the



(a) Tank Vaults



b) Process Building

Figure O-1. Damage Curve for the (a) Tank Vaults and (b) Process Building.

probability of this magnitude of an earthquake is approximately 11 percent during the 1,000-year period.

O.2.2.2 Snow

The structures have been designed for the 50-year snow load; however, even the 1,000-year snow load is not estimated to cause damage unless concrete degradation and corrosion have significantly weakened the structures.

O.2.2.3 Wind and Tornadoes

Winds and tornadoes will not damage underground structures. Because of the way the process facilities were constructed, winds and tornadoes would not affect the structures until concrete degradation and corrosion had significantly weakened them. A tornado strike with winds in excess of 322 km/h (200 mph) is considered unlikely; however, a parametric analysis considered wind speeds up to 483 km/h (300 mph). While walls external to the process cells were assumed to be destroyed, the process building process cells remained intact (NRC 1982).

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APPENDIX P

CONSULTATIONS WITH OUTSIDE AGENCIES, WETLANDS INVESTIGATION AND DELINEATION

Department of Energy
Ohio Field Office
West Valley Area Office
P.O. Box 191
West Valley, NY 14171

June 29, 1995

Mr. D. Wiggins, Director
Environmental Protection Department
Seneca Nation of Indians
1508 Route 438
Irving, NY 14081

Dear Mr. Wiggins:

Thank you for your review of the DOE's Draft Environmental Assessment for the treatment of Class A Low-Level and Mixed Low-Level Waste. We have received your letter of June 5, 1995, and are currently reviewing your comments concerning the proposal to treat West Valley Demonstration Project (WVDP) low-level waste.

In another matter, Mr. Ahmad Al-Daouk is the official Tribal Liaison for the DOE's West Valley Area Office (DOE-WV). In that capacity, he functions as the DOE's point of contact for interfacing with the Seneca Nation of Indians. In order to facilitate effective government-to-government relations, please forward correspondence and direct telephone calls to him (see information below). Mr. Al-Daouk will coordinate efforts with the West Valley Nuclear Services Co., Inc. (WVNS) Public Relations Manager.

Mr. Ahmad Al-Daouk
Tribal Liaison
U. S. Department of Energy
West Valley Area Office
P.O. Box 191
West Valley, NY 14171-0191

Phone: (716) 942-4629

I thank you for your continued interest in the DOE's WVDP activities and look forward to continuing, for our mutual benefit, the direct working relationship currently being developed between DOE-WV and the Seneca Nation of Indians.

Sincerely,

R. B. Provencher, Associate Director
West Valley Area Office

AA:018:95-1281:95:01

AA/tle

- Section 4.5 Cultural Resources on page #10 addresses cultural resource impacts. This section fails to begin addressing cultural resource impacts of surrounding communities and inappropriately equates cultural resources as resources eligible for classification under the N.Y.S. Historic Places and National Register of Historic Places. Using such narrow criteria to assess cultural impacts is entirely inappropriate. Cultural impacts of a community suffered as a result of West Valley activities are certainly not going to be addressed using historical registry eligibility as a criteria for impact consideration. Using 'historic' eligibility as a criteria for cultural impact circumvents a community's cultural values by requiring state or federal recognition of such cultural importance. Though places such as burial grounds and religious structures may fit the 'historic place' eligibility, such criteria fails to consider cultural impacts to the cultural lifestyle of the community.

- In section 5.2.2 Incident-Free Dose Assessment, the first paragraph states the collective dose for transporting LLW to Oak Ridge does not correspond with the referenced table (Table 6). The total exposure estimated to the public is stated as 37 person-rem. This is based on what rem exposure?

- As many Indian tribes are affected by various DOE facilities, it is important that DOE be consistent with the involvement of each stakeholder in site facility activities. In selecting the Clive facility to receive and transport waste (or any other facility), has WVDP been assured of the involvement by affected Indian tribes. With respect to the Clive facility, has the Skull Valley Reservation been involved in the environmental impact assessments.

Thank you for this opportunity to comment on the Draft Environmental Assessment for the Treatment of Class A Low-Level and Mixed Low-Level Waste. Comments on additional documents provided by West Valley will be forwarded to you in the following week.

Sincerely,

Douglas A. Wiggins, Director
Environmental Protection Department

xc: D. Bowen, President
A. Stevens, Treasurer
file

The Secretary of Energy
Washington, DC 20585

January 24, 1994

The Honorable Barry E. Snyder, Sr.
President
Seneca Nation of Indians
1490 Route 438
Irving, New York 14081

Dear President Snyder:

Thank you for your inquiry for membership in the State and Tribal Government Working Group. The Department recognizes the Seneca Nation as an equal partner in its efforts in the environmental restoration and waste management arena. The Seneca Nation's commitment to the environment can be a valuable resource for the Department in our cleanup efforts.

Historically, the working group has always made the final decision on membership. The Department will be pleased to forward your request to the working group for discussion at their next meeting scheduled for February 8-9, 1994, in Washington, D.C. Thank you again for your interest and desire to improve the Department of Energy's operations and contribute to the success of the Environmental Management program.

Sincerely,

Hazel R. O'Leary

Seneca Nation of Indians

President - Barry E. Snyder, Sr.
Clerk - Barbara A. Hemlock

1490 ROUTE 438
IRVING, NEW YORK 14081

Tel. (716) 532-4900
Tel. (716) 532-4907
FAX (716) 532-9132

SENECA NATION of INDIANS
Keeper of the Western Door

Treasurer - Rae L. Snyder

P.O. BOX 231
SALAMANCA, NEW YORK 14779

Tel. (716) 945-1790
FAX (716) 945-3917

16 December 1993

Secretary Hazel O'Leary
Department of Energy
1000 Independence Avenue
Washington, D.C. 20585

Dear Secretary O'Leary:

The Seneca Nation of Indians is pleased to send you this letter expressing our support for your stated goals of environmental restoration and proper waste management. We strongly believe in your commitment to increase the participation of all stakeholders in the Department of Energy's (DOE) activities. We seek to increase our participation in the DOE planning process and believe an appropriate mechanism would be membership in the State and Tribal Government Working Group (STGWG).

The Seneca Nation of Indians is a federally recognized Indian nation that occupies 52,789 acres within the boundaries of New York State, divided into three reservations: Cattaraugus, Allegany, and Oil Spring. The attached map depicts the location of our three territories within western New York. The Cattaraugus Reservation, located at the juncture of Cattaraugus, Chautauqua, and Erie Counties, encompasses Cattaraugus Creek from Gowanda, New York to the shore of Lake Erie. The Cattaraugus Creek watershed is of great cultural and economic significance to the Seneca Nation of Indians and constitutes one of our major water bodies.

Currently, the Seneca Nation of Indians is affected by Environmental Restoration and Waste Management activities of DOE occurring at the West Valley Demonstration Project site (WVDP) situated on Cattaraugus Creek. The Nation is located downstream and in close proximity to this facility, and discharges from the WVDP have contaminated our land and water. For example, releases from the WVDP have created known "hot spots" with radionuclide contaminating sediments in Cattaraugus Creek.

The WVDP is intended to demonstrate a solidification process of over 660,000 gallons of high level radioactive waste. Low-level radioactive waste generated through the initial phases of the solidification process is currently being buried on-site. A Phase II Environmental Impact Statement is underway and tentatively will be ready by the end of 1995. Consent orders, compliance agreements, and other hazardous waste permit applications are presently being negotiated with the U.S. Environmental Protection Agency and the State of New York. The FY 1993-1997 budget for these activities is projected to be over 600 million dollars. If all goes well, this facility will eventually be turned over to the State of New York.

The DOE and the Seneca Nation of Indians have a mutual interest in ensuring the success of this project. For instance, we have an important stake in ensuring that the environmental monitoring that began at the WVDP in compliance with DOE order 5400.1 is being performed adequately and addresses our concerns, many of which are unique to the Seneca culture and way of life. The Seneca Nation can regulate environmental discharges that impact us through the Comprehensive Environmental Responsibility, Compensation, and Liability Act, as is currently being demonstrated by Indian nations in the southwest, primarily the Pueblo of San Ildefonso. Although the ability of Indian tribes to regulate environmental activities through the Resource Conservation and Recovery Act is limited at this time, we believe that Congress intends to correct this situation.

Despite being an important stakeholder, thus far our involvement in the DOE decision-making and planning processes has been minimal. Solution of the complex problems facing the DOE and yourself, including the legacy bequeathed to you by past administrations, will require the combined efforts of all stakeholders working in concert. We desire to be a part of the DOE solution-finding process. For without our input, without regard to our cultural sites and resources, without considering in detail our way of life, the herbs we gather and consume, and the degree of our subsistence on aquatic life within Cattaraugus Creek, the assessment of questions such as acceptable risks and future land use scenarios will be incomplete and open to legal and technical challenge.

It is our understanding that several tribes and states are members of the STGWG by virtue of their proximity to DOE authorized facilities. It is critical that our involvement with the DOE increase before decisions are made that affect us greatly and upon which we will have had no significant influence. We seek your assistance regarding membership in the STGWG and interaction with DOE officials and affected tribes and states.

Through conversations with member tribes, it is clear that STGWG does not have any participation from Indian nations located in the northeastern United States. Our membership will remedy this imbalance with a unique perspective that can only serve to enhance the function of the STGWG and assist DOE.

We look forward to your reply and to the growth of our cooperative efforts.

Sincerely,

Barry E. Snyder, Sr.
President

cc: Thomas P. Grumbly, EM-1, DOE
T. Jay Pierce, SNI Environmental Quality Assurance Officer

tjp

West Valley
Nuclear Services Company
Incorporated

P.O. Box 191
West Valley, New York 14171-0191

MS-A
WZ:93:0173
September 24, 1993

Mr. Adrian Stevens
Assistant to the President
Seneca Nation of Indians
1490 Route 438
Irving, NY 14081

Dear Mr. Stevens:

SUBJECT: Informational Meeting Request

The Department of Energy's West Valley Demonstration Project (WVDP) is presently developing an Environmental Impact Statement (EIS) which will evaluate alternatives for future clean up and closure of WVDP facilities, and closure and/or long-term management of the Western New York Nuclear Service Center (WNYNSC). In this effort, it is necessary to consider a wide variety of environmental factors that could be affected including factors such as the economy and cultural resources. To accurately evaluate factors and concerns, the input of numerous agencies, organizations and individuals is needed.

As part of the EIS process we are conducting a cultural resources study to evaluate the site's potential historical and cultural significance. One aspect to consider is the potential significance of the site to native American cultures. In this regard, we would like to consult with the Seneca Nation and receive input on our evaluation.

In the larger scope, I think that it is important that the Seneca Nation is provided as much information as possible regarding the WVDP's clean up and waste management activities, including the EIS. I also think that it is important that a channel for ongoing communications be established.

As you know our primary contact with the Seneca Nation has been the Nation's Health Department. I discussed the need to meet with appropriate representatives of the Seneca Nation with Ms. Maybee, SNI Sanitarian, and then with Mr. Printup, Chairman of the Nation's Natural Resources Committee. Mr. Printup directed me to you.

I would like to talk with you at your earliest convenience about how we can proceed. We would be pleased to hold a meeting at the WVDP for you and the appropriate Nation representatives or provide a presentation at your offices.

Please contact me at 716/942-4610. I will be looking forward to your call.

Very truly yours,

John D. Chamberlain
Manager, Community Relations
West Valley Nuclear Services Company, Inc.

EF:93:0139

JDC:imk

cc: Lisa Maybee, SNI, Health Dept., 1501 Route 438, Irving, NY 14081
Celand Printup, SNI, P.O. Box 231, Salamanca, NY 14779
Barry Nichols, SAIC, P.O. Box 4875, Reston, VA 22090
T. J. Rowland, DOE-WVPO, P.O. Box 191, West Valley, NY 14171
P. L. Piciulo, NYSERDA, WVPO, P.O. Box 191, West Valley, NY 14171

1520IMK.LTR

ORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
ife Resources Center
0 Troy-Schenectady Road
Latham, NY 12110-2400

(518) 783-3932

Langdon Marsh
Commissioner

February 23, 1995

T. J. Rowland, Director
West Valley Area Office
P.O. Box 191
West Valley, New York 14171

Dear Mr. Rowland:

We have reviewed the New York Natural Heritage Program files with respect to your recent request for biological information concerning the U.S. Department of Energy West Valley Demonstration Project Endangered Species Act Compliance, area of site as indicated on your enclosed map, located in the Towns of Ashford and Concord, Cattaraugus and Erie Counties, New York State.

There has been no change to the information sent you in our Sept. 21, 1993 response to your last request for information. Continue to use that information for your environmental review needs.

Our files are continually growing as new habitats and occurrences of rare species and communities are discovered. In most cases, site-specific or comprehensive surveys for plant and animal occurrences have not been conducted. For these reasons, we cannot provide a definitive statement on the presence or absence of species, habitats or communities. This information should not be sutstituted for on-site surveys that may be required for environmental assessment.

This response applies only to known occurrences of rare animals, plants and natural communities and/or significant wildlife habitats. You should contact our regional office, Division of Regulatory Affairs, at the address on the enclosed list for information regarding any regulated areas or permits that may be required (e.g., regulated wetlands) under state law.

If this proposed project is still active one year from now we recommend that you contact us again so that we can update this response.

Sincerely,
Information Services
NY Natural Heritage Program

Encs.

35270
0519:95:07

BC:95:0124

New York State Department of Environmental Conservation
Wildlife Resources Center
Information Services
700 Troy-Schenectady Road
Latham, New York 12110-2400

Thomas C. Jorling
Commissioner

September 21, 1993

Thomas J. Rowland
U.S. Dept. of Energy, Idaho Operations Office
West Valley Project Office, PO Box 191
West Valley, NY 14171

Dear Mr. Rowland:

We have reviewed the New York Natural Heritage Program files with respect to your recent request for biological information concerning the 63 acre Nuclear Service Center site, as indicated on your enclosed map, located in Cattaraugus and Erie Counties, New York State.

Enclosed is a computer printout covering the area you requested to be reviewed by our staff. The information contained in this report is considered sensitive and may not be released to the public without permission from the New York Natural Heritage Program.

Our files are continually growing as new habitats and occurrences of rare species and communities are discovered. In most cases, site-specific or comprehensive surveys for plant and animal occurrences have not been conducted. For these reasons, we can only provide data which have been assembled from our files. We cannot provide a definitive statement on the presence or absence of species, habitats or natural communities. This information should not be substituted for on-site surveys that may be required for environmental assessment.

This response applies only to known occurrences of rare animals, plants and natural communities and/or significant wildlife habitats. You should contact our regional office, Division of Regulatory Affairs, at the address enclosed for information regarding any regulated areas or permits that may be required (e.g., regulated wetlands) under State Law.

If this proposed project is still active one year from now we recommend that you contact us again so that we can update this response.

Sincerely,

Nancy Davis-Ricci, Info. Data Asst.
NY Natural Heritage Program

Enc.
cc: Reg. 9, Wildlife Mgr.
Reg. 9, Fisheries Mgr.
Dean Bouton, Wolf Road

BC:95:0124

Recd.
Rec. Mgmt.
September 8, 1993

Department of Energy
Idaho Operations Office
West Valley Project Office
P.O. Box 191
West Valley, NY 14171

DW:93:1190

September 7, 1993

New York State Department of
Environmental Conservation
Wildlife Resources Center
Significant Habitat Unit
700 Troy-Schenectady Road
Latham, NY 12110-2400

SUBJECT: The U.S. Department of Energy (DOE) West Valley Demonstration Project (WVDP) Endangered Species Act Compliance

Dear Sir or Madam:

The Federal Endangered Species Act of 1973, as amended, requires each federal agency to ensure that any action it authorizes, funds, or carries out does not jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of their critical habitat.

In addition, similar requirements are found in the New York Environmental Conservation Law Section 11-0305 for endangered and threatened animal species as well as Section 9-1503 for protected plant species.

The DOE West Valley Project Office (WVPO) requests information from the New York State Department of Environmental Conservation to assist in complying with the federal and state statutes.

Please provide the most recent New York State List of Protected Native Plants and a current list of state endangered, threatened, species of special concern, proposed, candidate species, and/or critical habitats that may be present in the area of Cattaraugus and Erie Counties, New York. The enclosed site map delineates the specific area of concern. The WVPO is located on an approximately 63 hectare site within the boundaries of the Western New York Nuclear Service Center (WNYNSC), a 1,335 hectare reserve owned by the state of New York. The WNYNSC is situated on the southern border of Erie County and the northern border of Cattaraugus County.

If there are any questions, please contact Elizabeth Matthews of my staff at (716) 942-4930.

Sincerely,

T. J. Rowland, Director
West Valley Project Office

Enclosure: Site Map

cc: J. L. Lyle, DOE-ID, MS 1115, w/o enc.
T. L. Perkins, DOE-ID, MS 1146, w/enc.
M. F. McGarry, WVNS, MS Z 05, w/o enc.

EAM:149:93 - 0591:93:11

EAM/caf

Elizabeth

United States Department of the Interior

FISH AND WILDLIFE SERVICE
3817 Luker Road
Cortland, New York 13045

February 7, 1995

Mr. T.J. Rowland, Director
West Valley Area Office
Department of Energy
P.O. Box 191
West Valley, NY 14171

Attention: Mr. Daniel W. Sullivan

Dear Mr. Rowland:

This responds to your letter of January 13, 1995, requesting reconfirmation of our September 29, 1994, letter on the presence or absence of Federally listed species at the West Valley Demonstration Project, Erie and Cattaraugus Counties, New York.

There has been no change in the status of your site since our previous letter.

If you have any questions regarding this letter, contact Kim Claypoole at (607) 753-9334.

Sincerely,

Mark W. Clough
ACTING FOR
Sherry W. Morgan
Field Supervisor

cc: NYSDEC, Olean, NY (Regulatory Affairs)
NYSDEC, Latham, NY

BC:95:0124

Department of Energy
Ohio Field Office
West Valley Area Office
P.O. Box 191
West Valley, NY 14171

January 13, 1995

RECEIVED
JAN 17 1995
[redacted]

Mr. David A. Stilwell
Acting Field Supervisor
U.S. Department of the Interior
Fish and Wildlife Service
3817 Luker Road
Cortland, NY 13045

SUBJECT: U.S. Department of Energy (DOE) West Valley Demonstration Project (WVDP) Endangered Species Act Compliance

REFERENCE: Letter 1550:94:10, D. A. Stilwell to T. J. Rowland, "Federally Listed and Proposed Endangered and Threatened Species in New York," dated September 29, 1994

Dear Mr. Stilwell:

The DOE West Valley Area Office (WVAO) requests information from the Fish and Wildlife Service for the purpose of complying with the Endangered Species Act of 1973, as amended, which requires each federal agency to ensure that any action it authorizes, funds, or carries out does not jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of their critical habitat.

Specifically, please provide a current list of endangered and threatened, or proposed candidate species, and the critical habitats that may be present in the areas of Cattaraugus and Erie counties in New York. The letter cited above included such information in response to a previous request. If there has been no change to this information, please simply indicate that fact.

Enclosed is a portion of the U.S. Geological Survey (USGS) Ashford Hollow Quadrangle map that delineates the specific area of concern. The WVDP is located on approximately 63 hectares within the boundaries of the Western New York Nuclear Service Center (WNYNSC), a 1,335-hectare reserve owned by New York State. The WNYNSC is situated on the southern border of Erie County and the northern border of Cattaraugus County.

If there are any questions, please contact Daniel W. Sullivan of my staff at (716) 942-4016.

Sincerely,

Tom Rowland

T. J. Rowland, Director
West Valley Area Office

Enclosure: Portion of USGS Ashford Hollow Quadrangle Map

cc: S. Smiley, DOE-OH, OSE, Room 327, w/enc.
S. G. Schneider, WVNS, MS Z23, w/enc.
L. M. Coco, Dames & Moore, MS Z05, w/enc.

DWS:007:95 - 0048:95:10

DWS/smn

File

Department of Energy
Idaho Operations Office
West Valley Project Office
P.O. Box 191
West Valley, NY 14171

June 21, 1994

New York State Department of Environmental Conservation
Region 9, Division of Regulatory Affairs
Attention: Regional Permit Administrator
270 Michigan Avenue
Buffalo, NY 14203-2999

Department of the Army
Attention: Chief, Regulatory Branch
Buffalo District, Corps of Engineers
1776 Niagara Street
Buffalo, NY 14207

SUBJECT: West Valley Demonstration Project (WVDP) Wetlands Delineation

REFERENCE: "Final Wetlands Investigation and Delineation of the 550-Acre West Valley Assessment Area," Dames & Moore, dated December 3, 1993

Dear Sir or Madam:

A 550-acre area within the Western New York Nuclear Service Center (WNYNSC) was investigated to identify and delineate Clean Water Act (CWA), Section 404 jurisdictional wetlands and/or wetlands regulated by the New York State Department of Environmental Conservation (NYSDEC). The 550-acre assessment area includes the approximately 200-acre WVDP site. The WVDP is a U. S. Department of Energy (DOE) managed cleanup project located within approximately 3,300 acres of the New York State owned Western New York Nuclear Service Center (WNYNSC).

Wetlands were identified and delineated based on criteria described in the Corps of Engineers Wetlands Delineation Manual, Technical Report Y-87-1, U. S. Army Corps of Engineers Waterway Experiment Station, Vicksburg, Mississippi (Environmental Laboratory, 1987). We have enclosed a copy of the final wetlands delineation report for your review. Your concurrence with the delineation will expedite the siting of future projects associated with timely completion of the WVDP.

If you have any questions or comments, please do not hesitate to contact Elizabeth Matthews of my staff at (716) 942-4930.

Sincerely,

Tom Rowland
T. J. Rowland, Director
West Valley Project Office

Enclosure: Referenced Document

cc: S. G. Schneider, WVNS, MS Z23, w/o enc.
P. L. Piciulo, NYSERDA, w/o enc.

EAM:063:94 - 3038:93:10

EAM/ams

New York State Office of Parks, Recreation and Historic Preservation
Historic Preservation Field Services Bureau
Peebles Island, PO Box 189, Waterford, New York 12188-0189 518-237-8643

[illegible]
Bernadette Castro
Commissioner

June 15, 1995

JUN 1995
RECEIVED
NYSERDA

Paul L. Piciulo, Ph.D.
Program Director
Radioactive Waste Management Program
Department of Energy
P.O. Box 191
West Valley, NY 14171

Dear Dr. Piciulo:

Re: DOE
West Valley Demonstration Project
Ashford, Cattaraugus County
95PR1233

Thank you for requesting the comments of the State Historic Preservation Office (SHPO). We have reviewed the materials submitted in accordance with Section 106 of the National Historic Preservation Act of 1966 and the relevant implementing regulations.

Based upon this review, it is the SHPO's opinion that the West Valley Demonstration Project Site (the site of the former Nuclear Fuels Service Irradiated Fuels Processing Plant) is not eligible for inclusion in the National Register of Historic Places.

When responding, please be sure to refer to the SHPO project review (PR) number noted above. If you have any questions, please feel free to call me at (518) 237-8643 ext. 255.

Sincerely,

Robert D. Kuhn, Ph.D.
Historic Preservation Coordinator
Field Services Bureau

RDK:cm

File / Elizabeth

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
270 Michigan Avenue
Buffalo, NY 14203-2999
(716) 851-7165

Langdon Marsh
Commissioner

August 4, 1994

1994
RECEIVED
DOE-WV

Mr. T. J. Rowland, Director
USDOE - West Valley Project Office
P.O. Box 191
West Valley, New York 14171

Dear Mr. Rowland:

**12/3/93 DAMES & MOORE REPORT
WETLANDS INVESTIGATION
& DELINEATION**

In response to your June 21st transmittal of the above report, Department staff reviewed the information and conducted a July 22nd inspection of the identified wetlands. It was determined that wetlands designated in the report as AI, BA, BD, BE, BF, BG, CA and CD are linked and meet criteria for regulation as a single wetland pursuant to Article 24 of the New York State Environmental Conservation Law and Part 663 of the Regulations (6NYCRR 663).

Consequently, the Department's Division of Fish and Wildlife will include the linked wetland on next available proposed amendment to the official New York State Freshwater Wetlands Map for Cattaraugus County. Once the amended map is promulgated a permit must be obtained from this office prior to conducting certain activities within the wetland and its one hundred foot wide adjacent area.

Additionally, this Department is New York State's designated agency for the issuance of Water Quality Certification under Section 401 of the Federal Water Pollution Control Act (33 USC 1341). Consequently, applications filed pursuant to Section 404 of that Act for work within delineated federally regulated wetlands may require this office's prior issuance under Part 608 of the Regulations (6NYCRR 608) of Water Quality Certification.

Application procedures for both Freshwater Wetlands Permits and Water Quality Certifications are identified in Part 621 of the Regulations (6NYCRR 621). Please note that recent changes have now eliminated application fees.

32204
3038:93:10

If you have any questions concerning matters discussed in this letter or in the attached copies of law and regulation, please do not hesitate to contact me at the above number.

Respectfully,

Paul D. Eismann
Deputy Permit Administrator
Division of Regulatory Affairs

PDE/dz

Enclosure

cc: Mr. Michael Ermer - Region 9 Division of Fish & Wildlife w/r
Mr. John Krajewski - Region 9 Division of Hazardous Substances Regulation
~~Ms. Elizabeth Matthews - US Department of Energy, WVPO~~
Mr. Paul Piciulo - NYS Energy Research and Development Authority w/enc.

The New York State Office of Parks,
Recreation and Historic Preservation
Field Services Bureau
Post Office Box 189, Peebles Island
Waterford, New York 12188-0189

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No Postage Required

File Elizabeth

T. J. Rowland, Director, West Vally Project Office
Department of Energy, Idaho Operations Office
P.O. Box 191
West Valley, New York 14171

DOE MODIFICATIONS TO BUILDING 01-14
Agency/Project Name

ASHFORD, CATTARAUGUS COUNTY	MARCH 4, 1994	94PR0487
Township/County	*Date*	*OPRHP Project Review Number*

Dear Mr. Rowland,

The New York State Historic Preservation Officer (SHPO) has reviewed the materials you submitted in accordance with the relevant implementing regulations. Based upon this review, it is the opinion of the SHPO your project will have no effect/impact on those characteristics of the property which would qualify it for inclusion in the State and National Registers of Historic Places.

This notification certifies your compliance with the Federal §106 and/or State §14.09 Preservation Laws. This card should be retained in your files to demonstrate compliance with these laws at any future date. If you need any additional information regarding this project, please contact the Project Review Unit of the Field Services Bureau at 518/237-8643. Please cite the above-referenced OPRHP Project Review Number on any future inquiries.

Sincerely,

Julia S. Stokes

Julia S. Stokes
Deputy Commissioner for Historic Preservation

29785

0455:94:11

File

Department of Energy
Idaho Operations Office
West Valley Project Office
P.O. Box 191
West Valley, NY 14171

March 28, 1994

W. G. Poulson, President
and General Manager
West Valley Nuclear Services Co., Inc.
P. O. Box 191
West Valley, NY 14171

ATTENTION: S. G. Schneider, Environmental Affairs Manager, MS Z23
S. J. Szalinski, Environmental Planning and Assessment Manager, MS B1L

SUBJECT: Response from the New York State Historical Preservation Officer (SHPO) to Request for Determination of No Adverse Effect

REFERENCES: Letter EAM:048:94 - 0455:94:11, B. A. Mazurowski to S. G. Schneider and S. J. Szalinski, "Response to Request for Determination of No Adverse Effect for Modifications to Building 01-14," dated March 16, 1994

Record of Telephone Conversation Between Elizabeth Matthews (DOE) and Elizabeth Johnson (SHPO), dated March 21, 1994

Dear Sir:

The referenced Record of Telephone Conversation (enclosed) clarifies that the response provided to our Request for Determination of No Adverse Effect applies to the Cooling Tower replacement project, as well as the proposed modifications to Building 01-14. Per that response (transmitted to you in the referenced letter), the SHPO has determined that neither project will impact the characteristics of the site which may qualify it for listing on the State and National Registers of Historic Places, and therefore they may proceed. Elizabeth Matthews may be contacted on Extension 4930 if you have questions.

Sincerely,

Tom Rowland
for B. A. Mazurowski, Deputy Director
West Valley Project Office

Enclosure: Record of Telephone Conversation

EAM:056:94 - 0455:94:11
0227:94:01

EAM/jam

RECORD OF TELEPHONE CONVERSATION

DATE: March 21, 1994 EAM 3/21/94

PARTICIPANTS: Elizabeth Matthews (DOE-WVPO) with Elizabeth Johnson (Representative of the New York State Historical Preservation Officer - SHPO)

SUBJECT: Request for Determination of No Adverse Effect for Modifications to Building 01-14 and the Cooling Tower Replacement at the West Valley Demonstration Project (WVDP), (letter EAM:018:94 - 0227:94:01, dated March 3, 1994)

REFERENCE: Letter 0455:94:11, J. S. Stokes to T. J. Rowland, "DOE Modifications to Building 01-14," dated March 4, 1994

Ms. Johnson returned my call. I indicated that we had received the referenced letter, but were unsure whether it applied to both projects (Building 01-14 and the Cooling Tower) for which we had submitted a Request for Determination of No Adverse Effect on March 3, 1994. She said that the response applied to the entire package and that we could proceed with both projects. I thanked her for the rapid turnaround.

DISTRIBUTION:

B. A. Mazurowski, DOE-WVPO
W. H. Hunt, DOE-WVPO
D. C. Cook, DOE-WVPO
D. W. Sullivan, DOE-WVPO
S. G. Schneider, WVNS, MS-Z23
L. C. Salvatori, WVNS, MS-B1L
P. J. Bembia, NYSERDA

file

Department of Energy
Idaho Operations Office
West Valley Project Office
P.O. Box 191
West Valley, NY 14171

March 3, 1994

Elizabeth Johnson
Program Assistant
Field Services Bureau
Division of Historic Preservation
New York State Historic Preservation Office
P.O. Box 189
Peebles Island
Waterford, NY 12188-0189

SUBJECT: Request for a Determination of No Adverse Effect for Modifications to Building 01-14 and the Cooling Tower Replacement at the West Valley Demonstration Project (WVDP)

Dear Ms. Johnson:

The U. S. Department of Energy has responsibility for demonstrating solidification of high-level radioactive waste left behind by the former Nuclear Fuels Service reprocessing facility in Ashford Township, Cattaraugus County, New York, in accordance with P. L. 96-368, the West Valley Demonstration Project Act, signed by the President of the United States in 1980. While this facility and the reservation on which it is located is the property of the State of New York, the Department of Energy must comply with the provisions of the Act. By agreement with the State, DOE has committed to the use of existing facilities to the extent technically feasible.

Under the provisions of the WVDP Act, the Department of Energy has selected vitrification as the solidification process, and, as contemplated by Congress in passing the WVDP Act, since 1982 has been decontaminating and modifying portions of the existing plant, and adding new facilities to accomplish the objective. In accordance with plans established as early as 1984, facility modifications have been designed and installed, and pretreatment systems have already processed 15 million curies of radioactive waste. Certain additional modifications are necessary to complete the objectives to safely process the liquid waste.

Although portions of the process plant are highly contaminated with radioactivity and have undergone modifications since it last operated in 1972, and the facility is less than 50 years old, the Department of Energy is preparing a determination of eligibility for listing on the National Register that will be submitted in the near future for your review and determination.

Irrespective of eligibility, we believe that the two subject modifications involve minor elements of the center and that their alteration or removal will have no adverse effect on the potential historic character of the nuclear fuels reprocessing center. Because of the urgent need to proceed with the Demonstration Project's work, we are requesting consideration of the application in advance of the determination of eligibility.

The planned modifications consider the removal and replacement in kind of the cooling tower. This resource might be a contributing element of the reprocessing center. The modifications also involve some alterations to the fabric and some new machinery in Building 01-14. This is a relatively new building that was constructed as part of an expansion plan for the nuclear fuels reprocessing center and was never operated as part of the commercial venture. Therefore, this resource is, most likely, not an element contributing to any potential historic character of the reprocessing center.

The enclosed documentation will provide you with a description of the past use of the nuclear fuels reprocessing center, a description of the currently planned modifications, and a description regarding the relationship of Building 01-14 and the cooling tower to the reprocessing facility.

In order to make your review go as smoothly as possible, as well as ensure that we remain on schedule to provide a demonstration of solidification of high-level radioactive waste, we would be happy to visit your offices at your convenience to provide you with any additional information or answer any questions you may have regarding the enclosed. Please contact Elizabeth Matthews of my staff at (716) 942-4930, if you have any questions or would like to schedule such a meeting.

Sincerely,

Barbara A. Mazurowski
for T. J. Rowland, Director
West Valley Project Office

Enclosure: Documentation Supporting Request for Determination of No Adverse Effect

cc: P. L. Piciulo, New York State Energy Research and Development Authority, w/enc.
J. L. Little, West Valley Nuclear Services Co., Inc., MS 07, w/enc.
J. J. Volpe, West Valley Nuclear Services Co., Inc., MS 41A, w/enc.

EAM:018:~~94~~ 0227:94:01

EAM/smn

FINAL

WETLANDS INVESTIGATION AND DELINEATION OF THE 550-ACRE WEST VALLEY ASSESSMENT AREA

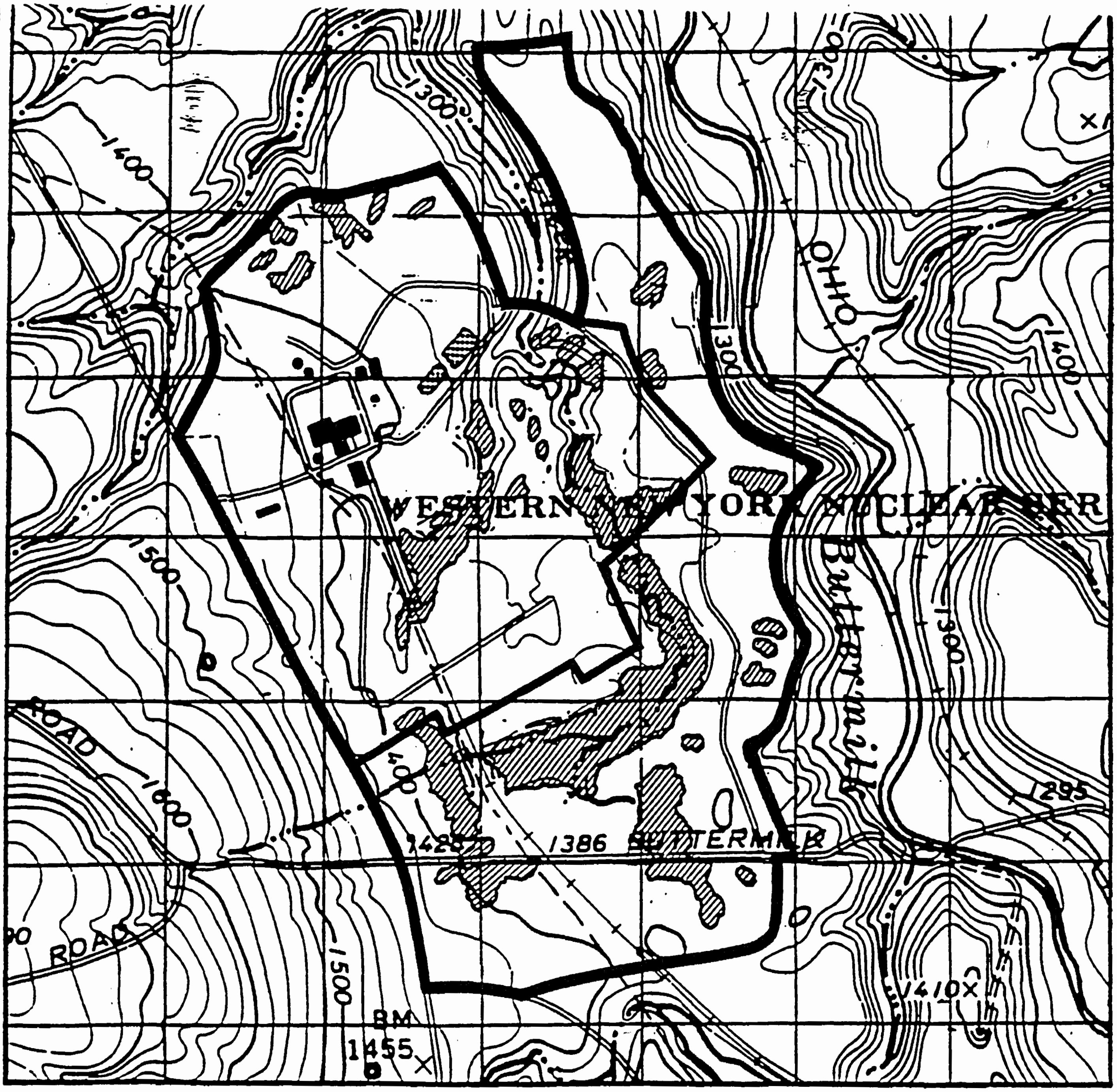
SUMMARY OF WETLANDS INVESTIGATION

A field investigation was performed during May and August, 1993 to identify and delineate Clean Water Act, Section 404, jurisdictional wetlands, and/or those that may be regulated by the State of New York within a portion of the Western New York Nuclear Service Center (WNYNSC), including all of the U.S. Department of Energy (DOE) West Valley Demonstration Project (WVDP). The location of the assessment area is shown in Figure 1. The wetland investigation was limited to an 220-ha (550-acre) assessment area that includes the Project Premises and adjacent parcels north, south, and east of the Project Premises boundary. The selected assessment area included areas for which WVDP completion activities are ongoing or may be needed. Examples include installing or repairing water lines from the north and south reservoirs and extending electrical power to the live firearms range. The assessment area is located in Ashford township, in the northern part of Cattaraugus County, New York. The town of Springville in Erie County, approximately 6.4 km (4 mi) northwest of the assessment area, is the closest population center (see Figure 1). The closest metropolitan area is Buffalo, New York, located 48 km (30 mi) north of the assessment area.

Clean Water Act, Section 404 jurisdictional wetlands are defined as those areas satisfying the technical criteria found in the *Corps of Engineers Wetlands Delineation Manual*, Technical Report Y-87-1, U.S. Army Corps of Engineers Waterway Experiment Station, Vicksburg, Mississippi (Environmental Laboratory, 1987), which is referred to as the 1987 Manual. Wetlands were identified and delineated through assessment of three ecological parameters: hydrophytic vegetation, hydric soils, and wetland hydrology. Assessment of these parameters was conducted through application of methods similar to "routine" level methods described in the 1987 Manual.

Fifty-one areas within the assessment area satisfied the three mandatory wetland criteria and were identified and delineated as jurisdictional wetlands. Delineated wetland areas ranged in size from several hundred square feet to over 4 ha (9.2 acres). Total wetland area, as field surveyed and planimetered, is approximately 14 ha (35 acres). Figure 1 shows the approximate location of delineated wetlands on the USGS 7 1/2 minute Ashford Hollow, New York quadrangle. Figure 2 shows the surveyed wetland features at a more detailed scale.

The survey results are reported in, *Final Wetlands Investigation and Delineation of the 550-Acre West Valley Assessment Area*, Dames & Moore, 1993.



SOURCE: U.S.G.S. 7.5 Minute Series Topographic
Ashford Hollow, NY 1979

LEGEND:

- APPROXIMATE WETLANDS LOCATIONS
- APPROXIMATE ASSESSMENT BOUNDARY
- FACILITY COMPOUND BOUNDARY

0 1000 Ft.

SCALE

Figure 1
WEST VALLEY SITE
FACILITY COMPOUND AND
PROPOSED DEVELOPMENT AREA
APPROXIMATE LOCATIONS OF MAJOR WETLANDS

Dames & Moore

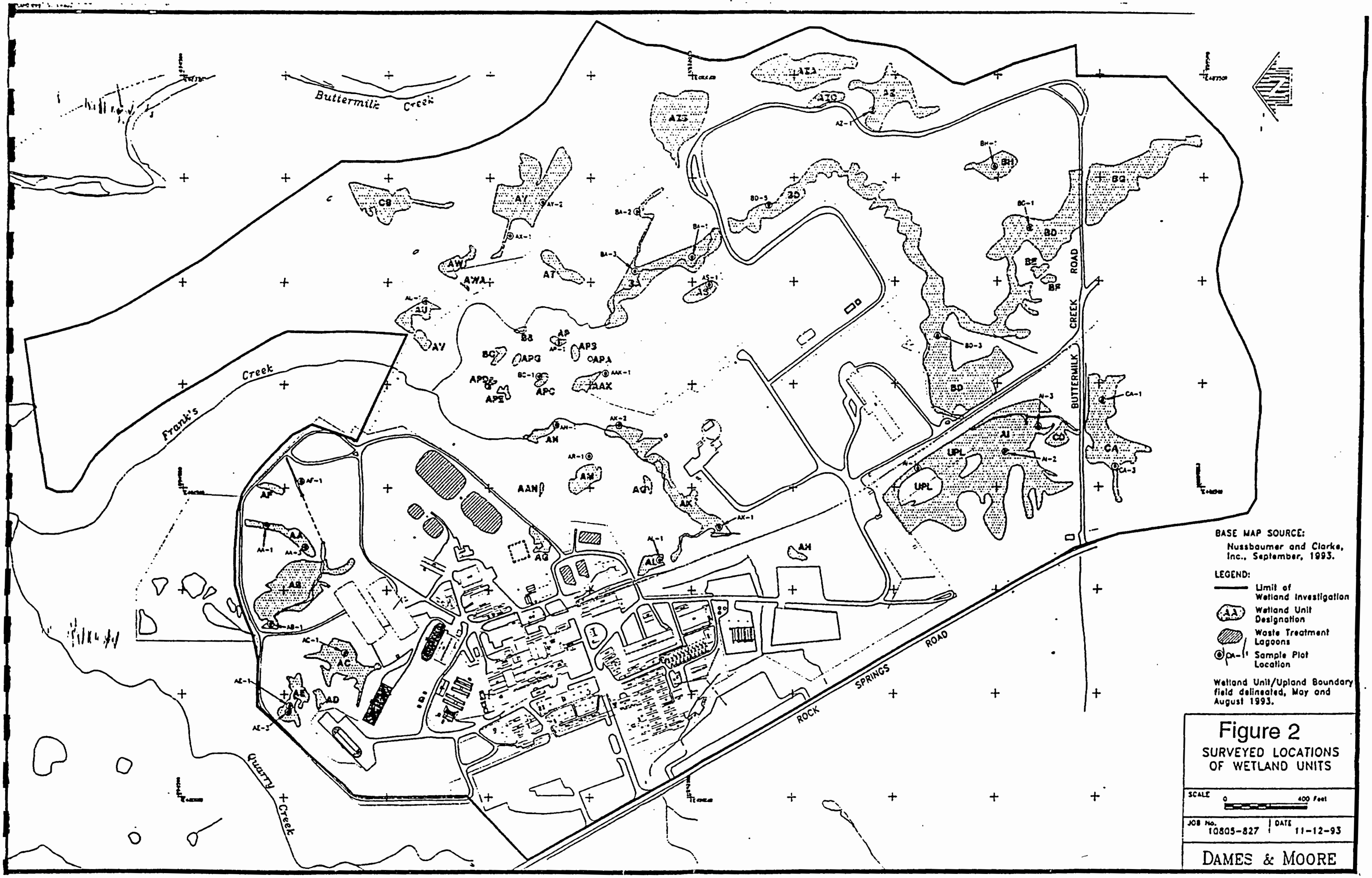


Figure 2
SURVEYED LOCATIONS OF WETLAND UNITS