Brookhaven Graphite Research Reactor Decommissioning Project

DRAFT
CANAL AND WATER TREATMENT HOUSES, EQUIPMENT, AND ASSOCIATED SOILS COMPLETION REPORT

April 15, 2002

BROOKHAVEN NATIONAL LABORATORY
BROOKHAVEN SCIENCE ASSOCIATES
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EXECUTIVE SUMMARY

This report documents the status of a removal action authorized by the U.S. Department of Energy (DOE) at Brookhaven National Laboratory. The removal action, at the Brookhaven Graphite Research Reactor (BGRR), was conducted to complete a Time-critical Removal Action of the Canal and Water Treatment House structures and a Non-time-critical Removal Action of the Lower Canal and Water Treatment House, Equipment, and Associated Soils. The activities encompassed three major areas of work: removing the Canal and Water Treatment House structures, remediating of the Canal and Canal areas, and removing of contaminated below-ground piping and soils.

The work was performed in accordance with the *Comprehensive Environmental Recovery, Liability, and Compensation Act* of 1980 (CERCLA) through the Interagency Agreement between the DOE, the U. S. Environmental Protection Agency (EPA), and the New York State Department of Environmental Conservation (NYSDEC).

The Canal and Water Treatment House structures were removed using a CERCLA Time-critical Removal Action Memorandum dated January 5, 2001. These structures were packed for disposal at authorized radioactive, hazardous, and clean waste disposal facilities.

Remediation work on the lower Canal area, piping systems, and associated contaminated soils was authorized by the Engineering Evaluation and Cost Analysis (EE/CA) process under CERCLA [1]. The work was authorized in a Non-time-critical Removal Action Memorandum prescribing Alternative 2 of the EE/CA. The Action Memorandum acknowledged that the choice of Alternative 2 was an interim decision, and not final. The major contaminants of concern were Cesium-137 and Strontium-90.

The majority of the work described in Alternative 2 was accomplished. All contaminated piping systems associated with the Canal House and those associated with the Water Treatment Houses were removed. The piping associated with the Walkway sump remains. All surface contaminated soils were removed from the associated soils areas to levels that are at, or near, background.

The Canal area has not been decontaminated to the cleanup goals established in the EE/CA. Therefore, the Final Status Survey Plan cannot be performed. The contaminated soils below and around the Canal remain in place, pending the final decision about the end-state of the BGRR complex.

The results of a radiological survey indicate a thorough review of the costs and risks associated with completing Alternative 2 is warranted now. As directed in the Action Memorandum, the BGRR Project is taking "…actions to reexamine the acceptability of this alternative as further progress is made." Therefore, physical work was suspended and the area stabilized. The Canal project was placed "on hold" pending the Record of Decision (ROD) for the entire BGRR Project.

ACRONYMS, ABBREVIATIONS, AND UNITS OF MEASUREMENT

Am-241	Americium-241
amsl	Above mean sea level
AOC	Area of Concern
BAO	Brookhaven Area Office
BGRR	Brookhaven Graphite Research Reactor
BHG	Brookhaven Group
BNL	Brookhaven National Laboratory
BSA	Brookhaven Science Associates
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act* of 1980
Cs-137	Cesium-137
DOE	Department of Energy
EE/CA	Engineering Evaluation/Cost Analysis
EPA	U.S. Environmental Protection Agency
ERD	Environmental Restoration Division
FY	Fiscal year
IAG	Interagency Agreement
mCi/gm	milliCuries per gram
mr/hr	millirem per hour
NEPA	*National Environmental Policy Act*
NESHAPS	National Emission Standards of Hazard Air Pollutants
NYSDEC	New York State Department of Environmental Conservation
ORISE	Oak Ridge Institute for Science and Education
pCi/gm	picoCuries/gram
Pu-239	Plutonium-239
RESRAD	A computer code developed by Argonne National Laboratory that calculates radiation dose from residual radioactivity in the ground.
ROD	Record of Decision
SAP	Sampling and Analysis Plan
Sr-90	Strontium-90
U-238	Uranium-238
USID/SE	Unreviewed Safety Issue Determination/Safety Evaluation

1.0 INTRODUCTION

1.1 Purpose

This completion report documents the work conducted to complete the time-critical removal action of the Canal and Water Treatment House structures, and the non-time-critical removal action of the Lower Canal and Water Treatment House, equipment and associated soils for the Brookhaven Graphite Research Reactor (BGRR). The latter actions to date were performed in accordance with those described in Alternative 2 of the Lower Canal and Water Treatment House, Equipment, and Associated Soils Engineering Evaluation/Cost Analysis (EE/CA) [1]. This report becomes part of the Administrative Record and satisfies the Interagency Agreement (IAG) between the U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), and the New York State Department of Environmental Conservation (NYSDEC) [2].

2.0 SITE DESCRIPTION AND HISTORY

2.1 Brookhaven National Laboratory

Brookhaven National Laboratory (BNL) is located in Upton, Long Island, New York, near the geographic center of Suffolk County, approximately 60 miles east of New York City (Figure 1). Approximately 1.32 million people reside in Suffolk County and about 0.41 million people reside in Brookhaven Township, within which BNL is situated.

The Laboratory encompasses 5,265 acres (8.23 square miles). The terrain is gently rolling, with elevations varying between 44- and 120-feet above mean sea level (amsl). The land lies on the western rim of the shallow Peconic River watershed, with a principal tributary of the River in the north and west sections of the site.

With a few exceptions, the principal facilities are located near the site's geographic center. The facilities cover an area of approximately 900 acres, of which about 500 acres were originally developed by the U.S. Army. The remaining 400 acres are occupied, for the most part, by various large research facilities. Outlying facilities take up about 550 acres and include apartment areas, biology research fields, a solid-waste management area, closed landfills, a sewage treatment plant, and firebreaks. The balance of the site, approximately 75 percent of its total area, is largely wooded. The U.S. Army occupied the Brookhaven site, formerly known as Camp Upton, during World Wars I and II, and it was used as the Civilian Conservation Corps Camp between the wars. In 1947, ownership was transferred to the Atomic Energy Commission for peaceful research on atomic energy and materials. The site subsequently was transferred to the Energy Research and Development Administration in 1975, and finally to the DOE in 1977. These later transfers reflected the agencies, name changes, not changes in occupancy or function.

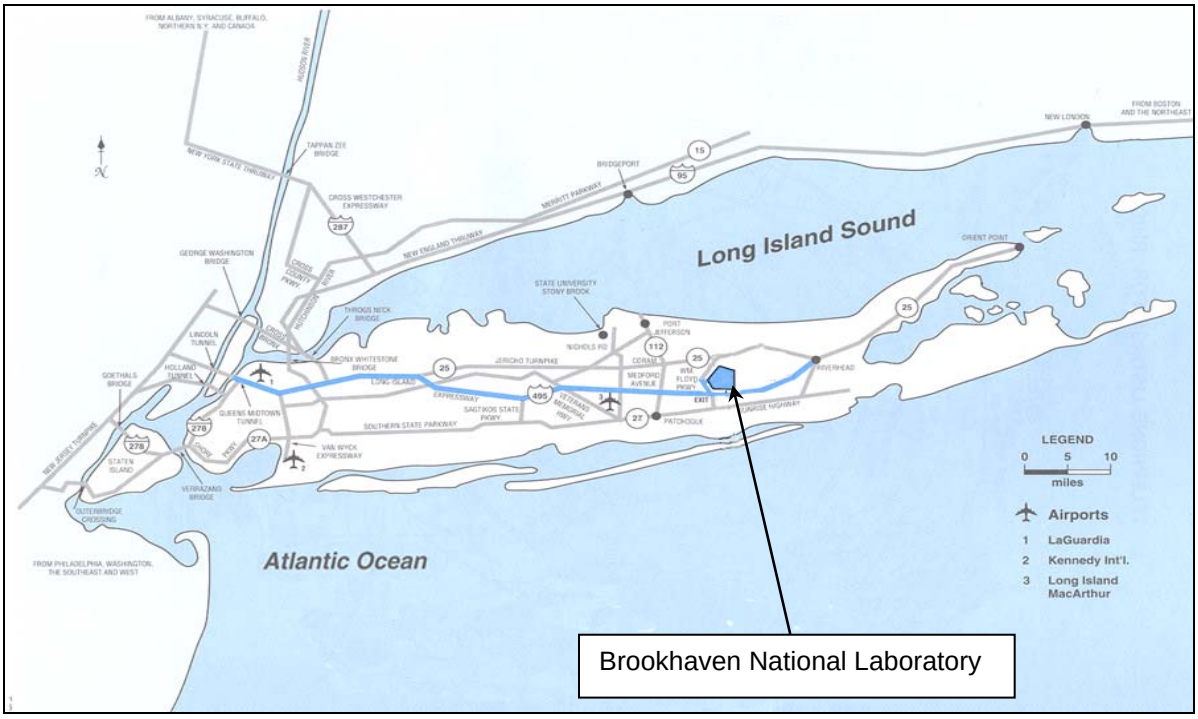


Figure 1. The Laboratory Location

Brookhaven National Laboratory carries out basic and applied research in the fields of high-energy nuclear- and solid-state physics, fundamental material and structure properties and the interactions of matter, nuclear medicine, biomedical, and environmental sciences, and selected energy technologies.

2.2 Brookhaven Graphite Research Reactor

The BGRR was the first reactor built at Brookhaven for the sole purpose of providing neutrons for research. During its years of operation, it was one of the principal research reactors in the United States. Its construction was completed in August 1950, and the reactor reached initial criticality in the same month. The BGRR operated until June 10, 1968, when its operation was terminated and deactivation of the facility started. In June 1972, defueling and shipment of the fuel to the DOE's Savannah River site was completed. The U.S. Atomic Energy Commission described the BGRR complex as being in a safe shutdown condition and it became a surplus facility within the DOE complex. From 1977 until 1997, portions of the facility were used as the BNL Science Museum.

The BGRR was an air-cooled graphite-moderated reactor. The primary air-cooling system used cooling fans that were located in a separate building (704) from the reactor building itself (701). Exhaust ducting, constructed of reinforced concrete, runs in two separate ducts below the ground

from the reactor's exhaust plenums to the system's filters and coolers. Downstream of the coolers, the ducting rises above the ground and is combined into one large duct, which was located on, and supported by, the Fan House (704). The individual cooling fans took suction through 48-inch-diameter ducts, that penetrated the building's roof and connected at the duct's bottom. There was approximately 225 feet of above-grade ducting. The Above-Ground Duct Removal Action is complete. Figure 2 is an aerial picture of the BGRR site.

During reactor operations, the fans drew filtered outside cooling-air across the reactor pile through this ductwork. The air then moved through the ductwork, where it was filtered and cooled, and to the Fan House eventually left through the 320-foot-tall exhaust stack.

The Canal House is attached to the east side of Building 701 (Figure 3). A portion of the Canal is inside to Building 701, twelve feet below-grade at elevation 97 feet. The west end of the Canal has a chute connected to the south plenum area between the biological-shield wall and the graphite pile. Used fuel was moved into the chute area that is attached to a deep pit section of the Canal; this section contained 20 feet of water while the Canal had 9 feet. The fuel and irradiated components that were moved into the deep pit were left for some time to allow radioactivity to decay before they passed into the Canal for segmentation, packaging, and loading for shipping. Much of the segmentation work and loading of the materials into shielded casks was performed under water. The Canal's monorail crane was used to move the casks to the main floor where the exterior of the cask was decontaminated and loaded for shipment.

2.3 Canal Area

The BGRR's Canal, Area of Concern (AOC) 9A, broadly includes the Canal House, below-grade Canal structure, Water Treatment House, related piping systems, equipment and sumps, underground fuel-storage vault, and surrounding area(s), all of which were impacted by activities in and around the BGRR Canal. Impacted equipment, systems, and areas within AOC 9A include the following:

1. The underground portion of the Canal structure east of Building 701 (wall column 7) including the concrete walls, floor, walkway, and Canal sumps.
2. The Water Treatment House's foundation.
3. Equipment in the Canal area and Water Treatment House, including portable lights, pumps, hoses, hand tools, concrete Canal covers, miscellaneous steel parts, and the monorail crane.
4. Concrete, asphalt, and soils in the outdoor work area that surrounds the Canal and Water Treatment House on its north, east, and south sides.
5. Related piping systems, pipe trenches, and associated soils.

Figure 2. The BGRR Site Looking North

Figure 3. The East Side of Building 701

6. The East yard sump, located in the outdoor work area east of the Canal structure.
7. Associated surface soils extending approximately 120 feet east of Building 701, as is the Canal and Water Treatment Houses, south awning, and structural steel, and 160 feet south of Building 703.

Figure 3 shows the above-grade portion of the Canal. The darker blacktop area is included.

Figure 4 shows the soils area south of the Canal from which several below-grade piping lines and four concrete vaults were removed. A new storm drain system was installed to separate it from the buildings 703 and 801 drains. The new storm drain flows though the catch basin seen on the far right side of the picture.

The Canal House had a large equipment door on the east side (Figure 5) through which equipment and fuel casks were removed from the Canal House and loaded on trucks for shipment using the monorail crane.

2.4 Stakeholder Participation

Stakeholders, including the public, regulators, legislators, and Brookhaven's employees, were informed of and involved in, the Canal area removal action through several scheduled events and media releases. From the beginning, the BGRR Decommissioning Project informed the stakeholders about its plans for decommissioning of the BGRR and solicited community values that could be compared with the values stated in the *National Environmental Policy Act* (NEPA) and CERCLA regulations to determine a path forward for decommissioning.

In parallel with the aforementioned efforts, a *Removal Action Alternative Study* [3], dated April 13, 2000, was done by an independent contractor. The hazardous and radiological material characterization of the Canal area began in August 2000. In August 2001, the EE/CA for the Lower Canal and Water Treatment House, Equipment, and Associated Soils [1] was prepared and submitted to the DOE, EPA, and NYSDEC for their review and comment. After incorporating comments from these regulatory agencies, the DOE distributed the EE/CA for public comment from August 22, 2001 to September 20, 2001. Notices of Availability were prepared and published in *Newsday* and in *Suffolk Life* on August 22, 2001. The DOE extended the public comment period one month until October 19, 2001, following requests from several stakeholders; notice of the extension was also published in *Newsday* and *Suffolk Life*. Informal public meetings were held on August 28, 2001 and September 18, 2001. A presentation about the EE/CA was made to the Brookhaven Executive Roundtable on September 19, 2001 and to the Community Advisory Council on October 11, 2001.

Additionally, the BGRR Working Group was formed in June 2000. Composed of community members and local regulators, the group meets monthly with the BGRR Project team. The agenda usually includes a discussion of the status of ongoing work and planned activities.

Figure 4. South Soils Area of the Canal Removal Action

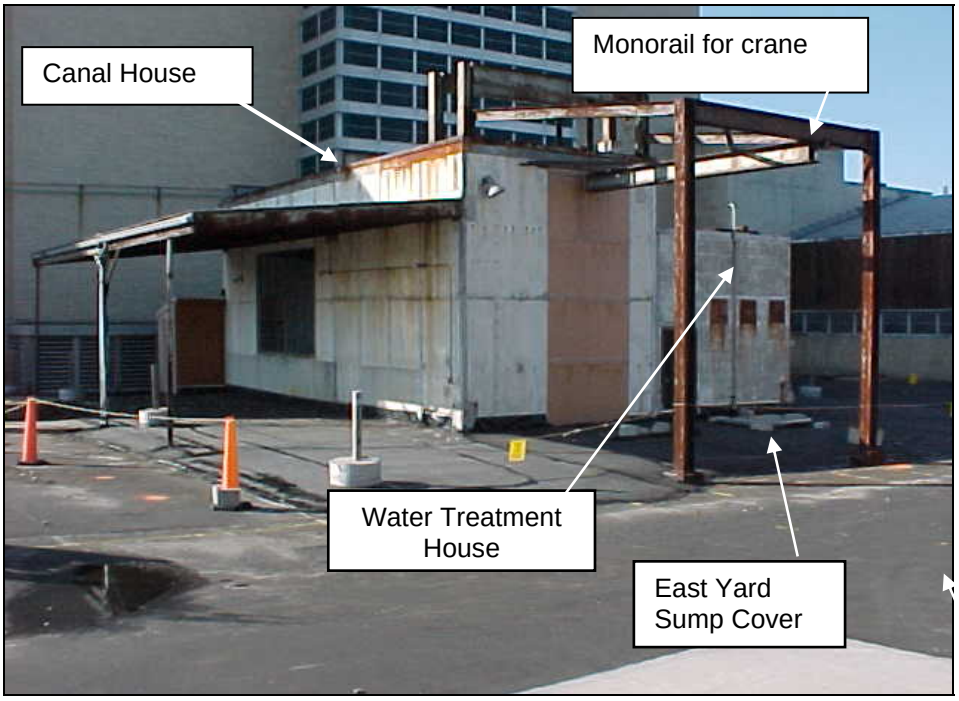


Figure 5. The Canal and Water Treatment Houses and Surrounding Areas

The BGRR Working Group provides valuable feedback to the Project team during the planning and implementation phases of proposed work. Work on the Canal project was discussed with the Working Group twice in 2001, on August 15, and October 17. There were seven meetings in 2001, January 16, February 20, June 19, July 17, August 21, October 16, November 21, and two in 2002, January 15, and March 12.

Appendix 3, Community Relations, captures some of the ways used to communicate information on the progress of the BGRR Decommissioning Project, and the removal of the Canal and Water Treatment Houses, contaminated soils, and below-grade piping. It demonstrates the Project's commitment to informing and involving stakeholders in all facets of the decommissioning.

3.0 REMOVAL ACTIVITY

3.1 Objectives

The removal activity had the following objectives:

- To remove the above-ground contaminated structures of the Canal and Water Treatment Houses, the contaminated foundation slab of the latter, the associated asphalt and surface soils, and the below-grade contaminated piping.

- To reduce the amount of contamination in the concrete structures of the Canal through scabbling and shaving of its surfaces.

- To remove contaminated surface soils to reduce the "footprint" of the BGRR Complex, and to completely remediate AOC 9C east of Building 701's east wall in accordance with the IAG, following the time-critical and non-time-critical removal actions set out in memoranda.

3.2 Activities

3.2.1 Time-critical Removal Actions

The time-critical removal actions removed the Canal and Water Treatment Houses, contaminated equipment, and the latter's concrete slab foundation. The debris from these structures was placed into containers for transfer to a licensed radioactive waste disposal facility.

3.2.1.1 Canal and Water Treatment House Structures

The Canal House consisted of a steel-framed structure with a cement and asbestos containing material siding approximately 39 feet long, 15 feet wide, and 19 feet high. It covered the 4-feet-wide by 14-feet-long-opening in its floor providing access to the Canal for taking equipment in

and out of the Canal and a hatch for the movement of personnel between the Canal area's walkway at elevation 97 feet 4 inches, and the main floor at grade elevation 109 feet amsl. The steel framing extended approximately 15 feet beyond the east-end double doors, and supported a 5-ton trolley crane used to move equipment in and out of the Canal. An awning attached to the south side of the building covered a bermed work area. The structure covered an area on the east side of the building that was used for decontaminating equipment removed from the Canal.

3.2.1.2 Water Treatment House

The Water Treatment House was a concrete block structure erected on a concrete slab foundation that contained equipment for processing Canal water. The structure was approximately 38 feet long, 15 feet wide, and 13 feet high. The building was subdivided into four concrete- and steel-shielded filter compartments. The compartment walls were made of 16-inch thick concrete blocks with up to 3 inches of steel plate for shielding.

3.2.2 Non-time-critical Removal Actions

The non-time-critical removal actions were performed in accordance with criteria established in EE/CA Alternative 2. Major areas remediated included the below-grade piping systems associated with the reactor and Canal; the Water Treatment House foundation; the Canal structure, including the removal of the inside concrete surfaces; Canal sumps; and associated soils.

The below-grade piping systems and any associated contaminated soils were removed. This removal included the reactor's pneumatic-transfer piping that ran east underground from Building 701's east truck-bay door, east and then north and south to Buildings 703 and 801, respectively. The "F" waste-transfer line from Building 701 to Building 801 was taken out, and the line was plugged and capped at the Building 801 north-wall penetration. Over 250 linear feet of Canal discharge line was removed between the Canal and the A & B pipe-trench connection running north and south between Buildings 801 and 811. The discharge line was cut and capped at the A & B pipe-trench connection. Contaminated surface soils, asphalt, and concrete associated with the piping removal were excavated.

Four vaults located on the south side of the Canal were removed – the rod-storage vault, and three low-level waste-storage vaults.

The lower Canal area and Canal concrete was decontaminated to the extent practical using hand-held and machine-mounted scarifiers and scabbling equipment. Radiological surveys indicated high readings at floor-to-wall joints in the Canal and Walkway area. Due to these and other elevated readings, a determination was made to suspend physical work and stabilize the area. Additionally, based on the radiological data, a thorough review of the costs and risks associated with completing EE/CA Alternative 2 will be performed in the future.

The waste materials generated during the remediation were packaged for disposal. Waste generated from demolition of the above-ground structures and the below-grade piping are planned for shipment during fiscal year (FY) 02. The contaminated asphalt, concrete, and associated soils are planned for shipment during FY03.

A new storm drain system was installed so that a contaminated storm-drain catch basin on the south side of the Canal could be removed.

3.3 Remediation Criteria

Contaminated materials and soils will be left behind after finishing this remediation work. The following presents the criteria expected at the completion of Alternative 2. However, since all activities identified in Alternative 2 were not completed and additional contamination was found, the following remediation criteria has not been met.

3.3.1 The remaining RESRAD-modeled contaminated components include the following:

- Canal concrete walls and floor
  Concentrations modeled as 50 picoCuries per gram (pCi/g) Cesium-137 (Cs-137) and 5 pCi/g Strontium-90 (Sr-90)
  Total Activity: 4.9 milliCuries (mCi) Cs-137, and 0.55 mCi Sr-90
- Soils beneath the Canal's floor (in three layers for RESRAD modeling)
  Peak concentrations: 1,500 pCi/g Cs-137 and 400 pCi/g Sr-90
  [with 6.2 pCi/g Uranium-238 (U-238), and 5.2 pCi/g Plutonium-239 (Pu-239)]
  Total Activity: 9.3 mCi Cs-137, and 4.2 mCi Sr-90
- Contaminated concrete in the foundation pedestal
  Peak Concentrations: 30 pCi/g Cs-137, and 3 pCi/g Sr-90
  Total Activity: 0.45 mCi Cs-137, and 0.05 mCi Sr-90

3.4 Characterization Information

3.4.1 Structures of the Canal and Water Treatment Houses

The structures of the Canal and Water Treatment Houses contained both radiological-and hazardous-materials. The structures were radiologically contaminated internally with fixed- and loose-surface contamination up to 1,000,000 disintegrations per minute per 100 square centimeters. Some construction materials used in the Canal House's structure contained asbestos.

3.4.2 The Canal Area and Underlying Soils

The Canal area and the associated soils immediately adjacent to and below the structures were characterized using an approved sampling and analysis plan [4], the results of which are documented in the EE/CA [1]. Initially, the radioactive contamination of the Canal area and associated soils was thought to be widespread over the entire remediation area. Characterization revealed that contamination of the associated soils around the Canal was mostly restricted to the surface layers; contamination existed at deeper levels, below sumps or pipes that had leaked into the soil. The Canal's construction joint at the Canal and Building 701's east wall had allowed contaminated water to infiltrate into the soil. Where leaks occurred, the resulting contamination was found to be in narrow vertical columns. However, the characterization data did not accurately reflect the actual contamination found. Section 5.0 discusses this under lessons learned.

The range of measurements for each contaminant of concern from the characterization of the Canal concrete and the soils below the Canal is summarized below:

Table 1. Characterization Summary: Canal Concrete and Soils

Description	Contaminant of Concern Cs-137 pCi/gm range	Contaminant of Concern Sr-90 pCi/gm range	Contaminant of Concern Americium-241 (Am-241) pCi/gm range
Canal floor, concrete surface	60 - 42,000	NA[1]	NA[1]
Canal floor, concrete 2" below surface	19 - 2,790	0.69 - 790	0.17 - 7.5
Canal floor, concrete surface soil side	ND - 1,810	NA	NA[2]
Canal walls, concrete surface	1,050 - 2,870	NA[1]	NA[1]
Canal concrete walls, 1" below surface	173 - 809	0.21 - 118	0.3 - 4.9
Canal walls, concrete surface soil side	ND	ND	ND
Below Canal floor soils	ND - 5,241	0.2 - 2,715	ND

ND = not detectable

NA = not analyzed

[1] No analysis was performed on the surface concrete because it was to be removed during scabbling. Analysis at depth will provide the information needed to develop the RESRAD model for an end-state to meet the remediation criteria.

[2] No analysis was performed on the soil side of the concrete for this radionuclide. The soil directly under the concrete was sampled and analyzed for the radionuclide.

3.4.3 Below-grade Piping Systems and Associated Soils

Figure 6 shows below-grade piping systems associated with the Canal soils. The piping systems contained varying levels of internal contamination from non-detectable to dose rates up to 4 mrem/hr in the Canal Discharge line. The below-ground piping systems removed were at depths ranging from 3 to 15 feet where the Canal Discharge line entered the piping trench that runs between Buildings 801 and 811.

3.5 Present Conditions

The Canal project was placed "on hold" pending the Record of Decision (ROD) for the entire BGRR Project. The work on the lower Canal was stopped due to the emergence of several issues that had the potential to greatly increase the scope and cost of completing the project as planned.

The status of additional radioactivity found during EE/CA Alternative 2 removal actions include the following:

- Canal outer walls indicating 11,000pCi/gm Cs-137 and 300 pCi/gm Am-241.
- Canal extension pad is contaminated. Soil contaminated – 142 pCi/gm Cs-137
- Walkway floor-to-wall joint indicating elevated dose rates from 0.5 to 3.3 millirem per hour (mr/hr); soil at 60 pCi/gm Cs-137
- Canal floor-to-wall joint indicating 3 to 5 mr/hr; soil at 900 pCi/gm Cs-137
- Walkway sump indicating 200 mr/hr
- Canal overflow sump indicating 26 mr/hr

The Canal and adjacent areas were stabilized to assure that the present work area will provide a secure environment and will control water runoff away from the Canal structure during the interim. The following work was performed to establish and monitor the affected areas:

- The contaminated exterior walls were coated with a fixative.
- The existing excavation was backfilled.
- A 10-foot-wide sheet rubber lining was installed beneath the surface pitching away from the Canal. This will prevent rainwater percolating through the soil, previously covered by blacktop, from moving deeper into the ground.
- The area was then graded for installation of a larger “weather-rated” tent.

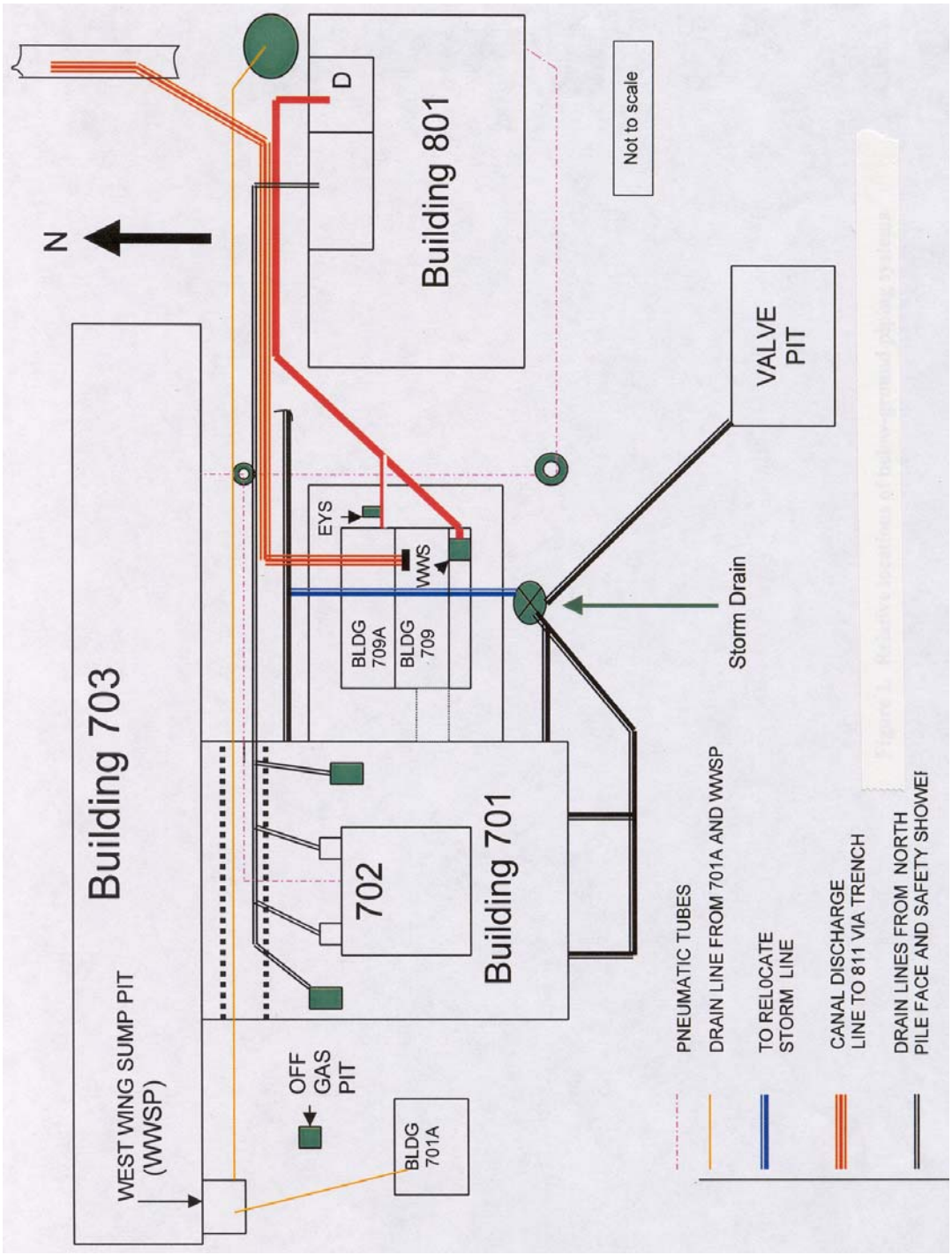


Figure 6. Sketch of the Below-grade Piping Systems Associated with the Canal Soils

- The "weather-rated" tent that was installed extends 5 feet beyond and over the existing tent. (This precludes the expense of surveying and removing the existing tent, and will prevent contaminating the new one. Hence, work within the Canal will be possible under present controls.)
- A monitoring well south of the construction joint between Building 701 and the Canal, damaged while excavating soil south of the Canal, was repaired.
- A soil survey was undertaken to reduce the size of the radiologically controlled area.
- The core-bore holes, made in the East Wall, and the S-2 and S-3 sumps excavations were plugged and sealed.

A surveillance program will be established to periodically monitor the conditions within the Canal.

An independent verification sampling and analysis was performed on the soils around the Canal discharge line trench (Appendix 7). The results confirmed that these soils meet established cleanup criteria.

3.6 Conclusions

The Canal House, Water Treatment House, piping systems, and associated soils were successfully removed, and a preliminary radiological survey performed to reduce the size of the radiologically controlled area. All activities identified in EE/CA Alternative 2 were completed, except for the removal of the Walkway sump and drain lines.

The Lower Canal remediation progressed to the extent practical at this time, but the radiological conditions necessary to perform a final status survey were not met. Significant amounts of contamination were found that indicated the need for additional characterization and remediation. Preliminary cost estimates were prepared to determine the scope of additional remediation or the selection of another decommissioning alternative.

3.7 Cost of Work

The following details the to-date and projected costs in dollars, as of writing:

Description	Project to Date	To Go	Estimate at Completion	Baseline	Cost Variance
BNL Labor	184,414	160,864	345,278	215,639	(129,639)
Subcontracts	1,381,114	348,232	1,729,347	998,510	(730,837)
Materials	531,826	21,835	553,660	266,168	(287,492)
BNL Plant Engineering Support	521,816	20,275	542,091	154,649	(387,442)
Other Distributed Costs	457,417		457,417	38,745	(418,672)
Facility Services Support	808,607	28,722	837,329	427,545	(409,784)
Subtotal	3,885,194	579,928	4,465,122	2,101,256	(2,363,866)

Note: This summary includes the cost for some of the remediation associated with the "BGRR Remaining Soils Removal AOC 9C" Work Package 147, and will be adjusted using the Baseline Change Procedure to reflect the costs associated with the appropriate Work Package. Some relief expected on cost variance due to common work between Canal and Removal of Soils.

4.0 WASTE MANAGEMENT

4.1 Soils

Approximately 67,500 cubic feet[1] of waste in the form of asphalt, soils, and concrete were generated during remediation. The materials, stored in "Supersacks," are being held on the BNL site[2] until funds for disposal are available in FY03.

4.2 Debris

Approximately 10,288 cubic feet of debris waste were generated during remediation in the form of concrete, asbestos, wood, soil, steel, piping, and lead. These materials have been packaged for shipment and disposal during FY02 to Envirocare.

[1] This volume includes waste from the "BGRR Remaining Soils Removal AOC 9C" Work Package 147, and will be adjusted using the Baseline Change Procedure to reflect the volumes associated with the appropriate Work Package.

[2] Storage on the BNL site will be maintained in compliance with the requirements stated in the Standards-based Management System subject area.

5.0 LESSONS LEARNED

5.1 Administrative

The following lessons were learned during this project:

- The need for consistent and clear communication throughout all levels of the project.

- The need for consistent and clear communication with occupants of nearby facilities. When physical work is planned, it is essential to communicate the work planned, its expected duration, and the increased traffic near the facility.

- A poor project baseline results in significant cost and schedule variances. Poor estimates regarding such parameters as resource needs and schedule durations, will lead to poor performance reported through cost and schedule variances.

- Following basic project management principles – such as the timely processing of baseline changes, as warranted, and ensuring work is charged to the applicable work package – can minimize such variances.

5.2 Characterization

- A thorough understanding of, and accounting for, operational history might have aided in identifying issues associated with the Canal. For example, if it had been known that the Canal leaked at the floor-to-wall joint, then identification of the leak paths at this joint might have been pursued.

- A better understanding of the operational history of the Water Treatment House and prior knowledge regarding flooding of the floor space may have aided in identifying whether contaminated water could have contaminated the adjacent vertical wall of the north Canal Walkway.

- Identification of specific cleanup criteria and remediation methodology are required in work plans to completely scope, schedule, and cost-out a project. In this example, the Canal EE/CA stated that contaminated systems would be removed or remediated, but neither the EE/CA nor the Technical Work Document list the Walkway drain lines as part of the work scope. This work should have been identified.

5.3 Waste Management

- Close coordination with the Waste Management Division for the timely processing, characterization, and proper inventory management of the waste being generated is essential to minimize the schedule and costs of the project.

- A detailed waste-specific Waste Management Quality Plan and waste profiles are key elements in the project's overall success and must be developed before starting physical work.

6.0 REFERENCES

1. Brookhaven National Laboratory, "Brookhaven Graphite Research Reactor Decommissioning Project Lower Canal and Water Treatment House, Equipment, and Associated Soils Engineering Evaluation/Cost Analysis," BGRR-033, August 15, 2001.

2. Federal Facility Agreement under CERCLA Section 120, Administrative Docket Number II-CERCLA-FFA-00201, United States Environmental Protection Agency, Region II, United States Department of Energy, and the New York State Department of Environmental Conservation. In the matter of the U.S. Department of Energy's Brookhaven National Laboratory, 1992.

3. Brookhaven National Laboratory, "Brookhaven Graphite Research Reactor Decommissioning Project Removal Action Alternatives Study," BGRR-015, Rev. 0, April 13, 2000.

4. Brookhaven National Laboratory, "Brookhaven Graphite Research Reactor, Sampling and Analysis Plan for the Canal and Water Treatment Houses, Equipment, and Associated Soils," BGRR-027, Rev. 0, August 1, 200 (amended by modification BGRR-027-01, February 2, 2001).

APPENDIX 1

DOE/BHG AUTHORIZATION TO PROCEED WITH REMOVAL OF THE CANAL AND WATER TREATMENT HOUSE STRUCTURES

APPENDIX 2

APPROVAL OF TIME-CRITICAL AND NON-TIME-CRITICAL ACTION MEMORANDUMS FOR REMOVAL OF THE CANAL AND WATER TREATMENT HOUSE STRUCTURES AND REMEDIATION OF THE CANAL AND ASSOCIATED SOILS

APPENDIX 3

COMMUNITY RELATIONS

In addition to the required public notices, the BGRR Decommissioning project involved its neighbors and stakeholders in planning and implementing EE/CA Alternative 2 for the Canal. This Appendix captures some of the methods used to present the progress of that project.

The BGRR Decommissioning project hosted two informal public meetings on August 28 and September 18, 2001 to discuss the Canal EE/CA with interested stakeholders. In addition to continuous dialogue with the BGRR Working Group, the EE/CA was also discussed with the Brookhaven Executive Roundtable (September 19, 2001) and the Community Advisory Council (October 11, 2001).

APPENDIX 4

NESHAPS EVALUATION

APPENDIX 5

APPROVAL OF UNREVIEWED SAFETY ISSUE DETERMINATION / SAFETY EVALUATION (USID) FOR THE ABOVE GROUND CANAL AND WATER TREATMENT HOUSE REMOVAL AT THE BROOKHAVEN RESEARCH REACTOR DECOMMISSIONING PROJECT

APPENDIX 6

PICTORIAL REVIEW OF THE REMOVAL ACTIVITY

REMOVAL OF THE CANAL AND WATER TREATMENT HOUSES

View of the Canal and Water Treatment House and the associated soils area before work began. The Canal House was constructed of a steel frame with "cemestos" siding (a concrete-asbestos containing material) a flat built-up roof, and a cemestos south pad awning. The main floor of the Canal House had a 4-foot by 14-foot opening that was used to raise and lower equipment and wastes from the Canal area (approximately 9 feet below grade level elevation of 109 feet).

The Water Treatment House was an addition to the Canal House and was connected to the north wall of the Canal structure. It was constructed of concrete blocks, with a built-up roof and its foundation was a slab of concrete.

A concrete pad area extended around the Canal and Water Treatment structures. It was covered with a heavy plastic membrane and filled with crushed stone. A layer of asphalt was placed over the stone to control drainage for the area.

The first step of the plan taken to remove the Canal and Water Treatment House structures and equipment was to apply a fixative to the interior walls, floors, and ceilings to fix all loose surface contamination. The next was to remove the awning and its framework, the exterior structural steel, and monorail crane. A large tent with two personnel doors and a door large enough to mobilize equipment was erected over the Canal and Water Treatment structures. A high efficiency/particulate filter system was installed to maintain a slightly negative pressure on the tent to insure all air leaving the tent was filtered and monitored. The tent acted as a barrier to weather and contamination for the lower Canal area that was exposed when the permanent structure was removed.

Once the structures were removed, a small tent was erected inside the large tent that just covered the Canal area. This reduced the "footprint" to allow removal of the concrete pad area that surrounded the structures

Spots under the asphalt layer of the paved area were known to be contaminated. There were several piping systems below grade that were removed during the execution of the Canal work. Among the items removed were the Canal discharge line, the reactor's pneumatic transfer lines, one section of an existing storm drain that was known to be contaminated, the rod storage vault, and three low-level radioactive waste storage vaults located on the south side of the Canal.

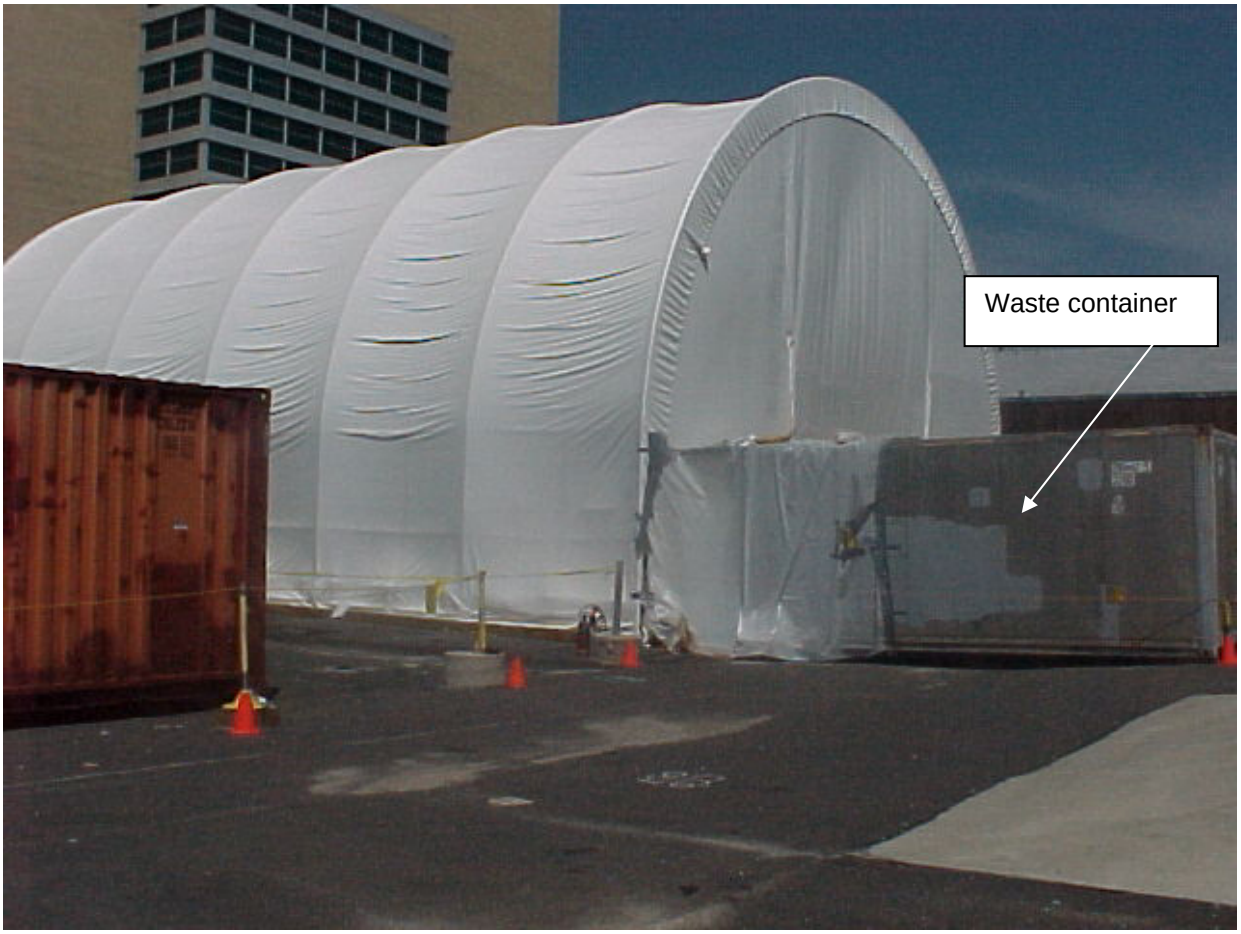
To remove the old storm-drain system the existing storm drains first had to be rerouted and a new system installed.

Asbestos workers on a manlift, removing awning panels. Each panel contained asbestos, requiring piece-by-piece removal, rather than allowing the material to fall and shatter.

Once the asbestos awning panels were removed, a portable crane was used to hold and remove the steel beam frames while they were being disconnected.

Looking northeast from Building 701, the steel awning superstructure being removed from the south side of the Canal House.

Plant Engineering and BGRR Project personnel erected the tent structure. Riggers, crane operators, carpenters, health-physics personnel, and D&D workers were involved.



The tent provided the necessary containment and confinement for demolishing the Canal and Water Treatment structures. The container attached to the tent is a waste container that was filled with debris and wastes generated during demolition.

The Canal House looking west. The asbestos-containing material siding panels have been removed. The east equipment door of the Canal House is open. A lift, the green piece of equipment, was used to remove the upper siding panels.

This is the first beam of the steel framing of the Canal House staged to be reduced in size for packaging and disposal. The Canal House was disassembled -- rather than demolished -- because demolition would have made control of the hazardous asbestos-containing material siding more difficult. The asbestos would have become friable, requiring workers to take additional precautions.

The Water Treatment House looking east with the concrete roof panels partially removed. The Canal House has been removed; it used to be on the right side of the picture. Green paint was used to demarcate de-energized electrical equipment that was removed from the wall.

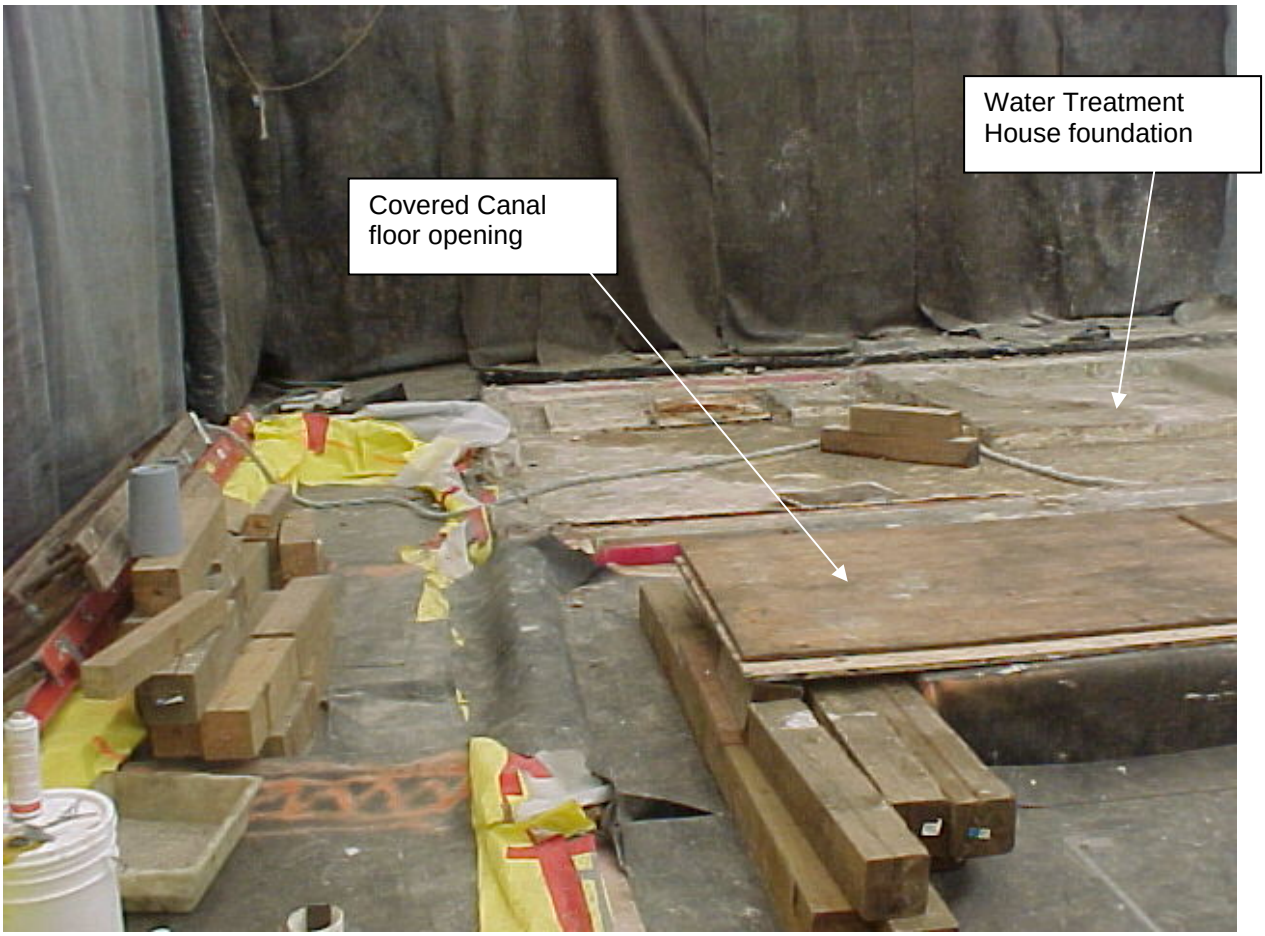
Asbestos-containing roof slabs were packaged for disposal.

The partially demolished Water Treatment House's wall, the last section of the concrete structure to be taken down.

A small portion of the debris from the wreckage of the Water Treatment House. Such material was loaded into B-52 containers for disposal at a licensed offsite facility.

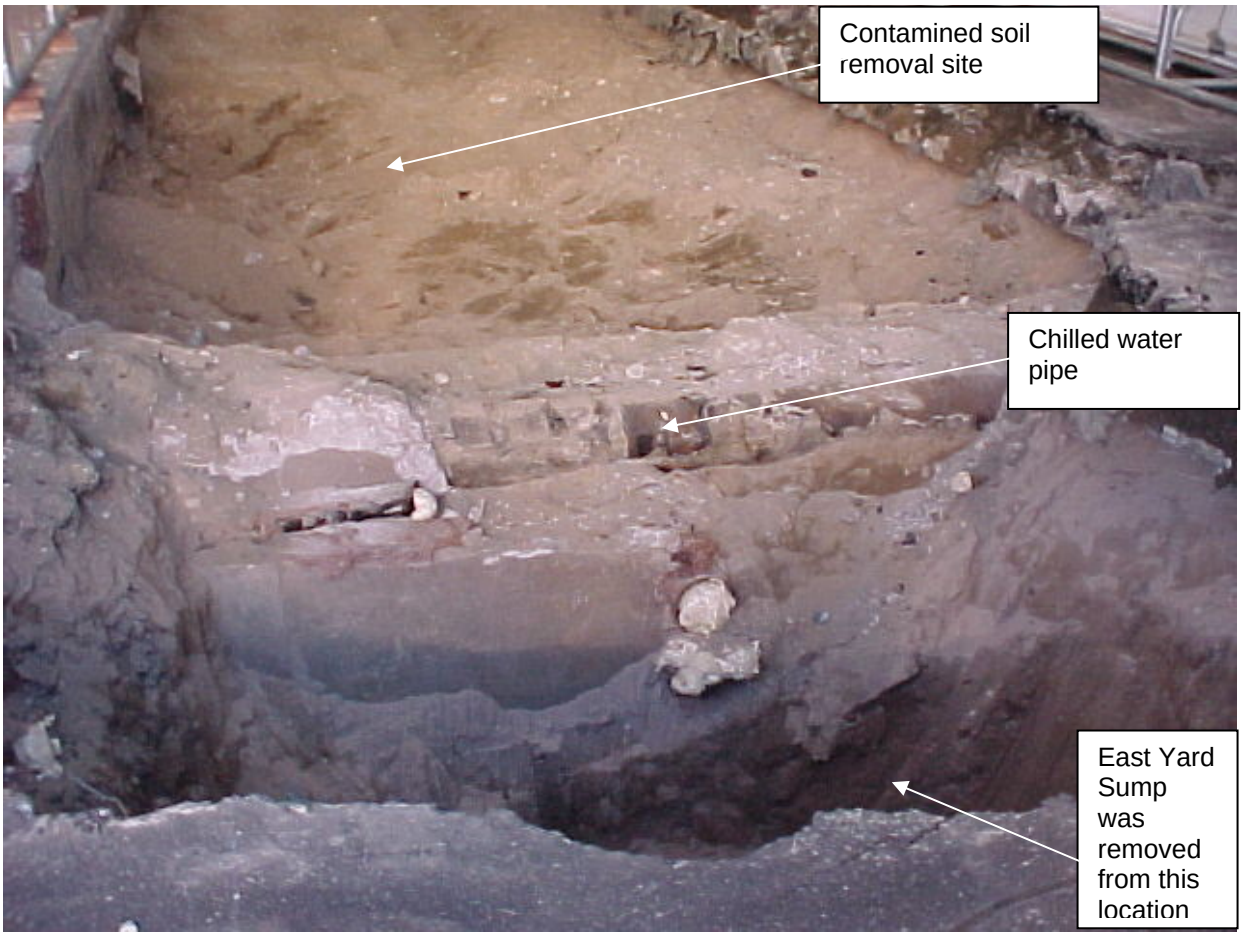
Workers wore protective clothing, respirators, and safety equipment during the destruction of the Water Treatment House. The dark material was hung from the back side of the tent to protect its fabric from being torn or compromised when the Water Treatment House's concrete walls were destroyed.

B-52 box filled with concrete debris from demolishing of the Water Treatment House.



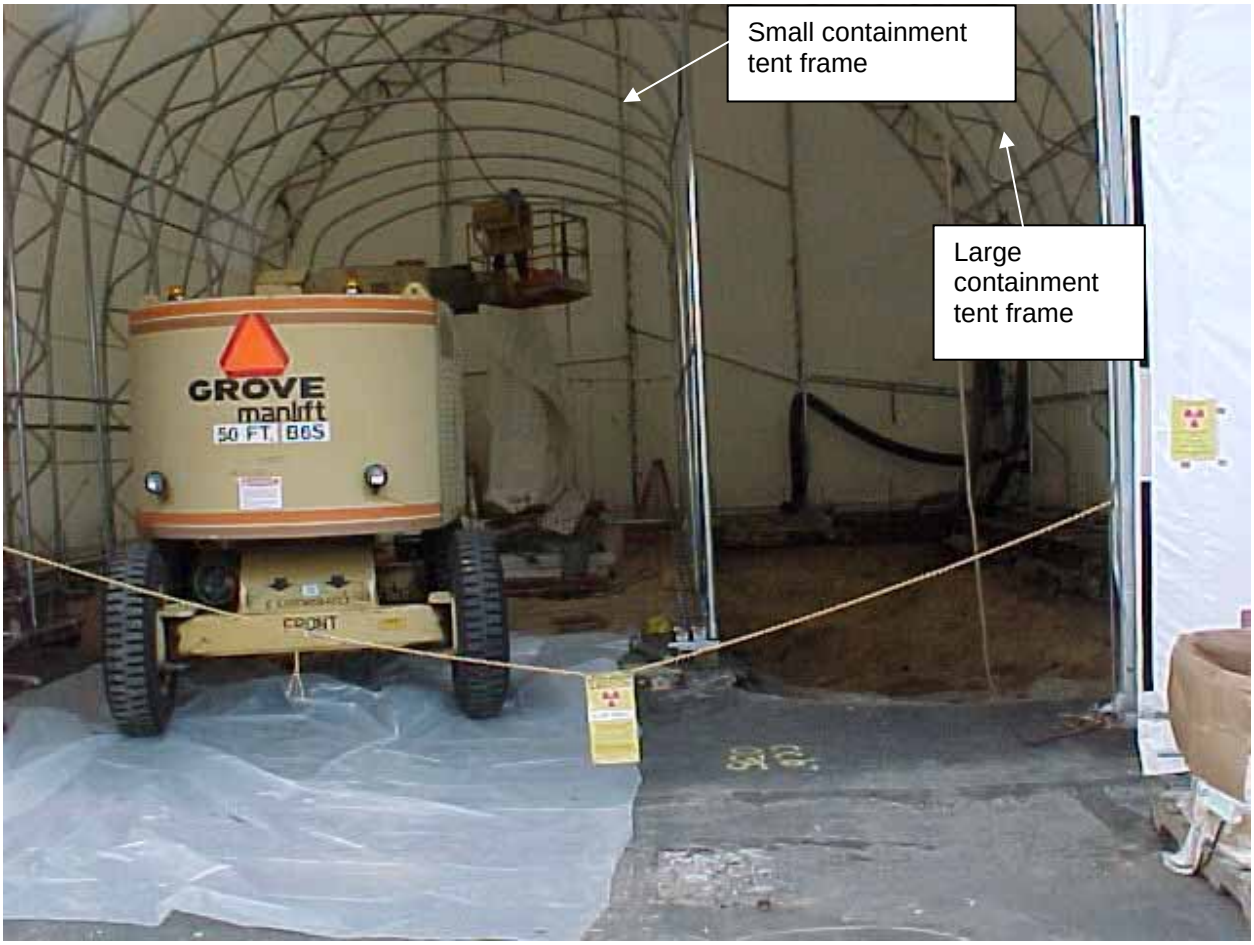
The northwest section of the large tent. All that remained in the tent were the Canal floor openings to the lower Canal, and the concrete slab that was the foundation of the Water Treatment House.

The Water Treatment House's floor drain system looking west, towards Building 701. Just west of the first drain, the pipe leaked water contaminated with Cs-137 and Sr-90 to the soil.



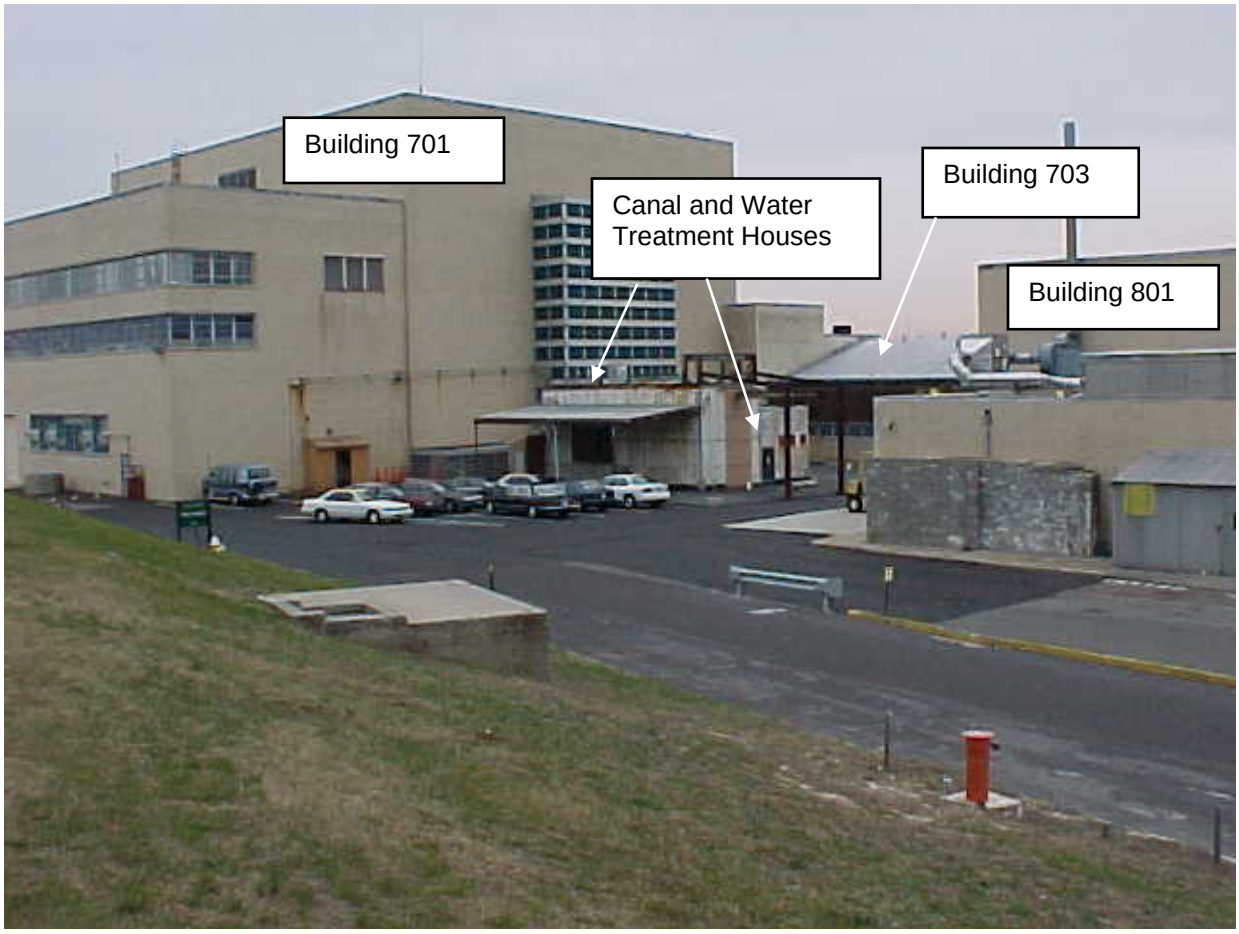
The Water Treatment House's foundation area looking west toward Building 701. The contaminated soil below the floor drains was carted away for disposal. The two large pipes are abandoned chill-water pipes that were removed. The East Yard Sump was removed from the hole at the bottom of the picture, to the east of the chilled-water piping.

A portable 70-ton crane was used to move the East Yard Sump and place it into a disposal container.



Once the debris and rubble were removed from the containment tent, the equipment door at the east end of the large tent could be opened for the next step in decommissioning. The small tent that was used to cover the Canal area and the openings to the lower Canal was erected using a manlift inside the large tent. The large tent was then decontaminated and surveyed by Health Physics technicians for release from the radioactive material control area. After the small tent was erected, the large tent then could be disassembled.

REMAINING SOILS AREA REMOVAL



Looking northwest toward Building 708 and the Canal and Water Treatment Houses. The area to their south contained spill sites and below-grade piping that had to be removed before to work began. Normal Laboratory operations had to continue in Buildings 703 and 801 while the excavation proceeded.

Photo taken from the southeast corner of Building 701 shows the beginning of the excavation of the asphalt and soils on the south side of the Canal area.

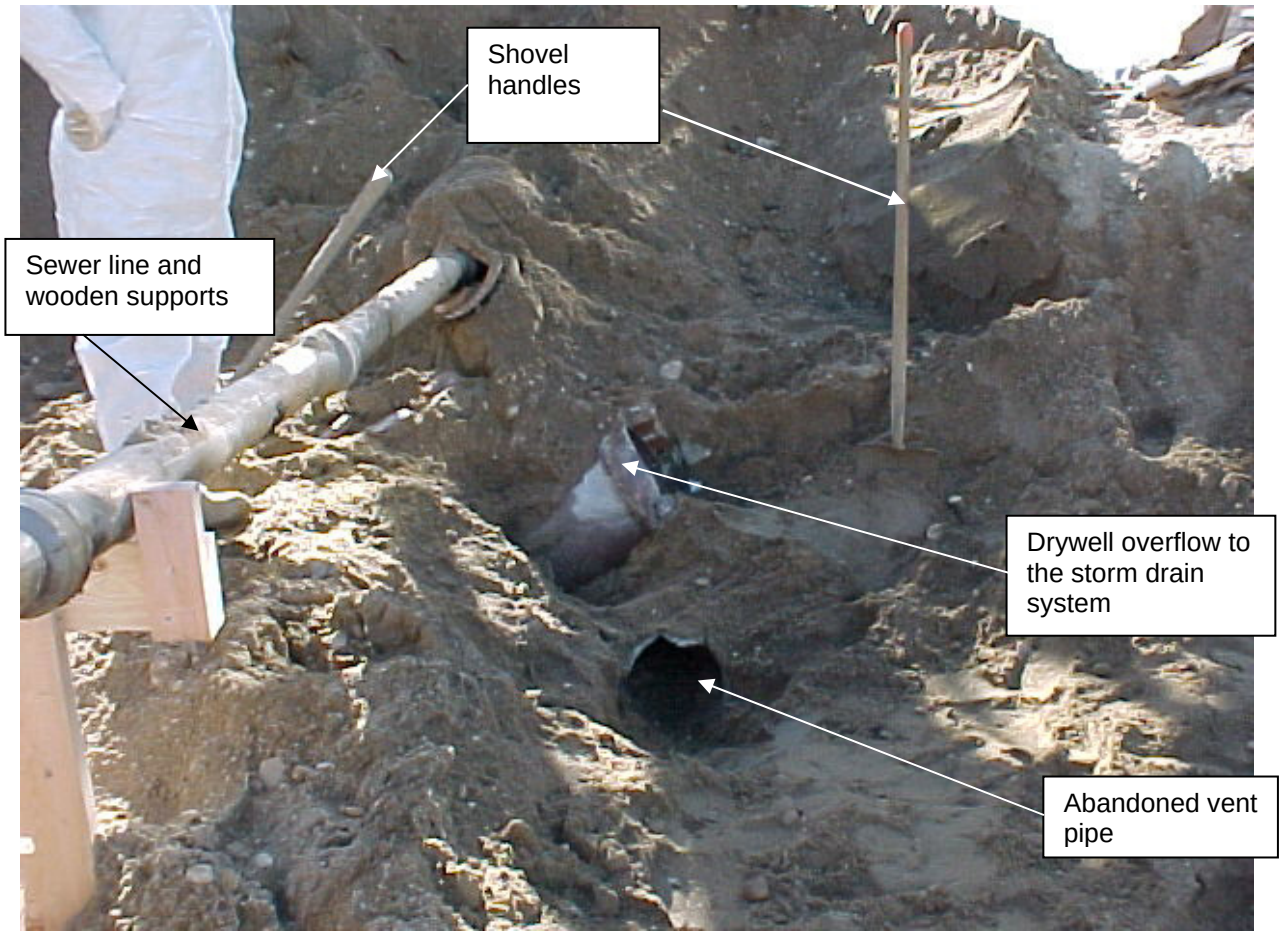
Excavation of the reactor's pneumatic transfer lines. As lines were being dug out, an unexpected shielded area of the piping was encountered where the lines turn north toward Building 703. Approximately 200 lead bricks, each approximately 2" by 4" by 8" and weighing 28 pounds, were removed from the area, along with the concrete blocks that formed the shielded cave. These lead bricks required special handling for waste disposal. Building 703 is at the top of the picture.

The pneumatic transfer lines at the Building 703 wall. There are four copper pipes, approximately 1 1/2" in diameter within the larger 6" cement line. One of the smaller lines has been cut; the other small line shows discoloration from the previous cutting process.

When removing the asphalt along the south side of Building 703, a pocket of contaminated soils was found extending under the overhang of the buildings basement wall. The contaminated soils were removed and the area verified clean through sampling and field-laboratory analysis.

The excavation continued east of Building 703 and became much deeper to uncover the Canal's discharge line that ran east into the piping trench extending from Building 801 to Building 811. The discharge line in this area was approximately 12 feet below-grade.

The Canal discharge line was removed in sections suitable for packaging. The covered sections of line were placed into disposal containers. The exteriors of the pipes were not contaminated.



The excavation of the Canal discharge line from the east side of Building 703 westward toward the Canal. This was a very congested location. A storm-drain catch-basin turned out to be a drywell, located just to the right of the overflow pipe. The drywell was excavated and the contaminated soils below it were removed. The EPA and Suffolk County Department of Health Services (SCDHS) were notified. SCDHS field-personnel witnessed the follow-up soil sampling.

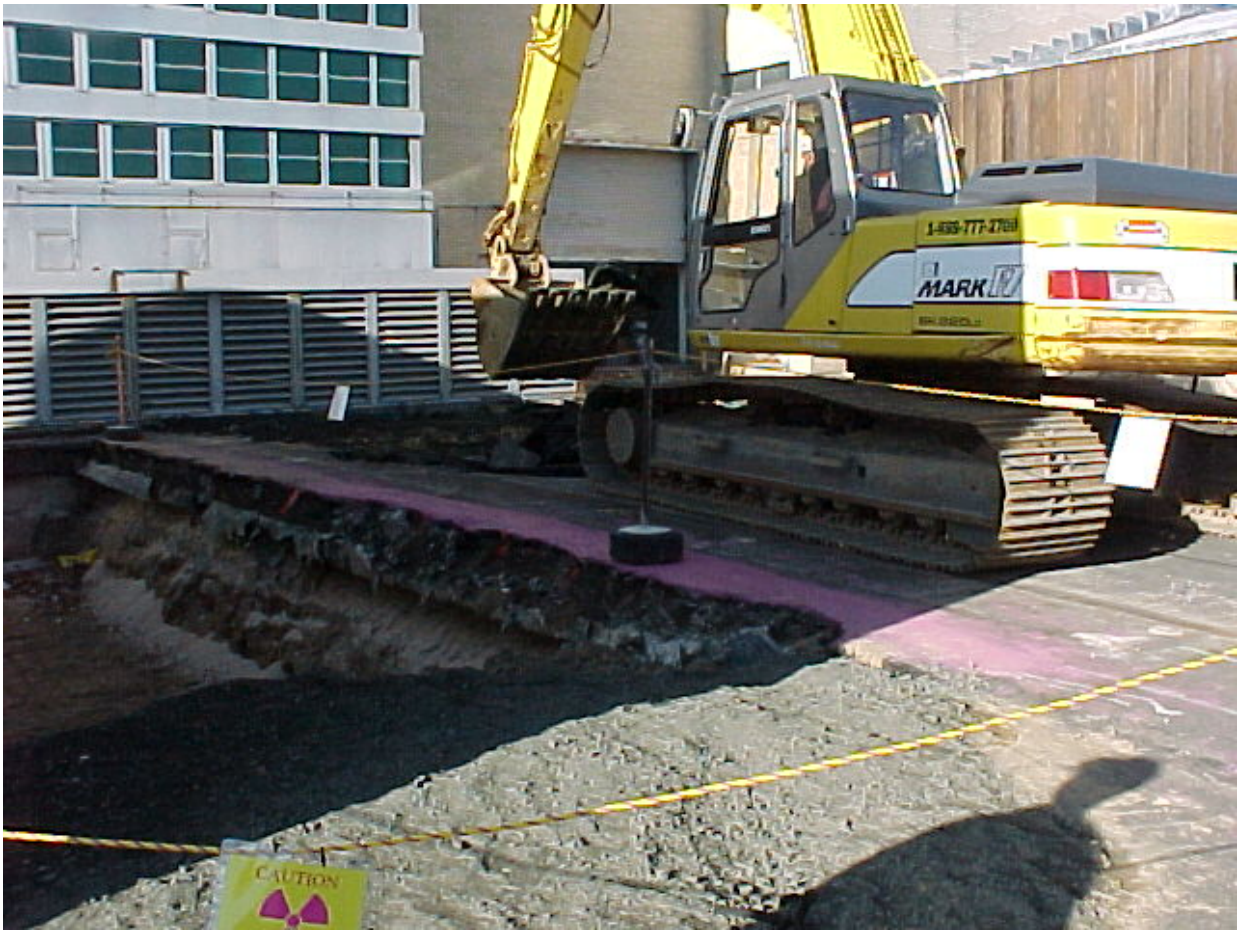
Two storm-drain catch basins were opened downstream of this contaminated drywell to sample for contamination. There was no contamination of the soil nor the two storm-drain catch basins downstream. The lowest opening is an abandoned vent line that was removed in the area of the Canal discharge line removal. The inclined tile line above the vent line was the overflow from the drywell to the storm drain system. The support line is a sewer line from Building 703 that connects to the eastward sewer catch basin.

The sewer line was supported during the excavation for the deeper Canal discharge line. It had to be removed and replaced because it was close to the discharge line. The sewer line is a cooling-water discharge line from a laser device in Building 703. The Laser was not used for approximately two weeks to give the project enough time to remove the sewer line and gain access to the Canal discharge line. Once the Canal discharge line was taken out, the sewer line was replaced and the laser could be operated again.

Once the area was cleared, the storm drain piping had to be replaced. The water in the trench is clean storm-drain water (rainwater run-off).

Looking west along the north side of the tent with Building 701's primary cooling air intake louvers at the top of the picture. The Water Treatment House has been removed, and the concrete on the left is the Canal's north wall, which is supporting the tent. The asphalt and concrete on the right side is the north pad of the Canal.

Here, contaminated soil extended below the foundation of the Water Treatment House's concrete slab floor. Apparently during operation, one of the floor drain lines leaked allowing contaminated water into the soil. The contaminated materials in this area could not be removed until the large tent that covered the Canal and Water Treatment House's was dismantled.



The excavator begins to remove the materials from the Canal's north pad.

Fill being placed into the area to allow vehicles' access to the west truck-bay door of Building 801 so as not to affect Laboratory operations in that building.

Looking east, of the abandoned chilled-water and air lines are moved from the new storm drain trench. Workers were protective clothing and respirators due to the pipes' asbestos coating and the potential for the piping to be internally contaminated. One of the new storm drain catch basins has been installed near the bottom of the picture.

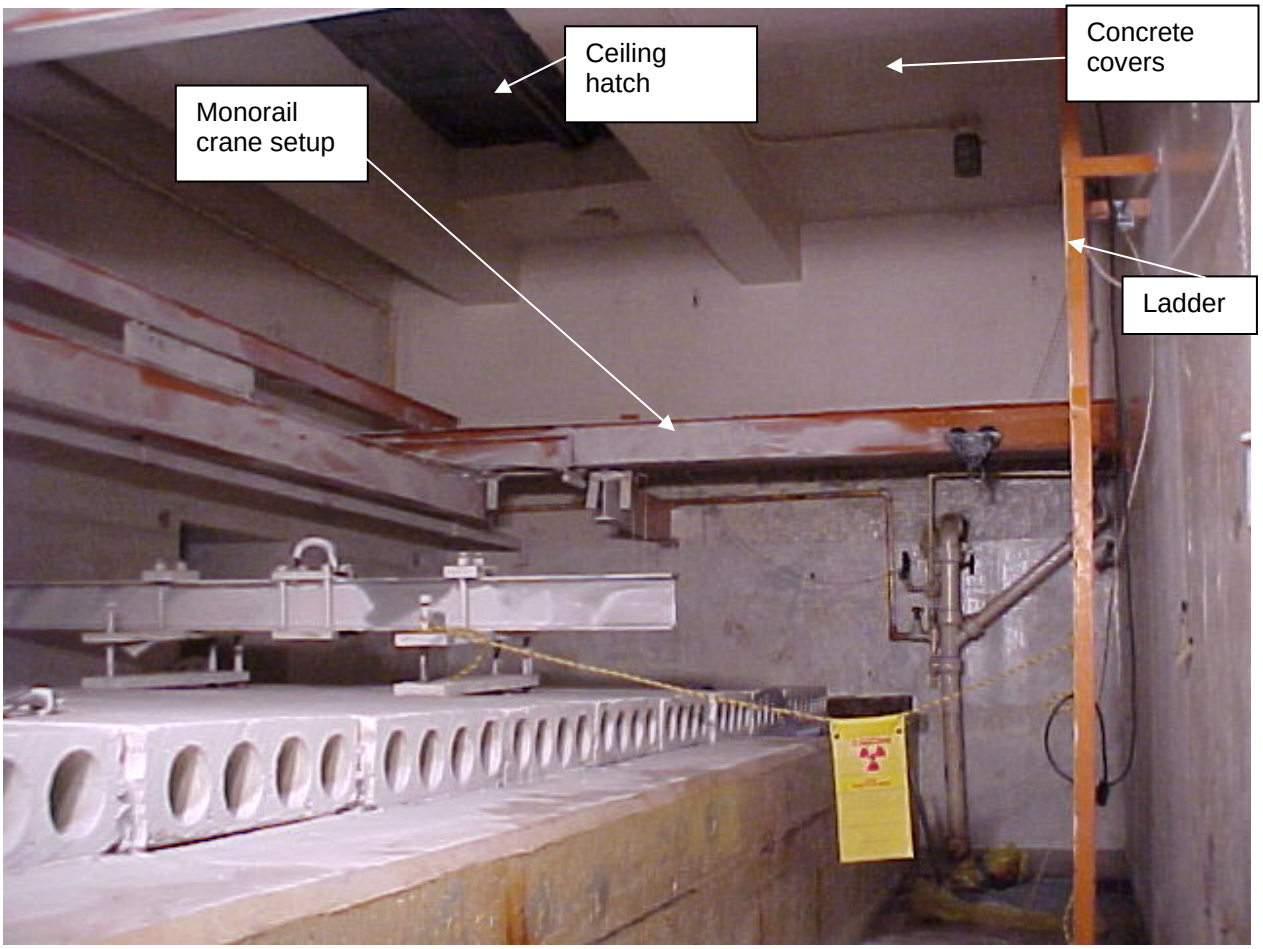
Back fill of the area near the south side of the large tent. A lift then was placed in this area to assist in the disassembling of the large tent.

Installation of the new storm drain piping system. When this is completed, the storm drains will be connected to the new system. After of the new concrete storm-drain catch basin is finally in place, near the center of the picture, it will catch the surface rainwater run-off. This picture was taken from Building 701looking east; the corner of Building 801 is visible in the back left.

LOWER CANAL WORK ACTIVITIES

The remaining Canal floor after removing the removal of the Canal and Water Treatment building structures. The small tent covers the "footprint" of the Canal's main floor-area. The equipment hatch is open and is surrounded by yellow railings to warn workers that the hatch to the lower Canal is open. Workers are installing the vent line connection through the wall of the tent to the HEPA-ventilation exhaust system outside. The system maintained a negative pressure in the tent to ensure the air exhausting from the tent was filtered.

Before work could begin in the lower Canal, below the surface in the photo above, the peeling paint had to be scraped from all surfaces of the Canal and Canal area. Then Health Physics technicians performed operational surveys. Following this, in any areas where loose surface-contamination was identified at levels up to 1,000,000 disintegrations per minute per 100 square centimeters, a fixative was applied to prevent its spread.



The east end of the lower Canal area. The ceiling contained the equipment hatch to the main floor of the Canal area; The ladder gave personnel access to and from the main floor. The concrete covers were still in place. The orange steel-framing was the monorail crane setup in the lower Canal area that to moved equipment and material from the deep pit on the west end of the Canal into and along it.

The Canal walkway looking west from the personnel ladder. The concrete covers have been removed from the Canal, and a fixative applied to the area to prevent the spread of loose surface-contamination.

This area was scabbled using hand-held and machine-mounted scarifiers and scabblers. This equipment was attached to a super-vacuum to reduce the amount of dust released and to remove the surface materials loosened by the scabblers into a waste container for disposal. Over 3,000 square feet of surface area had to be decontaminated. The packages on the left side are sample packages. The HEPA vacuum on the walkway was used to vacuum debris from scraping the walls to remove peeling paint. The wooden beam is wrapped in plastic to prevent its contaminating. Hoses used in the Canal were hung from it.

One of the Canal's three floor low-point drain sumps. A flashlight supplied the source of light for this picture; hence, the odd glow in the bottom of the sump. Note the paint peeling from the surrounding floor surfaces. The sumps were removed.

Characterization of the Canal and the soils below it required taking concrete core bores through the Canal floor at many locations. This shows a six-inch diameter core bore near one of the floor drain sumps. The concrete in this section is 2 feet thick.

Following the initial core bores, more fixative was applied to the Canal area. This picture was taken from the Canal floor looking west. The small diesel-engine-driven Geoprobe, weighing 2,500 pounds, was lowered 18 feet from grade level to the floor of the 9-foot-deep Canal. The Geoprobe to extracted soil samples to ground water for characterization. The Canal's walls are 9 feet high and its floor is 6 feet wide. The concrete covers that sealed the top of the Canal were removed to provide access.

Initially, the Canal walkway was scabbled using a walk-behind floor scarifier. This removed contamination that was bound in the several layers of paint fixative. Additionally, a layer of epoxy was removed from the roughened concrete floor. The hose in this picture is attached to the scarifying equipment and to the super vacuum. The corners and walls surfaces were decontaminated next.

Workers using hand held scabbling equipment to clean the walls of the Canal's walkway. The workers wear protective clothing and use respirators.

A worker is using an electric chipping hammer to remove the contamination from the corners where the walls and floor meet.

The Canal area construction joint following its decontamination. The joint runs along the Canal Walkway's floor.

APPENDIX 7

INDEPENDENT VERIFICATION CONTRACTOR (ORISE) SAMPLING AND ANALYSES RESULTS

APPENDIX 8

INDEPENDENT OFF-SITE LABORATORY RESULTS FOR FINAL STATUS SURVEY

(This activity has not been performed pending the final Record of Decision for the entire BGRR Project)

APPENDIX 9

NYSDEC INDEPENDENT RADIOLOGICAL VERIFICATION RESULTS

(This activity has not been performed pending the final Record of Decision for the entire BGRR Project)

APPENDIX 10

FIELD LABORATORY GAMMA SPECTROSCOPY AND BETA SCINTILLATION, TABULATED DATA

(This activity has not been performed pending the final Record of Decision for the entire BGRR Project)

APPENDIX 11

EVALUATION RESULTS FOR THE RADIOLOGICAL SUM OF THE FRACTIONS AND SIGNS TEST

(This activity has not been performed pending the final Record of Decision for the entire BGRR Project)