RSI-KES-DLV-TO3-001

Historical Site Assessment for the F-Complex

December 2022

Prepared for:
U.S. Department of Energy
Environment Management Consolidated Business Center –
New York Project Office

Prepared by:

Contract Number: 89303321DEM000057

Task Order Number: 89303321FEM400235

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ACRONYMS

ACME	Alternate Coolant Mockup Experiment
amsl	above mean sea level
ATR	Advanced Test Reactor
ca.	Circa
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
Cs-137	Cesium-137
cm	centimeter
cm2	square centimeter
DOE	U.S. Department of Energy
DOE-EM	DOE Office of Environmental Management
EE/CA	Engineering Evaluation/Cost Analysis
EMCBC	Environmental Management Consolidated Business Center
EPA	U.S. Environmental Protection Agency
FCPE	Full Core Physics Experiment
FPR	Flexible Plastic Reactor
ft	foot, feet
H-3	Hydrogen-3
HDPE	High Density Polyethylene
hr	hour
HSA	Historical Site Assessment
HVAC	Heating, Ventilation, and Air Conditioning
IFE	Inactive Facilities Engineering
KAPL	Knolls Atomic Power Laboratory
LLC	Limited Liability Company
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
mrem	millirem
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NR	Office of Naval Reactors
NTCRA	Non-Time Critical Removal Action
NY	New York
NYSDEC	New York State Department of Environmental Conservation
PCB	polychlorinated biphenyls
pCi	picoCurie
PMA	Plastic Moderated Assembly
PPA	Preliminary Pile Assembly
PTR	Proof Test Reactor

R	Roentgen
RA	Radiation Area
RADIAC	Radiation Detection, Indication, and Computation
RCA	Radiologically Controlled Area
RCM/RCMA	Radiological Controls Required for Modification Areas
RCRA	Resource Conservation and Recovery Act
RCSP	Radiological Controls Standard Practices
Rem	Roentgen equivalent man
RMA	Radioactive Material Area
RME	Regulated Materials Engineering
RSI	RSI Services, LLC
SF	Square Feet
SHA	Solid Homogeneous Assembly
SNM	Special Nuclear Material
SPDES	State Pollutant Discharge Elimination System
SPRU	Separations Process Research Unit
Sr-90	Strontium-90
SWMU	Solid Waste Management Unit
TRU	Transuranic
TTR	Thermal Test Reactor
VOC	Volatile Organic Compound
WRF	Waste Reduction Facility
µg	microgram

EXECUTIVE SUMMARY

The F-Complex Historical Site Assessment (HSA) has been prepared for the U.S. Department of Energy (DOE) and Office of Naval Reactors (NR) at the Knolls Atomic Power Laboratory (Knolls Laboratory) in Niskayuna, NY. As the F-Complex has reached the end of its mission and cannot be reused by Knolls Laboratory in its present state, DOE no longer has a need for the buildings and is seeking a disposition alternative that is protective of human health and the environment while balancing its effectiveness, implementability, and cost.

Disposition of the F-Complex is being planned as a Non-Time Critical Removal Action (NTCRA) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. The HSA is a precursor document that assists DOE with implementing a NTCRA pursuant to CERCLA and is the initial step in communicating with and seeking input from regulatory agencies and public stakeholders on F-Complex disposition.

The F-Complex HSA presents the history and assessment of current F-Complex conditions, identifies the nature and extent of contamination, and demonstrates reasonableness to conclude that no detectable environmental releases have occurred. The HSA collects and reviews available historical information and other sources to determine if sufficient data exist to identify contamination at levels that could pose a risk to human health or the environment, thereby determining the need for a removal action to address those risks. The determination of risk leads to an Engineering Evaluation/Cost Analysis (EE/CA), the follow-on step to the HSA that evaluates removal action alternatives for disposition of the F-Complex.

The Knolls Laboratory site, which is used by NR to conduct research and development for the design and operation of naval nuclear propulsion plants for the U.S. Navy, is owned by the DOE and operated by their contractor, Fluor Marine Propulsion, LLC. The F-Complex is located in the northwest portion of the upper level of the Knolls Laboratory site and comprises five buildings referred to as Buildings F1, F2, F3, F4, and F6 (F5 was demolished in 1978). Constructed between 1951 and 1970, the complex supported the Knolls Laboratory mission over its lifetime. From the early 1950s to the 1980s, the F-Complex housed various operational research reactors, three of which remain in place, are inactive, have been defueled, and were placed in a lay-up condition to minimize the required level of legacy facility management.

While research reactor operations concluded in 1995, portions of the complex were at one time repurposed for multiple uses such as office space; storage; a radiation detection, indication, and computation (RADIAC) calibration facility; and a machine shop. The F-Complex is currently part of the Knolls Laboratory legacy facility management plan and is deemed inactive at this time. Turnover from NR to the DOE Office of Environmental Management (DOE-EM) will follow the CERCLA decision.

The F-Complex contains residual radiological and chemical contamination. The structures were built with materials that contained asbestos, heavy metals, and polychlorinated biphenyls (PCBs), materials commonly used at the time of construction. Past processes also contributed to contamination such as beryllium in overhead areas as a result of machine shop operations. In addition, radioactivity from legacy research reactor operations is present in discrete areas, piping, and isolated ventilation systems.

Under current conditions, the probability of an environmental release is very low due to the fixed nature of the contaminants and the largely intact structures. Routine environmental monitoring data show no evidence of any measurable contamination releases, and there are no documented releases outside the buildings. Further, potential risks are tightly managed with engineered and administrative controls.

While the buildings continue to be maintained in a safe condition, as the facilities age and deteriorate the potential for a release to the environment increases. The available process knowledge, historical documents, facility management records, and survey and inspection reports present sufficient information on contamination and risks to support development, evaluation, and selection of a preferred removal action alternative through the EE/CA process. Following selection of a removal alternative, additional characterization of facility structural materials, defueled research reactor components, and potentially contaminated areas is likely needed to better understand risks associated with implementing the alternative.

1.0 HISTORICAL SITE ASSESSMENT PURPOSE AND SCOPE

1.1 Historical Site Assessment Purpose

The purpose of this HSA is to document and determine the quality and adequacy of available F-Complex contamination and risk information to support an EE/CA, which is the next step in the CERCLA NTCRA process that identifies removal alternatives for the buildings. The HSA is used as the primary reference document for removal alternative development and technical and programmatic decisions.

The information and data compiled in the HSA support preparation of an EE/CA, pursuant to U.S. Environmental Protection Agency (EPA)/540-R-93-057 and in compliance with the National Environmental Policy Act (CERCLA/NEPA Policy, dated July 11, 2002). The EE/CA identifies the objectives of the removal action and analyzes the effectiveness, implementability, and cost of various alternatives that may satisfy the objectives.

Figure 1-1 delineates the phases of the CERCLA NTCRA process for the F-Complex, and the position and timing of the HSA and EE/CA in the overall process.

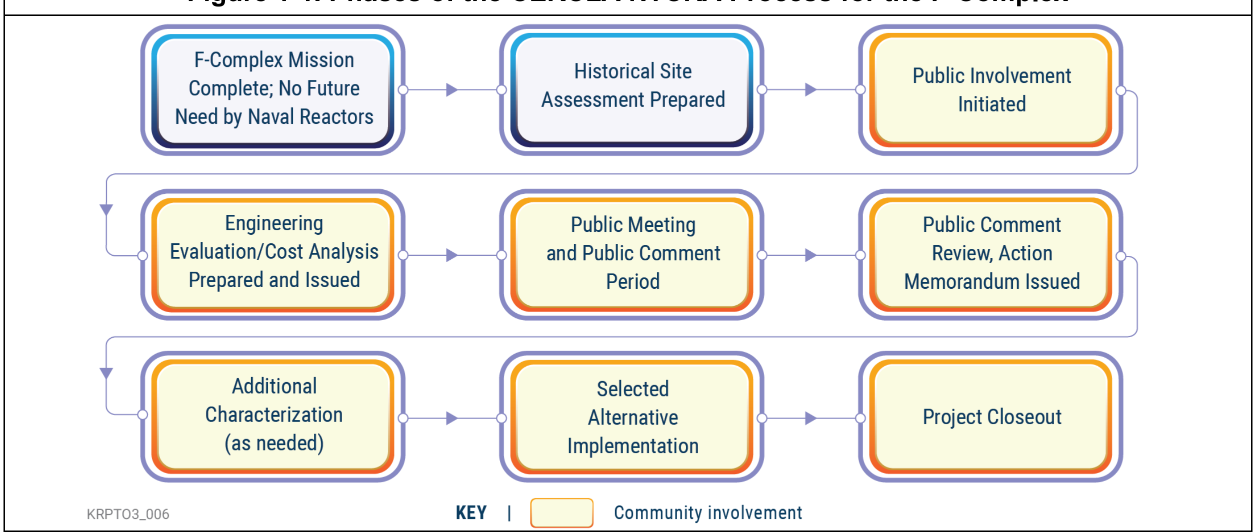
1.2 Historical Site Assessment Scope

The scope of the HSA is to review and compile available documents, information, and data that can be used to identify, evaluate, and select a removal alternative for the F-Complex. The HSA documents existing information describing the F-Complex buildings, including property identification, site history, physical characteristics, operations performed, process components, construction features, modifications, and current status of buildings and process systems.

The HSA also documents current radiological and chemical risks in the F-Complex based on available historical information. This includes identifying the location of hazards and contamination within the existing facilities and determining potential hazards to the environment, public, and Knolls Laboratory employees. Existing Solid Waste Management Units (SWMUs) associated with or adjacent to the F-Complex are also identified in the HSA. SWMUs are areas associated with the F-Complex that formerly stored solid or hazardous waste. SWMUs are regulated by the New York State Department of Environmental Conservation (NYSDEC) under the Resource Conservation and Recovery Act of 1976 (RCRA).

Information reviewed to document the F-Complex history, features, status, and nature and extent of contamination, as well as to determine the occurrence and potential of environmental releases, includes historical documents, technical drawings, visible inspection of the site, and interviews with personnel familiar with F-Complex operations.

Figure 1-1. Phases of the CERCLA NTCRA Process for the F-Complex



2.0 HISTORICAL SITE ASSESSMENT METHODOLOGY

The HSA is prepared in accordance with the *Policy on Decommissioning Department of Energy Facilities Under CERCLA* (DOE and EPA, 1995); *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA* (EPA, 1993); and the *Decommissioning Implementation Guide* (DOE, 1999). The HSA satisfies the requirements of a Removal Site Evaluation, as required under CERCLA. Chapter 3 of *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* (DOE 2000, Revision 1) was also used to guide data collection and organization.

2.1 Data Research

Data gathering for the HSA involved collecting, reviewing, and evaluating existing data to assess its utility in determining the likelihood of existing hazards in F-Complex that could impact the environment, the public, and/or Knolls Laboratory workforce. A variety of data sources were sought and evaluated to assist in determining if contamination exists in F-Complex at levels or in forms that could pose a risk to human health or the environment. This information was used to evaluate removal action alternatives (through an EE/CA) to address those risks.

2.2 Information Sources

The HSA team conducted extensive research to identify information relevant to the objectives of this assessment to document the construction, history, modification, and current status of the F-Complex; determine the nature and extent of contamination; and evaluate data adequacy to inform an EE/CA. Documents reviewed included reports (e.g., environmental monitoring, incident); radiological surveys; RCRA reports; and State Pollutant Discharge Elimination System (SPDES) permits. Information concerning construction features and chronology of activities was derived from technical drawings, maps, and photographs.

During the primary period of HSA development, regular meetings regarding F-Complex were held among representatives of RSI Services, LLC (RSI); DOE Environmental Management Consolidated Business Center (EMCBC) personnel at Knolls Laboratory; and NR and their contractors. Inquiries were made regarding facility history, operations, incidents, the nature and extent of various types of contamination, and present conditions. Discussions and interviews were held with knowledgeable Knolls Laboratory personnel, including present and past facility managers, operational specialists, regulatory and environmental compliance engineers, and others, enabling a thorough evaluation of the historical and present conditions in the complex.

Table 2-1 summarizes the information sources used in developing the HSA.

Table 2-1. Information Sources Used to Develop the HSA

Source Type	Information Identification and Collection
Historical Documents	• Refer to the References section for a list of historical documents used to support HSA development
Technical Drawings	• F1 Plumbing, ca. 1960 • F3 Heating, Ventilation, and Air Conditioning (HVAC) Replacement System – New Equipment and Ducts, July 2018 • F4 Full Core Physics Experiment (FCPE) Drain System (date illegible) • F4 FCPE Mechanical Equipment Room, Groundwater Disposal System, ca. 1971 • F1, F2, F3 and F6 Ventilation Flow Diagram (date illegible)
Photographs	• Extensive F-Complex photo archive provided by NR
Site Visits	• F-Complex site visit conducted in September 2021 to meet with site representatives, visually inspect structures, and note existing conditions (internal and external)
Interviews	• Legacy Facilities Program – F-Complex Facility Owner, Knolls Laboratory • Compliance Engineers, Knolls Laboratory • Environmental Lead, NR • Former Decommissioning and Decontamination Manager for NR • Weekly calls with EMCBC, NR, and Knolls Laboratory throughout HSA development

3.0 F-COMPLEX PROPERTY IDENTIFICATION

3.1 Physical Characteristics

The F-Complex is located on the 170-acre Knolls Laboratory site in eastern New York State, approximately two miles east of the City of Schenectady in the Town of Niskayuna. Figure 3-1 shows the location of Knolls Laboratory relative to its regional setting. The Knolls Laboratory site and F-Complex are located on a bluff overlooking the southern bank of the Mohawk River. Surface elevations at the site range between approximately 330 feet (ft) above mean sea level (amsl) at the top of the bluff to 230 ft amsl on the lower portions of the site along the river.

Knolls Laboratory was established in May 1946 and houses administrative offices; chemistry, physics, and metallurgical laboratories; engineering offices; computer facilities; machine shops; a sewage pumping station; a boiler house; oil storage facilities; cooling tower; and RCRA-permitted hazardous and mixed waste storage facilities. The F-Complex is located in the northwest portion of the upper level of the Knolls Laboratory site (Figure 3-2) and comprises five integrally connected masonry and steel frame buildings, referred to as Buildings F1, F2, F3, F4, and F6 (F5 was demolished in 1978). F-Complex buildings were constructed between 1951 and 1970 and have been used for various missions over their lifetime.

Figure 3-1. Regional Location of Knolls Laboratory

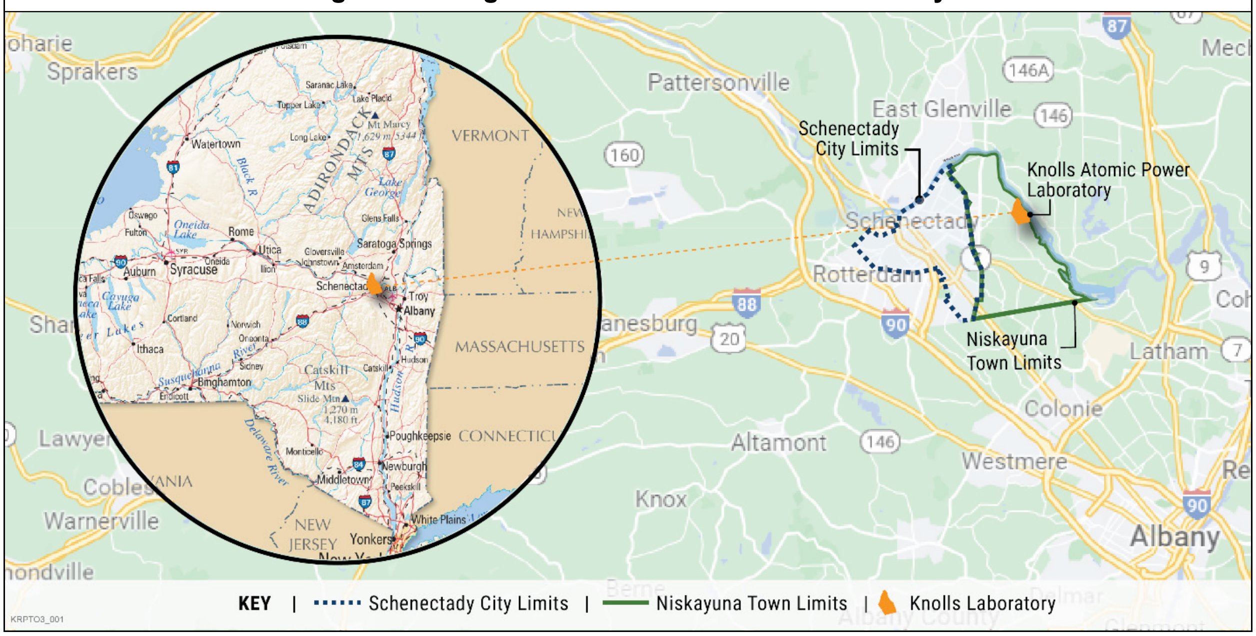
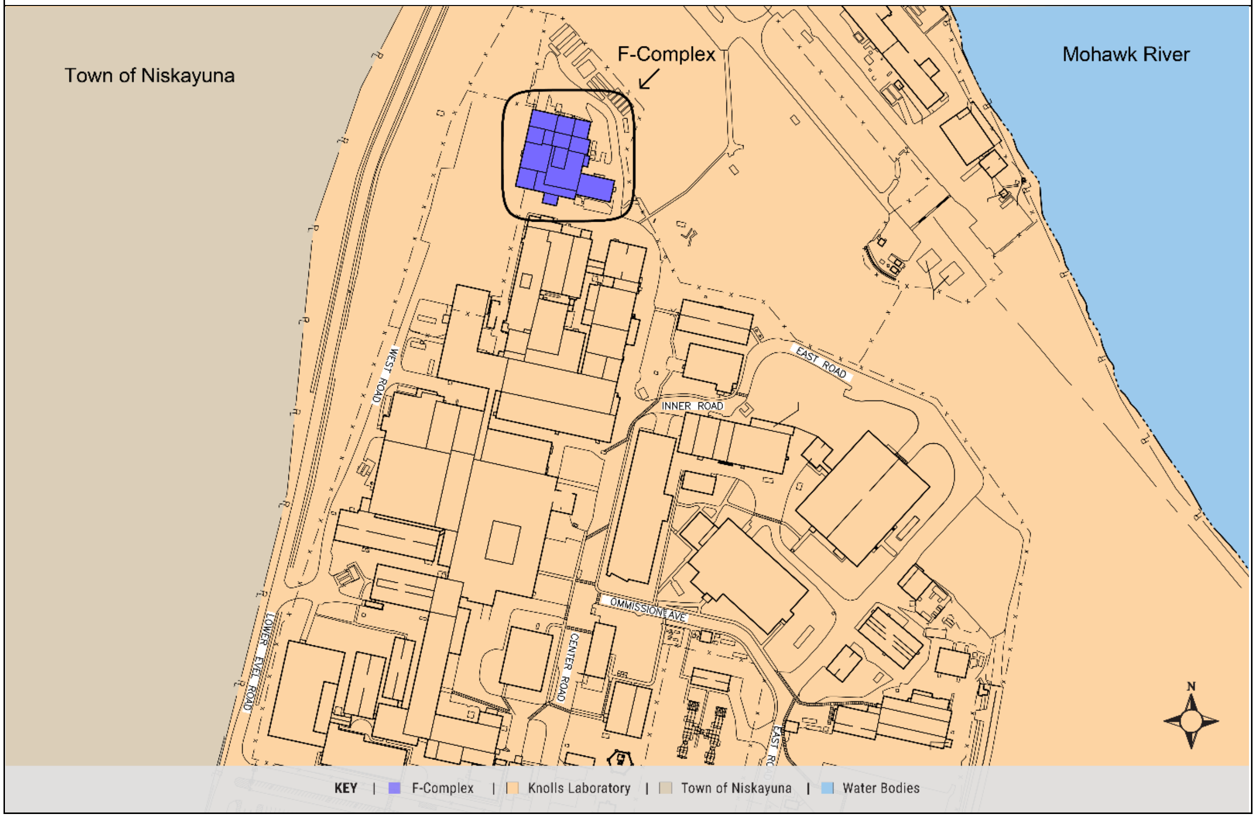


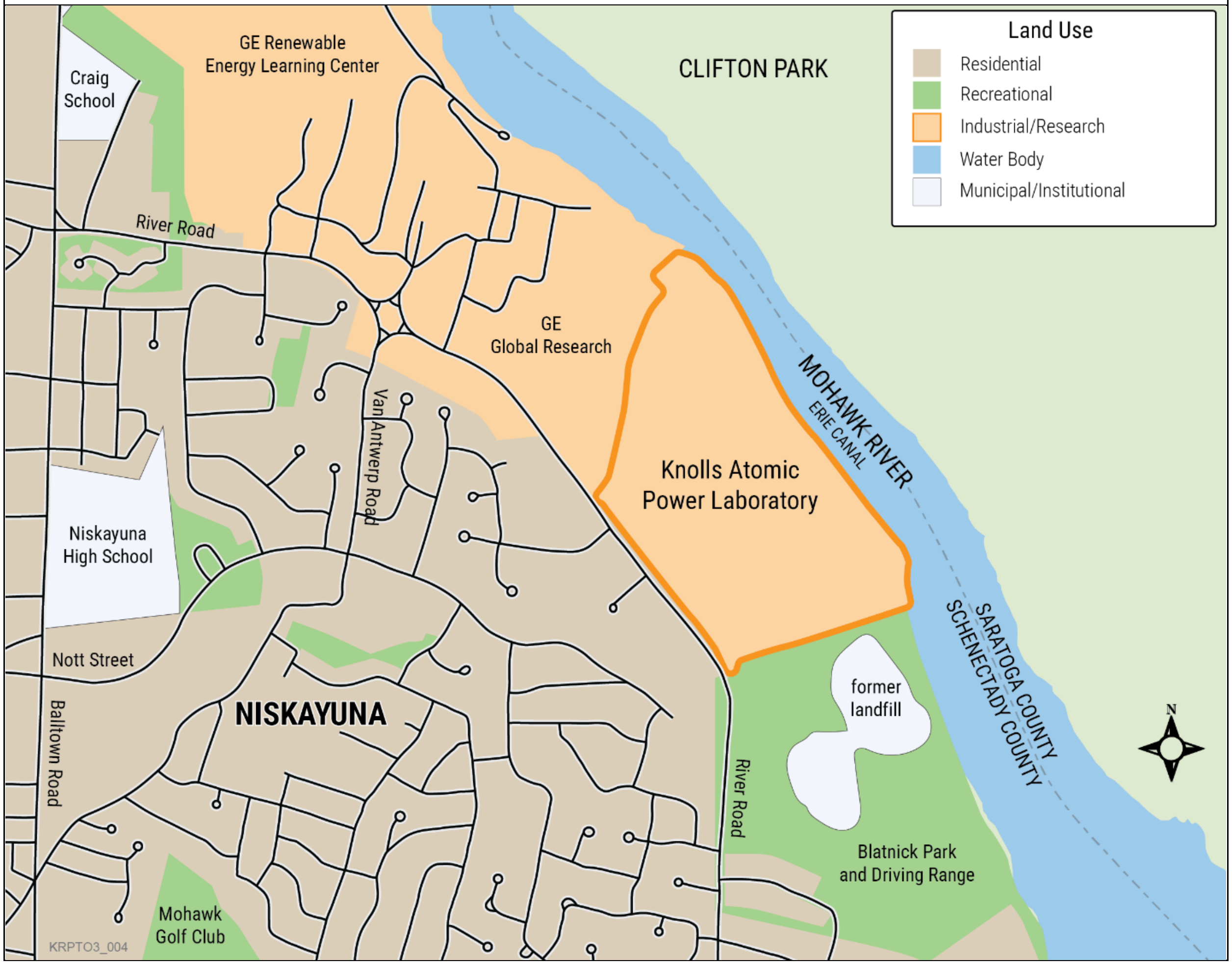
Figure 3-2. Location of F-Complex on Knolls Laboratory



3.2 Adjacent Land Use

Outside the boundaries of the Knolls Laboratory site are multiple industrial, residential, and recreational land uses. Figure 3-3 shows land use in the areas adjacent to Knolls Laboratory. The area has been used for research and development since the late 1940s. The General Electric Company continues to operate a research and development facility to the northwest of the site and a Renewable Energy Learning Center located further to the northwest along the river. West and south of the site is the Town of Niskayuna, which includes medium- to high-density residential housing and recreational areas such as a driving range, hiking trails, and bike path along the river. To the northeast, the Mohawk River is under the jurisdiction of the Canal Corporation, and across the river is low-density residential housing in the Town of Clifton Park. The area across the river also includes farms, orchards, and nature preserves.

Figure 3-3. Land Use in the Knolls Laboratory Vicinity



3.3 Environmental Setting

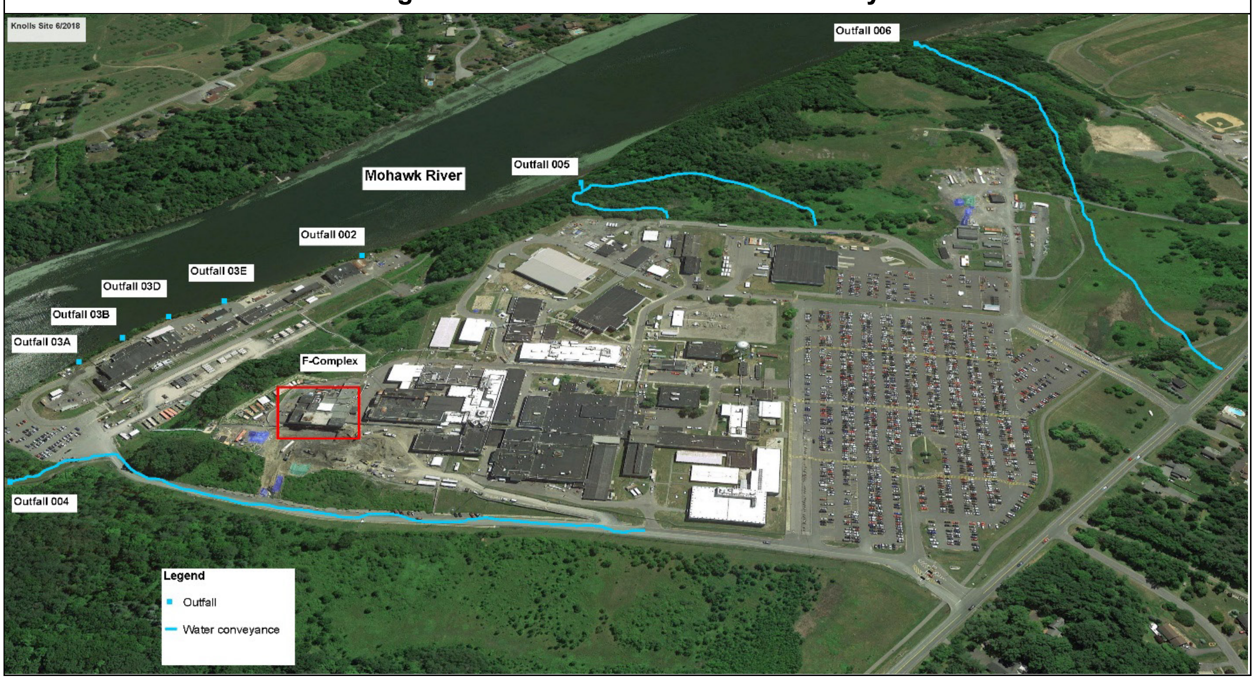
Near the F-Complex, the Mohawk River flows from west to east toward its confluence with the Hudson River approximately 15 miles downstream. The Mohawk River drains the southern portion of the Adirondack Mountains to the northwest and portions of the Catskill Mountains to the south. Median monthly discharge from the Mohawk River ranges between 2,000 and 10,000 cubic feet per second. Average annual precipitation near the site is 44 inches per year. Surface water from the Knolls Laboratory property drains to the northeast into the Mohawk River by way of three stormwater streams.

Knolls Laboratory stormwater is regulated via SPDES permit NY0005851 issued by the NYSDEC. Liquid effluent from Knolls Laboratory enters the Mohawk River through a submerged outfall (Outfall 002); four small surface outfalls (Outfalls 03A, 03B, 03D, and 03E); and the three stormwater streams (Outfalls 004, 005, and 006). Figure 3-4 depicts representative outfalls from the overall Knolls Laboratory system.

Outfall 002 discharges noncontact cooling water, process water, stormwater, and groundwater through a submerged drain line directly to the Mohawk River. The Outfall 002 monitoring station includes a system for collecting samples that are proportional to effluent flow. Weekly and monthly grab samples are taken at Outfall 002 and analyzed for non-radiological constituents as specified in the SPDES permit. A monthly composite sample is prepared from the proportional samples and analyzed for radioactivity.

Outfalls 03B and 03D discharge Mohawk River water used for once-through noncontact cooling, municipal water, stormwater, and groundwater. Outfalls 03A and 03E discharge only groundwater and stormwater as allowed by the SPDES permit. Stormwater outfalls 004, 005, and 006 are commonly referred to as the West Boundary Stream, Midline Stream, and East Boundary Stream (downstream), respectively. Non-radiological monitoring for these outfalls is performed at various frequencies as required to meet SPDES parameters.

Figure 3-4. Outfalls at Knolls Laboratory



Radiological monitoring involves analyzing monthly grab samples at Outfalls 03A, 03B, 03D, 03E, 004, 005, and 006 per SPDES permit requirements. Some of the monthly grab samples are composited and counted quarterly. Background grab samples are also taken monthly at the upper West Boundary Stream, Site Service Water, and Mohawk River Cooling Water Intake. Seepage samples are currently collected at least annually from the Mohawk riverbank, if there is a sufficient sample volume.

While the stormwater outfall system represents potential pathways for contaminant migration from the F-Complex vicinity, routine monitoring results for both chemical and radiological parameters are not indicative of site-related contaminants entering the surface waters (Knolls Laboratory 2020). Tables 3-1 and 3-2 summarize the radiological and non-radiological monitoring frequency and routine contaminant analysis performed for the liquid effluent associated with the Knolls Laboratory outfall system. Table 3-1 also includes monitoring requirements for background sampling locations and Mohawk riverbank seepage.

Table 3-1. Knolls Laboratory Outfall System and Additional Location Radiological Contaminant Monitoring

Monitoring Location	Analysis Frequency	Routine Analysis
• Outfall 002	Monthly – Continuous Composite Sample	Gross Alpha, Gross Beta, Hydrogen-3 (H-3), Strontium-90 (Sr-90), Cesium-137 (Cs-137)
• Outfall 03A • Outfall 03D • Outfall 03E	Monthly – Grab Sample	Gross Alpha, Gross Beta, Sr-90
	Monthly Grab Samples taken and combined into a Quarterly Composite for analysis	Cs-137
• Outfall 03B	Monthly Grab Samples taken and combined into a Quarterly Composite for analysis	Gross Alpha, Gross Beta, Sr-90, Cs-137 if Gross Beta >10 pCi/liter
• Outfall 004 (West Boundary Stream)	Monthly – Grab Sample	Gross Alpha, Gross Beta, Sr-90, Cs-137
• Outfall 005 (Midline Stream) • Outfall 006 (Lower East Boundary Stream)	Monthly Grab Samples taken and combined into a Quarterly Composite for analysis	Gross Alpha, Gross Beta, Sr-90, Cs-137
Background Sampling Locations: • Upper West Boundary Stream • Site Service Water • Mohawk River Cooling Water Intake	Monthly – Grab Sample	Gross Alpha, Gross Beta, H-3, Sr-90, Cs-137
• Mohawk Riverbank Seepage	At least annually	Gross Alpha, Gross Beta, Sr-90, Cs-137

Source: *Knolls Laboratory and Kesselring Site, Environmental Monitoring Report – 2020*

Table 3-2. Knolls Laboratory Outfall System Chemical Contaminant Monitoring

Monitoring Location	Analysis Frequency	Routine Analysis
• Outfall 002	Weekly	Oil and Grease, Total and Net Total Copper (when Copper Ion Generator is in use)
• Outfall 03A	Quarterly	Thallium, Oil and Grease
• Outfall 03B	Weekly	Total and Net Total Copper (when Copper Ion Generator is in use)
	Monthly	Oil and Grease
• Outfall 03D	Weekly	Total and Net Total Copper (when Copper Ion Generator is in use)
	Monthly	Oil and Grease
• Outfall 03E	Quarterly	Oil and Grease
• Outfall 004	Quarterly	Oil and Grease, Thallium, Volatile Organic Compounds (VOCs) and Chlorides
• Outfall 005	Quarterly	Oil and Grease, VOCs, Chlorides
• Outfall 006	Quarterly	Oil and Grease, VOCs (second quarter only), Chlorides

Source: *Knolls Laboratory and Kesselring Site, Environmental Monitoring Report – 2020*

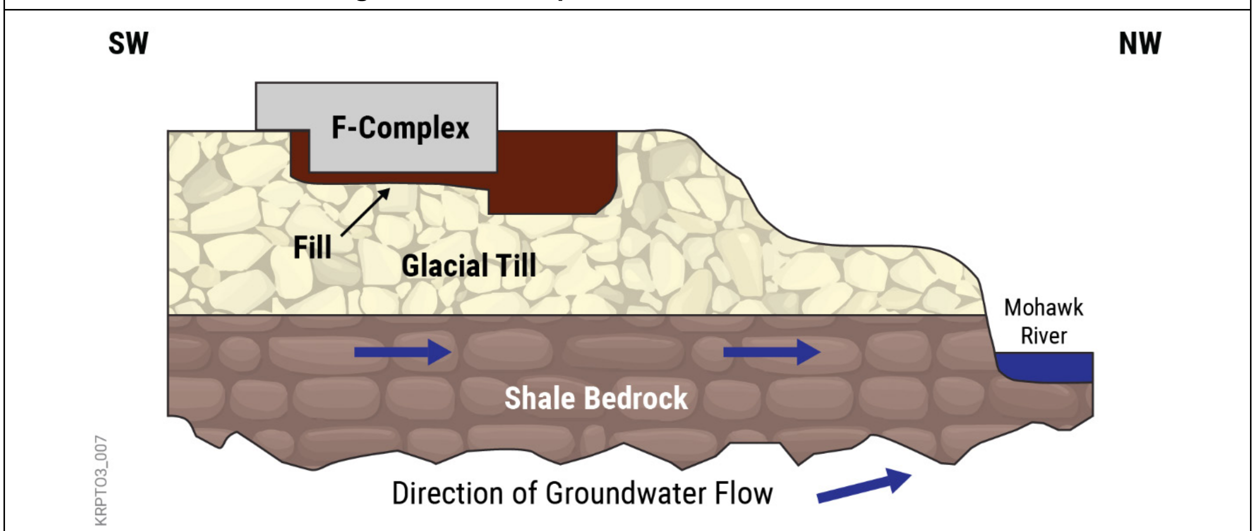
Based on ERM-Northeast's *1992 Final Report – Hydrogeologic Evaluation of the Knolls Atomic Power Laboratory – Knolls Site*, surficial deposits at Knolls Laboratory consist of tightly compacted glacial till up to 70 ft thick that acts as an aquiclude, minimizing the downward infiltration of water. Gray till in the vicinity of F-Complex is approximately 13-14 ft below grade based on a 1950s-era site plan drawing. The till thins toward the Mohawk River, where it is absent or up to a maximum of 10 ft thick. Glacial lake deposits of silt and fine sand are present at the surface in isolated areas. The surficial glacial deposits are underlain by bedrock consisting predominantly of Ordovician Schenectady Formation shale, with some interbedded siltstone that is up to 600 ft thick. The bedrock typically has low porosity and is relatively impermeable.

The groundwater conditions at the Knolls Laboratory have been extensively studied. Figure 3-5 illustrates the typical site hydrogeology (ERM 1992). At the Knolls Laboratory site, shallow, perched groundwater is encountered intermittently in the glacial till and lake deposits and, when found, is not laterally continuous. Where encountered, the water table in the shale bedrock is approximately 70 ft below grade, and groundwater flow is generally to the north or northeast toward the Mohawk River, moving at less than 5 to 10 ft per year (DOE 2006). The F-Complex building foundations extend to a depth of up to 20 ft below grade. Shallow groundwater of approximately 6-7 ft below ground surface flows preferentially through the more permeable backfill around the buildings. Groundwater flow patterns are perturbed by topography and artificial fill for building and piping around the F-Complex.

Through routine monitoring, the Knolls Laboratory groundwater monitoring program concludes that previous operations and waste disposal practices have resulted in some small, measurable effects on the groundwater quality in discrete areas of the site. Groundwater sampling results for radiological constituents and VOCs near the F-Complex are consistently below the Decision Level Concentrations and Reporting Limit, demonstrating no threat to public health. There are no known releases from the F-Complex contributing to groundwater contamination.

In addition, upstream and downstream monitoring of the Mohawk River conclude past or current Knolls Laboratory operations have had no detectable effect on river water quality. The groundwater is limited in quantity and is not used as a drinking water supply. In addition, the Knolls Laboratory site is not located over any principal or primary bedrock or overburden aquifers. Therefore, the groundwater at Knolls Laboratory does not pose any threat to public health (Knolls Laboratory 2020).

Figure 3-5. F-Complex Groundwater Schematic



4.0 OPERATIONAL HISTORY OF F-COMPLEX BUILDINGS

The F-Complex, shown in Figure 4-1, was constructed between 1951 and 1970 and operated as a nuclear reactor testing facility until 1995 to generate physics and design information in research areas such as critical mass, reactivities, power distribution, temperature coefficients, and experimental information in high-temperature physics. Currently covering a footprint of 31,094 SF, the F-Complex originally comprised six facilities designated F1 through F6 (structure F5 was demolished) and housed nine test reactors over the course of the complex's lifetime.

Following the cessation of test reactor operations in 1995, portions of the complex were repurposed for multiple uses such as office space, storage, a RADIAC calibration facility, and a machine shop. As of completion of this document, there are no active areas remaining in the F-Complex. Figure 4-2 depicts the F-Complex current layout.

Figure 4-1. Aerial View of the F-Complex

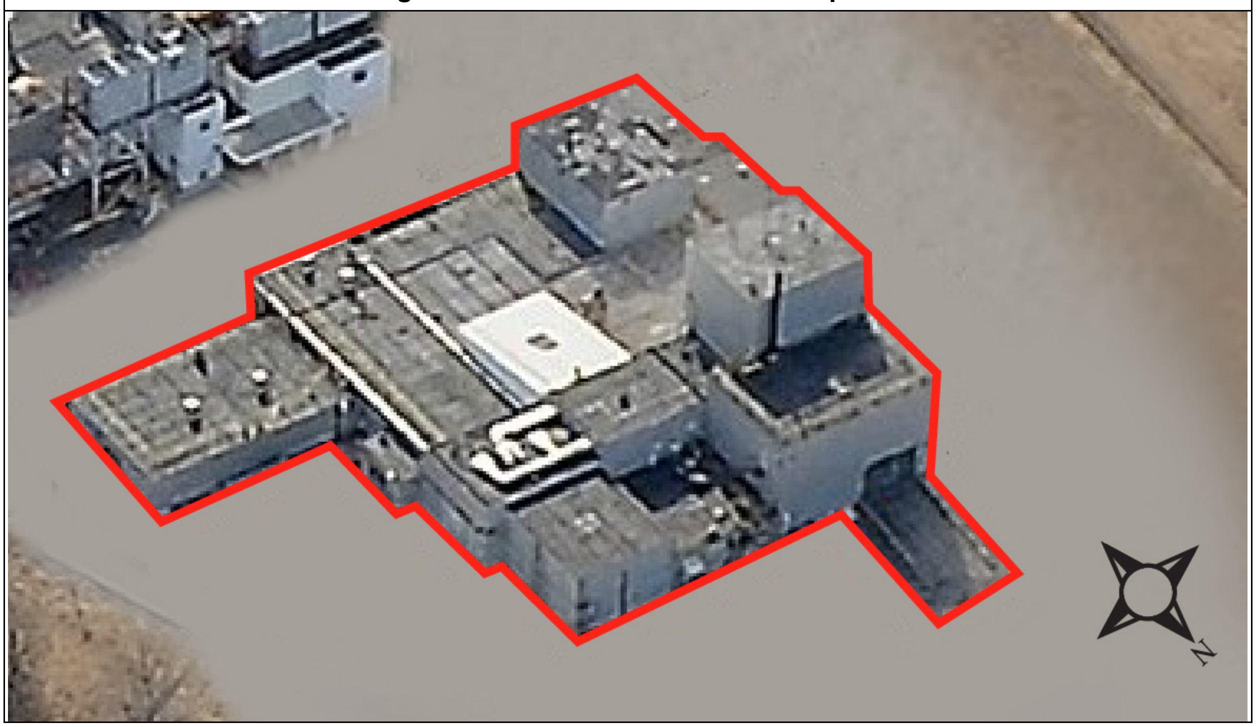
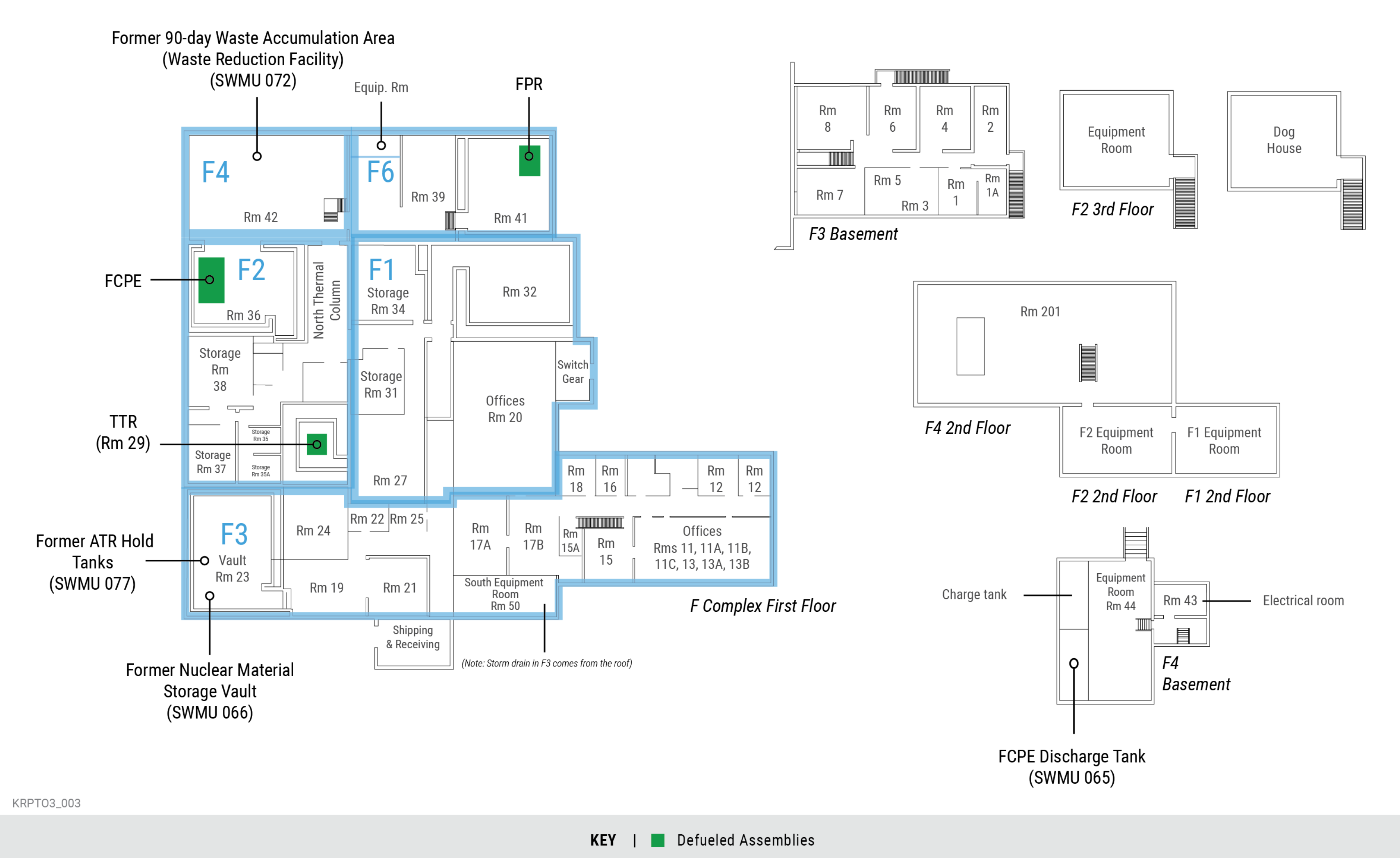


Figure 4-2. F-Complex Current Layout



As summarized in Table 4-1, the F-Complex housed nine test reactors over its lifetime. These test reactors were experimental and either operated without producing power (zero power) or generated low level power that was not used outside of laboratory experiments. Zero-power is a controlled operating state where the reactor does not generate significant heat or radiation.

The three remaining, inactive test reactors have been defueled and placed in a lay-up condition to minimize legacy facility management requirements. These inactive reactors include the Thermal Test Reactor (TTR), Full Core Physics Experiment (FCPE), and Flexible Plastic Reactor (FPR).

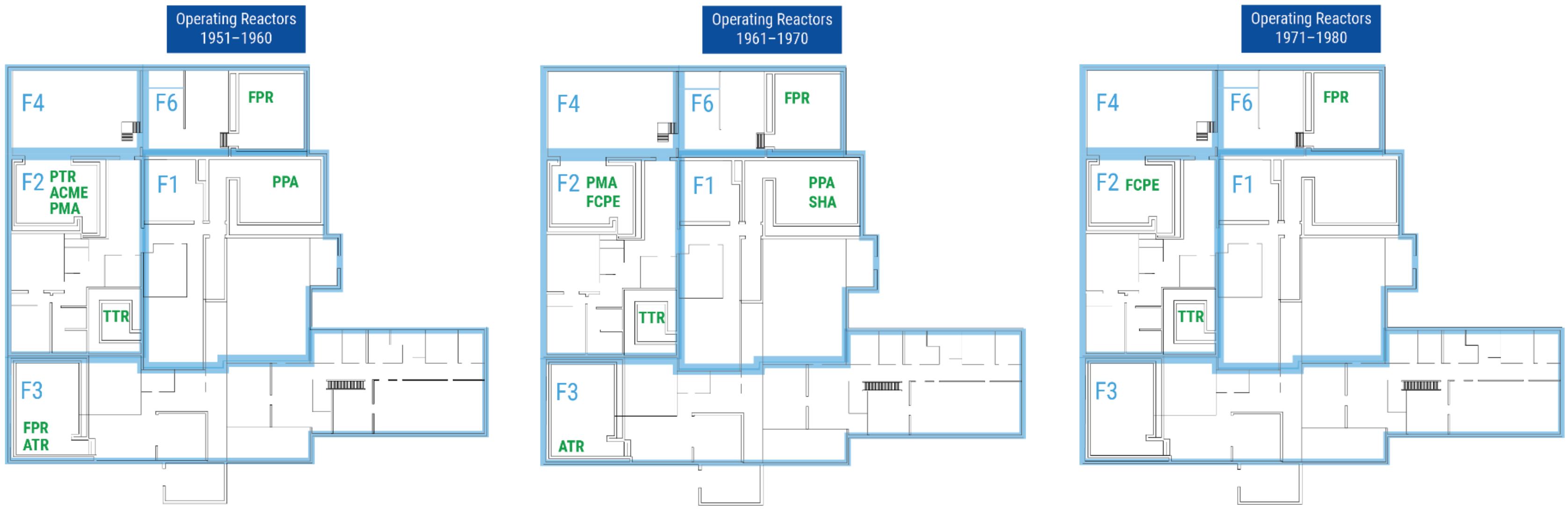
Table 4-1. F-Complex Research Reactor Operating History

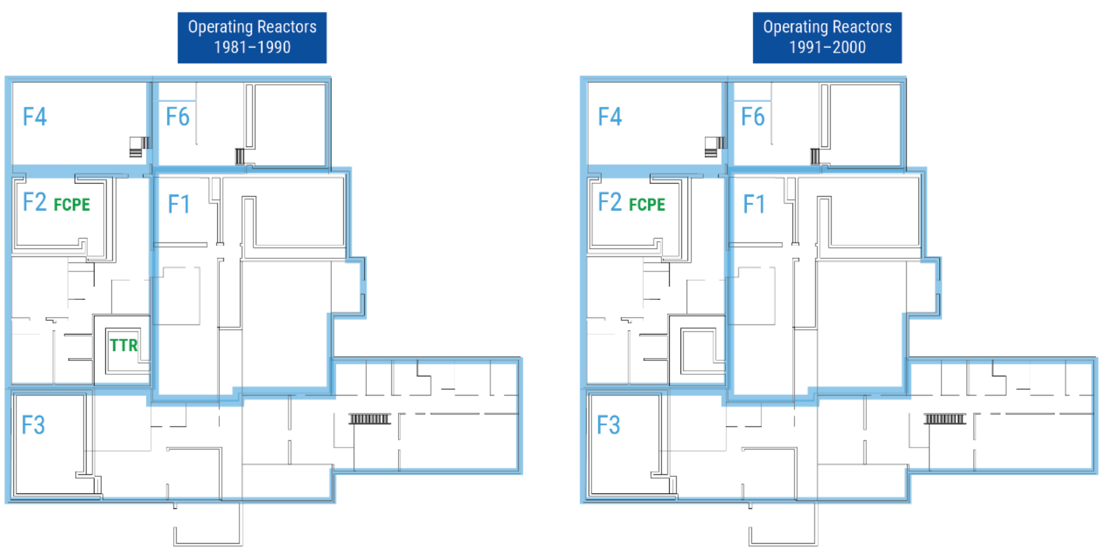
F-Complex Building	Research Reactors and Locations	Years of Operation
F1	• Preliminary Pile Assembly (PPA), Room 32 – not present • Solid Homogeneous Assembly (SHA), Room 32 – not present	• 10/1951 – 06/1961 • 06/1961 – 12/1970
F2	• TTR, Room 29 • Proof Test Reactor (PTR), Room 36 – not present • Alternate Coolant Mockup Experiment (ACME), Room 36 – not present • Plastic Moderated Assembly (PMA), Room 36 – not present • FCPE, Room 36	• 01/1954 – 12/1983 • 11/1953 – 07/1956 • 07/1956 – 06/1957 • 06/1957 – 07/1965 • 05/1970 – 01/1995
F3	• Advanced Test Reactor (ATR), Room 23 – not present • FPR, Room 23 – moved to F6 in 1959	• 06/1954 – 06/1970 • 06/1955 – 07/1959
F4	• Used as an assembly room for FCPE	• 05/1970 – 05/2015
F6	• FPR, Room 41	• 07/1959 – 03/1972

During the early decade of F-Complex operations, reactors were regularly installed and then removed and replaced with different reactors. For example, the PTR was installed in Room 36 of F2 in November 1953 and removed in July of 1956. Following the removal of the PTR, the ACME reactor was installed in the same location and operated until June 1957. A similar arrangement occurred in Room 32 of F1, where the PPA was installed in October 1951, removed in June of 1961, and followed by the placement of the SHA reactor in June 1961.

Figure 4-3 illustrates the F-Complex reactor location history over the decades from 1951 to 2000.

Figure 4-3. F-Complex Reactor Assembly History





Reactor Operation Dates

- **PPA:** Oct. 1951 – Jun. 1961
- **PTR:** Nov. 1953 – Jul. 1956
- **TTR:** Jan. 1954 – Dec. 1983
- **ATR:** Jun. 1954 – Jun. 1970
- **FPR:** Jun. 1955 – Jul. 1959 (F3)
- **FPR:** Jul. 1959 – Mar. 1972 (F6)
- **ACME:** Jul. 1956 – Jun. 1957
- **PMA:** Jun. 1957 – Jul. 1965
- **SHA:** Jun. 1961 – Dec. 1970
- **FCPE:** May 1970 – Jan. 1995

4.1 Building Operations, Process Systems, and Construction Features

Table 4-2 summarizes the operational history of the F-Complex buildings, including operations performed, process components, construction features, and building status.

Table 4-2. Operational History Summary

Overall F-Complex

General Facts/Operations Performed:

- Nuclear research facility until 1995 that generated physics and design information
- Originally comprised of 6 facilities, F1 through F6 (F5 previously demolished)
- Built between 1951 and 1970; total footprint covers 31,094 SF
- Includes subterranean levels and multi-height, above-grade levels
- Housed 9 research reactor assemblies, 3 of which remain in place and are in an inactive, defueled state
- Areas were repurposed for office space, storage areas, and a RADIAC following research completion and reactor removal/defueling
- All areas of the facility are deemed to be inactive in preparation for turnover to DOE-EM and implementation of the selected removal alternative

Process Components and Status:

- 9 research reactors, 6 of which have been removed, 3 of which are in place and have been defueled/deactivated
- Former office space, storage areas, and calibration facility were rendered inactive through removal of legacy materials, furniture, and equipment by the Knolls Laboratory Inactive Facilities Engineering (IFE) organization
- Legacy operations and construction materials (e.g., asbestos) resulted in the presence of residual regulated, hazardous, potentially hazardous, and radiological materials in discrete areas throughout the facility; materials are generally contained but must be addressed and mitigated prior to any removal operations

Construction Features (including features designed to contain hazards):

- Steel frame, reinforced concrete, and masonry block; some areas have hardened security features
- HVAC equipment, some dedicated to reactors and filtered as an emergency isolation feature
- Fire protection systems and equipment that include wet pipe sprinkler systems and/or smoke/heat detectors; obsolete fire protection equipment remains in place and is labeled as out of service
- Reactor assemblies were operated remotely from dedicated reactor control rooms to achieve adequate radiation protection
- All roofs have precast concrete planks with rigid insulation board and multi-ply roofing

Building F1

General Facts/Operations Performed/Process Components and Status:

- Built in 1951; footprint covers 8,108 SF consisting of mostly office space and storage areas
- Room 31 is a former assembly area and machine shop where machining of beryllium materials occurred
- Room 32 served as a reactor cell, housing the former PPA and SHA test reactors (now removed); also served as a Container Storage Facility
- Room 34 is a former fuel vault for storage
- Partially dismantled former control room for the TTR (located in F2)

Construction Features (including features designed to contain hazards):

- 1 to 1.5 story masonry and steel-framed structure on a reinforced concrete slab
- Structural steel walls in office areas are enclosed with cement-asbestos siding wood over rigid insulation board
- Room 32 has 5 to 6 ft thick concrete walls, and a 5 ft wide x 7 ft tall x 3-inch-thick solid steel swinging door
- Room 34, former fuel vault, has 1 ft thick concrete walls and a 3 ft x 6.5 ft Mosler® steel vault door

Building F2

General Facts/Operations Performed/Process Components and Status:

- Built in 1954; footprint covers 4,460 SF
- Room 29 housed operations of the TTR – now defueled and inactive
- Room 36 housed operations of the FCPE reactor – now defueled and inactive
- Room 36 previously housed the PTR, ACME, and PMA reactors
- Operations support to the reactor assemblies
- Two high-radiation components (a loading plug and two resin columns) that are shielded in place
- FCPE stack monitors exhaust from the FCPE/F-Complex and is the National Emission Standards for Hazardous Air Pollutants (NESHAP) location for most of F-Complex; the air filter is changed and tested weekly

Table 4-2. Operational History Summary

Construction Features (including features designed to contain hazards):
- Multi-story masonry and steel-framed structure; above-grade portions extend up approximately 4 stories; basement and sub-basement portions extend approximately 20 ft below grade
- Room 29 has 5 to 6 ft thick reinforced concrete walls with a 2 ft thick sliding concrete door
- Room 36 has 2, 2 ft thick concrete sliding doors (one for personnel and one for equipment); a basement and sub-basement levels extending 20 ft below grade; and a 30 ft tall (above-grade) masonry walls
- FCPE pressure vessel and head assembly measure ~12 ft in diameter by 20 ft tall and weigh ~120 tons

Building F3

General Facts/Operations Performed/Process Components and Status:
- Built in 1954; footprint covers 11,501 SF
- Room 23 initially housed FPR until it was transferred to F6 upon the building's construction in 1959
- Room 23 housed ATR and a glovebox to support non-destructive fuel handling operations; glovebox measured approximately 8 ft long x 3 ft tall x 2 ft deep
- Room 23 most recently served as an operational Special Nuclear Material (SNM) storage area; SNM has since been removed from the facility
- F3 basement area previously contained small-scale lab/assembly facilities
- Basement rooms 07 and 08 were used as Activation Counting Rooms for determining beta-gamma activity on irradiated materials and for gamma scanning fuel strips and plates from the assemblies; all equipment has been removed
- Some rooms were previously used as office space by NR's deactivation and decommissioning subcontractor

Construction Features (including features designed to contain hazards):
- Multi-story masonry structure
- East wing includes a basement level approximately 15 ft below grade
- F3 southwest side has a masonry block high bay shipping and receiving annex
- Room 23 has 2 to 3 ft thick reinforced concrete walls and a 2 ft thick sliding concrete door

Building F4

General Facts/Operations Performed/Process Components and Status:
- Built in 1970; footprint covers 4,766 SF
- In operations from 1996 to 2015, used as an assembly room for FCPE
- Houses SWMU-072, the Waste Reduction Facility and former Waste Accumulation Area that was closed in accordance with State regulations in 2015 (no further action recommended for SWMU-072)
- FCPE Mechanical Equipment Room (Room 44) is constructed of 12-inch-thick concrete
- Mechanical Equipment Room shares a wall with SWMU-065 FCPE Discharge Tank, which includes two stainless steel-lined tanks that were drained and taken out of service in 1995
- Demineralizer system was used after the primary water was dumped into the discharge tank
- Light-duty shop space was previously used in F4

Construction Features (including features designed to contain hazards):
- Two-story masonry and steel frame structure, a portion of which includes a basement level extending 10 ft below grade and surrounded by a reinforced concrete foundation
- Steel-framed, steel deck mezzanine on second level of F4
- Reinforced concrete foundation

Building F6

General Facts/Operations Performed/Process Components and Status:
- Built in 1959; footprint covers 2,259 SF
- Room 41 currently houses FPR, a zero-power dry (no fluid systems) test reactor
- Previously used for equipment storage and housing the Knolls Laboratory RADIAC Calibration Facility in Rooms 39 and 41

Construction Features (including features designed to contain hazards):
- 1 to 1.5 story masonry and steel framed structure on a concrete slab; facility includes cemesto partitions
- Room 41 has 2 ft thick walls, except for the west wall, which is 4 ft thick
- FPR is currently encased in a five-sided (no bottom) wood box with a sheet metal covering to prevent potential radiological contaminant migration

4.2 Solid Waste Management Units Associated with the F-Complex

The SWMUs listed in Tables 4-3 and 4-4 are located within or near the F-Complex buildings. The SWMUs are listed in the 6 New York Codes, Rules and Regulations Part 373 Hazardous Waste Management Permit #4-4224-00024/00001, issued to Knolls Laboratory pursuant to the State's authority under RCRA. The permit enables the DOE to operate a hazardous and mixed waste container storage facility that supports overall Knolls Laboratory operations and requires environmental releases to be addressed under the Corrective Action provisions in the permit.

The five SWMUs located within the F-Complex footprint have either been closed, removed, or are inactive and require no further action. Two SWMUs located near the F-Complex building footprint require investigation to address the potential for releases of hazardous constituents. These include the Former Pilot Incinerator/Storage Facility (SWMU-033) and the Laundry Drain Line (SWMU-055). The recommended remediation path forward for these SWMUs will be determined based on characterization data collected at a future date.

Table 4-3. Solid Waste Management Units Within F-Complex
SWMU-054, Wastewater Drain System
• Encompasses wastewater drains across the Knolls Laboratory site • F-Complex portion of this SWMU includes drain lines and sumps in Building F4 used to convey wastewater within and from the building • Drains are stainless steel or heavy cast iron, including below slab drain lines that drained to sumps • Drains are inactive, with portions removed and capped • Wastewater consisted of industrial and bench scale laboratory wastewater • VOCs, metals, and PCBs were found in sump water • No spills or releases to the environment • No further action for the F-Complex portion of this SWMU
SWMU-065, FCPE Discharge Tank
• Located in Building F4, Room 44 (Mechanical Equipment Room) • Discharge tank is located adjacent to a similar charging tank; each tank is 8 ft wide x 15 ft long x 13 ft deep; the bottom 10 ft of each tank is lined with stainless steel • Charge tank was used to store coolant prior to use, and the discharge tank was used to store coolant subsequent to use • Tanks were drained and taken out of service in August 1995; less than an inch of residue remains in the tanks • No spills or releases to the environment • No further action
SWMU-066, Nuclear Material Storage Vault
• Located in Building F3, Room 23; consists of a concrete fuel storage vault measuring ~40 ft wide x 30 ft long • Initially used to store SNM; when fuel storage operations ceased, the vault was briefly used during 1994 and 1995 to store construction and demolition debris. • No spills or releases to the environment • No further action
SWMU-072, F4 <90-Day Waste Accumulation Area
• Located in Building F4, SWMU-072, also referred to as the Waste Reduction Facility (WRF), was a 90-day waste accumulation area that operated from July 1996 to May 2015 and was closed in accordance with State regulations • Consisted of ~1,600 SF of floor area equipped with a welded stainless steel secondary containment structure • Recyclable materials were prepared for off-site recycling in the vicinity of the building; preparation included disassembly, segregation, and/or paint stripping • Wastes generated from preparation activities were containerized and stored in this area • No spills or releases to the environment • No further action
SWMU-077, Former ATR Hold Tanks
• Two above-ground, stainless-steel tanks were located within the Building F3, Room 23 ATR cell • Tanks were 3.5 ft in diameter and 6 ft high and had a combined capacity of 750 gallons • ATR and the hold tanks were disassembled and shipped to another DOE facility for use • No spills or releases to the environment • No further action

Table 4-4. Solid Waste Management Units Near F-Complex
SWMU-033, Former Pilot Incinerator/Storage Facility
• Located at the north end of the Knolls Laboratory site's upper-level security area • Previously identified as Building F5 (demolished in 1978) • Initially consisted of an incinerator housed within a three-sided, corrugated transite-sided, steel framed structure • Incinerator operated for a one-year period in the early 1950s and was used to incinerate combustible solid waste, primarily air filters from the Separations Process Research Unit (SPRU) • Later modified into a 24 SF, enclosed waste storage building until 1963 and equipment storage until 1970 • Stored methyl isobutyl ketone and slurry waste, potentially containing heavy metals • Radioactivity detected in the soil indicates a potential chemical release from this SWMU • Further action is required to determine if a release occurred
SWMU-055, Laundry Drain System
• Consists of former drain lines that conveyed laundry wastewater between buildings in the upper and lower portions of the Knolls Laboratory site for processing • Drain lines were 3-inch diameter welded stainless steel that were removed in 1986 and 1987, with a small remaining portion removed in 2006 • Portion of this SWMU footprint is located just north of the F-Complex footprint • Laundry wastewater contained citric and oxalic acids, ethylenediamenetetraacetic acid (a chelation agent) and/or phosphates, and non-hazardous wastewater (potentially containing hazardous constituents) • Further action is required to determine if a release occurred

4.3 Current Legacy Facility Management

From January 2019 to August 2022, the F-Complex underwent transition to the Knolls Laboratory IFE Unit in preparation for turnover to the DOE-EM. All areas of the facility are deemed to be inactive in preparation for the selected removal alternatives following the EE/CA.

Regular walkdowns occur throughout Knolls Laboratory as a part of Knolls Laboratory's Facility Inspection Program to identify actions needed to keep site facilities in a safe and acceptable condition for their present usage. Preventive maintenance of radionuclide emission control equipment is conducted in accordance with Knolls Laboratory requirements.

Corrective maintenance tasks are performed for a variety of systems from HVAC to electrical and plumbing. Examples include replacing asbestos floor tiles, addressing emergency lighting and fire sprinkler system deficiencies, addressing concrete wall spalling, repairing doors, repairing/replacing chilled water coils, stabilizing peeling paint, and attending to ladder deficiencies. While certain maintenance actions have been completed, others have been deferred pending a decision for F-Complex disposition, the subject of the CERCLA review of which the HSA is the initial step.

The IFE reviews existing preventive and corrective maintenance items to determine what actions are necessary to maintain the facility in an acceptable state for turnover to DOE-EM and implementation of the selected removal alternative. Surveillance activities include continued verification that postings are maintained for Radiological Controls Required for Modification Areas (RCMA/RCM), Radiation Areas (RA), Radioactive Material Areas (RMA), Radiologically Controlled Areas (RCA), asbestos areas, confined spaces, beryllium areas, and identified physical hazards from deteriorating conditions.

Table 4-5 summarizes the routine surveys that will continue.

Table 4-5. Ongoing F-Complex Surveillances

Inspections/Surveys	Responsible Party	Frequency
Inspections to identify cracks, gouges, or crevices in floors, walls, and surface coatings	IFE Facility Owner	Annual
Radiation and radiological contamination surveys	Radiological Monitoring	Quarterly/Monthly
Fire extinguisher checks	Fire Protection Engineering	Monthly
Fire protection sprinkler inspections	Fire Protection Engineering	Biannual

IFE preparation activities for turnover to the DOE-EM have included clearing the complex of all items designated for removal. Figures 4-4 through 4-8 depict the present condition of the buildings.

Figure 4-4. F1, Room 17-A, Looking South

Figure 4-5. F2, Room 37 Cage, Looking Southeast

Figure 4-6. F3, Room 11/13, Looking Northeast

Figure 4-7. F4, Room 42, Looking West

Figure 4-8. F6, Room 40, Looking Northeast

5.0 CURRENT HAZARDS AND RISKS OF F-COMPLEX BUILDINGS

This section documents the current chemical, radiological, and other hazards and risks of the F-Complex buildings based on available historical information to support the EE/CA evaluation of removal action alternatives. Historical process knowledge, discussions with personnel, reports, and other sources identify asbestos as the highest risk in the complex, with beryllium, heavy metals, and radioactivity all sharing the next highest risk. Chemical and radiological contamination and radiation areas have resulted from both the legacy operations of the research reactors and the construction materials (e.g., asbestos floor tiles, lead-based paint) that were commonly in use at the time the structures were built.

- **Chemical contamination** refers to the hazardous substances (e.g., beryllium, lead, or PCBs) and potentially hazardous building materials (e.g., asbestos) that are present in materials within the building (such as in dust, floor tiles, piping, paint, equipment, etc.).
- **Radiological contamination** refers to the radioactivity that is present in the defueled assemblies or components and in any other materials within the building (such as in dust, piping, walls, floors, etc.).

5.1 Chemical Contamination

Historical process knowledge has identified asbestos, beryllium, lead, and PCBs as primary contaminants of concern. Friable and non-friable asbestos is the most prevalent contaminant and present throughout the F-Complex. Examples of asbestos-containing materials include thermal system insulation, floor and ceiling tiles, transite, insulation, paint, caulk/sealant, and the gas-fired boiler and tanks within the FCPE Mechanical Equipment Room. More than 900 locations with asbestos contamination have been identified and documented in a database.

Beryllium dust contamination is located above the main hallways of F1 and F2 and in overhead areas in Room 31. Beryllium machining operations caused suspended dust particles to be deposited on overhead ducts and the floor, with subsequent tracking from the room to the hallways.

Lead-based and PCB-containing paints exist throughout the buildings due to building materials and equipment commonly used in the 1940s–1950s typically including these constituents. Lead is present in reactor shielding components, masonry wall anchors, electrical equipment (e.g., switches, relays, wiring), and other equipment (e.g., piping, meters, fluorescent lamps, batteries). PCBs are likely present in equipment and machine oils throughout the F-Complex. There is the potential for additional PCB contamination to be encountered during subsequent characterization activities. Mercury contamination is likely to be found in old utility switches and gauges throughout the complex.

Other constituents of lesser concern based on historical process knowledge and physical form include borated polyethylene, potassium tetraborate, hydrazine, graphite reflectors, cadmium sheets, bismuth bricks, refrigerants in air conditioning units, and other metals and alloys in reactor assemblies.

Figure 5-1 depicts the areas of chemical contamination within the F-Complex.

Figure 5-1. General Location of Chemical Contamination Within F-Complex

KRPTO3_003

KEY | Defueled Assemblies | Asbestos | Beryllium | Lead

5.1 Radiological Contamination and Controlled Areas

This section describes the current level, type, and location of radiological contamination and controlled areas in F-Complex buildings based on available radiological survey data. No single survey covers the entire complex due to past radiological surveys targeting specific areas of the facility. Appropriate radiological controls are posted throughout the complex to identify and effectively communicate potential hazards, which could include contamination or areas with radiation.

The F-Complex is estimated to contain approximately 1 Curie of radioactivity within the former research reactors, associated process equipment and piping, and as loose or fixed contamination on building and equipment surfaces. The highest radioactivity levels are associated with the inactive research reactor assemblies housed within the F-Complex. One-half a Curie is estimated to exist within the defueled assemblies, nearly all of which is contained within two resin columns of the TTR. One-half a Curie is estimated to exist within known fixed contamination areas, inaccessible areas, pipe runs, and closed tank systems. See Appendix A for additional information on the estimated F-Complex radiological inventory.

Radiological surveys historically performed within the buildings have identified >1,000 picoCurie (pCi)/100 cm^2 of loose (removable) alpha surface contamination and >200,000 pCi/100 cm^2 loose beta-gamma contamination within extant reactor assemblies. Accessible areas are maintained at <20 pCi/100 cm^2 alpha and <450 pCi/100 cm^2 beta-gamma. Localized higher levels are known or suspected in inaccessible areas, including above ceilings. Discussions with F-Complex personnel included accounts of upset operational conditions that resulted in releases of radiological contamination within the facility. None of these reported events resulted in extensive residual contamination.

Radiologically posted areas and access controls are in place throughout the F-Complex to avoid worker exposure. Knolls Laboratory's radiological controls standard practices include criteria for defining radiation and contamination areas and posting radiological controls. Most areas in F-Complex are posted as RCMA/RCM. RCMA/RCM indicates areas where work that could result in accessing previously inaccessible surfaces requires radiological evaluation. Example work activities include moving installed equipment or posted, moveable equipment; opening piping, systems, or equipment; moving installed items such as partitions, ceiling tiles, and fixtures; and removing paint, lagging, and floor tiles. Areas continue to receive quarterly contamination surveys.

Additional postings in F-Complex include RA, RCA, and RMA. An RA is an area with a general radiation level of greater than or equal to 1 mrem/hr but less than 100 mrem/hr. An RCA indicates the presence of accessible contamination that is controlled by establishing a Controlled Surface Contamination Area in the room or facility. An RMA is an area where radiological materials are stored and controlled.

Figure 5-2 depicts the various radiologically posted and controlled areas within the F-Complex as well as areas with potential radiological contamination.

Figure 5-2. General Location of Radiological Postings and Contamination Within F-Complex

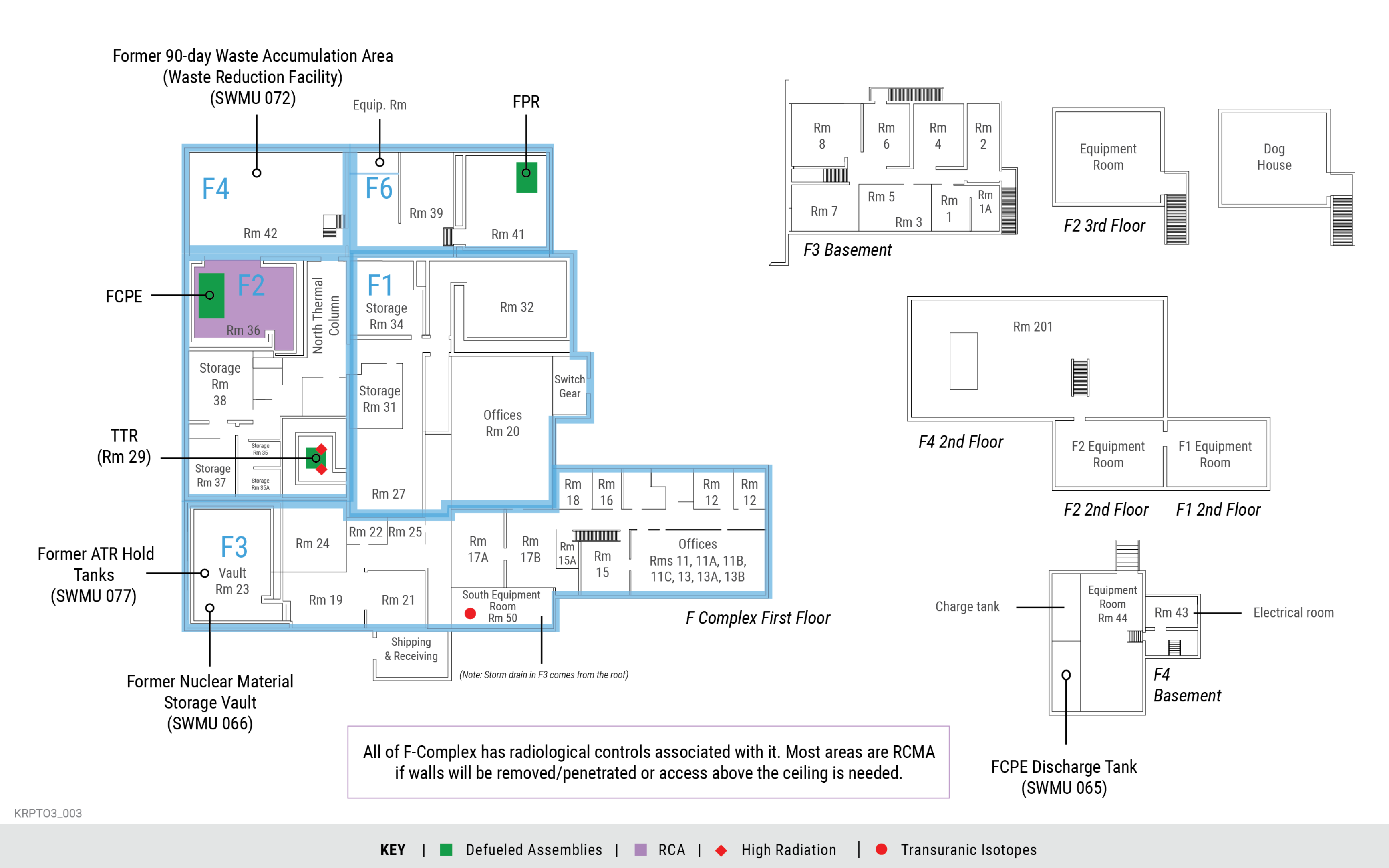


Table 5-1 lists posted areas that may require further evaluation based on work activities associated with the selected removal alternative.

Table 5-1. Current F-Complex Radiological Postings

Room	Posting
F1 – Second floor Equipment Room	RCMA
F2 – 35 and 35A	RCMA
F2 – 37	RCMA
F2 – 38	RCMA
F2 – North Thermal Column Hallway and Storage Area	RCMA, Beryllium Overhead Only
F1/F2 – Upstairs Equipment Rooms	RCMA
F2 – 40 Waste Reduction Facility	RCMA
F2 – 201 Upper Waste Reduction Facility	RCMA
F1 – Hallway	RCMA, Beryllium Overhead Only
F3 – Dog House on Rooftop	RCMA
F3 – 11 Office Area	RCM, Above Ceiling Only
F3 – 12	RCM, Above Ceiling Only
F3 – 15 and 15A	RCM, Above Ceiling Only
F3 – 16	RCM, Above Ceiling Only
F3 – 18	RCM, Above Ceiling Only
F3 – 20	RCM, Above Ceiling Only
F1 – 34 Container Storage Vault	RCMA
F3 – Basement	RCMA
F3 – Load Center	RCM, Above Ceiling Only
F3 – Hallway	RCM, Above Ceiling Only
F6 – Equipment Room	RCMA
F6 – Walkway	RCMA

Table 5-2 identifies hazards and impacted areas within the F-Complex with radioactive contamination above background levels. Figures 5-3, 5-4, and 5-5 show the location of the remaining F-Complex research reactor assemblies, including FCPE and TTR in F2 and FPR in F6.

Table 5-2. Location of Radiological Hazards Within F-Complex

F-Complex Building	Radiological Hazards Within Building
F2	• Room 29 (TTR cell) has two localized High Radiation Areas (≥100 mrem/hr) around the TTR end cap and ion exchangers • Room 29 contains two high radiation components that are shielded in place, a loading plug (4 R/hr unshielded, 0.3 mrem/hr shielded) and two resin columns (3 R/hr unshielded, 2.5 mrem/hr shielded). Nearly one-half curie of radiation is contained within these two resin columns. • >200,000 pCi/100 cm^2 beta-gamma contamination levels remain within core structural housing • North Thermal Column (unnumbered room, north of Room 29) is a Radioactive Material Storage Area • Room 36 houses the FCPE assembly and is a Radiologically Controlled Area (uranium control system) and Radioactive Material Storage Area
F3	• Plutonium-alpha TRU isotopes were identified on the original concrete floor of the F3 South Equipment Room (Room 50) from contaminated tools/equipment • Concrete floor was initially painted, covered with plywood, and permanently covered with tiles
F6	• Room 41 houses the FPR core structural assembly believed to contain up to 1,000 pCi/100 cm^2 of loose alpha surface contamination

Figure 5-3. F2, Room 29, TTR

Figure 5-4. FCPE in Building F2, Room 36

Figure 5-5. FPR Enclosure in Building F6, Room 41

5.2 Likelihood of Contamination Migration/Environmental Releases

The presence of radiological and chemical contamination within the F-Complex is well known and documented, although additional contamination may be discovered in areas that are currently inaccessible. Contamination is predominantly in a fixed state (i.e., attached to surfaces, contained within construction materials), stable, and contained within the facilities. Therefore, the likelihood of an environmental release is very low.

NR performs ongoing and comprehensive environmental monitoring at and around Knolls Laboratory. This includes collection of surface water, air, groundwater, and sediment samples for radiological and chemical analyses. The results of the monitoring are published annually in the Environmental Monitoring Report. The data show that Knolls Laboratory is in compliance with applicable Federal, State, and local regulations governing use, emission, treatment, storage, and/or disposal of solid, liquid, and gaseous materials.

Independent assessments by regulators have verified the status of environmental compliance at Knolls Laboratory. For example, in 2020, a sitewide environmental inspection focused on SPDES and RCRA waste found that Knolls Laboratory was operating in compliance with all permits with no significant issues identified.

5.2.1 Known and Potential Migration Pathways

Despite the low probability of contaminant release and migration from the F-Complex, there is the potential that conditions could lead to migration. Potential migration pathways for contaminants from the F-Complex include any penetrations/openings from the basements, slabs, walls, and roofs. The F-Complex NESHAP location is an exhaust stack for the FCPE (F2, Room 36) that is monitored weekly with no contamination reported. Since most of the above-grade building structure has been reasonably maintained, the most likely migration pathways are associated with the basement features that include drains and sumps. SWMU-054 (Wastewater Drain System) encompasses all drain lines, associated sumps, trenches, tanks, and lift/transfer stations used to convey wastewater from facilities internal to building structures. Pursuant to the RCRA permit, a Sampling Visit is required when this SWMU becomes accessible. Table 5-3 summarizes the status of these potential migration pathways.

Table 5-3. Potential Migration Pathways to the Environment from F-Complex

Location	Discharge Type	Description
F1 – Equipment Room	Storm water	Active floor drain
F2 – Equipment Room	Storm water	Inactive floor drain
F2	Storm water	Active groundwater sumps for F-Complex and FCPE foundation drainage
F3/1A	Storm water	Sump for active foundation drainage
F3 – Equipment Room	Storm water	Tapered floor drain with no check valve, isolation, or direct discharge; drains water filling room/covering floor
F3 – Room 17A	Sump	Inactive/removed steam condensate
F3 – Room 23	Sump	Inactive/removed area drainage
F3 – Shipping & Receiving Area	Sump	Active dock lift pit sump (rainwater from vehicles, etc.)
F3 – North Thermal Column	Storm drain	Capped teed roof drain in hallway near floor
FCPE Cell	Sumps (2)	Inactive air conditioner condensate
F4 FCPE Radiological Sump	Sump	Inactive collection point for floor drains and process tanks associated with FCPE operation
F4 – Room 44	Sump	Active non radiological sump for rainwater and groundwater
F6 – Room 41	Sump	Inactive drainage from the electrical trench in the F6 FPR Cell

Figure 5-6 shows a photo of the sump pit in F4, Room 44. Figure 5-7 depicts sump and drain locations within the F-Complex that are potential pathways for contaminant release to the environment.

5.2.2 Known and Potential Release Mechanisms

The most likely potential release mechanisms from the F-Complex involve water intruding into the facility, contacting existing contaminated areas, and exiting to the environment via cracks in the structures and the sumps/drains listed in Table 5-3. Contamination could enter the groundwater or stormwater system and subsequently make its way to the Mohawk River. Specifically, groundwater intrusion is known to occur in Building F4 where there is a sump designed to collect groundwater intrusion and prevent water from contacting existing contaminated areas. There has been no known contamination associated with the sump.

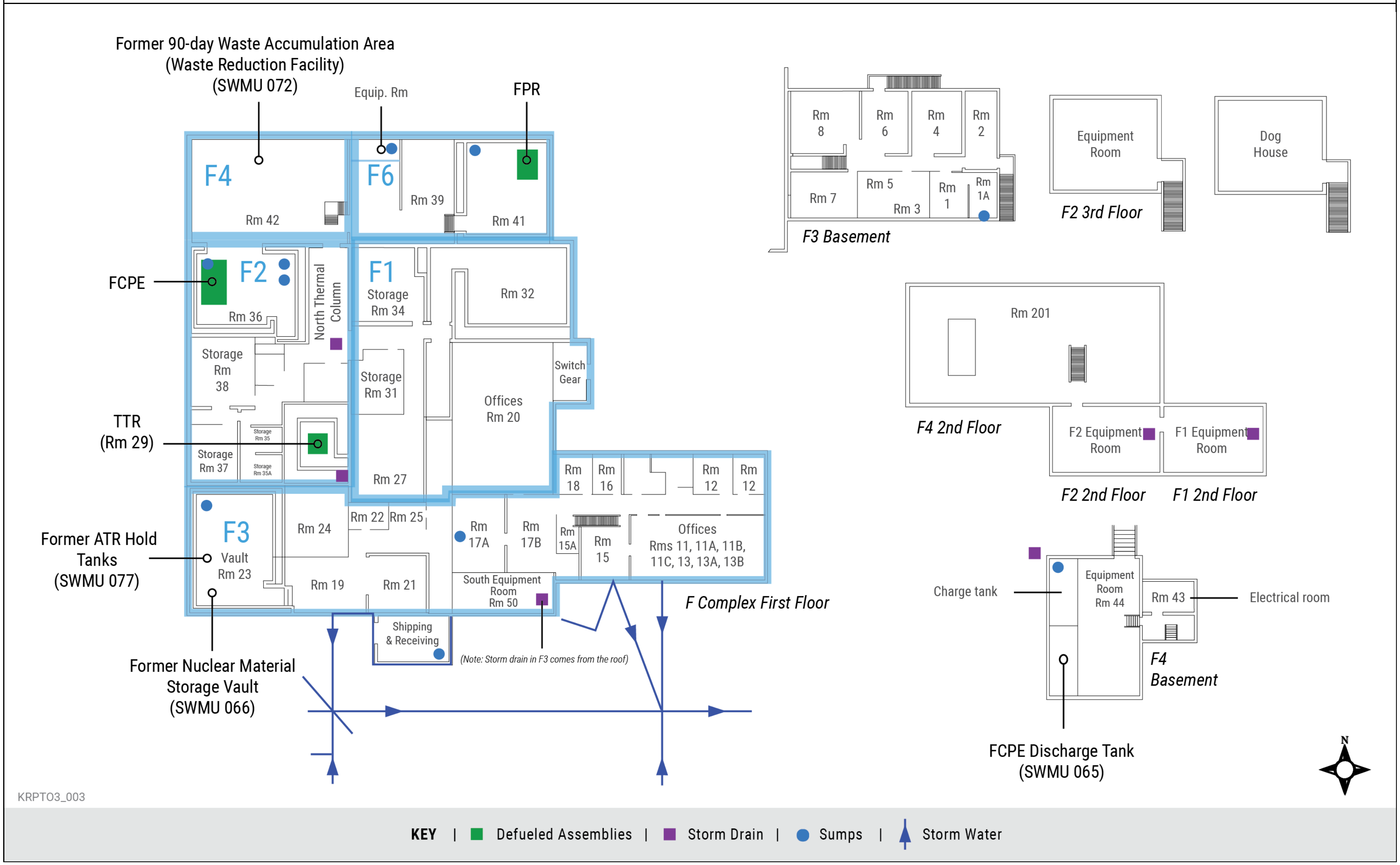
Other potential release mechanisms include the degradation of the F-Complex structure over time or because of a catastrophic event (i.e., flood, tornado, earthquake) that severely damages the structure, exposing radiological-, chemical-, and asbestos-contaminated areas to the environment.

Under current conditions, contaminant migration outside of the F-Complex is unlikely due to the fixed nature of the contaminants and the relatively intact structure. In addition, current facility management activities reduce the likelihood of contaminant migration to surface water or groundwater via runoff or infiltration through preventive maintenance. The ongoing environmental monitoring program is also designed to identify any increases in contaminants present in Knolls Laboratory liquid and gaseous effluent.

Consistent with the Knolls Laboratory RCRA permit and the F-Complex SWMUs, there are no known chemical spills or releases to the environment. Further, evaluation of the information reviewed for this HSA indicates no evidence of contaminant migration outside the F-Complex.

Figure 5-6. F4, Room 44, Sump Pit

Figure 5-7. Locations of Sumps and Drains



6.0 CONCLUSIONS

F-Complex HSA development involved collecting and reviewing historical documents and other data to determine if contamination exists at levels that could pose a risk to human health or the environment, thereby determining the need for an EE/CA to evaluate removal action alternatives to address those risks. Information reviewed during this assessment included extensive historical documentation, drawings, maps, surveys, reports, permits, and regular discussions and interviews with Knolls Laboratory personnel. Information evaluation activities associated with this assessment conclude that an EE/CA is required to evaluate removal action alternatives to address potential risks associated with F-Complex contamination.

Hazards identified include legacy radiological (beta-gamma, alpha) and chemical (asbestos, beryllium, lead, PCB) contamination throughout the F-Complex. Potential pathways for migration and exposure include subsurface sumps and drains, building deterioration, or a catastrophic event that damages the structural integrity of the buildings. Under current conditions, the probability of a release of these contaminants to the environment (soil, groundwater, surface water, air) is very low due to the fixed nature of the contaminants, the condition of the buildings (relatively intact structure), and on-going legacy facility management activities.

Current data from environmental monitoring around Knolls Laboratory show no evidence that any measurable contamination is or has been released from the F-Complex. Independent assessments by environmental regulators have verified the status of environmental compliance at Knolls Laboratory. In addition, there are no current risks to human health or to the environment as potential risks are tightly controlled through administrative and engineered controls. There are no personnel currently working in the buildings, and all areas are inactive in preparation for transfer to DOE-EM.

While the complex is well managed and under tight controls, changed conditions such as continuing structural degradation or an event that exposes the interior contamination to the environment create an increased potential for contaminant migration and exposure to the environment, Knolls Laboratory site workers, and the public. As a result, these potential risks pose a risk to human health or the environment and present a need for an EE/CA to evaluate removal action alternatives to address those risks.

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APPENDIX A
F-COMPLEX RADIOLOGICAL INVENTORY

This document provides an estimate of approximately one Curie (Ci)[1] [footnote to explain "Curie"] of residual radioactivity present in the F-Complex. This residual Curie content includes the three remaining defueled research reactors ("defueled assemblies"), i.e., the FCPE, TTR, and FPR, and potential contributions from residuals in piping and tanks and low-level fixed contamination in various locations throughout the complex. Table A-1 on the following page provides detailed information on the Curie estimate.

The defueled assemblies have relatively low levels of radiological contamination because of their research purpose and their operation at zero to low power levels. There is a likelihood of activated metals existing within the core structures of the research reactors. The activated metals in the research reactors are bound within the metallic structures they reside in, and only over extremely long periods of time (possibly many thousands of years) will corrosion be sufficient to release these activated metals from within the metallic structures where they reside.

The F-Complex Research Reactor Radiological Inventory is shown in Table A-1. The provided inventories are surrogates to represent current conditions within each defueled assembly. The total activity is composed of four sub-inventories. The TTR Resin Columns make up the majority of the total activity from F-Complex. The resin columns are assumed to contain mixed fission products from operations of the TTR. Currently, the TTR and FPR defueled assemblies are encased in shielding to maintain as low as reasonably achievable (ALARA) in the areas.

Based on available historical information and predictive modeling, the Knolls Laboratory conservatively estimates the research reactors to account for half of the one Curie of contamination remaining in F-Complex. The radiological inventory (Table A-1) shows the three research reactors contain an estimated 0.46 Ci of contamination.

In addition to the Curie contribution from the research reactors, conservatively, Knolls assumes the known fixed contamination, inaccessible areas, pipe runs, and closed tank systems account for approximately half of a Curie of contamination that remains in the F-Complex. Future characterization will gather additional source term information for all areas in the F-Complex.

[1] A Curie (Ci) is a measure the intensity of radioactivity in a sample of material. This value refers to the amount of ionizing radiation released when an element (such as uranium) spontaneously emits energy as a result of the radioactive decay (or disintegration) of an unstable atom.

Table A-1 Research Reactor Radiological Inventory Table					
Radionuclide	**TTR Core Plug Activated Metal (Ci)(1)**	**TTR Resin Columns (Ci)(2)**	**FPR Assembly Cell (Ci)(3)**	**FCPE Process Water (Ci)(4)(5)**	**Total Activity (Ci)**
Inventory	**A**	**B**	**C**	**D**	**(A+B+C+D)**
Alpha (α)	–	–	–	1.21E-08	1.21E-08
Gross Beta (β)	–	–	–	7.03E-08	7.03E-08
Ac-225	–	1.27E-17	–	–	1.27E-17
Ac-227	–	9.40E-18	–	–	9.40E-18
AC-228	–	3.35E-21	–	–	3.35E-21
Am-241	–	3.85E-05	2.29E-07	–	3.87E-05
At-217	–	1.27E-17	–	–	1.27E-17
Ba-137m	–	1.11E-01	–	–	1.11E-01
Bi-210	–	6.29E-14	–	–	6.29E-14
Bi-211	–	9.31E-18	–	–	9.31E-18
Bi-212	–	2.76E-21	–	–	2.76E-21
Bi-213	–	1.27E-17	–	–	1.27E-17
Bi-214	–	2.87E-13	–	–	2.87E-13
C-14	9.74E-08	–	–	–	9.74E-08
Cd-109	–	–	1.23E-06	–	1.23E-06
Ce-144	–	2.27E-14	–	–	2.27E-14
Cl-36	–	–	1.09E-08	–	1.09E-08
Cm-244	–	5.54E-06	–	–	5.54E-06
Co-60	4.76E-05	–	2.64E-06	1.08E-07	5.03E-05
Cs-134	–	1.41E-06	–	–	1.41E-06
Cs-137	–	1.17E-01	–	1.08E-08	1.17E-01
Eu-154	–	9.81E-04	–	–	9.81E-04
Fe-55	6.20E-06	–	–	–	6.20E-06
Fr-221	–	1.27E-17	–	–	1.27E-17
Fr-223	–	1.30E-19	–	–	1.30E-19
H-3	3.36E-08	–	–	3.37E-05	3.37E-05
Ni-59	2.34E-06	–	–	–	2.34E-08
Ni-63	2.24E-04	–	–	–	2.24E-04
Nb-94	5.26E-09	–	–	–	5.26E-09
Np-237	–	2.71E-10	–	–	2.71E-10
Pa-231	–	3.35E-17	–	–	3.35E-17
Pa-233	–	2.70E-10	–	–	2.70E-10
Pb-209	–	1.27E-17	–	–	1.27E-17
Pb-210	–	6.30E-14	–	–	6.30E-14
Pb-211	–	9.31E-18	–	–	9.31E-18
Pb-212	–	2.76E-21	–	–	2.76E-21
Pb-214	–	2.87E-13	–	–	2.87E-13
Pm-147	–	3.07E-05	–	–	3.07E-05
Po-210	–	5.93E-14	–	–	5.93E-14
Po-211	–	2.54E-20	–	–	2.54E-20
Po-212	–	1.77E-21	–	–	1.77E-21
Po-213	–	1.24E-17	–	–	1.27E-17
Po-214	–	2.87E-13	–	–	2.87E-13
Po-215	–	9.31E-18	–	–	9.31E-18
Po-216	–	2.76E-21	–	–	2.76E-21
Po-218	–	2.87E-13	–	–	2.87E-13
Pr-144	–	2.27E-14	–	–	2.27E-14
Pr-144m	–	3.24E-16	–	–	3.24E-16
Pu-238	–	3.25E-03	–	–	3.25E-03
Pu-239	–	2.78E-06	9.12E-08	–	2.87E-06
Pu-240	–	6.32E-06	–	–	6.32E-06
Pu-241	–	2.89E-04	–	–	2.89E-04
Ra-223	–	9.31E-18	–	–	9.31E-18
Ra-224	–	2.76E-21	–	–	2.76E-21

Table A-1 Research Reactor Radiological Inventory Table

Radionuclide	TTR Core Plug Activated Metal (Ci)(1)	TTR Resin Columns (Ci)(2)	FPR Assembly Cell (Ci)(3)	FCPE Process Water (Ci)(4)(5)	Total Activity (Ci)
Ra-225	–	1.28E-17	–	–	1.28E-17
Ra-226	–	2.87E-13	–	–	2.87E-13
Ra-228	–	3.35E-21	–	–	3.35E-21
Rh-106	–	2.66E-12	–	–	2.66E-12
Rn-219	–	9.31E-18	–	–	9.31E-18
Rn-220	–	2.76E-21	–	–	2.76E-21
Rn-222	–	2.87E-13	–	–	2.87E-13
Ru-106	–	2.66E-12	–	–	2.66E-12
Sm-147	–	6.06E-12	–	–	6.06E-12
Sr-90	–	1.15E-01	3.00E-08	2.31E-08	1.15E-01
Tc-99	2.05E-09	–	1.65E-07	–	1.67E-07
Th-227	–	9.21E-18	–	–	9.21E-18
Th-228	–	2.76E-21	–	–	2.76E-21
Th-229	–	1.29E-17	–	–	1.29E-17
Th-230	–	5.75E-11	4.80E-07	–	4.80E-07
Th-231	–	9.30E-14	–	–	9.30E-14
Th-232	–	5.33E-21	2.64E-08	–	2.64E-08
Tl-207	–	9.28E-18	–	–	9.28E-18
Tl-208	–	9.91E-22	–	–	9.91E-22
Tl-209	–	2.75E-19	–	–	2.75E-19
U-233	–	1.50E-14	–	–	1.50E-14
U-234	–	3.60E-07	–	1.98E-08	3.60E-07
U-235	–	9.30E-14	7.31E-08	5.75E-10	7.37E-08
U-236	–	6.35E-12	–	3.87E-11	4.51E-11
U-237	–	7.09E-09	–	–	7.09E-09
U-238	–	–	5.07E-04	5.02E-11	5.07E-04
Y-90	–	1.15E-01	–	–	1.15E-01
Total	**2.80E-04**	**4.63E-01**	**5.12E-04**	**3.39E-05**	**4.63E-01**

(1) The source term data provided was taken from the activated stainless steel of a TTR fuel stringer.
(2) The source term data was generated by calculating the TTR Resin Column curie content from a known 1986 dose rate and using that curie content in the Predictive Plum Model for Mixed Fission Products to arrive at 2020 radionuclide distributions.
(3) The source term data provided was generated from a list of materials present as part of the FPR Cell.
(4) The source term data was generated from the characterization of 22,000 gallons of FCPE process water in 1995.
(5) The process water is no longer present; it was previously removed.