3.0 FACILITY DESCRIPTION

PURPOSE OF THIS SECTION

The purpose of this section is to describe the facility and its environs. This information provides a foundation for understanding the rest of the plan. Section 3 is also intended to provide information to allow NRC staff to evaluate DOE's estimation of (1) the impacts of the decommissioning activities on the site and its surrounding areas, and (2) the impacts of the environment on the site in the event of natural phenomena such as floods, tornados, and earthquakes.

INFORMATION IN THIS SECTION

This section begins with the location and description of the site, including subsurface conditions. Facilities associated with the WVDP are addressed, including those that existed in 2008 and are to be removed before activities under this plan begin. As with other sections of the plan, these facilities are organized by waste management area (WMA), with the focus on facilities located on the project premises.

The following matters are also addressed: (1) population distribution, (2) current land use and plans for future land use, (3) meteorology and climatology, (4) geology and seismology, (5) surface water hydrology, (6) groundwater hydrology, and (7) natural resources in the area.

All figures referred to in the text, which include photographs, are grouped at the end of the section.

RELATIONSHIP TO OTHER PLAN SECTIONS

To put into perspective the information in this section, one must consider the information in Section 1 on the project background and those facilities and areas within the scope of the Phase 1 decommissioning. Consideration of the information in Section 2 on site history, processes, and spills will also help place information in Section 3 into context. The information in this section serves as the foundation for later sections, such as radiological status in Section 4, the dose modeling in Section 5, and the decommissioning activities in Section 7.

3.1 Site Location and Description

3.1.1 Site Location

The WVDP is located about 30 miles south of Buffalo, in the Town of Ashford, Cattaraugus County, New York at approximately 42.450° north latitude and 78.654° west longitude. The site location with respect to major natural and man-made features in the region is shown in Figure 3-1.

The facility (i.e., the project premises) lies 2.4 miles southeast of Cattaraugus Creek at its nearest approach. Cattaraugus Creek forms the boundary between Cattaraugus and Erie counties. Buttermilk Creek, a tributary to Cattaraugus Creek, is 0.5 mile east of the project premises. Lake Erie lies approximately 30 miles west.

3.1.2 Site Description

The WVDP site consists of approximately 167 acres within the 3,345-acre Center. Figure 3-2 delineates the boundaries of the Center and the WVDP. The brief description here focuses on the Center, the WVDP, subsurface conditions on the site, and site groundwater.

The Center

The Center is located within the glaciated northern portion of the Appalachian Plateau Province of Western New York which is characterized by deep valleys which dissect rather flat-topped plateaus and range in elevation from 1,100 to 1,850 feet above mean sea level (Figure 3-3). The average elevation across the Center is 1,300 feet above mean sea level.

Slopes range from less than five percent to greater than 25 percent, with five to 15 percent slopes predominant. The Center is drained by Buttermilk Creek, which flows into Cattaraugus Creek.

Prior to 1961, much of the Center was cleared for agriculture. As a result, the Center now consists of a mixture of abandoned agricultural areas in various stages of ecological succession, forested tracts, and wetlands, along with transitional ecotones between these areas. The area of the WVDP would be classified as an industrial land use.

The WVDP Site

The WVDP lies on a plateau that ranges in elevation from 1,300 to 1,445 feet above mean sea level, 1929 datum. The plateau margins are defined by Franks Creek, Erdman Brook, and Quarry Creek which drain the WVDP and empty into Buttermilk Creek. This plateau is subdivided by Erdman Brook into the north plateau and south plateau areas. The topography on and around the WVDP site is shown on Figure 3-4.

A posted, barbed-wire fence surrounds the Center. An inner, eight feet high chain-link fence surrounds the WVDP site, with access controlled through one gate. The inner fence defining the WVDP boundary, i.e., the project premises, is shown in Figure 3-5.

Most major activities related to the WVDP, including all involving radioactivity, are performed within the WVDP site boundary. Although the State-Licensed Disposal Area

(SDA) is located within the WVDP security fence, as shown in Figure 3-5, it is not considered part of the project premises.

Subsurface Conditions and Groundwater

The subsurface conditions underlying the north plateau are different from the subsurface conditions underlying the south plateau, as shown in Figures 3-6 and 3-7. The thickness of the unsaturated zone in the weathered till on the south plateau fluctuates annually, averaging approximately 10 feet below ground surface. Groundwater flow in the weathered Lavery till on the south plateau is generally controlled by surface topography and flow is eastward (WVNSCO 1995).

More detailed information on subsurface conditions and groundwater can be found below in Sections 3.5, 3.6, and 3.7.

3.1.3 Facility Description

The following descriptions focus on the WVDP facilities as they are expected to appear at the conclusion of the interim end state in 2011. The facilities to be removed before 2011 are also briefly described.

Major Facilities

The principal facilities at the site include the former irradiated nuclear fuel reprocessing facility, known as the Main Plant Process Building; the Waste Tank Farm; and the Low-Level Waste Treatment Facility. These facilities are located on the north plateau. The two radioactive waste burial areas, the NRC-Licensed Disposal Area (NDA) and the SDA, are located on the south plateau. Figure 3-8 shows the locations of these facilities.

Waste Management Areas

For administrative purposes, the Center has been divided into 12 WMAs as listed below. The locations of WMA 1 through WMA 10 are shown in Figure 3-8. WMAs 11 and 12 are shown in Figure 3-9.

- WMA 1 Main Plant Process Building and Vitrification Facility area,
- WMA 2 Low Level Waste Treatment Facility area,
- WMA 3 Waste Tank Farm area,
- WMA 4 Construction and Demolition Debris Landfill,
- WMA 5 Waste Storage Area,
- WMA 6 Central Project Premises,
- WMA 7 NDA and associated facilities,
- WMA 8 SDA and associated facilities,
- WMA 9 Radwaste Treatment System Drum Cell Area,
- WMA 10 Support and Services Area,

- WMA 11 Bulk Storage Warehouse and Hydrofracture Test Well Area, and
- WMA 12 Balance of the Site.

Project Premises Facilities Removed Before Decommissioning Activities Begin

WMA 1

Cold Chemical Facility

Contact Size Reduction Facility

Emergency Vehicle Shelter

Laundry Room

Master-Slave Manipulator Repair Shop

Radwaste Process (Hittman) Building

Recirculation Ventilation System Building

WMA 2

O2 Building

Test and Storage Building

Maintenance Shop

Maintenance Storage Area

Vehicle Repair Shop

Vitrification Test Facility

WMA 5

Chemical Process Cell Waste Storage Area

Lag Storage Building

Lag Storage Addition 1

WMA 5 (continued)

Lag Storage Addition 2

Lag Storage Addition 3

Hazardous Waste Storage Lockers

WMA 6

Old Warehouse

Old Sewage Treatment Facility

New Cooling Tower (except basin)

North Waste Tank Farm Training Platform

Road-Salt and Sand Shed

WMA 7

Interim Waste Storage Facility

NDA Hardstand

WMA 10

Administration Building

Expanded (Environmental) Laboratory

Fabrication Shop

Vitrification Diesel Fuel Oil Building

WMA 1: Main Plant Process Building and Vitrification Facility Area

Figure 3-10 shows the layout of WMA 1. Figure 3-11 is an aerial photograph of the Main Plant Process Building and Vitrification Facility area. A description of each facility in WMA 1 follows:

WMA 1 facilities within the scope of this plan are:

- Main Plant Process Building;
- Vitrification Facility;
- Load-In/Load-Out Facility;
- Utility Room and Utility Room Expansion;
- Fire Pumphouse and Water Storage Tank;

- Plant Office Building;
- Electrical Substation;
- 01-14 Building;
- Vitrification Off-Gas Trench;
- Source Area of the North Plateau Plume; and
- Concrete Floor Slabs for the Laundry Room, Fuel Receiving and Storage Ventilation Building, Radwaste Process Building, Cold Chemical Facility, and other removed facilities.

Main Plant Process Building. The Main Plant Process Building (Process Building) was built between 1963 and 1966, and was used by Nuclear Fuel Services (NFS) from 1966 to 1971 to recover uranium and plutonium from spent nuclear fuel. This multi-storied building is approximately 130 feet wide and 270 feet long, and rises approximately 79 feet above the ground surface at its highest point. Figures 3-12 through 3-21 show the building exterior, interior layouts, and representative areas.

The major Process Building structure rests on approximately 480 driven steel H-piles. The building is composed of a series of cells, aisles, and rooms that are constructed of reinforced concrete and concrete block. The reinforced concrete walls, floors and ceilings range from one to six feet thick. The reinforced concrete walls are typically surrounded by walls of lighter concrete and masonry construction and metal deck flooring. Six floor layout plans of different levels of the Process Building appear in Figures 3-13A through 3-13F.

Most of the facility was constructed above grade, with some of the cells extending below ground (i.e., below the ground surface reference elevation of 100 feet). The deepest cell, the General Purpose Cell, extends approximately 27 feet below-grade. The Cask Unloading Pool and the Fuel Storage Pool, located in the Fuel Receiving and Storage Area on the east side of the building, were used to receive and store spent fuel received for reprocessing, and extend approximately 49 and 34 feet below grade, respectively.

Cells such as the Process Mechanical Cell, the Chemical Process Cell, and Extraction Cells 1, 2, and 3 were constructed of reinforced high-density concrete three to five feet thick. Such thicknesses were needed to provide radiation shielding.

The operations performed in the cells were remotely controlled by individuals working in the various aisles of the Process Building, which were formed by adjacent walls of the cells. The aisles contained the manipulator controls and valves needed to support operations in the cells. Rooms not expected to contain radioactivity were typically constructed with concrete block and structural steel framing.

Wastewater generated during reprocessing was managed in one of two ways, depending on activity. High-level waste was transferred from the Process Building to the Waste Tank Farm via two underground transfer lines (7P-113 and 7P-120) to Tank 8D-2 and Tank 8D-4. Low-level wastewater was transferred to the Low Level Waste Treatment Facility via below-grade transfer lines associated with the interceptor system.

The WVDP modified portions of the Process Building to support its primary mission of solidifying HLW. Equipment in the Chemical Process Cell was removed to allow its use for storage of canisters of vitrified HLW. Extraction Cell 3 and the Product Purification Cell were emptied of equipment which was replaced with equipment used to support the Liquid Waste Treatment System. This system was used to manage supernatant and sludge wash solutions from Tank 8D-2 which contained HLW.

Vitrification Facility. Shown in Figures 3-22 and 3-23, this structural steel frame and sheet metal building houses the Vitrification Cell, operating aisles, and a control room. The Vitrification Cell is 34 feet wide, 65 feet long and 42 feet high. Figure 3-23 shows how it looked when it went into service.

At the north end of the Vitrification Cell is the melter pit. The pit is 34 feet wide by 25 feet long with its bottom about 14 feet below grade. The Vitrification Cell is lined with 0.125-inch-thick stainless steel up to 22 feet above grade.

As explained in Section 2, HLW transferred from HLW Tank 8D-2 was mixed with glass formers and vitrified into borosilicate glass within the Vitrification Cell. Vitrification operations were performed remotely by operators in the operating aisles or in the control room. The Vitrification Cell contained the Concentrator Feed Makeup Tank, Melter Feed Hold Tank, the slurry-fed ceramic melter, turntable, off-gas treatment equipment, canister welding station, and the canister decontamination station. All equipment was removed from the Vitrification Cell during the deactivation of this facility in 2003 and 2004.

Load-In/Load-Out Facility. The Load-In/Load-Out Facility is located adjacent to the west wall of the Equipment Decontamination Room of the Process Building in WMA 1. It is a structural steel and steel sided building that is approximately 80 feet long, 55 feet wide, and 54 feet tall. The floor is poured concrete, and the roof is metal sheeting with insulation.

This facility was used to move empty canisters and equipment into and out of the Vitrification Cell. It has a truck bay and a 15-ton overhead crane that is used to move canisters and equipment. After the new Canister Storage Facility is constructed, the Load-In/Load-Out facility will be used to transfer the vitrified HLW canisters from the Process Building to that facility.

Utility Room and Utility Room Expansion. The Utility Room and the Utility Room Expansion can be seen in Figures 3-10 and 3-11. The Utility Room is a concrete block and steel framed building located on the south end of the Process Building. It consists of two adjoining buildings that were built at different times, the original Utility Room and the Utility Room Expansion.

The original Utility Room, which was built during the construction of the Process Building, makes up the western portion of the facility and is 80 feet wide, 88 feet long, and

20 feet high. It contains equipment that supplies steam, compressed air, and various types of water to the Process Building.

The Utility Room Expansion was built in the early 1990s immediately adjacent to the original Utility Room. The Utility Room Expansion is approximately 85 feet long, 56 feet wide, and 25 feet high. It contains equipment similar to that in the Utility Room.

***Fire Pump House and Water Storage Tank**.* The Fire Pump House was constructed in 1963 and is 20 feet wide, 24 feet long, and 10 feet high at the peak. The structure is of steel frame and sheet metal construction on a four-inch concrete slab floor, which is supported on a concrete foundation wall. Its location is shown in Figure 3-10.

The Pump House contains two pumps on concrete foundations. An adjacent small metal storage shed is used to store fire hoses and fire extinguishers. The 475,800-gallon water storage tank (Tank 32D-1) is located outside the Utility Room, as shown in Figure 3-11.

***Plant Office Building**.* The Plant Office Building is a three-story concrete block and structural steel framed structure located adjacent to the west side of the Process Building. It is approximately 40 feet wide, 95 feet long, and 44 feet high and contains offices and men's and women's locker rooms. Figures 3-11 and 3-14 show the building.

***Electrical Substation**.* The electrical substation is located adjacent to the southeast corner of the Process Building. A 34.5 kilovolt/480 volt transformer rests on a concrete foundation behind a steel framed structure. Its location is shown in Figure 3-10.

***01-14 Building**.* The 01-14 Building is a four-story, 64 feet tall concrete and steel frame building located next to the southwest corner of the Process Building, as shown in Figures 3-10 and 3-11. This building was built in 1971 to house an NFS off-gas system and acid recovery system, but it was never used to support NFS operations. The 01-14 Building was modified to house the Vitrification Off-Gas System and the Cement Solidification System.

The off-gas system was used to treat off-gases generated in the melter in the Vitrification Facility. The Cement Solidification System was used to stabilize radioactive waste generated from the Liquid Waste Treatment System in a cement matrix and to package this mixture in drums that were stored in the Radwaste Treatment System Drum Cell in WMA 9.

***Laundry Room**.* The Laundry Room is located southeast of the Utility Room as shown in Figure 3-10. It is a concrete block structure 26 feet by 56 feet by 20 feet high with metal decking and asphalt roofing. The floor is a concrete slab six inches thick, which contains a sump.

The Laundry Room contains a commercial size washer and dryer, along with sorting tables and racks for laundering contaminated protective clothing. It is separated into a radiologically “hot” side and a “clean” side. It will be removed down to its concrete floor slab at grade before the start of Phase 1 decommissioning activities.

***Cold Chemical Facility Slab**.* The Cold Chemical Facility was a structural steel frame and sheet metal building that was approximately 34 feet wide, 57 feet long, and 36 feet tall. It was located immediately west of, and adjacent to, the Vitrification Facility, as shown in Figure 3-27. It was used to prepare non-radioactive feed materials, such as nitric acid and glass formers, which were used in the vitrification process. The Cold Chemical Facility was demolished to its concrete floor slab at grade in November 2006.

***Fuel Receiving and Storage Ventilation Building Slab**.* This steel-framed and sheet metal sided structure was located adjacent to the Radwaste Process Building. It was 30 feet by 35 feet by 12.2 feet high and rested on a six-inch-thick concrete slab. It contained equipment that provided the majority of the heating, ventilation, and air conditioning systems for the Fuel Receiving and Storage Building. It was removed down to its concrete floor slab at grade in October 2006.

***Radwaste Process Building Slab**.* This 15 feet wide by 46 feet long by 12 feet high steel structure, also known as the Hittman Building, was located north of the Fuel Receiving and Storage Building. It was used to manage shielded casks for high-integrity containers used to store loaded resins from the Fuel Pool Submerged Water Filtration System. This building was removed down to its concrete floor slab at grade in October 2006.

WMA 2: Low-Level Waste Treatment Facility Area

WMA 2, the Low Level Waste Treatment Facility area as it existed in 2008 is shown in Figure 3-24. Figure 3-25 shows the area before the advent of the WVDP.

This facility was used by NFS and then by the WVDP to process low-level radioactive wastewater generated on-site. The current Low Level Waste Treatment Facility includes the Neutralization Pit, interceptors, Lagoons 2-5, and the LLW2 Building. It is expected to still be in use when Phase 1 decommissioning activities begin.

WMA 2 facilities within the scope of this plan are:

- The LLW2 Building;
- Closed Lagoon 1;
- Active lagoons 2, 3, 4, and 5;
- The two New Interceptors;
- The Old Interceptor;
- The Neutralization Pit;
- The Maintenance Shop Leach Field;
- The Solvent Dike; and
- Concrete floor slabs such as those for the 02 Building, Maintenance Shop, Test and Storage Building, and Vitrification Test Facility.

A description of the WMA 2 facilities follows:

The LLW2 Building. Located southwest of Lagoon 4, this pre-engineered, single-story, metal-sided building rests on a concrete wall foundation, measuring 40 feet by 60 feet. The building houses two skid-mounted process equipment modules that are used to treat wastewater from WMA 1, WMA 3, and radiologically contaminated groundwater from the WMA 7 NDA Interceptor Trench and the north plateau groundwater plume. Figure 3-26 shows the building. The LLW2 Building was built in 1998 to replace the 02 Building, the original low-level wastewater treatment facility that was built by NFS in 1971.

The building is divided into three work areas and an office. The processing area contains the process modules (including ion exchangers, valves, piping, pumps, filters, instrumentation, and controllers), two surge tanks, and a sand filter. The packaging room contains a four feet by four feet by nine-feet-deep stainless steel lined catch basin. A portable ventilation unit located outside of the packaging area contains a high-efficiency particulate air (HEPA) filter and a short stack on the roof of the building.

Lagoon 1. Lagoon 1 was an unlined pit excavated into the sand and gravel unit that was approximately 80 feet long on each side and 5 feet deep. It was fed directly from the Old Interceptor and the New Interceptors, and had a storage capacity of more than 200,000 gallons. As explained in Section 2, it was removed from service in 1984. Most of the contaminated sediment was transferred to Lagoon 2 and Lagoon 1 was filled with contaminated debris from the NFS hardstand and then capped with clay and topsoil.

Figure 3-27 shows the area of Lagoon 1. Section 2.4.1 discusses the radioactivity in the closed lagoon.

Lagoon 2. Lagoon 2 is an unlined 17-foot deep basin excavated in the unweathered Lavery till. This lagoon has a storage capacity of 2.4 million gallons and is used to store wastewater discharged from the New Interceptors before its transfer to the LLW2 for treatment.

From 1965 to 1971, before the installation of the Low Level Waste Treatment Facility system – which initially consisted of the O2 Building and Lagoons 4 and 5 – wastewater was routed through Lagoons 1, 2, and 3 in series before discharge to Erdman Brook. Between 1971 and 1982, low-level wastewater was routed sequentially through Lagoon 1, Lagoon 2, and the O2 Building for treatment, then to Lagoons 4 or 5, and finally to Lagoon 3 before discharge to Erdman Brook. From 1982 following the closure of Lagoon 1 to the present, low-level wastewater has been routed sequentially through Lagoon 2, the O2 Building or LLW2 for treatment, Lagoons 4 or 5, and then to Lagoon 3 before discharge to Erdman Brook.

A French drain was installed on the northwest sides of Lagoons 2 and 3 and the northeast side of Lagoon 3 to prevent groundwater from flowing into Lagoons 2 and 3. The French drain was capped in 2001 and no longer discharges into Erdman Brook.

Lagoon 3. Lagoon 3 is a 24-foot deep unlined basin excavated in the unweathered Lavery till. It has a storage capacity of 3.3 million gallons. Lagoon 3 receives treated water from Lagoons 4 and 5. Lagoon 3 is periodically batch discharged to Erdman Brook through a State Pollutant Discharge Elimination System (SPDES) permitted discharge.

Lagoon 4. Lagoon 4 is a basin constructed in the sand and gravel unit on the North Plateau with a capacity of 204,000 gallons. It receives only treated water from LLW2 and discharges to Lagoon 3.

Lagoon 4 was originally excavated into the sand and gravel unit on the North Plateau and lined with reworked glacial tills. In 1974 a synthetic membrane liner was installed after NFS identified that Lagoons 4 and 5 were potential sources of tritium to groundwater in the sand and gravel unit (WVNSCO 1997). In the late 1990's, the synthetic membrane liners were removed and replaced with concrete grout and a XR-5 liner, an ethylene inter-polymer alloy membrane.

Lagoon 5. Lagoon 5 is a basin constructed in the sand and gravel unit on the North Plateau with a capacity of 166,000 gallons. It receives only treated water from the LLW2 facility and discharges to Lagoon 3.

Lagoon 5 was originally excavated into the sand and gravel unit on the north plateau and lined with reworked glacial tills. In 1974 a synthetic membrane liner was installed after NFS identified that Lagoons 4 and 5 were potential sources of tritium to groundwater in the sand and gravel unit (WVNSCO 1997). In the late 1990's, the synthetic membrane liners were removed and replaced with concrete grout and a XR-5 liner, an ethylene inter-polymer alloy membrane.

Neutralization Pit. The Neutralization Pit is a nine feet by seven feet by 5.5 feet deep concrete tank constructed with six-inch thick concrete walls and floor that are lined with stainless steel. The pit receives low-level radioactive wastewater from WVDP process areas. This liquid is subsequently transferred to the interceptors.

Old Interceptor. The Old Interceptor is a 40 feet by 25 feet by 11.5 feet deep unlined concrete liquid waste storage tank located below-grade. The floor is 24-inches thick and the walls 12 inches thick[1]. The roof is made of steel.

The Old Interceptor received low-level liquid waste generated at the Process Building from the time of initial plant operation until the new interceptors were constructed. The Old Interceptor is currently used for temporarily storing radiologically contaminated liquids that exceed the effluent standard of 0.005 µCi/mL gross beta activity. After verification of acceptable radiological contamination concentrations, the contents are transferred by steam jet to the New Interceptors.

[1] The floor of the Old Interceptor was initially 12 inches thick. An additional 12 inches of concrete was poured on the floor during NSF operations to provide radiation shielding.

New Interceptors. The New Interceptors are twin open-top concrete storage tanks, each 22 feet by 20 feet by 11.5 feet deep, located below grade. The walls and floor are 14 inches thick, and are lined with stainless steel. The roof is steel. The New Interceptors were built in 1967 to replace the Old Interceptor, which had high levels of radioactivity (WVNSCO 1997). The New Interceptors are used to collect and sample wastewater before it is transferred to Lagoon 2.

Solvent Dike. The Solvent Dike is located about 300 feet east of the Process Building. It was an 30 foot by 30 foot unlined basin excavated in the sand and gravel layer. The Solvent Dike received rainwater runoff from the Solvent Storage Terrace, which formerly housed an acid storage tank and three storage tanks containing a mixture of used n-dodecane and tributyl phosphate. The sediment has been removed and the area has been backfilled, but the Solvent Dike still contains radiologically contaminated soil.

Maintenance Shop Leach Field. The Maintenance Shop Leach Field is located just northeast of where the Maintenance Shop stood and consists of three septic tanks, a distribution box, a tile drain field, and associated piping. The leach field, which occupies an area of approximately 1,500 square feet, was used until1988; all three tanks are out of service and filled with sand. Because it is located within the area of the north plateau groundwater plume, low levels of contamination may be present.

Groundwater Pump and Treat System. Installed in 1995, this system is located in the northwest corner of WMA 2 and draws water from two recovery wells at the western lobe of the north plateau groundwater plume, which is discussed in Section 2 and in Section 4.2. Groundwater is pumped to the Low Level Waste Treatment Facility for treatment by ion exchange to remove Sr-90 contaminants. The treated groundwater is pumped to Lagoon 4 or Lagoon 5, and then to Lagoon 3, and, eventually, discharged into Erdman Brook through the permitted outfall.

Pilot Scale Permeable Treatment Wall. Installed in 1999 and located northwest of Lagoon 5, this treatment wall is about 30 feet wide, seven feet thick, and 25 feet deep, extending down to the Lavery till. It is filled with clinoptilolite, a natural zeolite material, and covered with soil. Its purpose was to evaluate the effectiveness of such systems in treating groundwater contaminated with Sr-90.

O2 Building Slab. The O2 Building was a two-story, steel-framed concrete block structure 27 feet wide, 39 feet long, and 30 feet high. It contains a 16 feet deep stainless steel lined sump. Figure 3-25 shows the building when it was in service.

The O2 Building once housed filters, ion exchangers and other equipment used by NFS and the WVDP to treat radioactive wastewater before transfer to Lagoon 3. It was replaced with the LLW2 Building, It was demolished down to its concrete floor slab at grade in October 2006.

Test and Storage Building Slab. The Test and Storage Building was an 80 feet by 120 feet by 22 feet high timber frame and metal sided building located northeast of the

Process Building. It contained office spaces, a tool crib, and garage space. An 18 feet by 26 feet by 12 feet concrete block addition housed radiation and safety operations. It was demolished down to its concrete floor slab at grade in June 2007.

Vitrification Test Facility. This 40 feet wide and 120 feet long and 36 feet high metal building with a concrete floor contains a scale vitrification facility and a bulk chemical storage tank. It will be removed down to its concrete floor slab at grade before Phase 1 of the decommissioning.

Maintenance Shop Slab. The Maintenance Shop was a 60 feet by 100 feet by 28 feet high metal building with steel supports. It housed locker rooms, lavatories, instrument shops, work areas, and a finished office area. The Maintenance Shop was demolished down to its concrete floor slab at grade in June 2007.

Permeable Treatment Wall. A full-scale passive permeable treatment wall is expected to be installed before Phase 1 of the decommissioning to mitigate the off-site migration of Sr-90 contaminated groundwater in the sand and gravel unit in the north plateau.

The permeable treatment wall is planned to be located in WMA 2 immediately south of the Construction Demolition and Debris Landfill in WMA 4 approximately perpendicular to the flow path of the north plateau groundwater plume. It will be approximately 750 feet long in a northwest-southeast direction. The permeable treatment wall will be two to four feet thick, extend down into the underlying unweathered Lavery till, and be composed of granular zeolite to reduce Sr-90 concentrations in groundwater through ion-exchange.

Alternatives for potential mitigation of Sr-90 in surface water in the swamp ditch west of the Construction Demolition and Debris Landfill and downgradient of the permeable treatment wall will be considered after installation of the permeable treatment wall.

WMA 3: Waste Tank Farm Area

Shown in Figures 3-29 and 3-30, WMA 3 includes the waste storage tanks (8D-1, 8D-2, 8D-3, and 8D-4), and their associated tank vaults, the HLW transfer trench, the Permanent Ventilation System Building, the Equipment Shelter and condensers, the Con-Ed Building, and the Supernatant Treatment System Support Building.

WMA 3 facilities and equipment within the scope of this plan are:

- Tanks 8D-1, 8D-2, 8D-3, 8D-4, and the associated vaults[2];
- The HLW mobilization and transfer pumps;
- The HLW transfer trench piping;
- The Equipment Shelter and Condensers; and
- The Con-Ed Building.

Descriptions of the WMA 3 facilities follow.

[2] Only removal of the pumps from the tanks is within the scope of Phase 1 decommissioning activities.

***Waste Storage Tanks**.* The waste storage tanks were built to store the liquid HLW generated during the spent nuclear fuel reprocessing operations. The WVDP subsequently modified these tanks to support treatment and vitrification of the HLW. Modifications included constructing a fabricated steel truss system over tanks 8D-1 and 8D-2 to carry the weight of sludge mobilization and transfer pumps and installation of the Supernatant Treatment System equipment in Tank 8D-1.

Tank 8D-1, Tank 8D-2, and Vaults. Tanks 8D-1 and 8D-2 are identical in size and construction, with each tank housed within its own cylindrical concrete vault. Each tank is 27 feet high by 70 feet in diameter, with a storage capacity of 750,000 gallons. Figure 3-31 shows a cutaway view of a tank.

The tanks were constructed with reinforced carbon steel plate ranging in thickness from 0.4375 inch for the roofs and walls to 0.656 inch for the floors. The roof of each tank is supported internally by forty-five eight-inch diameter vertical pipe columns that rest on a horizontal gridwork of wide flange beams and cross members in the bottom two feet of each tank. Each tank rests on two six-inch-thick layers of perlite blocks that rest on a three-inch layer of pea gravel. The tank, perlite blocks, and pea gravel are contained within a carbon steel pan which rests on a three-inch layer of pea gravel that separates the pan from the floor of the vault.

Each tank and its associated pan are housed within a cylindrical reinforced concrete vault that has an outside diameter of 78.6 feet. The walls of each vault are 18 inches thick and extend nearly 36 feet above the floor of the vaults.

The floor of each vault is 27 inches thick, except under the six 30-inch diameter vertical concrete columns that support the vault roof. These columns pass upward from the floor of the vault through the tanks and are encased in steel pipes 48 inches in diameter that are welded to the top and bottom of each tank. The columns are located approximately 16 feet from the center of the tank. The floor of each vault is underlain by a four feet thick bed of gravel. The concrete vault roof is two feet thick and is supported by the six concrete columns. The top of the vaults are six to eight feet below grade.

Despite their robust construction, the tank vaults have not proven to be watertight. Groundwater seeps into both vaults and has to be regularly pumped out. A tank and vault drying system will be installed during deactivation work to achieve the interim end state to dry Tanks 8D-1, 8D-2, 8D-3, 8D-4 and their associated vaults. The tanks and vaults are expected to be in a dry condition several years after the start of Phase 1 of the decommissioning. The Tank and Vault Drying System will then maintain the tanks and vaults in a dry state.

The current conceptual design of the Tank and Vault Drying System includes a pre-cooling condensing unit and a desiccant wheel with a heater. Outside air will be pre-cooled as needed to lower the relative humidity entering the drying unit. The air will then flow through the desiccant unit for further drying and heating before being distributed to the bottom of the tanks and vaults.

The dry air supplied to the bottom of the tanks will displace moist air which will follow the tank ventilation flow path from the top of the tanks through the tank ventilation lines to the Permanent Ventilation System Building for treatment. At the Permanent Ventilation System Building, the moist air flow from the tanks will flow through a moisture separator, a heater, pre-filters, and two sets of HEPA filters before being discharged through the Permanent Ventilation System Building stack.

The dry air supplied to the bottom of the vaults will be a recirculation loop displacing moist vault air which will be removed at the top of the vaults. Moist exhaust air from the vaults will be drawn back through the desiccant wheel along with the necessary make up air. Make up air will be necessary since the dry air that goes in to the tanks is not returned to the desiccant unit.

The desiccant in the desiccant wheel will need to be regenerated periodically. Moisture in the desiccant unit will be removed with filtered heated air passing through the reactivation sector of the desiccant drying unit. The moist air exiting the unit will be vented to the Permanent Ventilation System Building where it will join the air flow from the Supernatant Treatment System Support Building and the tanks before flowing through the moisture separator, heater, pre-filters and two sets of HEPA filters before discharge through the Permanent Ventilation System Building stack.

The HLW transfer pumps and the mobilization pumps in Tanks 8D-1 and 8D-2 will be removed during Phase 1 of the decommissioning. These pumps are illustrated in Figure 3-32.

Tanks 8D-1 and 8D-2 each contain a single HLW transfer pump. Each centrifugal multi-stage turbine type pump is more than 55 feet long and is driven by a 150 horse power motor. Tanks 8D-1 and 8D-2 also contain a total of nine mobilization pumps. These pumps are approximately the same size as the HLW transfer pumps.

Tanks 8D-1 and 8D-2 each contain an additional suction pump used in waste pretreatment and processing. The Tank 8D-1 pump is a vertical turbine pump mounted on a pipe column with an overall length of approximately 31 feet. The Tank 8D-2 pump is a submersible pump mounted on a three inch pipe column with an overall length of approximately 33 feet. All of the pumps in the underground waste tanks are expected to be highly contaminated as explained in Section 4.1.

Tank 8D-1 was modified by the WVDP to support operation of the Supernatant Treatment System and it contains the following Supernatant Treatment System equipment:

- Supernatant pre-filter
- Supernatant feed tank (1,726 gal)
- Supernatant cooler
- Four zeolite columns (1,900 gal each)
- Supernatant sand filter

- Sluice lift tank (2,142 gal)
- Associated transfer piping.

The operation of the Supernatant Treatment System is described below.

Tank 8D-3, Tank 8D-4 and Vault. Tanks 8D-3 and 8D-4 are identical in size and construction, and both are housed within a single reinforced concrete vault. Each tank is 12 feet in diameter and 15.67 feet high, with a nominal volume of 15,000 gallons. The shell of each tank is 0.313 to 0.375 inch thick; both the tanks and their associated piping were constructed from 304L stainless steel.

The concrete vault that houses the tanks is approximately 32-feet long, 19-feet wide, and 25-feet tall. The walls, floor, and roof of the vault are 21-inches thick. The bottom of the vault is lined with stainless steel to a height of 18 inches above the floor. The floor contains a stainless-steel-lined sump. The top of the vault is six to eight feet below grade.

The HLW transfer pumps in tanks 8D-3 and 8D-4 will be removed to facilitate removal of liquids in these tanks during deactivation work to achieve the interim end state. The transfer pumps will be replaced with submersible pumps equipped with chemical resistant transfer lines. The submersible pumps and transfer lines will be removed during Phase 1 of the decommissioning.

High-Level Waste Transfer Trench. The HLW transfer trench is a long concrete vault containing piping that conveyed waste between the Waste Tank Farm and the Vitrification Facility. Approximately 500 feet long, the trench extends from the Tank 8D-3/Tank 8D-4 vault along the north side of Tank 8D-1 and Tank 8D-2, before turning to the southwest and entering the north side of the Vitrification Facility. It is six to 20 feet wide and its height ranges from six to nine feet. Figure 3-33 shows the trench under construction.

The trench was constructed with reinforced concrete walls and floors, with pre-cast concrete covers. Stainless steel-lined concrete pump pits that house the upper sections of HLW transfer pumps are located on top of each of the tank vaults. The walls and floors of the pump pits are reinforced concrete, with pre-cast concrete covers forming the roof. Figure 3-34 shows a typical pump pit.

There are six piping runs in the trench, two of which are unused spares, comprising approximately 3000 linear feet of double-walled stainless steel pipe.[3] The trench also contains associated valves and jumpers. The pump pits each contain the upper part of the HLW transfer pump and flow monitoring equipment. Pump Pit 8Q-2 over Tank 8D-2 also contains grinding equipment used to size reduce zeolite.

The piping and related equipment will be removed during Phase 1 of the decommissioning.

[3] Portions of the trench contain only two piping runs; the section connecting to the Vitrification Facility contains all six runs.

***Permanent Ventilation System Building**.* The Permanent Ventilation System Building is located approximately 50 feet north of Tank 8D-2, as shown in Figure 3-30. This steel framed and sided building is 40 feet wide, 75 feet long, and 16 feet tall and is attached to a 12 inch thick concrete floor slab supported by concrete footings. The building has a sheet metal roof which supports the Permanent Ventilation System discharge stack.

The Permanent Ventilation System was designed to provide ventilation to the Supernatant Treatment System Support Building, the Supernatant Treatment System valve aisle, the Supernatant Treatment System pipeway, and the HLW tanks. A skid-mounted, Permanent Ventilation System Stack Monitoring Building is located near the east end of the building.

Equipment Shelter and Condensers. The Equipment Shelter is a one-story concrete block building lies immediately north of the Vitrification Facility, as shown in Figures 3-29 and 3-30. It is 40 feet long, 18 feet wide, and 12 feet high and has a concrete floor six inches thick, with a small extension on the west side.

This structure houses the Waste Tank Farm ventilation system that was formerly used to ventilate the four waste storage tanks and the Supernatant Treatment System vessels in HLW Tank 8D-1.

The condensers are located immediately west of the Equipment Shelter. They were designed to condense the overheads from Tanks 8D-1 and 8D-2, which were originally designed to be in a self-boiling condition during NFS operations. The Equipment Shelter and condensers will be removed during Phase 1 of the decommissioning.

***Con-Ed Building**.* The Con-Ed Building is a concrete block building located on top of the concrete vault containing Tank 8D-3 and Tank 8D-4, as shown in Figures 3-29 and 3-30. This building, which is 10 feet wide, 13 feet long, and 11 feet high, houses the instrumentation and valves used to monitor and control the operation of Tanks 8D-3 and 8D-4. This building will be removed during Phase 1 of the decommissioning.

Supernatant Treatment System Support Building. This building is located adjacent to and above Tank 8D-1. It is a two-story structure that contains equipment and auxiliary support systems needed to operate the Supernatant Treatment System.

The Supernatant Treatment System is a zeolite ion-exchange system that was designed to primarily remove radioactive cesium from the high-level PUREX supernatant and sludge wash solutions from Tank 8D-2. The majority of the Supernatant Treatment System equipment is located in Tank 8D-1. This system was also capable of removing strontium and plutonium from these wastes. The high-level supernatant was pumped from Tank 8D-2 and was treated in the Supernatant Treatment System between May 1988 and January 1991.

The Supernatant Treatment System was also used from 1991 to 1995 to remove radioactive cesium from sludge washes generated from the sludge mobilization and wash system which was designed to remove sulfate salts from the sludge in Tank 8D-2 using a dilute caustic wash solution to dissolve the salts. Once a wash cycle was completed, the wash water was treated in the Supernatant Treatment System. Two sludge-wash cycles were completed between 1992 and 1994, and a third sludge wash was completed in 1995. During this third sludge wash campaign, THOREX waste in Tank 8D-4 was transferred to Tank 8D-2, where the combined PUREX/THOREX mixture was washed.

The upper level of the Supernatant Treatment System Support Building is a steel framework structure covered with steel siding. The lower level of the building was constructed with reinforced concrete walls, floors, and ceilings.

This building contains a control room; heating, ventilation and air conditioning equipment; utilities; and storage tanks for fresh water and fresh zeolite to support Supernatant Treatment System operations. A shielded valve aisle is located on the lower level of the support building, adjacent to Tank 8D-1.

The Supernatant Treatment System pipeway is located on top of the Tank 8D-1 vault. This concrete and steel structure contains the Supernatant Treatment System piping and structural members that support the Supernatant Treatment System equipment located in Tank 8D-1.

WMA 4: Construction and Demolition Debris Landfill Area

WMA 4, which includes the Construction and Demolition Debris Landfill, is a 10-acre area in the northeast portion on the north plateau of the WVDP as shown in Figure 3-8. The landfill, which was utilized as described in Section 2, is the only waste management unit in WMA 4. It will be monitored and maintained during Phase 1 decommissioning.

WMA 5: Waste Storage Area

The facilities in WMA 5 are shown in Figure 3-35 and are described below. WMA 5 facilities within the scope of this plan are:

- Lag Storage Addition 4 and its associated Shipping Depot;
- The Remote-Handled Waste Facility;
- Concrete slabs and foundations for the Lag Storage Building, Lag Storage Additions 1, 2, and 3, Chemical Process Cell Waste Storage Area; and
- Several hardstands consisting of compacted gravel pads.

Lag Storage Addition 4. Lag Storage Addition 4 is a clear-span structure, with a pre-engineered steel frame and steel sheathing. Approximately 291 feet long, 88 feet wide and 40 feet high, it rests on a seven-inch concrete slab. It is similar to Lag Storage Addition 3, except that it includes a shipping depot, a container sorting and packaging facility, and a covered passageway between the two storage areas. The shipping depot is connected to Lag Storage Addition 4 and is a 91 feet by 85 feet metal frame structure. This facility and its concrete floor slab will be removed during Phase 1 of the decommissioning.

Remote-Handled Waste Facility*.* The Remote-Handled Waste Facility is located in the western portion of WMA 5 as shown in Figure 3-35. It is a metal-sided, steel-frame building that includes a Receiving Area, a Buffer Cell, a Work Cell, a Waste Packaging Area, an

Operating Aisle, and a load-out /truck bay. Figure 3-36 shows the facility under construction and Figure 3-37 shows the layout of the first floor.

The Receiving Area includes a 20-ton bridge crane that also provides access into the adjacent Buffer Cell. The Buffer Cell is an air lock between the Receiving Area and the contaminated Work Cell. The Work Cell is the primary work area, with provisions for fully remote handling, surveying, segmenting, decontaminating, and repackaging operations. This shielded space is 55 feet by 22 feet by 26 feet high, and is served by a 30-ton bridge crane.

Any spent decontamination solutions generated during operations are transferred to below-grade wastewater storage tanks located in a vault below the building for management before treatment. These tanks and vault will be removed during Phase 1 of the decommissioning.

The Waste Packaging Area includes capability to load both waste drums and boxes. The Operating Aisle houses two waste processing and packaging work stations and one waste sampling transfer work station. Each work station includes a shield window in the shield wall, and controllers for remotely operating facility equipment.

This facility and its concrete floor slab will be removed during Phase 1 of the decommissioning.

Lag Storage Building Slab. The Lag Storage Building was a sheet metal structure built in 1984 to store LLW. It was supported by a clear span frame and anchored to a 140 feet long by 60 feet wide concrete slab foundation. The slab surface was coated with an acid-resistant, two-coat, application of epoxy sealer. It was demolished down to its concrete floor slab in October 2006.

Lag Storage Addition 1 Slab*.* Lag Storage Addition 1 was a pre-engineered steel frame and fabric structure built in 1987 to store containerized LLW. It was 191 feet long by 55 feet wide by 23 feet high. It was removed down to its grade level floor in October 2006.

Lag Storage Addition 2 Foundation. Lag Storage Addition 2 was a tent structure that was built in 1988 and dismantled in 1993 after it was damaged by high winds. The foundation consists of eight inches of crushed stone covering an area 65 feet by 200 feet.

Lag Storage Addition 3*.* Lag Storage Addition 3, like Lag Storage Addition 4, is a clear-span structure, with a pre-engineered steel frame and steel sheathing, about 291 feet long, 88 feet wide and 40 feet high, on a seven-inch concrete slab. It is scheduled to be removed down to its concrete floor slab during the work to achieve the interim end state.

Hardstands**.** Several compacted gravel pads or hardstands are located within WMA 5:

- The Lag hardstand, also known as the old/new hardstand storage area, is located southwest of Lag Storage Additions 3 and 4 and is used to store packaged equipment and containers of LLW;

- The cold hardstand area, which is located west of the Construction and Demolition Debris Landfill, has been used as a nonradioactive material staging and storage area;
- The vitrification vault and empty container hardstand is located north and west of the hazardous waste storage lockers; and
- The HLW tank pump storage vault area.

Chemical Process Cell Waste Storage Area. This waste storage area is a structure used to store equipment removed from the Chemical Process Cell. It is a 200 feet by 70 feet by 30 feet high galvanized steel-panel enclosure with a gravel pad floor. It will be removed down to its gravel pad during the work to achieve the interim end state.

Hazardous Waste Storage Lockers. Four steel hazardous waste storage lockers are located east of the Waste Tank Farm. Each locker measures eight feet by 16 feet by eight feet high and is used for short-term storage of hazardous waste. The lockers will be removed during the work to achieve the interim end state.

WMA 6: Central Project Premises

Facilities in WMA 6, the Central Project Premises shown in Figure 3-38, include the rail spur, the above ground petroleum storage tank, the Sewage Treatment Plant, the New Cooling Tower, the two Demineralizer Sludge Ponds, the Equalization Basin, the Equalization Tank, the South Waste Tank Farm Test Tower, the Road-Salt and Sand Shed, and the LLW Rail Packaging and Staging Area.

WMA 6 facilities within the scope of this plan are the:

- Sewage Treatment Plant,
- Equalization Basin and Tank,
- Demineralizer Sludge Ponds,
- South Waste Tank Farm Test Tower,
- Concrete slab for the Old Warehouse, and
- Cooling Tower basin.

Rail Spur. The rail spur runs about 8,000 feet from the south side of the Process Building to where it connects to the main line of the railroad. Figure 3-39 shows the tracks near the Process Building. The rails are cast iron and the ties are creosote pressure-treated wood. Low-level radioactive contamination identified in soil along a section of dual track east of the Old Warehouse is discussed in Section 4.2.

Sewage Treatment Plant. The Sewage Treatment Plant is a wood frame structure 41 feet by 44 feet by 15 feet high, with metal siding and roofing. The base of the facility is concrete and crushed stone. The Sewage Treatment Plant is used to treat sanitary waste and it contains six in-ground concrete tanks, one above-ground polyethylene tank, and one above-ground stainless steel tank.

Equalization Basin. The Equalization Basin is a lined 75 feet wide, 125 feet long, by 10 feet deep basin excavated into the sand and gravel layer. It has been used for non-radioactive discharges.

Equalization Tank*.* The Equalization Tank is a 20,000-gallon underground concrete tank immediately north of the Equalization Basin that serves as a replacement for the Equalization Basin.

Demineralizer Sludge Pond*s.* The north and south demineralizer sludge ponds are separate, unlined basins excavated in the sand and gravel layer. They are approximately 100 feet long, 50 feet wide, and five feet deep. They were used to receive water softener regeneration waste, clarifier overflow and blow-down, boiler blow-down, sand filter backwash, and demineralizer regeneration waste from the Utility Room.

The north pond is nearly filled with sediment. Both ponds are radiologically contaminated. As of 2004, the ponds were no longer in service.

Old Warehouse Slab*.* The Old Warehouse was a pre-engineered steel building with three sections. The main warehouse section was 80 feet by 144 feet by approximately 21 feet high at the roof peak. A 38 feet by 42 feet by 15 feet high room was attached to the north end of the building that housed a radiological counting facility. A double-wide office trailer was located on a concrete foundation wall at the south end of the building. The Old Warehouse was removed down to its concrete floor slab at grade in May 2007.

New Cooling Tower. The new cooling tower, shown in Figure 3-40, is 20 feet by 20 feet by 11 feet high and it stands on a concrete basin. The floor of the basin is an eight-inch-thick concrete slab. The facility will be removed, leaving the basin in place, during work to achieve the interim end state.

Waste Tank Farm Test Towers*.* The Waste Tank Farm Test Towers are pre-engineered structures erected as a stack of modules including ladders, handrails, and grating. The exterior “skin” is fabric. The north Tower was 16 feet by 16 feet by 57 feet high. The south Tower is 16 feet by 16 feet by 48 feet high. The north tower was removed to its foundation in October 2006. The south tower will be removed during Phase 1 of the decommissioning.

Road-Salt and Sand Shed. The Road-Salt and Sand Shed is a storage bin and a sand stall resting on asphalt pavement. It is constructed with a wooden frame covered with galvanized steel siding. This facility will be removed during work to achieve the interim end state.

LLW Rail Packaging and Staging Ar*ea.* The LLW Rail Packaging and Staging Area covers approximately 27,000 square feet east of and adjacent to the railroad tracks at the south end of WMA 6. The area contains two eight-inch-thick reinforced concrete pads and another section covered with crushed limestone.

WMA 7: NDA and Associated Facilities

WMA 7, shown in Figures 3-8 and Figure 3-41, includes the NDA and ancillary structures. The NDA is a near-surface radioactive waste disposal facility about 400 feet wide and 600 feet long. The only WMA 7 facility within the scope of this plan is the NDA Hardstand gravel pad.

The NDA is divisible into three distinct areas: (1) the NFS waste disposal area containing shallow special holes and deep burial holes, (2) the WVDP disposal trenches and caissons, and (3) the area occupied by the Interceptor Trench Project. Other structures and facilities include the Liquid Pretreatment System, the NDA Hardstand, an inactive plant water line, a leachate transfer line, and a former lagoon located beneath the former Interim Waste Storage Facility floor slab. This floor slab was removed in May 2008 as required for the planned installation of the geomembrane cover over the NDA.

The NDA was operated by NFS under license from the NRC for disposal of solid radioactive waste exceeding 200 mrem/h from fuel reprocessing operations. Section 2.4.2 describes the contents of the NDA and the estimated amount of radioactivity it contains.

Descriptions of the various features of the NDA follow:

NFS Deep Holes. About 6,600 cubic feet of leached cladding from reprocessed fuel, also known as hulls, are buried in approximately 100 deep disposal holes located in the eastern portion of the U-shaped area. Most of these holes are 2.7 feet by 6.5 feet by 50 to 70 feet deep.

The hulls were contained in 30-gallon steel drums stacked three abreast in the deep holes. Three of these drums contain irradiated, unreprocessed fuel with damaged cladding from the N-Reactor at the Hanford Site. The deep holes also contain LLW generated during fuel reprocessing.

NFS Special Holes. Approximately 230 NFS Special Holes are located in the northern and western portions of the U-shaped NFS burial area. The special holes are typically about 20 feet deep, with various lengths and widths; most are about 12 feet wide and 20 to 30 feet long.

The length and width of each special hole were varied according to the quantity of waste requiring disposal at each disposal event, and the dimensions of large waste items such as failed equipment. Miscellaneous wastes, other than leached hulls or related spent fuel debris, were packaged in several types of containers, including steel drums, wooden crates, and cardboard boxes.

At least 22 1,000-gallon tanks containing a mixture of spent n-dodecane and tributyl phosphate in absorbent material were disposed in several special holes during the late 1960s and the early 1970s (Blickwedehl et al. 1987). Eight of these tanks in special holes 10 and 11 were believed to be the source of n-dodecane and tributyl phosphate detected in a nearby monitoring well in the NDA on November 1983.

The following actions were taken by the WVDP between October 1985 and May 1987 to mitigate the migration of the n-dodecane and tributyl phosphate from special holes 10 and 11 (Blickwedehl et al. 1987):

- The eight 1,000-gallon tanks containing the n-dodecane/tributyl phosphate contaminated absorbents were removed.
- The tanks were size-reduced, contaminated absorbents and soils removed, and all waste packaged for disposal.
- Liquid n-dodecane and tributyl phosphate was removed and solidified into a qualified waste form suitable for disposal.
- Special holes 10 and 11 were backfilled.

Approximately 9,700 cubic feet of packaged contaminated soil, contaminated absorbents, size-reduced tanks, and solidified n-dodecane and tributyl phosphate were generated during this removal activity. Low level waste generated during this removal was either disposed of at the Nevada Test Site or the EnergySolutions Clive, Utah disposal site[4], or remains in storage at the WVDP awaiting disposal. Transuranic waste remains in storage at the WVDP awaiting a path for disposal as WVDP transuranic waste is currently not approved for disposal at the Waste Isolation Pilot Plant.

WVDP Trenches*.* The twelve WVDP trenches contain approximately 200,000 cubic feet of LLW resulting from decontamination activities performed between 1982 and 1986. Most of these wastes are in the parcel of land located inside the U-shaped disposal area used by NFS.

The WVDP Trenches are typically about 30 feet deep and about 15 feet wide. The lengths vary from 30 feet to 250 feet. Trenches 9 and 11 have composite liners and caps. All other WVDP Trenches are capped with clay.

WVDP Caissons*.* Four steel-lined concrete caissons – cylindrical concrete vaults seven feet in diameter and 60 feet deep – were constructed by the WVDP near the eastern and southern corners of the NDA. WVDP disposal records indicate approximately 823 cubic feet of waste in drums was placed in Caisson 1. The WVDP disposal records do not indicate that any waste was placed in the other three caissons. The caissons are plugged with concrete for shielding and covered with a plastic shield to prevent rainwater infiltration.

Interceptor Trench and Liquid Pretreatment System*.* The Interceptor Trench and associated Liquid Pretreatment System were installed after groundwater contaminated with tributyl phosphate, n-dodecane, and several radionuclides was detected in a well in the NDA. The purpose of the project was to intercept potentially contaminated groundwater migrating from the NDA.

[4] Which was the Envirocare Clive, Utah site at the time.

The trench is located on the northeast and northwest boundaries of the disposal area. The base of the trench extends to a minimum of one foot below the interface of the weathered Lavery till with the unweathered Lavery till.

The trench is drained by a drainpipe that directs accumulated water to a collection sump. The collection sump has a submersible pump to transfer groundwater to the Liquid Pretreatment System. As of 2008, no groundwater has ever been transferred to the Liquid Pretreatment System.

Liquid that collects in the sump is routinely sampled, analyzed, and transferred to the Low Level Waste Treatment Facility in WMA 2 for treatment and release. Treated wastewater is discharged from Lagoon 3 in WMA 2 to Erdman Brook through the SPDES permitted outfall.

The liquid pretreatment system consists of seven tanks made of carbon steel: one 5,000-gallon holding tank, two 1,000 gallon pre-filtration holding tanks, two 700-gallon tanks containing granular activated carbon, and two 1,000-gallon post-filtration holding tanks. The granular activated carbon tanks are housed in a wooden shed 12 feet long by 10 feet wide. The other five tanks are located in a Quonset-style building.

Groundwater Barrier Wall. In July 2008, a subsurface groundwater barrier wall was installed on the southwest and southeast sides of the NDA to minimize groundwater migration into the disposal area (Figure 3-41). This barrier wall is a soil-bentonite slurry wall with a maximum hydraulic conductivity of 1E-07 cm/s that is keyed at least five feet into the underlying unweathered Lavery till. The slurry wall is approximately 850 feet long, three feet wide, and is 15 to 20 feet deep.

Geomembrane Cover. In the fall of 2008, the NDA was covered with XR-5, an ethylene inter-polymer alloy geomembrane, to limit infiltration of precipitation into the disposal area. Prior to the installation of the XR-5 geomembrane, imported backfill was placed on the surface of the NDA and the surface was graded to form a suitable foundation for the installation of the XR-5 geomembrane.

NDA Hardstand. The NDA Hardstand, located near the southeast corner of the NDA, was an interim storage area where radioactive waste was staged before being disposed. The NDA Hardstand originally was a three-sided structure with cinder block walls, located on a sloped pad of crushed rock 20 feet wide and 20 feet long. The NDA Hardstand is radiologically contaminated. The block walls were removed down to crushed rock pad in September 2006. The crushed rock pad will be removed during Phase 1 of the decommissioning.

Inactive Plant Water Line. An eight-inch diameter cast iron water line from the plant runs along the southwestern border of the NDA. It was formerly used to supply clean water from the reservoirs to the Process Building, but was taken out of service in 1986 and capped with cement.

Leachate Transfer Line. The leachate transfer line is a two-inch diameter polyvinylchloride pipeline that runs along the northeast and northwest sides of the NDA, and continues northward across WMA 6 and terminates at Lagoon 2 in WMA 2. It was originally used to transfer liquids from the SDA lagoons via a pumphouse next to the NDA hardstand, to Lagoon 1

The total length of the line is 4,000 feet. The section of the transfer line from the SDA to the interceptor trench sump is inactive and the two ends are capped. The section of the line from the northeast corner of the NDA to Lagoon 2 is currently used to transfer groundwater from the NDA interceptor trench sump.

Former Lagoon. This lagoon, formerly used by NFS for collecting surface water runoff, was located in the northeastern portion of the NDA. Around 1972 it was filled with radiologically contaminated soil from cleanup after a HEPA filter was dropped at the NDA during disposal operations.

WMA 8: SDA

The SDA, which is shown on Figure 3-8, is not within the scope of this plan.

WMA 9: Radwaste Treatment System Drum Cell

WMA 9 is located south of WMA 7 and it contains the Radwaste Treatment System Drum Cell (Figure 3-42).

Drum Cell. The Drum Cell was built in 1987 to store radioactive waste solidified in cement and packaged in square 71-gallon drums. It is a pre-engineered metal building 375 feet long, 60 feet wide, and 26 feet high. The facility consists of a base pad, concrete shield walls, remote waste handling equipment, container storage areas, and a control room within the weather structure. The base pad consists of concrete blocks set on a layer of compacted crushed stone, underlain by geotextile fabric and compacted clay. Concrete curbs to support the drum stacks lie on top of the base pad.

All of the drums stored in the Drum Cell were removed in 2007 and disposed of at off-site LLW disposal facilities. The Drum Cell will be removed during Phase 1 of the decommissioning.

Subcontractor Maintenance Area. The Subcontractor Maintenance Area is a compacted gravel pad measuring approximately 20 feet by 30 feet located in the northwest corner of WMA 9. Prior to 1991, it was used by construction subcontractors to clean asphalt paving equipment with diesel fuel. In November 1991, the area was remediated by removing the upper six inches of soil and replacing it with clean gravel. The removed soil was tested for toxicity characteristic leaching procedure parameters and found to be nonhazardous solid waste. Since 1991, the area has been used as a staging area for heavy equipment and construction materials (stone, gravel). The gravel pad will be removed during Phase 1 of the decommissioning.

NDA Trench Soil Container Area. The NDA Trench Soil Container Area is a gravel pad storage area located on the north side of WMA 9. It was used to store roll-off containers containing soil excavated during the installation of the NDA Interceptor Trench which was completed in 1990. The containers were covered with tarps to prevent infiltration of precipitation and the rear gate was equipped with a rubber gasket to prevent the discharge of any soil or liquid. The roll-off containers and their contained soil have been removed and disposed of offsite. The gravel pad will be removed during Phase 1 of the decommissioning.

WMA 10: Support and Services Area

WMA 10, shown in Figure 3-43, covers approximately 30 acres on the north plateau and south plateau, and includes: (1) the Administration Building, (2) the Expanded Laboratory, (3) the New Warehouse, (4) the security gate house, (5) the Meteorological Tower, (6) the main parking lot, and (7) the south parking lot. In addition, concrete slabs and foundations from several removed structures remain in place, along with the former Waste Management Storage Area.

The WMA 10 facilities within the scope of this plan are the New Warehouse, the former Waste Management Storage Area, and the remaining concrete floor slabs and foundations.

Administration Building. The administration building is a single-story structure 130 feet long and 40 feet wide, 10 feet high at the eaves, and 11.7 feet high at the peak. The concrete base is nine inches thick. Construction materials include the concrete foundation, wood frame, metal siding, and metal roofing.

The administration building was built during the 1960s. The trailers were added beginning in 1982, and an addition to the west side of the building was added during the early 1980s. The trailers were removed in 2005. The addition to the administration building is approximately 94 feet long and 30 feet wide with a concrete base six inches thick. This facility will be removed to grade during the work to achieve the interim end state.

Meteorological Tower. The meteorological tower is located south of the administration building. Constructed of steel, it stands approximately 200 feet high on a concrete foundation. It has three main support columns with interior trusses and is anchored with five support cables. A stand-by generator and electrical boxes rest on a concrete pad.

Security Gatehouse and Fences. The main security gatehouse is located adjacent to the Administration Building. It was constructed in 1963. The gatehouse is 34 feet long, 20 feet wide, and nine feet high at the edge of the roof. Construction materials include a concrete foundation, concrete block walls, a concrete slab floor, and a built-up roof with metal deck.

A barbed wire security fence runs along the perimeter of the Center property line and the public roads running through it. The fencing has a total running length of approximately 24 miles.

A steel security fence surrounds the WVDP, the SDA, and miscellaneous other locations. It is made of galvanized chain link with galvanized steel pipe posts, with a spacing of 10 feet. The fence is seven feet high with a total length of 4.7 miles. Three strands of barbed wire are stretched across the top of the fence. Figure 3-5 shows the location of the fence around the project premises.

Expanded Lab. The Expanded Laboratory is located south of the Administration Building. It was constructed during the early 1990s. The laboratory is 92 feet long and 50 feet wide, and consists of eight one-story modular units supported by 72 concrete piers. It was manufactured from light wood framing, metal roofing, and siding. An addition, 20 feet wide and 50 feet long on a concrete foundation wall, was built on the east side of the laboratory. This facility will be removed to grade during the work to achieve the interim end state.

New Warehouse. The New Warehouse was built during the 1980s and is located east of the administration building. It is a pre-engineered steel building, 80 feet wide, 250 feet long, and 21.5 feet high at the roof peak, resting on about 40 concrete piers and a poured concrete foundation wall. The concrete floor is underlain with a gravel base.

Former Waste Management Storage Area. This area is a lay-down area associated with the New Warehouse.

Parking Lots and Roadways. Two parking lots are located off Rock Springs Road: the Main Parking Lot and the South Parking Lot.

The Main Parking Lot has a total paved surface area of 180,000 square feet and is covered with asphalt underlain with gravel. The South Parking Lot with approximately 80,000 square feet of parking area is also paved with asphalt. A guardrail approximately 1,200 feet long borders the lot along its southern, eastern and western sides.

Roadways are constructed of a stone sub-base approximately eight-inches thick, covered with asphalt approximately four-inches thick. The total area of pavement is approximately 1,296,000 square feet.

WMA 11: Bulk Storage Warehouse and Hydrofracture Test Well Area

The facilities within WMA 11, as shown in Figure 3-9 are not within the scope of this plan. The Bulk Storage Warehouse was formerly called the Plutonium Storage Facility and it was used by NFS in the late 1960s and early 1970s to store plutonium nitrate solution recovered from its nuclear fuel reprocessing operation. The plutonium nitrate solution was contained in 10-liter doubly sealed polyethylene bottles that were stored in containers consisting of two 55-gallon stainless steel drums welded end-to-end and filled with concrete except for a void formed by an embedded 7-inch pipe. In 1974, the Plutonium Storage Facility was deactivated and all stored plutonium nitrate was removed. The building became known as the Bulk Storage Warehouse as it was used by the WVDP as a warehouse to store files and office equipment and was also used as a primary emergency assembly area for the WVDP.

WMA 12: Balance of the Site

The facilities within WMA 12, as shown in Figure 3-9, are not within the scope of this plan.

3.1.4 Surrounding Communities, Businesses, and Transportation System

The Center is located in a rural area with few population centers (Figures 3-1 and 3-2). The nearest incorporated village is Springville, 3.5 miles north of the WVDP. The hamlet of West Valley and the communities of Riceville and Ashford Hollow also lie within a five-mile radius of WVDP.

Businesses, farms, and community centers within a 3.1-mile radius of the WVDP site in 2004 are listed in Table 3-1. Additional businesses, community centers and manufacturing facilities between 3.1-and 5 mile radii in 2008 included several retail stores, small manufacturing facilities, a concrete supplier, a nursery, a hospital, and two nursing homes.

Table 3-1. Businesses, Farms, and Community Centers within a 3.1- Mile Radius of the WVDP Site

Sector Direction	Facilities	Distance from Stack (miles)
	Businesses	-
NE	Split Rail Farm – Horse boarding and breeding	1.42
W	Storage Warehouse	2.36
W	NORCO Propane Co./Pioneer Propane	2.34
W	Countryside Car Center	2.37
WSW	Country Gifts and Storage	2.35
WSW	Starcrest Homes (Home Business) & U-Haul	2.34
WSW	Heritage Pipe Organ	2.43
WSW	(Riefler Inc.)	2.78
ESE	Harrigan Realty – Attorney at Law	2.13
NW	Springville Country Club	3.04
WSW	M&M Holland Propane	2.40
W	L. A. Hazard	2.27
SE	Gerwitz and McNeil Electric	2.01
W	Ashford Auto and Marine Repair	2.31
SE	Fox Valley Greenhouse	1.83
NW	Jack R. Preston’s AutoBarn	0.94
SW	Phillip’s Christmas Tree and Wreath	3.01
N	Codd’s Flower Shop	1.57

Table 3-1. Businesses, Farms, and Community Centers within a 3.1- Mile Radius of the WVDP Site

Sector Direction	Facilities	Distance from Stack (miles)
NNW	Model Shop	1.28
W	House of Steel	2.26
N	Schichtel's Nursery – Bond Rd	1.56
WNW	Schichtel's Nursery – Peters Rd	2.62
	Farms	-
S	Tom Stuebchen - Fruit Trees	2.28
S	Charles Schichtel – Dairy Farm	2.32
N	Clemence and Claudia Wolniewicz - Grain and Hay	2.45
NNW	David Reed – Dairy Farm	2.33
SE	Wayne Widrig – Dairy Farm	1.80
SE	Gary Feldman – Dairy Farm	3.11
WNW	Willard and Ann Miller – Dairy Farm	2.55
SE	Kevin Hebdon – Dairy Farm	2.95
WNW	David Cobo – Farm	1.15
WSW	Timothy Klahn – Dairy Farm	2.51
	Community Centers	-
SE	American Legion	3.00
E	Islamic Academy	2.91
N	Springfield Field and Stream	3.09
WNW	Trinity Lutheran	1.19
ENE	Cattaraugus County Houndsmen and Conservation Club	1.62
E	Riceville Community Church	2.83
SE	Ashford Municipal Building	1.71

A small military research installation is located in Cattaraugus County approximately 3.1 miles northeast of the WVDP. This facility was used to conduct research for the U.S. Department of Defense Air Force Automatic Liquid Agent Detector Program.

Transportation System

Transportation facilities near the Center include highways, transport repair and refueling services, rail lines, and aviation facilities.

The primary method of transportation near the site is motor vehicle traffic on the highway system shown in Figure 3-2. In Cattaraugus County, all roads with the exception of those within the cities of Olean and Salamanca are considered rural roads.

Rural principal arterial highways connect population and industrial centers. These include U.S. Route 219, located 2.6 miles west of the site, Interstate 86, located approximately 21.7 miles south of the site, and the New York State Thruway (I-90), approximately 21.7 miles north of the site. Traffic volume along the section of U.S. 219 west of the site between New York Route 39 and the Cattaraugus County Line averaged 9966 vehicles per day in 2002 (NYDOT 2005). Construction of a 4.2 mile extension of U.S. Route 219 began in 2007.

Collectors are roads from smaller communities and industrial centers to the rural principal arterial highways. They frequently are intra-county in nature and serve short hauls and cross-county traffic. There are three county collector roads within 1.2 miles of the site. Schwartz Road and Rock Springs Road serve as the principal site access roads. State Route 240, also identified as County Route 32, is 1.2 miles northeast of the site. The average annual daily traffic volume on State Route 240 near the site was 978 vehicles in 2002 (NYDOT 2003).

Dutch Hill Road, approximately one mile west of the WVDP, is an oil and stone chip surface on a gravel base designed to accommodate local, lightweight vehicles. Edies Road is of similar construction. Mill Street is asphalt paved over a gravel base located on unstable soils.

Railroad service in a north-south direction is provided to the central part of Cattaraugus County. The Buffalo and Pittsburgh Railroad transects the Center approximately 0.5 mile east of the project premises at its nearest point. This rail line is now abandoned north of the Center. The Center is served by a railroad siding from this line, often referred to as the rail spur.

There are no commercial airports in the site vicinity. The only major aviation facility in Cattaraugus County is the Olean Municipal Airport, located in the Town of Ischua, 21 miles southeast of the site, which does not offer regularly scheduled commercial air service. The nearest major airport is Buffalo Niagara International Airport, 34 miles north of the site.

3.2 Population Distribution

Local population information was obtained from a demographic survey performed in the area of the WVDP in 2002 (URS 2002) and regional population information from the 2000 U.S. census (Census Bureau 2003). This demographic survey referenced in Sections 3.2 and 3.3 has not been updated as of 2008. For analysis purposes, the area surrounding the WVDP is divided into 16 compass-direction sectors, with the WVDP main stack as the reference point.

3.2.1 Local Population Data

The 2002 demographic survey was performed out to a 3.1-mile radius from the WVDP Main Plant stack and included all permanent structures that may be inhabited in that area.

Results of this survey appear in Tables 3-2 and 3-3.

In 2002, approximately 1,050 people lived within a 3.1-mile radius of the site. The largest numbers of individuals were located east of the site. Figure 3-44 shows the results of the demographic survey by compass vectors.

Table 3-2. 2002 Resident Population Estimates by Directional Sector Within a 3.1-Mile Radius of the Main Plant Stack (URS 2002)

Sector		Radius (miles)					
		0.3-0.6	0.6-1.2	1.2-1.9	1.9-2.5	2.5-3.1	TOTAL
A	N	0	0	19	17	18	54
B	NNE	0	0	19	52	34	105
C	NE	0	3	17	0	21	41
D	ENE	0	2	27	0	19	48
E	E	0	0	38	55	81	174
F	ESE	0	0	4	48	15	67
G	SE	0	0	6	29	30	65
H	SSE	0	0	0	26	24	50
I	S	0	0	6	12	8	26
J	SSW	0	0	2	10	19	31
K	SW	0	0	9	0	43	52
L	WSW	0	0	9	14	4	27
M	W	0	8	35	21	15	79
N	WNW	0	29	41	4	24	98
O	NW	0	9	65	13	2	89
P	NNW	0	6	14	19	11	50
TOTALS		**0**	**57**	**311**	**320**	**368**	**1,056**

The nearest residences are located 0.76 to 1.94 miles from the WVDP site as shown in Table 3-3. The numbers of wells or springs used as drinking water within 3.1 miles of the WVDP are listed in Table 3-4. The information in the table is not inclusive of every well used for water consumption because the survey was subject to residential participation.

Table 3-3. Nearest Residences by Sector (URS 2002)

Compass Direction	Distance (mi)	Residence Location
WNW	0.76	6491 Boberg Rd.
NW	0.83	10493 Rock Springs Road
W	1.09	10314 Dutch Hill Rd.
NNW	1.17	10596 Rock Springs Rd.
NE	1.20	10653 Rte. 240

Table 3-3. Nearest Residences by Sector (URS 2002)

Compass Direction	Distance (mi)	Residence Location
ENE	1.22	10625 Rte. 240
SW	1.33	10086 Dutch Hill Rd.
WSW	1.33	10122 Dutch Hill Rd.
S	1.42	9911 Rock Springs Rd.
E	1.53	5761 Heinz Rd.
N	1.53	10927 Bond Road
NNE	1.63	10845 Rte. 240
ESE	1.63	5579 Buttermilk Rd
SSW	1.76	10043 Dutch Hill Rd.
SE	1.80	5768 Fox Valley Rd.
SSE	1.94	5872 Fox Valley Rd.

Table 3-4. Number of Residential Wells or Springs used for Drinking Water by Sector within a 3.1-Mile Radius of the Main Plant Stack

Sector	Direction	Number of Wells or Springs(1)
A	N	14
B	NNE	23
C	NE	5
D	ENE	10
E	E	36
F	ESE	20
G	SE	8
H	SSE	12
I	S	7
J	SSW	11
K	SW	20
L	WSW	9
M	W	22
N	WNW	24
O	NW	27
P	NNW	11

Table 3-4. Number of Residential Wells or Springs used for Drinking Water by Sector within a 3.1-Mile Radius of the Main Plant Stack

Sector	Direction	Number of Wells or Springs[(1)]
TOTAL		**259**

NOTE: (1) Numbers of wells and springs estimated based upon resident interviews in URS 2002.

3.2.2 Population Distribution

The Center lies within Cattaraugus and Erie counties. Regional population data within a 50-mile radius of the WVDP was obtained from the 2000 U.S. Census.

Summary of Current Population In and Around the Site

The 1960 through 2000 resident populations of towns and villages within 10 miles of the WVDP are presented in Table 3-5[5]. The populations of New York and Pennsylvania counties within 50 miles of the WVDP are presented in Table 3-6.

Erie County had a population of 950,265 in 2000, which is a 10.7 percent decline from 1960. Although both Erie County and the City of Buffalo have experienced a population decline, populations in the rural townships south of Buffalo – such as Orchard Park, Hamburg, East Aurora, and West Falls – have increased. The population of southern Erie County near the WVDP site is concentrated primarily in small villages and along roadways, much like in Cattaraugus County. The majority of people residing in these areas work in agriculture or nearby small industries.

Table 3-5. Locations and Populations of Towns and Villages Partially or Totally Within 10 Miles of the Site (from 2000 census)

TOWN/ VILLAGE[(1)]	DISTANCE/ DIRECTION (Miles)	POPULATION					POP. DENSITY per sq.mi.	1960-1990 % CHG.	1990-2000 % CHG.
		1960	1970	1980	1990	2000			
Ashford (T)	Note (4)	1,490	1,577	1,922	2,162	2,223	43	45.1	2.82
Concord (T)	3.0N	6,452	7,573	8,171	8,387	8,526	122	30.0	1.66
Springville (V)[(2)]	3.5N	3,852	4,350	4,285	4,310	4,252	N/A	11.9	-1.35
Sardinia (T)	4.0 NNE	2,145	2,505	2,792	2,667	2,692	54	24.3	0.94
Yorkshire (T)	3.5 NNE	2,012	2,627	3,620	3,905	4,210	114	94.1	7.81
Delevan (V)[(3)]	8.9 ENE	777	994	1,113	1,214	2,321	N/A	56.2	91.2
Machias (T)	4.0 ESE	1,390	1,749	2,058	2,338	2,482	61	68.2	6.16
Franklinville (T)	7.8 SSE	3,090	2,847	3,102	2,968	3,128	60	-3.9	5.39
Ellicottville (T)	12.0 S	1,968	1,779	1,677	1,607	1,738	39	-18.3	8.15
Mansfield (T)	7.5 SSW	632	605	784	724	800	20	14.6	10.50

[5] In New York state, a town is the major subdivision of each county and a village is an incorporated area, usually within a town.

Table 3-5. Locations and Populations of Towns and Villages Partially or Totally Within 10 Miles of the Site (from 2000 census)

TOWN/ VILLAGE(1)	DISTANCE/ DIRECTION (Miles)	POPULATION					POP. DENSITY per sq.mi.	1960-1990 % CHG.	1990-2000 % CHG.
		1960	1970	1980	1990	2000			
East Otto (T)	3.0 SW	701	910	942	1,003	1,105	27	43.1	10.17
Otto (T)	7.5 WSW	715	731	828	777	831	26	8.7	6.95
Collins (T)	7.5 WNW	6,984	6,400	5,037	6,020	8,307	173	-13.8	37.99
North Collins(T)	8.9 NW	3,805	4,090	3,791	3,502	3,376	79	-8.0	-3.60
TOTAL (OR AVERAGE)		31,384	33,393	34,724	36,060	39,418	---	14.9	14.9

NOTES: (1) (T) indicates town and (V) indicates village.
(2) Springville village population is included in the town of Concord.
(3) Delevan village population is included in the town of Yorkshire.
(4) The WVDP is located within the geographical boundary of the Town of Ashford.

Population Density

Using the 2000 census data, the maximum population density of 448 persons per square mile occurs between 20 and 30 miles from the site. Table 3-5 includes the population densities of towns within 10 miles of the WVDP site.

Table 3-6. Populations of Selected Municipalities, Counties, and States within 50 Miles of the Site (1960-2000) (from U.S. Census, years cited)

MUNICIPALITY/ COUNTY/STATE(1)	POPULATION					% Change 1960-2000
	1960	1970	1980	1990	2000	
NEW YORK (S)	16,782,304	18,241,391	17,558,072	17,990,455	18,976,457	13.1
Cattaraugus (C)	80,187	81,666	85,697	84,234	83,955	4.7
Erie (C)	1,064,688	1,113,491	1,015,472	968,532	950,265	-10.7
Hamburg (M)	41,288	47,644	53,270	53,735	56,259	36.3
Orchard Park (M)	15,876	19,978	24,359	24,632	27,637	74.1
Buffalo (M)	532,759	462,768	357,870	328,123	292,648	-45.1
Allegany (C)	43,978	46,458	51,742	50,470	49,927	13.5
Wyoming (C)	34,793	37,688	39,895	42,507	43,424	24.8
Chautauqua (C)	145,377	147,305	146,925	141,895	139,750	-3.9
Livingston (C)	44,053	54,041	57,006	62,372	64,328	46.0
Genesee (C)	53,994	58,722	59,400	60,060	60,370	11.8
Niagara (C)	242,269	235,720	227,101	220,756	219,846	-9.3

Table 3-6. Populations of Selected Municipalities, Counties, and States within 50 Miles of the Site (1960-2000) (from U.S. Census, years cited)

MUNICIPALITY/ COUNTY/STATE(1)	POPULATION					% Change 1960-2000
	1960	1970	1980	1990	2000	
Steuben (C)	97,691	99,546	99,135	99,088	98,726	-1.1
PENNSYLVANIA (S)	11,319,366	11,800,766	11,866,728	11,881,643	12,281,054	8.5
Warren (C)	45,582	47,682	47,449	45,050	43,863	-3.8
McKean (C)	54,517	51,915	50,635	47,131	45,936	-15.7
Potter (C)	16,483	16,395	17,726	16,717	18,080	9.7

NOTE: (1) (M) indicates municipality, (C) indicates county, and (S) indicates state.

Transient Population

The transient population around the site includes daily and seasonal transients including the workforce at the WVDP. In 2008, an average of 300 employees was working at the site during daytime hours.

This transient population is projected to vary in future years according to the activities on site. The seasonal transient population is associated with the area's numerous small recreation sites. Where significant, this transient population is included in the distribution and projection figures.

Future Projected Population

According to the Greater Buffalo-Niagara Regional Transportation Council, the total Concord/Springville population is expected to reach 10,000 by the year 2020, a gain of almost 10 percent per decade. It is projected that the present 50/50 population split will continue, with Springville having 5070 people and the unincorporated areas of the town 4930 in 2020 (ECPD 1999). Population projections for Cattaraugus County were prepared by Cornell University in September of 2002 and are available for public viewing on the New York State Information System website (http://www.nysis.cornell.edu/cattaraugus.pdf). Projected population changes for Cattaraugus County were as follows:

2005 - 83,881	2010 - 83,674	2015 - 83,359
2020 - 82,815	2025 - 81,989	2030 - 80,886

Population trends may be influenced by the expansion of Route 219 through Cattaraugus County. The baseline population projections are projections illustrating the impact of recent rates of population change. Census 2000 county populations have been projected using current life expectancy and survival rates, age specific fertility rates, and rates of net migration. The rates of net migration have the greatest impact on changes in population size. These net migration rates are based on an analysis of total population change between the 1990 census and the 2000 census. In 2008, the U.S. Census Bureau estimated that the population of Cattaraugus County was 79,688.

3.3 Current and Future Land Use

This section describes current land use on the site and in the vicinity in detail, and future land use on site and in the vicinity within the limitations of available information.

3.3.1 Current Land Use

Detailed information on current land use is available from a number of sources.

Onsite Land Use

The project premises have served only industrial uses since the reprocessing plant was built in the 1960s. The balance of the Center, often referred to as the retained premises, has served only as a buffer area for the plant since that time. In 2008, no definitive information on plans for future use of the Center was available.

Land Use in Vicinity of the WVDP

Land use within five miles of the WVDP site is predominantly associated with agriculture, arboriculture, and forestry. The major exception is the Village of Springville, in which many areas are devoted to residential, commercial, and industrial land uses. Other major non-agricultural land uses within five miles of the site are:

- Hamlet of West Valley – residential/commercial/land use, 3.4 miles to the southeast;
- Cattaraugus County Forest – forestry/recreation, 3.7 miles to the south;
- Campground – five miles to the southwest;
- Machine shop – industrial land use, four miles to the northwest;
- Two retail shopping complexes - commercial land use - four miles to the north northwest; and
- Warehouse – commercial land use, 3.8 miles to the north-northwest in the village of Springville.

Cattaraugus County ranks fifth in the state for number of farms and eleventh in the state for the amount of land in farming. Approximately 24 percent of the county’s total acreage is farmland (NYASS 2005). Production and sale of important agricultural commodities in Cattaraugus County are shown in Table 3-7. The dairy industry is the dominant agricultural activity, with meat production occurring on a smaller scale.

Table 3-7. Leading Agricultural Products in Cattaraugus County[1]

Product	2002 Sales in $1000s	Percent of Total Sales	County Rank in New York
Dairy Products	36,486	63	19
Nursery and Greenhouse	9,676	17	5
Cattle and Calves	4,832	8	22
Hay & Silage	1,976	3	28
Grains and Dry Beans	1,628	3	22
Other Products	3754	6	
Total Sales	58,352	-	22

NOTE: (1) From NYASS 2005.

Farming Statistics

In 2002, a livestock and crop production survey within a 3.1-mile radius of the WVDP was taken in conjunction with the population survey. The results of this survey are shown in Tables 3-8 and 3-9.

Table 3-8. 2002 Consumable Animal Population Estimates[1] by Sector within a 3.1-Mile Radius of the Main Plant Stack (URS 2002)

Sector	Direction	Dairy Cattle	Beef Cattle	Goats	Sheep	Pigs	Fowl[2]
A	N	0	0	0	0	0	0
B	NNE	0	11	0	0	0	0
C	NE	0	23	0	0	0	0
D	ENE	12	11	15	12	5	20
E	E	17	31	0	7	0	0
F	ESE	0	0	0	0	0	6
G	SE	135	0	0	15	0	32
H	SSE	0	0	0	0	0	0
I	S	100	12	0	0	0	0
J	SSW	60	45	0	0	2	4
K	SW	3	0	0	0	2	17
L	WSW	0	5	0	0	0	0
M	W	0	36	5	0	2	21
N	WNW	70	0	0	0	0	9
O	NW	5	0	0	0	1	13
P	NNW	60	0	0	30	0	20
TOTALS		**462**	**174**	**20**	**64**	**12**	**142**

NOTES: (1) Numbers of animals are estimated based upon resident interviews and site reconnaissance.
(2) Fowl includes: Chickens, Ducks, Geese, Turkey, Ostrich (4) and Emu (1).

Dairy and beef cattle farming dominate within 3.1 miles of the WVDP. The majority of livestock production occurs northwest and southeast of the WVDP. Farming within 3.1 miles of the site typically occurs northwest and south and east of the site. The principal use of farmland is hay and pasture land. Hay and pasture lands account for approximately 57 percent of land used for agricultural purposes. The production of corn and oats accounts for 45 percent of agricultural land use.

Land-use surrounding the Center property – based on county land-use maps and tax parcel information – is shown in Figure 3-45.

Table 3-9. 2002 Crop Estimates in Acres by Sector within a 3.1-Mile Radius of the Main Plant Stack (from URS 2002)

Sector	Direction	Corn	Oats	Hay & Pasture	Ground Fruit(1)	Fruit Trees(2)	Garden Vegetables(3)
A	N	60	0	0	1	0	0.4
B	NNE	0	0	0	0	0	1.8
C	NE	0	0	0	0	0	0.5
D	ENE	0	0	0	0	0.2	1.1
E	E	0	0	0	0	0	1.3
F	ESE	0	0	100	0	0	0.2
G	SE	83	34	250	0	0	1.7
H	SSE	0	0	30	0	0	0.4
I	S	50	50	100	1	0	1.2
J	SSW	30	30	50	0	0	0.8
K	SW	0	0	0	0	0	1.0
L	WSW	0	0	0	0	0	0.0
M	W	0	0	80	0	0	0.8
N	WNW	230	0	100	0	0	0.7
O	NW	0	0	0	0	0	1.0
P	NNW	0	0	0	0	0	0.8
TOTALS		**453**	**114**	**710**	**2**	**0.2**	**13.7**

NOTES: (1) Ground Fruit includes: blueberries, raspberries, strawberries, and grapes.
(2) Fruit Trees includes: apples and pears
(3) Garden vegetables included: beans, cabbage, corn, cucumbers, peas, potatoes, pumpkins, tomatoes, squash, and zucchini.

Agricultural lands cultivated to produce fruits and vegetables represent less than one percent of the total agricultural acreage within 3.1 miles of the site. Fruit and vegetable fields tend to be smaller than dairy fields, and are not distributed in proportion to the occurrence of farmland. In general a few towns contain a disproportionately large share of these lands. Crops include lettuce, cabbage, broccoli, spinach, snap beans, tomatoes, sweet corn, potatoes, grapes, and apples. Total land area devoted to such production in Erie and Cattaraugus counties is estimated at 10,189 acres and 2,319 acres, respectively.

3.3.2 Summary of Anticipated Land Uses

The project premises will be available for only limited future uses in the coming decades. The ability to anticipate land use in the vicinity in future years is limited by the limited available information from planning boards.

Future Use of Project Premises and the Center

Future use of the retained premises will depend upon the wishes of NYSERDA as the property owner and will need to be consistent with institutional controls, where applicable. As of 2008, no definitive information on NYSERDA plans for future use of the Center was available. However, the Southern Tier West Regional Planning and Development Board has an ongoing West Valley Redevelopment Strategy Project in response to the ongoing decommissioning of the WVDP.

Future Use of Land in the Vicinity

It is expected that future land uses in the vicinity of the Center will be similar to the historical land uses summarized in Section 3.3.1. Information from local, regional, and State planning boards is limited. On June 9, 1999 the Town of Concord and the Village of Springville held a public hearing to review a draft of the joint comprehensive plan (ECPD 1999). The vision of the plan was expressed as follows:

> “The Concord/Springville community values and wishes to preserve the scenic beauty, farmland, hamlets, and unique natural environment of the Town of Concord. It also wishes to enhance and strengthen the Village of Springville as the civic, cultural and economic center of Concord and the surrounding non-town area, and maximize its location at the southern gateway to Erie County.”

Proposed developments related to this vision included:

- A 50-acre planned business park adjacent to US Route 219;
- Revitalization of downtown Springville;
- A new planned residential area in the northeastern section of the Village,
- Upgrading of the Town and Village Hall facilities; and
- Park and recreation improvements, which included a new park at Scoby Hill Dam and a new greenway along Spring Brook.

The greenway development would include a four-mile-long park area bordering Spring Brook from Middle Road to Cattaraugus Creek at Felton Bridge on Mill Street. This park would include nature trails, bicycle paths, canoe landings, and picnic areas.

The new park at Scoby Hill Dam would include a canoe landing, fishing access, and recreational use. Further recreational development is proposed to encourage the development of hiking/biking trails, golf, snowmobiling, and skiing.

Additional proposals utilized the abandoned Buffalo-Pittsburgh Railroad line from Springville to Salamanca to be developed either as a tourism train, connected with a railroad museum in Salamanca, or as a extensive bike trail as part of the “rails to trails” program.

Industrial and business development would be encouraged at or near current locations (along Cascade Drive and near the railroad tracks), with the exception of a planned new business park located near the Zoar Valley Road, with a connector road intended to the future Route 219. If Route 219 were to be extended down to Salamanca, certain land adjacent the route would be developed for business and/or industrial use (Ashford 1994).

Sand and gravel mining is a growing industry within the area with nine areas now designated for mining. Future intentions are to develop this industry to promote economic development in the area (Bishop, et al. 2004).

Cattaraugus County

The 1994 Comprehensive Master Plan anticipated much of its land use based on the extension of Route 219 and the development of the nuclear fuel industry through the WVDP. Given these assumptions, industrial and business development was planned to occur near the Route 219 extension and on some Center property.

Parcels reserved for industry in the future land use plan are located near the following roads: Henrietta Road (300 acres), Schwartz Road (50 acres), Route 219 (80 acres), Thomas Corners (350 acres), and within the Town of Ashford (265 acres). The closest business development complex to the WVDP property would be the Ashford Business and Education Park at the location of the Ashford Office Complex. The intersection of Route 219 and Schwartz Road, and Thomas Corners have been intended for residential development (Ashford 1994).

The Record of Decision on the Route 219 expansion was published in April 2003. The New York Department of Transportation selected the freeway alternative, which proposes a four-lane freeway from Springville to Salamanca. Construction of the Route 219 expansion began in 2007.

Since the Comprehensive Master Plan was published, gravel mining has expanded rapidly. In 1993, 53 parcels of land totaling 3,455 acres were assessed for mining and quarrying in the Route 16 corridor of Cattaraugus County. This number increased to 76 parcels totaling 4,502 acres in 1999. In 2000, there were 49 active mining permits covering 1,030 acres.

Issues raised by concerned citizens have resulted in the Town of Yorkshire adapting zoning plans to remediate gravel mining activities. As of October 2002, the Town of Ashford had not adapted any zoning regulations.

3.4 Meteorology and Climatology

This section begins with a description of the general climate in the region, followed by a discussion of severe weather phenomena. Weather-related radionuclide transmission factors and site deterioration factors are then described. Finally, site meteorology is discussed, along with air quality in the area.

3.4.1 The General Climate of Western New York

Western New York is exposed to a variety of air masses that create a moist continental climate. Cold dry air masses that form over Canada reach the area from the northwest. Prevailing winds from the southwest and south bring warm, humid air masses from the Gulf of Mexico and neighboring waters of the subtropical Atlantic Ocean. On occasion, cool, cloudy, and damp weather affects Western New York through air flow from the east and northeast.

Western New York is affected by a variety of cyclonic and anti-cyclonic pressure systems as they move across the continent. Continental storms and frontal systems move frequently across or near this region. In addition, Western New York usually feels the effects of well-developed storms moving up the Atlantic Coast.

Temperature

The coldest winter temperature normally varies between -10 °F to -20 °F in the southwestern highlands (WVNSCO 2007). Extreme winter temperatures as cold as -40 °F have been recorded in the higher elevations of Cattaraugus County (WVNSCO 2007). Severe winter cold with below-zero minimums and/or lengthy periods of continuous temperatures below freezing occur between early December and mid-March. Winter thaws typically result in temperatures in the 40s to low 50s for a few days at a time, with rare maximums in the 60s.

The summer seasons are cool with the temperature typically ranging from 60 °F at night to the low 80s in the afternoon (WVNSCO 2007). On the average, temperatures of 90 °F or higher are recorded on five days or less per year at the higher elevations and along the shore of the Great Lakes (WVNSCO 2007). Such temperatures occur between early June and early September. Readings of 100 °F or higher are rare. It is sunny for 65 percent of the total daylight hours on the average during the summer (WVNSCO 2007).

Temperatures from mid-September to mid-October frequently rise to the 60s and 70s in the daytime and cool to the 30s and low 40s at night. The comparatively warm waters of the Great Lakes reduce cooling at night to the extent that freezing temperatures in lakeside counties are normally delayed until mid-October or later.

Precipitation

Lake Erie and Lake Ontario exert a major controlling influence on the climate of the region. In winter, cold air crossing unfrozen lake water picks up moisture and releases it as snow as the air stream moves inland over higher terrain. Heavy snow squalls frequently occur, producing from one to two feet of snow and occasionally as much as four to seven feet. Cattaraugus County and Erie County are generally subject to lake-effect snows in

November and December, but as the lake gradually freezes lake-effect snow becomes less frequent. The snow season normally begins in mid-November and extends into mid- or late-April.

Winter precipitation is heaviest east of Lake Erie, where the average total snowfall is in excess of 120 inches (WVNSCO 2007). Summer season precipitation ranges from 10 to 12 inches with the rainfall distribution pattern reflecting the influences of the cool Lake Ontario waters to the north and the hilly terrain in the Southern Tier (WVNSCO 2007). Rains resulting from warm fronts are usually light but last for several days; cold fronts often cause heavier rainfall in shorter periods.

3.4.2 Severe Weather Phenomena

Figures 3-46 through 3-48, provided by the National Weather Service observing station in Buffalo, show the distribution patterns of tornadoes (1950-2002), thunderstorm winds (1955-2002), and hail events (1955-2002) for western and north central New York. The National Weather Service has not updated these figures as of 2008. Corresponding charts depict distribution of events by month, time, and rating of severity.

Severe weather phenomena occurred during the 1993-2002 period as follows:

- Six tornadoes;
- Seventy-five thunderstorm wind or hail events (where thunderstorm winds measured 58 mph or greater or produced damage, or where hail measuring 0.75-inch or larger fell);
- Seven injuries due to lightning strikes;
- Forty-nine flood or flash flood events (about one-third due to ice jams);
- Twenty-eight high wind events (high winds caused by large-scale, synoptic low pressure systems);
- Three ice storms (with ice accumulations of one-half inch or greater);
- One blizzard in March 1993 (with winds or frequent gusts of 35 mph or greater and visibilities of less than one-fourth mile sustained for three hours or more); and
- Sixty-six snowstorms (with seven inches or more of snow within a 12- hour period, or nine inches or more of snow within 24 hours, about two-thirds due to lake-effect snows.)

Additional historical meteorological data is provided in WVNSCO 1993b, which summarizes regional meteorological information, analyzes trends, and correlates meteorological data collected by the National Weather Service with data collected at the site's regional and primary monitoring stations.

3.4.3 Weather-Related Radionuclide Transmission Factors

Winds at the site are generally from the west and south at about 10.3 miles per hour (4.6 m/s) and 9.6 miles per hour (4.3 m/s) respectively, based on data from 1991-2002. Figure 3-49 depicts the average wind vectors on site.

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 (WVNSCO 1993).

Average and extreme duration of precipitation events are not measured at the WVDP. Only annual, monthly, or daily precipitation data are available, recorded as inches fallen in a 24-hour period.

3.4.4 Weather-Related Site Deterioration Parameters

Routine and extreme weather-related site deterioration parameters are considered in this section.

Routine Parameters

Note that precipitation intensity is indicated by information provided in Section 3.4.5. The hourly average maximum recorded wind speed in the area was 35.3 miles per hour in December of 1987 (WVNSCO 1993).

Wind vectors were addressed in Section 3.4.3. Temperature gradients were discussed in Section 3.4.1. Limited data are available on pressure gradient variation: reported barometric pressure measurements in 1991 and 1992 have ranged from lows of 29.51 in March of 1991 and 28.17 in May of 1992 to highs of 30.67 in December of 1991 and 30.43 in January of 1992 (WVNSCO 1993b).

Extreme Parameters

Most extreme weather-related deterioration events that occurred during the 1993 – 2002 period were summarized in Section 3.4.2. Regarding extreme air pollution, the WVDP and Cattaraugus County are considered “in attainment” or “unclassifiable” with respect to the National Ambient Air Quality Standards for criteria pollutants. As of 2002, no extreme air pollution violations have been identified within Cattaraugus County.

3.4.5 Site Meteorology and Climatology

Site topographic features previously discussed produce locally significant variations in climate. Meteorological data are collected both on site and at a nearby meteorological station on Dutch Hill Road. Wind speed and direction, barometric pressure, temperature, dewpoint, and rainfall are measured on site. Wind speed and direction are measured at the regional location.

Temperature

The average monthly temperatures recorded at site from 1984 – 2002 are listed below:

January: 24.26 °F	May: 55.22 °F	September: 58.82 °F
February: 25.34 °F	June: 63.86 °F	October: 48.74 °F
March: 32.36 °F	July: 67.46 °F	November: 38.66°F
April: 44.6 °F	August: 66.02 °F	December: 28.22°F

Extreme temperatures have been as high as 98.6 °F and as low as -43.6 °F.

Precipitation and Wind Vectors

Average annual precipitation for the site is 39.4 inches, including an average 120 inches of snow, based on 1985 – 2002 data, and is evenly distributed throughout the year. Winds are generally from the west and south at about 10.3 miles per hour (4.6 m/s) and 9.6 miles per hour (4.3 m/s) respectively, as previously noted.

Severe Weather Phenomena

According to U.S. Weather Bureau meteorological analysis, the theoretically greatest precipitation (probable maximum precipitation) that could be expected over the applicable drainage area in a 24-hour period is 24.9 inches. Factors figuring into this estimate include the size of the 1,200-acre drainage area, its topography, and seasonal effects. The highest measured 24-hour total as of 2003 was five inches.

Atmospheric Water Vapor

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 3-50 illustrates the percent frequency of occurrence of ceilings (defined as cloud cover of 5/8 or greater) less than 3,000 feet and/or visibility less than three miles at Buffalo and Niagara Falls, the closest locations with this data. The cycle of maximum and minimum occurrence should be approximately the same at West Valley. (WVNSCO 1993)

The normal annual number of hours of sunshine is approximately 2,100. In summer the daily value is approximately nine hours and in winter the normal is 3.5 hours.

Fog

Fog has a well-defined seasonal cycle with annual maximums occurring during the winter months. Buffalo has a normal expectation of ten days per year of dense fog; light fog occurs much more frequently.

Atmospheric Stability

Measurements of temperature, wind speed, and wind direction made at the 10-meter and 60-meter heights at the on-site meteorological tower are used for determining wind patterns and for determining atmospheric stability characteristics at the site. Seven Pasquill-Gifford atmospheric stability categories (A through F) have been determined for the site based on vertical temperature differences (temperature lapse rates, ΔT) calculated from temperatures measured at the 197 feet (60-meter) and 33 feet (10-meter) heights at the onsite meteorological tower.

These stability class conditions determine how a parcel of air will react when it is displaced adiabatically (ΔT/ΔZ method), i.e., without exchanging heat. Stability classifications were determined in accordance with the methodology described in NRC Regulatory Guide 1.23 (NRC 2007) on onsite meteorological programs and Regulatory

Guide 1.145 (NRC 1982) on atmospheric dispersion models. Hourly-averaged values of temperature obtained at the 197 feet (10-meter) and 33 feet (60-meter heights) at the tower were used in the calculations. The temperature differences were derived from temperature data collected at the on-site meteorological tower, from January 1, 1994, through December 31, 1998 (Spector and Grant 2003).

Joint frequency distributions of wind speed and direction for each stability class are tabulated in Table 3-10 for measurements at a height of 33 feet (10 meters) and Table 3-11 for measurements at a height of 197 feet (60 meters) (Spector and Grant 2003). These joint frequency distributions were derived from data collected at the on-site meteorological tower from January 1, 1994, through December 31, 1998. Wind directions are grouped into 16 principal directions (22.5-degree sectors centered on true north, northeast, and so on). Wind speeds are classified into seven wind speed categories. Calms are distributed, in the form of hourly-averaged wind speeds, into the first wind speed category representing the 0-0.5 m/s speed bin (Spector and Grant 2003).

Table 3-10. Wind Speed and Direction Frequency Distributions at 10 Meters (January 1, 1994 through December 31, 1998, based on Spector and Grant 2003, Attachment G)

Stability Class	Wind Speed (m/s)	Direction From															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
A	0.0-1.5	0	0	0	0	0	0	0	0.005	0.01	0.005	0.002	0.005	0.02	0	0.002	0
	1.5-3.0	0.051	0.044	0.032	0.027	0.039	0.017	0.022	0.015	0.022	0.027	0.039	0.024	0.027	0.054	0.113	0.047
	3.0-6.0	0.049	0.029	0.024	0.029	0.022	0.015	0.024	0.024	0.051	0.039	0.034	0.007	0.007	0.098	0.592	0.164
	6.0-9.0	0	0	0	0	0	0	0	0	0.002	0	0	0	0	0	0.005	0.015
	9.0-12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	<12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B	0.0-1.5	0	0.005	0.007	0.005	0	0	0.002	0.005	0	0.005	0.002	0	0.002	0.002	0	0
	1.5-3.0	0.059	0.069	0.054	0.032	0.037	0.024	0.037	0.047	0.056	0.083	0.122	0.064	0.083	0.164	0.291	0.083
	3.0-6.0	0.044	0.037	0.024	0.01	0.017	0.01	0.039	0.098	0.103	0.064	0.066	0.024	0.034	0.149	0.59	0.233
	6.0-9.0	0	0	0	0	0	0	0.005	0	0.007	0	0	0	0	0.002	0.002	0.005
	9.0-12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	<12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	0.0-1.5	0.002	0.022	0.012	0.007	0.005	0.007	0.012	0.005	0.012	0.007	0.007	0.007	0.005	0.02	0.017	0.01
	1.5-3.0	0.174	0.095	0.081	0.044	0.042	0.054	0.095	0.095	0.166	0.181	0.25	0.118	0.174	0.35	0.497	0.233
	3.0-6.0	0.073	0.027	0.027	0.015	0.049	0.034	0.108	0.103	0.181	0.071	0.073	0.047	0.051	0.176	0.835	0.289
	6.0-9.0	0	0	0	0	0.01	0	0.005	0.022	0	0	0	0	0	0.005	0.01	0.012
	9.0-12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	<12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D	0.0-1.5	0.321	0.34	0.223	0.22	0.252	0.343	0.468	0.441	0.695	0.72	0.629	0.615	0.832	1.05	0.906	0.36
	1.5-3.0	1.031	0.639	0.416	0.348	0.394	0.769	1.616	1.307	2.274	2.296	1.785	1.227	2.025	3.529	6.305	1.542
	3.0-6.0	0.308	0.113	0.071	0.286	0.313	0.495	1.709	1.951	1.506	0.693	0.443	0.235	0.524	1.809	4.447	1.205
	6.0-9.0	0	0	0	0.02	0.002	0.005	0.279	0.661	0.061	0.002	0.002	0	0	0.002	0.02	0.01
	9.0-12.0	0	0	0	0	0	0	0.01	0.071	0	0	0	0	0	0	0	0
	<12.0	0	0	0	0	0	0	0	0.007	0	0	0	0	0	0	0	0
E	0.0-1.5	0.093	0.093	0.078	0.132	0.233	0.279	0.673	1.408	1.983	1.092	0.686	0.654	0.71	0.776	0.428	0.147
	1.5-3.0	0.02	0.02	0.022	0.02	0.037	0.179	1.06	1.694	2.191	0.705	0.144	0.1	0.162	0.448	0.654	0.083
	3.0-6.0	0.002	0	0	0	0.01	0.017	0.487	1.165	0.771	0.095	0.007	0.007	0.007	0.005	0.069	0.007
	6.0-9.0	0	0	0	0	0	0	0.007	0.23	0.024	0	0	0	0	0	0	0
	9.0-12.0	0	0	0	0	0	0	0	0.027	0	0	0	0	0	0	0	0
	<12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F	0.0-1.5	0.039	0.024	0.049	0.042	0.103	0.235	0.546	1.741	1.547	0.676	0.406	0.272	0.166	0.069	0.049	0.056
	1.5-3.0	0	0.002	0	0	0.002	0.034	0.176	0.333	0.24	0.022	0.002	0.01	0.017	0.005	0.015	0.01
	3.0-6.0	0	0	0	0	0	0.002	0.007	0.024	0	0	0	0	0	0	0	0
	6.0-9.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9.0-12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	<12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G	0.0-1.5	0.012	0.04	0.015	0.029	0.039	0.13	0.637	2.931	1.704	0.411	0.218	0.125	0.039	0.01	0.02	0.022
	1.5-3.0	0	0	0	0	0.002	0.007	0.066	0.208	0.054	0	0	0.002	0.002	0	0	0
	3.0-6.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6.0-9.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9.0-12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	<12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3-11. Wind Speed and Direction Frequency Distributions at 60 Meters (January 1, 1994 through December 31, 1998, based on Spector and Grant 2003, Attachment H)

Stability Class	Wind Speed (m/s)	Direction From															
		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
A	0.0-1.5	0	0	0	0	0.002	0	0.002	0.002	0	0	0	0	0.002	0.002	0	0
	1.5-3.0	0.017	0.007	0.007	0.015	0.022	0.01	0.005	0.007	0.005	0.005	0.012	0.012	0.01	0.017	0.019	0.022
	3.0-6.0	0.005	0	0	0	0	0	0.002	0.002	0.017	0.053	0.051	0.027	0.039	0.211	0.296	0.099
	6.0-9.0	0.005	0	0	0	0	0	0.002	0.002	0.017	0.012	0.029	0.012	0.01	0.17	0.143	0.051
	9.0-12.0	0	0	0	0	0	0	0	0	0.002	0	0	0	0.002	0.005	0.007	0.002
	<12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B	0.0-1.5	0.007	0	0.002	0	0	0.005	0	0.005	0	0.002	0.002	0	0	0	0	0
	1.5-3.0	0.034	0.051	0.046	0.019	0.017	0.022	0.017	0.015	0.019	0.07	0.012	0.022	0.039	0.075	0.075	0.056
	3.0-6.0	0.053	0.051	0.039	0.024	0.034	0.01	0.036	0.07	0.083	0.109	0.175	0.102	0.092	0.386	0.408	0.175
	6.0-9.0	0	0	0	0	0	0.002	0.012	0.029	0.017	0.036	0.029	0.024	0.046	0.133	0.124	0.017
	9.0-12.0	0	0	0	0	0	0	0	0	0.005	0.002	0	0.002	0	0.015	0.002	0
	<12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	0.0-1.5	0.005	0.002	0.01	0.002	0.002	0.007	0.002	0	0.01	0.005	0.005	0.002	0	0.002	0.007	0.01
	1.5-3.0	0.126	0.067	0.068	0.034	0.034	0.034	0.066	0.309	0.036	0.068	0.073	0.07	0.085	0.116	0.129	0.129
	3.0-6.0	0.109	0.053	0.041	0.034	0.051	0.036	0.097	0.092	0.148	0.26	0.294	0.172	0.279	0.645	0.631	0.238
	6.0-9.0	0	0	0	0.002	0.017	0.01	0.01	0.034	0.027	0.022	0.041	0.032	0.034	0.192	0.099	0.036
	9.0-12.0	0	0	0	0	0.007	0	0.002	0.015	0	0	0	0	0.005	0.029	0.002	0
	<12.0	0	0	0	0	0	0	0	0.002	0	0	0	0	0	0	0	0
D	0.0-1.5	0.199	0.204	0.18	0.184	0.15	0.206	0.209	0.092	0.102	0.058	0.07	0.112	0.119	0.119	0.17	0.163
	1.5-3.0	0.757	0.568	0.468	0.255	0.306	0.531	0.9	0.551	0.393	0.587	0.99	1.063	1.281	1.42	1.272	0.755
	3.0-6.0	0.636	0.405	0.24	0.473	0.519	0.682	1.628	1.662	1.153	2.203	3.237	2.587	4.215	5.63	3.458	1.138
	6.0-9.0	0.034	0.002	0.15	0.024	0.029	0.08	0.548	0.784	0.675	0.495	0.718	0.439	1.228	1.815	0.781	0.112
	9.0-12.0	0	0	0	0.007	0.002	0	0.129	0.495	0.131	0.015	0.005	0.005	0.058	0.078	0.019	0
	<12.0	0	0	0	0	0	0	0.015	0.109	0.012	0	0	0	0	0	0	0
E	0.0-1.5	0.113	0.104	0.087	0.097	0.133	0.269	0.544	0.403	0.158	0.095	0.92	0.073	0.078	0.102	0.114	0.136
	1.5-3.0	0.175	0.083	0.078	0.085	0.143	0.294	1.23	0.818	0.432	0.422	0.371	0.485	0.446	0.4	0.325	0.158
	3.0-6.0	0.024	0.01	0.017	0.034	0.034	0.102	1.104	1.301	1.269	1.767	1.429	0.604	0.726	0.694	0.488	0.15
	6.0-9.0	0	0	0	0	0.015	0.002	0.121	0.502	0.548	0.33	0.167	0.015	0.017	0.024	0.015	0
	9.0-12.0	0	0	0	0	0	0	0	0.184	0.068	0	0	0	0	0.002	0	9
	<12.0	0	0	0	0	0	0	0	0.034	0.002	0	0	0	0	0	0	0
F	0.0-1.5	0.102	0.049	0.068	0.068	0.095	0.175	0.908	1.109	0.175	0.046	0.063	0.066	0.044	0.063	0.104	0.107
	1.5-3.0	0.019	0.01	0.07	0.007	0.17	0.085	0.946	0.694	0.243	0.211	0.112	0.136	0.121	0.133	0.126	0.083
	3.0-6.0	0	0	0	0	0	0.015	0.393	0.325	0.34	0.279	0.16	0.073	0.053	0.61	0.85	0.032
	6.0-9.0	0	0	0	0	0	0	0.007	0.019	0.002	0	0	0.002	0	0	0	0
	9.0-12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	<12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
G	0.0-1.5	0.036	0.046	0.068	0.041	0.066	0.153	0.769	1.344	0.24	0.067	0.061	0.078	0.049	0.051	0.075	0.058
	1.5-3.0	0.005	0.002	0	0.005	0.002	0.029	0.895	1.24	0.417	0.277	0.211	0.165	0.09	0.061	0.107	0.039
	3.0-6.0	0	0	0	0	0	0.005	0.216	0.267	0.296	0.403	0.119	0.017	0.019	0.015	0.015	0.002
	6.0-9.0	0	0	0	0	0	0	0	0	0.002	0.002	0	0	0	0	0	0
	9.0-12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	<12.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Air Quality

The EPA regulates National Ambient Air Quality Standards for criteria pollutants as defined in the Clean Air Act Titles I through VI, which are designed to protect human health and welfare from adverse effects. Cattaraugus County falls within the Southern Tier West Intrastate district (Air Quality Control Region 164), with the following status of attainment: “Better than National Standards/Unclassifiable (cannot be classified).”

Radiological emissions are regulated under the National Emission Standards for Hazardous Air Pollutants regulations. Non-radiological air emissions are regulated by the NYSDEC whose regulations dictate monitoring and compliance of stationary and mobile sources of air pollution. The WVDP was approved for a capping plan for non-radiological emissions. There were no cases where air permit or regulatory criteria were exceeded during calendar year 2007. (WVES and URS 2008)

3.5 Geology and Seismology

The geology and seismology of the site and surrounding areas are described in this section.

3.5.1 Regional Physiography

The Center is located within the glaciated northern portion of the Appalachian Plateau Province, a maturely dissected upland region underlain in western New York by shales and siltstones of Devonian age. This region is bounded on the north by the Erie Ontario Lowlands, on the east by the Tughill Upland, on the south by the unglaciated Appalachian Plateau, and on the west by the Interior Lowlands (Figure 3-51).

The Appalachian Plateau of western New York has been subjected to multiple glaciations during the Wisconsinan glacial period 38,000 to 14,500 years ago, that resulted in the deepening and oversteepening of many pre-glacial valleys and in the accumulation in those valleys of as much as 500 feet of glacial tills, lacustrine, and glaciofluvial sediments. The Center is situated within one of these north-trending valleys (Figure 3-3).

3.5.2 Site Stratigraphy

The Center is located in a glacial valley filled with upwards of 500 feet of Pleistocene age glacial tills, lacustrine, and glaciofluvial sediments that were deposited during the Wisconsinan glacial period. The thickness of glacial deposits at the site ranges from five feet or less on the uplands to 500 feet along the axis of the valley. These glacial sediments were deposited on shales and siltstones of the Middle Devonian Conneaut and Canadaway Groups which comprise the uppermost portion of the Paleozoic bedrock that underlies the Center.

The Paleozoic section in the vicinity of the Center is approximately 7,500 feet thick and is comprised predominantly of shales, siltstones, sandstones, carbonates, and evaporites of Cambrian through Devonian age (Table 3-12). Bedrock stratification in the area is nearly flat and essentially undeformed. However, bedrock is tilted to the south at an average dip of six to eight meters per kilometer (approximately 32 to 42 feet per mile). The Paleozoic bedrock underlying the Center was deposited on a basement of older Precambrian-age rocks that are part of the Grenville Orogenic Belt which extends from eastern Canada, through the United States, and into Mexico.

Table 3-12. Generalized Paleozoic Stratigraphic Section for Southwestern New York[1]

System	Series	Group	Unit	Lithology	Thickness (ft)
Pennsylvanian		Pottsville	Olean	Ss, Cgl	75 – 100
Mississippian		Pocono	Knapp	Ss, Cgl	50 – 100
Devonian	Upper	Conewango		Sh, Ss, Cgl	700
		Conneaut	Chadakoin	Sh, Ss	700
		Canadaway	Undiff	Sh, Ss	1100 – 1400
			Perrysburg	Sh, Ss	
		West Falls	Java	Sh, Ss	375 – 1250
			Nunda	Sh, Ss	
			Rhinestreet	Sh, Ss	
		Sonyea	Middlesex	Sh	0 – 400
		Genesee		Sh	0 – 450
	Middle		Tully	Ls	0 – 50
		Hamilton	Moscow	Sh	200 – 600
			Ludlowville	Sh	
			Skaneateles	Sh	
			Marcellus	Sh	
			Onondaga	Ls	30 – 235
	Lower	Tristates	Oriskany	Ss	0 – 40
		Helderberg	Manlius	Ls	0 – 10
			Rondout	Dol	
Silurian	Upper		Akron	Dol	0 – 15
		Salina	Camillus	Sh, Gyp	450 – 1850
			Syracuse	Dol, Sh, Salt	
			Vernon	Sh, Salt	
		Lockport	Lockport	Dol	150 – 250
		Clinton	Rochester	Sh	125
			Irondequoit	Ls	
	Lower		Sodus	Sh	75
			Reynales	Ls	
			Thorold	Ss	2 – 8

Table 3-12. Generalized Paleozoic Stratigraphic Section for Southwestern New York[1]

System	Series	Group	Unit	Lithology	Thickness (ft)
		Medina	Grimsby	Sh, Ss	75 – 160
			Whirlpool	Ss	0 – 25
Ordovician	Upper		Queenston	Sh	1100 – 1500
			Oswego	Ss	
			Lorraine	Sh	900 – 1000
			Utica	Sh	
	Middle	Trenton-Black River	Trenton	Ls	425 – 625
			Black River	Ls	225 – 550
	Lower	Beekmantown	Tribes Hill /Chuctanunda	Ls	0 – 550
Cambrian	Upper		Little Falls	Dol	0 – 350
			Galway (Theresa)	Dol, ss	575 – 1350
			Potsdam	Ss, Dol	75 – 500
Precambrian				Meta Rx	

NOTE: (1) From Jacobi and Fountain 1993.

LEGEND: Cgl = conglomerate, Dol = dolomite, Gyp – gypsum, Ls = limestone, Sh = shale, Ss = sandstone, Meta Rx = metamorphic rocks

Site Glacial Stratigraphy

The WVDP is underlain by upwards of 500 feet of Pleistocene-age glacial sediments that were deposited in a northwest-trending bedrock valley (Figure 3-52). The principal glacial units are identified below.

Surficial Sand and Gravel Unit

The surficial sand and gravel unit is a silty, sandy gravel deposit that incorporates two overlapping units of different ages and origins. The older unit, the slack-water sequence, is a Wisconsinan glaciofluvial deposit deposited in Buttermilk Creek Valley by draining glacial meltwaters of Lavery-age ice. The younger unit, the thick-bedded unit, is a post-glacial Holocene-age alluvial fan deposited by streams entering Buttermilk Creek Valley.

This unit is found at grade in the north plateau area of the Center where it has a maximum thickness of 41 feet in the center of the plateau. The sand and gravel unit thins to a few feet towards the northern, eastern, and southern margins of the north plateau where it has been truncated by the downward erosion of stream channels bounding the north plateau. The Process Building, Vitrification Facility, and adjacent facilities were built on these alluvial and glaciofluvial deposits (Figure 3-5).

The composition of the sand and gravel unit varies, but on the average it is a mixture of gravel (41 percent), sand (40 percent), silt (11 percent), and clay (8 percent). X-ray diffraction analysis indicates the mineralogy of this unit is dominated by quartz, illite, chlorite, and plagioclase with subordinate amounts of calcite and dolomite.

Surficial sands and gravels that are equivalent to the surficial sand and gravel unit in the north plateau are located in a number of areas within the Center (Figure 3-53). These sands and gravels have been quarried for gravel in three locations within the Center. Two of the gravel pits are located west of the Process Building on the west side of Rock Springs Road (Figure 3-8). These gravel pits are no longer in operation and were closed in accordance with NYSDEC regulations. The third gravel pit was located on the southeastern margin of the Center (Figure 3-9). This gravel pit was quarried by the Town of Ashford. The three gravel pit quarries do not contain any residual radioactive contamination from NFS or WVDP operations.

Lavery Till

The Lavery till is predominantly an olive-gray, silty-clay, glacial till with lenses of sand, gravel, silt, and rhythmic clay-silt laminations (Albanese, et al. 1983). This unit underlies the surficial sand and gravel unit in the north plateau and is exposed at the surface in the south plateau (Figure 3-53). As noted previously, the Lavery till is the host unit for both the SDA and the NDA.

The thickness of the Lavery till ranges from a few feet at its western margin to upwards of 130 feet to the east towards Buttermilk Creek. The Lavery till is a mixture of clay (50 percent), silt (30 percent), sand (18 percent), and gravel (two percent) (WVNSCO 1993e). The mineral composition of the till largely resembles that of local bedrock.

On the south plateau, the upper three to 16 feet of the Lavery till is weathered to a brown color and it contains root tubes and numerous fractures whose number decrease with depth. This upper layer is referred to as the weathered Lavery till and it is principally found in the south plateau of the Center. The weathered Lavery till is either absent or only a few inches thick on the north plateau.

X-ray diffraction analysis indicates the mineralogy of the weathered Lavery till is composed mainly of illite, quartz, calcite, kaolinite, plagioclase feldspar, and dolomite in decreasing quantities. The mineralogy of the unweathered Lavery till is composed mainly of quartz, illite, calcite, and kaolinite in decreasing abundance.

A borrow pit excavated into the Lavery till is located on the south plateau east of the SDA between Franks Creek and Buttermilk Creek (Figure 3-9). Clay was excavated from this pit beginning in the 1970's to provide clay fill for use at the SDA. The borrow pit did not contain any residual radioactive contamination from NFS or WVDP operations. The pit covered an area of less than one acre and it was closed by backfilling and grading in accordance with the NYSDEC Mined Land Reclamation Program in the early 2000's.

Lavery Till-Sand Unit

The Lavery till-sand unit is a lenticular shaped, silty, sand layer that is locally present within the Lavery till in the north plateau of the Center, immediately southeast of the

Process Building. It is thought to be either a pro-glacial sand deposit or a reworked kame deposit.

The till-sand is limited in areal extent, occurring on the north plateau in an east-west band approximately 750 feet wide. It lies within the upper 20 feet of the Lavery till (Figure 3-6) and is up to seven feet in thickness.

Re-examination of borehole logs from the north plateau in 2007 resulted in a re-evaluation of the areal extent of the Lavery till sand. From 1991 to 2007, the Lavery till sand was inferred to be present to the west, south, and southeast of the Process Building in a location that was hydraulically upgradient and cross-gradient to the north plateau groundwater plume. Earlier interpretations of the borehole logs considered a prominent clay-rich geologic horizon up to several feet in thickness as part of the unweathered Lavery till and the underlying sandy unit as the Lavery till sand.

Following the completion of the 1993 soil boring program to support the RCRA Facility Investigation, the 1993 borehole data indicated that the sand and gravel unit was composed of two distinct subunits, the thick-bedded unit and the underlying slack water sequence which are separated by the prominent clay-rich geologic horizon mentioned earlier. In 2007 it was noted that the elevation of the original Lavery till sand west and southwest of the Process Building was much shallower in elevation than the Lavery till sand to the southeast of the Process Building. It was determined that this western and southwestern portion was more consistent with the elevation of the slack water sequence of the sand and gravel unit and it was reclassified as part of the slack water sequence. As a result, the areal extent of the Lavery till sand was substantially reduced and it is now located southeast of the Process Building away from the north plateau groundwater plume as shown in Figure 3-64.

Kent Recessional Sequence

The Kent Recessional Sequence underlies the Lavery till on both the north and south plateaus and it includes both lacustrine and kame delta deposits; it is 30 to 60 feet thick at the WVDP. Lacustrine strata composed of laminated silt and clay forms the lower 30 feet of the Kent Recessional Sequence, which is present in the subsurface across the entire WVDP.

The lacustrine section is interpreted as forming in a pro-glacial lake that formed after the recession of the Kent ice margin (LaFleur 1979). The lacustrine section is composed mainly of quartz, illite, calcite, dolomite, and plagioclase feldspar in decreasing abundance. Calcite and dolomite together make up 12 to 20 percent of the lacustrine section by weight.

The lacustrine section in the eastern portion of the WVDP is overlain by upwards of 30 feet of sand and gravel believed to represent several kame deltas. (Figure 3-6) Several of these kame deltas are exposed along Buttermilk Creek and extend into the WVDP west of the NDA (Bergeron, et al. 1987).

The kame deltas were deposited during pauses in the recession of the Kent glacier through a pro-glacial lake that allowed the accumulation of kame deltas over lakebed silts and clays. This unit is underlain by at least two older silty-clay tills, the Kent till and the Olean till, which also are separated by similar lacustrine and glaciofluvial deposits (LaFleur 1979).

3.5.3 Site Geomorphology

Karst terrains are not developed at the Center as there are no occurrences of carbonate bedrock in the vicinity of the site. Natural subsidence of surficial soils has not been observed at the Center. However, small scale subsidence has been observed over some of the burial holes in the NDA and SDA during their operating history which are believed related to collapse and compaction of buried waste.

Geomorphological studies at the WVDP have focused on the major erosional processes acting on Buttermilk Creek and Franks Creek drainage basins near the WVDP. 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 3-13. Results vary based on location and methodology used in the measurements.

Channel Incision

The streams in the vicinity of the WVDP are at a relatively young stage of development and are characterized by steep profiles, V-shaped cross-sections, and little or no floodplains. At this stage, streams are able to move large quantities of sediment and erode their channels, a process referred to as channel incision or stream downcutting. The channel incision process is greatest during high-flow, high-energy rainfalls from prolonged soaking storms and brief, high-intensity thunderstorms.

These streams are also actively elongating their stream course or profiles through erosion upstream, a process referred to as headward advance. Headward advance starts when the movement of channel sediment is blocked by debris in the stream channel, which results in an abrupt change in the longitudinal profile of the stream bed, referred to as a knickpoint.

The stream erodes the knickpoint area by simple basal scour due to an attached impinging jet which undercuts the knickpoint face. Large blocks of material are then removed by cantilever mass failure and are then dispersed and washed downstream.

The shape of the channel cross-section changes from a U-shape, or flatbottom, with a low erosion rate to a V-shaped channel with a higher erosion rate. The knickpoint migration rate has been measured at 10.7 feet per year along Erdman Brook and 7.5 feet per year along Franks Creek (WVNSCO 1993d).

Slope Movement

Slope erosion within the Buttermilk Creek and Franks Creek drainage basin has been dominated by the formation of slump blocks along the stream valley wall. Slumps develop when water infiltrates into fractures within stream banks, causing an increase in soil pore pressures, which reduces the soil strength until the slope slumps down into the stream valley. Slumps also occur on the outside of a stream meander loop, where the increased stream flow velocity undercuts the base of the slope, decreasing the slope stability and accelerating the slumping process.

Three slump blocks have been identified along Franks Creek, one on Erdman Brook, and one on Quarry Creek. The blocks vary in length from about five feet to greater than 100 feet and tend to be about three to four feet in height and width when they initially form (WVNSCO 1993d).

On the basis of data collected from 1982 to 1991, the rate of downslope movement within the slump blocks on Erdman Brook is reported to range from 0.09 and 0.16 feet per year, which equates to a stream valley rim widening rate of approximately 0.07 to 0.12 feet per year.

Gullying

The steep walls of the stream channels within the Buttermilk Creek and Franks Creek drainage basin are susceptible to gully formation. Gullies are most likely to form along stream banks, where slumps and deep fractures are present, groundwater seeps are flowing, and the toe of the slope intersects the outside of a stream meander loop.

Gully formation occurs during thaws and after thunderstorms, where a concentrated stream of water flows over the side of a plateau, which is great enough to promote entrainment and removal of soil particles from the base of the gully. Surface water runoff into the gully contributes to gully growth by removing fallen debris at the base of the scarp.

More than 20 major and moderate-sized gullies have been identified near the WVDP. The initiation and growth of gullies may be the most rapid means for eroding the north and south plateaus. Gully advance was calculated at 1.2 feet per year near the SDA on the south plateau, and at 2.2 feet per year for two areas on the north plateau (WVNSCO 1993d).

Table 3-13. Summary of Erosion Rates Near the WVDP

Location	Erosion Rate (m/y)	Reference	Method
Sheet and Rill Erosion	0 to 0.0045	URS 2001	Erosion frame measurements (11-year average rate)
Deepening of Buttermilk Creek	0.0015 to 0.0021	LaFleur 1979	Carbon-14 date of terrace - depth of stream below terrace
Deepening of Buttermilk Creek	0.005	Boothroyd, et al. 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

Table 3-13. Summary of Erosion Rates Near the WVDP

Location	Erosion Rate (m/y)	Reference	Method
Downcutting of Buttermilk Creek	0.0032	USGS 2007	Optically stimulated luminescence age dating of 9 terraces along Buttermilk Creek
Buttermilk Creek Valley Rim Widening	4.9 to 5.8	Boothroyd, et al. 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 Soil Conservation Service TR-32 method
NP3 Gully Headward Advancement	0.7	Dames & Moore 1992	Gully advancement Soil Conservation Service TR-32 method
006 Gully Headward Advancement	0.7	Dames & Moore 1992	Gully advancement Soil Conservation Service TR-32 method

Slope Stability

Landslides provide an active mechanism to headward erosion for altering the landform in Buttermilk Creek Valley. Since landslides typically occur on slopes that have a relief of more than 10 feet, all currently eroding surfaces except the upland flats have potential for landslide development. Landslides range from three feet to 65 feet in height. Landsliding has been recognized since the mid-1970s along the small streams bordering the burial areas.

Stratigraphy affects both landslide location and development. Landsliding takes place along Buttermilk Creek where the Lavery till unit is dissected and the underlying lower sand and gravel of the Kent Recessional Sequence is exposed. These unconsolidated sands and gravels are removed by stream erosion, leaving the overlying till unsupported, followed by bank collapse, bringing down large blocks of the valley wall.

Landslides on the smaller streams draining the WVDP tend to occur as the channel cuts downward through the Lavery till, increasing the steepness of the stream banks, which eventually results in a series of short slide blocks. The blocks tend to be less than four feet high and occur along the slope from the edge of the plateau to the edge of the stream channel.

Creep occurs on the slopes of Buttermilk Creek and its tributaries at relatively slow rates of a few centimeters per year. A slope may have surface layers a few centimeters thick that move a few centimeters per year. If highly charged with water, the surface soils may liquefy and then move down-slope as mudflows. These mudflows occur most frequently in conjunction with landsliding.

Down-slope movement of till in the Buttermilk Creek Valley by landslides, slumping, and earthflow appears to be a continuous process measured at an average rate of five feet per year (Boothroyd, et al. 1982). The average volume of material delivered to Buttermilk Creek has been estimated to be 5,250 cubic feet per year (Boothroyd, et al. 1982).

Landslide mapping and monitoring suggests areas most susceptible to failure have the following characteristics: surface slopes exceeding eight degrees, slopes composed of silty and clayey tills or alluvial fan material, an active stream channel at the foot of slope, and little or no vegetative cover or heavy overburden (WVNSCO 1993c).

3.5.4 Regional Structure and Tectonics

The bedrock in the immediate vicinity of the Center is composed of interbedded shales, siltstones, and sandstones of the Upper Devonian Canadaway and Conneaut Groups (Rickard 1975). These and underlying Paleozoic sediments were deformed by compressive stresses originating from the Pennsylvanian-Permian Alleghanian orogeny which was the last major orogenic episode affecting the Appalachian mountain belt.

The major manifestations of this Alleghanian deformation are the prominent regional folds, thrust faults, and metamorphism that are found to the southeast in the Appalachian Valley and Ridge, Blue Ridge, and Piedmont Provinces (Figure 3-51). However, Alleghanian deformation did extend into the Appalachian Plateau Province of western New York where geologic structure such as joints, low amplitude folds, and thrust faults with small stratigraphic separation were developed in Paleozoic bedrock.

Alleghanian Folds and Thrust Faults

The Alleghanian deformation within the Appalachian Plateau of western New York principally affected the Upper Silurian Salina Group and overlying Devonian-age rocks (Table 3-14). During the Alleghanian orogeny, Paleozoic strata overlying the Salina Group was detached from underlying older strata by a decollement in the Salina Group. The stratigraphic section overlying this decollement was deformed, shortened, and translated to the northwest during the Alleghanian orogeny. The deformation of the strata overlying the decollement was manifested in the development of thrust faults, folds, and systematically oriented bedrock fractures.

The thrust faults that splayed off of the Salina decollement into the Lower to Middle Devonian section displaced and folded overlying bedding, producing an arcuate fold belt in western and central New York (Figure 3-54). The trend of this fold belt changes across New York State. Anticline fold axes, which trend roughly northeast-southwest in Chautauqua, Cattaraugus, and Allegany Counties, are observed to rotate to the east and become more east-west trending in Steuben and Chemung Counties.

These folds have low amplitudes with limb dips that are generally 1 to 2 degrees (Wedel 1932, Engelder and Geiser 1980). The low amplitudes of these folds are related to the small amount of stratigraphic separation that occurs across the thrust faults forming these folds. Higher amplitude folds, with corresponding higher limb dips and larger amount of separation across thrust faults, are found in the Valley and Ridge Province of Pennsylvania (Figure 3-51).

The Bass Islands Trend, a northeast trending, oil and gas producing structure extending from northeastern Ohio into western New York, is an example of an Alleghanian foreland fold and thrust structure. The Bass Islands Trend extends from the southwest corner of New York State, through Chautauqua Lake, northwestern Cattaraugus County, and into southern Erie County (Figure 3-55). The Bass Islands Trend is a regional fold that formed as the result of a thrust fault ramping up-section from the Salina Group into the overlying Lower Devonian section.

Bedrock mapping in the south branch of Cattaraugus Creek, approximately 12 miles west of the WVDP, indicates the presence of northeast-striking inclined bedding, folds, and faults which are attributed to faults associated with the Bass Islands Trend (Baudo and Jacobi 1999, Jacobi and Zhao 1999). Recent field mapping in the Ashford Hollow quadrangle, in which the Center is located, indicates the presence of northwest and northeast striking fractures that represent typical Alleghanian age cross-fold and fold-parallel fracture sets (Tober and Jacobi 2000).

Table 3-14. Summary of Observed Faults on Seismic Lines WVN-1 and BER83-2A(1)

Seismic Line	Shot Point Location Top of Fault	Displacement (feet)	Shot Point Location Base of Fault	Fault Apparent Dip Angle	Fault Type	Displace Trenton
WVN-1	155.5		156.5	82.1E	Reverse	No
	204.5	75	206.0	85.4E	Normal	No
	241.5	35	239.0	84.6W	Reverse	No
	265.0	23	264.5	88.9W	Reverse	?
	467.0	47	465.0	81.4W	Normal	No
	478.5	23	484.0	81.7E	Reverse	No
	486.0	35	502.0	50.9E	Reverse	No
	522.5	47	506.5	62.9W	Reverse	?
	557.0					
	601.0	70	585.0	61.3W	Reverse	Yes
	621.5	35	622.0	88.0E	Normal	No
	633.0	58	631.0	86.2W	Reverse	Yes
	668.5	58	667.5	87.7W	Reverse	Yes

Table 3-14. Summary of Observed Faults on Seismic Lines WVN-1 and BER83-2A[1]

Seismic Line	Shot Point Location Top of Fault	Displacement (feet)	Shot Point Location Base of Fault	Fault Apparent Dip Angle	Fault Type	Displace Trenton
	699.0	10	699.5	88.7E	Reverse	?
	740.0	28	737.5	87.6W	Normal	Yes
	766.0	287	764.5	88.6W	Normal	Yes
	797.5	57	792.0	65.7W	Reverse	No
	871.0	48	859.5	65.0W	Normal	Yes
BER83-2A	412.0	51	421.5	75.9S	Normal	Yes
	451.5	38	457.0	84.3S	Normal	Yes
	452.5	102	457.0	85.3S	Normal	Yes
	519.0		521.0	81.0S	Normal	No
	681.0		684.0	84.3S	Normal	No
	709.5	13	714.0	85.0S	Normal	Yes
	748.0		752.0	83.4S	Normal	No
	779.5	26	791.5	70.1S	Reverse	No
	800.0	39	822.0	60.7S	Reverse	No
	828.0	12	842.0	87.2S	Normal	No

NOTE: (1) From Bay Geophysical 2001.

The presence of northeast trending fracture intensification domains suggest thrust faults associated with the Bass Island Trend or other Alleghanian thrust faults may extend eastward into the Ashford Hollow quadrangle (Tober and Jacobi 2000). Alleghanian folds and thrust faults are no longer tectonically active or seismically active. As a result there is no rate of deformation associated with these structures.

Bedrock Fractures

Fractures are ubiquitous in the Paleozoic bedrock of western New York. Systematically oriented fracture or joint sets have been identified in the Paleozoic bedrock of the Appalachian Plateau of western New York (Engelder and Geiser 1980, Fakundiny, et al. 1978, Geiser and Engelder 1983, McKinney, Gross and Engelder 1991, Jacobi, et al. 1996, Zhao and Jacobi 1997). These joint sets are part of a regional fracture system that formed primarily in response to compressive stresses originating during the Pennsylvanian-Permian Alleghanian Orogeny. However, other joint sets identified in bedrock in western New York may have originated in response to the contemporary east-northeast regional stress field currently affecting eastern North America (Engelder and Geiser 1980, Geiser and Engelder 1983, Gross and Engelder 1991), or post-Precambrian movements along the Clarendon-Linden Fault System (Jacobi, et al. 1996, Zhao and Jacobi 1997).

Three vertical joint sets in Paleozoic bedrock from western New York, including rocks from the Upper Devonian Canadaway and Conneaut Groups have been identified (Engelder and Geiser 1980). Two of these joint sets, trending approximately north 45° west (N45W) and N45E, were produced from the compressive stresses generated during the Alleghanian orogeny (Figure 3-54).

The N45E joint set parallels fold axes in the Appalachian plateau and formed during the Alleghanian-age compression that produced these folds. The N45W joint set is generally perpendicular to fold trends in this area and was produced before the folding of bedrock in the Appalachian Plateau (Figure 3-54). A third set trending N60E is found throughout New York and probably formed under the current east-northeast regional compressive stress field. These joints sets are cells found in the Devonian bedrock in and around the Center.

Eight systematic joint sets were identified in rocks from the Canadaway and Conneaut Groups in Allegany County (Engelder and Geiser 1980, Zhao and Jacobi 1997). The strike of these joint sets ranged from west-northwest to east-northeast and they were produced at various stages of the Alleghanian deformation that affected western New York. The orientation of these joint sets reflects changes in the orientation of the principal stresses that were associated with the deformation of the Appalachian plateau of western New York, beginning with north-northwest trending cross fold joints followed by the progressive development of joint sets to the east and west.

Regional Northwest Trending Lineaments and Structures

Regional northwest trending lineaments have been identified across the eastern United States based on analyses of regional gravity and magnetic anomaly trends. These lineaments are typically hundreds of kilometers in length and are believed to be the surface expression of regional crustal fracture zones that extend into the crust and which juxtapose rocks of differing densities and magnetic susceptibility. Examples of these lineaments include the Tyrone-Mt. Union lineament in Pennsylvania and the Lawrenceville-Attica lineament in New York (Figure 3-56).

The Tyrone-Mt. Union lineament is believed to extend southeast from Lake Erie to beyond the Atlantic coastline of the United States where it is thought to coincide with transform faults associated with the mid-Atlantic ridge system. Subsurface geologic mapping and analysis of regional magnetic and gravity patterns suggest significant lateral displacement of at least 31 to 37 miles across this lineament.

The Lawrenceville-Attica lineament in western New York extends northwest from Lawrenceville, New York through Attica, New York and into western Lake Ontario. The Lawrenceville-Attica lineament may be contiguous with the Georgian Bay Linear Zone, a northwest-trending zone extending from Georgian Bay in southern Ontario southeastward in western New York State.

The Georgian Bay Linear Zone is an 18.6-mile wide structural zone that extends from Georgian Bay to the southeast across southern Ontario, western Lake Ontario, and into western New York (Figure 3-56). The Georgian Bay Linear Zone has been delineated by a set of northwest-trending aeromagnetic lineaments, one of which parallels the straight eastern shoreline of Georgian Bay.

A variety of neotectonic structures and features have been identified in surficial bedrock and in lake bed sediments within the Georgian Bay Linear Zone. These include faults and bedrock pop-ups and linear pockmarks and linear acoustic backscatter anomalies imaged on seismic sidescan profiles in lake bed sediments that may represent bedrock fractures and faults.

Clarendon-Linden Fault System

The Clarendon-Linden Fault System is located approximately 19 miles east of the Center (Figure 3-56) and is comprised of at least five north-south striking, high-angle faults which extend southward from Lake Ontario through Orleans, Genesee, and Wyoming Counties, and into Allegany County.

Stratigraphic relationships indicate that the overall sense of movement across the Clarendon-Linden Fault System is consistent with reverse faulting from east to west with up to 330 feet of stratigraphic separation across the Clarendon-Linden Fault System. Recent bedrock mapping and soil gas surveying in Allegany County suggests the Clarendon-Linden Fault System extends further south into Allegany County based on the presence of at least seven north-south striking fracture intensification domains and associated soil gas anomalies.

The southwest trending Attica Splay has been interpreted to splay off of the western north-south trending fault approximately 0.75 mile south of Batavia (Figure 3-56) and to continue to the southwest through Alexander and Attica, New York to a point approximately 1.25 miles northwest of Varysburg, New York. Seismic reflection data suggest the presence of at least two east-dipping faults extending from the Precambrian basement into the Paleozoic section forming a graben structure with a stratigraphic separation of 74 - 148 feet (Fakundiny, et al. 1978). The eastern fault is a reverse fault showing east to west movement and the western fault is a normal fault showing west to east movement.

Seismic reflection profiling suggests that the faults comprising the Clarendon-Linden Fault System are contiguous with faults located within the Grenville Province Central Metasedimentary Belt which underlies the Paleozoic bedrock of western New York. The Central Metasedimentary Belt has been subdivided into two distinct terrains, the Elzevir terrain and the Frontenac terrain, which are separated by the Elzevir-Frontenac Boundary Zone, a northeast trending six- to 22-miles wide crustal shear zone. The eastern boundary of the Elzevir-Frontenac Boundary Zone, which is known as the Maberly shear zone in southern Ontario, appears contiguous with the Clarendon-Linden Fault System in Western New York.

The Clarendon-Linden Fault System has been active at least since the Middle Ordovician and has displayed a complicated movement history alternating from normal or extensional faulting, to reverse or compressional faulting during the Paleozoic. The episodic movement along the Clarendon-Linden Fault System during the Paleozoic occurred in response to orogenic induced subsidence of the Appalachian basin. Normal faulting with down-to the-east motion occurred when the basin axis was located east of the Clarendon-Linden Fault System. Reverse faulting with east to west movement sense occurred when the basin axis was located west of the Clarendon-Linden Fault System.

WVDP Seismic Reflection Survey

In June 2001, the WVDP collected nearly 18 miles of seismic reflection data along an east-west line in southern Erie County, approximately 5 miles north of the Center (Bay Geophysical 2001). (See Figure 3-57.) This seismic survey was designed to image any north or northeast-trending structures in the Precambrian basement and overlying Paleozoic bedrock.

The WVDP also reviewed approximately 16 miles of reprocessed seismic reflection data collected in 1983 along a north-south line along Route 219 in Erie and Cattaraugus Counties. This line was reviewed to evaluate whether any east-west trending structures were present in the Precambrian basement and Paleozoic bedrock near the Center.

Both seismic lines indicate the presence of numerous high-angle faults originating in Grenville-age basement which extend up-section into Middle Ordovician or Middle Devonian strata. (See Figure 3-57) The majority of these faults terminate near the Middle Ordovician Trenton Group. These faults have apparent dips of 50 to 89.45° to the west, east, or south, show reverse and normal offset of bedding, and have up to 300 feet of stratigraphic separation.

Strata overlying some of the fault terminations are folded above the Middle Devonian Onondaga Formation, suggesting that these faults were emplaced or reactivated after the deposition of the uppermost folded unit. The most recent period of movement along these faults cannot be determined based on a lack of definitive age-dating relationships. Two faults near Sardinia, New York were interpreted to continue up-section through the Middle Devonian Onondaga Formation. These west-dipping normal faults show up to 300 feet of estimated stratigraphic separation (Figure 3-57).

A series of east- and south dipping high-angle faults spaced at intervals of 500 to 4,500 feet were interpreted in the Silurian to Devonian section northwest of Springville, New York. These faults originate in the Silurian Salina Group and cut up-section to the northwest through the Middle Devonian Onondaga Formation. These are believed to be thrust faults associated with the Bass Islands Trend.

3.5.5 Historical Seismicity

Earthquake catalogs maintained by the U.S. Geological Survey's National Earthquake Information Center were used to identify historical earthquakes with a magnitude of three or greater and a Modified Mercalli Intensity of IV or more within a 200-mile radius of the site. Three of the National Earthquake Information Center earthquake catalogs were queried to obtain information on earthquake activity in western New York. These included the Preliminary Determination of Epicenters, the Significant U.S. Earthquakes, and the Eastern, Central, and Mountain States of the United States catalogs. The historical seismicity search also utilized historical events identified in the Safety Analysis Report for Waste Processing and Support Activities (WVNSCO 2007). Historical seismicity within 200 miles of the site is summarized in Table 3-15. Table 3-15 also lists the date, location, time, depth, intensity, magnitude, distance, and information source.

From 1840 to 2003, there have been 45 recorded earthquakes with epicentral magnitudes of 3 or greater and Modified Mercalli Intensity of IV or greater within 200 miles of the WVDP. None of these earthquakes were reported to have caused landsliding or liquefaction events in the vicinity of the site. The geographic distribution of this seismicity is shown on Figure 3-55.

Table 3-15. Historical Seismicity Within 320 Kilometers (200 Miles) of Site[(1)]
(Only events with a magnitude $\geq$ 3 or a MMI intensity $\geq$ IV are listed)

Date	Latitude (°N)	Longitude (°W)	Origin Time	Depth (km)	Intensity (MMI)	Magnitude (m_b)	Distance (km)	NEIC Catalog
1840 9/10	43.20	79.90	-	-	5←	-	113.7	Unk
1853 3/12	43.70	75.50	-	-	6←	-	302.3	Unk
1853 3/13	43.10	79.40	-	-	5←	-	74.9	Unk
1857 10/23	43.20	78.60	2015	-	6←	4.3 FA	83	USHIS
1873 7/6	43.00	79.50	-	-	6←	-	73.6	Unk
1900 4/9	41.40	81.90	14	-	6←	3.4 FA	293	USHIS
1906 6/27	41.40	81.60	-	-	5	4.2	269.8	Unk
1912 5/27	43.20	79.70	-	-	5←	-	100.6	Unk
1914 02/10	44.98	76.92	1831	-	7	5.20 FA	313	Unk
1927 1/29	40.90	81.20	-	-	5	-	275.8	Unk
1928 9/9	41.50	82.00	21	-	5	3.70 FA	297	SRA
1929 8/12	42.91	78.40	112448.70	9	8←	5.20 Mn	54*	SRA/ USHIS
1929 12/2	42.80	78.30	-	-	5←	-	47.4*	Unk
1932 1/21	41.10	81.50	-	-	5	-	280.9	Unk
1934 10/29	42.00	80.20	-	-	5←	-	134.9	Unk

Table 3-15. Historical Seismicity Within 320 Kilometers (200 Miles) of Site[(1)]
(Only events with a magnitude ≥ 3 or a MMI intensity ≥ IV are listed)

Date	Latitude (°N)	Longitude (°W)	Origin Time	Depth (km)	Intensity (MMI)	Magnitude (m_b)	Distance (km)	NEIC Catalog
1938 7/15	40.68	78.43	224612	-	6←	3.30 FA	233	SRA/ USHIS
1943 3/09	41.63	81.31	032524.90	7	5	4.50 Mn	238	SRA/ USHIS
1951 12/03	41.60	81.40	0702	-	4	3.20 FA	246	SRA
1954 01/31	42.90	77.3	12:30:00	-	4	3.1	121	NCEER
1954 02/1	43.03	76.65	00:37:50	-		3.3	178	NCEER
1954 02/21	41.20	75.90	-	-	+7←	-	288.5	Unk
1954 04/27	43.10	79.20	02:14:08	-		4.1	85	NCEER
1955 5/26	41.50	81.70	-	-	5	3.8	272.0	Unk
1955 6/29	41.50	81.70	-	-	5	3.8	272.0	Unk
1955 8/16	42.90	78.30	-	-	5	-	53.5*	Unk
1958 5/1	41.50	81.70	-	-	5	4.0	272.0	Unk
1958 07/22	43.00	79.50	01:46:40	-		4.4	92	NCEER
1958 08/4	43.13	80.00	20:25:58	-	4	3.8	134	NCEER
1958 08/22	43.00	79.00	14:25:05	-		3.6	67	NCEER
1962 3/27	43.00	79.30	-	-	5←	3.0	61.0	Unk
1963 01/30	44.00	75.90	1450	-	4	3.00 ML	281	SRA
1964 02/13	40.38	77.96	194640.80	1	5	3.30 Mn	237	SRA
1964 05/12	40.30	76.41	064510.70	1	6	4.50 mb	303	SRA/ USHIS
1965 07/16	43.20	78.50	110655	-	4	3.50 ML	84	SRA
1965 08/28	43.00	78.10	0155	-	4	3.10 ML	75	SRA
1966 1/1	42.84	78.25	132339	0	6←	4.70 mb	54*	SRA/ USHIS
1967 6/13	42.84	78.23	190855.50	1	6←	4.40 Mn	54*	SRA/ USHIS
1980 6/6	43.56	75.23	131552	1	5	3.80 UK	304	PDE
1980 6/6	43.57	75.14	131552.90	1	5	3.80 Mn	311	SRA
1983 10/4	43.44	79.79	171840	2	4	3.10 Mn	144	PDE

Table 3-15. Historical Seismicity Within 320 Kilometers (200 Miles) of Site[1]
(Only events with a magnitude ≥ 3 or a MMI intensity ≥ IV are listed)

Date	Latitude (°N)	Longitude (°W)	Origin Time	Depth (km)	Intensity (MMI)	Magnitude (m_b)	Distance (km)	NEIC Catalog
1986 1/31	41.65	81.16	164642.30	2	6	5.00 mb	226	SRA/ USHIS
1986 1/31	41.65	81.16	164643.33	10	6	5.00 mb	226	PDE
1987 7/13	41.90	80.77	054917.43	5	4	3.80 Mn	185	PDE
1991 1/26	41.54	81.45	032122.61	5	5	3.40 Mn	253	PDE
1991 8/15	40.79	77.66	071607.15	1	5	3.00 Mn	202	PDE
1992 3/15	41.91	81.25	061355.22	5	4	3.50 Mn	222	PDE
1993 10/16	41.70	81.01	063005.32	5	4	3.60 Mn	212	PDE
1995 5/25	42.99	78.83	142232.69	5	4	3.00 Mn	62	PDE
1998 9/25	41.49	80.39	195252.07	5	6	5.20 Mn	179	PDE
2001 1/26	41.94	80.80	030320.06	5	5	4.40 Mn	186	PDE
2003 6/30	41.80	81.20	192117.20	4	4	3.60 Mn	223	PDE
2005 10/20	44.68	80.48	211628.75	11		4.20 Mn	316	PDE
2006 6/20	41.84	81.23	201118.54	5		3.80 Mn	239	PDE
2007 3/12	41.28	81.38	231816.41	5		3.70 Mn	271	PDE

NOTE: (1) From earthquake catalogs of the U.S. Geological Survey's National Earthquake Information Center. The coordinates used in the search criteria were latitude 42.450N and longitude 78.654W, which correspond to a point near the process Building.

LEGEND: ←Could have been felt at site * Associated with Clarendon-Linden Structure

Origin time is the time the earthquake occurred.

PDE = NEIC Preliminary Determination of Epicenters
NCEER = National Center for Earthquake Engineering Research
USHIS = NEIC Significant U.S. Earthquakes
SRA = NEIC Eastern, Central, and Mountain States of the United States
MMI = Modified Mercalli Intensity
Mn = Nuttli magnitude
ML = Local magnitude
Mb = Compressional Body Wave (P-wave) Magnitude
FA = Felt Area Magnitude
UK = Unknown Magnitude

The Buffalo-Lockport earthquake of October 23, 1857 affected an area of approximately 18,000 square miles. The epicentral intensity of VI was felt in an area 75 miles long, from north-northeast to south-southwest, and 62 miles wide. This earthquake was felt at Hamilton, Petersborough, and Port Hope in Ontario and at Rochester, New York, Warren, Pennsylvania, and Dayton, Ohio.

The August 12, 1929 earthquake occurred near Attica, New York, about 30 miles northeast of the WVDP. The affected area of approximately 50,000 square miles included parts of Canada. The earthquake was felt most strongly in the eastern part of the city of Attica and immediately to the east. There was less effect on structures immediately to the south of the epicenter, but changes in groundwater conditions were noted. Based on the reported damage, an epicentral intensity of VII and a Compressional Body Wave magnitude m_b = 5.2 was assigned to the 1929 Attica event (WVNSCO 2007).

The Attica earthquakes of January 1, 1966 (Modified Mercalli Intensity VI) were felt over approximately 3,500 square miles of western New York, northwestern Pennsylvania, and southern Ontario, and the main shock was most strongly felt at Varysburg, about eight miles southwest of Attica. The Attica earthquake of June 13, 1967 (Modified Mercalli Intensity VI) was felt over an area of about 3,000 square miles in western New York. Slight damage was sustained at Attica and at Alabama, New York, where the shock was felt by many people. Focal mechanism solutions of these earthquakes indicate focal depths of approximately 1.2 to 1.9 miles and a combination of right-lateral strike-slip and reverse faulting on planes parallel to the northerly trend of the Clarendon-Linden Structure (Herrmann 1978).

3.5.6 Evaluation of Seismic Hazard

A site-specific probabilistic seismic hazard analysis of the Center was performed to estimate the levels of horizontal ground motions that could be exceeded at specified annual return periods at the site (Wong, et al. 2004). The hazard for the site was computed for a hard rock condition. Site response analyses were also performed for the north and south plateau areas of the site to evaluate the potential ground motion amplification resulting from soils and unconsolidated sediments that underlie the site, such as the Surficial Sand and Gravel Unit, Lavery till, and Kent Recessional Sequence.

A total of 19 seismic sources were included in the probabilistic hazard analysis, including four fault systems or fault zones and 15 regional seismic source zones. The fault systems considered in the analysis included the Clarendon-Linden fault zone, the Charleston fault zone, the New Madrid fault system, and the Wabash Valley fault system. The analysis considered the Southern Great Lakes seismic source zone in which the Clarendon-Linden fault zone is located. Regional seismic source zones were included in the analysis to incorporate the hazard associated with earthquakes affiliated with buried or unknown faults.

Peak horizontal ground acceleration and 0.1 and 1.0 second horizontal spectral accelerations) were calculated for bedrock at the Center for three DOE-specified return periods (Table 3-16). Figure 3-58 shows the various hazard curves for peak ground acceleration at the site including the mean and median curves. The hazard curves for the 1.0 second SA are shown in Figure 3-59.

The analysis indicates the largest contributor to the hazard at the Center is the Clarendon-Linden fault zone at almost all return periods, whereas seismicity within the Southern Great Lakes seismic source zone is the second most important contributor to seismic hazard at the site (Figure 3-60).

Table 3-16 Site-Specific Mean Spectral Accelerations on Hard Rock (g's)[1]

Return Period (yrs)	PGA	0.1 sec SA	1.0 sec SA
500	0.04	0.07	0.02
1,000	0.05	0.11	0.03
2,500	0.10	0.20	0.06

NOTE: (1) From Wong, et al. 2004.
LEGEND: PGA = peak ground acceleration, SA = spectral acceleration.

Site response analyses were performed for the north and south plateau areas for return periods of 500 and 2,500 years to evaluate potential ground motion amplification resulting from the unconsolidated glacial sediments underlying these areas (Tables 3-17 and 3-18). The increased peak ground acceleration in the north plateau evaluation suggests slight amplification of ground motions in the north plateau area of the site (Tables 3-16 and 3-17). The south plateau evaluation suggests ground motions for the 500 year return period are deamplified whereas ground motions are slightly amplified for the 2,500 year return period (Tables 3-16 and 3-18).

Table 3-17 Site-Specific Mean Spectral Accelerations on Soil (g's) for the North Plateau[1]

Return Period (yrs)	PGA	0.1 sec SA	1.0 sec SA
500	0.05	0.09	0.04
2500	0.14	0.24	0.11

NOTE: (1) From Wong, et al. 2004.
LEGEND: PGA = peak ground acceleration, SA = spectral acceleration.

Table 3-18 Site-Specific Mean Spectral Accelerations on Soil (g's) for the South Plateau

Return Period (yrs)	PGA	0.1 sec SA	1.0 sec SA
500	0.03	0.08	0.05
2500	0.11	0.22	0.14

NOTE: (1) From Wong, et al. 2004.
LEGEND: PGA = peak ground acceleration, SA = spectral acceleration.

3.6 Surface Hydrology

3.6.1 Hydrologic Description

The WVDP watershed is drained by three named streams: Quarry Creek, Franks Creek, and Erdman Brook (see Figure 3-3). Erdman Brook and Quarry Creek are tributaries to Franks Creek, which in turn flows into Buttermilk Creek. The WVDP drainage basin is approximately 1,200 acres.

The point where all surface runoff from the site reaches a single stream channel (the watershed outfall) is located at the confluence of Franks Creek and Quarry Creek, north of the main project facilities. On the WVDP site, numerous drainage ditches and culverts direct flow away from roadways and facilities to the channels of the stream headwaters that are located on or around the site. The most significant of these ditches and culverts would be those associated with the site railroad spur and Rock Springs Road.

Erdman Brook has a 140-acre drainage area and drains the central portion of the developed project premises, including a large portion of the disposal areas, the areas surrounding the lagoon system, the Process Building, warehouse areas, and a major part of the parking lots. Following treatment, the project's waste waters are also discharged to this brook.

Erdman Brook flows from a height of over 1,400 feet above mean sea level west of Rock Springs Road to 1,305 feet above mean sea level at the confluence with Franks Creek northeast of the lagoons. It flows through the project facilities for about 3,000 feet.

Quarry Creek drains the largest area of the three named streams (740 acres) and receives runoff from the HLW Tank Farm, the north half of the northern parking lot, and the Lag Storage Buildings. It flows from an elevation of 1,930 feet west of Dutch Hill Road to 1,245 feet at its confluence with Franks Creek. The segment that flows along the north side of the project is about 3,500 feet in length.

Franks Creek has a drainage area of 295 acres and receives runoff from the east side of the project, including the Drum Cell, part of the SDA, and the Construction and Demolition Debris Landfill. Franks Creek flows into Buttermilk Creek about 2,000 feet downstream of its confluence with Quarry Creek. It flows from an elevation of 1,790 feet above mean sea level west of Rock Springs Road, to 1,245 feet at the Quarry Creek confluence, to 1,180 feet at the Buttermilk Creek confluence. About 6,000 feet of its length lies adjacent to WVDP facilities. (WVNSCO 1993c)

Buttermilk Creek, shown in Figure 3-2, roughly bisects the Center property and flows in a northwestwards direction to its confluence with Cattaraugus Creek at the northwest end of the Center. Several tributary (perennial) streams flow into Buttermilk Creek in the Center (Figure 3-61).

The flow length of Buttermilk Creek through the Center is about 4.7 miles. Within the Buttermilk Creek watershed, a small 18-acre sub-basin on the east side of Buttermilk Creek drains the area around the Bulk Storage Warehouse.

Buttermilk Creek lies in a deep, narrow valley cut into glacial deposits, with a downstream portion down-cut to shale bedrock. The reach of stream to the east of the WVDP facilities has down-cut through the Lavery till and the underlying Kent Recessional Sequence, and is presently incising the Kent till. The Kent Recessional Sequence is discussed below.

The stream invert drops from an elevation of 1,310 feet above mean sea level at the southern Center boundary, to 1,215 feet at the northern edge of the Project facilities, to 1,110 feet at the confluence with Cattaraugus Creek. The drainage area of the Buttermilk Creek basin has been estimated to be 19,600 acres (Boothroyd, et al. 1982).

Buttermilk Creek flows at an average rate of 46 cubic feet per second to its confluence with Cattaraugus Creek. Peak flows were 340.3 cubic feet per second at the confluence of Quarry Creek and Franks Creek, 161 cubic feet per second where Franks Creek leaves the project premises, and 60 cubic feet per second in Erdman Brook downstream of the SDA. Peak flow measured at the U.S. Geological Survey USGS gauge station at the Bond Road Bridge over Buttermilk Creek (which operated from 1962 to 1968) was 3,910 cubic feet per second on September 28, 1967. The historic high-water level of 1,358.6 feet above mean sea level in the reservoirs was recorded on the same day.

Cattaraugus Creek flows westward generally at a rate of 353 cubic feet per second from the Buttermilk Creek confluence to Lake Erie, 39 miles downstream. The total drainage area is estimated to be 524 square miles. A gauging station has been maintained at Gowanda, New York since 1939. The drainage basin to this point is estimated to be about 432 square miles. The drainage area of Cattaraugus Creek upstream of the Buttermilk Creek confluence is an estimated 220 square miles.

A small hydroelectric dam and water impoundment is located on Cattaraugus Creek about 1,000 feet upstream of where the Scoby Road bridge was located, southwest of Springville, New York. Neither Buttermilk Creek nor Cattaraugus Creek downstream of the WVDP are used as a regular source of potable water. Cattaraugus Creek downstream of Buttermilk Creek is a popular fishing and canoeing/rafting waterway. As such, Cattaraugus Creek water, fish, and sediments are monitored as part of the WVDP environmental monitoring program.

The WVDP obtains potable and process water from two water supply reservoirs located south of the main plant facilities (see Figure 3-12). The reservoirs were formed by damming headwater tributaries to Buttermilk Creek and collect drainage from numerous small streams over a 3,100-acre drainage basin, of which 2,000 acres drain directly to Reservoir 1 and 1,100 acres drain directly to Reservoir 2. The storage capacity of the reservoirs is 19,815,435 cubic feet at 1,353 above sea level, and 17,857,265 cubic feet at 1,350.5 above sea level. An emergency spillway is located at the south end of Reservoir 1.

As explained in Section 3.1.3, the Low Level Waste Treatment Facility includes four in-series lagoons (lagoons 2, 3, 4, and 5). The largest is Lagoon 3, which has a capacity of 467,900 cubic feet. Lagoon 3 is the final lagoon in the system before the wastewater is discharged into Erdman Brook.

The site Sewage Treatment Plant discharges to a gully that flows into Erdman Brook. A former equalization basin for the Sewage Treatment Plant in 2004 served as a sludge pond for utility room discharges.

3.6.2 WVDP Effluents

WVDP effluents discharged to surface waters must meet limits prescribed by the NYSDEC for non-radiological parameters in a State Pollutant Discharge Elimination System permit and by DOE for radiological parameters. Discharges are monitored to ensure that all standards are met. Monitoring is performed at the point of effluent discharge and several surface water drainage locations. There are two permitted discharge locations at the WVDP:

- Outfall 007 (WNSP007) with an average daily flow of approximately 10,000 gallons (WVES and URS 2008). This outfall includes waters from the site sanitary and industrial wastewater treatment facility, and
- Outfall 001 (WNSP001) is batch discharged from lagoon 3. Approximately seven batches are discharged annually, totaling approximately 13.5 million gallons per year, including water from the Low Level Waste Treatment Facility.

3.6.3 Influence of Flooding on Site

Franks Creek, Quarry Creek, and Erdman Brook are located in deep steep-sided valleys bounding the north and south plateaus. Historical evidence and computer modeling indicate that flood conditions, including the probable maximum flood, will not result in stream flows overtopping their banks and flooding the north or south plateau. Therefore, the effects on the WVDP of flooding by these creeks are negligible, as supported by historical data. Figure 3-4 shows the 100-year floodplains of these streams.

An analysis of the probable maximum flood has been evaluated (URS 2008). The probable maximum flood is generally more conservative than the 500-year flood because it is defined as the flood resulting from the most severe combination of meteorological and hydrological conditions (DOE 2002).

Peak discharges of the probable maximum flood were generated for the sub-areas constituting the watershed using the SCS TR-20 computer modeling program (USSCS 1983). These discharges were then used to determine the depth of flow at four stream locations adjacent to site facilities. The results of these analyses demonstrate that the depths of flow associated with the probable maximum flood on area streams are well below the elevations of site facilities

The results of this analysis indicate that the probable maximum flood floodplain is very similar to the 100-year floodplain, particularly in areas adjacent to the developed portions of the site including areas where waste is stored or buried (URS 2008). Most of the stream channels near the developed portions of the north plateau area have relatively steep sides and the probable maximum flood flow remains in these channels. The probable maximum flood floodplain is wider than the 100-year floodplain in areas where the topography is relatively flat, such as the extreme upper reaches of Erdman Brook and Franks Creek.

Indirect short-term impacts, including stream bank failure and gully head advancement in the event of high stream flows could impact Lagoons 2 and 3 in WMA 2, the NDA in WMA 7, and site access roads in several locations of the project premises.

3.6.4 Water Use

Current Water Use of Buttermilk Creek

The project premises lies entirely within the Buttermilk Creek watershed. The Center property is adjacent to Buttermilk Creek nearly the entire stream length from its intersection with the Buffalo and Pittsburgh Railroad to its outlet into Cattaraugus Creek, approximately 3,000 feet upstream of the Felton Bridge. There is no public or private use of stream water within the Center property.

Current Water Use of Cattaraugus Creek

From the Buttermilk Creek outlet, Cattaraugus Creek flows approximately 39 miles to Lake Erie. The use of water within Cattaraugus Creek varies along the length of the stream.

Downstream of the Buttermilk outlet, Cattaraugus Creek flows through the Zoar Valley Multiple Use Area, Deer Lick Nature Sanctuary, the town of Gowanda, the Cattaraugus Indian Reservation, the town of Versailles, the town of Irving, and the town of Hanover, and outlets into Lake Erie at the hamlet of Sunset Bay. Cattaraugus Creek is not used as a source of public drinking water, as noted previously. Land use adjacent to Cattaraugus Creek is comprised of agricultural, forest, residential, recreational, and commercial. Some water is taken from Cattaraugus Creek for irrigation purposes.

The segment of Cattaraugus Creek which flows through the Zoar Valley Multiple Use Area is used for unsupervised swimming, rafting, and canoeing where water depth permits. Motorized boating is generally limited to within two miles of Lake Erie. Sunset Bay at the mouth of Cattaraugus Creek is a dense residential area with mixed recreation such as swimming beaches, marinas, boating and fishing.

Cattaraugus Creek downstream of the Springville dam provides habitat for lake-based fisheries, is a popular recreational fishing area, and is a top salmonid spawning stream within the Lake Erie drainage basin. Since 1994, New York has stocked Cattaraugus Creek with walleye, steel head trout, and brown trout.

Current Water Use of Lake Erie

Lake Erie is used for transportation, industrial, commercial, and recreational purposes. Recreational activities include sailing, boating, jet skiing, fishing, and swimming beaches.

Recent information on commercial fishing in the New York waters of Lake Erie is contained in the New York State Department of Environmental Conservation (NYSDEC) Annual Report to the Great Lakes Fishery Commission's Lake Erie Committee (NYSDEC 2004).

This report indicates that rainbow smelt currently are the target of a major commercial fishing industry on the Ontario, Canada side of Lake Erie, but are fished less in the United States waters. Since 1960, New York commercial fishing efforts have focused on walleye and yellow perch. However, yellow perch and walleye production from New York is a small fraction (less than five percent) of total Lake Erie landings for those species.

Open lake sport fishing in 2003 measured 352,128 angler-hours, the second lowest total in 16 years. Peak fishing activity occurred in July and Dunkirk Harbor was the most frequently used access site. Harvested fish include walleye, smallmouth bass, yellow perch, and lake trout. Electro-fishing surveys within Cattaraugus Creek document high densities of spawning-phase walleye, and continued stocking efforts are planned.

3.7 Groundwater Hydrology

Groundwater hydrology in the WVDP area is summarized below.

3.7.1 Description of the Saturated Zone

The subsurface of the WVDP has been investigated since the early 1960's, resulting in hundreds of borings and installation of groundwater wells and other subsurface monitoring equipment. As explained previously, the hydrogeology of the WVDP site includes a sequence of glacial sediments underlain by shale bedrock. In chronologically descending order, this sequence is composed of an alluvial-glaciofluvial sand and gravel unit on the north plateau underlain by a sequence of up to three relatively impermeable glacial tills of Lavery, Kent, and possibly Olean age, separated by stratified fluvio-lacustrine deposits, which are in turn underlain by shale bedrock.

The sediments above the Kent till – the Kent Recessional Sequence, the weathered and unweathered Lavery till, the Lavery till-sand, and the surficial sand and gravel – are generally regarded as containing all of the potential routes for the migration of contaminants (via groundwater) from the WVDP site. Figures 3-6 and 3-7 are generalized cross-sections across the north and south plateaus showing the relative locations of these sediments. The Lavery till, the Kent Recessional Sequence, and the Kent till are common to both the north and south plateaus. Detailed geologic cross sections have been constructed using lithologic data collected from boreholes installed from 1961 to the present.

The WVDP does not use groundwater for drinking or operational purposes, nor does it discharge effluent directly to groundwater. No public water supplies are drawn from groundwater downgradient of the WVDP or from Cattaraugus Creek downstream of the WVDP. However, groundwater upgradient of the WVDP is used for drinking water by local residents.

Sand and Gravel Unit

As explained previously, the sand and gravel unit is unique to the north plateau and is a silty sand and gravel layer composed of younger Holocene alluvial deposits, the thick-bedded unit, that overlie older Pleistocene-age glaciofluvial deposits, the slack-water sequence. Together these two layers range up to 41 feet in thickness near the center of the plateau and pinch out along the edges of the plateau, where they have been truncated by the sidewall of the bedrock valley or the downward erosion of stream channels.

Disturbed materials and fill from construction activities also exist to varying depths on the developed portions of the north plateau. These are typically composed of re-compacted original sediment.

Depth to groundwater within the sand and gravel unit varies from 0 to 16 feet, being deepest generally beneath the central area of the north plateau, decreasing to the west, east, and north, and intersecting the ground surface farther northeastward toward the security fence.

Groundwater in this unit generally flows northeastward toward Franks Creek (Figure 3-62). Groundwater near the northwestern and southeastern margins of the sand and gravel layer also flows radially outward toward Quarry Creek and Erdman Brook, respectively.

In areas upgradient of the north plateau groundwater plume, recharge is limited by run-off diversions and culverts that channel surface flow to distant parts of the plateau. There is minimal groundwater flow downward into the underlying Lavery till. The overall hydraulic gradient across the north plateau has been calculated at 0.031; gradients up to 0.049 and as little as 0.026 exists in localized areas. An average groundwater velocity of 61.0 feet per year has been calculated for this unit (WVNSCO 1993e).

Recharge to the north plateau has been estimated as ranging from 3.0 inches to 13.5 inches and averaging 6.8 inches per year. Precipitation and bedrock underflow are the largest contributors to this recharge. Discharge occurs through evapotranspiration and drainage to streams, seeps, and springs along the edge of the north plateau, with a negligible amount as downward flow into the underlying Lavery till.

Weathered and Unweathered Lavery Till

Groundwater flow in the weathered till has both horizontal and vertical components. Groundwater typically flows laterally across the south plateau before moving downward or discharging to nearby incised stream channels. A lateral groundwater velocity has been calculated at 4.4 feet per year in this unit.

Groundwater elevation contours of the weathered Lavery till illustrate a potentiometric surface that dips generally to the northeast (Figure 3-63), with the exception of the northern section of the NDA, which is controlled by the operation of the interceptor trench. Groundwater in areas next to the trench flows directly toward and into the trench. Once inside the trench, laterals along the bottom of the trench drain the water toward the manhole sump (monitoring location NDATR on Figure 3-63), where it is pumped regularly to Lagoon 2.

On the north plateau, the weathered Lavery till is much thinner or nonexistent, and the sand and gravel unit typically immediately overlies the unweathered Lavery till, as noted previously. Hydraulic head distributions in the unweathered Lavery till indicate that groundwater flow is predominantly vertically downward at a relatively slow rate, toward the underlying Kent Recessional Sequence. A vertical groundwater velocity of 0.2 feet per year has been calculated for this unit.

Lavery Till-Sand Unit

The Lavery till-sand is a sandy unit of limited areal extent that is up to 16 feet thick within the Lavery till, primarily beneath the southeastern portion of the north plateau. The potentiometric surface of the Lavery till-sand is characterized by a variably sloping surface that generally dips to the east and southeast across the entire unit towards Erdman Brook (See Figure 3-64). Surface discharge locations have not been identified.

Kent Recessional Sequence

The Kent Recessional Sequence is a fine-grained lacustrine unit of interbedded clay and silty clay layers locally overlain by coarse-grained glacial sands and gravels. These deposits are found below the Lavery till beneath most of the site and range up to 75 feet in thickness beneath the eastern portions of the site (WVNSCO 1993e).

Groundwater flow in the Kent Recessional Sequence is predominantly to the northeast, toward Buttermilk Creek (Figure 3-65). Recharge comes primarily from bedrock in-flow in the southwest, with limited recharge from the overlying Lavery till. The Kent Recessional Sequence discharges to Buttermilk Creek. Because of the limited recharge received from the overlying Lavery till, the upper portions of the Kent Recessional Sequence are unsaturated. The deeper portions are saturated, and the groundwater velocity has been calculated at 0.4 feet per year (WVNSCO 1993e).

Groundwater elevation contours of the Kent Recessional Sequence illustrate a potentiometric surface that dips to the northeast. The steepest gradient is found in the southwestern portion of the south plateau, where the shoulder of the underlying bedrock valley slopes steeply to the northeast. Toward the middle of the south plateau, the glacial sediments filling the valley thicken, and the groundwater contours flatten somewhat and begin to slope to the north-northeast.

Shale Bedrock

The bedrock underlying the site occurs as a U-shaped valley of upper Devonian shales and siltstones. The upper 10 feet of rock is weathered and fractured. Bedding in these units generally dips 0.5 degree southward.

3.7.2 Monitoring Wells

Monitoring Equipment Inventory

There are currently 286 wells, well points, piezometers, seepage points, manholes, and surface water elevation hubs in the WVDP groundwater monitoring equipment inventory. Of this total, 222 devices are actively used for various monitoring purposes, and 64 are considered inactive (i.e., not used for any purpose). A total of 235 monitoring devices have previously been removed from service via approved decommissioning protocols. The monitoring equipment inventory includes equipment installed since 1960.

Aquifer tests were performed at the WVDP to support development of the North Plateau Groundwater Recovery System and the pilot Permeable Treatment Wall in 1996 and in 2003, respectively. Slug tests are also routinely performed on selected groundwater monitoring wells as part of a site-wide well maintenance program. This information is used to determine if degradation of a well has occurred, indicating that redevelopment is needed.

3.7.3 Physical Hydrogeologic Parameters in the Saturated Zone

Saturated Hydraulic Conductivity

The WVDP performs hydraulic conductivity testing of selected wells on an annual basis in accordance with approved site procedures and good engineering practices. A rotational system of testing a different group of selected wells every year ensures that most wells are tested periodically.

A summary of averaged hydraulic conductivity results for the five hydrogeologic units, based on testing performed from 1987 through 2004, is provided in Table 3-19.

Table 3-19. WVDP Hydraulic Conductivity (K) Testing Summary Table(1)

Geologic Unit	Sub-Unit	Maximum K (cm/s)	Average K (cm/s)	Minimum K (cm/s)
Sand and Gravel Unit	Thick-Bedded Unit	3.78 E-02	4.43 E-03	1.25 E-04
	Slack Water Sequence	1.13 E-01	2.44 E-02	8.19 E-04
Weathered Lavery Till	NA	1.50 E-03	3.36 E-04	4.87 E-07
Unweathered Lavery Till	Upper 3 meters	na	1.00 E-06	na
	Below 3 meters	na	6.00 E-08	na
Lavery Till-Sand	NA	4.54 E-03	2.04 E-03	1.06 E-04
Kent Recessional Sequence	NA	1.62 E-03	7.03 E-04	2.98 E-06

NOTE: (1) From DOE and NYSERDA 2008.
LEGEND: NA = Not Applicable
na = not available

The WVDP does not regularly perform hydraulic conductivity tests on bedrock wells because so few onsite wells penetrate bedrock. The hydraulic conductivity of bedrock at the WVDP, based on values collected for similar rock types, is estimated to range from 1.0E-07 cm/s for unweathered rock to 1.0E-05 cm/s for the weathered zone (WVNSCO 1993e).

Transmissivity

The transmissivity of the sand and gravel unit varies across the north plateau due to the variability of its saturated thickness and hydraulic conductivity. The transmissivity ranges from 4.8 E-03 cm^2/s to 6.8 E-03 cm^2/s (WVNSCO 1993e).

3.7.4 Unsaturated Zone

Description of the Unsaturated Zone

The unsaturated zones (vadose zones) within the surficial sand and gravel layer and the weathered Lavery till have been characterized separately, due to their different lithologies.

Hydrologic data obtained from unsaturated zone monitoring arrays were used to determine response to wetting and drying events. These data indicate that a downward migrating wetting front is generated after significant precipitation, and is dependent upon the soil moisture, soil hydrogeology, and structural features in the soil. When the soil is near saturation, this front raises the water table; when the soil is dry, the front will either redistribute into or evapotranspire from the vadose zone before contacting the water table.

The vadose zone in the weathered Lavery till fluctuates an average of 10 feet (i.e., one foot to 11 feet from grade) and varies with the season; horizontal and vertical fracture flow occurs within the entire fractured zone during the wet season and in the lower weathered zone during the dry season.

Dry season matric potentials in the Lavery till create an upward flow gradient from grade to five feet, with widening fractures increasing this depth during the late discharge season. The capillary fringe of the Lavery till is approximately seven feet thick.

Due to a varying topography, the vadose zone of the sand and gravel layer fluctuates in thickness over a generally uniformly sloping water table that itself annually fluctuates an average of 30 inches. Water within this vadose zone flows vertically downward to the water table. Dry season and matric potentials in the surficial sand and gravel create an upward flow gradient from grade to 6.9 feet (WVNSCO 1993f). The capillary fringe of the sand and gravel varies between 8.3 inches to 16.7 inches, depending on local lithology (WVNSCO 1993f).

The unsaturated zone at the WVDP has been modeled with several different computer codes. Results of these efforts are available in WVNSCO 1992.

Water Budget within the Unsaturated Zone

Precipitation occurring from December through April is lost mainly to rapid runoff and infiltration. From May through November, precipitation is lost mainly to infiltration and subsequent evapotranspiration, with a minor portion going to runoff.

Maximum recharge to most soils occurs when the ratio of the infiltration rate to precipitation rate is equal to or less than 1.0. For dry Lavery till soils (<75 percent saturated), precipitation is almost immediately absorbed and stored in the soil as recharge. In wet or nearly recharged soils (>75 percent saturated), the capillary potential of the primary pores is low, and any fractures may show less conductivity due to soil swelling. Thus, for the same precipitation rate, the wet season infiltration rate is lower and recharge is governed by the saturated hydraulic conductivity of the soil matrix and, to a lesser extent, by any fracture flow. However, if the fractures are not yet fully closed (as occurs in the late fall), the absorptive capacity of the bulk soil volume can still be high, allowing horizontal flow of the meteoric water.

The local runoff to precipitation ratio is highest in spring since the ground is saturated from late fall rains, early winter snow melt, and spring rains that contribute new water to soil profile of high antecedent soil moisture. This ratio lowers throughout the late spring, summer, and early fall (April–October) due to a soil moisture deficit that is produced from increasing summer evapotranspiration rates, as indicated by tensiometric data.

3.7.5 Description of Unsaturated Zone Monitoring Stations

In addition to groundwater monitoring wells, the WVDP maintains 11 surface water monitoring hubs (SE001 through SE011) to collect surface water elevations in areas of the north plateau where the water table in the sand and gravel unit intersects the ground surface. This information is correlated with groundwater well data and is used to define the water table surface in areas where monitoring well coverage is sparse or nonexistent.

3.7.6 Physical Parameters

Total and Effective Porosity

Total porosity of the sand and gravel unit has been calculated and ranges from 21.0 percent to 22.8 percent with an average value of 21.9 percent (WVNSCO 1993e).

Specific Yield

The specific yield (S_y) of the sand and gravel unit has been calculated to range from 0.10 to 0.25 (WVNSCO 1993e). Lower values reflect areas of poor sorting, and higher values reflect areas characterized by well sorted sands and gravels.

Specific Storage

The specific storage of the unweathered Lavery till has been calculated through consolidation tests, and was observed to decrease with depth from a maximum of 1.6E-05 per cm (6.3E-06 per inch) to a minimum of 2.0 E-06 per cm (7.9E-07 per inch), with an average of 8.0E-06 per cm (3.15 E-06 per inch) (WVNSCO 1993e).

3.7.7 Numerical Analysis Techniques

Three-dimensional far-field and near-field groundwater flow and transport models were developed to support the preparation of the Decommissioning EIS. These models were developed to evaluate site-wide groundwater flow patterns across the project premises and underlying geologic units, evaluate local changes in groundwater hydrology resulting from the proposed EIS closure alternatives, and identify transport parameters required to complete the performance assessments for the closure alternatives.

The three-dimensional site-wide groundwater flow model was the Finite Element Heat and Mass Transfer Code (FEHM), a finite element code developed by the DOE’s Los Alamos National Laboratory (LANL 2003). The FEHM model used in the preparation of the Draft EIS was an improvement over earlier models developed for the site which were limited to evaluating groundwater flow in the surficial sand and gravel unit in the north plateau of the Center. The FEHM model evaluated groundwater flow over a larger lateral and vertical extent of the Center, including the glacial geologic units underlying the surficial sand and gravel unit. The lateral and vertical boundaries of the site-wide FEHM model are as follows:

- Northern Boundary – from Quarry Creek eastward to Franks Creek downstream to its confluence with Buttermilk Creek,
- Western Boundary – follows the 1,450 foot surface elevation contour along Rock Springs Road between Quarry Creek and Franks Creek to the south,
- Southern Boundary – follows Franks Creek along the southern boundary of the South Plateau and continues as an imaginary line to Buttermilk Creek,
- Eastern Boundary – follows Buttermilk Creek from the confluence with Franks Creek to the north, to the intersection of the Southern Boundary with Buttermilk Creek in the south,
- Upper Boundary – the upper surface of the model domain follows the ground surface, and
- Bottom Boundary – the bottom surface of the model domain is at an elevation of 525 feet above sea level.

The finite-element grid used in the site-wide model used a total of 955 grid blocks with a uniform dimension of 140 feet in the x-y plane with a node located in the center of each grid block. The model was subdivided vertically into 23 discrete layers to represent the varying thicknesses of the 10 geologic units being modeled (thick-bedded unit, slack-water sequence, weathered Lavery till, unweathered Lavery till, Kent Recessional Sequence, Kent till, Olean Recessional Sequence, Olean till, weathered bedrock, and bedrock). The site-wide model has a total of 21,965 nodes with 955 in each model layer.

The site-wide model was calibrated both manually and with the automated calibration code, Parameter Estimation (PEST) (Doherty 2004). The manual calibration involved the comparison of model predicted heads with the median of observed groundwater level elevations from 56 well locations, and comparison of model predicted seepage flows with actual estimated seepage flows. The model simulated water table contours generated for the thick-bedded unit in the north plateau and the weathered Lavery till in the south plateau are in close agreement in most areas with the observed fourth quarter water table for the north plateau and south plateau. Differences were noted in several areas of the north and south plateaus that are partly attributed to the model grid size.

The site-wide FEHM groundwater flow model was not well suited for evaluating flows associated with the proposed small-scale close-in-place alternative and phased decision-making alternative engineered structures. A three-dimensional near-field groundwater flow model, the Subsurface Transport Over Multiple Phases Code (STOMP), was used to evaluate rates and directions of groundwater flow in the surficial sand and gravel unit that would be affected by the proposed engineered barriers associated with the close-in-place and phased decision-making alternatives. STOMP is a finite difference code developed by the Pacific Northwest National Laboratory (PNNL 2000). The stratigraphy and boundary conditions used in the FEHM far-field model were incorporated into the STOMP model to the maximum extent. The results of the STOMP near-field groundwater flow modeling associated with the WMA 1 and WMA 2 hydraulic barriers are described in Appendix D.

3.7.8 Distribution Coefficients.

An important aspect of site hydrogeology is the mobility of a contaminant in the various soil layers under the influence of groundwater. The distribution coefficient, also called partition coefficient or K_d, is used to describe the decrease in concentration of a contaminant in solution through interactions with geologic media in a soil-groundwater system. The K_d is defined as the ratio of the concentration (or activity in the case of radionuclides) of a species sorbed on the soil, divided by its concentration (or activity) in solution under steady-state conditions. It is an empirical parameter and its use in a given situation implies that the soil-groundwater system under study is in equilibrium.

The set of elements whose sorption onto West Valley geologic media have been studied over the years is representative in several respects. First, most of the elements considered have radioisotopes typically identified as key in post-closure performance assessments. The elements considered are also representative in that, based on location in the periodic table, several potentially different chemical behaviors are considered, such as monovalent and multivalent cations, chelation, formation of anionic species, and actinides.

K_d values for several important radionuclides have been determined for materials from those hydrogeological units of primary interest – the surficial sand and gravel unit on North Plateau, the weathered Lavery till, and the unweathered Lavery till. There are fewer results for the lacustrine unit and no data for the Kent Recessional till or bedrock.

Finally, K_d values at West Valley have been estimated by a variety of different techniques – batch studies, experimental sorption isotherms, column studies, and the analysis of contaminant migration in soil cores taken from the site.

K_d Studies at the Center

Five studies have been performed, as described below.

Brookhaven studies – Chemical Environment. K_d values for Cs, Co, Sr, Am, and Eu were determined in a series of experiments at the Brookhaven National Laboratory for four West Valley geochemical environments: the Lavery till, the lacustrine unit, overland flow, and the waste mass in the disposal trenches (Pietrzak et al. 1981). Samples of unweathered Lavery till collected at a depth of 35 feet in the SDA were tested for their sorption characteristics in the presence of trench leachate collected from sumps and well points. Batch K_d determinations were conducted in both oxic and anoxic environments. This study was sponsored by NRC.

A description of the equipment and procedures employed in the Brookhaven study, and preliminary results and conclusions, were reported in Columbo and Weiss 1979 and subsequently expanded by Pietrzak et al. 1981. The latter report includes K_d values for europium and americium as well as cesium, strontium, and cobalt, and discusses the observed effects of each of several variables on the sorption characteristics of the till.

In addition to quantifying distribution coefficients, the Brookhaven studies clearly demonstrate both the effects of anoxic or reducing environments on sorption, and the effect of complexing agents, i.e., organics in the trench water, on sorption. The studies also indicated that the soil disaggregation technique used in an experiment has an impact on the K_d. Hence, there is an element of uncertainty in the observed K_d values due to experimental method, as well as to natural variation, in the Brookhaven numbers.

***NFS Sorption Studies – Variation With Depth**.* In 1974, Duckworth (Duckworth, et al. 1974) reported percentage sorption for Cs-137, Sr-85, Ru-106, and Co-60 on a total of 37 samples of weathered and unweathered Lavery till taken from the SDA at depths of four to 51 feet. Iodine sorption percentages were also determined for 10 samples of weathered and unweathered till. Later, the WVDP used these data to calculate the distribution coefficients for the radioisotopes studied (WVNSCO 1993a).

The number and distribution of the samples tested clearly indicate differences between sorption on weathered and sorption on unweathered till but for not all radionuclides. This pattern is illustrated in Figures 3-66 through 3-68.

The right half of each figure shows stripplots[6] of the K_d values determined at four increasing depths: 10 feet, 25 feet, 30 feet, and 50 feet. The 10-foot K_d values are for weathered till and the remaining K_d values are for unweathered till. The left half of each figure shows the normal probability plot[7] of all of the K_d values where the weathered (10-foot) K_d values are solid black circles and the unweathered till K_d values are solid gray circles.

In the figures, cesium and strontium – and possibly iodine – show variation of the K_d with soil type (i.e., by depth). (The iodine data show a similar variation by soil type, but this trend is less statistically significant in light of the smaller number of samples involved.) Neither the ruthenium nor the cobalt K_d values vary with depth.

Finally, there is one drawback to this set of distribution coefficients: the longest contact time in the batch experiments was 16 hours, and it is unlikely that equilibrium was attained. However, shorter contact times lead, in principle to lower (more conservative) K_d values.

Oak Ridge National Laboratory Study - Competitive Sorption on the Lavery Till. Lavery Till samples from 1961 were submitted to Oak Ridge National Laboratory for batch-test radionuclide sorption studies. The locations and sampling depths were selected to provide coverage at both shallow to intermediate depths within the till, providing a comparison of the weathered and unweathered materials (WVNSCO 1993a).

The study results for cesium and strontium were numerically similar[8] to the results from Duckworth's data, showing that the Lavery till has a high affinity for cesium and a lower affinity for strontium. Cobalt-60 was almost completely sorbed by both weathered and unweathered tills with cobalt exhibiting no selectivity for either material.

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[6] Individual K_d determinations are plotted and grouped by weathered or unweathered.

[7] A normal probability plot presents the ordered values of the K_d versus the z-scores of the corresponding quantiles from the standard normal distribution. In these figures, the "Sample Quantiles" are just the K_d values and the "Theoretical Quantiles" are the z-scores. (A z-score is a measure of the distance in standard deviations of a sample from the mean.)

[8] The Oak Ridge tests were 24 hour batch tests. The Kd's were higher but still comparable

Some tests were also run for ruthenium, but the results were not considered particularly meaningful because they were conducted using ruthenium which had percolated through the Oak Ridge soil and from which the sorbable and filterable portions had been removed. The Oak Ridge sorption percentages were much lower than those observed by Duckworth. Chelation or complexation of the ruthenium in the Oak Ridge solution is a plausible explanation for the lower sorption.

Competitive sorption effects – cesium/potassium and strontium/calcium – were also examined in the Oak Ridge study. In both cases, the presence of a competitor species slowed sorption. The introduction of potassium ions reduced the sorption of cesium by a factor of six. Similarly the sorption of strontium was found to be reduced fourfold by the presence of calcium in the leachate.

United States Geological Survey Estimates. U.S. Geological Survey studies (Prudic 1986) on groundwater flow and contaminant transport in till immediately adjacent to the SDA have also included estimates of K_d values for several elements – cesium, strontium, hydrogen, and carbon. In this study, the K_d values were inferred from travel distances from the trench. The results for the carbon, cesium and strontium are consistent with the Brookhaven results for unweathered till under anoxic conditions. The tritium is assumed to be in the form of tritiated water and to experience no sorption[9] (i.e., a K_d of 0).

WVDP – North Plateau Sand and Gravel. In 1995 Dames and Moore reported the results for radionuclide sorption onto samples of the surficial North Plateau sand and gravel (Aloysius 1995 and Dames and Moore 1995). K_d values were determined for strontium, technetium, iodine, cesium, europium, uranium, neptunium, plutonium and americium. Most of the determinations used either batch tests and/or plots of the sorption isotherms.

This study also examined several related phenomena of potential interest. The effect of having tributyl phosphate/n-dodecane present was investigated for both uranium sorption and americium sorption. No effects were observed for either radionuclide. Competitive effects between technetium and iodine were also studied, indicating that iodine is preferentially sorbed.

At the present, Sr-90 is the primary radionuclide of interest in the north plateau surficial aquifer. For this reason, strontium's sorption behavior was studied in great detail by the investigators. In addition to batch and isotherm testing, the K_d of strontium was determined in column experiments and by the analyses of field data showing the distribution of Sr-90 in the surficial sand and gravel aquifer and the observed flow field of the aquifer. These dynamic estimates for the Sr-90 K_d were consistent with the batch and isotherm determinations.

The effect of the chemical environment on strontium sorption was also investigated. The K_d was found to be sensitive to small changes in pH and to increase with increasing pH. The strontium K_d was observed to increase with increasing ionic strength, but decrease with increasing calcium concentrations, i.e., the calcium is preferentially sorbed. These

[9] This neglects absorption into pore-space deadwater.

experimental findings were corroborated with geochemical modeling using the MINTEQA2 code.

Table 3-20 summarizes the distribution coefficients quantifying the sorption of fourteen elements onto West Valley soils. The primary Brookhaven references are not available and values have been taken from citing documents. Where possible, the values have been entered as ranges.

Table 3-20. Distribution Coefficients

Element	K_d(cm^3/g)	Geohydrological Unit	Notes	Reference
Hydrogen	0	Unweathered Lavery Till	Assumed zero (tritiated water)	Prudic 1986
Carbon	0.7 - 1.1	Unweathered Lavery Till	Anoxic conditions, organic carbon	Prudic 1986
	3 – 12	Unweathered Lavery Till	Anoxic conditions, inorganic carbon	Prudic 1986
Cobalt	1 – 5	Unweathered Lavery Till	Anoxic trench water	Pietrzak, et al. 1981 and Columbo and Weiss 1979
	1.8 - 2.3	Unweathered Lavery Till	Oxic trench water	Pietrzak, et al. 1981 and Columbo and Weiss 1979
	6400	Unweathered Lavery Till	16 hr batch	WVNSCO 1993a
	5400	Weathered Lavery Till	16 hr batch	WVNSCO 1993a
Strontium	4.5	Surficial Sand and Gravel	North plateau	Aloysius 1995
	6.9 - 7.4	Unweathered Lavery Till	Anoxic trench water	Pietrzak, et al. 1981 and Columbo and Weiss 1979
	25 – 32	Unweathered Lavery Till	Oxic trench water	Pietrzak, et al. 1981 and Columbo and Weiss 1979
	1 – 7	Unweathered Lavery Till	In-situ assessment, SDA, anoxic conditions	Prudic 1986
	30	Unweathered Lavery Till		WVNSCO 1993a
	130	Weathered Lavery Till		WVNSCO 1993a
Technetium	4.1	Unweathered Lavery Till	Regression fit of linear isotherm	Aloysius 1995
Ruthenium	1300	Unweathered Lavery Till		WVNSCO 1993a
	1200	Weathered Lavery Till		WVNSCO 1993a
Iodine	0.4 - 3.4	Lavery Till		WVNSCO 1993a
Cesium	48 – 260	Unweathered Lavery Till	Anoxic trench water	Pietrzak, et al. 1981 and Columbo and Weiss 1979
	100 – 200	Unweathered Lavery Till	Oxic trench water	Pietrzak, et al. 1981 and Columbo and Weiss 1979
	3350-4500	Unweathered Lavery Till		WVNSCO 1993a

Table 3-20. Distribution Coefficients

Element	$K_d(cm^3/g)$	Geohydrological Unit	Notes	Reference
	4900-8000	Weathered Lavery Till		WVNSCO 1993a
Europium	> 14,000	Surficial Sand and Gravel	Based on detection limit	Aloysius 1995
	600 – 2100	Unweathered Lavery Till	Anoxic trench water	Pietrzak, et al. 1981 and Columbo and Weiss 1979
	3700 – 4300	Unweathered Lavery Till	Oxic trench water	Pietrzak, et al. 1981 and Columbo and Weiss 1979
Radium	195	Unweathered Lavery Till		Pietrzak, et al. 1981 cites Bergeron, et al. 1987
Uranium	9.1 - 9.6	Unweathered Lavery Till	Regression fit of linear isotherm	Aloysius 1995
	11.9	Unweathered Lavery Till	Regression fit of linear isotherm, TBP/n-dodecane present	Aloysius 1995
Neptunium	2.3	Surficial Sand and Gravel	Recommendation	Aloysius 1995
	0.5 - 5.2	Unweathered Lavery Till	Regression fit of linear isotherm	Aloysius 1995
	5.5 - 18.1	Weathered Lavery Till	Regression fit of linear isotherm	Aloysius 1995
Plutonium	2600	Surficial Sand and Gravel	Kinetic sorption experiment (120 hr batch)	Aloysius 1995
	27900	Unweathered Lavery Till	Kinetic sorption experiment (120 hr batch)	Aloysius 1995
	5 – 56	Unweathered Lavery Till	Anoxic trench water	Matuszek 1980
Americium	111000	Unweathered Lavery Till		Aloysius 1995
	77,000-272,000	Unweathered Lavery Till	In presence of TBP/ n-dodecane	Aloysius 1995
Americium	420 – 1000	Unweathered Lavery Till	Anoxic trench water	Pietrzak, et al. 1981 and Columbo and Weiss 1979
	4000 – 4700	Unweathered Lavery Till	Oxic trench water	Pietrzak, et al. 1981 and Columbo and Weiss 1979

NOTE: (1) Range reflects differences due to experimental technique employed for soil disaggregation.

3.7.9 Hydraulic Properties

Prudic noted the abundant fractures in the weathered Lavery till zone, indicating that fractures with oxidized walls, spaced a few meters apart, extended down to about 14.7 feet (Prudic 1986). The oxidized zones bordering the fractures, as well as thin coatings of manganese and/or iron oxide, calcite, root hairs, and thin gray (reduced) zones on the inner surfaces of some fractures, clearly suggest water movement along the fractures.

The WVDP has total porosity data from several investigations. Table 3-21 shows results from samples obtained during monitoring well installation in the 1989-1990 period as reported in WVNSCO 1993e, which are representative of the available data. In the case of samples from the sand and gravel layer, the weathered Lavery till, and the unweathered Lavery till, total porosity was calculated using the equation:

$$P = [\ 1 - \rho\ /\ G\ ] \times 100\ \%$$

where P = total porosity

ρ = bulk dry density

G = specific gravity

An estimated bulk dry density of 2.1 g/cm^3 was used in the calculations for the sand and gravel layer and1.6 g/cm^3 for the Lavery till, both weathered and unweathered.

Table 3-21. Total Porosity(1)

Geologic Unit	Range of Total Porosity (%)	Average Total Porosity (%)
Sand and Gravel(2)	21 to 22.8	21.9
Weathered Lavery Till(3)	40.3 to 41	40.7
Unweathered Lavery Till(4)	41.4 to 42.5	41.7
Lavery Till Sand(5)	NA	25
Kent Recessional Sequence(5)	NA	25

NOTES: (1) From WVNSCO 1993a. The total porosity values were determined from boring samples collected during monitoring well installation in 1989 and 1990.

(2) From Table 2-1 of WVNSCO 1993e.

(3) From Table 3-1 of WVNSCO 1993e.

(4) From table 4-1 of WVNSCO 1993e.

(5) Estimated based on particle size and sorting.

3.8 Natural Resources

This section describes existing and potential natural resources at and in the vicinity of the WVDP. These resources include natural gas and oil, sand/gravel/clay deposits, surface water, groundwater, timber and two renewable energy sources–geothermal and wind energy.

3.8.1 Natural Gas and Oil

New York has proven natural gas and oil resources (NYSDEC 2001). The New York State Department of Environmental Conservation estimates that the state's 2001 production was enough to heat approximate 353,000 homes. A significant portion of these resources are found in Chautauqua, Cattaraugus, and Erie Counties.

The annual production of natural gas and oil in New York State during 2001 is summarized in Table 3-22 along with production in nearby areas such as the Town of Ashford. New York produced 28 billion cubic feet of natural gas in 2001. Cattaraugus County and Erie County were the fourth and fifth largest producing counties in the state accounting for 9 percent of the production for that year. The largest Western New York producer of natural gas was Chautauqua County which was responsible for almost 23 percent of the State's production.

Table 3-22. 2001 Natural Gas and Oil Production in Cattaraugus and Erie Counties, and the State of New York[1]

Location	County	Gas (1000s ft^3)	Oil (barrels)	Active Gas Wells	Inactive Gas Wells	Active Oil Wells	Inactive Oil Wells
Ashford	Cattaraugus	20,879	1,065	13	4	2	0
East Otto	Cattaraugus	6,133		6	2	0	1
Ellicottville	Cattaraugus	6,344		16	0	0	0
Machias	Cattaraugus	220		1	1	0	0
Yorkshire	Cattaraugus	23,740		18	3	0	0
Colden	Erie	6,374		11	6	0	0
Sardina	Erie	19,228		11	3	0	0
Total		82,918	1,065	76	19	2	1
Total Cattaraugus County		1,383,691	116,373	427	175	1,557	440
Total Erie County		1,132,634	45	875	239	1	1
New York State		28,020,207	175,666	5,949	843	3,373	1,416

NOTE: (1) From NYSDEC 2001.

Cattaraugus County was the top oil producing county in New York in 2001 contributing more than 66 percent to the state total. However, less than one percent of the county's contribution came from the Town of Ashford's two active oil wells. There are no active wells in any of the towns adjacent to Ashford.

Figure 3-69 shows the locations of all of the known wells associated with the production of natural gas and oil in Western New York. Figure 3-70 shows production in the Town of Ashford in Cattaraugus. The approximate location of the WVDP is indicated on Figure 3-72 by the black "**WV**." These two graphics clearly indicate that production occurs in the immediate vicinity of the site, but the site lies on the fringes of known resources. Most of the gas production occurs in a band paralleling Lake Erie west of the site, and most of the oil production occurs in the southern part of Cattaraugus County near the Pennsylvania state line.

3.8.2 Mineral Resources

Sand, Gravel, and Clay

As described above, the WVDP site and surrounding valley area are underlain by a sequence of glacial tills comprised mainly of clays and silts separated by sands and gravels. These materials are a potential mineral resource, although a determination of their classification (USGS 1980) as resource, reserve, marginal reserve, or sub-economic resource has not been evaluated. In any event these materials are currently restricted by virtue of the restricted access to the Center.

Sand and gravel mines are New York's most common type of mine. Construction sand and gravel is a high-volume, low-value commodity. The industry is highly competitive. Production costs vary widely depending on geographic location, the nature of the deposit, and the number and type of products produced. Transportation is a major factor in the delivered price of construction sand and gravel, and because of the high cost of transportation, construction sand and gravel continues to be marketed locally (NYSDEC 2005).

In 2001, there were 1931 active sand and gravel mines in the state producing more than 30 billion metric tons worth at least $162 million. Data for production by mine for that year are not available. However, based on permitted acreage two of New York's seven largest producers have mines in the vicinity of the WVDP (NYSDEC 2005). One is in the adjacent town of Machias, and the other in nearby Sardinia. There are approximately 20 mine sites within six miles of the WVDP. Approximately half of those were active in 2001.

The major clay minerals found in the site tills are illite and chlorite. Such clays are not particularly valuable for ceramic or industrial applications. There is one regulated clay mine in the Town of Concord which is within six miles of the site.

3.8.3 Water Resources

Both surface water and groundwater resources are found at the WVDP (see Sections 3.6 and 3.7). Buttermilk Creek Basin is a proven surface water resource. Its headwaters are located in and adjacent to the southern part of the site, and the creek flows northwest through the site. Two small water reservoirs were constructed on headwater tributaries to supply both potable and process water to Center and WVDP facilities.

Groundwater within the Center and the WVDP is not utilized for any purpose, as noted previously. However, groundwater is a proven if limited resource in the West Valley area as indicated by the use of several off-site residential wells. Approximately 259 homes within a 3.1-mile radius of the WVDP utilize groundwater as a potable water source. These wells utilize groundwater from surficial sand and gravel aquifers of limited areal extent, as well as weathered bedrock aquifers. Significant quantitative characterization of groundwater is limited to the WVDP, specifically the north plateau and south plateau. That effort has focused on contaminant hydrology as opposed to water resource characterization.

Using knowledge of the groundwater in the vicinity of the WVDP, one basin-wide aquifer is postulated, the weathered and fractured bedrock system. Lying above the competent, low permeability shale bedrock and below the low-permeability glacial tills, this system is recharged from the upland slopes bordering the valley. Discharge is largely to Buttermilk Creek which has cut through the till to bedrock in the valley floor. Little if any connection of the West Valley fractured bedrock aquifer with similar systems in the Connoissarauley and Broad Valleys is expected due to the intervening shale uplands.

Aquifers associated with the glacial drift are sand and/or gravel units of limited areal extent. The surficial sand and gravel unit of the north plateau receives significant recharge from infiltrating precipitation, is highly permeable, and lies on top of low-permeability clayey/silty till. However, it has limited lateral extent and discharges along much of its perimeter.

Subsurface sand and/or gravel units also appear to be limited in extent. Recharge to these units is poorly understood. Given the low permeability of the clayey/silty tills in which they are embedded, some connections with and recharge from the upland fractured-rock flow system at the valley periphery is plausible.

In sensitivity analyses with the three-dimensional site groundwater model, simulations have been run with and without the subsurface till sand unit which is situated on the north plateau east of the Project facilities. The simulations showed little sensitivity to the presence of this unit and the model fit was slightly better when it was left out. These results suggest that the flow associated with this system is not a significant participant in the overall scheme and this inference, by extension, implies that the unit (and others like it) are limited as water resources.

Finally, it is noted that the West Valley aquifer system is part of the Cattaraugus Creek Basin Aquifer System, designated as a sole source aquifer. Similar to West Valley, the sand and gravel aquifers in this system used as water sources tend to be local and limited in spatial extent. Generally, the gradient from the Cattaraugus sand and gravel aquifers is downward toward the fractured bedrock system or laterally to surface waters.

3.8.4 Timber Resources

The region's (Southern Tier) specific soil and climate help to produce several commercial species of hardwood timber including maple, ash, red oak and black cherry. The estimated annual net growth of timber amounts to over 1.6 million tons a year (STPRDB 2003). At present, about one third of this amount is being removed through harvesting, leaving a significant potential for future economic development, including the potential for increased domestic secondary use and export use.

Much of the Center is forested, as is characteristic of the region. A smaller portion of the WVDP is forest, however. The last sawtimber harvest occurred mid-century with cull, inferior, and smaller trees left. There has been no management in the interim. In 1978, the volume of sawtimber at the Center was estimated to be 3.2 million board feet having a total standing value of $313,000. Most of the value came from hardwoods. The annual growth rate was estimated to be low at 100 board-feet per acre per year. When corrected for inflation, the average stumpage rate of all eastern hardwoods increased by roughly 250 percent from 1978 to 1999 (Howard 2001). Neglecting new growth, degradation, the absence of management, changes in mix, etc., the current value of the Center forest would be $750,000.

3.8.5 Renewable Energy Resources

There are two renewable energy sources which are notable potential resources at or in the vicinity of the WVDP. These are geothermal energy and wind energy.

Geothermal

Geothermal energy is an inferred, i.e., unproven, resource at the Center. Recently development studies for the western Southern Tier (STPRDB 2003) have recognized the geothermal potential in that region. The reports indicate that low temperature geothermal wells are available in portions of Western New York. Analysis of bottom hole temperature data from Cambrian sandstones indicates the presence of extractable fluids in the low temperature geothermal target zone. The report notes that the potential of geothermal power has not yet been utilized in the region due to technological obstacles, high initial capital costs, and a reluctance to engage new resources. Low temperature geothermal resources may be used for direct heat, i.e., heat pumps, but not for the generation of electricity.

Wind

Recent work suggests that the hilltops to the west of the WVDP are suitable for the development of wind energy resources. In 2004, NYSERDA was engaged in wind energy research and recently has funded the development of wind resource maps for the entire state of New York (TrueWind 2005). Based on extensive meteorological data and numerical models, the maps rate every location in the state for wind energy potential. In these maps, locations along the ridge or hilltops separating West Valley from Connoissarauley Valley are rated as having a good potential for wind energy development.

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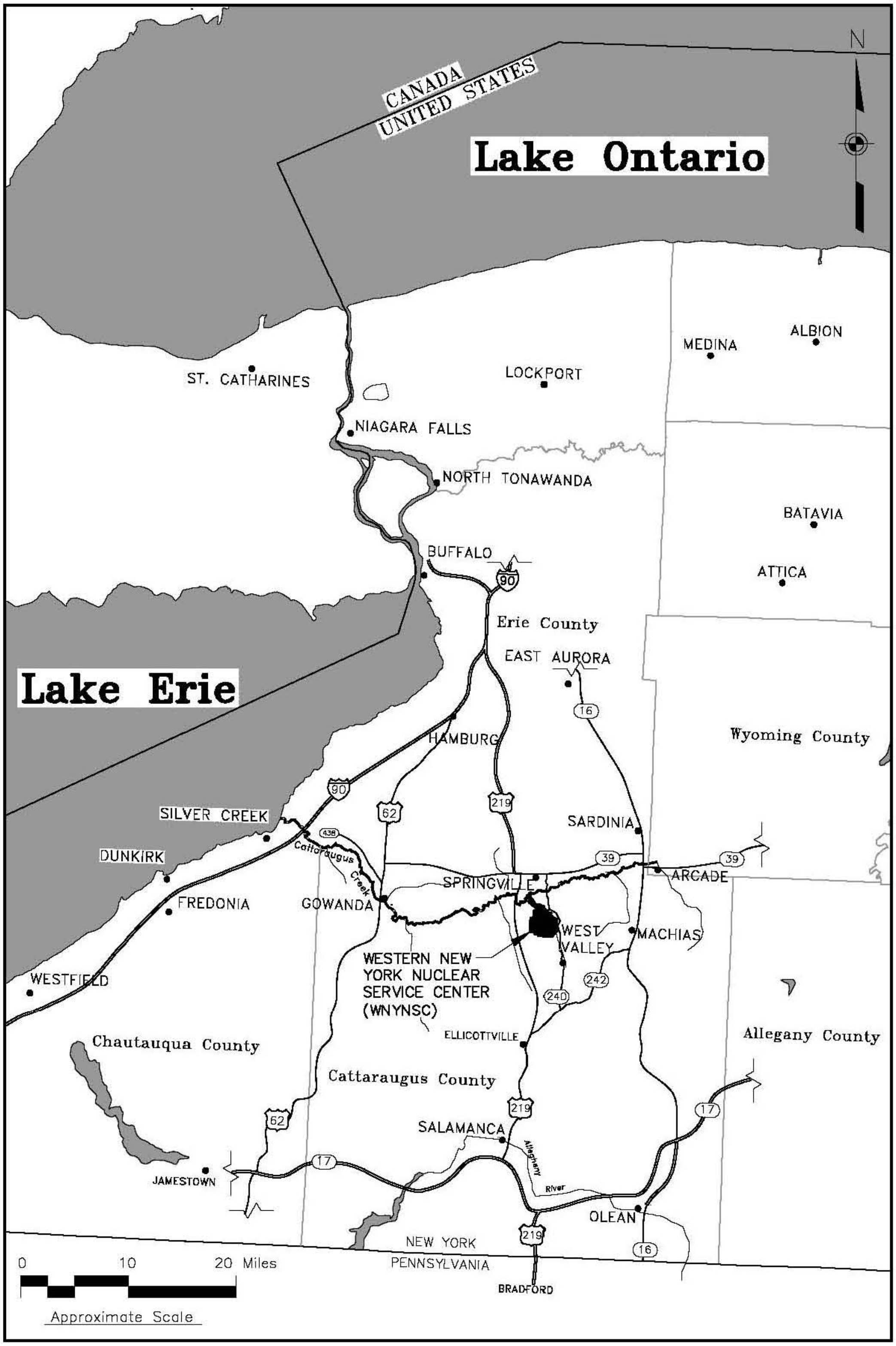


Figure 3-1. Location of the Center in Western New York

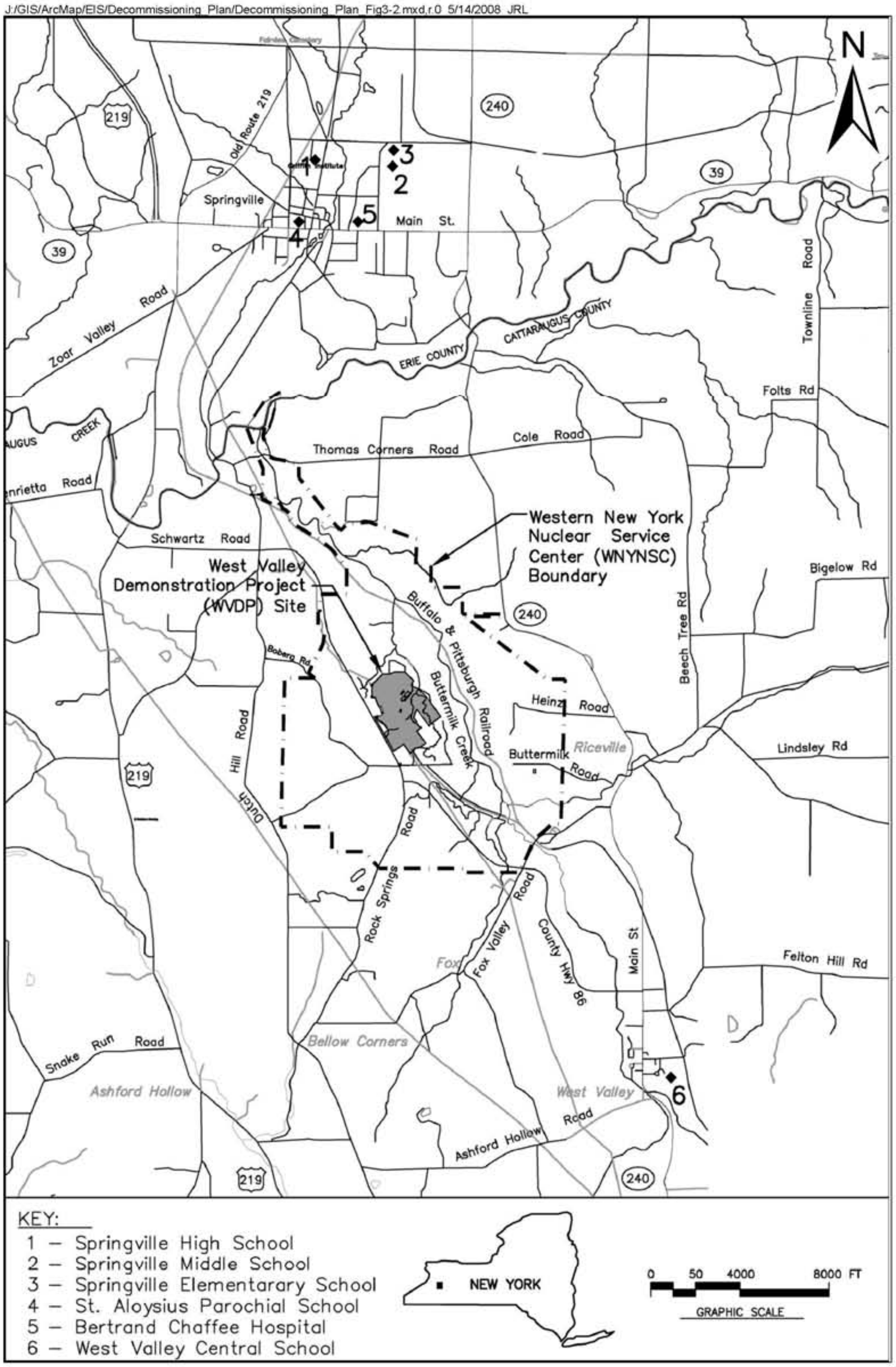


Figure 3-2. The Center, the WVDP, and the Surrounding Area

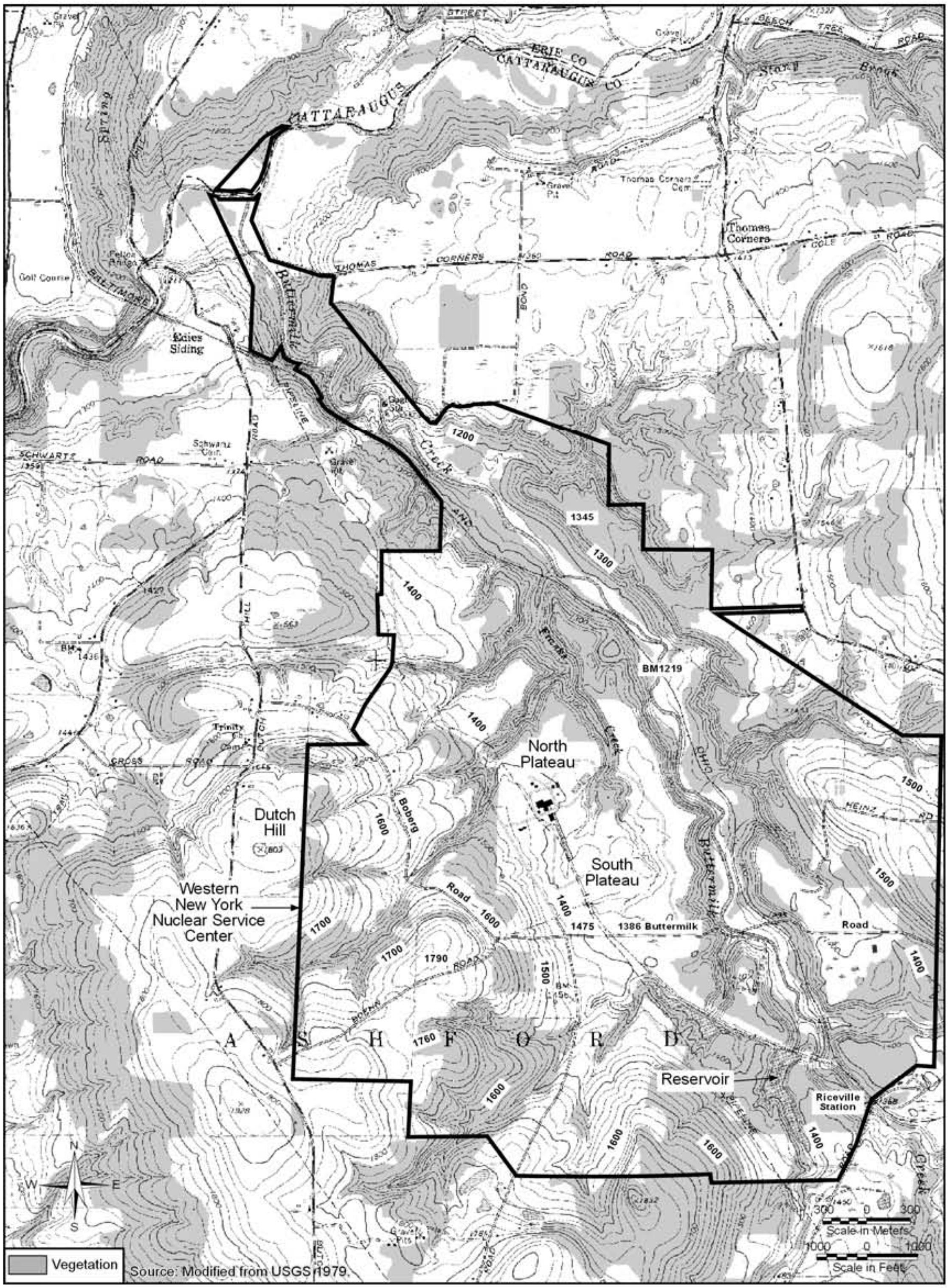


Figure 3-3. Topography of the Western New York Nuclear Service Center

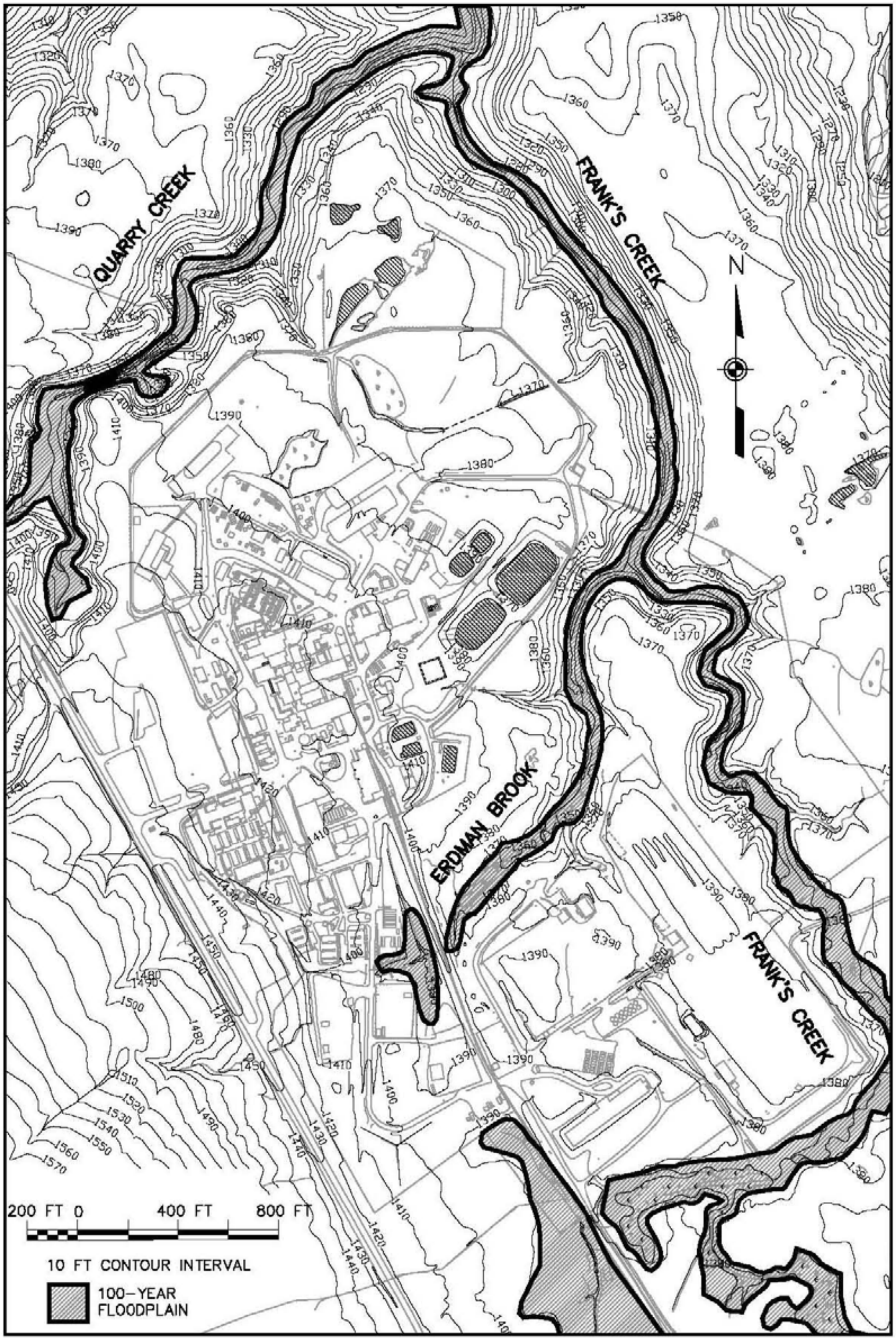


Figure 3-4. Topography of the Project Premises, Showing 100-Year Floodplain

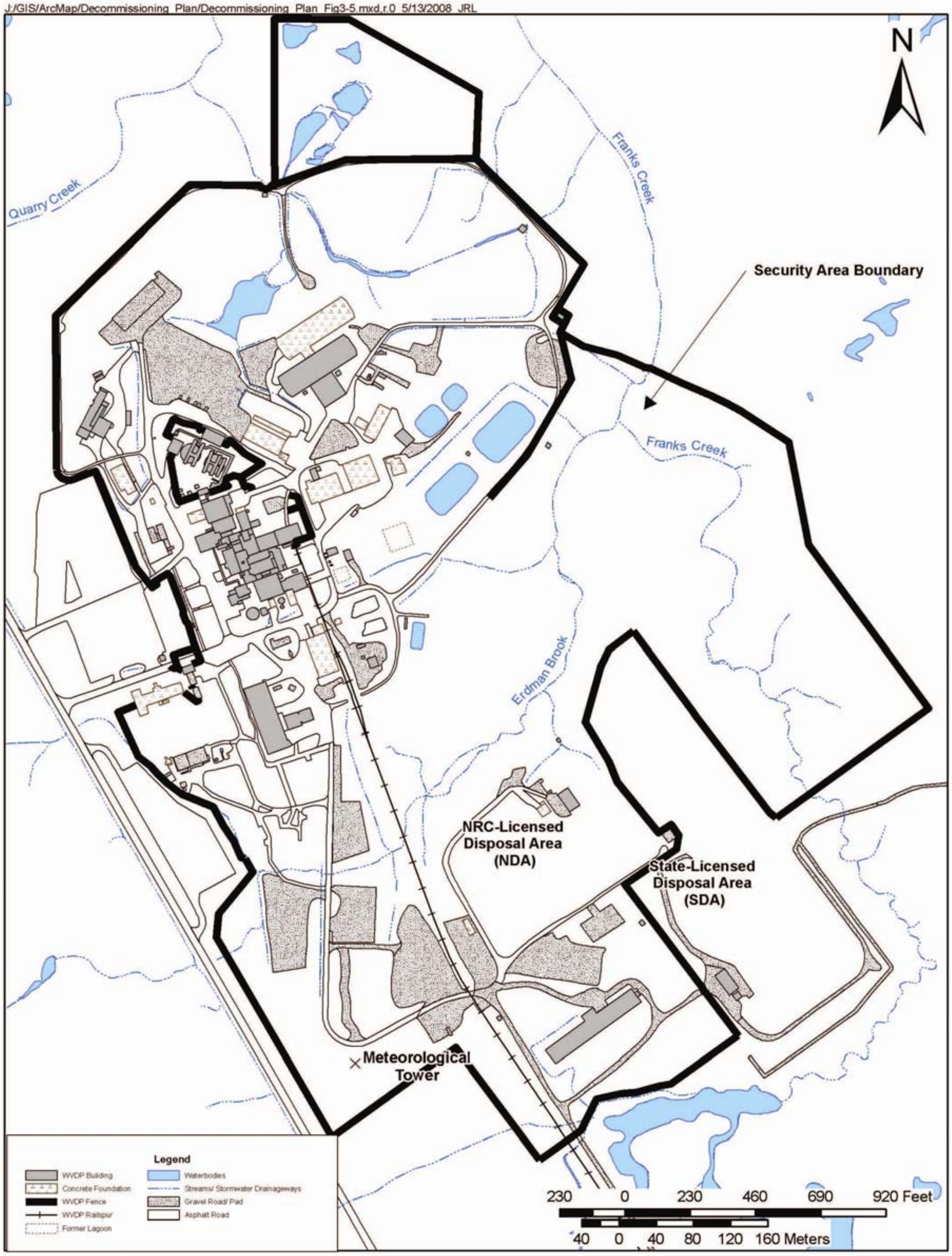


Figure 3-5. Security Fence Around WVDP Premises Boundary

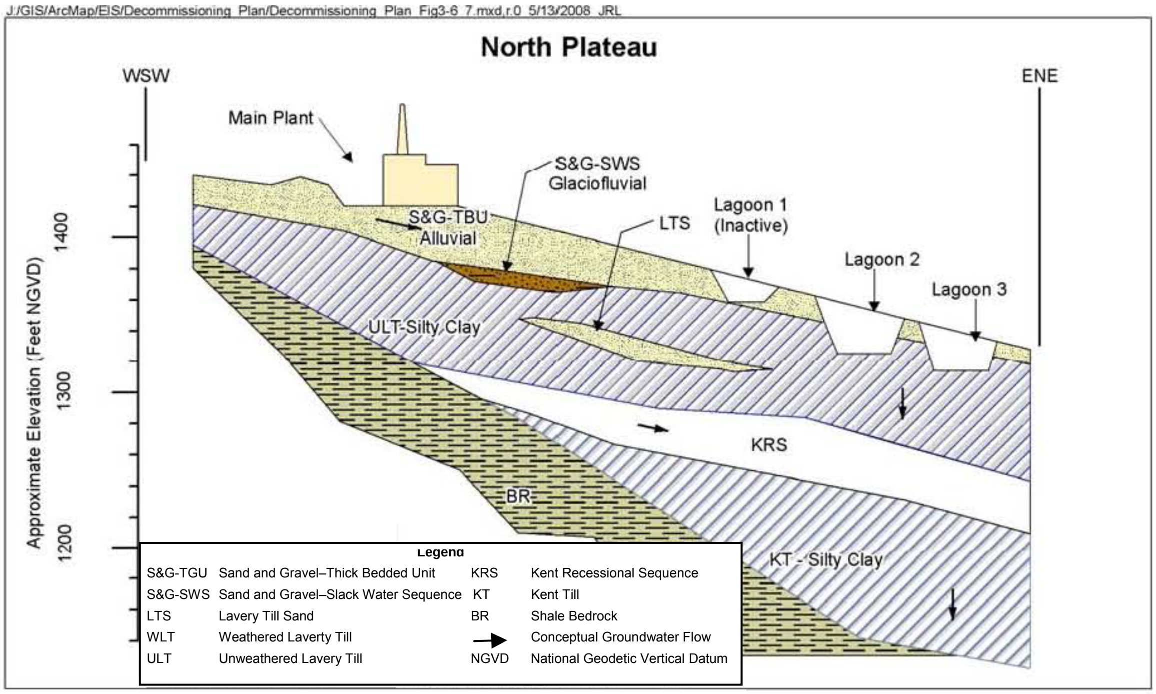


Figure 3-6. North Plateau Geologic Cross Section

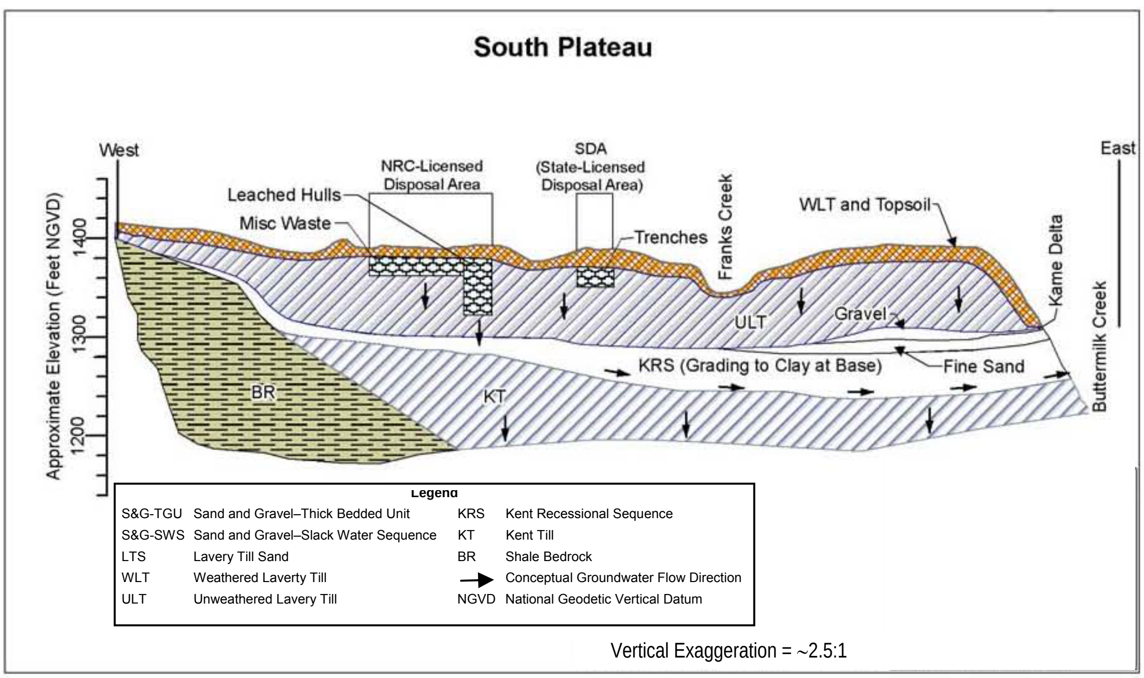


Figure 3-7. South Plateau Geologic Cross Section

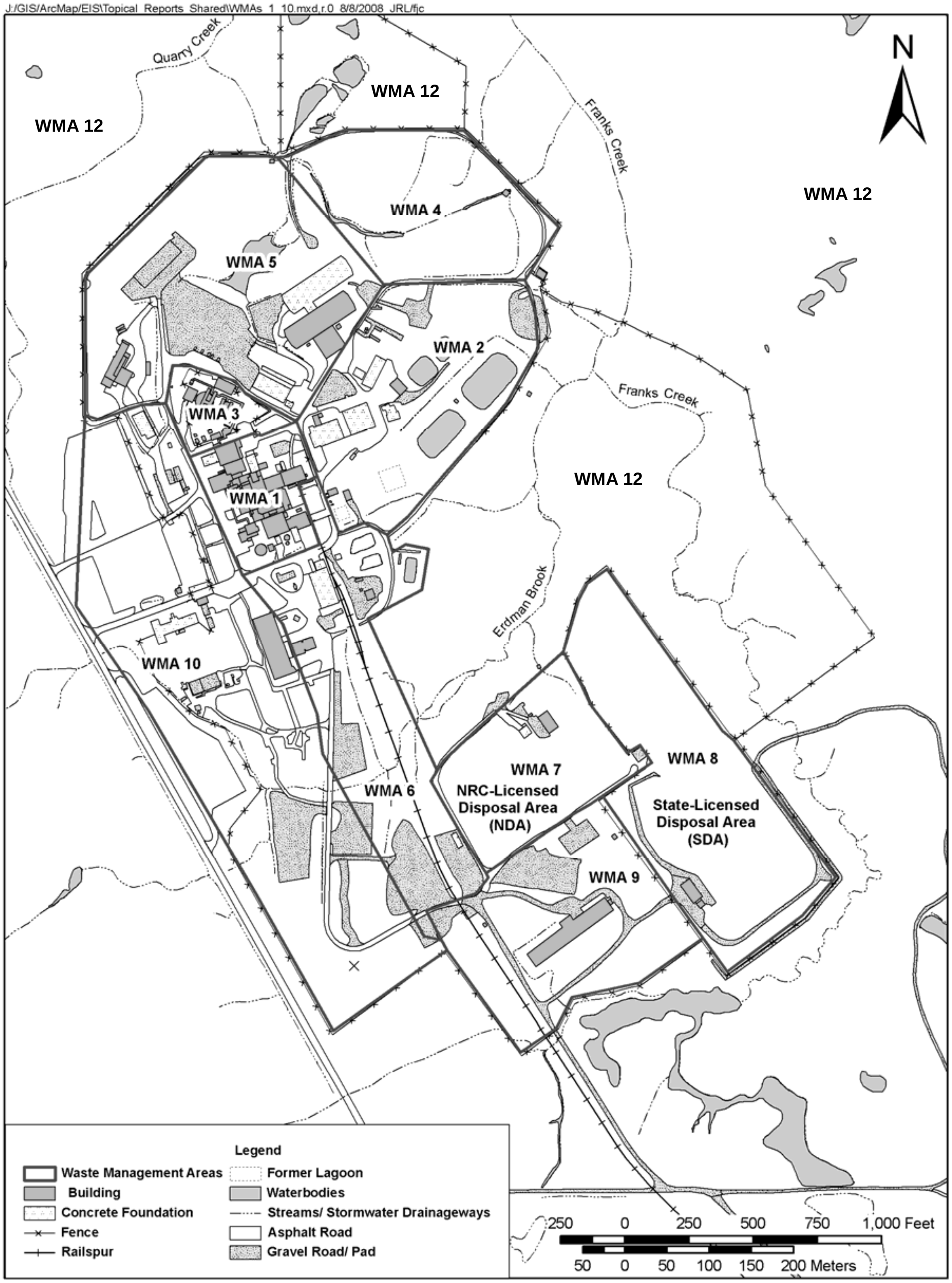


Figure 3-8. WMAs 1 through 10

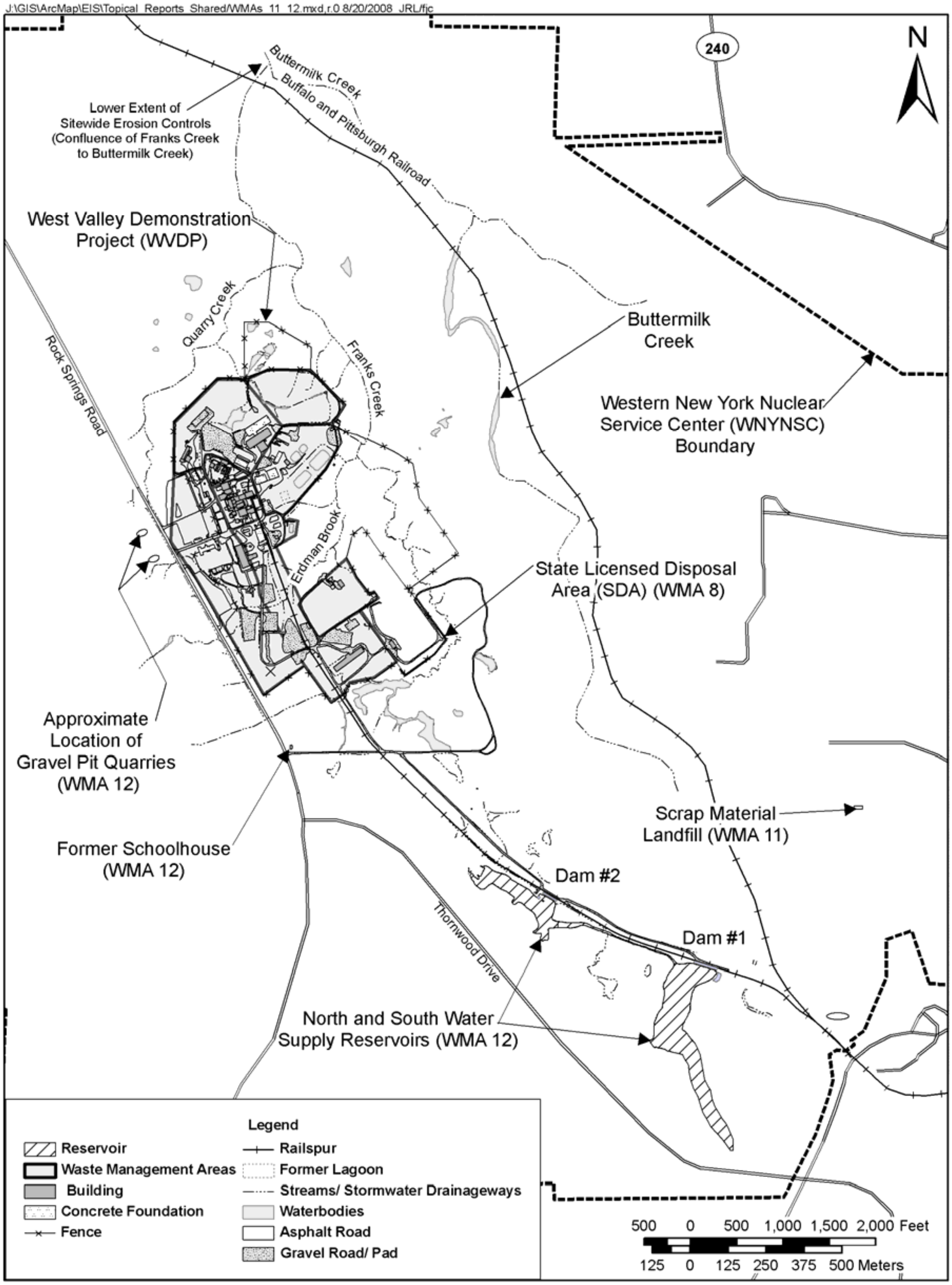


Figure 3-9. WMAs 11 and 12

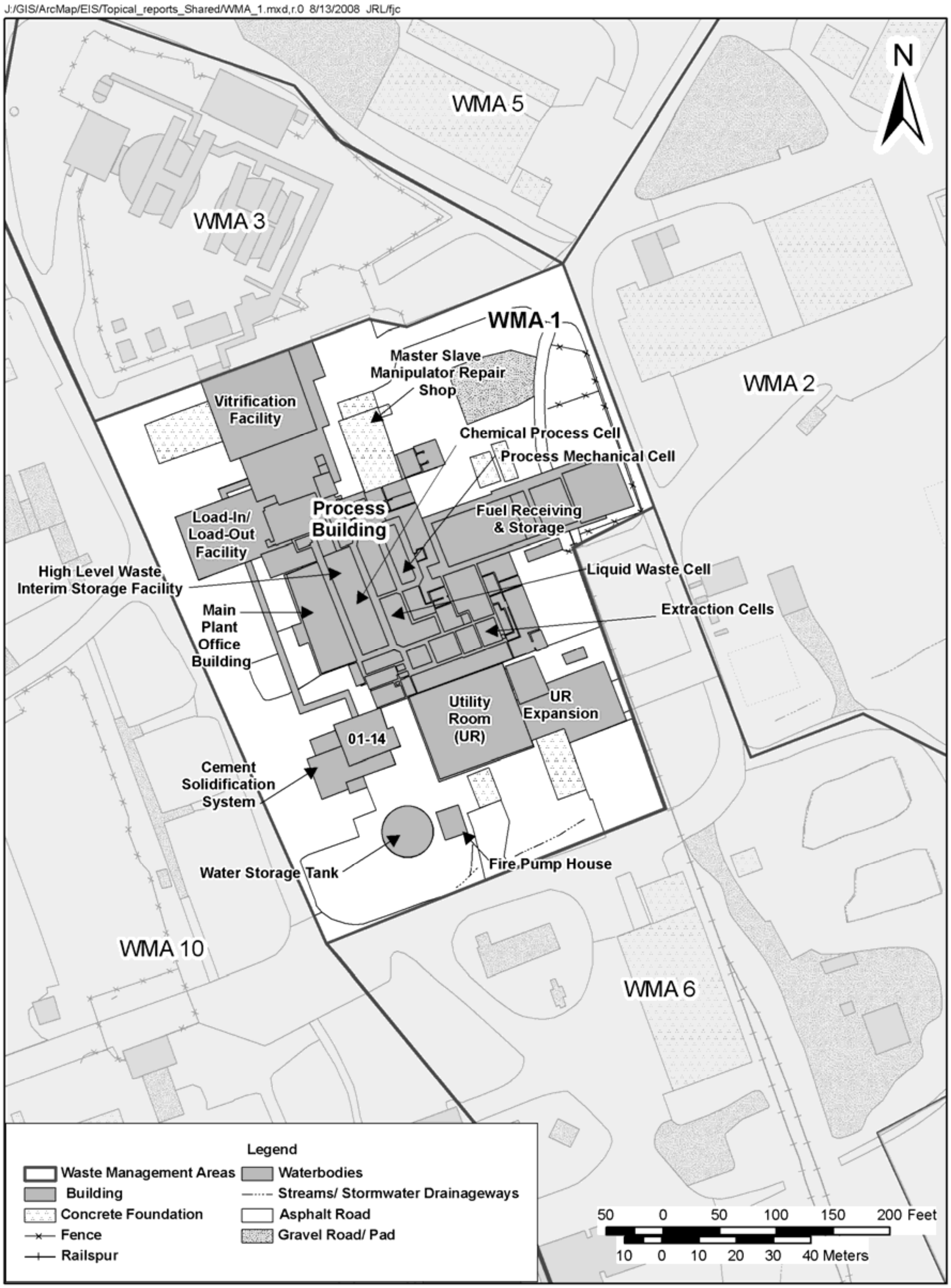


Figure 3-10. WMA 1. (The Phase 1 decommissioning activities will include removal of the facilities and the underlying north plateau groundwater plume source area.)

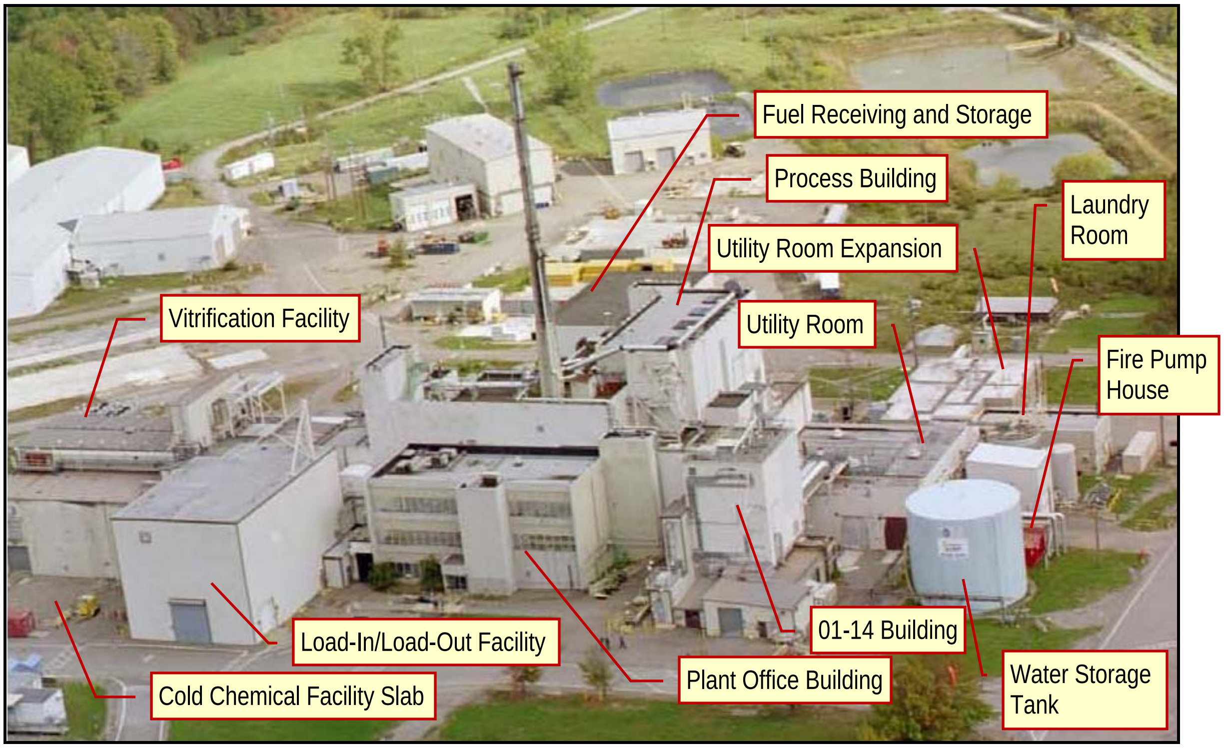


Figure 3-11. Aerial View of the Process Building Area and Vitrification Facility Area in 2007. (The Laundry Room will be removed before the Phase 1 of the decommissioning begins.)

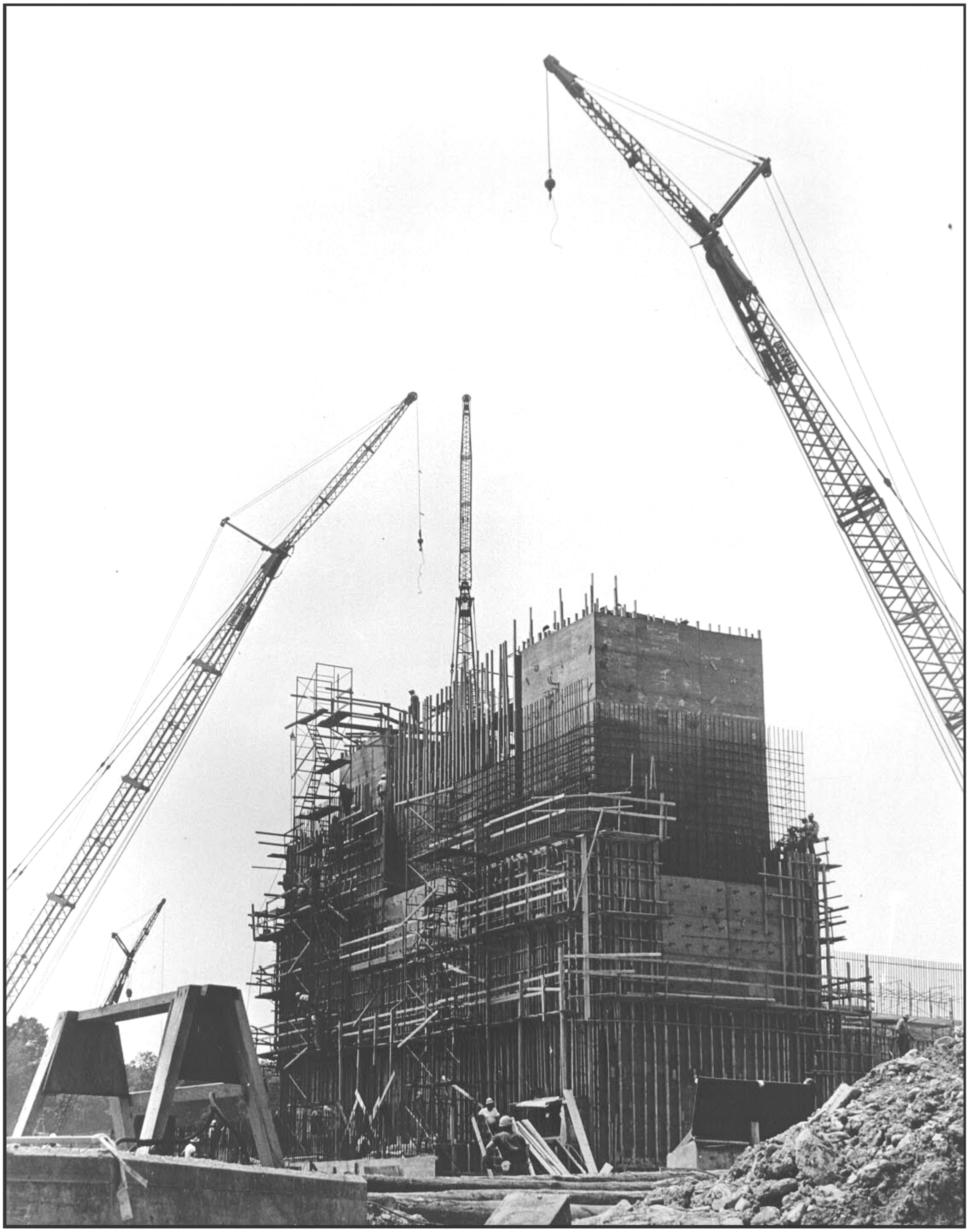
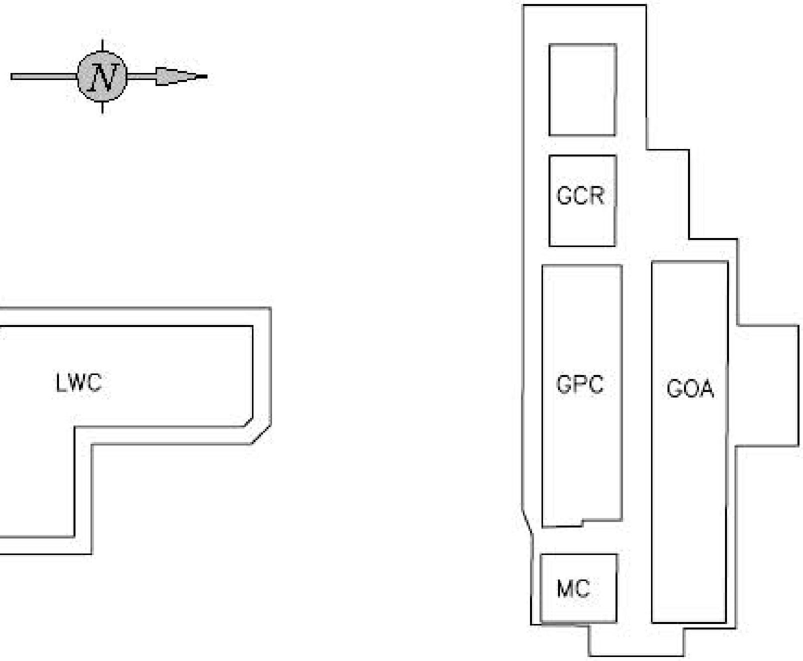


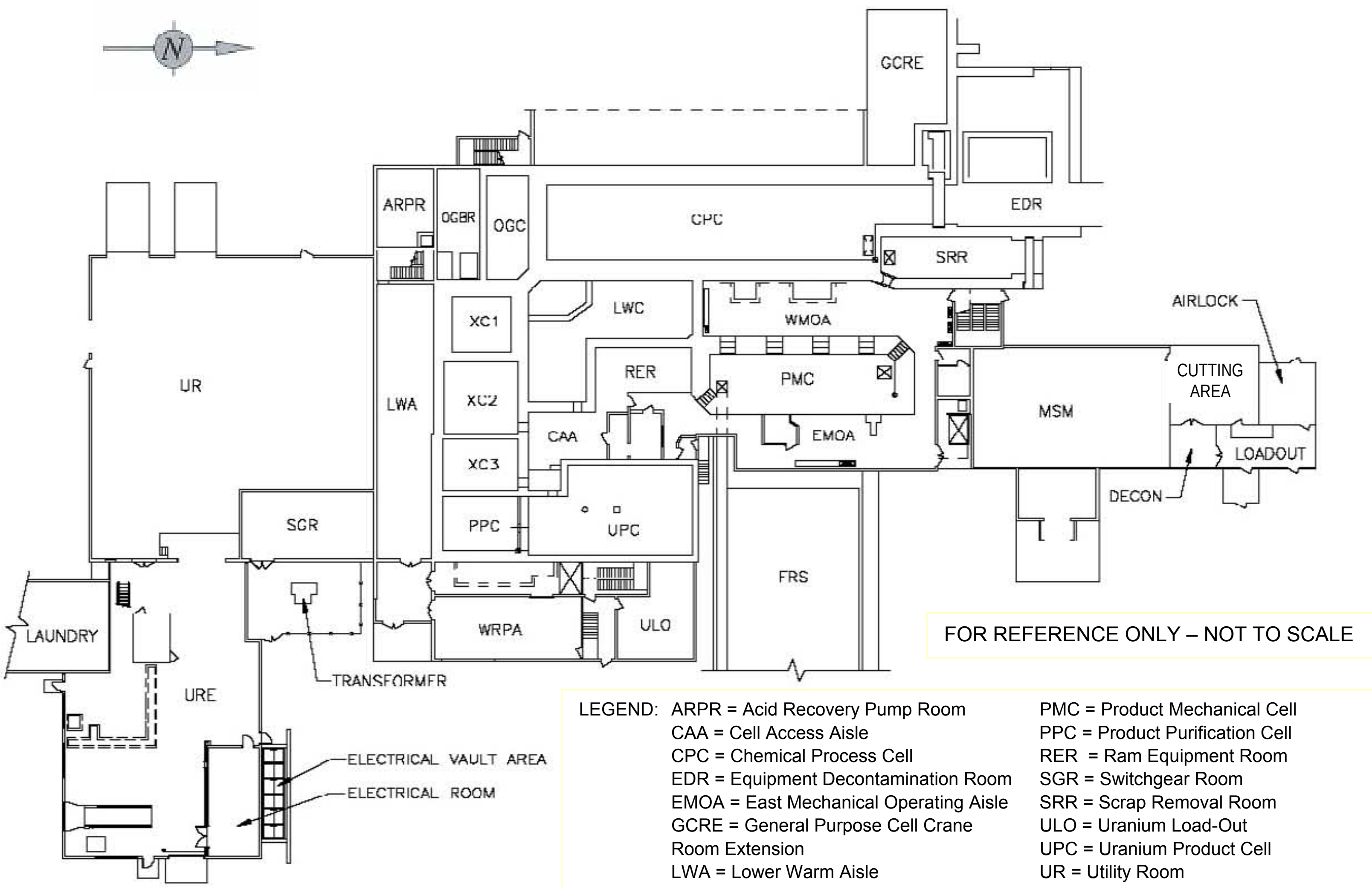
Figure 3-12. Construction of the Process Building.



FOR REFERENCE ONLY – NOT TO SCALE

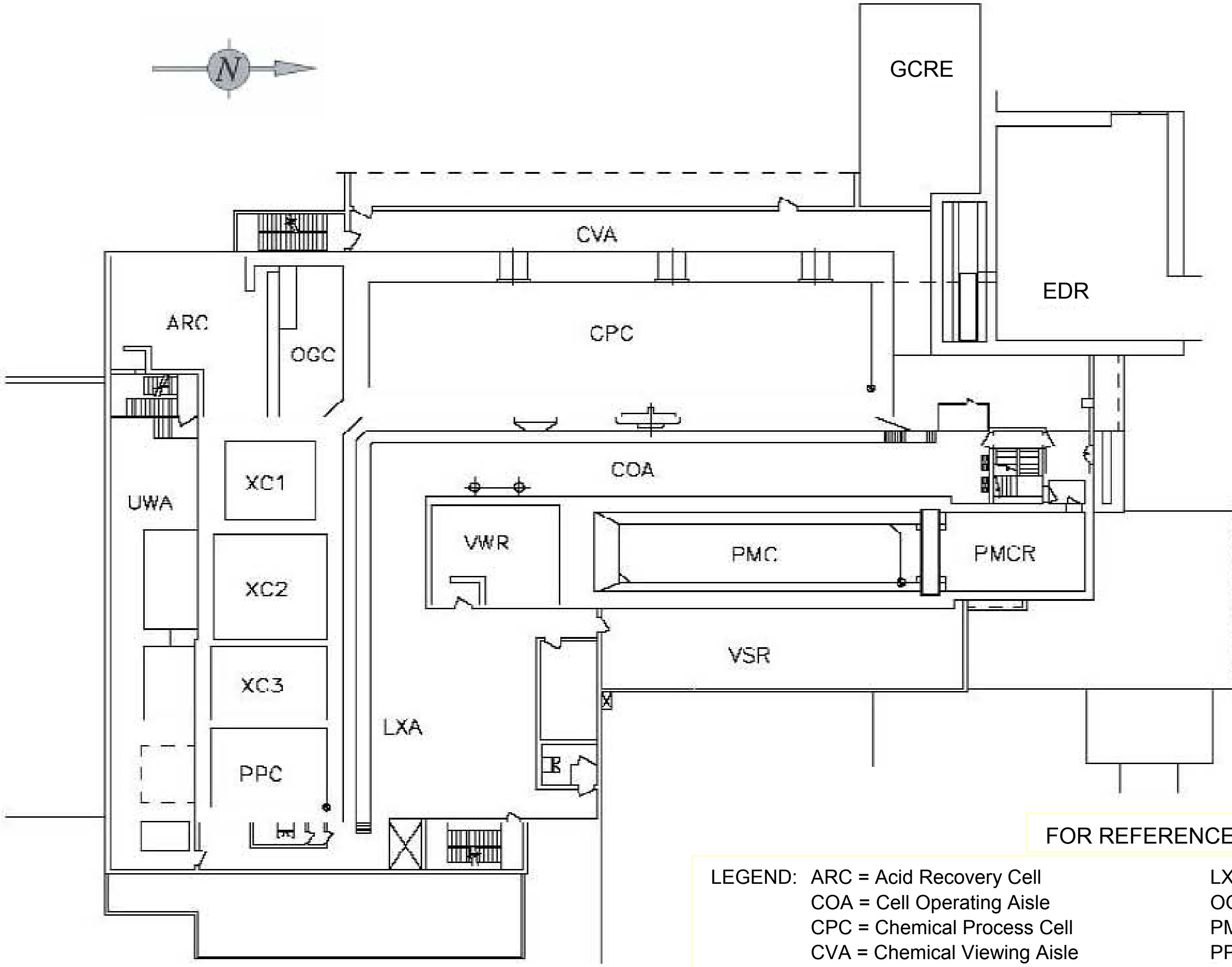
LEGEND: GCR = General Purpose Cell Crane Room
GOA = General Purpose Cell Operating Aisle
GPC = General Purpose Cell
LWC = Liquid Waste Cell
MC = Miniature Cell

Figure 3-13A. Process Building Layout – Below Grade



LEGEND:
ARPR = Acid Recovery Pump Room
CAA = Cell Access Aisle
CPC = Chemical Process Cell
EDR = Equipment Decontamination Room
EMOA = East Mechanical Operating Aisle
GCRE = General Purpose Cell Crane Room Extension
LWA = Lower Warm Aisle
LWC = Liquid Waste Cell
MSM = Manipulator Repair Shop
OGBR = Off-Gas Blower Room
OGC = Off-Gas Cell
PMC = Product Mechanical Cell
PPC = Product Purification Cell
RER = Ram Equipment Room
SGR = Switchgear Room
SRR = Scrap Removal Room
ULO = Uranium Load-Out
UPC = Uranium Product Cell
UR = Utility Room
URE = Utility Room Expansion
WMOA = West Mechanical Operating Aisle
WRPA = Waste Reduction & Packaging Area
XC = Extraction Cell

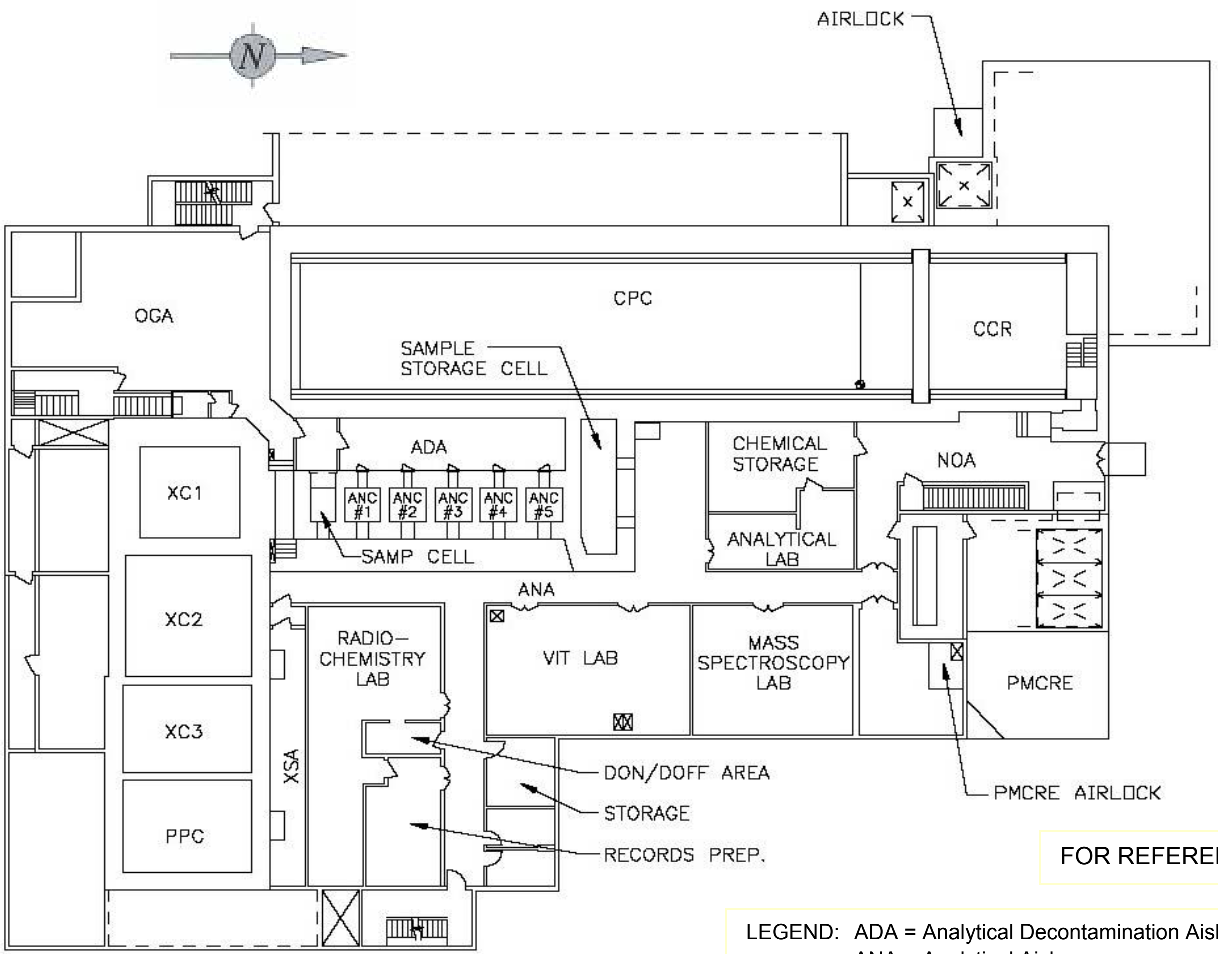
Figure 3-13B. Process Building Layout at 100-Foot Elevation



FOR REFERENCE ONLY – NOT TO SCALE

LEGEND:
ARC = Acid Recovery Cell
COA = Cell Operating Aisle
CPC = Chemical Process Cell
CVA = Chemical Viewing Aisle
EDR = Equipment Decontamination Room
GCRE = General Purpose Cell Crane Room Extension
LXA = Lower Extraction Aisle
OGC = Off-Gas Cell
PMC = Product Mechanical Cell
PPC = Product Purification Cell
PMCR = PMC Crane Room
VWR = Ventilation Wash Room
XC = Extraction Cell

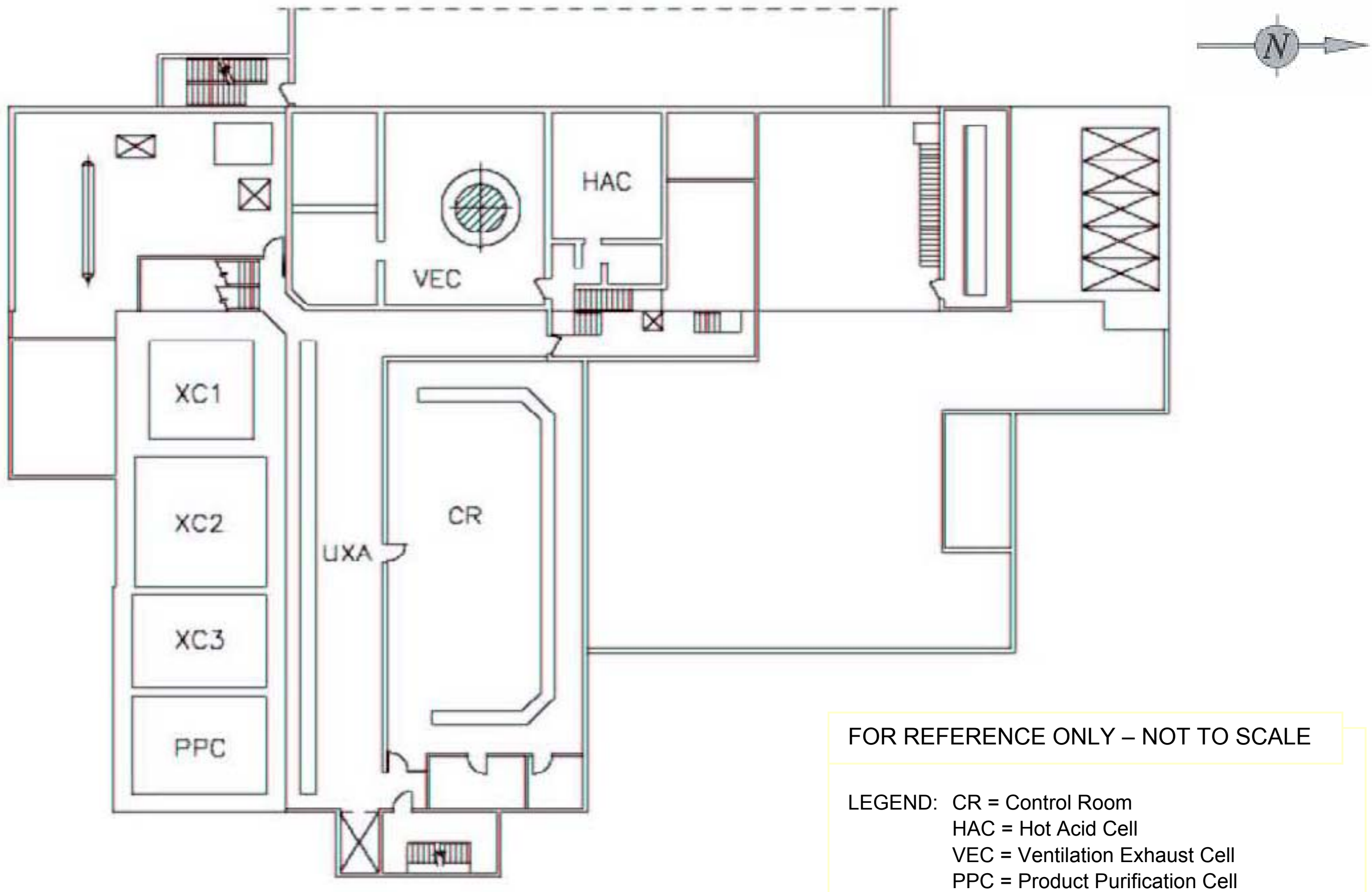
Figure 3-13C. Process Building Layout at 114.5-Foot Elevation



FOR REFERENCE ONLY – NOT TO SCALE

Figure 3-13D. Process Building Layout at 131-Foot Elevation

LEGEND:
ADA = Analytical Decontamination Aisle
ANA = Analytical Aisle
ANC = Analytical Sample Cell
CCR = CPC Crane Room
CPC = Chemical Process Cell
NOA = North Operating Aisle
OGA = Off-Gas-Acid Recovery Aisle
PMCRE = Process Mechanical Cell Crane Room Enclosure
PPC = Product Purification Cell
XC = Extraction Cell



FOR REFERENCE ONLY – NOT TO SCALE

LEGEND: CR = Control Room
HAC = Hot Acid Cell
VEC = Ventilation Exhaust Cell
PPC = Product Purification Cell
UXA = Upper Extraction Aisle
VEC = Ventilation Exhaust Cell
XC = Extraction Cell

Figure 3-13E. Process Building Layout at 144-Foot Elevation

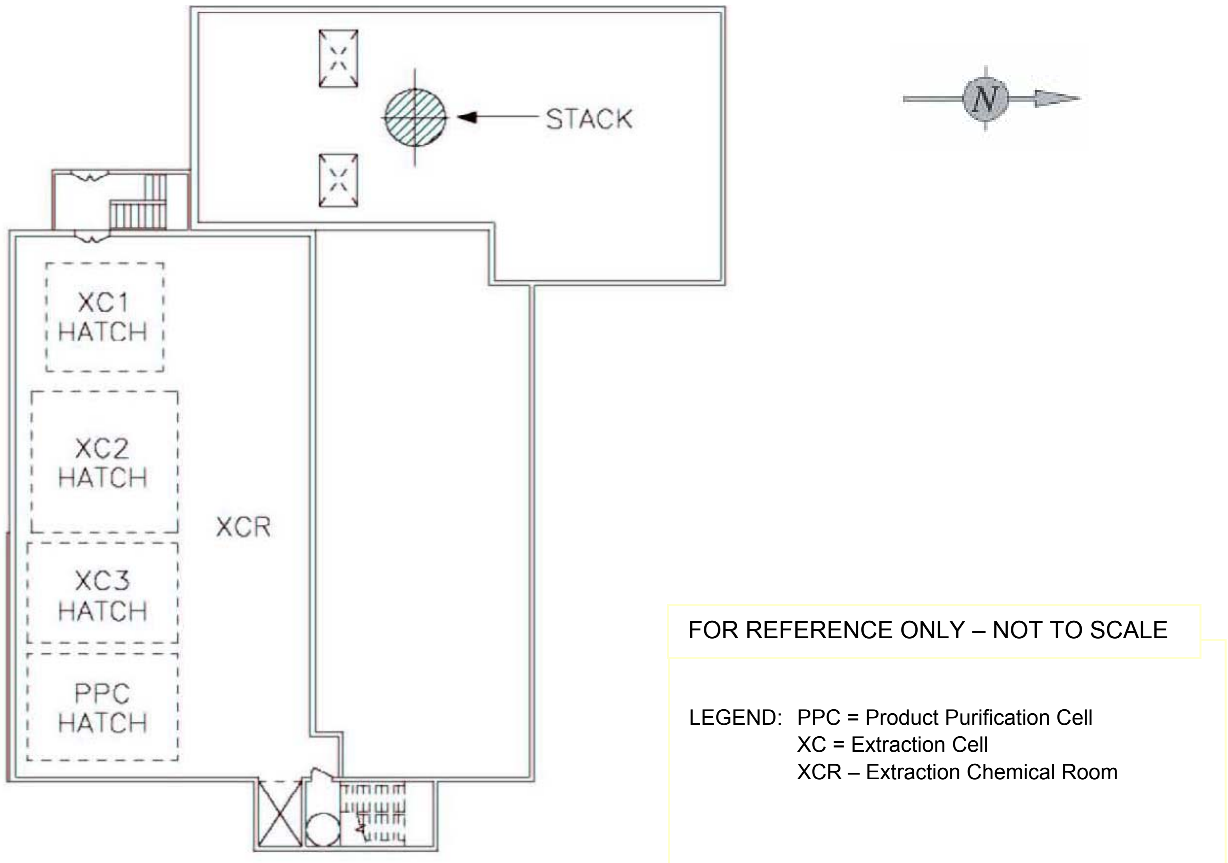


Figure 3-13F. Process Building Layout at 160-Foot Elevation

Figure 3-14. West Side of the Process Building. (The building with windows is actually the Plant Office Building. The plant part of the Process Building is behind the Office Building

Figure 3-15. Fuel Receiving and Storage Area. (This facility is located on the east side of the Process Building.)

Figure 3-16. HLW Canisters Stored in the HLW Interim Storage Area

Figure 3-17. Conditions in the General Purpose Cell in 1999. (These were the conditions before the beginning of cleanup in connection with deactivation.)

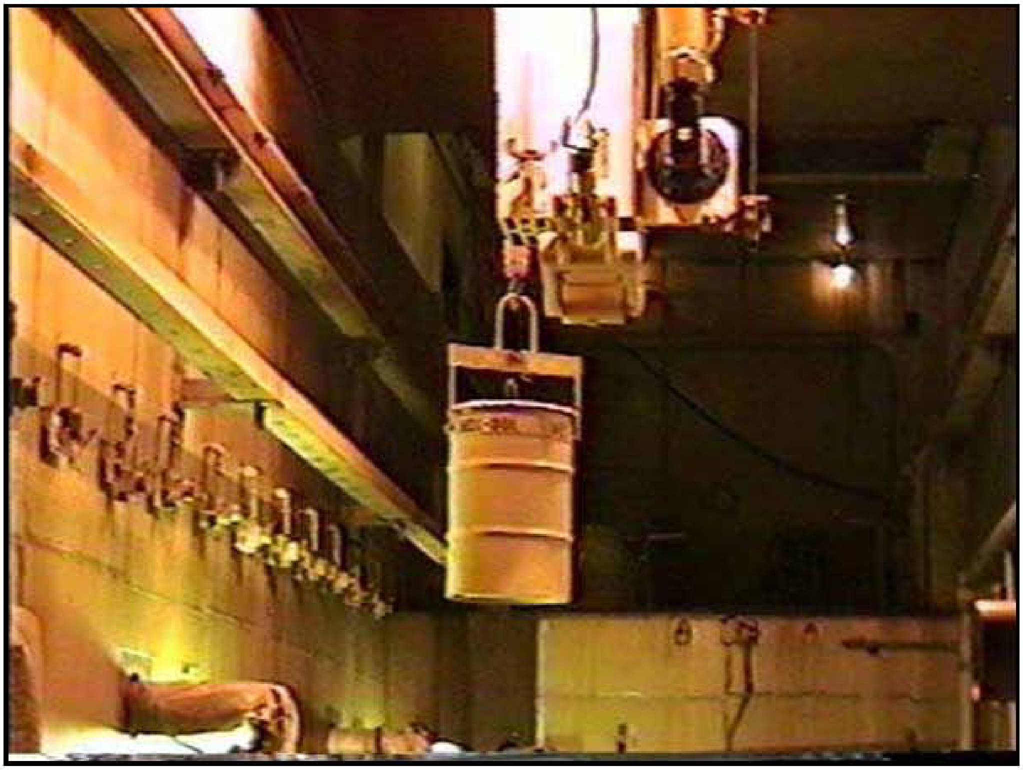


Figure 3-18. Process Mechanical Cell During Deactivation

Figure 3-19. Extraction Cell 3 (After removal of processing equipment and before installation of the WVDP Liquid Waste Treatment System Equipment)

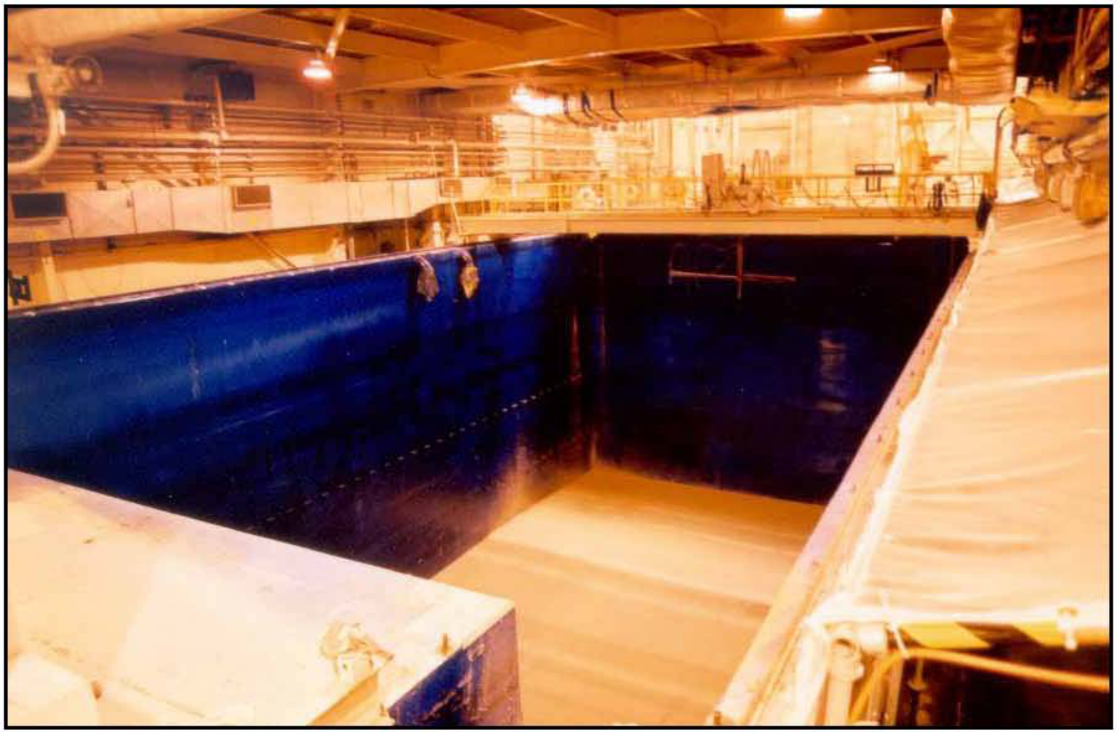


Figure 3-20. The Spent Fuel Pool After Deactivation

Figure 3-21. Equipment Decontamination Room Before Cleanup

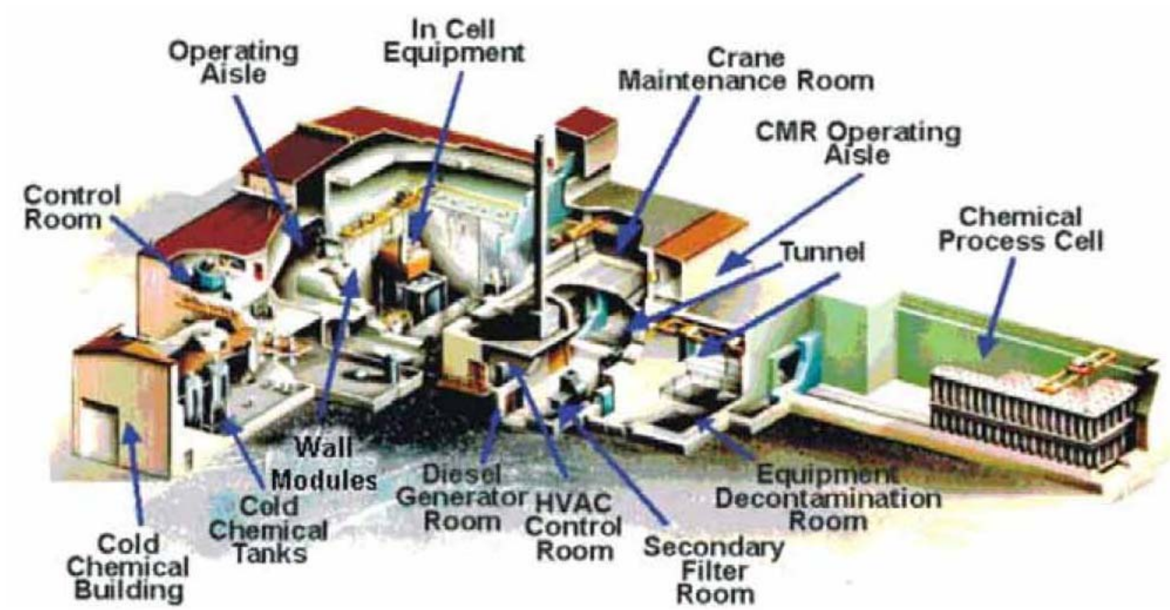


Figure 3-22. Vitrification Facility General Arrangement

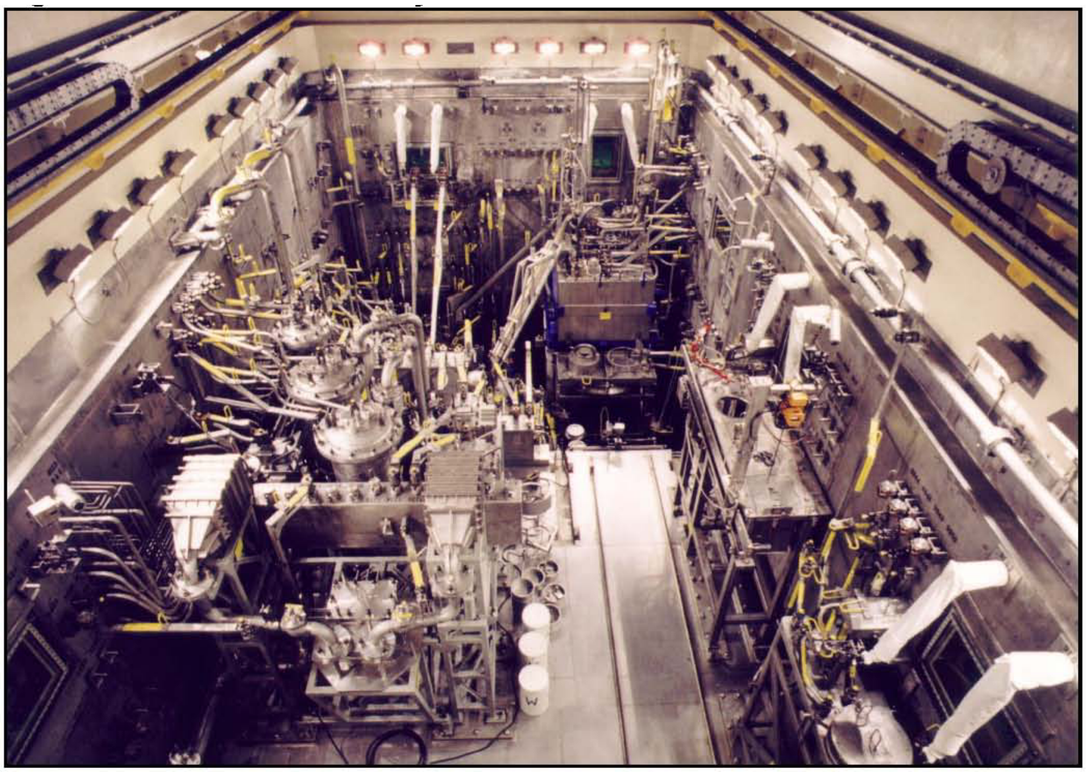


Figure 3-23. Vitrification Cell at Time of Startup

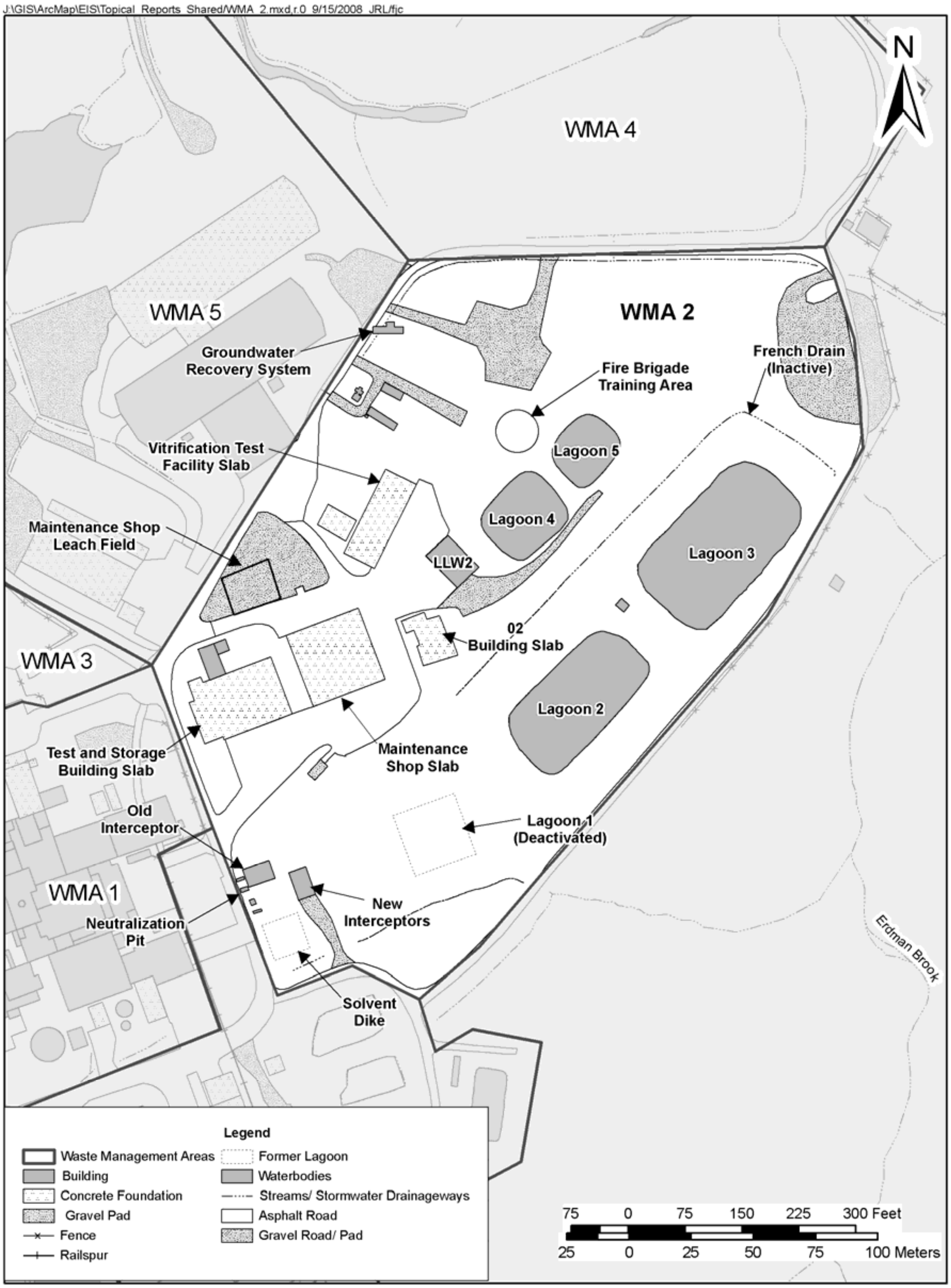


Figure 3-24. WMA 2. (The facilities to be removed during Phase 1 decommissioning activities include the Neutralization Pit, Interceptors, Lagoons, and remaining slabs.)

Figure 3-25. The Low-Level Waste Treatment Facility. (This photo shows the site in 1982, looking toward the southwest.)

Figure 3-26. The LLW2 Building that Replaced the O2 Building

Figure 3-27. The Lagoon 1 Area. (Radioactive debris was placed in Lagoon 1 when it was closed in 1985.)

Figure 3-28. The New Interceptors. (These are twin stainless-steel lined concrete holding tanks.)

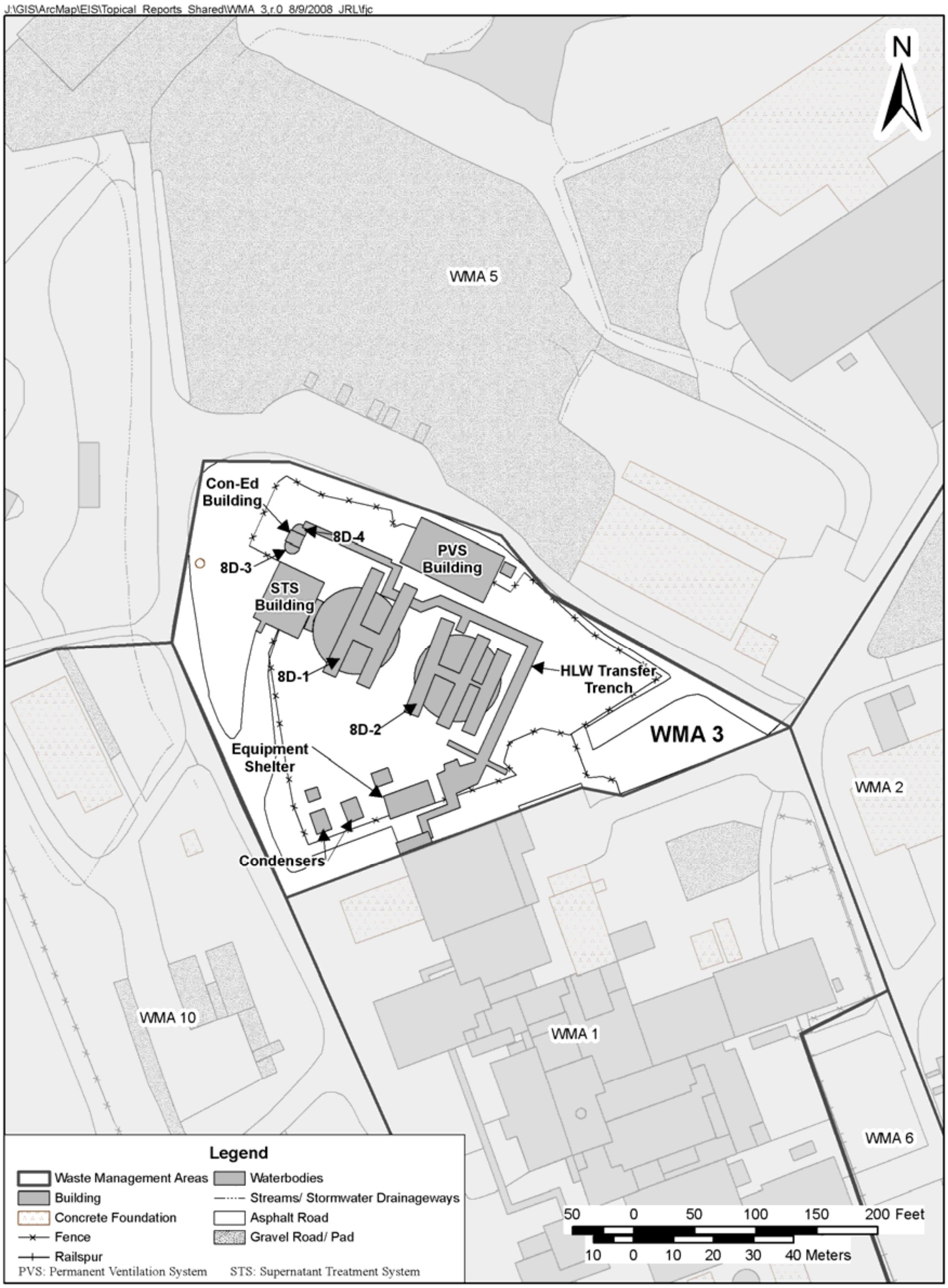


Figure 3-29. WMA 3. (Facilities to be removed during Phase 1 decommissioning activities include the Equipment Shelter, the condensers, the piping in the HLW transfer trench, and the Con-Ed Building.)

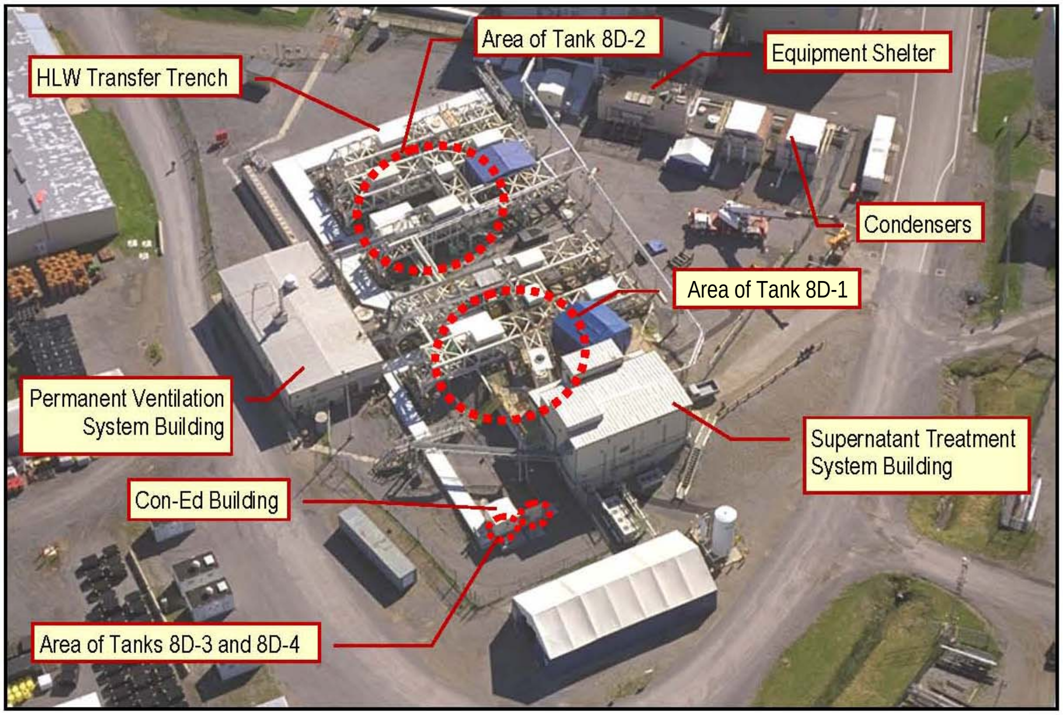


Figure 3-30. Aerial View of WMA 3 Area

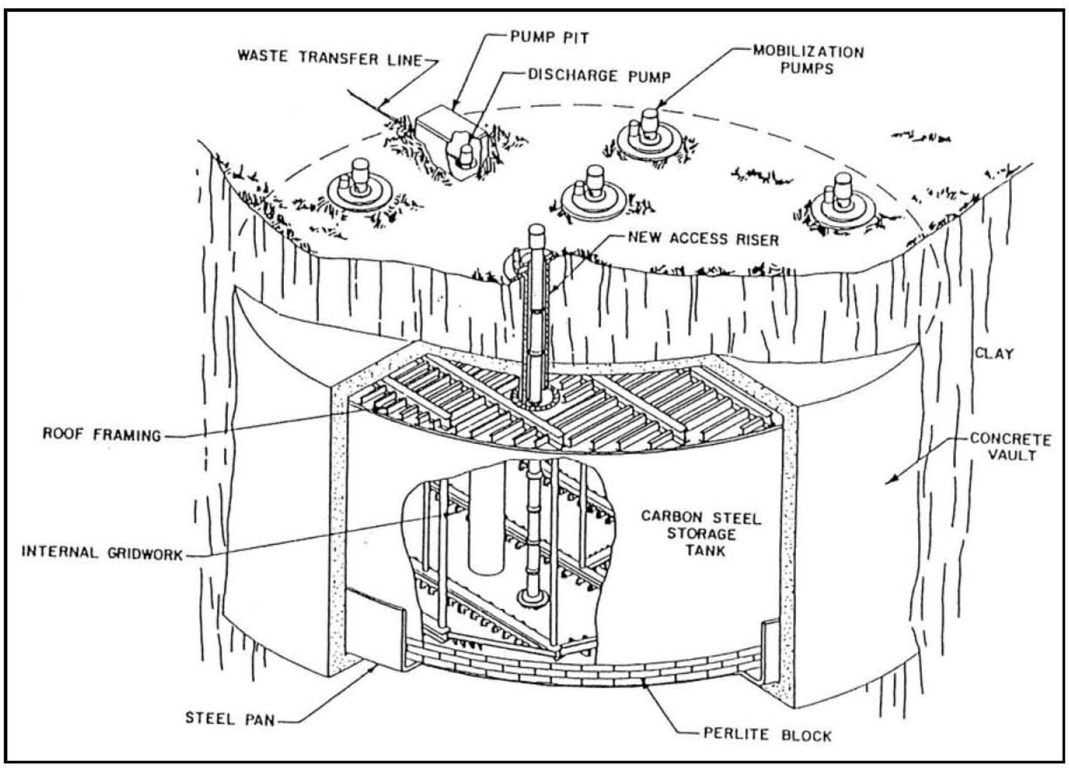
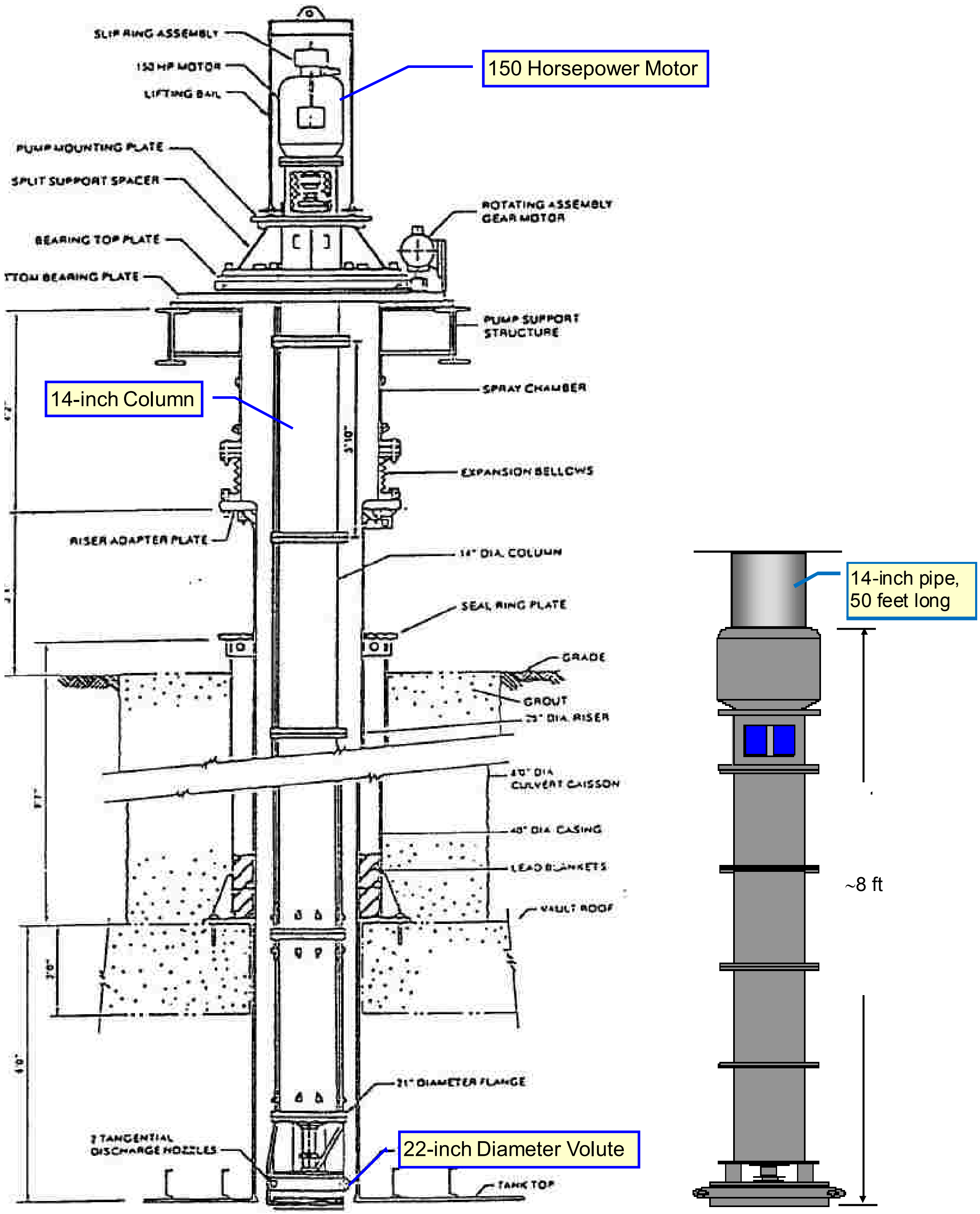


Figure 3-31. Cutaway View of 750-Gallon Underground Waste Tank



Transfer Pump **Mobilization Pump**

Figure 3-32. HLW Transfer and Mobilization Pumps

Figure 3-33. HLW Transfer Trench Under Construction

Figure 3-34. Typical HLW Pump Pit

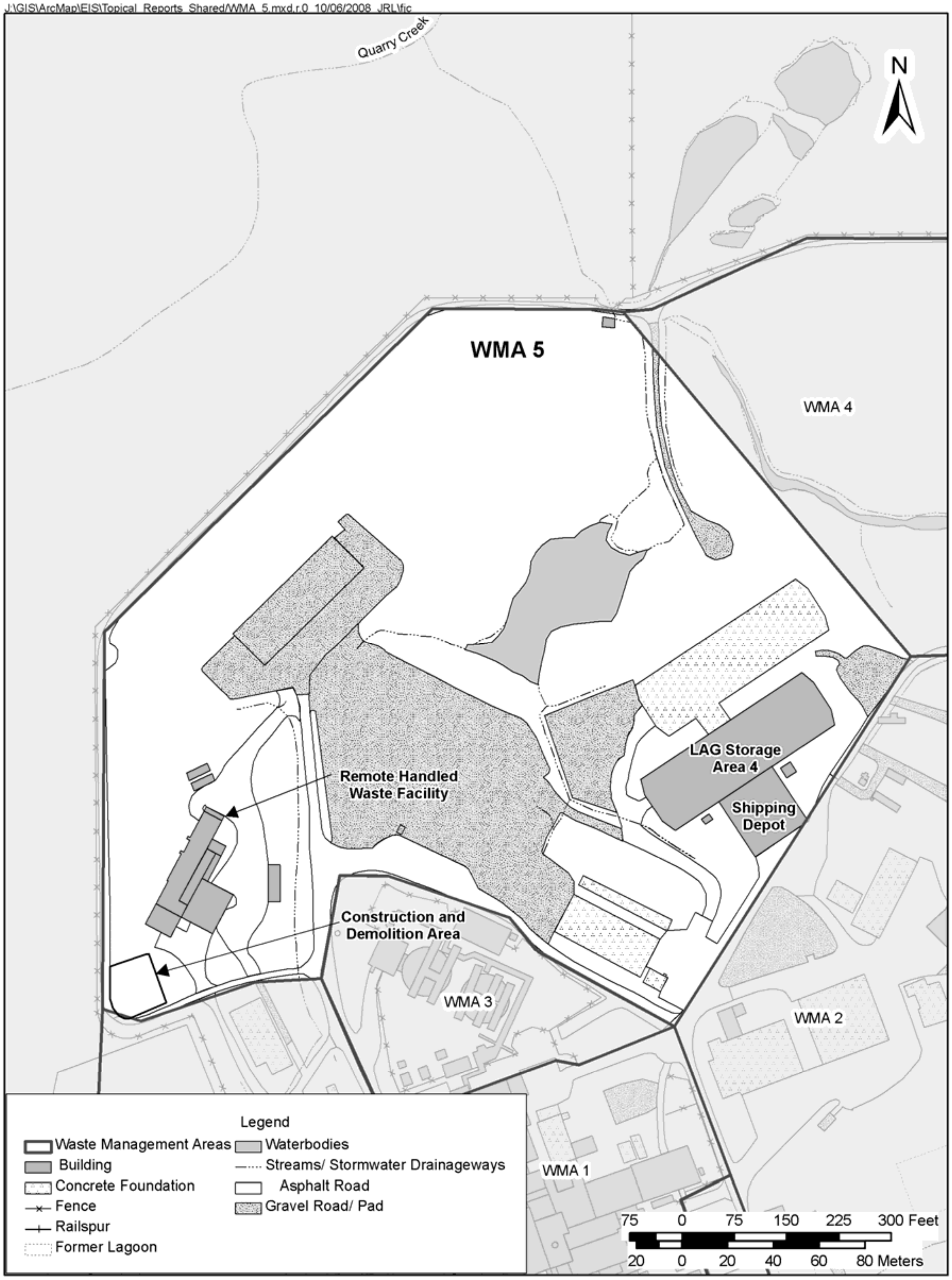


Figure 3-35. WMA 5. (Facilities to be removed during Phase 1 decommissioning include the Remote-Handled Waste Facility, Lag Storage Addition 4 and its Shipping Depot.)

Figure 3-36. The Remote-Handled Waste Facility. (Placed into service in 2004, this new building may contain significant contamination at the time it is removed.)

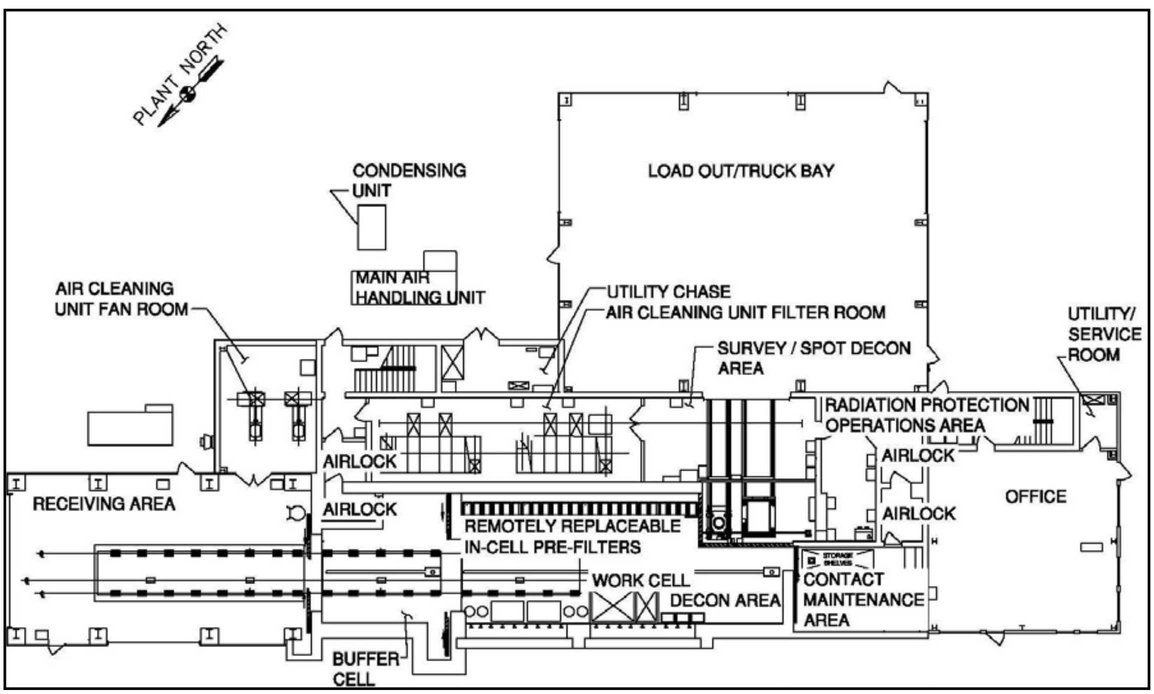


Figure 3-37. The Remote-Handled Waste Facility First Floor Layout.

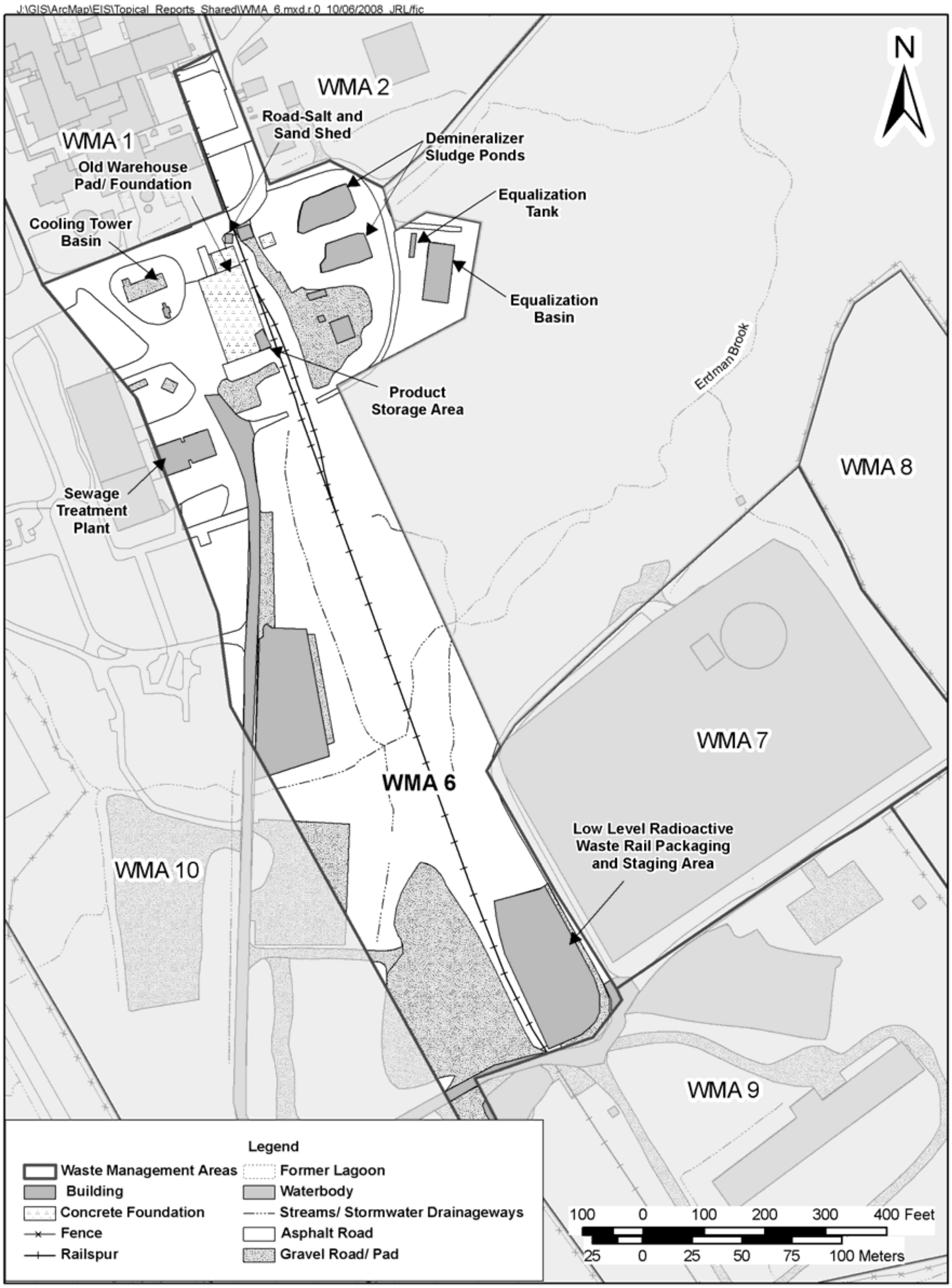


Figure 3-38. WMA 6. (Facilities to be removed during Phase 1 Decommissioning include the Demineralizer Sludge Ponds, the Sewage Treatment Plant, the Equalization Tank and Basin, the south Waste Tank Farm Training Platform, and the remaining slabs.)

Figure 3-39. The Rail Spur. (The rail spur leads to the Fuel Receiving and Storage Facility.)

Figure 3-40. The New Cooling Tower. (The cooling tower will be removed, except for its concrete basin, before Phase 1 decommissioning activities begin.)

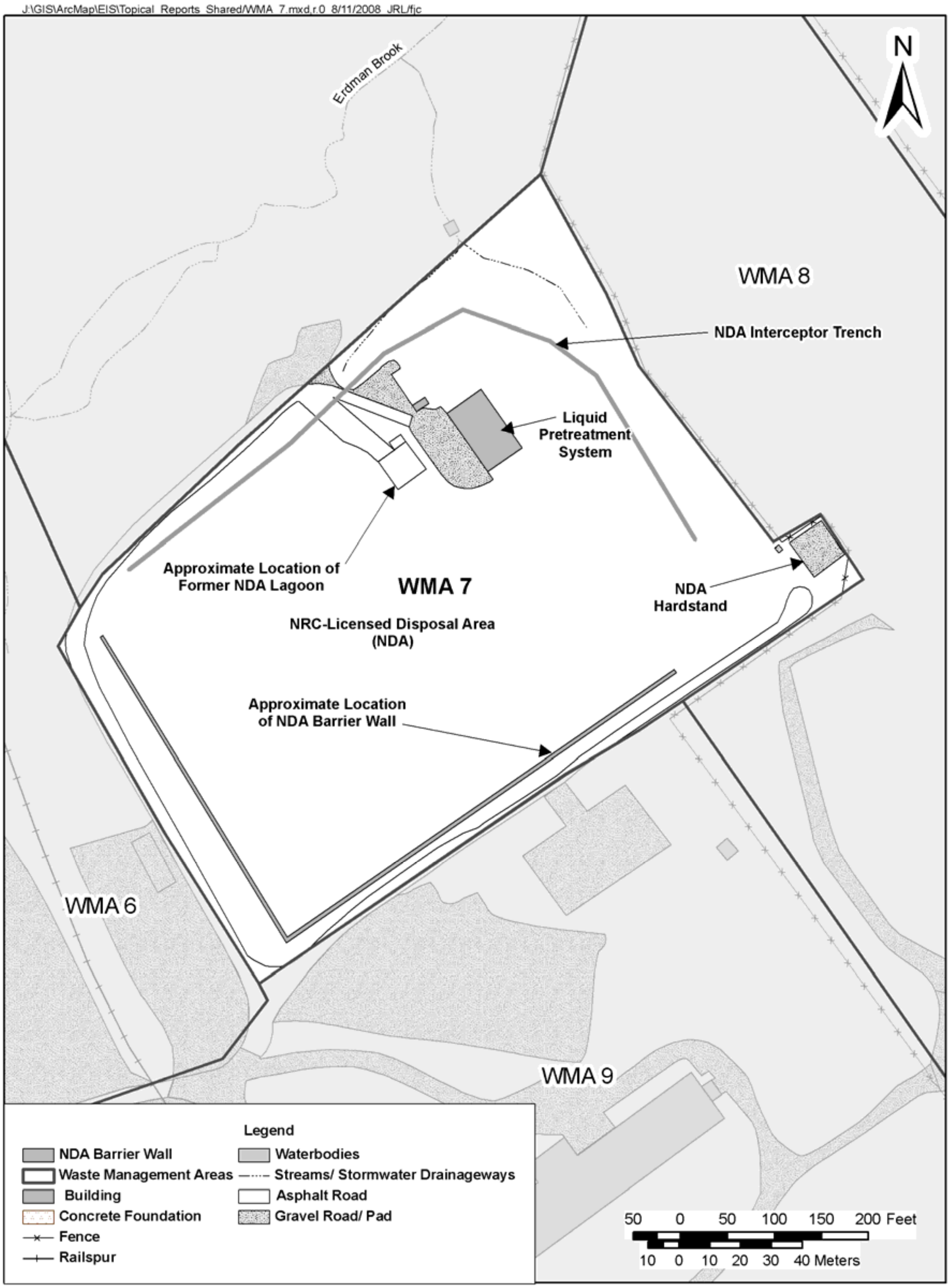


Figure 3-41. WMA 7. (The only facility to be removed during Phase 1 decommissioning is the NDA hardstand pad.)

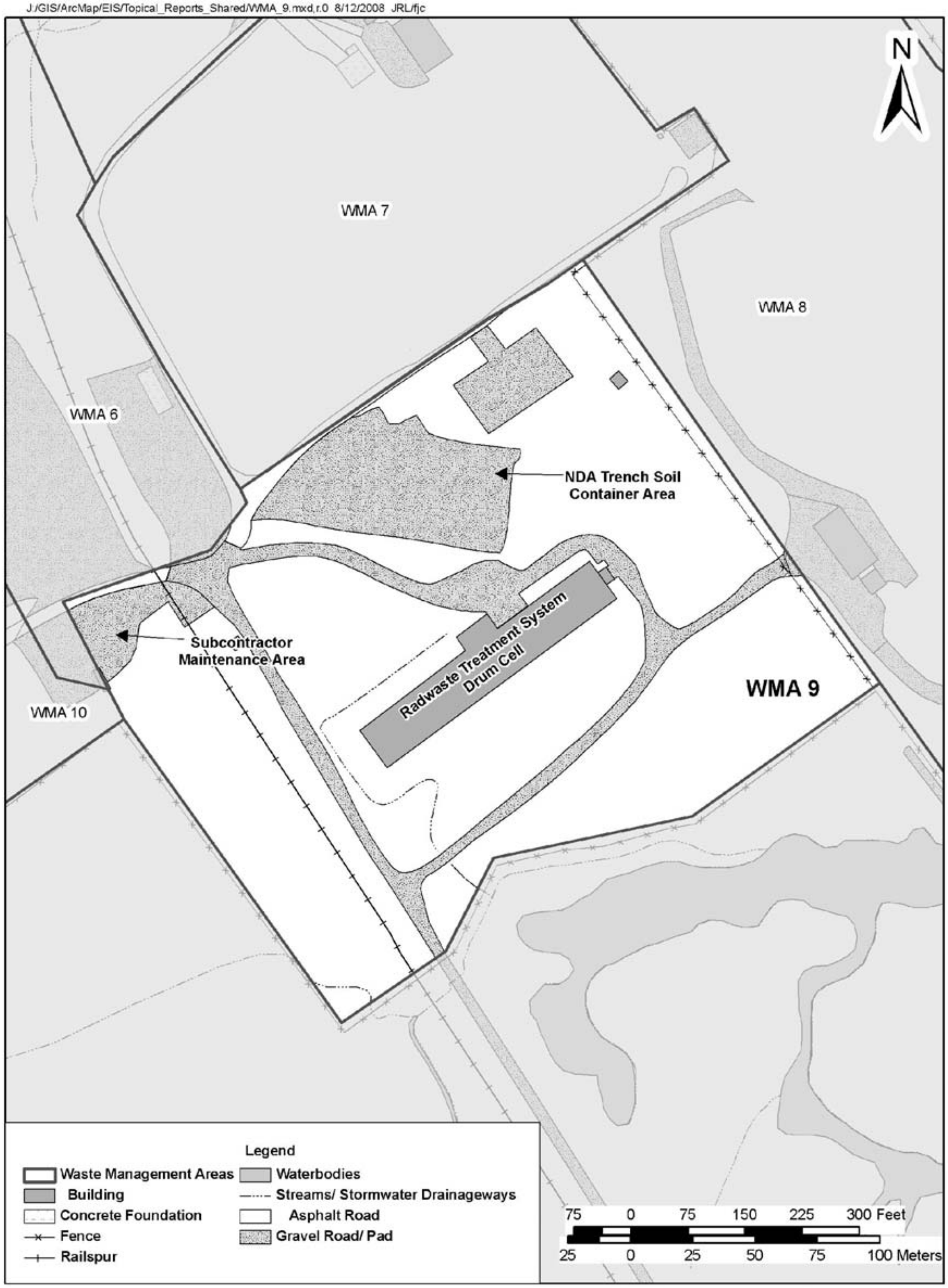


Figure 3-42. WMA 9. (The Drum Cell will be removed during Phase 1 decommissioning, along with NDA Trench Soil Container Area and the Subcontractor Maintenance Area.)

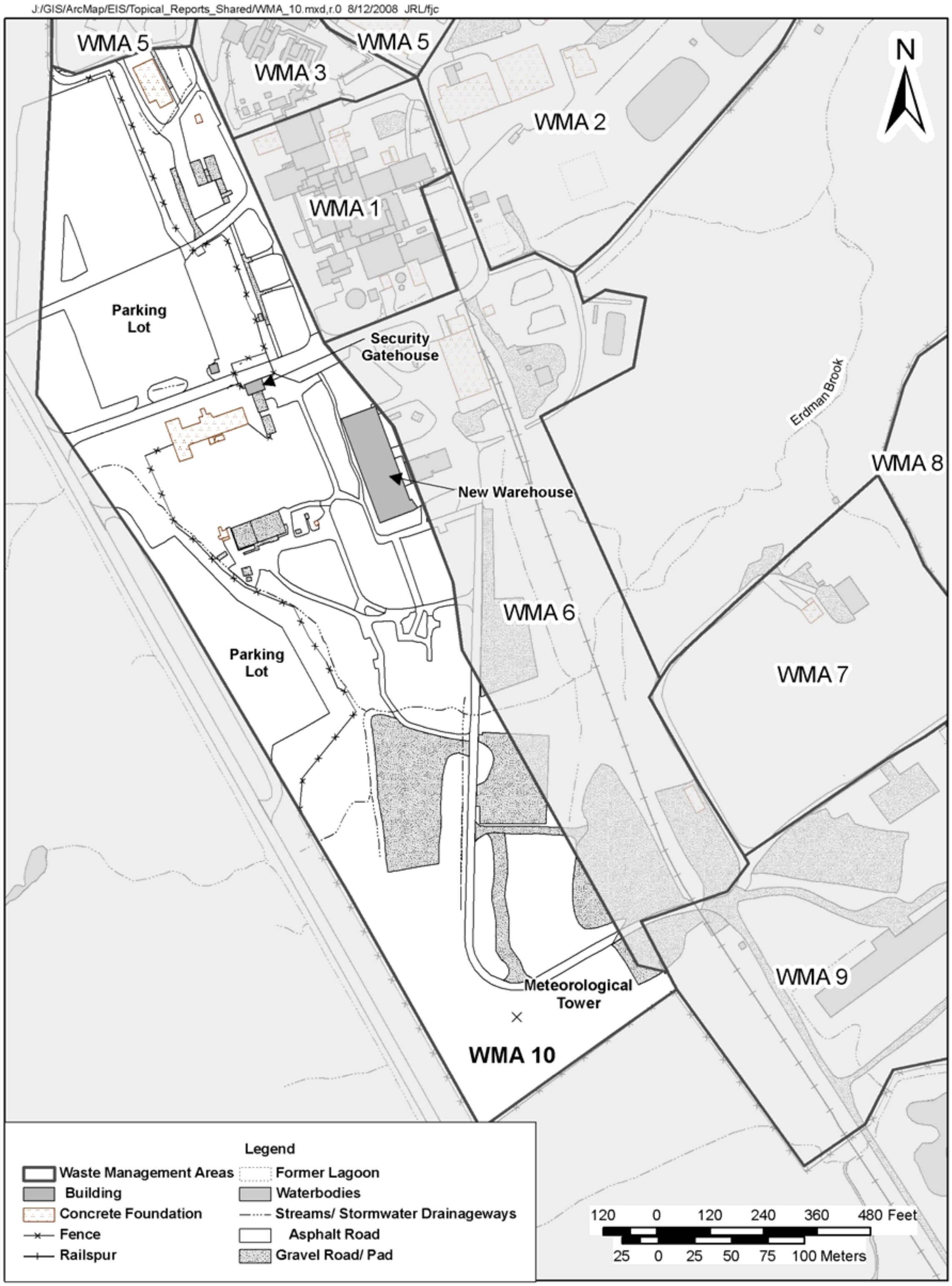


Figure 3-43. WMA 10. (Facilities to be removed during Phase 1 decommissioning include the New Warehouse and the remaining slabs and pads.)

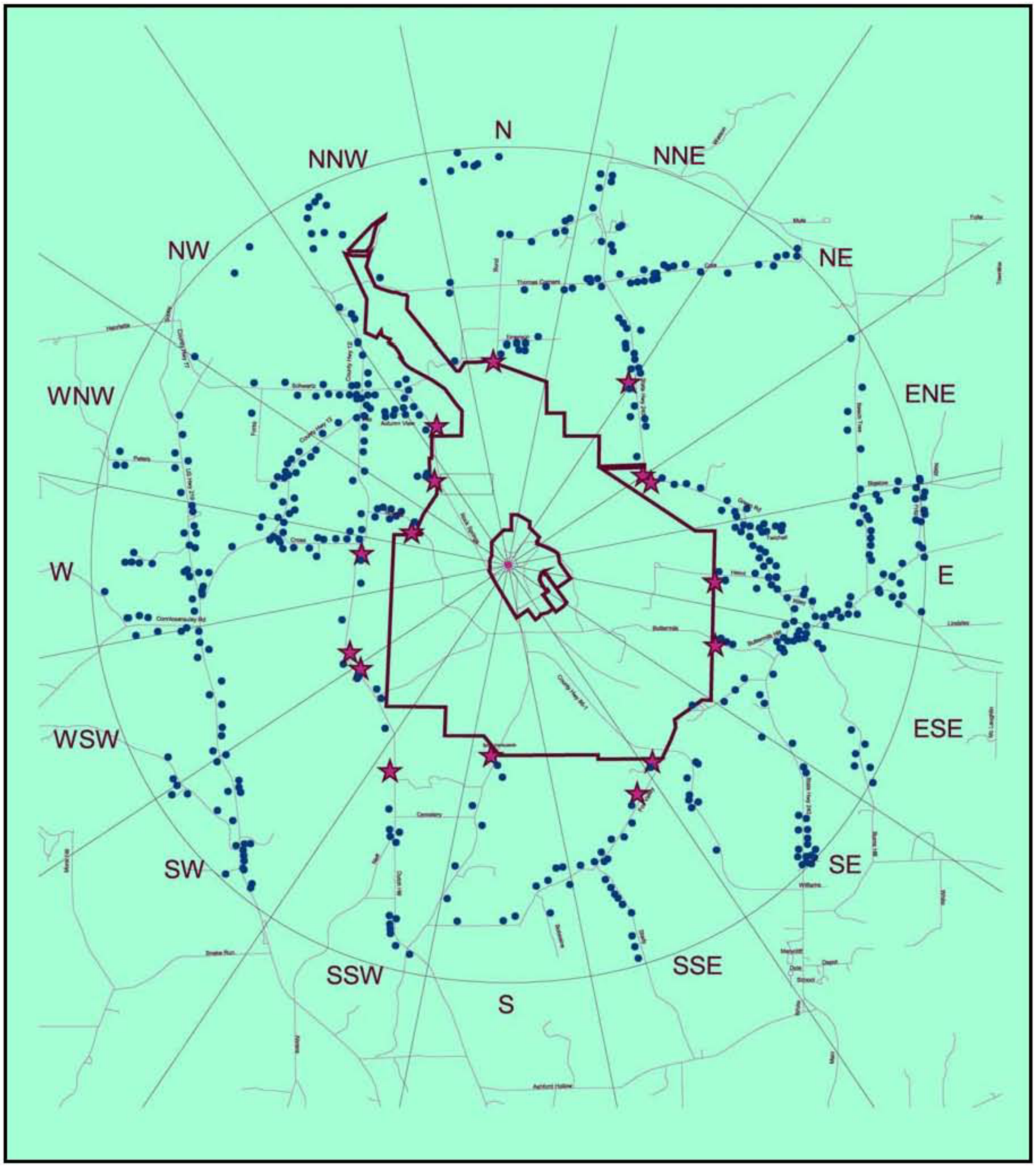


Figure 3-44. Population Around the WVDP by Compass Vector. (The dots represent residences. The stars show the nearest residences by compass vector.)

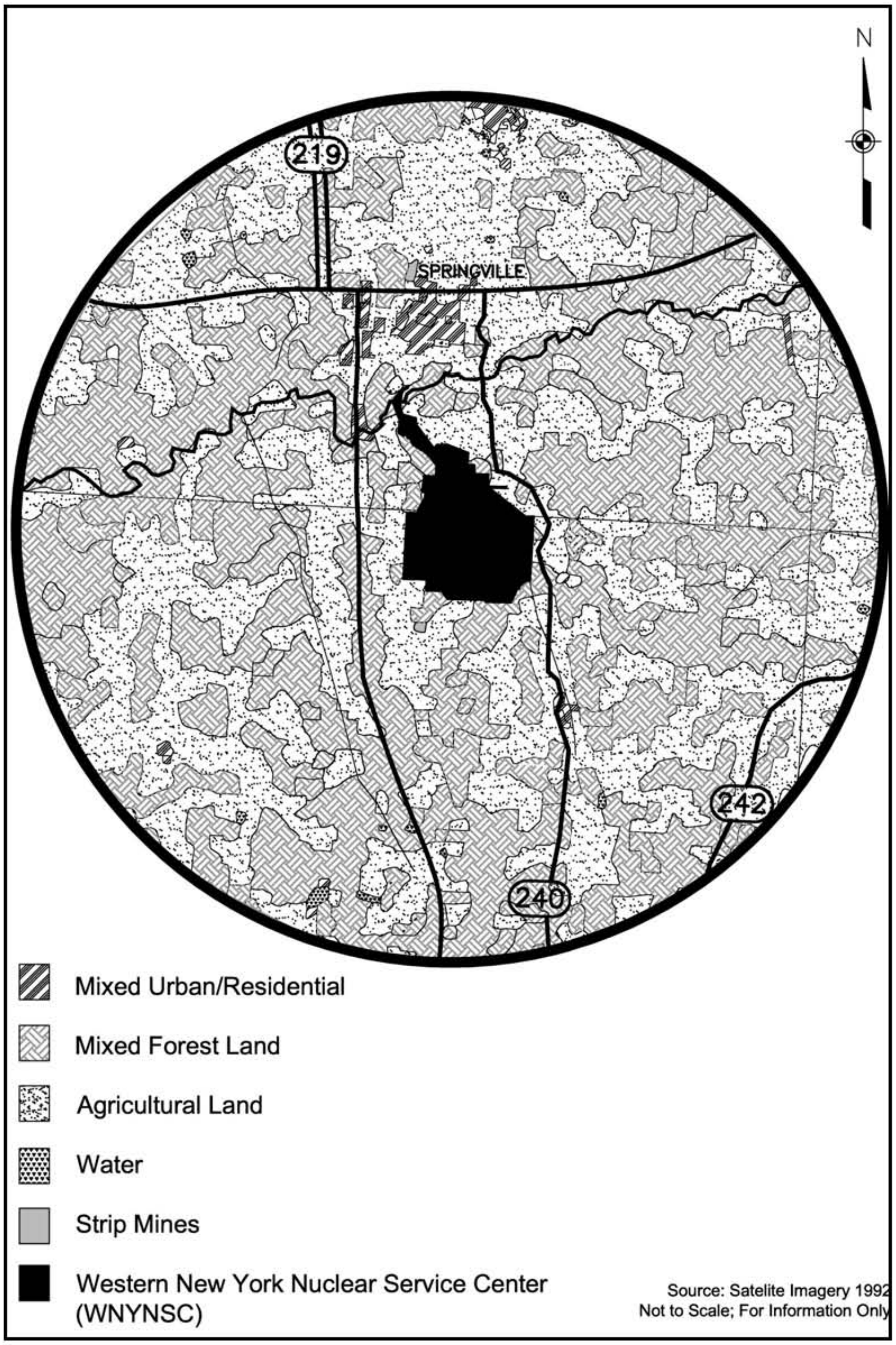


Figure 3-45. Land Use in the Vicinity of the Center

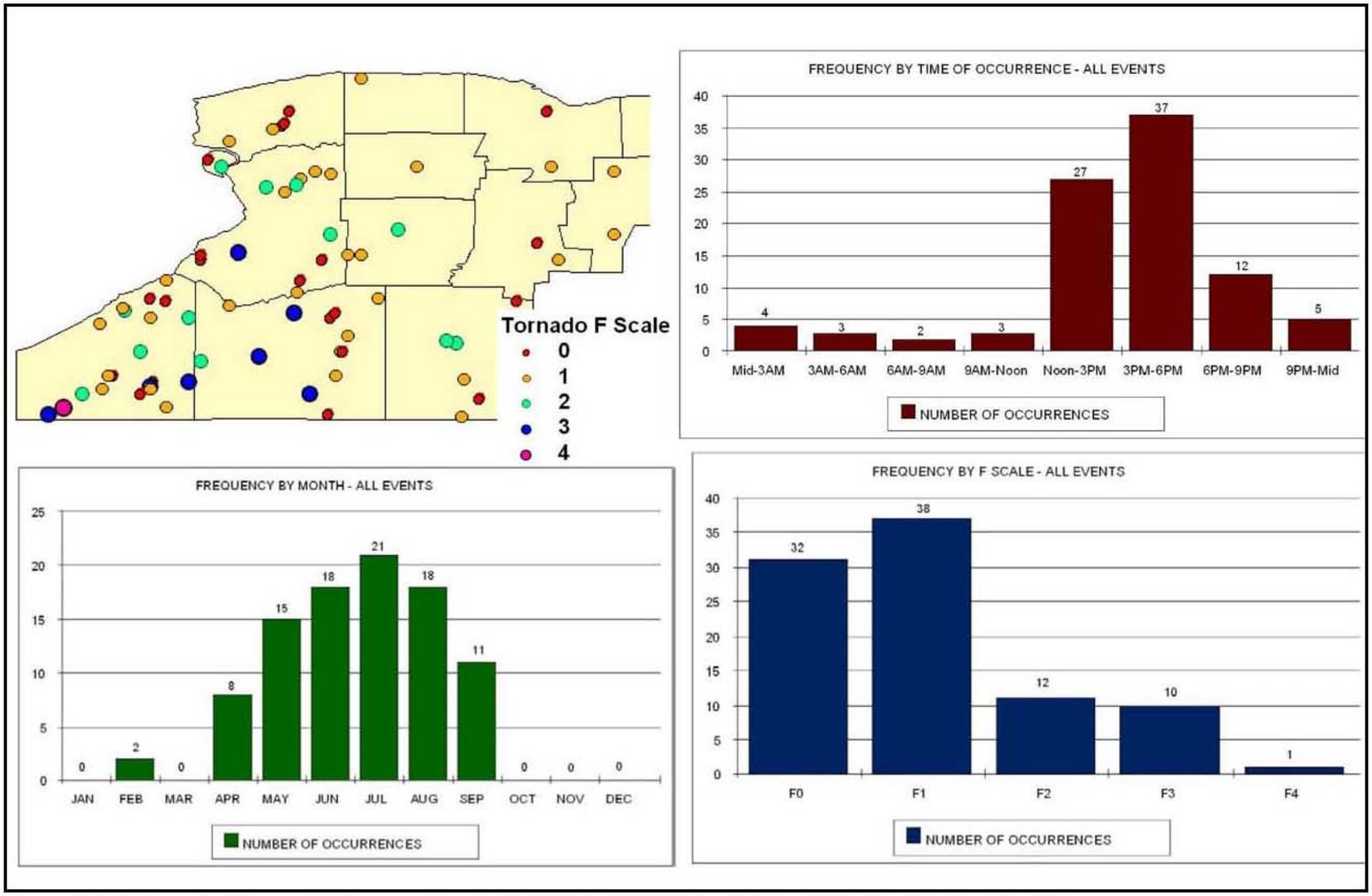


Figure 3-46. Tornado Events in Western New York (1950 – 2002) (From National Weather Service, Buffalo)

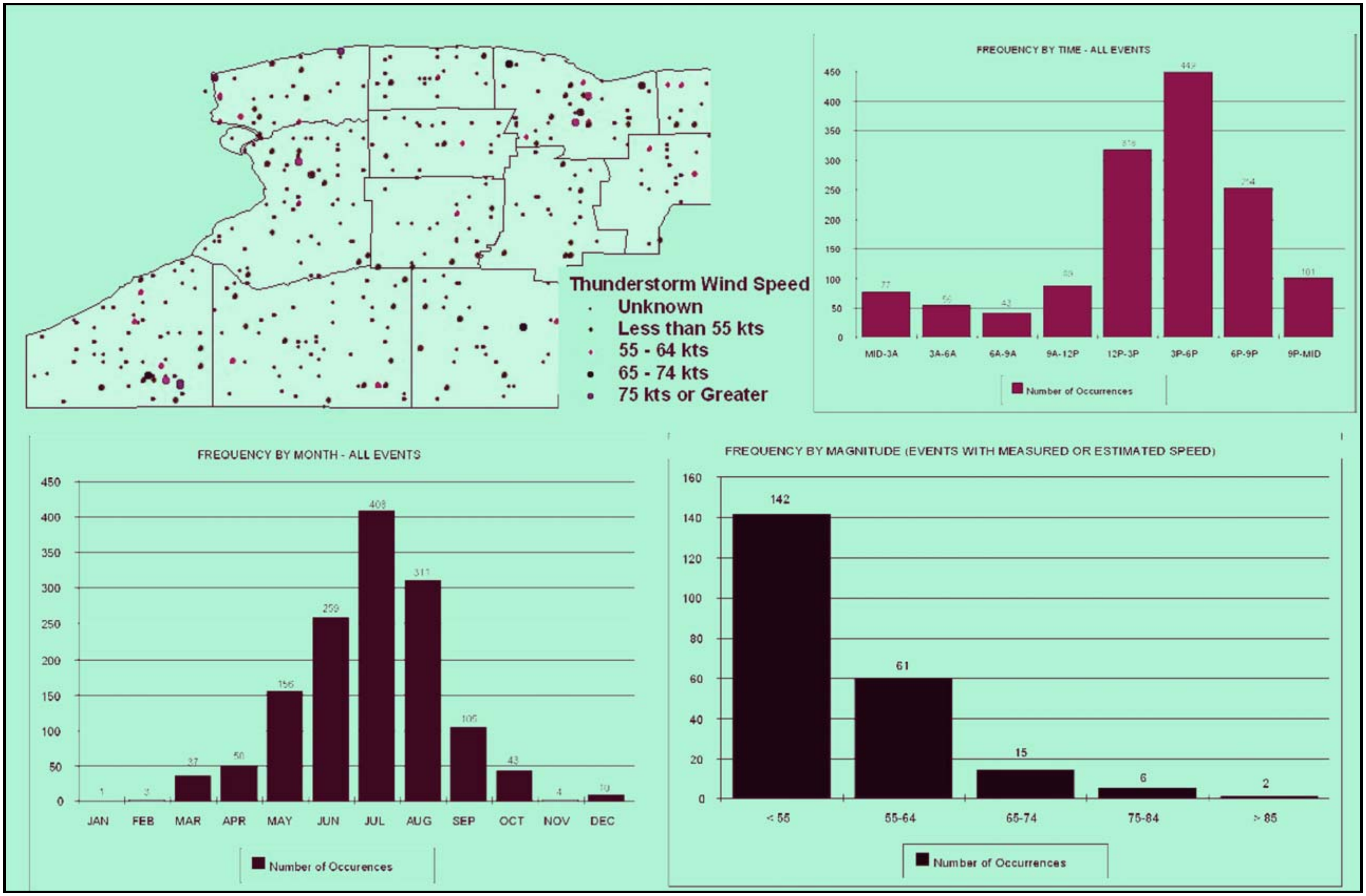


Figure 3-47. Thunderstorm Wind Events in Western New York (1950 – 2002) (From National Weather Service, Buffalo)

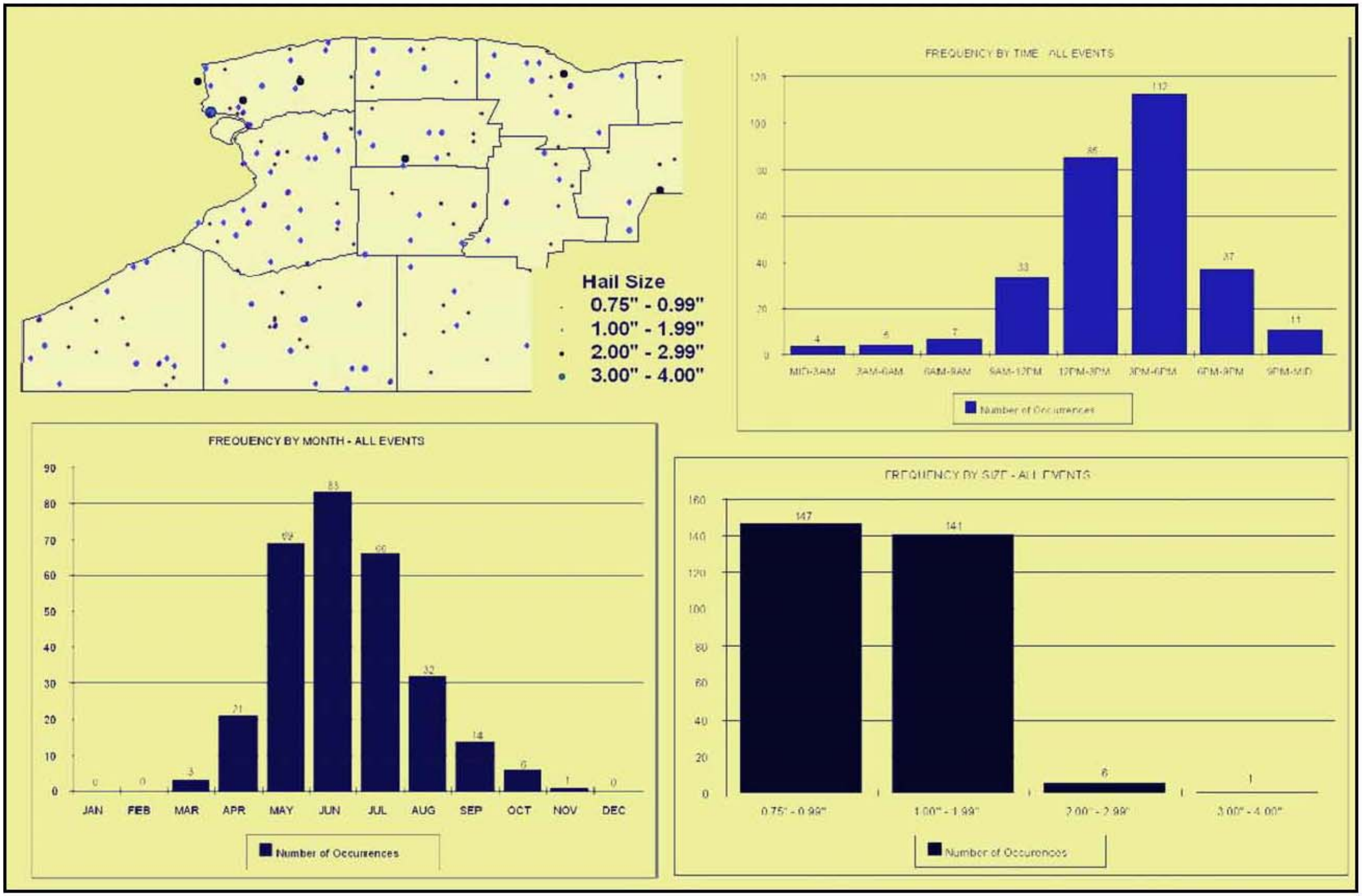


Figure 3-48. Hail Events in Western New York (1950 – 2002) (From National Weather Service, Buffalo)

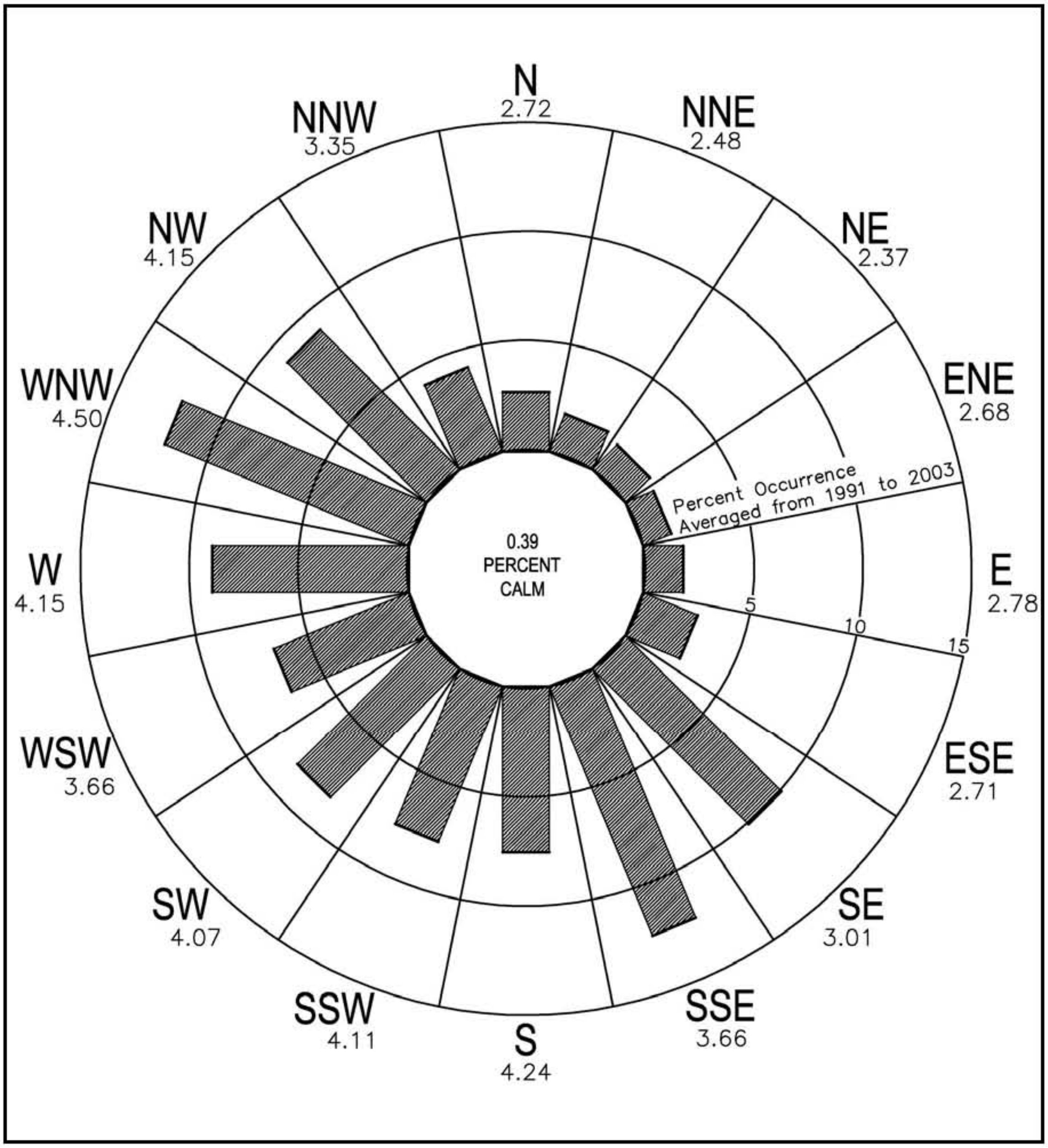
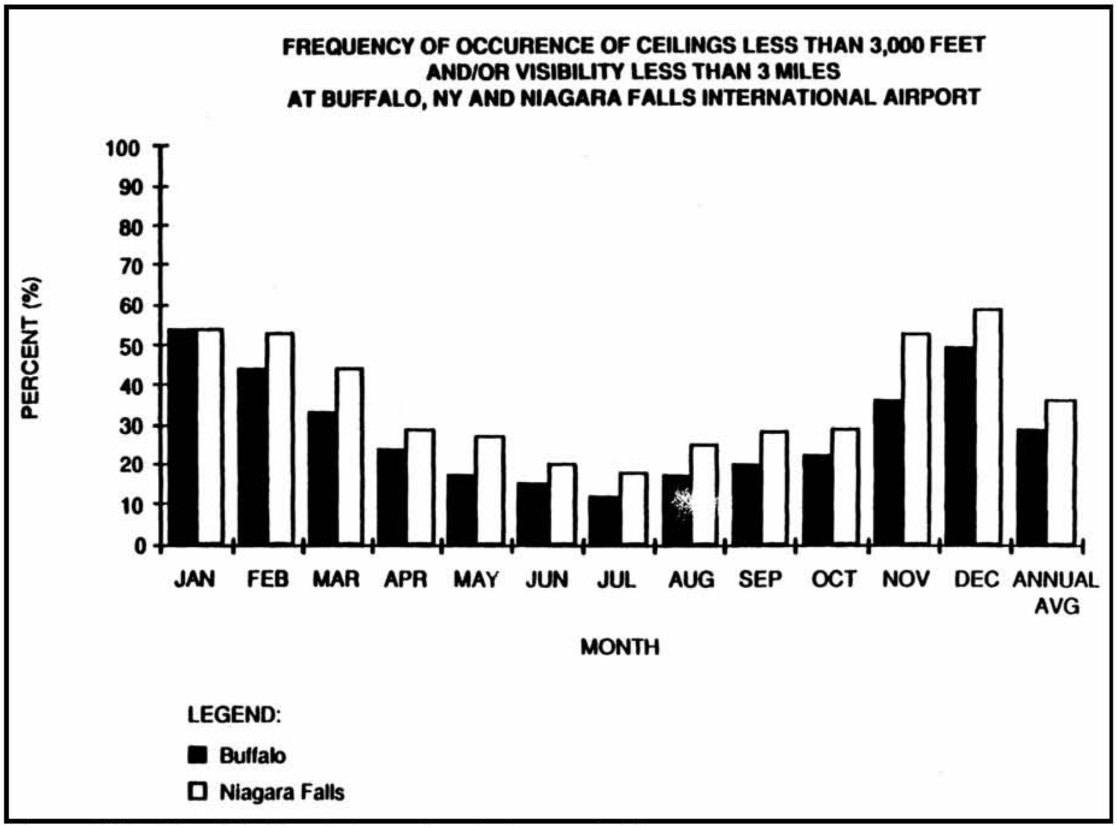


Figure 3-49. Wind Rose Diagram. (1991 – 2003 average head-wind direction and average wind speed in m/s)



F
igure 3-50. **Cloud Ceiling Information** (From reference 3-11)

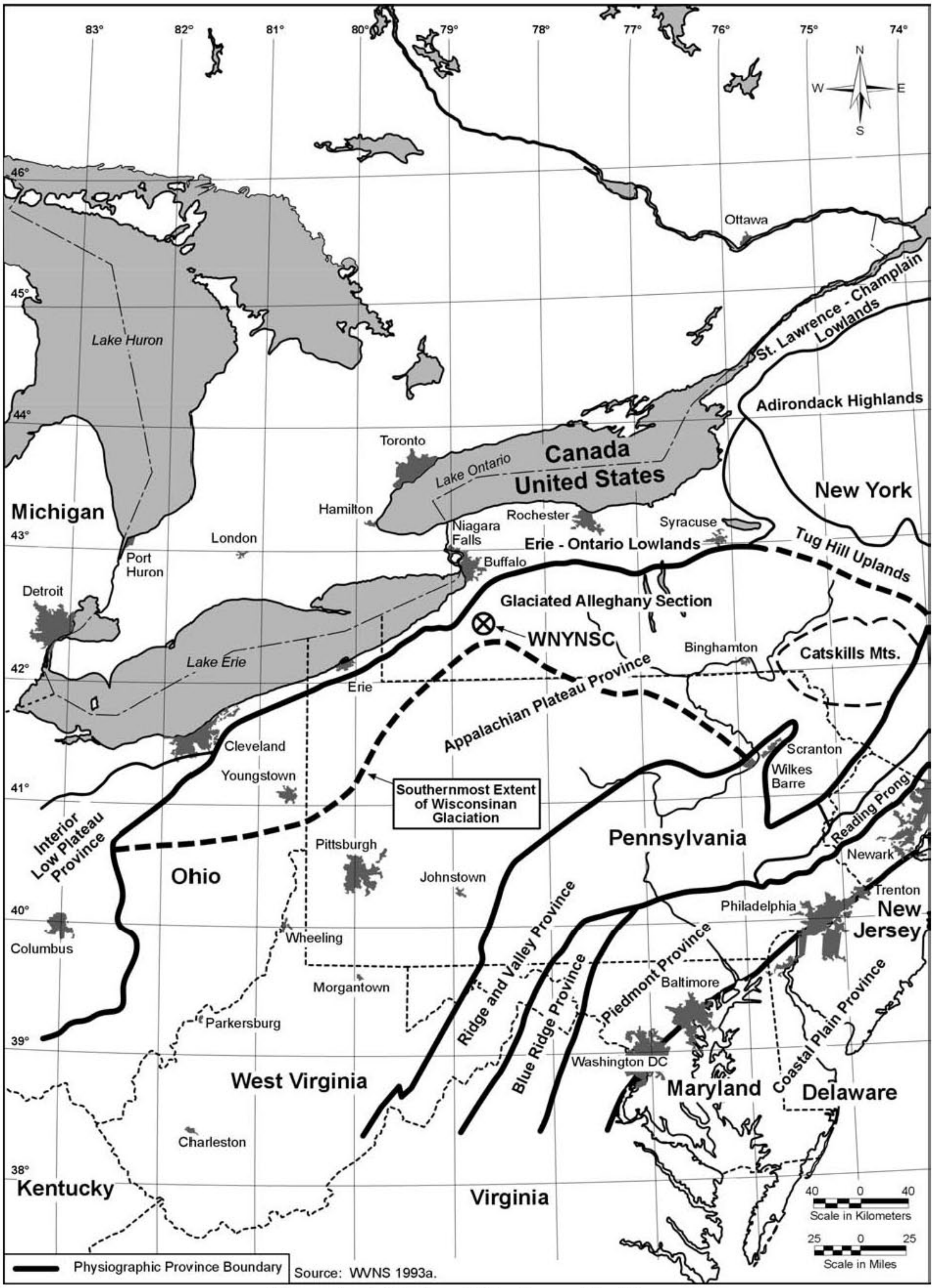


Figure 3-51. Regional Physiographic Map

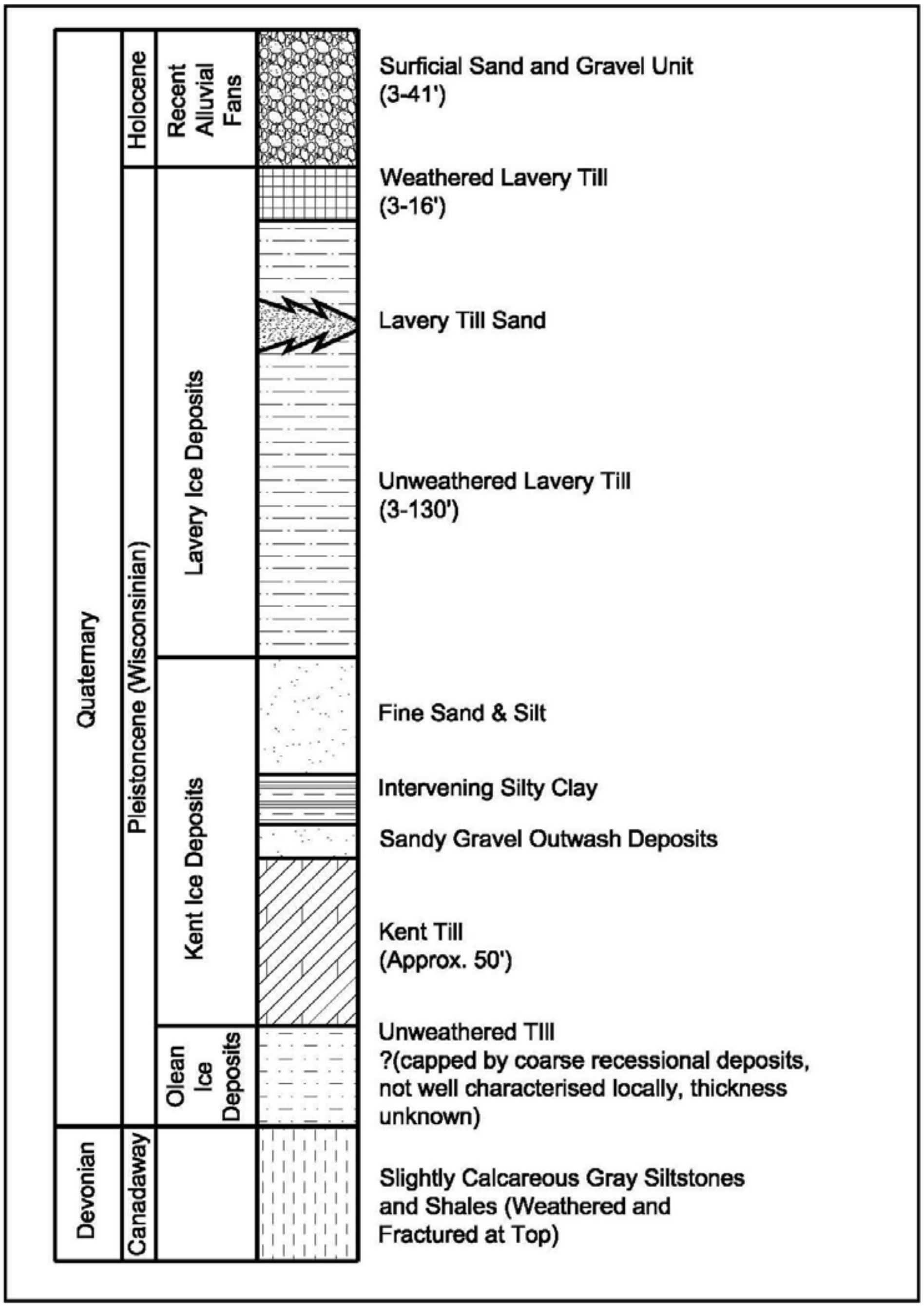


Figure 3-52. Bedrock and Glacial Stratigraphy of the WVDP

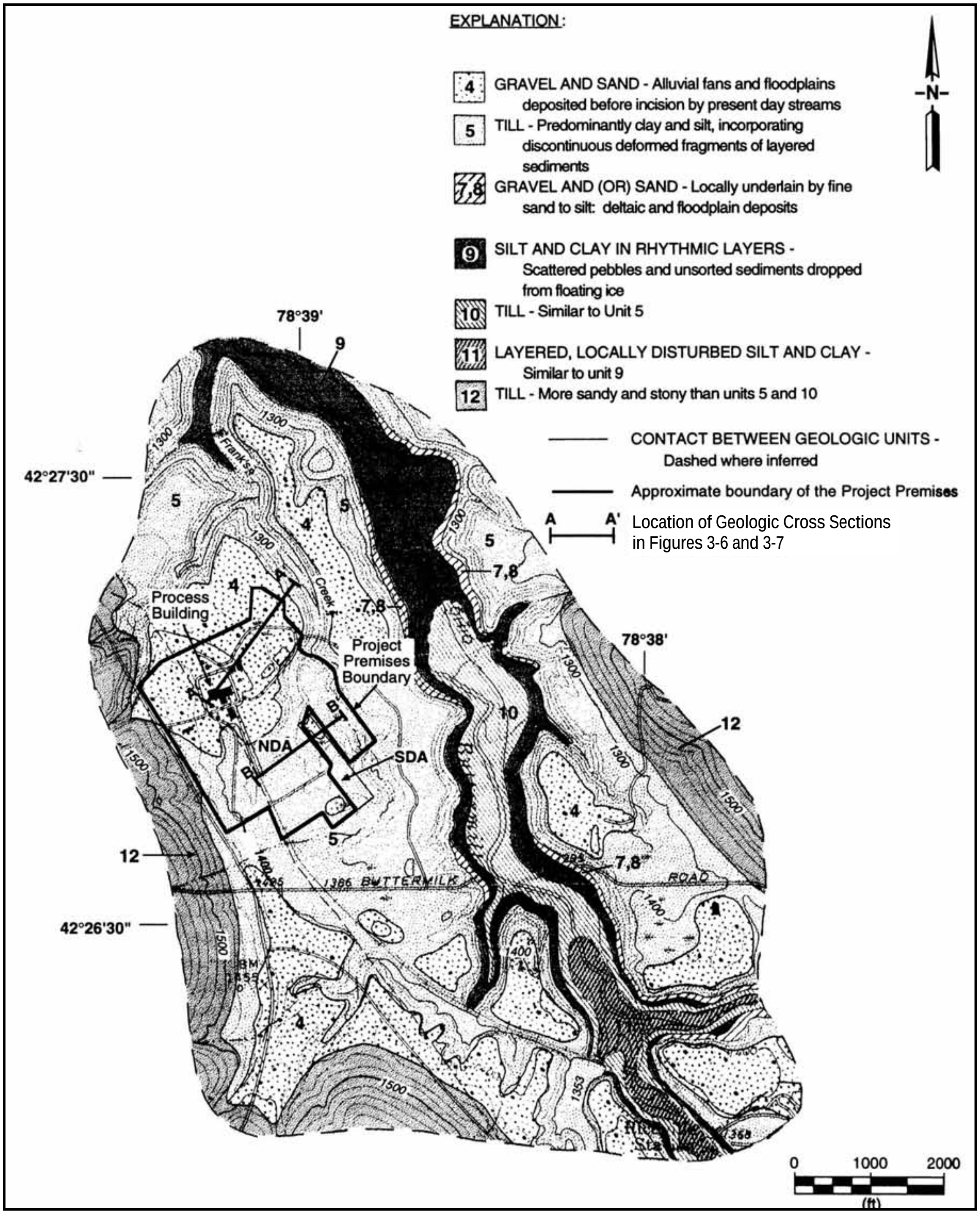


Figure 3-53. Surface Geology of the Project Premises and the SDA

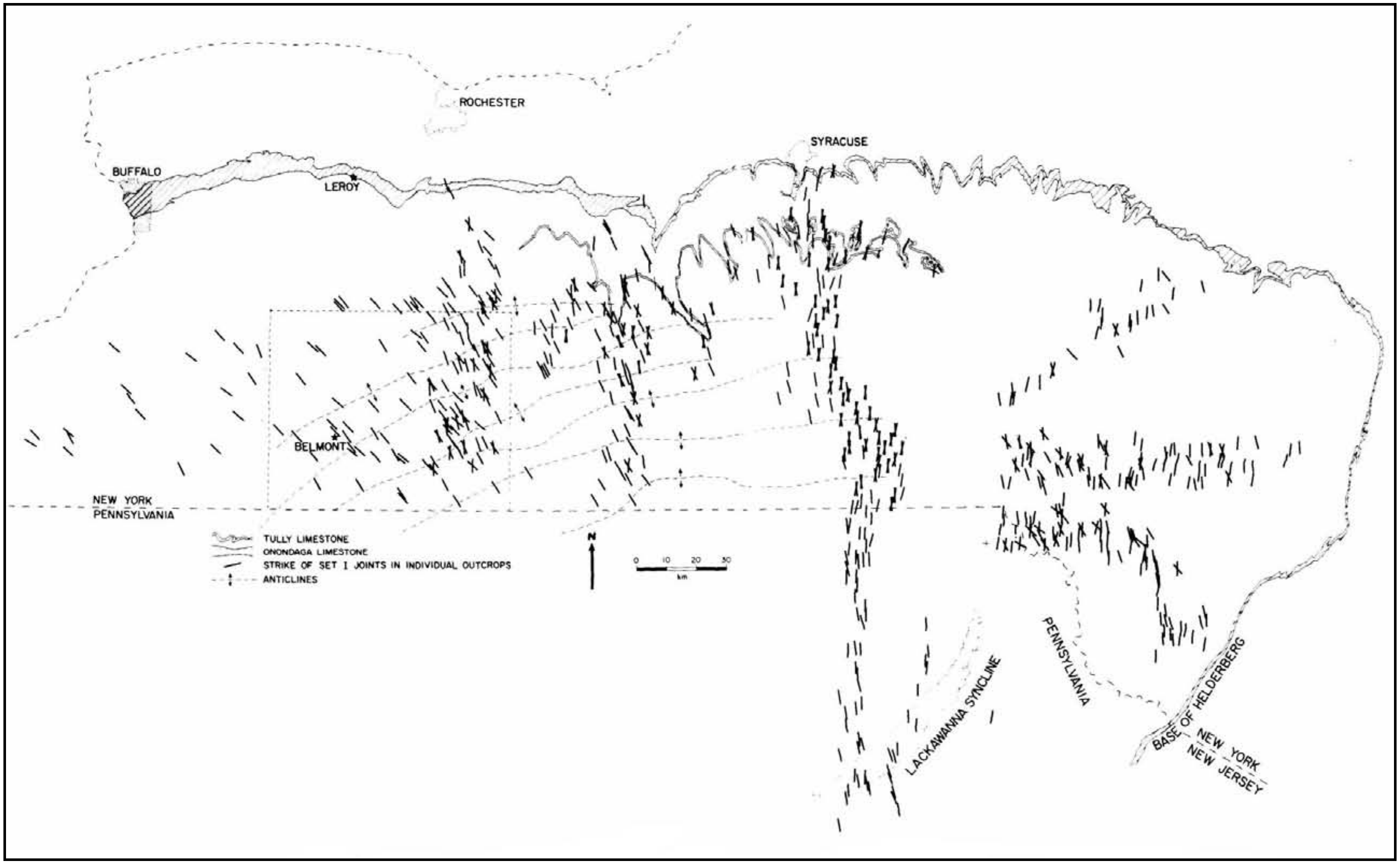


Figure 3-54. Fold and Selected Joint Trends in the Appalachian Plateau of Western and Central New York

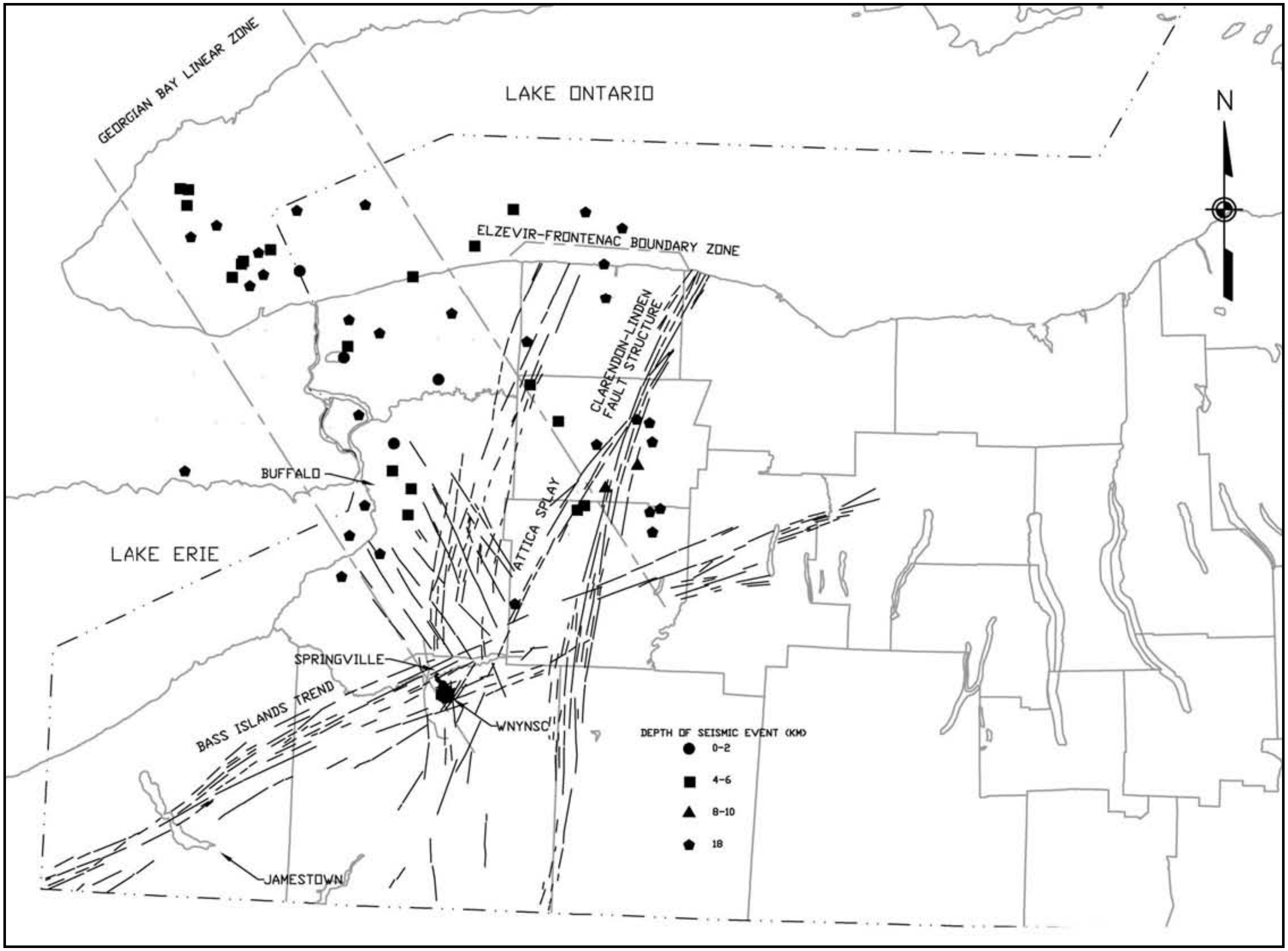


Figure 3-55. Seismo-Tectonic Map of Western New York Showing Selected Regional Geologic Structures

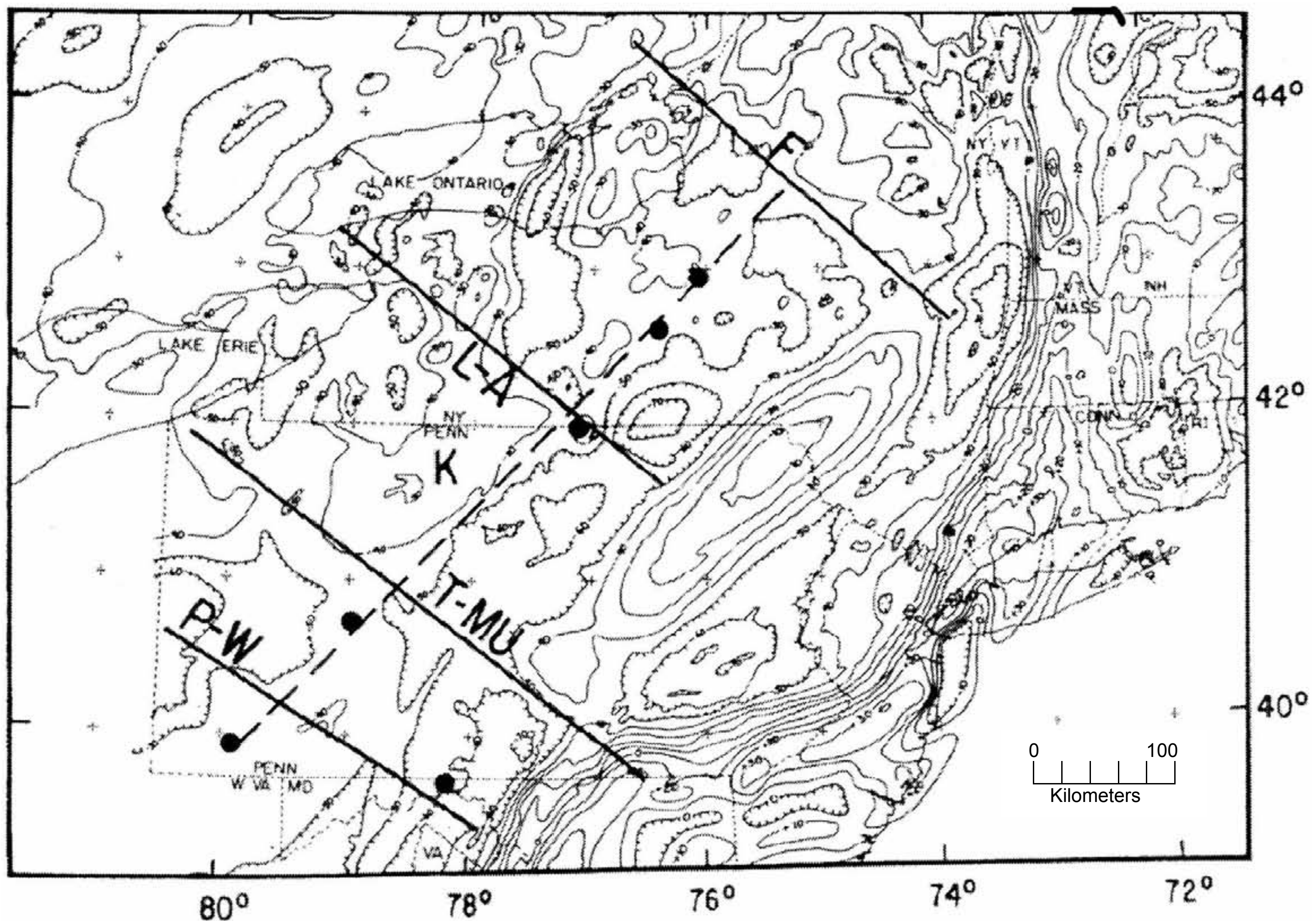


Figure 3-56. Major Northwest Trending Lineaments in New York and Pennsylvania (PW – Pittsburgh-Washington Lineament, T-MU – Tyrone-Mt. Union Lineament, L-A – Lawrenceville-Attica Lineament, F – F Lineament)

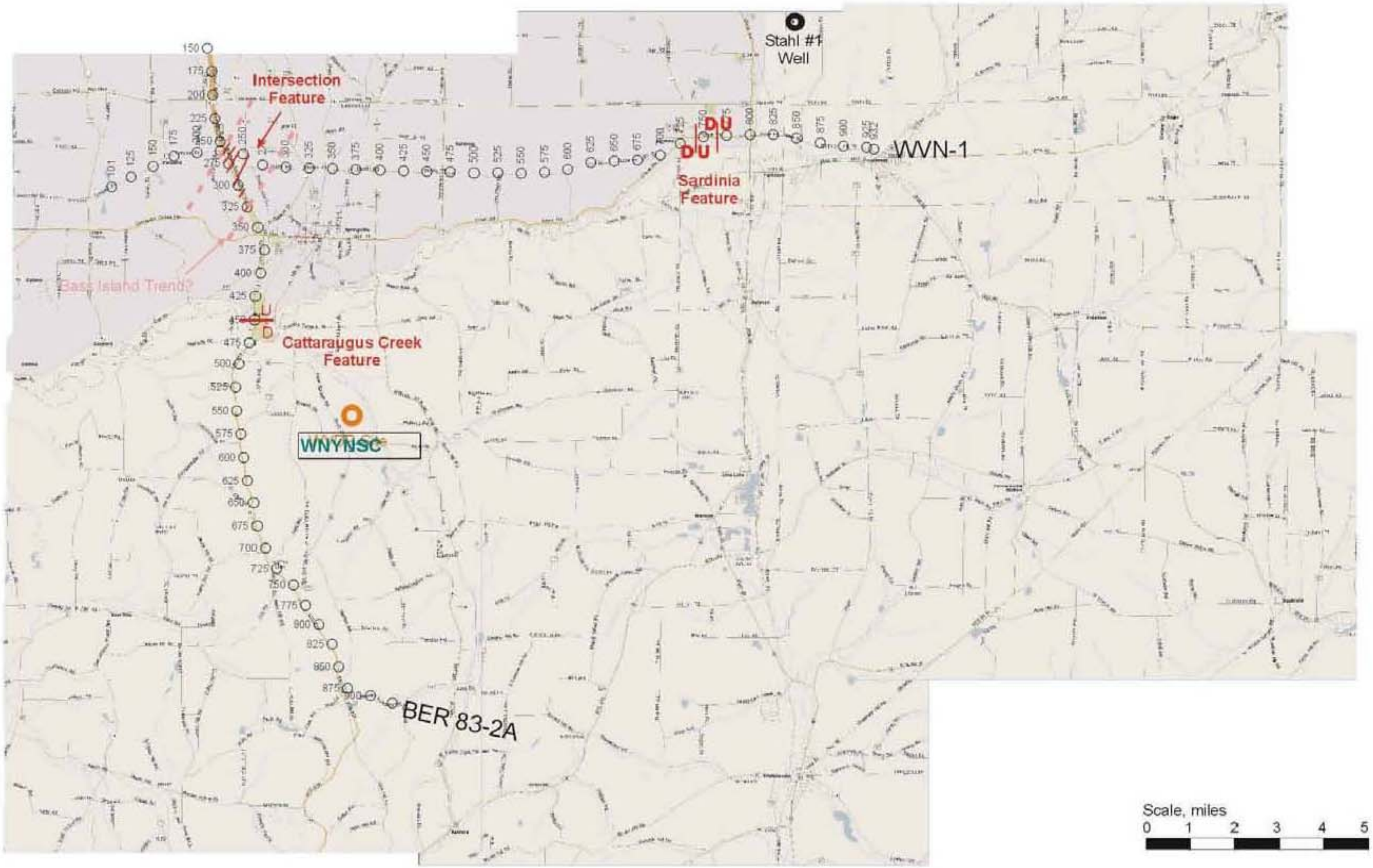


Figure 3-57. Location of Seismic Lines WVN1 and BER 83-2A

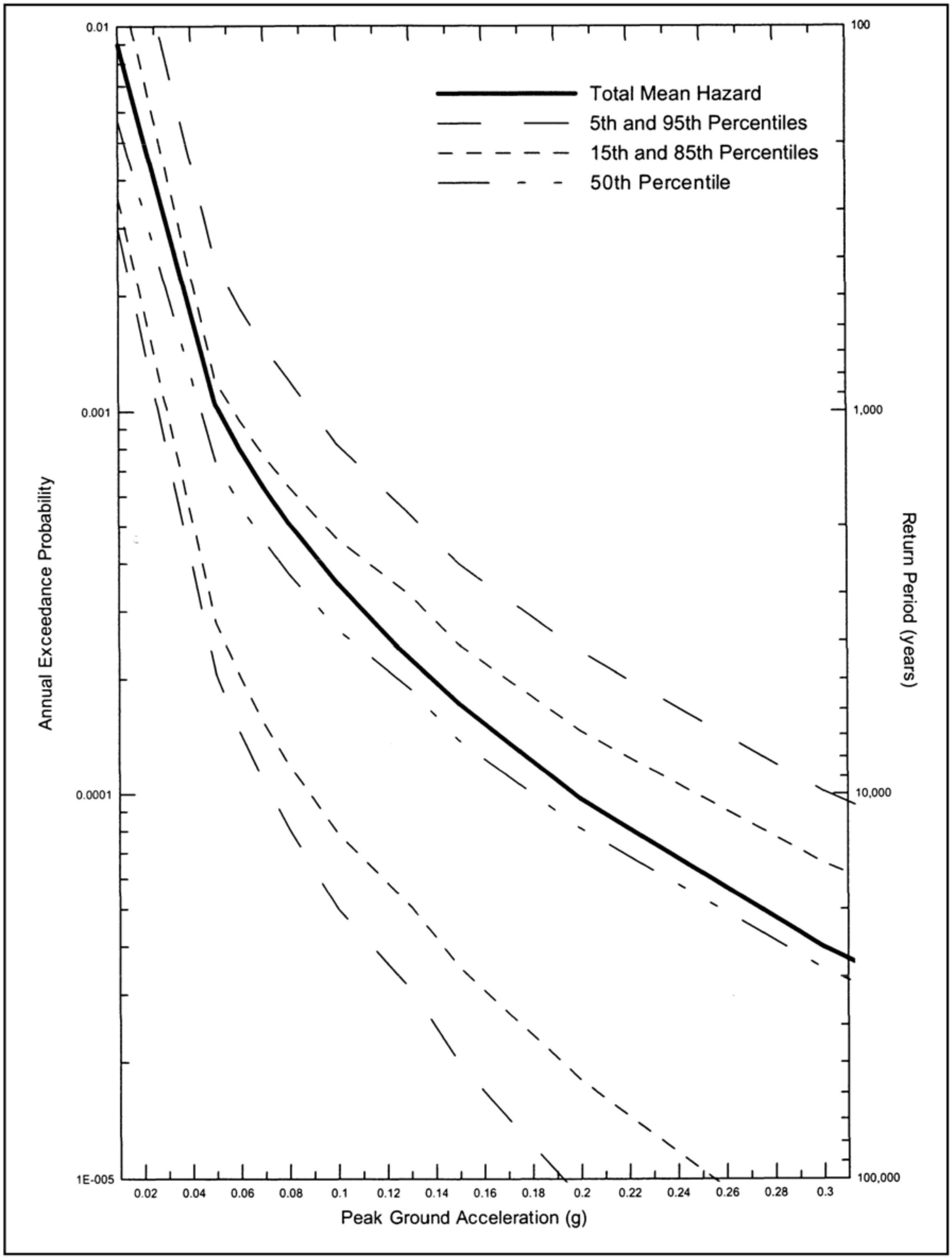


Figure 3-58. Seismic Hazard Curves for Peak Horizontal Acceleration

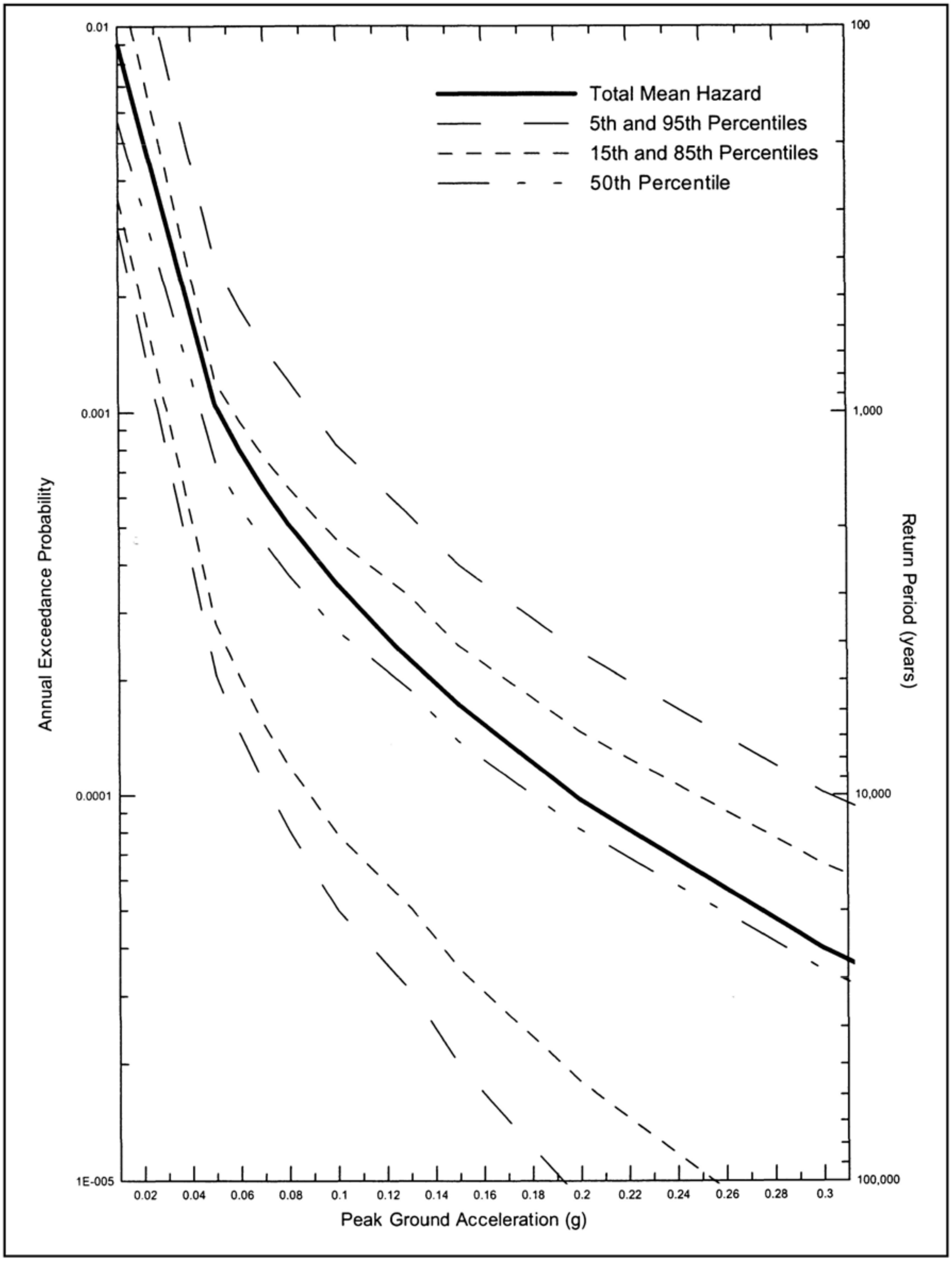


Figure 3-59. Seismic Hazard Curves for 1.0 Second Horizontal Spectral Acceleration

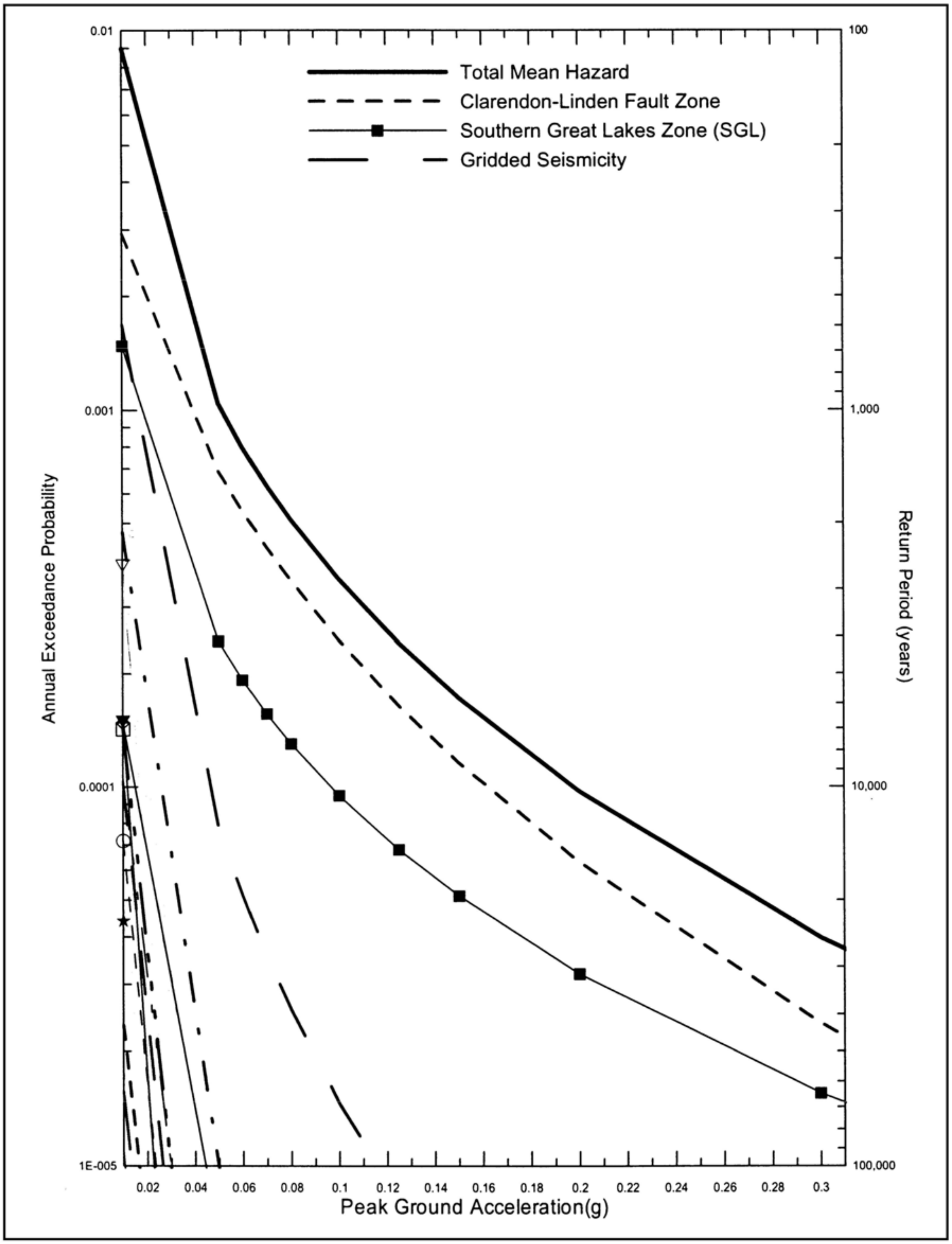


Figure 3-60. Seismic Source Contributions to Mean Peak Horizontal Acceleration Hazard

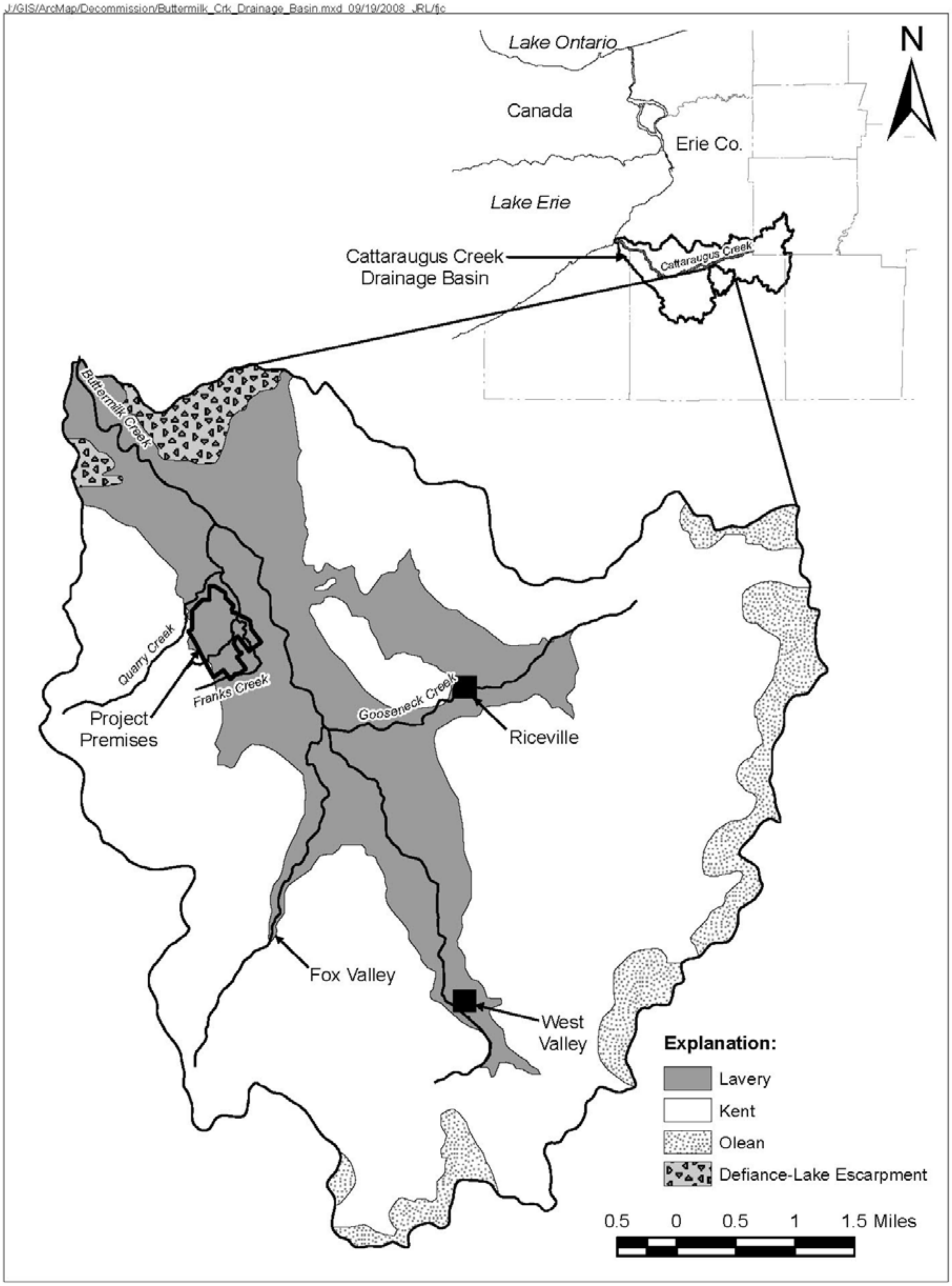


Figure 3-61. Buttermilk Creek Drainage Basin

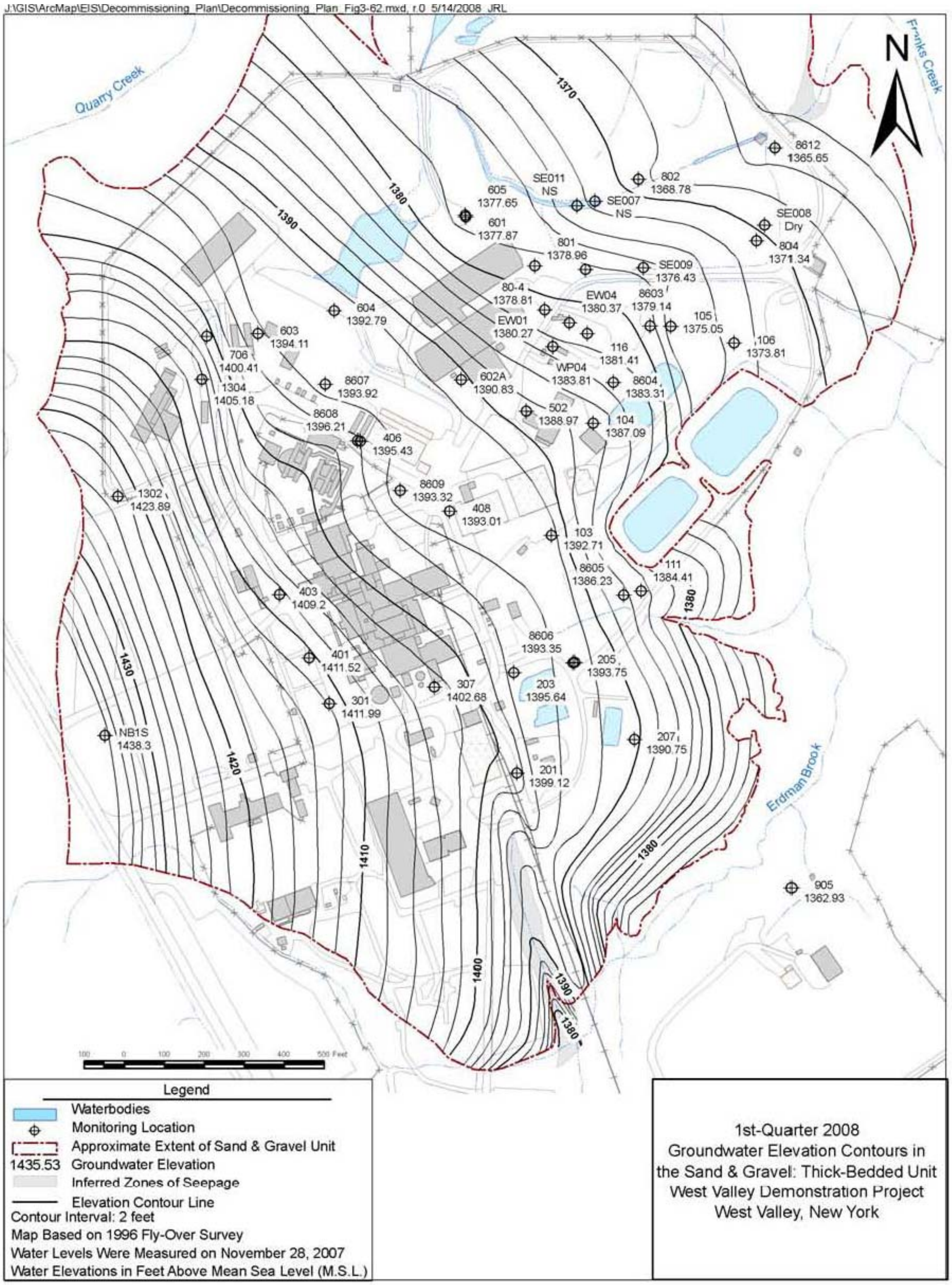


Figure 3-62. Groundwater Elevation Contours of the Sand and Gravel Unit, First Quarter 2008

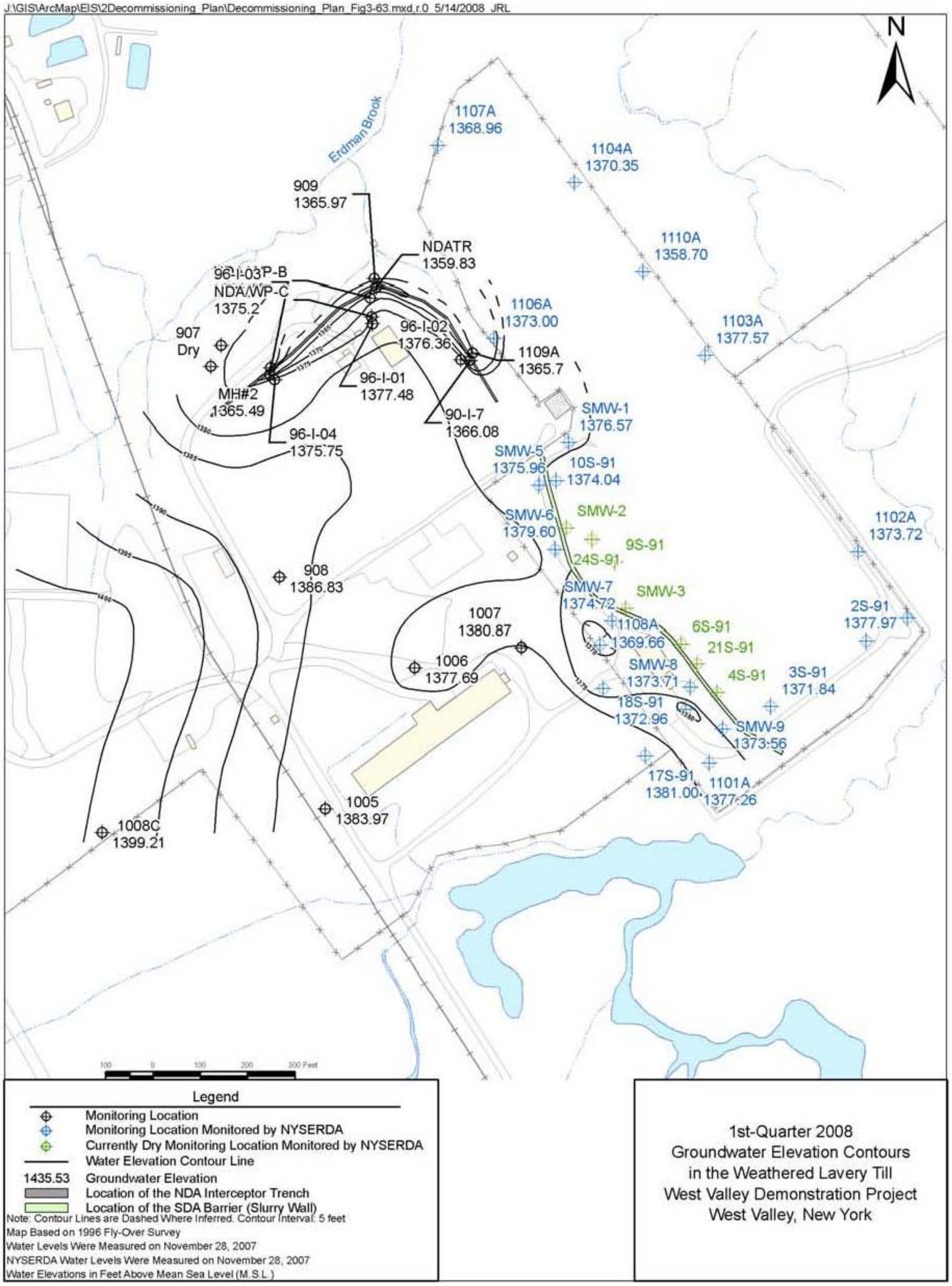


Figure 3-63. Groundwater Elevation Contours of the Weathered Lavery Till, First Quarter 2008

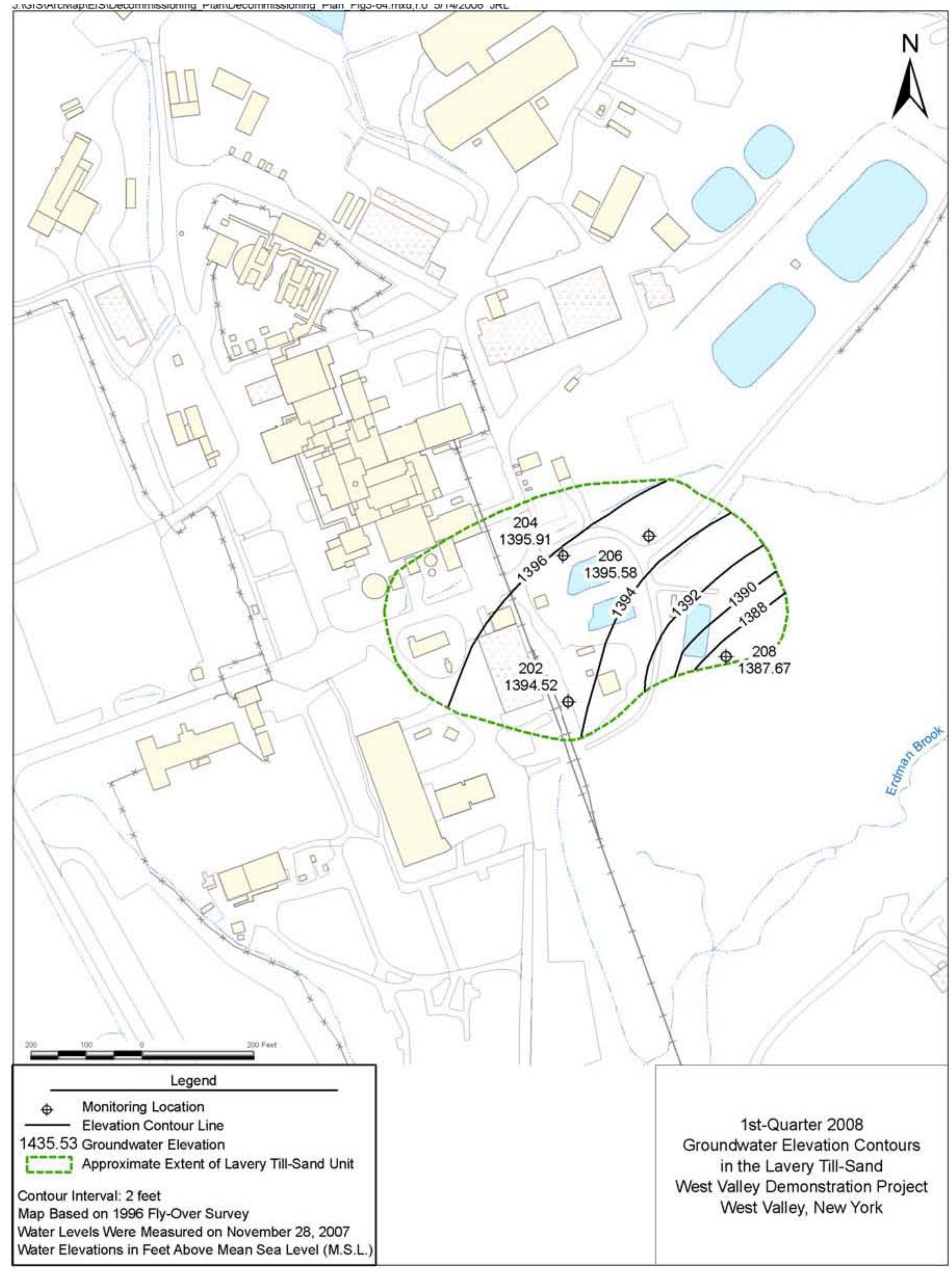


Figure 3-64. Groundwater Elevation Contours of the Lavery Till Sand, First Quarter 2008

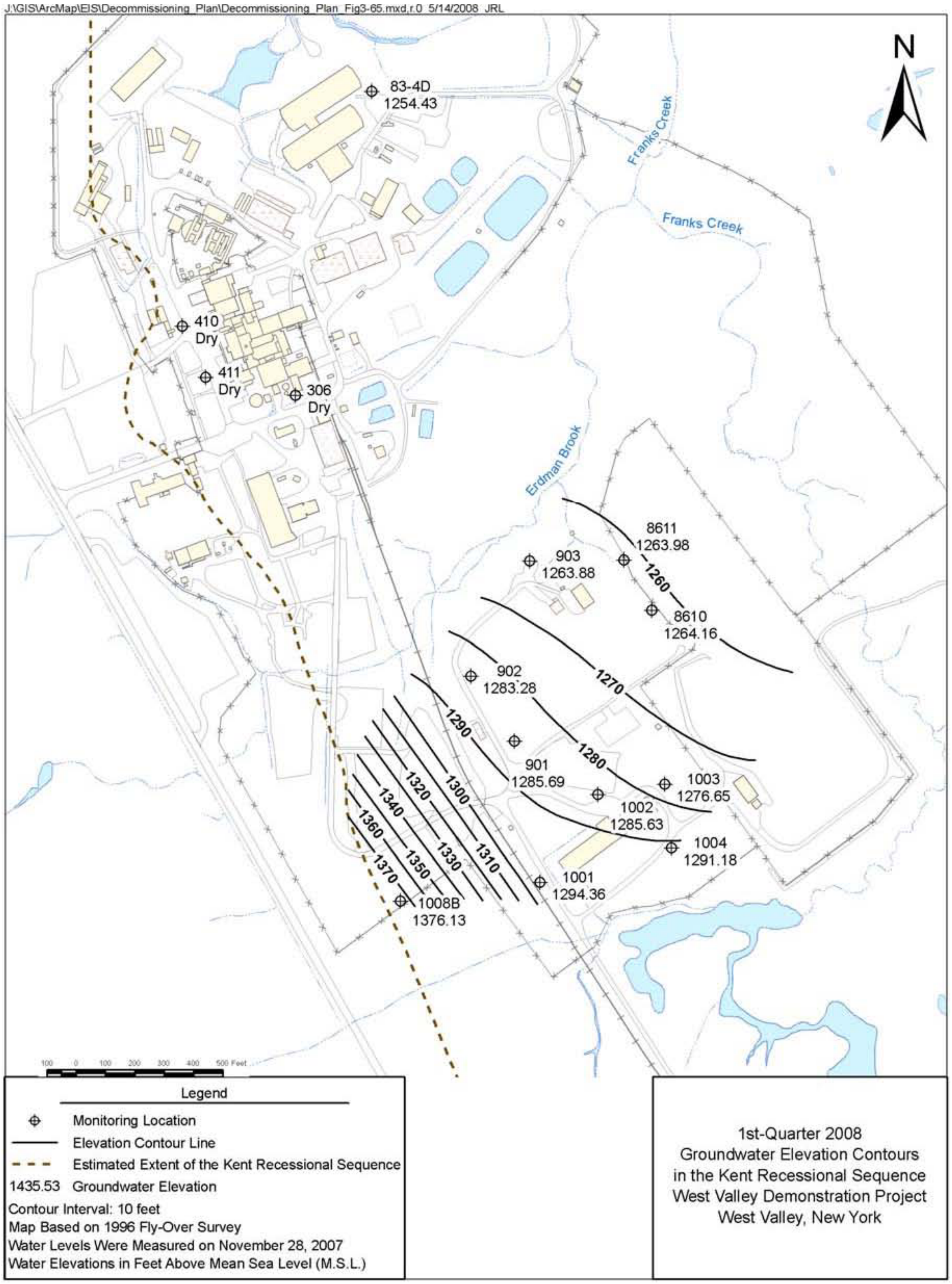


Figure 3-65. Groundwater Elevation Contours of the Kent Recessional Sequence, First Quarter 2008

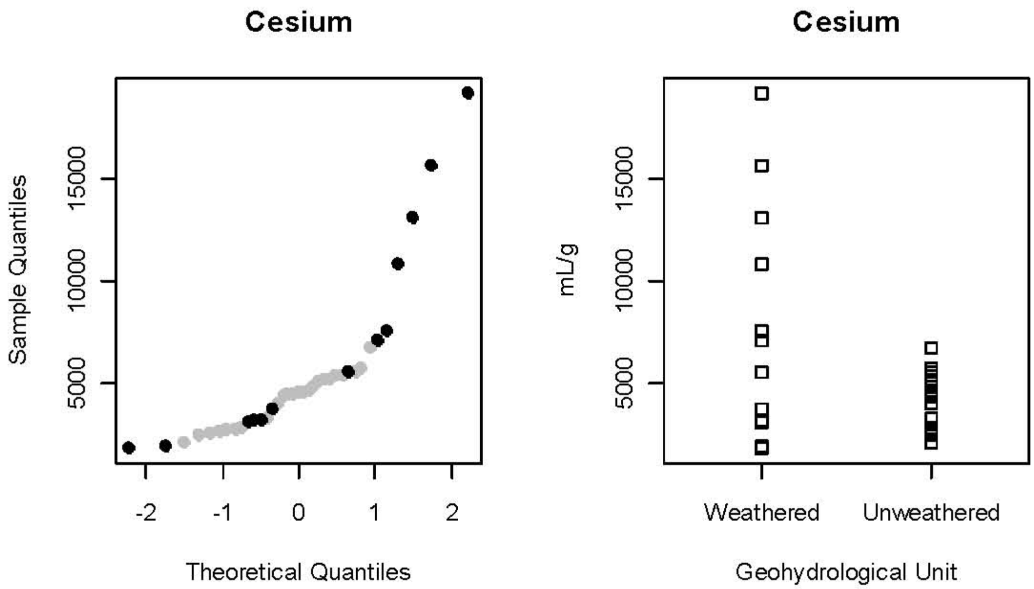


Figure 3-66. Vertical Distribution of Cesium K_d in the Weathered and Unweathered Tills (WVNSCO 1993a)

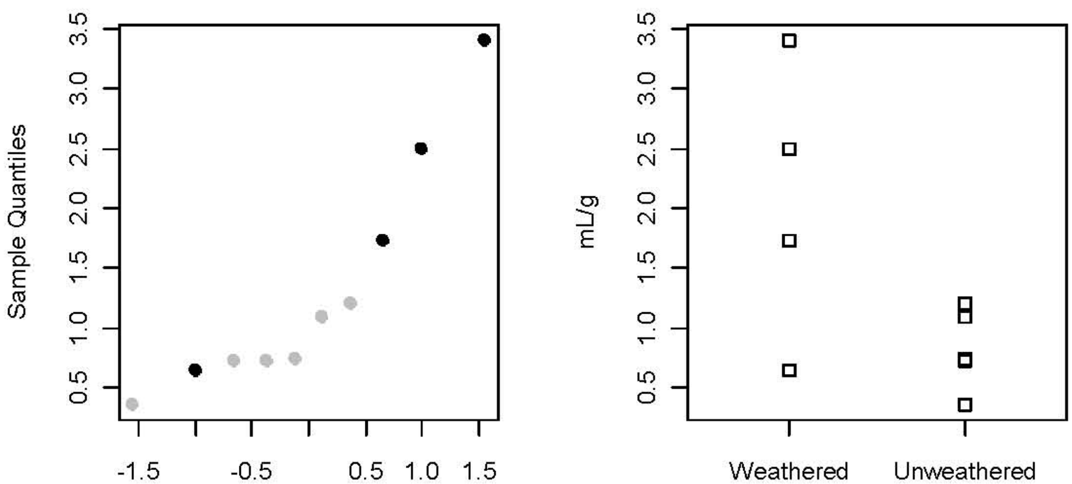


Figure 3-67. Vertical Distribution of Iodine K_d in the Weathered and Unweathered Tills (WVNSCO 1993a)

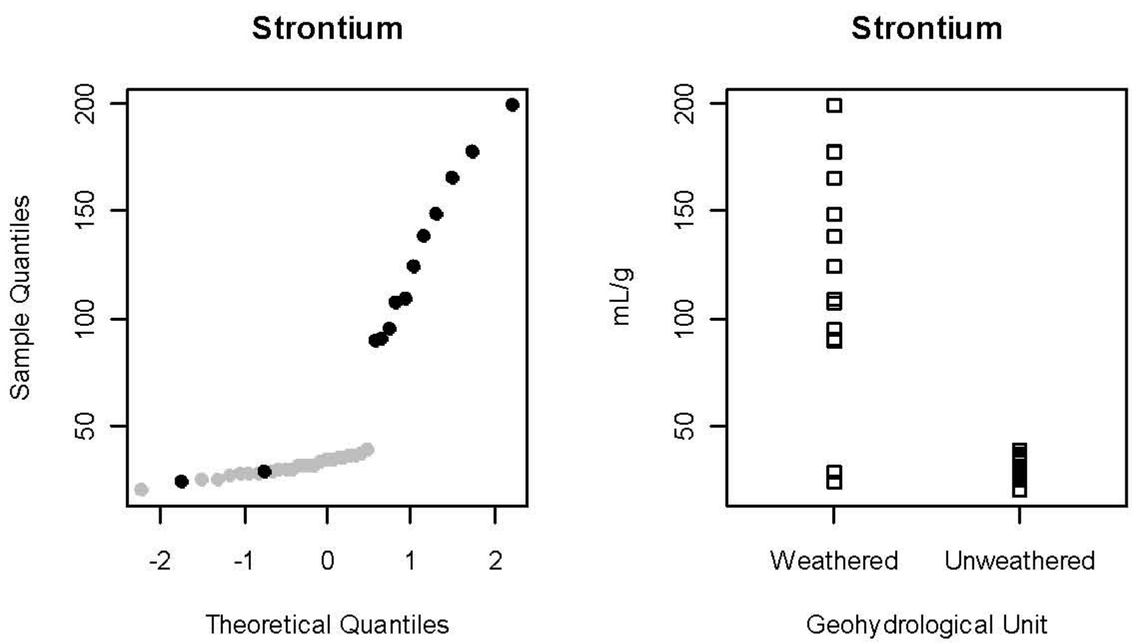


Figure 3-68. Vertical Distribution of Strontium K_d in the Weathered and Unweathered Tills (WVNSCO 1993a)

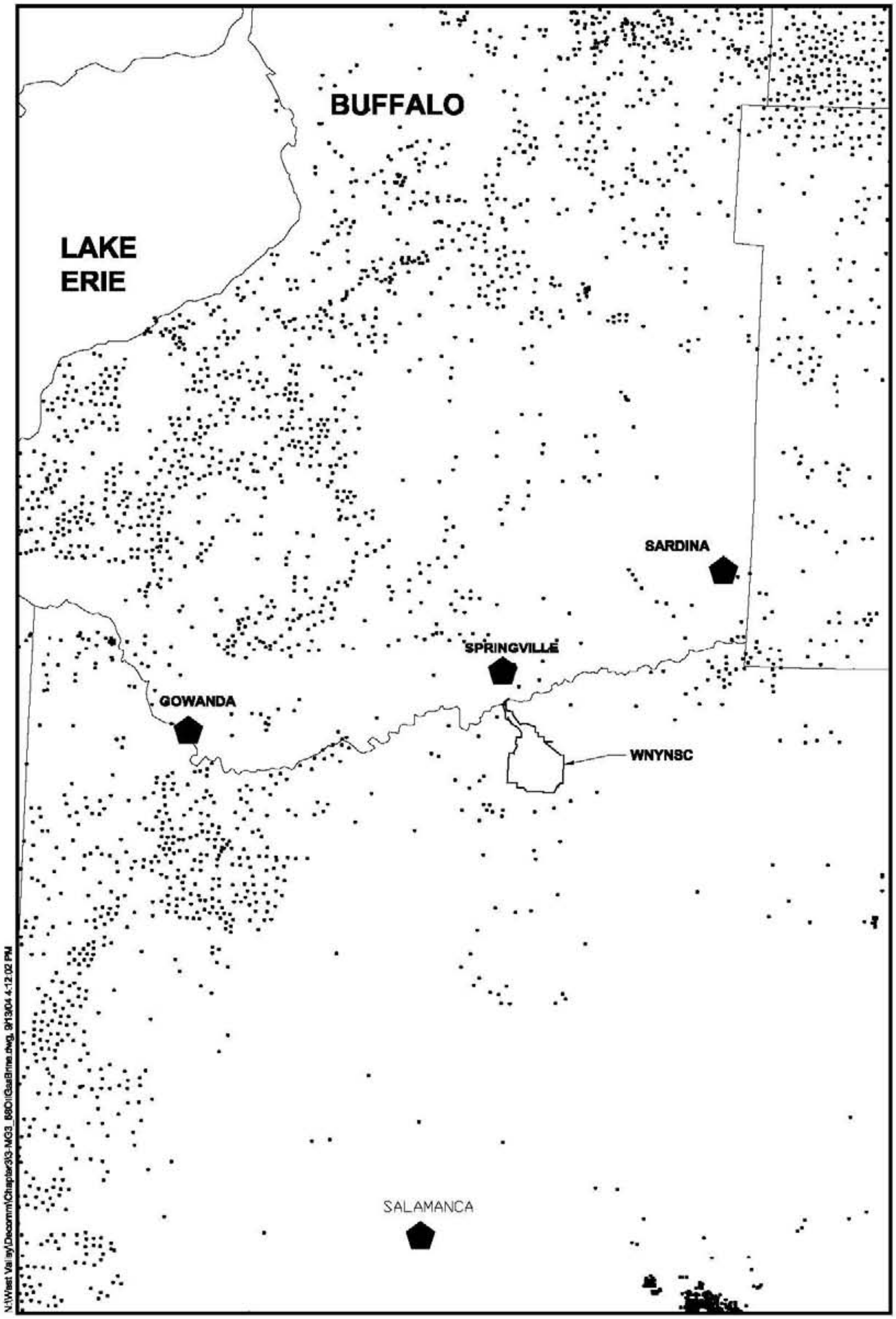


Figure 3-69. Locations of Natural Gas and Oil Wells in Western New York

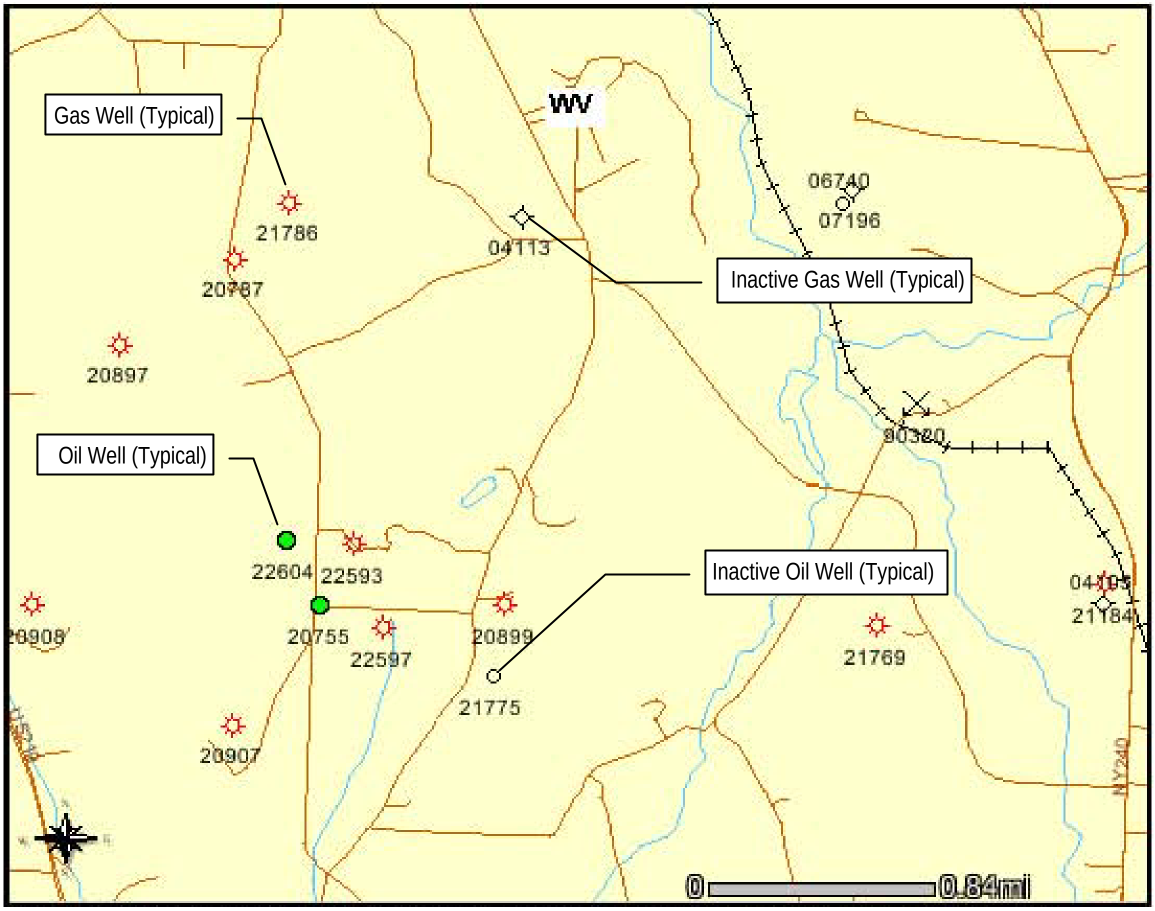


Figure 3-70. Locations of Natural Gas and Oil Wells in the Vicinity of the WVDP