U.S. DEPARTMENT OF ENERGY
BROOKHAVEN NATIONAL LABORATORY
CERCLIS Number NY 7890008975

FINAL RECORD OF DECISION
FOR
AREA OF CONCERN 31
HIGH FLUX BEAM REACTOR

February 2009

Prepared by

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I. DECLARATION OF THE RECORD OF DECISION

SITE NAME AND LOCATION

HIGH FLUX BEAM REACTOR
BROOKHAVEN NATIONAL LABORATORY
UPTON, NEW YORK
CERCLIS Number NY 7890008975

STATEMENT OF BASIS AND PURPOSE

This Record of Decision (ROD) documents the selected remedial action for the High Flux Beam Reactor (HFBR) at the U.S. Department of Energy's (DOE) Brookhaven National Laboratory (BNL) facility in Upton, New York.

The remedial action was selected in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) as amended (hereinafter jointly referred to as CERCLA), and is consistent, to the extent practicable, with the National Oil and Hazardous Substances Pollution Contingency Plan (National Contingency Plan). This decision is based on the documents included in the Administrative Record for the BNL Site.

The State of New York concurs with the selected remedial action.

ASSESSMENT OF THE SITE

Potential releases of hazardous substances from the HFBR complex present a threat to public health, welfare, or the environment if they are not addressed by implementing the remedial action selected in this ROD.

DESCRIPTION OF THE SELECTED REMEDY

The HFBR is Area of Concern (AOC) 31 and comprises of the HFBR complex and the Waste Loading Area. Several alternatives were evaluated for cleanup of the HFBR complex. Based on these evaluations, DOE and EPA selected a cleanup action (called the remedy) summarized below. The public was invited to comment on the proposed remedy as well as on the other alternatives considered.

Based on the evaluation of the alternatives, discussions with the regulatory agencies, and community input, the cleanup alternative that best balances the National Contingency Plan's remedy selection criteria is Phased Decontamination and Dismantlement with Near-Term Control Rod Blade Removal. This alternative is known as Alternative C in the Proposed Remedial Action Plan. This remedy includes all interim actions either completed or ongoing as described in Alternative C.

A number of interim actions have been completed or are currently underway.

Completed activities include the following:

- The HFBR fuel was removed and sent to an off-site facility.
- The primary coolant was drained and sent to an off-site facility.
- Scientific equipment was removed and is being reused.
- Shielding and chemicals were removed and are being reused at BNL and other facilities.
- The cooling tower superstructure was dismantled and disposed.
- The confinement structure and spent fuel canal were modified to meet Suffolk County Article 12 requirements.
- Stack Monitoring Facility (Building 715) was dismantled and disposed.
- Cooling Tower Basin and Pump/Switchgear House (Buildings 707/707A) were dismantled and disposed.
- Water Treatment House (Building 707B) was dismantled and disposed.
- Cold Neutron Facility (Building 751) contaminated systems were removed, the building was decontaminated, and the clean building has been transferred to another organization for re-use.
- Guard house (Building 753) was dismantled and disposed.

Activities currently underway include the following:

- Cleanup of the Waste Loading Area performed as a non-time-critical removal action authorized by the *Action Memorandum, High Flux Beam Reactor, Removal Action for Waste Loading Area* of October 2007
- Removal and disposal of the control rod blades and beam plugs performed as a non-time-critical removal action authorized by the *Action Memorandum, High Flux Beam Reactor, Removal Action for Control Rod Blades and Beam Plugs* of July 2008

Remaining activities included in the selected remedy are as follows:

- Dismantlement and disposal of ancillary buildings, and confirmation and/or cleanup of associated soils
  - Fan house (Building 704) and stack (Building 705)
  - Fan house (for Building 801) and tritium evaporation facility (Building 802)
- Removal of contaminated ducts and underground piping systems including the confirmation and/or cleanup of associated soils and disposal
- Removal and disposal of beam plugs
- Removal and disposal of other activated components:
  - Reactor vessel
  - Reactor internals

  - Thermal shield
  - Biological shield
- Removal and disposal of confinement building (Building 750) including all structures, systems, and components
- Confirmation and/or cleanup of accessible HFBR Complex contaminated soils
- Continued implementation of surveillance and maintenance
  - Periodic physical examination of the confinement building and interior structures, including inspection for water infiltration
  - Routine maintenance of the confinement building, and repair of deficiencies found during confinement building inspections in order to preserve the physical barriers that contain the radioactive materials in the HFBR Complex.
  - Continuation of air effluent monitoring
  - Continuation of groundwater monitoring and other actions in accordance with the Operable Unit (OU) III ROD
  - Periodic reporting to the Environmental Protection Agency (EPA) and the New York State Department of Environmental Conservation (NYSDEC)
- Continued implementation of land use and institutional controls (LUICs)
  - HFBR access control
  - Restrictions on excavation or any other physical activities that could disturb residual contamination at the HFBR Complex
  - Controls to ensure that future land use does not result in potential threats to human health and the environment
  - Periodic certification to NYSDEC

STATUTORY DETERMINATION

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost effective. This remedy uses permanent solutions to the maximum extent practicable for the HFBR Complex. Treatment of contaminated soil was not found to be practicable; therefore, this remedy does not satisfy the statutory preference for treatment as a principal element. However, techniques that minimize waste volumes or further stabilize wastes to meet disposal facility waste acceptance criteria will be factored into the detailed design work plan.

Because this remedy will result in some hazardous substances remaining above levels allowed for unlimited use and unrestricted exposure during the safe storage (decay) period, five-year reviews will be conducted pursuant to CERCLA§121(c) to ensure that the remedy continues to provide adequate protection of human health and the environment.

AUTHORIZING SIGNATURES

3/11/09

Michael C. Moore, Acting Director
Office of Small Sites Projects
Office of Environmental Management
U.S. Department of Energy

Date

4/1/09

Walter E. Mugdan
Director, Emergency & Remedial Response Division
U.S. Environmental Protection Agency – Region 2

Date

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ACM	asbestos-containing material
ALARA	as low as reasonably achievable
Am-241	americium-241
ARARs	applicable or relevant and appropriate requirements
BER	Brookhaven Executive Round Table
BGRR	Brookhaven Graphite Research Reactor
BNL	Brookhaven National Laboratory
BSA	Brookhaven Science Associates
CAC	Community Advisory Council
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
Ci	curies
CNF	Cold Neutron Facility
Co-60	cobalt-60
CRB	control rod blade
Cs-137	cesium-137
DOE	U.S. Department of Energy
dpm	disintegrations per minute
EPA	U.S. Environmental Protection Agency
Eu-154	europium-154
Eu-155	europium-155
Fe-55	iron-55
FHWMF	Former Hazardous Waste Management Facility
FS	feasibility study
ft	feet, foot
FY	Fiscal Year
H-3	tritium
HFBR	High Flux Beam Reactor
HVAC	heating, ventilation, and air conditioning
in.	inch
lb	pounds
LLRW	low-level radioactive waste
LUCMP	Land Use Controls Management Plan
LUIC	land use and institutional controls
MCL	maximum contaminant level
MIT	Massachusetts Institute of Technology
mrem/yr	millirem per year
NA	not applicable
NEPA	National Environmental Policy Act
NESHAP	National Emissions Standards for Hazardous Air Pollutants
Ni-59	nickel-59
Ni-63	nickel-63
NYCRR	New York Codes, Rules, and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OU I	Operable Unit I
OU III	Operable Unit III
ORNL	Oak Ridge National Laboratory
PCB	polychlorinated biphenyls
pCi/gm	pico curies per gram
RAO	remedial action objectives
RCRA	Resource Conservation and Recovery Act
RDIP	Remedial Design Implementation Plan
rem	Roentgen equivalent man
ROD	Record of Decision
S&M	surveillance and maintenance
SCDHS	Suffolk County Department of Health Services
SHPO	State Historic Preservation Officer
Sr-90	strontium-90
SRS	Savannah River Site
U.S.C.	United States Code
WLA	Waste Loading Area
yd^3	cubic yards

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II DECISION SUMMARY

1.0 SITE NAME, LOCATION, AND DESCRIPTION

BNL is owned by the U.S. Department of Energy (DOE), one of the 17 DOE national laboratories. BNL conducts research in the physical, biomedical, and environmental sciences, as well as in energy technologies and national security. The Laboratory also builds and operates major scientific facilities available to university, industry, and government researchers.

BNL is located in Suffolk County on Long Island, about 60 miles east of New York City (Figure 1.1). Approximately 1.4 million people reside in Suffolk County and approximately 450,000 reside in Brookhaven Township, within which BNL is situated. The BNL site covers almost 5,300 acres, much of which is wooded. BNL has operated since 1947 as a research facility for national science and technology programs, and is expected to continue this mission for the foreseeable future.

Most BNL facilities are located near the center of the site in a developed portion that covers about 1,700 acres. The HFBR Complex is within this central portion (Figure 1.2) of the BNL property. The complex covers about 13 acres, which is less than one-hundredth of the overall BNL site.

The HFBR Complex consists of multiple structures and systems that were necessary to operate and maintain the reactor (Figure 1.3). Portions of the HFBR Complex structures, systems, and components, some of which are underground, are contaminated with radionuclides and chemicals as a result of previous HFBR and Brookhaven Graphite Research Reactor (BGRR) operations.

The most recognizable feature of the HFBR is the hemispherical dome, which is the superstructure of the confinement building (Building 750). This structure is formed of welded steel plates supported on an integral I-beam framework resting on a cylindrical base. The steel plates in the hemispherical section are 0.250 in. thick, and those in the cylindrical base are 0.375 in. thick. The hemispherical portion of the dome is insulated on the outside, and the insulation is covered with aluminum sheets. The inside diameter of the hemisphere at its base is 176 ft 8 in. The cylindrical base is 22 ft 4 in. high and rests on a bedplate that is bolted to the reinforced concrete foundation ring. The foundation of the confinement building is a 5-ft thick reinforced concrete mat bearing on the soil beneath the building.

Access to the confinement building is provided by four airlocks: a personnel airlock (3 ft 3 in. by 7 ft by 9 ft) located between the equipment and experimental levels on the south side of the building; a forklift airlock (6 ft by 8 ft 9 in. by 18 ft) located on the north side of the experimental level; and two tractor trailer airlocks (12 ft by 14 ft by 65 ft), one entering on the north side of the experimental level and the other on the east side of the equipment level. The interior of the confinement building (Figure 1.4) contains the reactor and biological shield and is further divided into equipment, experimental, balcony, and operations levels.

Reactor and Biological Shield - The HFBR core consisted of 28 individual fuel assemblies arranged in a close-packed array (Figure 1.5). The fuel material was highly enriched (93 percent) uranium alloyed in aluminum and clad with aluminum in curved plates. Heavy water (D_2O) served as the moderator/reflector and primary coolant. The reactor vessel was fabricated from a 6061-T6 aluminum alloy and contained the active core, reflector, and control rods. The enclosed volume provided space and access for 16 experimental facilities which utilized the high neutron flux in the core region. The vessel consists of an 82 in. (inside diameter) spherical section welded via a transition piece to a 46 in. (inside diameter) cylinder. The overall height of the vessel assembly is 24.75 ft. The nine horizontal beam reentry tubes are integral parts of the vessel's spherical section.

There are 16 control rod blades (CRBs) within the reactor vessel, separated into main and auxiliary groups, each containing eight CRBs. The CRBs operated in the reflector region just outside the core. The CRBs are angle-shaped in cross-section, and are made of stainless steel, encapsulating europium oxide (Eu_2O_3) and dysprosium oxide (Dy_2O_3), both neutron absorbers.

A 9 in. thick thermal shield surrounds the reactor vessel. The thermal shield consists of a carbon steel shell lined with lead. Surrounding both the reactor vessel and the thermal shield is an 8 ft thick biological shield (Figure 1.6). It consists of an inner and outer steel shell filled with high-density concrete, which also serves as an essential component of the structural integrity of the confinement building. The biological shield supports the center of the operations level above.

Equipment Level - The equipment level is located at an elevation of 93 ft above sea level. It houses most of the reactor and building support equipment such as pumps, heat exchangers, filters, wastewater storage tanks, and piping networks. Shielded cells for the primary cooling water system pumps and heat exchangers are located in the center of the level. The spent fuel cooling and storage canal (also referred to as the spent fuel canal) is located to the east of the shielded cells. The canal is 8 ft wide, 43 ft long, and 20 ft deep for most of its length. A small bay, 8 ft by 10 ft, is located on the north side of the canal and was used primarily for cutting operations to remove the aluminum transition pieces from the spent fuel elements. At the west end of the canal, a 30 ft deep section is located immediately below the fuel discharge chute. The primary coolant purification system and one of its two D_2O storage tanks are installed in pits below the floor in the northeast quadrant. Along the south wall are three cells partitioned from the rest of the level by a confinement wall. These are the transformer room, blower room, and generator room. Each of these rooms has access from outside the building.

Experimental Level - The experimental level, located at an elevation of 113 ft 6 in., was for scientific users. The reactor biological shield which surrounds the reactor occupies the central portion of this level. The large open space surrounding the biological shield housed the substantial amounts of equipment used in the conduct of external neutron beam experiments. Laboratories and offices are located along the perimeter wall of this level.

Balcony - The balcony, located at an elevation of 128 ft 6 in., is approximately 21 ft wide, with its outer circumference at the confinement shell. Offices, locker rooms, toilets, and HVAC equipment are contained on this level. Two 30-in. diameter duct penetrations that provide fresh air intake are also located on the balcony.

Operations Level- The operations level is located at an elevation of 141 ft 6 in. The reactor biological shielding structure, which begins on the experimental level, rises to 7.5 ft above the operations level at the center of the building. The southwest quadrant of this level contains a steel building that houses pumps, a heat exchanger, and piping associated with the cooling water system for the experimental facilities. The second of the two D_2O storage tanks is also located in this area. Offices and workrooms are located on the east side of this level, with the reactor control room occupying the second story above the offices. A two-story cinderblock structure containing the instrument shop and offices is located on the west side of this level.

Ancillary buildings and services – The HFBR Complex includes several ancillary structures and underground duct and piping systems as shown in Figure 1.3 and 5.6. These facilities include:

- **Building 704 – Fan House**: This facility was initially constructed to provide primary and secondary cooling air for the BGRR. It encloses the BGRR discharge plenum. The building houses the electrical switchgear and the normal and emergency power batteries for the HFBR. This switchgear also provides normal power to Building 703 and in turn to Building 701. It also provides the pathway for the HFBR Building 750 exhaust through underground ductwork and filter banks.
- **Building 705 – Stack**: The 100-meter tall stack was initially constructed to provide an elevated exhaust of the BGRR primary and secondary cooling air. Subsequently, additional building exhausts were connected to the stack. They include multiple exhausts streams from Buildings 801, 815, 830, 901 and the HFBR confinement building (Building 750).
- **Building 802 – Fan House**: This structure houses the fans and equipment that provided the building exhaust flow for Buildings 801, 815, and 830. It also housed the equipment for evaporation of low-level tritiated water.

In addition to the exhaust ductwork connecting the buildings described above, there is a lined liquid waste pipe (D/F waste line) that transported contaminated liquids from the HFBR to Building 801.

Figure 1.1 BNL in relation to Long Island, New York

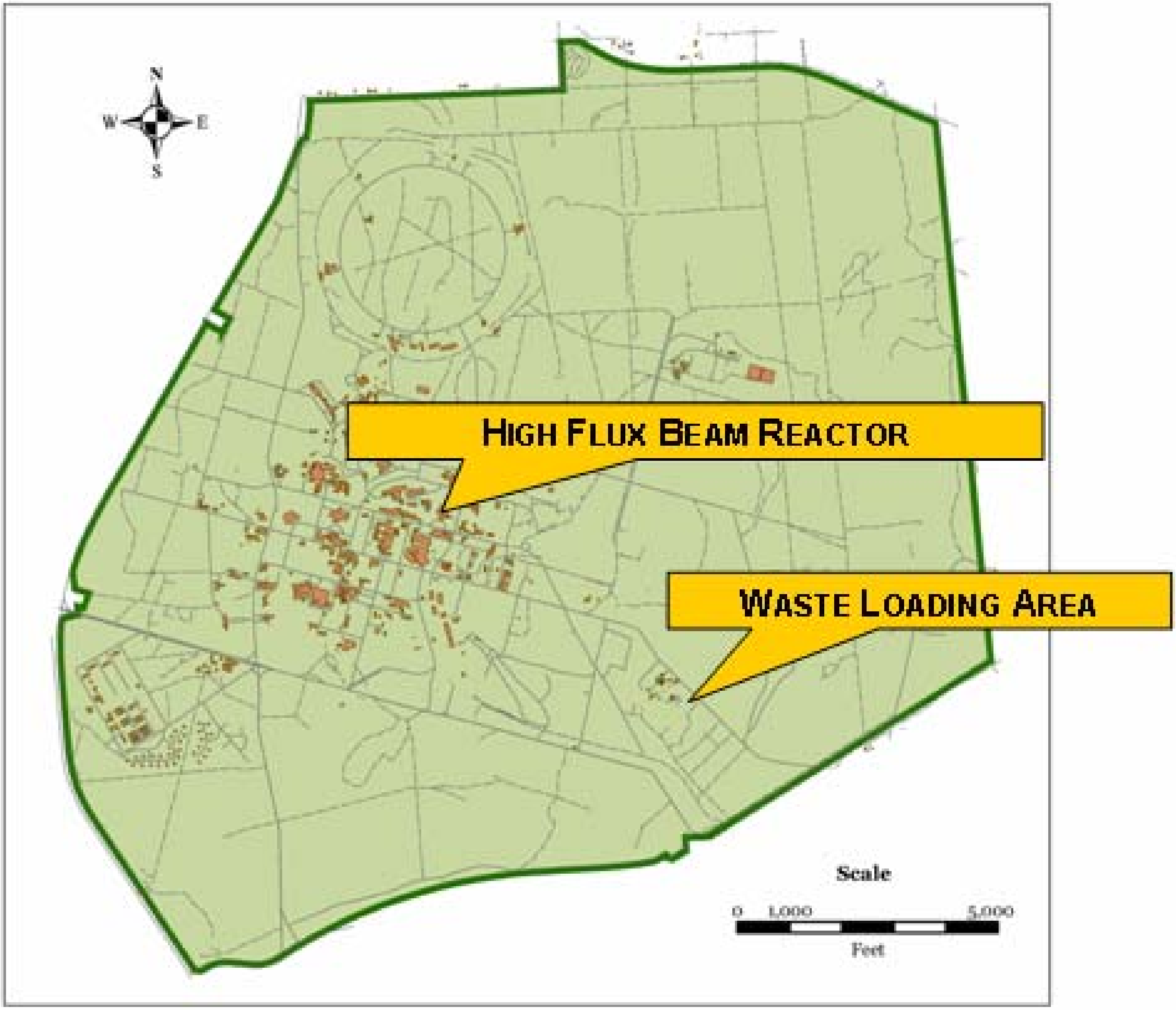

Figure 1.2 HFBR in Relation to BNL Property

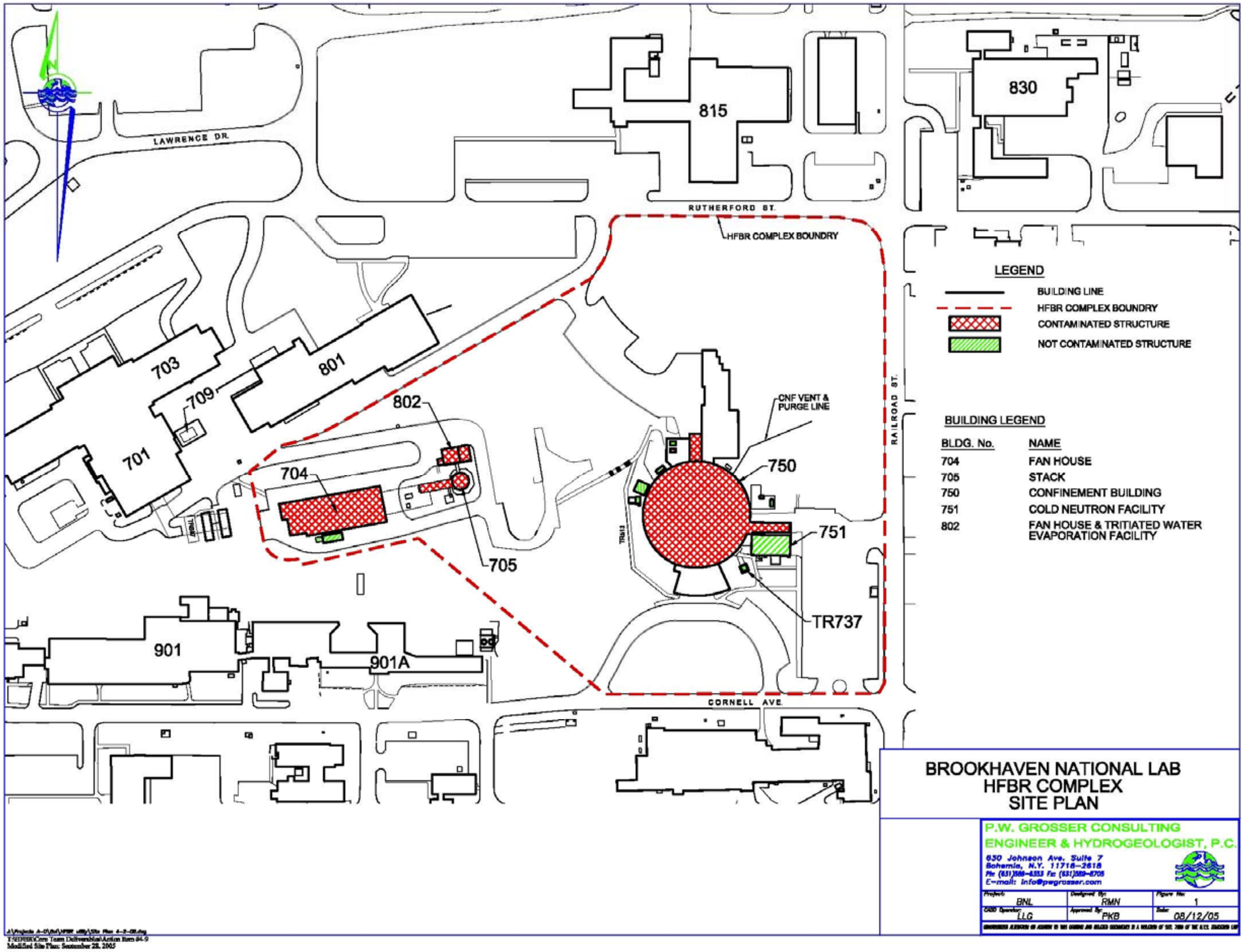

Figure 1.3 HFBR Complex

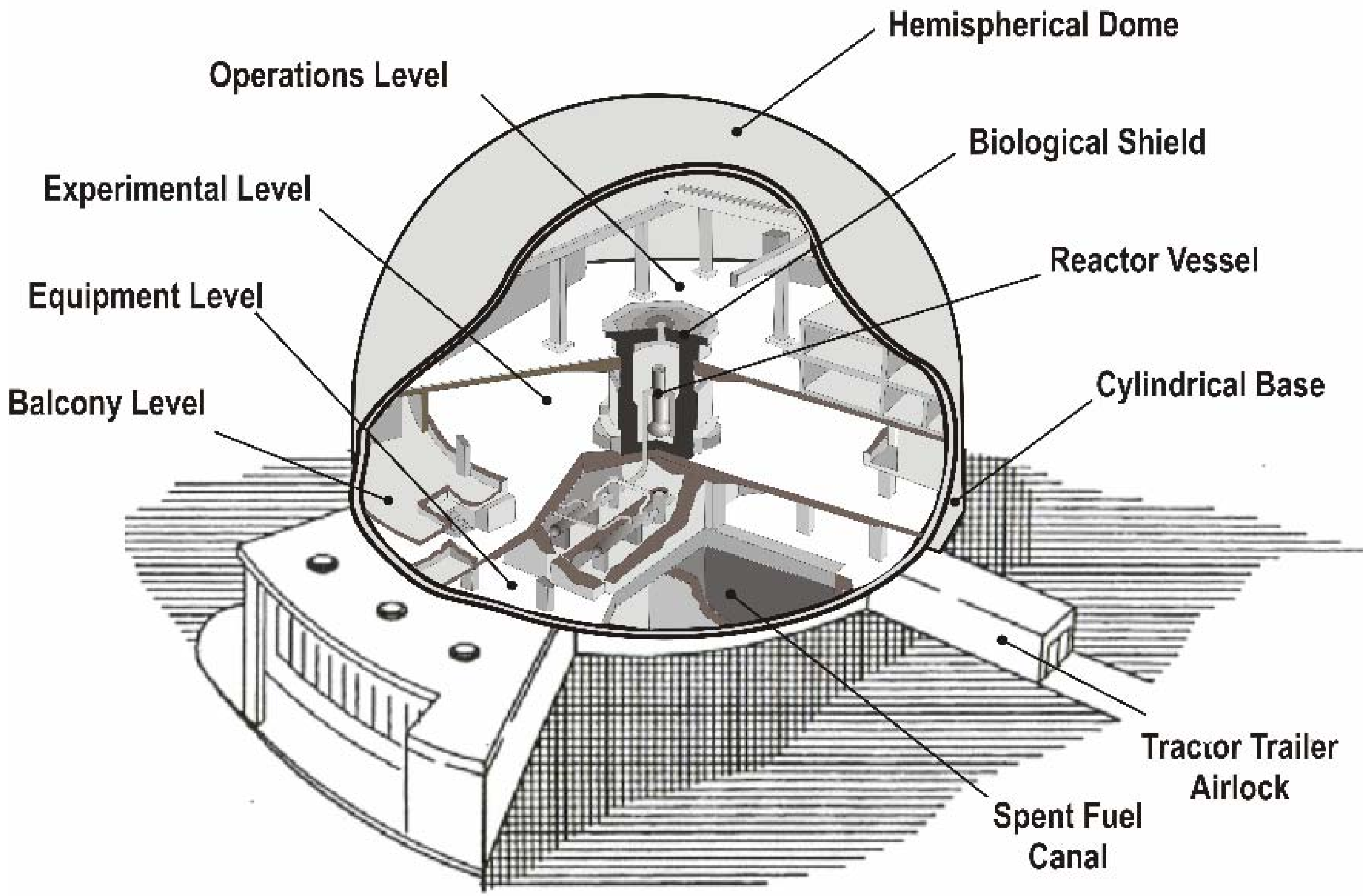

Figure 1.4 Cutaway View of the HFBR, Building 750

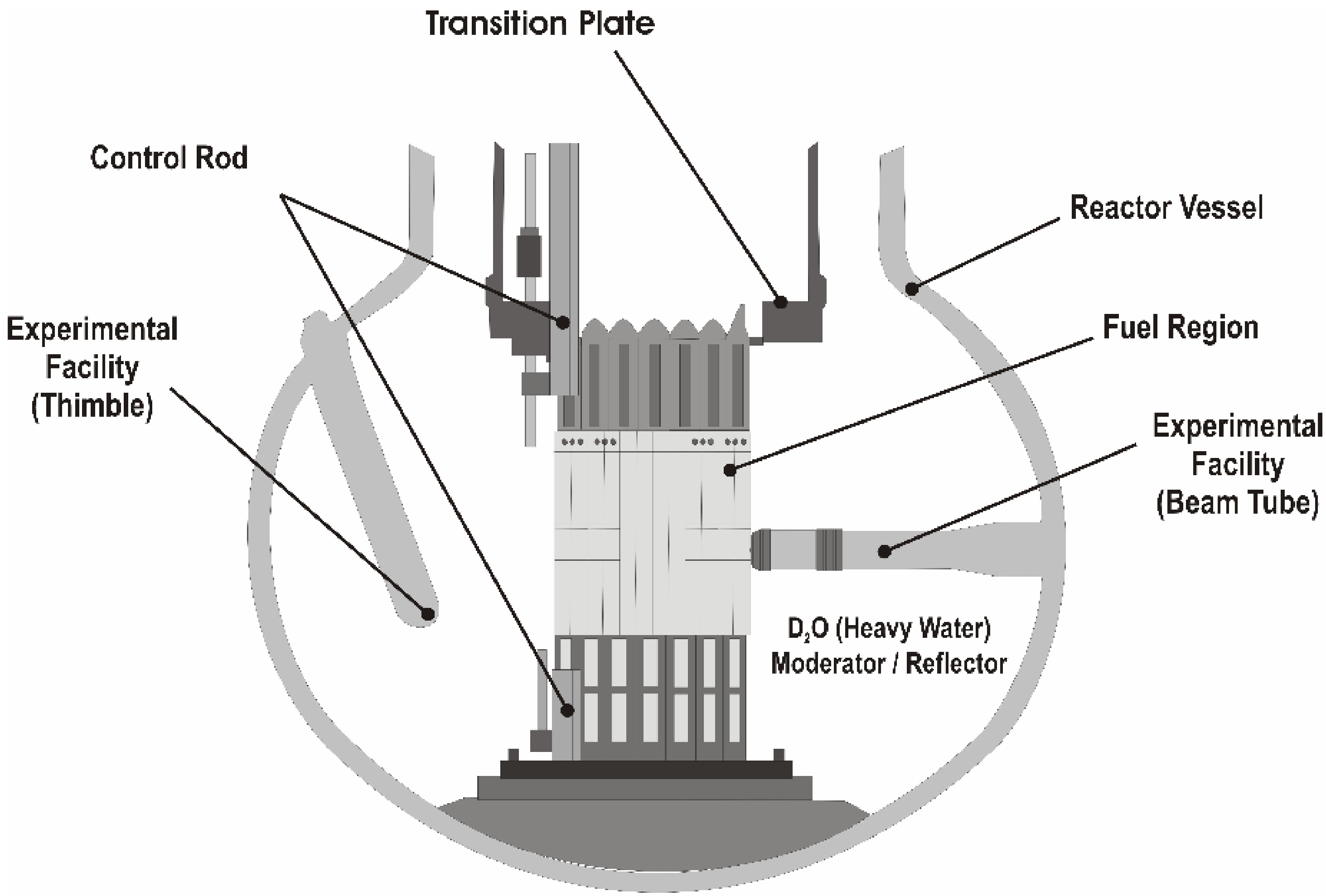

Figure 1.5 HFBR

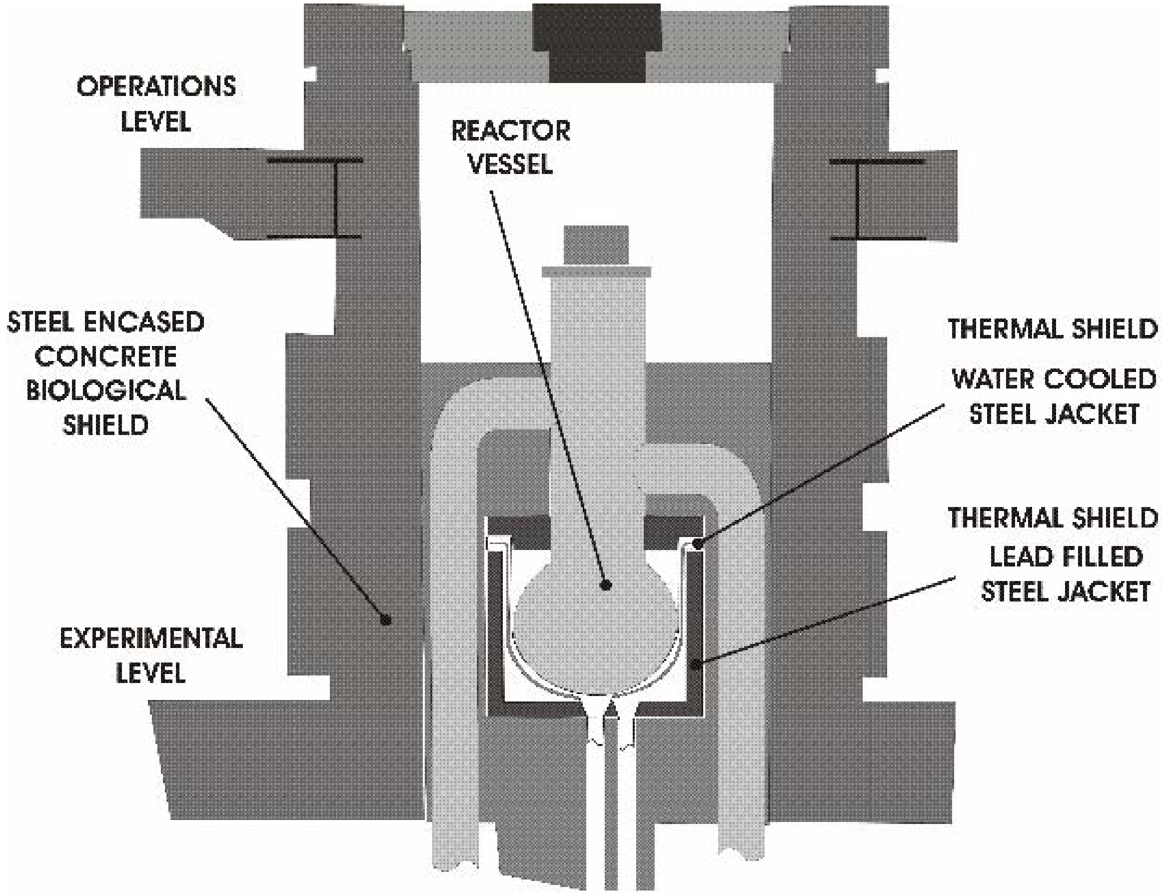

Figure 1.6 Reactor and Biological Shield

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2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

The U.S. Army occupied the BNL Site, formerly Camp Upton, during World Wars I and II. Between the wars, the Civilian Conservation Corps operated the BNL Site. It was transferred to the Atomic Energy Commission in 1947, to the Energy Research and Development Administration in 1975, and to DOE in 1977. Brookhaven Science Associates (BSA) operates BNL under a contract with DOE.

In 1980, the BNL Site was placed on the New York State Department of Environmental Conservation's (NYSDEC) list of Inactive Hazardous Waste Sites. In November 1989, the BNL Site was included on EPA's National Priorities List because of soil and groundwater contamination that resulted from the Laboratory's past operations. Subsequently, the EPA, NYSDEC, and DOE entered into a Federal Facilities Agreement (CERCLA-FFA, 1992) (also referred to as the Interagency Agreement; [IAG]) that became effective in May 1992.

The HFBR operated from 1965 to 1996, and was used solely for scientific research providing neutrons for materials science, chemistry, biology, and physics experiments. During a routine maintenance shutdown in 1996, tritium from the spent fuel canal was found in groundwater south of the reactor. Investigations revealed that the source of the tritium was a small leak in the ceramic tile lined concrete pool where spent nuclear fuel was stored. Operations at the HFBR were suspended and the DOE considered what to do. All of the spent fuel was removed and sent to DOE's Savannah River Site in 1998. The pool was drained and a freestanding, double-walled, stainless steel liner with an instrumented low point sump was installed to eliminate the potential for leakage to the environment. In November 1999, DOE announced it was permanently closing the reactor. The HFBR has been continuously maintained under a surveillance and maintenance (S&M) program from its initial operation in 1965. A number of actions have been taken to remove contaminated structures, systems, and components from the HFBR Complex. These actions are tabulated in Table 4.1. Most of the HFBR reactor systems have been put into a lay-up condition, and only some systems, such as the building heating, ventilation, and cooling (HVAC) systems remain in service.

Remediation of the Waste Loading Area (WLA) is also included in the scope of this ROD. The Waste Loading Area is an area of radiologically contaminated soil along the eastern boundary of the Former Hazardous Waste Management Facility (FHWMF, AOC 1). It was left in place (with contaminated soil) for its possible use as a waste staging and railcar loading area for the BGRR and HFBR projects. The remediation of this area (approximately two acres) was transferred to the HFBR project scope. Cleanup of the WLA using the dose-based cleanup goal and methodology specified for the FHWMF in the Operable Unit I ROD is in progress.

3.0 HIGHLIGHTS OF COMMUNITY PARTICIPATION

3.1 BNL Community Relations

The BNL Community Involvement Plan was published April 15, 1999. It is supplemented by project-specific plans. In the case of the HFBR, a Communications Plan for the Regulatory Decision-Making Process for Decommissioning the High Flux Beam Reactor was developed. In accordance with these two plans and CERCLA Sections 113 (k)(2)(B)(i-v) and 117, the Community Relations Program focuses on informing and involving the public in the decision-making process to ensure that the views of the internal and external stakeholder communities are considered. A variety of activities are used to provide information and to seek public participation, including distribution of materials to a stakeholders' mailing list; holding community meetings, information sessions, tours, and workshops; and preparing and distributing fact sheets.

The Administrative Record, which documents the basis for removal and remedial actions, was established and is maintained at the libraries listed below:

Brookhaven National Laboratory
Research Library, Bldg. 477A
Upton, NY 11973
631-344-3483 or
631-344-3489

U.S. EPA - Region II
Records Room
290 Broadway, 18th Floor
New York, New York 10007-1866
212-637-4308

3.2 Community Involvement in the Record of Decision

The community involvement process is and has been an integral part of making cleanup decisions at BNL. Community involvement and participation have been solicited for all significant documents and decisions associated with this ROD. The HFBR Feasibility Study and the Proposed Remedial Action Plan (PRAP) were made available for public review during a 68-day public comment period (January 10 through March 17, 2008), but community input and participation in the process began almost a decade earlier.

The HFBR began operating in 1965, providing neutrons for materials science, chemistry, geology, and physics experiments. Tritium was found in groundwater monitoring wells south of the HFBR in 1996. The tritium leak and contamination of the groundwater sparked significant public interest and concern over activities at BNL. In response, a Community Advisory Council (CAC) consisting of 32 representatives of local business, education, civic, employee, environmental, and health organizations was formed in 1998 to advise the Lab Director on this issue, and on other environmental, safety, and health issues. The CAC, which meets monthly, was involved in the decision-making process for the HFBR from the earliest days, including the DOE decision to permanently shut down the HFBR in 1999, the stabilization activities, and the interim actions that have occurred at the HFBR from 1999 through 2007. The CAC has been meeting regularly for 10 years and continues to serve as an essential component of the Lab's outreach efforts. In fact, the public comment period for the PRAP was specifically designed to cover three of the CAC's meetings, to give the CAC the opportunity to review the PRAP in detail and provide comments.

In addition to CAC input in the decision-making process for the PRAP, the Community Relations Office sought input from other stakeholders including the general public, employees, elected officials, the Brookhaven Executive Roundtable (BER), and civic associations. A timeline of significant community involvement activities is presented in Appendix A.

BNL's Environmental Restoration Project staff made numerous presentations to the CAC beginning in 1999, from the decision to close the reactor through the release of the PRAP. Periodic presentations and updates have kept the CAC abreast of actions taken to stabilize the HFBR, so that it could be maintained in a safe condition while waiting for decommissioning. The CAC had the opportunity for early input into the draft remedial alternatives. In 2005 and 2006, it was provided presentations on the history, operations, and characterization of the radiological inventory of the HFBR. The CAC had the opportunity to raise concerns, including those with regard to leaving the control rod blades in place, and issues surrounding maintenance of the confinement building. The CAC had a workshop and a tour of the facility in August 2006. Numerous updates on the progress of the project were given in 2007. The public comment period was designed to cover three regular CAC meetings: January 10, February 14, and March 13, 2008. CAC members reviewed the PRAP and had the opportunity to have all of their questions answered by a panel of subject matter experts. At the March CAC meeting, the CAC reached a consensus recommendation which was submitted to DOE on March 17, 2008.

Another group with early (2005 and 2006) access and input opportunities to the draft HFBR remedial alternatives was the BER. BER was established in 1997 by the DOE Brookhaven Site Office. Its membership consists of executive-level representation from DOE, BNL, EPA, NYSDEC, Suffolk County Department of Health Services (SCDHS), Suffolk County Planning Commission, Suffolk County Water Authority, Long Island Pine Barrens Commission, and the Town of Brookhaven, as well as federal, state, and local elected officials. BER was updated on the project throughout 2007 and given a presentation on the PRAP in January 2008.

In July of 2005, elected officials whose districts encompass the Laboratory were contacted by phone and faxed an overview of the pending planning process for decommissioning the HFBR. The elected officials were contacted again in January 2008 and notified of the release of the PRAP.

Between April and May 2006, a survey was taken of individuals and organizations that might have an interest in the red-and-white stack. Forty contacts with a historical or navigational interest were identified and surveyed to determine their level of interest in the decision-making process regarding possible demolition of the stack. Of the 40 contacts, 13 expressed interest in being contacted in the future with detailed information. The 13 contacts from the initial survey were sent letters announcing the start of the public comment period, together with the PRAP fact sheet, on January 8, 2008.

In April 2006, 26 letters were sent to local civic associations informing them that the decommissioning process was underway. As a result, presentations were made to the Manorville and East Yaphank civic associations. In January 2008, letters were again sent to these and other civic associations, together with copies of the PRAP fact sheet. Four civic associations requested additional information. Presentations were made to:

- Manorville Taxpayers & Civic Association, February 7, 2008
- East Yaphank Civic Association, February 7, 2008
- Affiliated Brookhaven Civic Organizations, February 18, 2008
- Middle Island Civic Association, February 21, 2008

The January 2008 East Yaphank Civic Association newsletter and the February 2008 Mastic Beach Property Owners Association newsletter included information on the HFBR decommissioning, the public comment period, and information sessions and the public meeting. The newsletters reached more than 300 additional residents south of the Laboratory.

A Notice of Availability announcing the availability of the PRAP for review and comment was published in the *Suffolk Life* newspaper on January 9, 2008 and in the Suffolk County edition of *Newsday* on January 10, 2008. Also on January 10, a news release, “DOE Seeks Public Comment on BNL Reactor Cleanup,” was sent to the BNL media list (more than 80 recipients).

A PRAP fact sheet was mailed to more than 200 individuals. An additional 300 copies were distributed to the CAC, BER, and regulators, and at civic meetings and in the lobby of Building 400.

A new web site for the HFBR, http://www.bnl.gov/hfbr, was launched in January 2008. The web site gave background information on the HFBR and the decision to decommission it, and provided links to information on characterization, transportation, surveillance and maintenance, and groundwater monitoring. Also included was a Community Input page that listed information on the public comment period and the information session and public meetings, and explained how to submit comments. The URL for the web site was included in the PRAP, the PRAP fact sheet, and other publications.

BNL employees were provided with numerous opportunities to learn about the PRAP and to submit comments. An article about the decommissioning plan was published in the January 11, 2008 edition of the employee newsletter, *The Bulletin*. An article also appeared in the January 7, 2008 Monday Memo, which is distributed to all employees. On February 14, 2008, an Environmental Restoration Project staff member gave a presentation to the Envoys, a group of Lab employees who meet regularly to learn about the Lab and give feedback to the Lab on the perspectives of community organizations they are involved in. Additionally, broadcast e-mails were sent out and the BNL home page carried information on the March information sessions and public meeting.

Information sessions on the HFBR PRAP were held on March 4 from noon to 2 p.m. and from 7 to 9 p.m., and the public meeting was held from 7 to 9 p.m. on March 6, 2008 at BNL. The times and dates for the information sessions and the public meeting were listed in the PRAP, the PRAP fact sheet, and on the HFBR, BNL, and CAC web pages. Advertisements for the two information sessions and the public meeting were published in the Suffolk County edition of *Newsday*, in *Suffolk Life*, the *North Shore Sun*, the *News Review*, *Southampton Press*, *Long Island Advance*, and the *Port Times Record* the week prior to meetings. The public comment period closed on Monday, March 17, 2008.

The Responsiveness Summary section of this ROD (Section III) provides the comments received during the public comment period and DOE's responses to these comments.

4.0 SCOPE AND ROLE OF HFBR RECORD OF DECISION

This ROD selects the remedial action for the HFBR Complex. Several interim actions have been completed and others are currently underway.

These interim actions were considered in determining the proposed remedy and are consistent with the selected remedy. These interim actions are being adopted as final actions in this ROD. In summary, this ROD addresses the remedial action necessary to complete the remedy for the HFBR Complex that is more fully described below and also in Section 10.0, Selected Remedy.

4.1 Completed Interim Actions

Following the permanent closure of the HFBR in 1999, a number of interim actions were completed. They are listed in Table 4.1.

4.2 Interim Actions Currently Underway

Cleanup of the Waste Loading Area

The Waste Loading Area (WLA) is an area (about two acres) along the eastern boundary of the Former Hazardous Waste Management Facility (HWMF). The Former HWMF is located in the southeastern portion of BNL. It was used during the period between 1947 and 1997 as the central receiving facility for storage, processing, and limited treatment of waste generated at BNL. Soil contamination at the Former HWMF resulted from spills during past waste handling operations.

The cleanup of the WLA was transferred to the HFBR scope of work in September 2005, through a modification to the Remedial Design Implementation Plan (RDIP) for the Former HWMF.

The cleanup of the WLA is currently in progress, performed as a non-time-critical removal action authorized by the *Action Memorandum, High Flux Beam Reactor, Removal Action for Waste Loading Area* of October 2007. The remediation (by excavation) of this area is being performed using the same cleanup goals and methodology required for AOC 1 in the OU I ROD.

Removal and Disposal of the Control Rod Blades and Beam Plugs

The removal/disposal of the CRBs and beam plugs is being performed as a non-time-critical removal action authorized by the *Action Memorandum, High Flux Beam Reactor, Removal Action for Control Rod Blades and Beam Plugs* of July 2008.

4.3 Remaining Actions within the Scope of this Record of Decision

The scope of this ROD also includes the remedial activities necessary to complete the selected remedy. These activities include the near-term (by FY2020) removal of the ancillary structures (stack, fan houses and tritium evaporation facility) and associated contaminated soils, and contaminated underground ducts and piping and associated soils; the complete removal of the

HFBR Complex (with the possible exception of the subsurface concrete structures of the confinement building base mat and stack foundation) after a decay period not to exceed 65 years; and the continuation of S&M and the use of land use and institutional controls (LUICs) during the decay period to ensure the protection of human health and the environment.

The decision to leave subsurface concrete structures of the confinement building base mat and stack foundation in place will be determined on the basis of radiological sampling and dose assessment performed in accordance with the methodology specified in the OU I ROD to satisfy the cleanup goal (for residential use) specified in the OU I ROD.

Completion of this remedial action will be documented through submittal of the closeout report associated with this ROD.

Table 4.1 Summary of Completed Interim Actions

Year	Material Addressed / Removed	Quantity	Disposition
1998	All spent nuclear fuel	1,050 elements	to SRS for storage
1999	Cooling tower super structure	NA	waste
2000	275,000 gal. cooling water holdup tank	74 tons	waste
2000	Shield blocks	500,000lb	reuse
2000	Shield blocks	168,000lb	reuse
2000	Contaminated lead brick	40,000lb	to MIT for reuse
2000	Chemicals (used in operations and experiments)	1,300 cont.	reuse
2000	Lead	250,000 lbs	waste
2001	Cadmium nitrate/gadolinium nitrate	350 gal	waste
2001	Primary coolant (tritiated heavy water)	10,000 gal	to SRS for storage
2001	Acid	1,500 gal	reuse
2002	Assorted low-level rad waste	11-B12's	waste
2002	Mixed waste	1 B12	waste
2002	H-6 Beam plug	1	waste
2003	Co-60 sources	21µCi	waste
2003	15 gal of used scintillation cocktail liquid (tritiated)	5,000 µCi	waste
2003	Assorted low-level radioactive waste (two B52 boxes)	22 yd^3	waste
2003	Sr-90 source	4 Ci	waste
2003	Cl-36 sources	0.14 µCi	waste
2003	CNF liquid nitrogen storage tanks	2	reuse
2003	Lead-lined sample hutch (8'x5'x3')	1	reuse
2004	Suffolk County Sanitary Code – Article 12[1] certification	NA	NA
2004	Beryllium filters and goniometers	NA	to ORNL for disposal
2004	20,000 gal double walled long-term cooling water tank	1	Saved for possible re-use
2004	Miscellaneous radioactive sources	1.5 Ci	waste
2004	Assorted low-level radioactive waste (connex boxes)	160 yd^3	waste
2004	Assorted industrial waste (CNF shed, MH-1A spacers)	35 yd^3	waste
2004	Tritiated oil	55 gal	waste
2004	Lead-lined drums and assorted mixed waste	4200 µCi	waste
2004	Assorted mixed waste	55 gal drum	waste
2004	Lead shielding	53,572 lb	waste
2005	Shield blocks	30	waste
2005	RaBe source removed from Sigma Pile	1 Ci	waste
2006	Stack Monitoring Facility (Bldg. 715)	100 yd^3 debris 620 yd^3 concrete recycled 30 tons metal recycled	
2006	Cooling Tower Basin and Pump/Switchgear House (Bldg 707/707A)		
2006	Water Treatment House (Bldg. 707B)		
2006	Guard shack (Bldg. 753)		
2006	Cold Neutron Facility (Building 751) contaminated systems (the building was transferred to another organization for re-use.)	2142 ft^2 high bay bldg w/ bridge crane	reuse

Note: Compliance with the codes pertaining to toxic and hazardous material storage and handling controls for the purpose of safeguarding the water resources of the County of Suffolk by controlling or abating pollution from such sources.

5.0 SUMMARY OF SITE CHARACTERISTICS

5.1 Nature and Extent of Contamination

Between 2000 and 2005, comprehensive sampling and analyses were performed to characterize the HFBR Complex. The non-radiological and radiological characterization results were published in several reports included as references to this ROD.

Certain chemicals and hazardous materials were used during the construction and operation of the HFBR. They include PCBs, asbestos and lead in materials of construction, organic solvents for degreasing equipment, and elemental mercury in certain instruments used in facility operations. Non-radiological characterization findings include the following:

- Asbestos-containing material (ACM) intrinsic to older floor and ceiling tiles, in gaskets, piping and wiring insulation, switchgear spark arrestors, and roofing materials.
- PCBs intrinsic to original paint, and hydraulic fluids.
- Lead intrinsic to paint, lead blocks and dust, shielding, and batteries.
- Other heavy metals of concern include zinc that was frequently detected and cadmium and beryllium that were found sporadically.
- Sampling for mercury revealed negative results but is intrinsic to capacitors, light ballasts, gearboxes, and in motor-operated valve lubricating oils.
- Solvents, degreasers, lubricants, oils, and petrochemicals intrinsic to equipment such as motors and compressors.
- Sodium hydroxide and sulfuric acid were used for water treatment. Chemical storage tanks were drained and rinsed.
- Lithium arsenite used in the confinement building air conditioning system.
- Suspected trace amounts of cadmium nitrate and gadolinium nitrate on the operations level due to leaks and spills.

The radiological characterization of the facility included activation analyses of the reactor vessel and its internal components, thermal shield, and biological shield. Radiological characterization also included the reactor building structures, systems, and components and the ancillary buildings comprising the rest of the HFBR Complex. Characterization of the outside areas included surface and subsurface soils and various underground duct and piping systems.

The total of the radioactive material remaining at the HFBR Complex predominantly consists of activated components within the reactor and the surrounding thermal and biological shields. There are small amounts of contamination contained within the confinement building structures, systems, and components and some of the ancillary structures. There are also isolated small areas of radiologically contaminated soils in the HFBR Complex. The entire radiological inventory of the HFBR Complex was estimated, as of January 2007, to be 65,000 curies (Ci). The nature and extent of this radiological contamination is described in Sections 5.2, 5.3, and 5.4.

5.2 Activated Components

Neutron activation of HFBR reactor components and immediately adjacent structures has resulted in a substantial inventory of radioactive material within the reactor and the inner region of the surrounding biological shield. The activated components inventory is calculated to be 65,000 Ci as of January 2007, which is more than 99 percent of the total radioactive material remaining at the HFBR Complex. Table 5.1 shows the total amount of activity and isotopic distribution contained within the activated components, with radiological decay calculated through 2107. Most of the activated iron (Fe-55) is in the thermal shield, CRBs, and the remaining reactor internals. Most of the cobalt (Co-60) and long-lived nickel (Ni-59 and Ni-63) is in the stainless steel components of the reactor internals and CRBs, while all of the europium (Eu-154 and Eu-155) is contained in the CRBs. Figure 5.1 illustrates the composite radiological decay of all activated components through 2107. Figure 5.2 provides the distribution of activity among the various activated components.

The physical form of these components, activated metal and concrete, makes the hazard primarily a direct exposure risk rather than a risk of environmental contamination through dispersal. The reactor vessel, internals, thermal shield, and the activated portion of the biological shield are well shielded in their current configuration. There are no significant radiological hazards from those materials until they are disturbed during dismantling and decommissioning.

It is important to note that the calculated dose rates associated with these components are very high. For example, the maximum CRB calculated dose rate is as high as 13,000 rem/hr at 1 ft. The calculated high dose rates developed in this document are based on standard calculation models that calculate dose rate from total activity and physical size and shape of the components. Dose rates are important to know so that effective controls and methods of handling can be developed. The actual dose rates to which workers would be exposed would be controlled by such means as remote handling, use of robotics, conduct of operations underwater, and the use of shielding. Typically, dose rates would be limited to much less than 100 mrem/hr. Worker radiation exposure would be controlled to stay within administrative and regulatory limits.

The dominant isotope driving these calculated dose rates is Co-60, with a half-life of 5.3 years. With Co-60 as the dominant dose rate driver (see Table 5.1), there is a rapid decrease in calculated dose rate as a function of time because of radioactive decay. Typical calculated dose rates for some of these components are shown in Table 5.2. For the CRBs, short-term dose rate is governed by the decay of Co-60 and Eu-154. The decay in activity for each component over the next 100 years is shown in Table 5.3. The corresponding dose rate reductions are shown in Figures 5.3 and 5.4. Figure 5.5 shows the dose rate reduction for the limiting large activated component, the thermal shield.

5.3 Contaminated Structures, Components, and Underground Ducts/Pipelines

The areas within the HFBR confinement building (Building 750) contain almost all of the radioactive contamination remaining in the reactor complex. The confinement building structure itself is contaminated to a small extent. All of the concrete floors and walls within the confinement Building 750 are estimated to contain approximately 0.1 Ci, primarily H-3 and Co-60, of fixed and/or removable contamination. While the Co-60 contamination is mostly found on the equipment level, the H-3 contamination discussed here is found on all levels of the confinement building. The extent of this contamination is noted “Interior of the confinement shell is contaminated with removable H-3” on the Conceptual Site Models (CSMs), included in Section 6, Figures 6.1 and 6.2 just under the title “Building 750: Confinement Structure.” The total contamination inventory inside of the reactor systems within the confinement structure is approximately 45 Ci. Estimates of the radiological inventory contained within Building 750, exclusive of the activated components, are detailed in Table 5.4.

Some of the ancillary buildings and underground duct and piping systems outside of the reactor confinement building, shown in Figure 5.6 contain small amounts of radioactive contamination. Contamination of these ancillary buildings and underground duct and piping systems is summarized as follows:

- **Building 704 - Fan House**: Concrete samples indicate concentrations of strontium (Sr-90) up to 92 pico curies per gram (pCi/g) in the fan cells concrete, and activity in the underground duct concrete of up to 6,900 pCi/g of Cs-137, 429 pCi/g of Sr-90, 503 pCi/g of H-3, and 36 pCi/g of americium (Am-241). The contamination was generally contained within the first half-inch of the concrete structures. Fixed radioactive contamination levels up to 75,000 dpm/100cm^2 exist in an area near the filter bypass facility. There are also elevated contamination levels near the underground plenum area. It is estimated that the total radioactive material inventory content in the steel, concrete, and soils is about 0.1 Ci, consisting primarily of Cs-137 and Sr-90. It should be noted that the Cs-137, Sr-90, and Am-241 contamination is attributable to previous operation of the BGRR.
- **Building 705 - Stack**: Smears of the interior lower portion of the stack indicated removable contamination up to 22,000-dpm/100 cm^2. Cs-137 was detected. Core bore samples were analyzed, and the average contamination concentrations over the first half-inch in depth were 141 pCi/g Sr-90, 77 pCi/g H-3, and 344 pCi/g Cs-137. Essentially all the contamination was found in the first 0.5 to 0.75 in. of depth. It is calculated that the total radioactive material inventory content present in the stack concrete is approximately 0.03 Ci. Again, the Cs-137 and Sr-90 contamination is attributable to previous operation of the BGRR.
- **Building 802 - Fan House and Tritium Evaporation Facility**: Based on process knowledge, the facility is contaminated with low levels of H-3 and Co-60. It is estimated that the total radioactive material inventory content in the steel, concrete, and soils is less than 0.01 Ci.
- **Stack underground ventilation ducts and lines**: Radiological characterization of the interconnecting ducts indicates that the ducts from Building 750, Building 801, and Building 802 are contaminated. Short sections of the ducts from Buildings 901 and 701 are also contaminated where they are connected to the stack or to other interconnecting ductwork. The activity is a combination of fixed and removable contamination, and it was identified as a combination of H-3, Co-60, Ni-63, and Cs-137. The total activity in these ducts is estimated to be less than 0.1 Ci.
- **D/F Waste Line**: Based on process knowledge, this double-walled underground pipeline that runs between Buildings 750 and 801 is contaminated. It is estimated that less than 0.1 Ci is present in this line, with an isotopic content of H-3, Co-60, Ni-63, and Cs-137.

- **Sanitary Sewage Line from the HFBR**: – Based on process knowledge the sanitary sewage line is contaminated. It is estimated that less than 0.1 Ci is present in this line, with an isotopic content of H-3, Co-60, Ni-63, and Cs-137.

5.4 Contaminated Soils

The soils surrounding and beneath the HFBR and support buildings were surveyed and sampled for radioactive contamination. The majority of the HFBR yard area as shown in Figure 1.3 is free of contamination. There are several, small isolated areas of soil contamination as summarized below:

- **Soils under Building 704 - fan house**: Sampling indicated soil contamination in the soil floor of the basement containing up to 33 pCi/g Sr-90, and 217 pCi/g Cs-137. It is estimated that the total radioactive material inventory in the soils under building 704 is less than 0.1 Ci. The detection of these radionuclides indicates the source to be the BGRR.
- **Soils around Building 705 – stack**: Samples indicated Cs-137 concentrations slightly above background levels of about 1 pCi/gram, but less than the values typically used at Brookhaven as cleanup criteria (23 – 67 pCi/g). The highest sample was 6.4 pCi/g. It is estimated the soils around Building 705 contain less than 0.01 Ci of radioactive material.
- **Soils under Building 750**: Samples indicated soil concentrations up to 47 pCi/g H-3, and up to 7,130 pCi/liter H-3 in the groundwater. It is estimated that the total radionuclide inventory in the soils beneath Building 750 is less than 1.0 Ci. Although the sample locations were chosen to be the most likely for detecting tritium contamination, it is possible that higher levels of tritium are present in soils, especially in isolated pockets.
- **Soils around the HFBR Complex** as shown in Figure 5.7: Twenty-one isolated areas of contamination were initially identified during site characterization. Because of their limited size, many of these areas were actually cleaned up through the process of obtaining the samples required for characterization. The eight soil contamination areas remaining are posted in accordance with DOE procedures. The soil contamination in the vicinity of the HFBR confinement building, sample points 3, 4, 11, 12, and 13, is Co-60 and exhibits dose rates ranging from 5 to11 µrem/hr at 1 ft. The soil contamination in the vicinity of the fan house, sample points 16, 17, and 18, is Cs-137 and exhibits dose rates from 12 to 20 µrem/hr at 1 ft. The isolated areas of contamination are shown in Figure 5.7. It is estimated the soils around the HFBR Complex contain less than 0.01 Ci of radioactive materials.

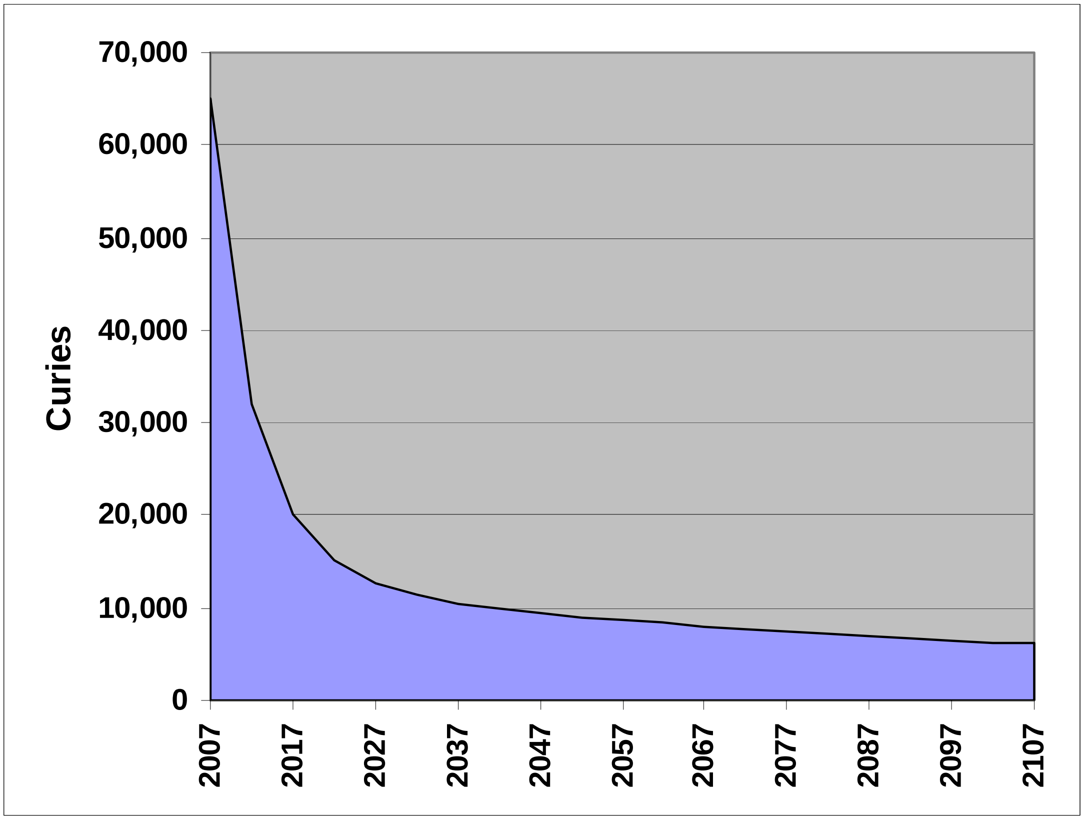


Figure 5.1 HFBR Activated Components – Decay through 2107

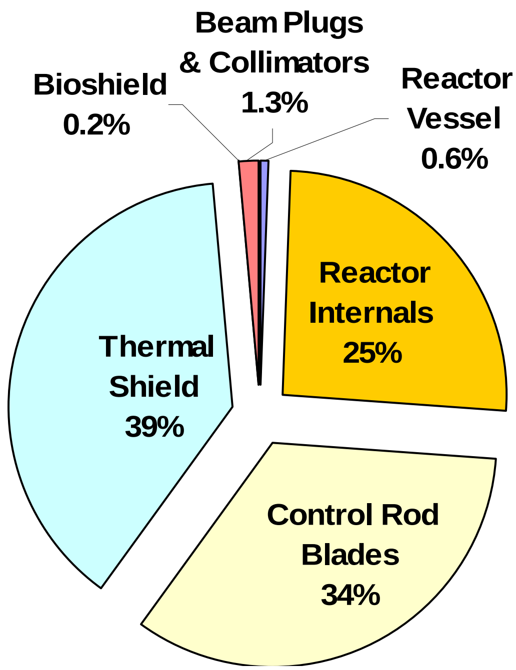
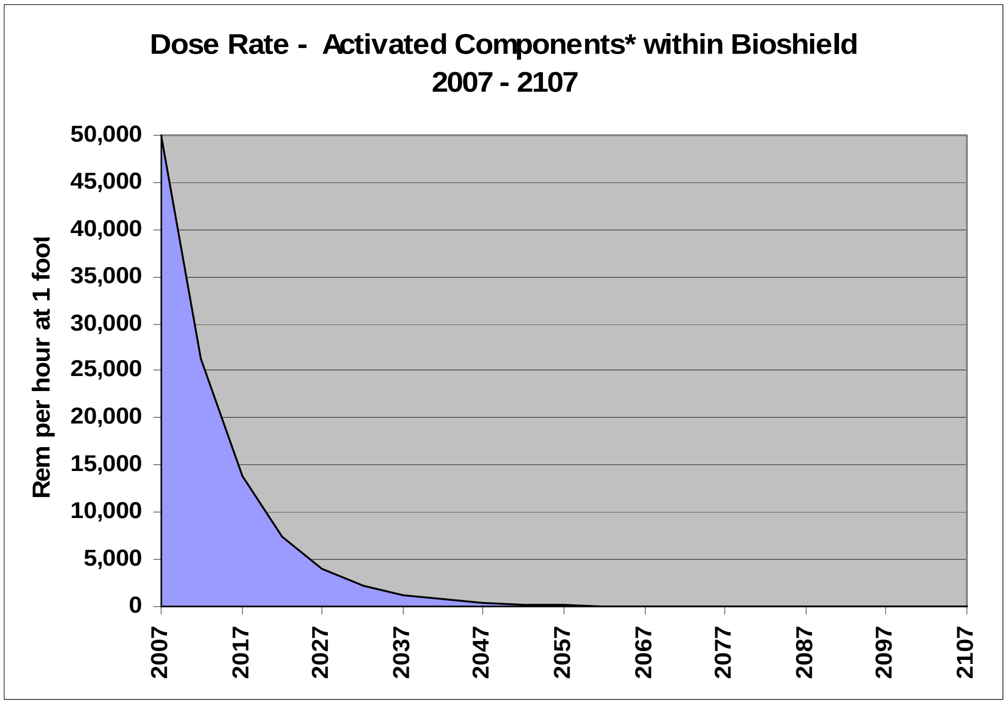
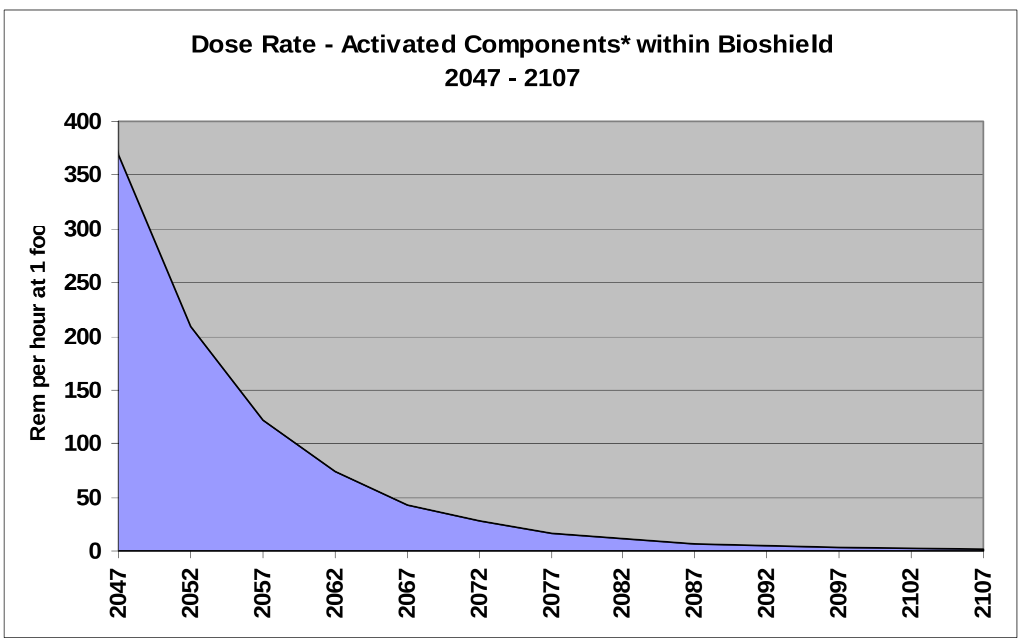


Figure 5.2 Percent of HFBR Activated Component Activity in 2007



*Excluding beam plugs and collimators

Figure 5.3 HFBR Dose Rate Reduction 2007 – 2107



*Excluding beam plugs and collimators

Figure 5.4 HFBR Dose Rate Reduction 2047 – 2107

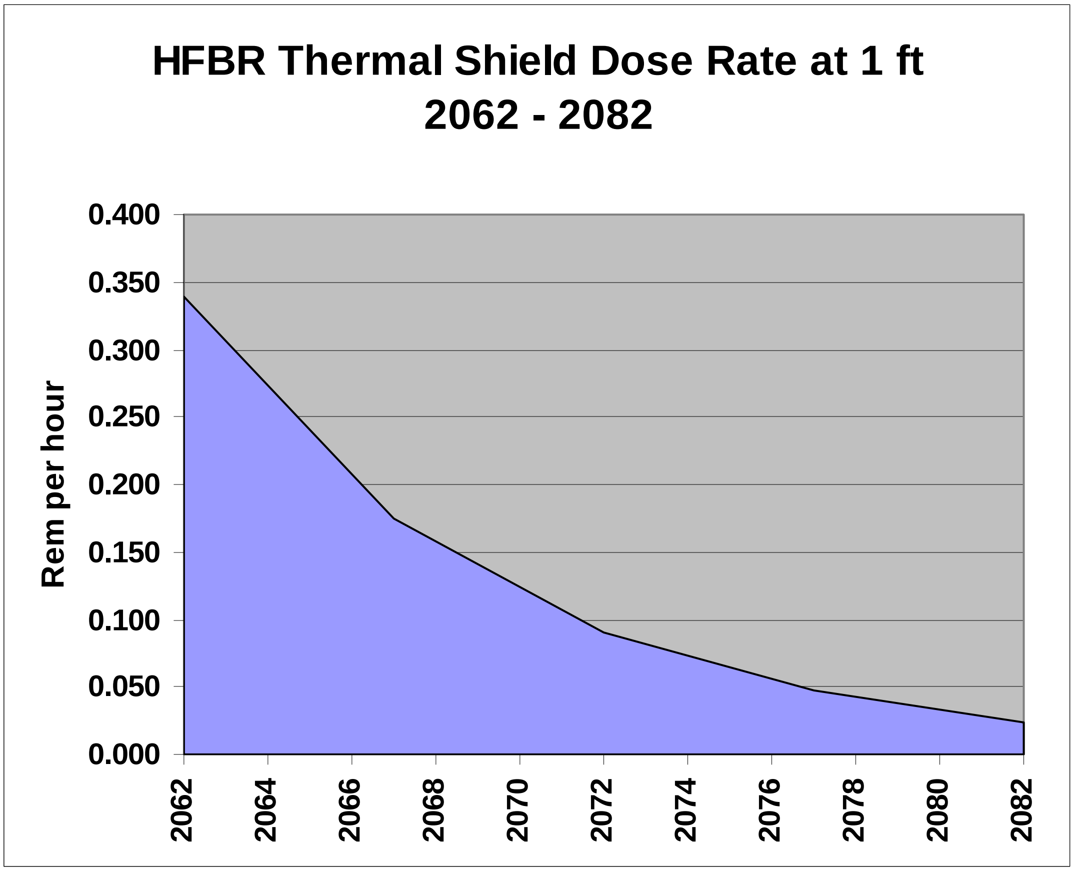


Figure 5.5 HFBR Limiting Large Activated Component

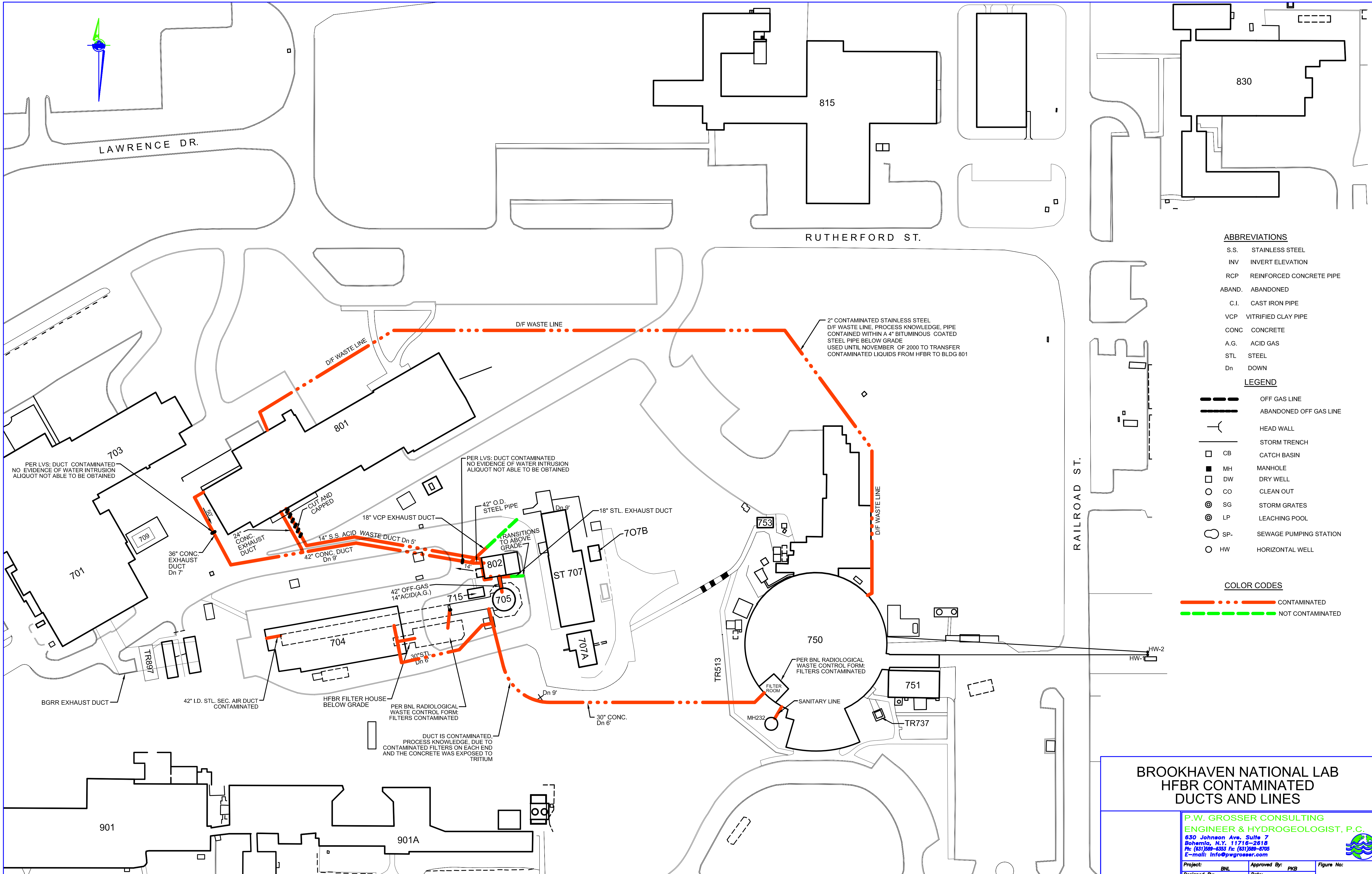


Figure 5.6 HFBR Contaminated Underground Ducts/Pipelines (SHEET 1 OF 2)

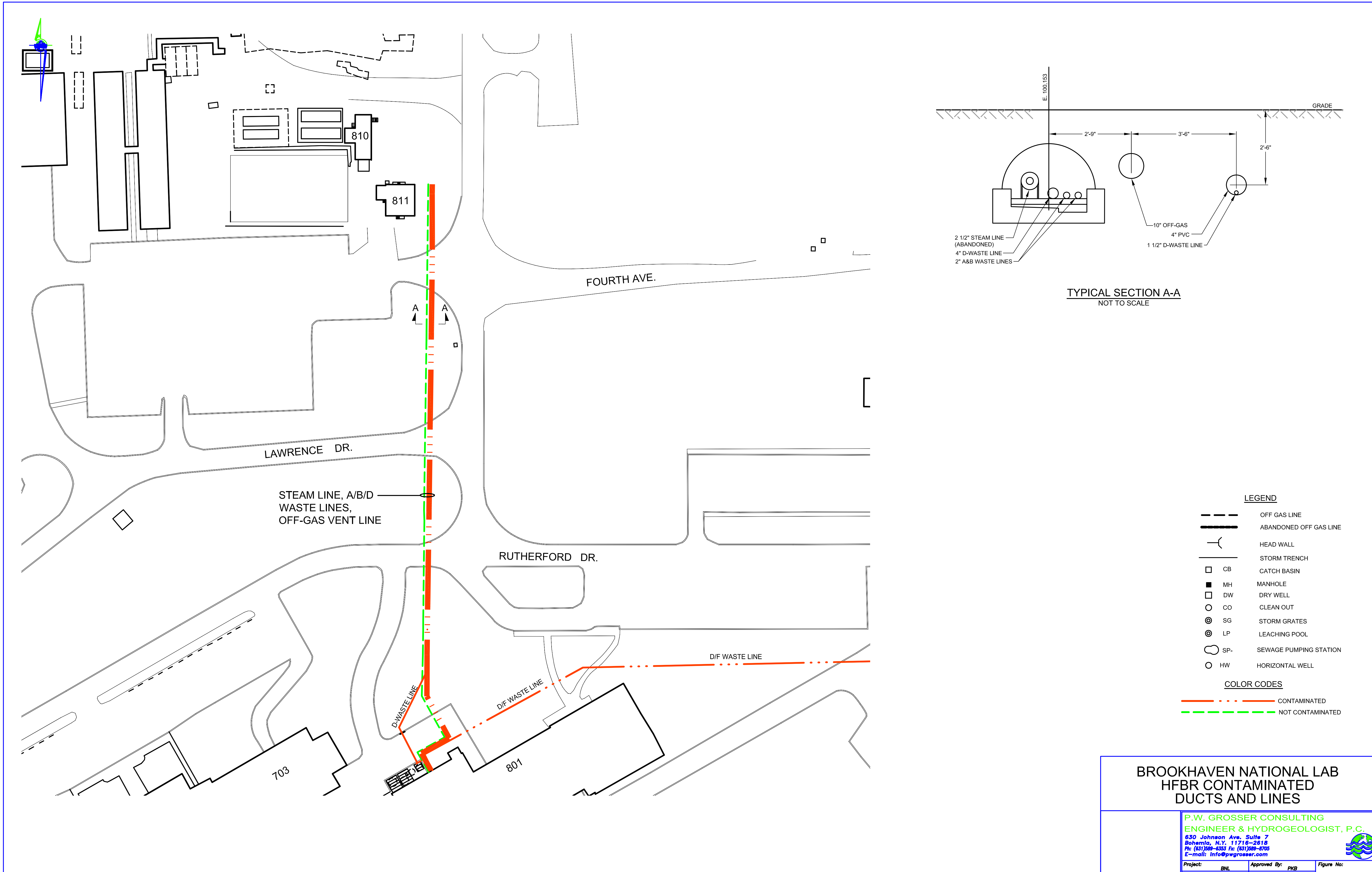


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Figure 5.6 HFBR Contaminated Underground Ducts/Pipelines (SHEET 2 OF 2)

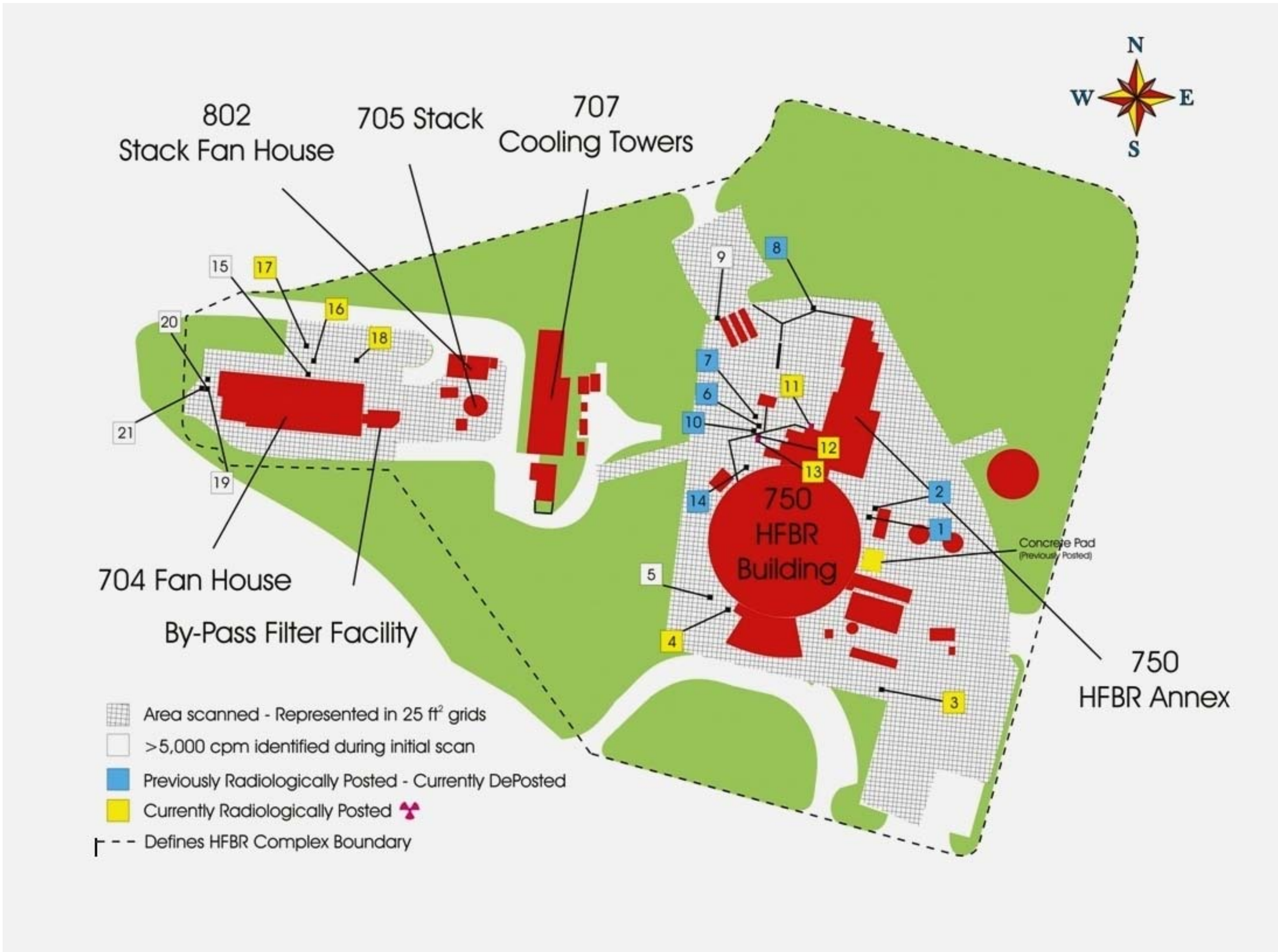

Figure 5.7 HFBR Remaining Soil Contamination Areas

Table 5.1 HFBR Total Activated Components Activity Decay by Radionuclide

	Half-Life (yr)	2007	2012	2017	2020	2026	2037	2047	2057	2067	2075	2087	2097	2107
Nuclide	**Half-Life (yr)**	**Total Activity (Ci)**	**Total Activity (Ci)**	**Total Activity (Ci)**	**Total Activity (Ci)**	**Total Activity (Ci)**	**Total Activity (Ci)**	**Total Activity (Ci)**	**Total Activity (Ci)**	**Total Activity (Ci)**	**Total Activity (Ci)**	**Total Activity (Ci)**	**Total Activity (Ci)**	**Total Activity (Ci)**
H-3	12.32	7	5	4	3	2	1	1	0	0	0	0	0	0
C-14	5,715	26	26	26	26	26	26	26	26	26	26	26	26	25
Fe-55	2.73	31,155	8,750	2,456	1,147	250	15	1	0	0	0	0	0	0
Co-60	5.271	16,387	8,489	4,396	2,963	1,345	316	85	23	6	2	0	0	0
Ni-59	76,000	62	62	62	62	62	62	62	62	62	62	62	62	62
Ni-63	101	11,932	11,529	11,140	10,913	10,473	9,711	9,066	8,465	7,903	7,481	6,889	6,432	6,005
Eu-154	8.593	3,610	2,412	1,611	1,264	779	321	143	64	28	15	6	3	1
Eu-155	4.75	1,336	644	310	200	83	17	4	1	0	0	0	0	0
Total	**N/A**	**64,500**	**31,900**	**20,000**	**16,600**	**13,000**	**10,400**	**9,400**	**8,600**	**8,000**	**7,600**	**7,000**	**6,500**	**6,100**

Table 5.2 Calculated Dose Rates at 1 Foot from Components

Component	rem/hr
Reactor Internals*	35,000
Single (maximum) control rod blade	13,000
Reactor vessel	15
Thermal shield	471
Biological shield (inner region)	3

Note: Calculated dose rates at 1 ft from components as of January 2007.

* Represents the calculated dose rate from all of the reactor internals excluding the control rod blades. However, this value is the calculated dose rate at 1 ft from the transition plate which because of its radionuclide inventory and physical location would mask the dose rate contribution from the other components in this category.

Table 5.3 HFBR Activated Component Decay

	2007	2012	2017	2020	2026	2032	2042	2052	2057	2067	2075	2082	2107
Nuclide	**Ci**	**Ci**	**Ci**	**Ci**	**Ci**	**Ci**	**Ci**	**Ci**	**Ci**	**Ci**	**Ci**	**Ci**	**Ci**
Reactor Vessel	380	251	207	194	179	170	157	147	142	132	123	119	101
Reactor Internals	16,387	10,249	7,707	6,894	5,961	5,452	4,940	4,575	4,415	4,119	3,900	3,719	3,138
Control Blades	21,900	12,047	7,783	6,380	4,767	3,933	3,231	2,860	2,727	2,509	2,363	2,246	1,890
Thermal Shield	24,876	8,971	4,127	2,993	2,059	1,737	1,521	1,400	1,349	1,259	1,192	1,137	961
Bioshield	125	47	23	17	11	9	8	7	6	6	5	5	4
Beam Plugs & Collimators	847	352	158	100	42	19	5	1	1	0	0	0	0
TOTAL	**64,500**	**31,900**	**20,000**	**16,600**	**13,000**	**11,300**	**9,900**	**9,000**	**8,600**	**8,000**	**7,600**	**7,200**	**6,100**

Table 5.4 HFBR System Radioactivity Calculation Summary

System	System Description	H-3 (Ci)	Co-60 (Ci)	Fe-55 (Ci)	Ni-63 (Ci)	Cs-137 (Ci)	Total Ci in 2007	Total Ci in 2057	Total Ci in 2107
SYS-01	Primary Coolant Water System	34.8	0.04	0.06	0.02	0.07	**35.0**	**2.1**	**0.1**
SYS-02	Primary System Purification	H-3 Note	0.06	0.13	0.02	0.00	**0.2**	**0.0**	**0.0**
SYS-04	Primary Sampling System	Note 1	0.00	0.00	0.00	0.00	**0.0**	**0.0**	**0.0**
SYS-05	Primary Pump Seal Cold Trap System	Note 1	0.00	0.00	0.00	0.00	**0.0**	**0.0**	**0.0**
SYS-06	DA Drain & D20 Transfer System	Note 1	0.00	0.01	0.00	0.01	**0.0**	**0.0**	**0.0**
SYS-08	Reactor Vessel Cover Gas System	Note 1	0.00	0.00	0.00	0.00	**0.0**	**0.0**	**0.0**
SYS-11	Shutdown Cooling System	Note 1	0.03	0.04	0.02	0.00	**0.1**	**0.0**	**0.0**
SYS-12	Thermal Shield Cooling System	Note 1	0.04	0.06	0.02	0.01	**0.1**	**0.0**	**0.0**
SYS-15	Auxiliary Water Purification System	Note 1	0.00	0.00	0.00	0.00	**0.0**	**0.0**	**0.0**
SYS-31	Experimental Facilities Cooling System	Note 1	0.20	0.31	0.11	0.04	**0.7**	**0.1**	**0.1**
SYS-34	Liquid D/F Waste Systems	0.53	0.78	1.20	0.43	0.14	**3.1**	**0.4**	**0.2**
Misc	Miscellaneous Hot Spots	0.00	0.57	0.90	0.32	0.00	**1.8**	**0.2**	**0.2**
Misc	Miscellaneous Low Activity Systems (Note 2)	3.54	0.17	0.27	0.09	0.02	**4.1**	**0.3**	**0.1**
Misc	Low level contamination on floors and structures	0.08	0.01	0.01	0.00	0.00	**0.1**	**0.0**	**0.0**
	Total for All Systems	**39.0**	**1.9**	**3.0**	**1.0**	**0.3**	**45.2**	**3.2**	**0.7**

H-3 Note: the Primary System Purification H-3 (10.5 Ci in 2007, 0.6 Ci in 2057, < 0.1 Ci in 2107) is part of the total estimated H-3 in SYS-01, and is not additive.

Note 1: D20 was drained from systems, but 10 gallons is assumed to be present as residual in various systems. This H-3 activity is included in the Primary Cooling Water System.

Note 2: Several low activity systems were assumed to add up to a combined 10% of the total systems activity.

Note that resin media and filters in various systems will be removed from the facility.

Beam plugs have been removed and are in storage in Bldg 750. They are not part of this systems activity calculation.

The Vertical Irradiation Tubes are part of the in-vessel activity determination

6.0 SUMMARY OF SITE RISKS

6.1 Evaluation of Exposure Pathways

Although there is no immediate threat to human health and the environment associated with the radiological and non-radiological contaminants, potential pathways of exposure to HFBR contamination have been assessed, considering current and future land use, institutional controls, and releases via various environmental media. The three pathways that were used to assess which contaminants from the HFBR could impact potential receptors include:

- Direct exposure to workers, resident, or trespasser. This includes external gamma radiation emanating from radionuclides remaining in the interior of the reactor building and the vessel and localized areas of soil.
- Direct contact to workers, resident, or trespasser. This includes direct exposure to and potential ingestion of radioactive contamination in soil or dispersible radioactive materials on surfaces of structures.
- Production of airborne or leaching of contaminants from source to the surrounding environment or groundwater. This includes potential inhalation of radioactive materials created as a result of disturbing contaminants or leaching from subsurface soil and structures.

Graphic illustrations depicting existing contaminant sources, actual and potential pathways, and control measures are provided in Figures 6.1 through 6.7 as conceptual site models for the HFBR and associated ancillary facilities. As illustrated by the conceptual site models, the sources of contamination at the HFBR Complex are prevented from impacting the postulated receptors. The potential for direct exposure (external radiation, ingestion, and dermal contact) to groundwater contamination has been addressed in the OU III ROD. The remedial actions and LUICs implemented in accordance with the OU III ROD will preclude exposure. This has been noted "SCOPE COVERED IN OU-3" on Figures 6.2 through 6.4, 6.6, and 6.7. The monitoring of the sewage treatment plant and recharge basins HO and HS , noted as "Outside scope of HFBR project" in Figures 6.2 and 6.4, is done under the site environmental monitoring program.

6.2 Justification for Action

As shown in Section 5.1, the HFBR Complex contains a large quantity of radioactive materials including the activated components with high dose rates. There are also non-radiological hazardous materials of construction that were originally used to build the HFBR Complex.

There is no immediate threat to human health and the environment associated with these radiological and non-radiological hazards. Several physical barriers and administrative requirements control personnel exposure to these hazards. These barriers also prevent the spread of contamination to the environment. S&M

of the HFBR Complex ensures the effectiveness of these physical barriers, and LUICs restrict access to the HFBR and control exposure to the remaining radiological and non-radiological hazards.

Although the quantity of radioactive material and radiation levels will be reduced over time as a result of radioactive decay, the radiological and non-radiological hazards would remain as a potential threat to human health and the environment for what is practically an indefinite period of time. This potential threat warrants remedial action in order to provide long-term and future protection of human health and the environment from:

- Activated components in the confinement building, and radioactive and hazardous materials in other structures, systems, and components in the HFBR Complex that could result in unacceptable human or environmental exposure.
- Non-fixed (removable or loose) radiological contamination or hazardous materials in the HFBR Complex that could result in unacceptable release of contamination to the environment.
- Contaminated soils around the HFBR Complex that could result in unacceptable human or environmental exposure.
- Contamination in soils that could impact groundwater at unacceptable levels.

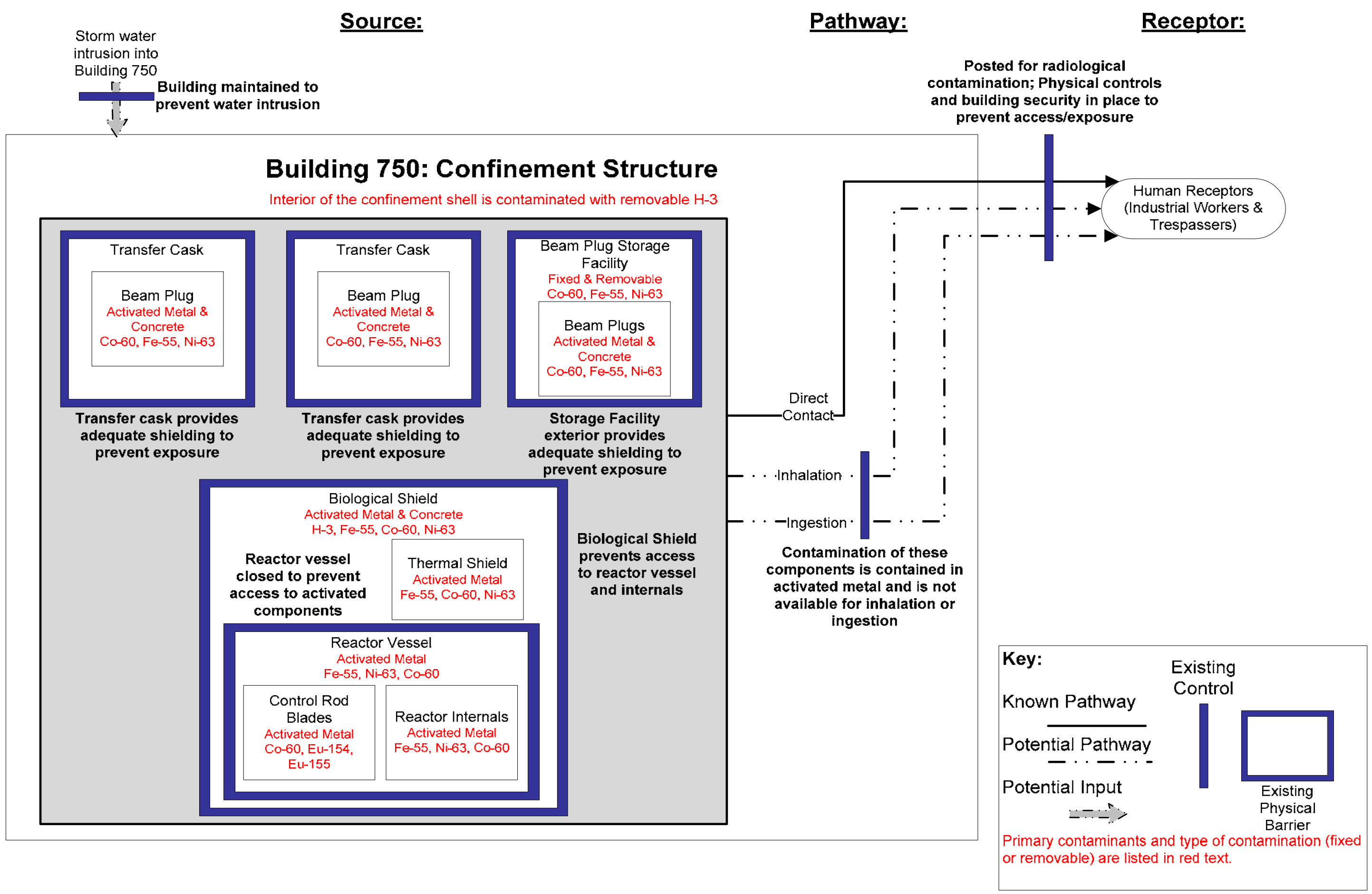

Figure 6.1 Building 750 Confinement Structure

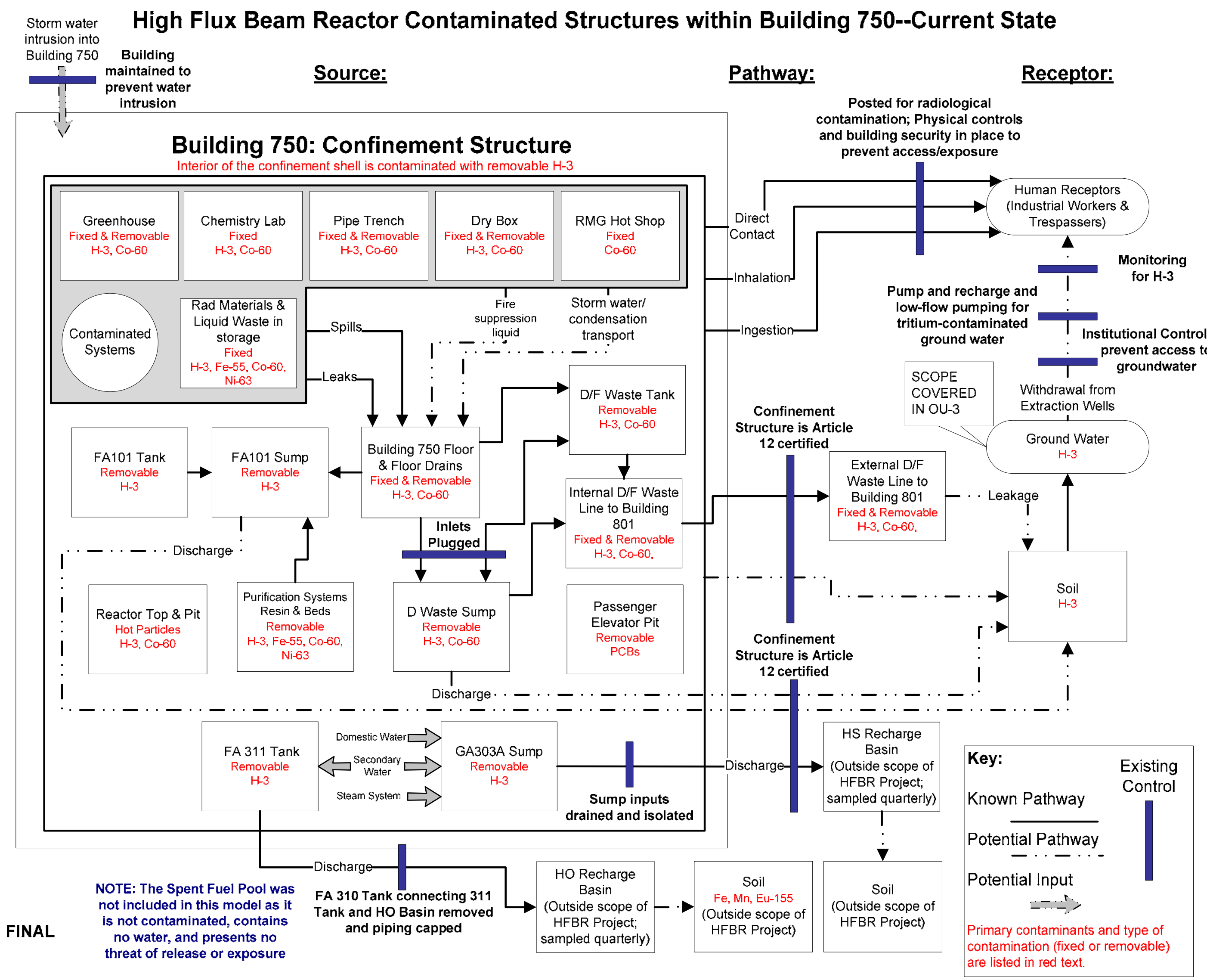

Figure 6.2 High Flux Beam Reactor Contaminated Structures within Building 750 – Current State

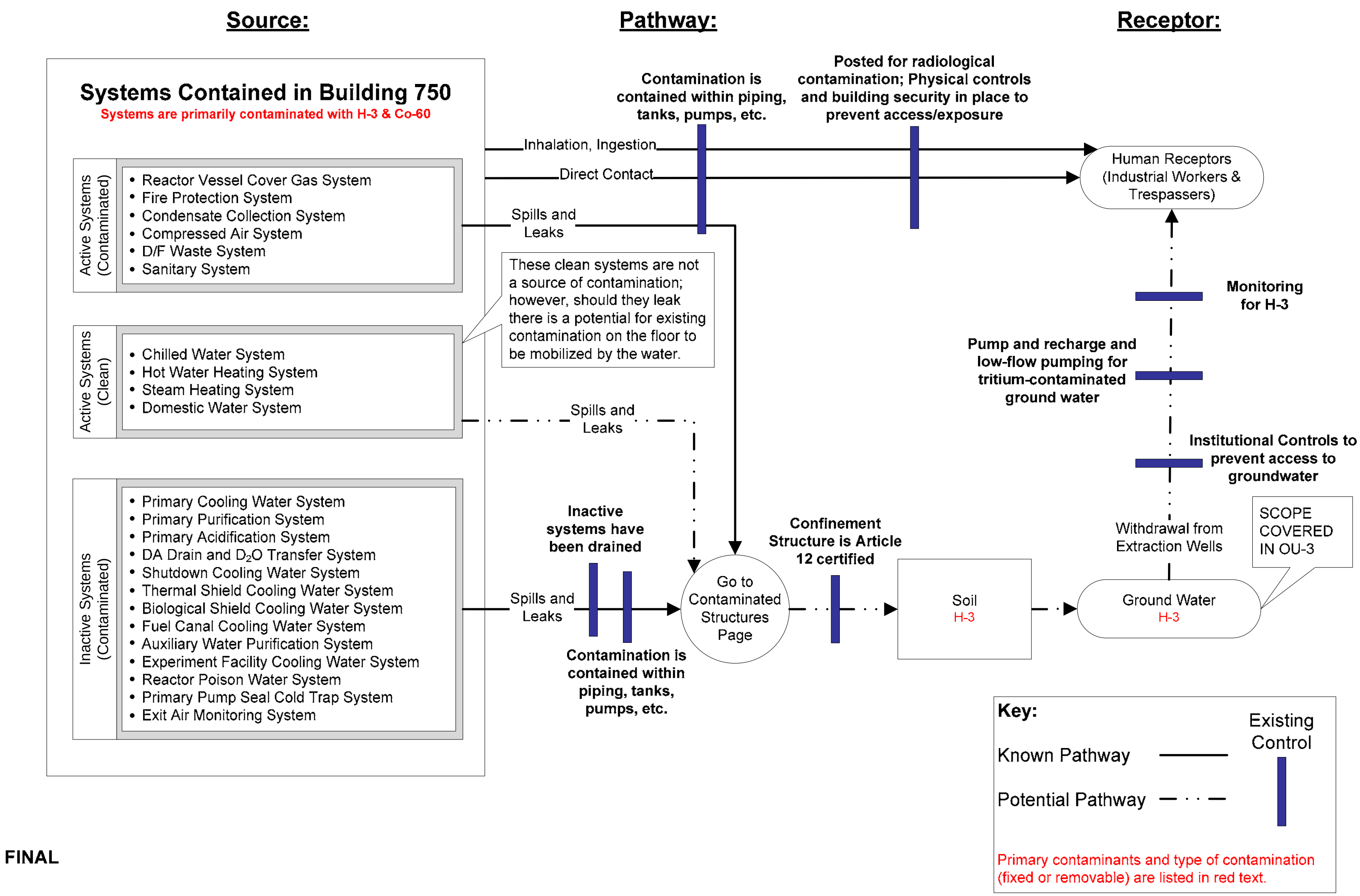

Figure 6.3 High Flux Beam Reactor Systems – Current State

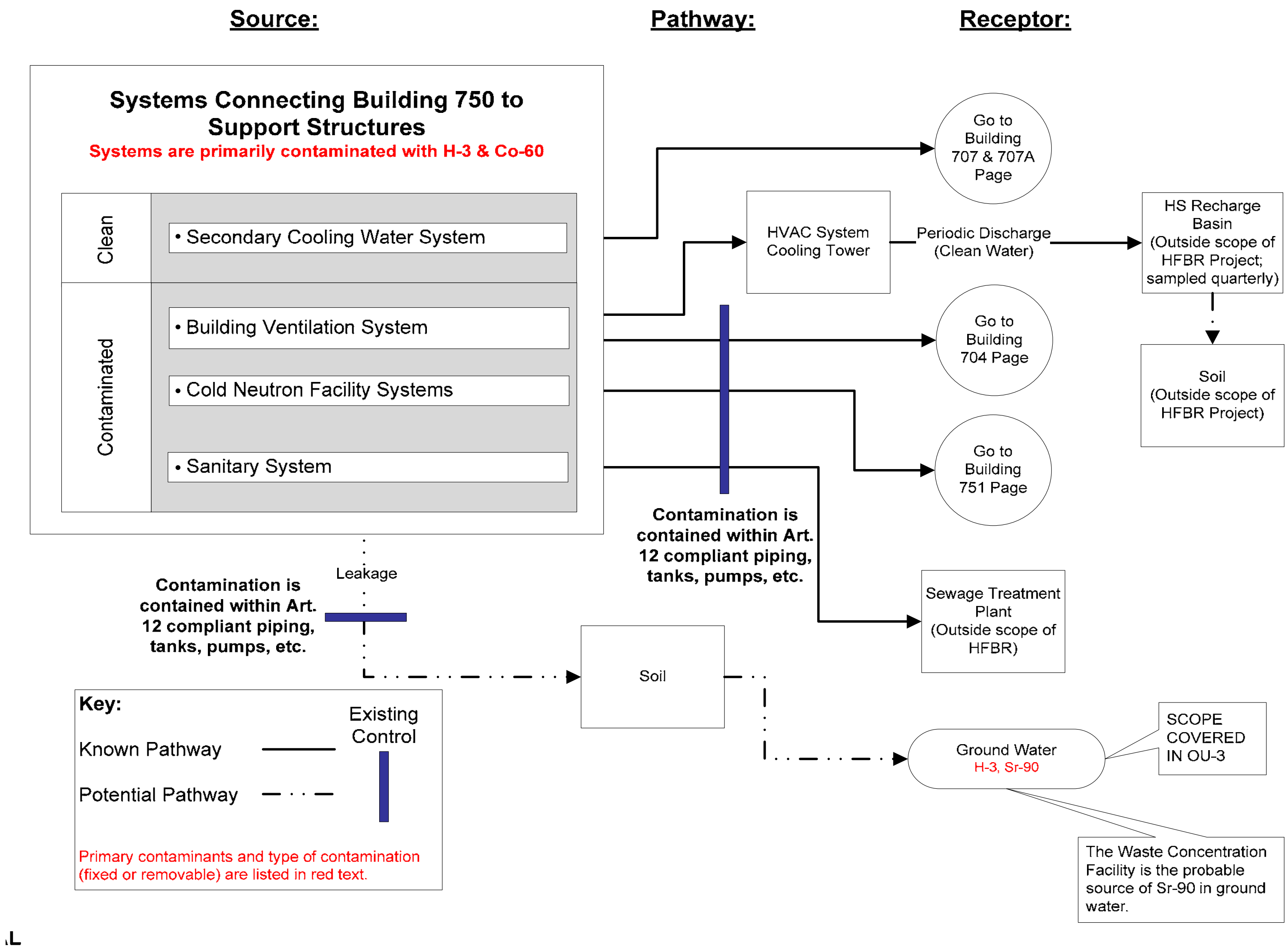

Figure 6.4 High Flux Beam Reactor Connecting Systems – Current State

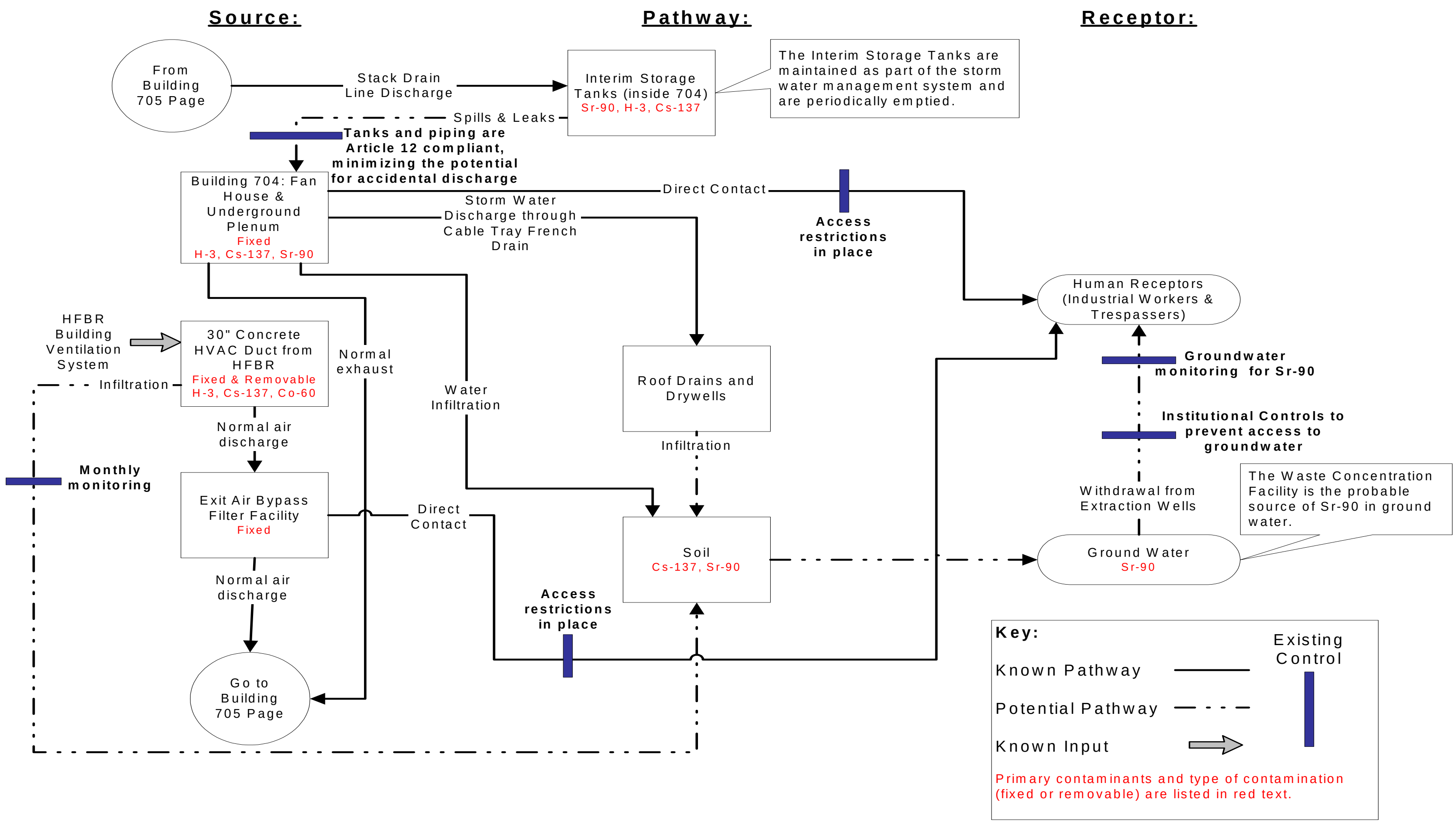

Figure 6.5 HFBR Support Structures: Building 704 – Current State

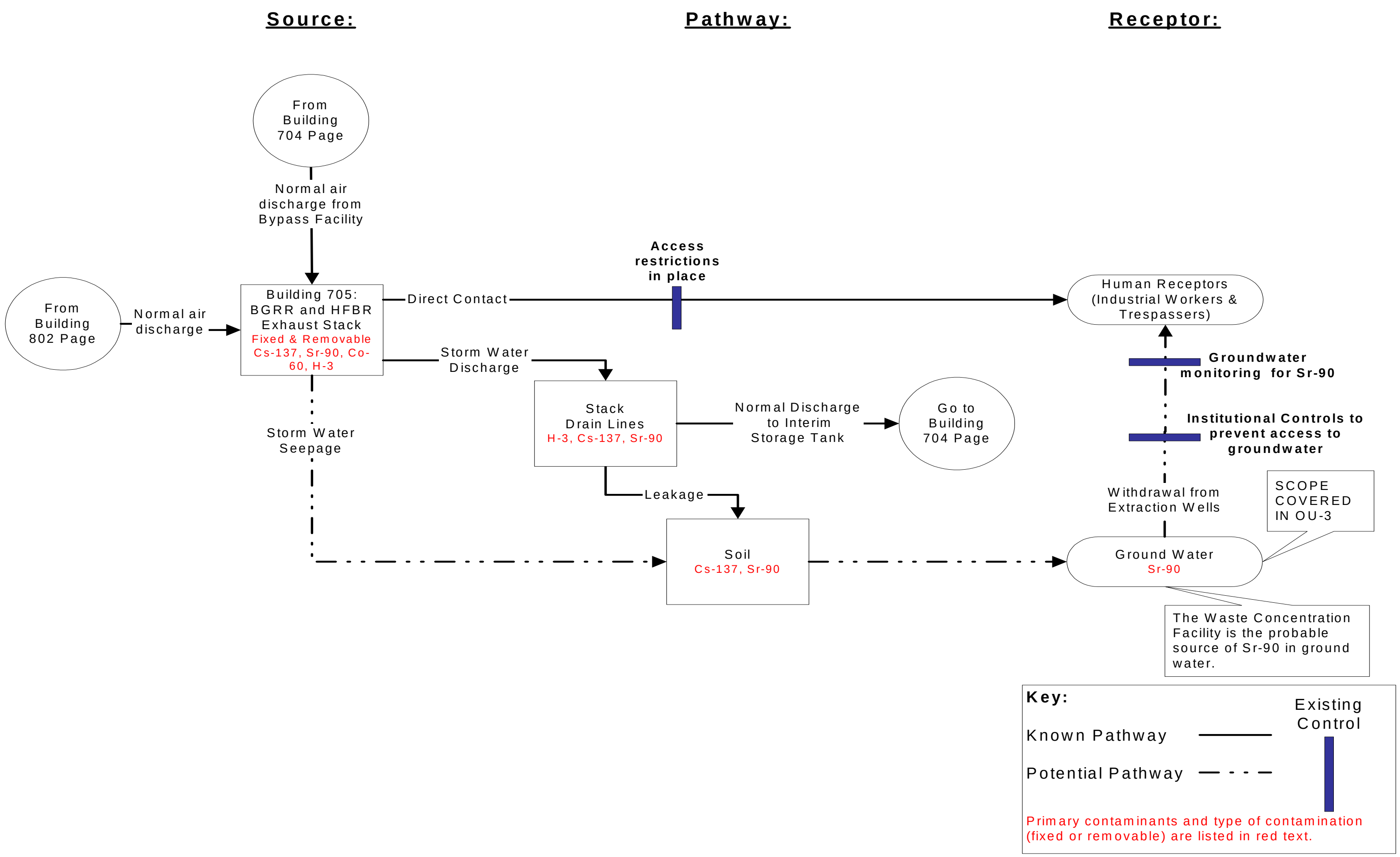

Figure 6.6 HFBR Support Structures: Building 705 – Current State

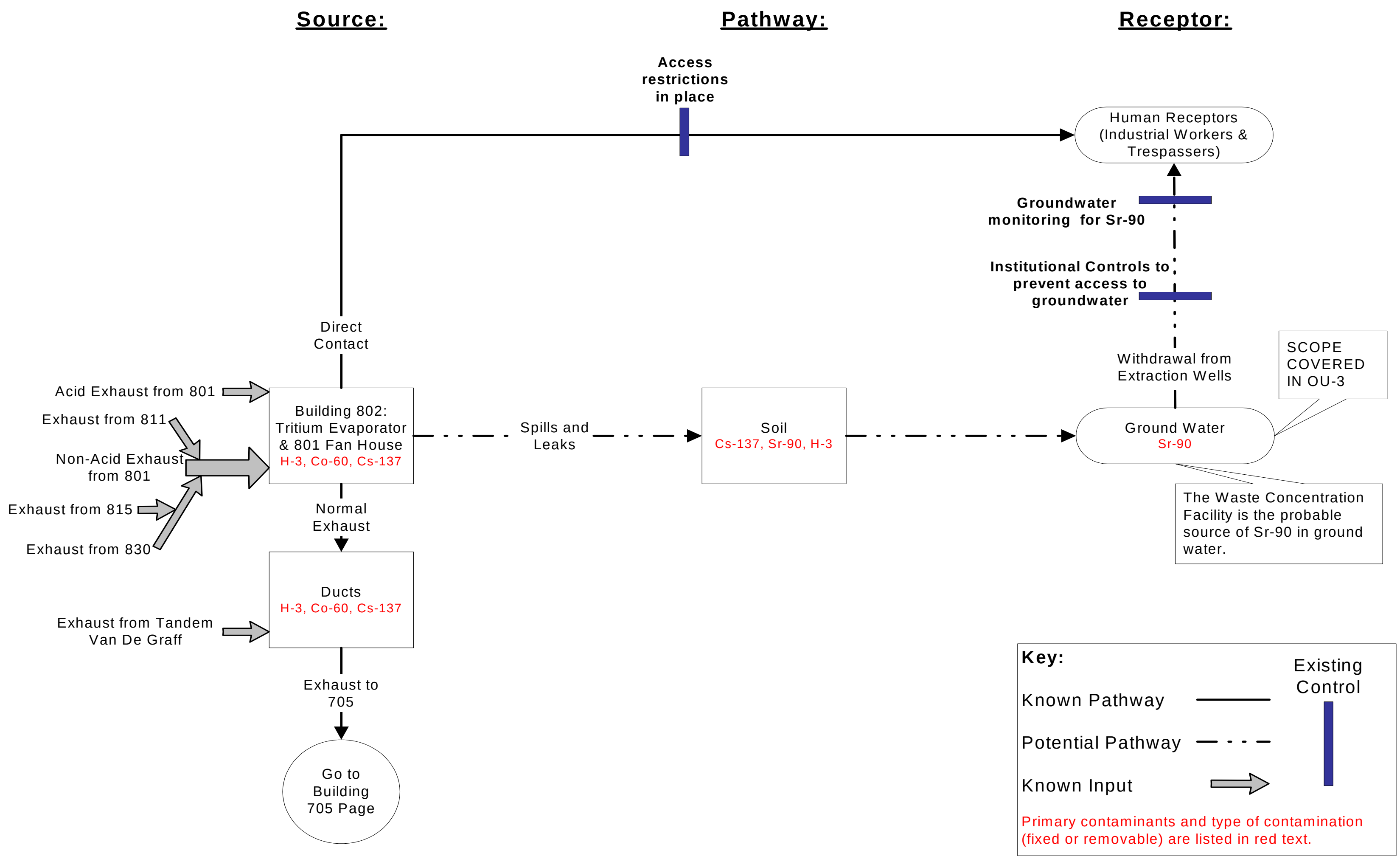

Figure 6.7 HFBR Support Structures: Building 802 – Current State

7.0 REMEDIAL ACTION OBJECTIVES

The Remedial Action Objectives (RAOs) used to evaluate the HFBR Complex remedial action alternatives were developed taking into consideration the potential exposure pathways. The RAOs for the HFBR Complex remedial actions are to control, minimize, or eliminate:

- All routes of future human and/or environmental exposure to radiologically contaminated facilities or materials
- The potential for future release of non-fixed radiological or chemical contamination to the environment
- All routes of future human and/or environmental exposure to contaminated soils
- The future potential for contaminated soils to impact groundwater

Table 7.1 provides a cross reference between these RAOs and the various components, systems, and structures comprising the HFBR Complex.

7.1 Land Use

BNL is a DOE research facility with associated support facilities and is expected to remain so for the foreseeable future. Access to the BNL site is currently restricted and controlled. To assist in the evaluation of risks associated with current and future uses of the sites, BNL developed a *Future Land Use Plan* in 1995, which articulates the projected land use at the end of the cleanup. The Plan is comprehensive and long-term, and provided the initial framework and assumptions for incorporating future land use considerations into cleanup decisions. The Plan provides guidance for future development and considers use restrictions determined to be necessary to support response actions in the protectiveness of human health and the environment. DOE and BNL continuously evaluate and update future land use plans through the DOE's Ten Year Site Planning process, which addresses the need for new facilities to meet emerging research needs while making maximum use of existing facilities and assets.

BNL has five general land use categories in its plans: 1) Industrial/commercial; 2) residential; 3) agricultural; 4) recreational; and 5) open space/wilderness. Only industrial and commercial uses are currently applicable to the HFBR complex.

Because the remedies for the HFBR will result in some hazardous substances remaining above levels allowed for unlimited use and unrestricted exposure during the safe storage (decay) period, five-year reviews will be conducted pursuant to CERCLA §121(c) to ensure that the remedy continues to provide adequate protection of human health and the environment. Additionally, as long as these hazardous substances remain above levels allowed for unlimited use and unrestricted exposure, future reuse of the HFBR complex will be limited to commercial or industrial uses. Commercial application involving the potential for continuous direct exposure in these areas to the general public, such as child day care or health care facilities, will be prohibited.

Land use control objectives for the HFBR complex are:

- Control future excavation and other actions that could disturb residual subsurface contamination
- Prohibit use of the HFBR complex for residential housing, schools, child care facilities or other uses involving the potential for continuous direct exposure to the general public
- Ensure worker safety through access control and other work control measures

Table 7.1 Application of Remedial Action Objectives

	Control, minimize or eliminate all routes of future human and/or environmental exposure to radiologically contaminated facilities or materials.	Control, minimize, or eliminate the potential for future release of non-fixed radiological or chemical contamination to the environment.	Control, minimize, or eliminate all routes of future human and/or environmental exposure to contaminated soils.	Control, minimize, or eliminate the future potential for contaminated soils to impact groundwater.
Activated Components	■			
Contaminated Structures within Building 750	■	■		■
Contaminated HFBR Systems	■	■		■
Contaminated HFBR Connecting Systems	■	■	■	■
Building 704	■	■	■	■
Building 705	■	■	■	■
Building 802	■	■	■	■

8.0 DESCRIPTION OF ALTERNATIVES

Four HFBR remedial action alternatives were identified and evaluated. The four remedial action alternatives were developed with the involvement of representatives from DOE, EPA, NYSDEC, NYSDOH, and SCDHS. These alternatives are as follows:

Alternative A: No Additional Action

Alternative B: Phased Decontamination and Dismantlement

Alternative C: Phased Decontamination and Dismantlement with Near-Term Control Rod Blade Removal

Alternative D: Near-Term Decontamination and Dismantlement

These alternatives are described in Sections 8.1 through 8.4. Note that remediation of the Waste Loading Area (WLA) is included in the scope of all four remedial alternatives.

As shown in Figure 8.1, the WLA is an area of radiologically contaminated soil along the eastern boundary of the FHWMF. The remediation of this area (approximately 2 acres) is included in the HFBR scope of work. The transfer of the WLA from the FHWMF to the HFBR project was documented in a modification to the FHWMF Remedial Design Implementation Plan. Cleanup of the WLA is currently in progress, using the cleanup goal and methodology specified for the FHWMF in the OU I ROD.

Table 8.1 shows the end-states and timeframes of the major dismantlement and removal activities.

8.1 Alternative A—No Additional Action

8.1.1 End State

Alternative A, no additional action, is used as a baseline alternative and is required to be considered under CERCLA. The Alternative A end state is defined as the as-is condition of the HFBR complex. This end state includes the intact structures, systems, and components described in Section 1. The end state radiological conditions are those determined during HFBR characterization and described in Section 5. The radiological inventory of 65,000 Ci would remain in place, and future reductions in this inventory would be solely the result of radioactive decay. (For example, the radioactive inventory would be reduced by approximately 88 percent, to 7,700 Ci in 65 years).

8.1.2 Scope of Alternative A

8.1.2.1 Active Decontamination and Dismantlement

Alternative A includes those actions listed in Table 4.1 that have already been completed. These actions are summarized as follows:

- The HFBR fuel was removed and sent to an off-site facility.
- The primary coolant was drained and sent to an off-site facility.
- Scientific equipment was removed and is being reused.
- Shielding and chemicals were removed and are being reused at BNL and other facilities.
- The cooling tower superstructure was dismantled and disposed.
- The confinement structure and spent fuel canal were modified to meet Suffolk County Article 12 requirements.
- The Stack Monitoring Facility (Building 715) was dismantled and disposed.
- The Cooling Tower Basin and Pump/Switchgear House (Building 707/707A) were dismantled and disposed.
- The Water Treatment House (Building 707B) was dismantled and disposed.
- The Cold Neutron Facility (Building 751) contaminated systems were removed and the clean building has been transferred to another organization for re-use.
- The Guard house (Building 753) was dismantled and disposed.

8.1.2.2 Surveillance and Maintenance

To manage the residual radiological inventory in the HFBR complex, Alternative A relies on S&M for an indefinite period of time. HFBR S&M would be implemented to ensure that the radiological inventory is maintained in a safe condition, to prevent water infiltration, and to preclude human exposure pathways or migration outside of the confinement structure and into the environment. S&M activities would include:

- Groundwater monitoring and other actions continue in accordance with OU III ROD
- Continuation of air effluent monitoring
- Periodic physical examination of the confinement building and interior structures, including inspection for water infiltration
- Routine maintenance of the confinement building and repair of deficiencies found during confinement building inspections in order to preserve the physical barriers that contain the radioactive materials in the HFBR complex
- Periodic reporting to EPA and NYSDEC

The HFBR S&M plan would be developed by DOE in consultation with EPA and NYSDEC.

8.1.2.3 Land Use and Institutional Controls

LUICs for Alternative A would be deployed for an indefinite period of time. At a minimum, these LUICs would include:

- Measures for controlling future excavation and other actions that could otherwise disturb residual subsurface contamination
- Land use restrictions and an acceptable method for evaluating potential impact that the remaining contaminants have on future development

- Land use restriction and reporting requirements that are passed on to future landowners through an environmental easement on the deed to the property. In light of the fact that a deed does not exist for property owned by a federal entity, DOE will be responsible for implementing these controls as long as the property remains under its ownership. In the event of property transfer to a non-federal entity, DOE will ensure that a deed is established and that the required environmental easements are added to the deed.
- Requirements for annual certification to EPA and NYSDEC stating that the institutional and engineering controls put in place are unchanged from the previous certification, and that nothing has occurred that would impair the ability of the controls to protect public health or the environment or constitute a violation or failure to comply with the site management plan. This annual certification would be prepared and submitted by a professional engineer or environmental professional acceptable to NYSDEC.

These LUICs are described in the Land Use Controls Management Plan (LUCMP) developed by DOE and reviewed and approved by EPA and concurred by NYSDEC.

An assessment of the long-term effectiveness of these S&M activities and LUICs would be included in the CERCLA Five-Year Reviews that are to be conducted by DOE and reviewed and approved by EPA and NYSDEC. The purpose of the five-year reviews is to determine whether the remedies implemented at BNL (including the HFBR) continue to be protective of human health and the environment. The five-year reviews will include an evaluation of the effectiveness of S&M activities, engineering controls, and LUICs. The methods, findings, and recommendations of the reviews will be documented in Five-Year Review Reports.

8.1.3 Schedule and Cost of Alternative A

By definition, the active (i.e., construction) phase of Alternative A is now complete except for the remediation of the WLA. The cleanup of the WLA using the dose-based cleanup goal of 15 mrem/yr (above background) and methodology specified in the OU I ROD is currently in progress. A Final Status Survey (FSS) will be performed to demonstrate that the cleanup goal for the WLA will be satisfied and will include a verification survey performed by an independent DOE contractor, Oak Ridge Institute for Science and Education. As shown in Figure 8.2, S&M and LUICs would continue for an indefinite period of time.

Previous expenditures to perform the work completed to date total approximately $25 M. Based on a bottom-up estimate, using production rates from RS Means and historical experience at BNL in the removal, transportation, and disposal of contaminated soil, the additional capital cost to complete the WLA cleanup is approximately $1 M, resulting in a total capital cost estimate to complete Alternative A of $26 M.

Based on operating experience, annual costs for S&M and LUICs total $400,000 per year. Because there is no limit on the required duration, the total cost of S&M and LUICs cannot be estimated.

8.2 Alternative B – Phased Decontamination and Dismantlement

8.2.1 End-State

Alternative B provides for the near-term dismantlement and removal of the ancillary buildings, contaminated underground and piping systems, and the cleanup of contaminated HFBR yard area soils by FY2020. The near-term soil cleanup of the HFBR yard area would be performed in accordance with the dose-based cleanup objectives for radiological soil contamination (for residential use) and methodology specified in the OU I ROD. The boundaries of the HFBR yard area soils are defined in the HFBR complex site plan (Figure 1.3).

This alternative includes a period of radioactive decay not to exceed 65 years to allow for the natural reduction of the high radiation dose rates associated with the activated components. The radioactive material would remain bound within the metal and concrete of the activated components (reactor internals, CRBs, reactor vessel, thermal shield, and biological shield). At the conclusion of this period, all remaining HFBR structures, systems, and components would be dismantled and disposed with the possible exception of the subsurface concrete structures, of the confinement building base mat, and the stack foundation. However, the final decision to leave either of the structures in place will be determined on the basis of radiological sampling and dose assessment performed in accordance with the methodology specified in the OU I ROD. The entire remaining radiological inventory would be removed at the conclusion of the period of radioactive decay. The cleanup, after dismantlement of the confinement building, would satisfy the dose-based cleanup objectives for radiological contamination (for residential use) and methodology specified in the OU I ROD. There will be no need for any additional period of LUICs.

8.2.2 Scope of Alternative B

8.2.2.1 Active Decontamination and Dismantlement

Alternative B includes those actions that have already been completed. These actions are summarized as follows:

- The HFBR fuel was removed and sent to an off-site facility.
- The primary coolant was drained and sent to an off-site facility.
- Scientific equipment was removed and is being reused.
- Shielding and chemicals were removed and are being reused at BNL and other facilities.
- The cooling tower superstructure was dismantled and disposed.
- The confinement structure and spent fuel canal were modified to meet Suffolk County Article 12 requirements.
- The Stack Monitoring Facility (Building 715) was dismantled and disposed.
- The Cooling Tower Basin and Pump/Switchgear House (Building 707/707A) was dismantled and disposed.
- The Water Treatment House (Building 707B) was dismantled and disposed.
- The Cold Neutron Facility (Building 751) contaminated systems were removed and the clean building has been transferred to another organization for re-use.

- The Guard house (Building 753) was dismantled and disposed.

Alternative B would also include the near-term dismantlement and disposal of the remaining HFBR ancillary buildings, contaminated underground duct and piping systems, and the removal and disposal of contaminated yard area soils by FY2020, as further described below.

All of the remaining HFBR ancillary buildings, including the structures, systems, and components (Figure 1.3) would be dismantled and disposed in the near term, by FY2020, to at least 2 ft below grade. Sampling and analysis would then be performed to verify that the underlying soils cleanup would be performed in accordance with the dose-based cleanup objectives for radiological soil contamination (for residential use) and methodology specified in the OU I ROD. To the extent required, contaminated soils would be removed to meet this cleanup goal. The remaining ancillary buildings include the following:

- Stack (Building 705)
- Fan house including underground plenum (Building 704)
- Fan house (for Building 801) and tritium evaporator (Building 802)

Contaminated underground duct and piping systems would be removed in the near term, by FY2020, including the confirmation and/or cleanup of soils, to the extent required, to be in accordance with the dose-based cleanup objectives for radiological soil contamination (for residential use) and methodology specified in the OU I ROD. The extent of underground service and piping system removal is shown on Figure 5.6, and Table 8.2 provides a description of this work. These services and piping systems include:

- Building exhaust ducts from Buildings 750, 801, and 802
- Sections of exhaust ducts from 815, 830, and the Tandem Van de Graaff generator
- Sanitary discharge line
- D/F waste line

Cleanup of the WLA is currently in progress.

Confirmatory sampling and analysis would be conducted in order to confirm that cleanup of the HFBR yard area soils is in accordance with the dose-based cleanup objectives for radiological soil contamination (for residential use) and methodology specified in the OU I ROD. Contaminated soil would be removed in the near term to the extent required to meet this goal. The boundaries of the HFBR yard area soils are defined in the HFBR complex site plan (Figure 1.3).

Subsequent to the completion of these decommissioning activities, the HFBR confinement building would be prepared for long-term safe storage to allow for the radioactive decay. The safe storage physical preparations include:

- Modification of building ventilation exhaust system to ensure the atmosphere in the confinement is safe for personnel access for S&M activities

- Modification of security system and alarms on all entryways to confinement
- Installation of a water infiltration detection system with remote alarms
- Modification of the confinement building lighting and electric power distribution to support surveillance activities

Implementation of miscellaneous physical preparatory activities that will also be required include:

- Correction of confinement building minor deficiencies
- Drain-down of mechanical systems, including the removal of residual heavy water from the primary system piping and components
- Removal of miscellaneous waste and excess combustible materials
- Improvement to storm water drainage by adjusting grades so water drains away from the HFBR in four areas outside the transformer room, north of the east truck dock, by the air conditioning cooling tower, and the entrance to the blower room.
- Modification to secure access/entry points from outside

When the physical preparations are complete, an S&M program for the long-term safe storage of the confinement building will be deployed, as described in the Surveillance and Maintenance subsection below.

At the conclusion of the radioactive decay period, Alternative B would include the segmentation, removal, and disposal of activated structures and components:

- Reactor vessel and internals
- Control rod blades
- Thermal shield
- Biological shield
- Beam plugs

Subsequent to activated component removal, this alternative would include the dismantlement and removal of the reactor confinement building (Building 750), including:

- All Building 750 structures, systems and components
- Cleanup of underlying soils to the extent required to meet the cleanup goal and methodology specified in the OU I ROD

At the conclusion of Alternative B, the entire HFBR complex and contaminated soils would be removed allowing for residential use based on the cleanup goal and methodology specified in the OU I ROD. All structures will be removed to at least 2 ft below grade, with the possible exception of the subsurface concrete structures of the confinement building base mat and stack foundation,

8.2.2.2 Surveillance and Maintenance

An S&M program would be deployed to manage the inventory of radioisotopes that would remain throughout the period of radioactive decay and the active phase of this alternative. HFBR S&M would be implemented to ensure that the inventory of stored radioisotopes and all residual contamination is maintained in a safe condition, and to preclude future human exposure pathways or migration from their locations within the reactor confinement building and HFBR yard area. The S&M program would cover the 65-year period of radioactive decay and the three years of HFBR dismantlement. The cleanup following the last phase of HFBR dismantlement would meet residual soil contamination levels that would allow for residential land use pursuant to the OU I cleanup goal, specified in the ROD. S&M activities would include:

- Groundwater monitoring and other actions would continue in accordance with OU III ROD requirements
- Continuation of air effluent monitoring
- Routine inspection of the reactor complex, including the maintenance and periodic refurbishment of structures, systems, and components that are important to the storage of the inventory of HFBR radioisotopes throughout the period of radioactive decay
- Routine inspection of the yard area, including routine maintenance and periodic refurbishment of ground cover to prevent soil erosion
- Periodic reporting to EPA and NYSDEC

The HFBR S&M plan would be developed by DOE in consultation with EPA and NYSDEC.

8.2.2.3 Land Use and Institutional Controls

LUICs for Alternative B would be deployed for a 65-year period of radioactive decay and the three years of HFBR dismantlement, as described above. At a minimum, these LUICs would include:

- Measures for controlling future excavation and other actions that could otherwise disturb residual subsurface contamination.
- Land use restrictions and an acceptable method for evaluating potential impact that the remaining contaminants have on future development.
- Land use restriction and reporting requirements that are passed on to future landowners through an environmental easement on the deed to the property. In light of the fact that a deed does not exist for property owned by a federal entity, DOE would be responsible for implementing these controls as long as the property remains under its ownership. In the event of property transfer to a non-federal entity, DOE would ensure that a deed be established and that the required environmental easements are added to the deed at that time.
- Requirements for annual certification to EPA and NYSDEC stating that the institutional and engineering controls put in place are unchanged from the previous certification, and that nothing has occurred that would impair the ability of the controls to protect public health or the environment or constitute a violation or failure to comply with the site management plan. This annual certification would be prepared and submitted by a professional engineer or environmental professional acceptable to NYSDEC.

These LUICs are described in the LUCMP developed by DOE and reviewed and approved by EPA and concurred by NYSDEC.

An assessment of the long-term effectiveness of these S&M activities and LUICs would be included in the CERCLA Five-Year Reviews that are to be conducted by DOE and reviewed and approved by EPA and NYSDEC. The purpose of the five-year reviews is to determine whether the remedies implemented at BNL (including the HFBR) continue to be protective of human health and the environment. The five-year reviews will include an evaluation of the effectiveness of S&M activities, engineering controls, and LUICs and an assessment of new technologies that could be implemented to reduce the overall time for remedy completion. The methods, findings, and recommendations of the reviews will be documented in Five-Year Review Reports.

8.2.3 Schedule and Cost of Alternative B

Earlier dismantlement of the remaining HFBR structures, systems, and components will be considered as part of the CERCLA Five-Year Reviews, and in any event would be removed after no more than 65 years. For the purpose of schedule and cost estimate development and comparison purposes, the 65-year bounding duration was used. After this period the balance of the HFBR structures, systems, and components would be removed over a three-year schedule. An S&M program and LUICs would be maintained throughout this entire duration. Following the active phase, there will be no need for any additional period of LUICs. The implementation schedule for Alternative B is illustrated in Figure 8.2.

Previous expenditures to perform the work completed to date total approximately $25 M. The additional capital cost to complete the active phase of Alternative B, including the WLA, is $110 M, and the total capital cost estimate is $135 M.

Based on operating experience, the annual costs of S&M is $400,000. With modifications to the HFBR complex, S&M costs would be reduced to $100,000 per year. Throughout 65 years of radioactive decay, major equipment refurbishment would be conducted at 20-year intervals. The estimated costs are $100,000 per interval. Following radioactive decay and upon completion of final HFBR dismantlement, the cost for implementing HFBR S&M and LUICs would be eliminated. Based on the foregoing, the consolidated cost estimate for the S&M and LUIC for Alternative B is $7 M.

The total estimated cost of Alternative B is $142 M, including capital, S&M, and LUIC costs across the entire project lifecycle.

8.3 Alternative C- Phased Decontamination and Dismantlement with Near-Term Control Rod Blade Removal

8.3.1 End State

The Alternative C end state is the same as that for Alternative B. As discussed herein, the only difference is in the timing of the dismantlement and removal activities.

Alternative C provides for the near-term dismantlement and removal of the ancillary buildings, contaminated underground services and duct and piping systems, and the remediation of contaminated HFBR yard area soils by FY2020. The near-term soil cleanup of the HFBR yard area would be performed in accordance with the dose-based cleanup objective and methodology for radiological soil contamination (for residential use) specified in the OU I ROD. The boundaries of the HFBR yard area soils are defined in the HFBR complex site plan (Figure 1.3). In addition, Alternative C provides for the near-term removal, by FY2020, of the CRBs and beam plugs.

This alternative includes a period of radioactive decay not to exceed 65 years to allow for the natural reduction of the high radiation dose rates associated with the remaining activated components. During this period the radioactive material would remain bound within the metal and concrete of the activated components (reactor internals, reactor vessel, thermal shield, and biological shield). At the conclusion of this period, all remaining HFBR structures, systems, and components would be dismantled and removed with the possible exception of the subsurface concrete structures of the confinement building base mat and the stack foundation. However, the final decision to leave either of the structures in place will be determined on the basis of radiological sampling and dose assessment performed in accordance with the methodology specified in the OU I ROD. The entire remaining radiological inventory would be removed at the conclusion of the period of radioactive decay. The cleanup, after dismantlement of the confinement building, would satisfy the cleanup goal (for residential use) and methodology specified in the OU I ROD. There will be no need for any additional period of LUICs.

8.3.2 Scope of Alternative C

8.3.2.1 Active Decontamination and Dismantlement

Alternative C is almost identical to that of Alternative B. The only difference is in the timing of the removal of the CRBs and beam plugs.

Alternative C includes those actions that have already been completed. These actions are summarized as follows:

- The HFBR fuel was removed and sent to an off-site facility.
- The primary coolant was drained and sent to an off-site facility.
- Scientific equipment was removed and is being reused.
- Shielding and chemicals were removed and are being reused at BNL and other facilities.
- The cooling tower superstructure was dismantled and disposed.
- The confinement structure and spent fuel canal were modified to meet Suffolk County Article 12 requirements.
- The Stack Monitoring Facility (Building 715) was dismantled and disposed.
- The Cooling Tower Basin and Pump/Switchgear House (Building 707/707A) was dismantled and disposed.
- The Water Treatment House (Building 707B) was dismantled and disposed.
- The Cold Neutron Facility (Building 751) contaminated systems were removed and the clean building has been transferred to another organization for re-use.

- The Guard house (Building 753) was dismantled and disposed.

Alternative C would also include the near-term dismantlement and removal of the HFBR ancillary buildings, contaminated underground services and duct and piping systems, the removal of contaminated yard area soils, and the removal of the 16 CRBs and beam plugs by FY2020, as further described below.

All of the HFBR ancillary buildings, including the structures, systems and components, (Figure 1.3) would be dismantled and removed in the near term, by FY2020, to at least 2 ft below grade. Sampling and analysis would be performed in accordance with the dose-based cleanup goal and methodology to verify that the underlying soils meet the cleanup goal specified in the OU I ROD for residential land use. To the extent required, contaminated soils would be removed to meet this cleanup goal. Ancillary buildings include the following:

- Stack (Building 705)
- Fan house including underground plenum (Building 704)
- Fan house (for Building 801) and tritium evaporator (Building 802)

Contaminated underground services and piping systems would be removed in the near term, by FY2020, including the confirmation and/or cleanup of soils to the extent required to meet the cleanup goal specified in the OU I ROD for residential land use. The extent of underground service and duct and piping system removal is shown in Figure 5.6, and Table 8.2 provides a description of this work. These services and duct and piping systems include:

- Building exhaust ducts from Buildings 750, 801, and 802
- Sections of exhaust ducts from 815, 830, and the Tandem Van de Graaff generator
- Sanitary discharge line
- D/F waste line

Cleanup of the WLA is currently in progress.

Confirmatory sampling and analysis would be conducted in accordance with the dose-based cleanup objective for radiological soil contamination in order to confirm that HFBR yard area soils meet the cleanup goal specified in the OU I ROD for residential use. Contaminated soil would be removed in the near term, by FY2020, to the extent required to meet this goal. The boundaries of the HFBR yard area soils are defined in the HFBR complex site plan (Figure 1.3).

The 16 CRBs in the reactor and the nine beam plugs located on the experimental level would also be removed in the near term, by FY2020. Removal of the CRBs would require flooding of the reactor vessel, interconnecting piping, and spent fuel canal. The spent fuel canal is a freestanding, double-walled, stainless steel liner with an instrumented low point sump to eliminate the potential for leakage to the environment. The CRBs would be removed from the reactor; transferred to the spent fuel canal; and packaged in shielded transportation casks for shipment and disposal. Following CRB removal, the up to 75,000 gallons of water used to flood the reactor and spent fuel canal would be processed and disposed. The reactor would be reassembled, and the spent fuel canal would be decontaminated. The beam plugs would be transferred from the beam plug storage facility and loaded into shielded transportation casks for shipment and disposal.

Subsequent to the completion of these decommissioning activities, the HFBR confinement building would be prepared for long-term safe storage to allow for the radioactive decay. The safe storage physical preparations include:

- Modification of building ventilation exhaust system that ensure the atmosphere in the confinement is safe for personnel access for S&M activities
- Modification of security system and alarms on all entryways to confinement
- Installation of water infiltration detection system with remote alarms
- Modification of confinement building lighting and electric power distribution to support surveillance activities

Implementation of miscellaneous physical preparatory activities that will also be required include:

- Correction of confinement building minor deficiencies
- Drain-down of mechanical systems including the removal of residual heavy water from the primary system piping and components
- Removal of miscellaneous waste and excess combustible materials
- Improvement to storm water drainage by adjustment of grades so it drains away from the HFBR in four areas outside the transformer room, north of the east truck lock, by the air conditioning cooling tower, and the entrance to the blower room.
- Modification to secure access/entry points from outside

Upon completion of the physical preparations an S&M program for the long-term safe storage of the confinement building, as described in the Surveillance and Maintenance subsection below, will be deployed.

After the remainder of the 65 year decay period, Alternative C would include the segmentation, removal, and disposal of activated structures and components:

- Reactor vessel and internals
- Thermal shield
- Biological shield

Subsequent to activated structures and components removal, this alternative would include the dismantlement and disposal of the reactor confinement building (Building 750), including:

- All Building 750 structures, systems and components
- Cleanup of underlying soils to the extent required to meet the cleanup goal and methodology specified in the OU I ROD

At the conclusion of Alternative C, the entire HFBR complex and contaminated soils would be removed, allowing for residential land use. All structures will be removed to at least 2 ft below grade, with the possible exception of the subsurface concrete structures of the confinement building base mat and stack foundation.

8.3.2.2 Surveillance and Maintenance

An S&M program would be deployed to manage the inventory of radioisotopes that would remain throughout the period of radioactive decay and the active phase of this alternative. HFBR S&M would be implemented to ensure that the inventory of stored radioisotopes and all residual contamination is maintained in a safe condition, and to preclude future human exposure pathways or migration from their locations within the reactor confinement building and HFBR yard area. The S&M program and LUICs would cover the 65-year period of radioactive decay and the three years of HFBR dismantlement. The cleanup following the last phase of HFBR dismantlement would meet residual soil contamination levels that would allow for residential land use pursuant to the cleanup goal and methodology specified in the OU I ROD. S&M activities would include:

- Groundwater monitoring and other actions would continue in accordance with OU III ROD requirements
- Continuation of air effluent monitoring
- Routine inspection of the reactor complex, including the maintenance and periodic refurbishment of structures, systems, and components that are important to the storage of the inventory of HFBR radioisotopes throughout the period of radioactive decay
- Routine inspection of the yard area, including routine maintenance and periodic refurbishment of ground cover to prevent soil erosion
- Periodic reporting to EPA and NYSDEC

The HFBR S&M plan would be developed by DOE in consultation with EPA and NYSDEC.

8.3.2.3 Land Use and Institutional Controls

LUICs for Alternative C would be deployed for a 65-year period of radioactive decay and the three years of HFBR dismantlement, as described above. At a minimum, these LUICs would include:

- Measures for controlling future excavation and other actions that could otherwise disturb residual subsurface contamination.
- Land use restrictions and an acceptable method for evaluating potential impact that the remaining contaminants have on future development.
- Land use restriction and reporting requirements that are passed on to future landowners through an environmental easement on the deed to the property. In light of the fact that a deed does not exist for property owned by a federal entity, DOE would be responsible for implementing these controls as long as the property remains under its ownership. In the event of property transfer to a non-federal entity, DOE would ensure that a deed be established and that the required environmental easements are added to the deed.

- Requirements for annual certification to EPA and NYSDEC stating that the institutional and engineering controls put in place are unchanged from the previous certification, and that nothing has occurred that would impair the ability of the control to protect public health or the environment or constitute a violation or failure to comply with the site management plan. This annual certification would be prepared and submitted by a professional engineer or environmental professional acceptable to NYSDEC.

These LUICs are described in the LUCMP developed by DOE and reviewed and approved by EPA and concurred by NYSDEC.

An assessment of the long-term effectiveness of these S&M activities and LUICs would be included in the CERCLA Five-Year Reviews that are to be conducted by DOE and reviewed and approved by EPA and NYSDEC. The purpose of the five-year reviews is to determine whether the remedies implemented at BNL (including the HFBR) continue to be protective of human health and the environment. The five-year reviews will include an evaluation of the effectiveness of S&M activities, engineering controls, and LUICs and an assessment of new technologies that could be implemented to reduce the overall time for remedy completion. The methods, findings, and recommendations of the reviews will be documented in Five-Year Review Reports.

8.3.3 Schedule and Cost of Alternative C

Alternative C provides for the near-term removal and disposal, by FY2020, of the CRBs and beam plugs. These activities will be accomplished prior to preparation of the confinement building for long-term safe storage.

Earlier dismantlement of the remaining HFBR structures, systems, and components will be considered as part of the CERCLA Five-Year Reviews, and, in any event, would be removed after no more than 65 years. For the purpose of schedule and cost estimate development and comparison purposes, the 65-year bounding duration was used.

The cost estimate considers all of the CRB removal activities. After the decay period, the balance of the HFBR structures, systems, and components would be removed over a three-year schedule. An S&M program and LUICs would be maintained throughout this entire duration. Following the active phase, there will be no need for any additional period of LUICs. The implementation schedule for Alternative C is illustrated in Figure 8.2.

Previous expenditures to perform the work completed to date total approximately $25 M. The additional capital cost to complete the active phase of Alternative C, including the WLA is $112 M, and the total capital cost estimate is $137 M.

Based on operating experience, the annual costs of S&M is $400,000. With modifications to the HFBR complex, S&M costs would be reduced to $100,000 per year. Throughout the period of radioactive decay, major equipment refurbishment would be conducted at 20-year intervals. These estimated costs are $100,000 per interval, respectively. Following radioactive decay and upon completion of final HFBR dismantlement, the cost for implementing HFBR S&M and LUICs would be eliminated. Based on the foregoing, the consolidated Alternative C S&M and LUIC cost estimate is $7 M.

The total estimated cost of Alternative C would be $144 M, including capital, S&M, and LUIC costs across the entire project lifecycle.

8.4 Alternative D – Near-Term Decontamination and Dismantlement

8.4.1 End State

- Alternative D provides for the complete near-term removal, by FY2026, of the HFBR complex (with the possible exception of the subsurface concrete structures of the confinement building base mat and stack foundation). It includes the near-term dismantlement and disposal of all HFBR structures, systems, and components, with the possible exception of the subsurface concrete structures, confinement building base mat, and the stack foundation. However, the final decision to leave either of the structures in place will be determined on the basis of radiological sampling and dose assessment performed in accordance with the methodology specified in the OU I ROD. The entire radiological inventory would be removed in the near term, by FY2026, with the exception of residual contamination under the dose-based soil cleanup goal of 15 mrem/yr (above background), and methodology specified in the OU I ROD for residential use in 50 years. Alternative D results in the dismantlement and removal of the HFBR complex by the end of 2026. S&M would be required through this period, and LUICs would be required for an additional 50 years.

8.4.2 Scope of Alternative D

8.4.2.1 Active Decontamination and Dismantlement

Alternative D includes those actions -that have already been completed. These actions are summarized as follows:

- The HFBR fuel was removed and sent to an off-site facility.
- The primary coolant was drained and sent to an off-site facility.
- Scientific equipment was removed and is being reused.
- Shielding and chemicals were removed and are being reused at BNL and other facilities.
- The cooling tower superstructure were dismantled and disposed.
- The confinement structure and spent fuel canal were modified to meet Suffolk County Article 12 requirements.
- The Stack Monitoring Facility (Building 715) was dismantled and disposed.
- The Cooling Tower Basin and Pump/Switchgear House (Building 707/707A) was dismantled and disposed.
- The Water Treatment House (Building 707B) was dismantled and disposed.
- The Cold Neutron Facility (Building 751) contaminated systems were removed and the clean building has been transferred to another organization for re-use.
- The Guard house (Building 753) was dismantled and disposed.

Alternative D includes the near-term dismantlement and removal, by FY2026, of all HFBR structures, systems, and components as described below.

All of the HFBR ancillary buildings, including the structures, systems, and components (Figure 1.3) would be dismantled to at least 2 ft below grade. Sampling and analysis would be performed to verify that the remediation of the underlying soils was performed in accordance with the dose-based cleanup objectives for radiological contamination and methodology specified in the OU I ROD for residential land use. To the extent required, contaminated soils would be removed to meet this cleanup goal. All ancillary buildings listed below would be removed:

- Stack (Building 705)
- Fan house including underground plenum (Building 704)
- Fan house (for Building 801) and tritium evaporator (Building 802)

Contaminated underground duct and piping systems would be removed, including the confirmation and/or cleanup of soils to the extent required to meet the OU I cleanup goal specified in the ROD for residential land use. These services and piping systems include:

- Building exhaust ducts from Buildings 750, 801, and 802
- Sections of exhaust ducts from 815, 830 and the Tandem Van de Graaff generator
- Sanitary discharge line
- D/F waste line

Cleanup of the WLA is currently in progress.

Alternative D would include the near-term segmentation, removal, and disposal, by FY2026, of activated structures and components:

- Reactor vessel and internals
- Control rod blades
- Thermal shield
- Biological shield
- Beam plugs

This alternative would also include confinement building dismantlement and disposal, including:

- All Building 750 structures, systems, and components
- Cleanup of underlying soils to the extent required to meet the OU I ROD cleanup goal for residential land use

Confirmatory sampling and analysis would then be conducted in order to confirm that HFBR yard area soils meet the OU I ROD cleanup goal for residential land use. Contaminated soil would be removed to the extent required to meet this goal. The boundaries of the HFBR yard area soils are defined in the HFBR complex site plan (Figure 1.3).

At the conclusion of Alternative D, the entire HFBR complex would be removed and residual soil contamination would meet the OU I ROD cleanup goal for residential land use. All structures will be removed to at least 2 ft below grade, with the possible exception of the subsurface concrete structures of the confinement building base mat and stack foundation.

8.4.2.2 Surveillance and Maintenance

An S&M program will be deployed to manage the small amount of contamination remaining in the HFBR complex. HFBR S&M would be implemented to ensure that this residual contamination is maintained in a safe condition, and to preclude future human exposure pathways or migration from its location within the HFBR yard area. The S&M program would be implemented for a period of 50 years following the completion of the active phase of decontamination and dismantlement. As described in the OU I ROD, this 50-year period is the time required to reach radiological conditions that would allow for residential land use. S&M activities would include:

- Groundwater monitoring and other actions would continue per the OU III ROD
- Routine inspection of the yard area
- Routine maintenance and periodic refurbishment of ground cover to prevent soil erosion
- Periodic reporting to EPA and NYSDEC

The HFBR S&M plan would be developed by DOE in consultation with EPA and NYSDEC.

8.4.2.3 Land Use and Institutional Controls

LUICs for Alternative D would be deployed for a period of 50 years as described above, following the completion of active decontamination and dismantlement. At a minimum, these LUICs would include:

- Measures for controlling future excavation and other actions that could otherwise disturb residual subsurface contamination.
- Land use restrictions and an acceptable method for evaluating potential impact that the remaining contaminants have on future development.
- Land use restriction and reporting requirements that are passed on to future landowners through an environmental easement on the deed to the property. In light of the fact that a deed does not exist for property owned by a federal entity, DOE will be responsible for implementing these controls as long as the property remains under its ownership. In the event of property transfer to a non-federal entity, DOE will ensure that a deed is established and that the required environmental easements are added to the deed at that time.
- Requirements for annual certification to EPA and NYSDEC stating that the institutional and engineering controls put in place are unchanged from the previous certification, and that nothing has occurred that would impair the ability of the controls to protect public health or the environment or constitute a violation or failure to comply with the site management plan. This annual certification would be prepared and submitted by a professional engineer or environmental professional acceptable to NYSDEC.

These LUICs are described in the LUCMP developed by DOE, and reviewed and approved by EPA and concurred by NYSDEC.

An assessment of the long-term effectiveness of these S&M activities and LUICs would be included in the CERCLA Five-Year Reviews that are to be conducted by DOE and reviewed and approved by EPA and NYSDEC. The purpose of the five-year reviews is to determine whether the remedies implemented at BNL (including the HFBR) continue to be protective of human health and the environment. The five-year reviews will include an evaluation of the effectiveness of S&M activities, engineering controls, and LUICs. The methods, findings, and recommendations of the reviews will be documented in Five-Year Review Reports.

8.4.3 Schedule and Cost of Alternative D

The active phase of Alternative D decontamination and dismantlement would be completed over an eight-year schedule. At the conclusion of this active phase, S&M and LUICs would continue for a period of 50 years. The Alternative D implementation schedule is shown in Figure 8.2.

Previous expenditures to perform the work completed to date total approximately $25 M. The additional capital cost to complete the active phase of Alternative D, including the WLA, is $176 M, and resulting total capital cost estimate is $201 M. Upon completion of the active phase, the estimated cost to implement HFBR S&M and LUICs is $35,000 per year. Based on the foregoing, the S&M and LUIC costs associated with Alternative D would total $4 M for the required 50-year period. The total estimated cost of Alternative D would be $205 M, including capital, S&M, and LUIC costs across the project lifecycle.

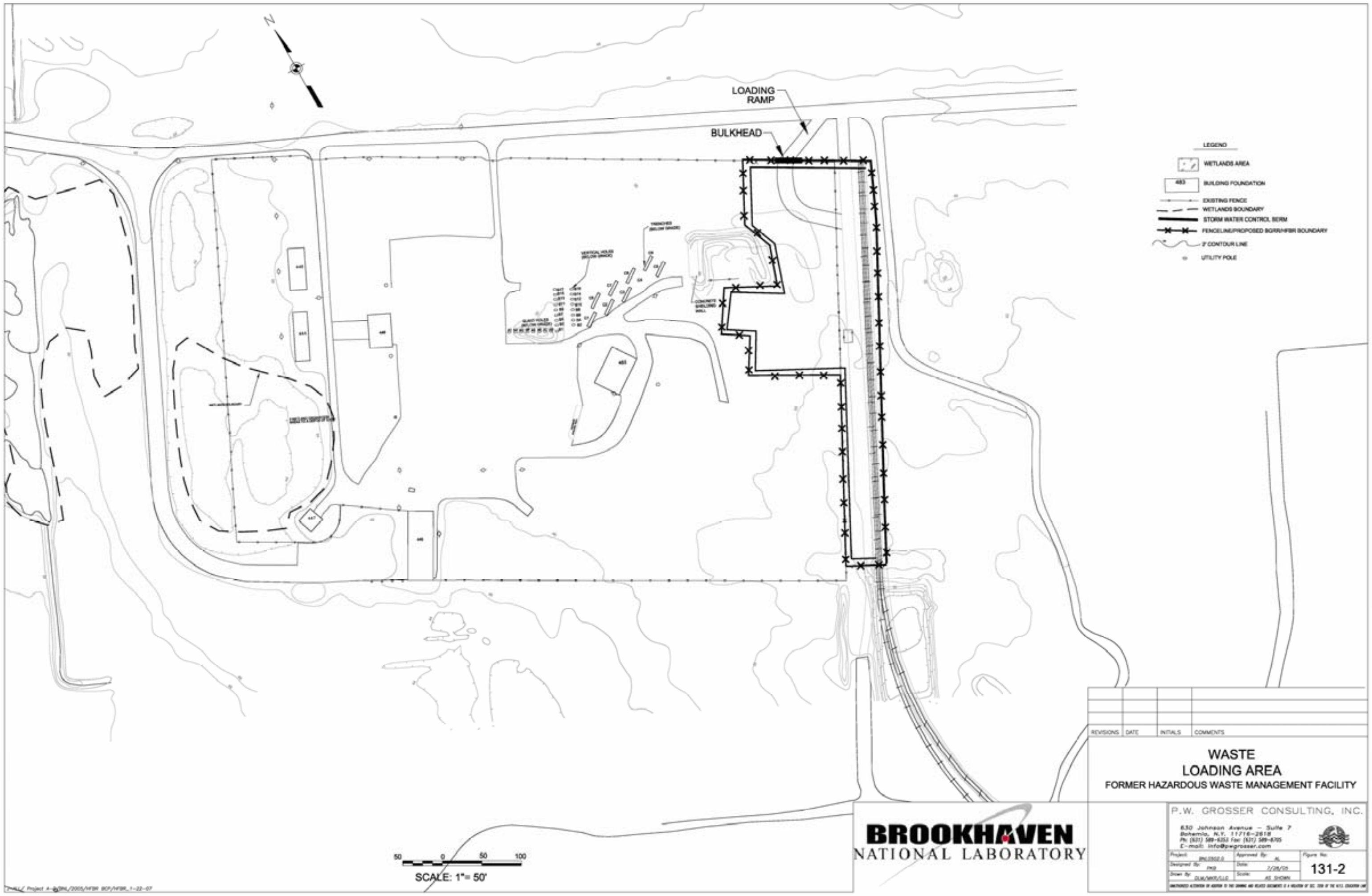

Figure 8.1 Waste Loading Area

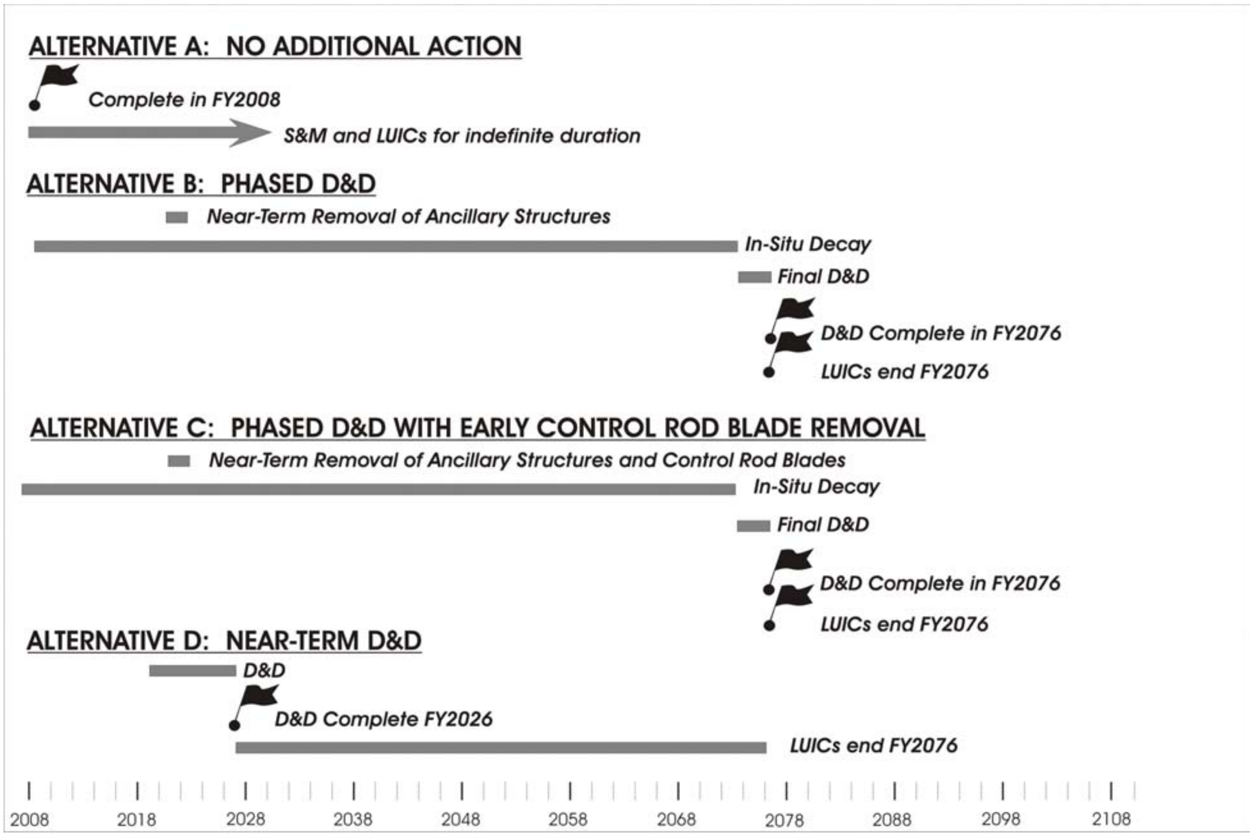

Figure 8.2 Comparison of Alternative Schedules

Table 8.1 End-States and Timeframes

	ALTERNATIVES			
	A	B	C	D
End State	*All remains as is*	*Everything removed*	*Everything removed*	*Everything removed*
Ancillary Buildings and Associated Soils	All remains as is	By end of FY2020	By end of FY2020	By end of FY2026
Ducts, Underground Piping, and Associated Soils	All remains as is	By end of FY2020	By end of FY2020	By end of FY2026
Control Rod Blades and Beam Plugs	All remains as is	After a decay period, not to exceed 65 years	By end of FY2020	By end of FY2026
Other Activated Components	All remains as is	After a decay period, not to exceed 65 years	After a decay period, not to exceed 65 years	By end of FY2026
Confinement Building	All remains as is	After a decay period, not to exceed 65 years	After a decay period, not to exceed 65 years	By end of FY2026
HFBR Complex Contaminated Soils	All remains as is	After a decay period, not to exceed 65 years	After a decay period, not to exceed 65 years	By end of FY2026

Table 8.2 Contaminated Ducts/Pipelines Requiring Removal (Sheet 1 of 2)

Size/Material	Duct/Line	Length (ft)	Status	Basis	Notes
36"/concrete	Duct Bldg. 801 to 42" duct	205	Contaminated	Characterization.	Duct runs from west wall of Bldg. 801 to a point approximately 60' south of Bldg. 801where it transitions from 36" to 42" diameter.
24"/concrete	Duct Bldg. 801 to 42" duct	60	Contaminated	Characterization.	Duct runs from south wall of Bldg. 801 to the 42" diameter duct just downstream of point where it transitions from 36" to 42".
42"/concrete	From connection with 36" duct from Bldg. 801 to Bldg. 802	220	Contaminated	Characterization.	Duct runs from transition point with the 36" duct to Bldg. 802.
42"/steel and 36"/steel	Duct from 42" concrete duct to Bldg. 802 and then to Bldg. 705	60	Contaminated	Characterization.	At 10' west of Bldg. 802 line transitions from concrete to steel. Includes all steel piping under Bldg. 802 and connection from south side of Bldg. 802 to Bldg. 705.
14"/stainless steel	Acid Waste Line Bldg. 801 to stack	300	Contaminated	Characterization.	An approximately 40' section of this line running south from Bldg. 801 was previously removed. Includes continuation of line to the south wall of Bldg. 802 and outside Bldg. 802 to Bldg. 705.
30"/steel	Duct Bldg. 704 to Bldg. 705	165	Contaminated	Process knowledge	Steel duct runs from valve pit to Bldg. 705 and back to HFBR Filter House inlet, below grade, to the BGRR plenum and from the filter house outlet to the plenum just upstream of Bldg. 705. Process knowledge shows filters up and downstream of duct are contaminated.
30"/concrete	Duct Bldg. 750 to Bldg. 705	415	Contaminated	Process knowledge	Concrete duct runs from Bldg. 750 to valve pit adjacent to the Bldg. 705 where it transitions to steel. Process knowledge shows filters up and downstream are contaminated.
18"/vitrified clay pipe	Duct Bldg. 815/830 to 42" duct	80	Contaminated	Characterization.	Characterization determined duct from Bldg. 815/830 clean to point 80' upstream of connection with 42" duct (closest point excavation could be made). Line cut and capped. Remaining 80' will be removed when 42" duct is removed.
18"/steel	Duct Bldg. 901A to Bldg. 705	22	Contaminated	Characterization.	Duct clean from Bldg. 901A to point just upstream of connection with 42" from Bldg. 802 to Bldg. 705. Removal of 22' section will encompass contaminated section and clean pipe upstream to a point where duct is 2 ft below grade.
42"/steel	Duct Bldg. 701 to Bldg. 704	60	Contaminated	Characterization.	Encompasses all steel duct work, including source of cross contamination, below floor of Bldg. 704 upstream to transition from steel to concrete duct coming from Bldg. 701.
8"/vitrified clay pipe	Line Bldg. 750 to Manhole MH232	26	Contaminated	Process knowledge	Line from Bldg. 750 to manhole MH232. Routine discharge of tritiated water from Bldg. 750 to sanitary system.
2"/steel within 4"/bituminous coated steel	D/F Line from Bldg. 750 to Bldg. 801	1,083	Contaminated	Process knowledge	Buried line runs from Bldg. 750 around the Bldg. 750 Annex to Bldg. 802. Process knowledge is that there was routine transfer of contaminated liquids until Nov 2000.

Table 8.2 Contaminated Ducts/Pipelines Requiring Removal (Sheet 2 of 2)

2"/stainless steel	A-waste line from Bldg. 801 to former Bldg. 811 Tanks	700	Contaminated	Process knowledge	Pipe within a buried concrete culvert runs from Bldg. 801 to the former Bldg. 811 A&B tanks. Process knowledge is that there was routine transfer of contaminated liquids from 1949 to 1961.
2"/stainless steel	B-waste line from Bldg. 801 to former Bldg. 811 Tanks	700	Contaminated	Process knowledge	Pipe within a buried concrete culvert runs from Bldg. 801 to the former Bldg. 811 A&B tanks. Process knowledge is that there was routine transfer of contaminated liquids from 1949 to 1961.
4"/mild steel	D-waste line from Bldg. 801 to former Bldg. 811 Tanks	700	Contaminated	Process knowledge	Pipe within a buried concrete culvert runs from Bldg. 801 to the former Bldg. 811 D-waste tanks. Process knowledge is that there was routine transfer of contaminated liquids from 1949 to 1952. Transfer ceased in 1952 due to leaks in the pipe.
1-1/2"/stainless steel within 4" PVC "clam shell" pipe	Stand-alone D-waste line from Bldg. 801 to former Bldg. 811 Tanks	700	Contaminated	Process knowledge	Buried line outside of the buried concrete culvert runs from Bldg. 801 to the former Bldg. 811 D-waste tanks. Process knowledge is that there was routine transfer of contaminated liquids from 1995 to 2001. Transfer ceased in 2001 because the secondary containment could not pass tightness testing. This pipe replaced a D-waste pipe in the same location that transferred contaminated liquids from 1952 to 1995.
2-1/2"/steel insulated with asbestos	Steam line Bldg. 801 to former Bldg. 811 Tanks	700	Not Contaminated	Process knowledge	Steam pipe within a buried concrete culvert runs from Bldg. 801 to the former Bldg. 811 Tanks. Operated from 1949 until disconnected in 2001.
10"/terra cotta	Non-Acid Off-Gas Pipe	700	Contaminated	Characterization	Buried line outside of the buried concrete culvert runs from Bldg. 801 to the former Bldg. 811 Tanks. Characterization in 1999 confirmed radiological contamination.

9.0 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

9.1 CERCLA Evaluation Criteria

There are nine CERCLA evaluation criteria that must be considered in the assessment of remedial action alternatives. The nine CERCLA criteria are divided into three groups:

Threshold Criteria: There are two threshold requirements that the remedial alternative must meet to be eligible for selection: overall protection of human health and the environment, and compliance with "applicable or relevant and appropriate requirements" (ARARs).

Balancing Criteria: The five primary balancing criteria are long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost. These are used to compare the tradeoffs among remedial alternatives.

Modifying Criteria: State and community acceptance are modifying criteria that must be considered in remedy selection.

The evaluation criteria and a brief description of their content are presented below:

Criterion 1
Overall Protection of Human Health and the Environment is the primary objective of the remedial action and addresses whether a remedial action provides adequate overall protection of human health and the environment. This criterion must be met for a remedial alternative to be eligible for consideration.

Criterion 2
Compliance with ARARs addresses whether a remedial alternative will meet all the applicable or relevant and appropriate requirements and other federal and State of New York environmental statutes, or provide grounds for invoking a waiver of the requirements. This criterion must be met for a remedial alternative to be eligible for consideration.

Criterion 3
Long-Term Effectiveness and Permanence refers to the magnitude of residual risk and the ability of a remedial alternative to maintain long-term reliable protection of human health and the environment after remedial goals have been met.

Criterion 4
Reduction of Toxicity, Mobility, or Volume through Treatment refers to an evaluation of the anticipated performance of the treatment technologies that may be employed in the remedy. Reduction of toxicity, mobility and/or volume contributes to overall protectiveness.

Criterion 5
Short-Term Effectiveness refers to evaluation of the speed with which the remedy achieves protection. It also refers to any potential adverse effects on human health and the environment during implementation of the remedial action.

Criterion 6
Implementability refers to the technical and administrative feasibility of a remedial action, including the availability of materials and services needed to implement the selected solution.

Criterion 7
Cost refers to an evaluation of the capital, operations and maintenance, and monitoring costs for each alternative.

Criterion 8
State Acceptance indicates whether New York State concurs with, the analyses and preferred alternative, as described in the FS and Proposed Remedial Action Plan.

Criterion 9
Community Acceptance assesses the general public response to the analyses and preferred alternative as described in the Proposed Remedial Action Plan received during the public comment period and open community meetings are an important indicator of community acceptance.

9.2 Comparative Analysis of Alternatives

A summary of the comparative analysis is provided in Table 9.1.

9.2.1 Overall Protection of Human Health and the Environment

The majority, more than 99 percent, of the HFBR radioactive material is in the form of activated concrete and steel components. In their existing locations and configuration, there are several physical barriers that are inherently effective in preventing human exposure to the radiation associated with these components or the potential spread of radioactive material to the environment:

- The radioactive material is actually a part of the activated concrete and steel components. In this form, the radioactive material is immobile because it is bound up within these components as an intrinsic part of their materials of construction. In this form, the radioactive material is inherently non-dispersible.
- The reactor internals and CRBs, the HFBR components with the highest dose rates, are encased in the 2-in. thick HFBR reactor vessel.
- The 8-ft thick heavily steel reinforced concrete biological shield surrounds the reactor vessel and thermal shield.
- All of these components are physically located above grade within the steel and concrete HFBR confinement building.

In their non-dispersible and stable state, and with these multiple barriers in place, these components do not pose a threat to human health or the environment. Continued S&M and LUICs are required to ensure the continued effectiveness of these barriers.

Alternative A would leave the HFBR complex in its present physical state. Because of the stability of the radioactive materials and the protective barriers, this remedy is currently protective of human health and the environment. However, the remaining activated components constitute a radiation hazard that would have to be managed for what is essentially an indefinite period of time. In the absence of a plan to eventually remove these components, S&M and LUICs would likewise need to be maintained for this same indefinite period of time in order to ensure that this remedy remains protective. Although S&M can be provided and LUICs maintained for a finite duration, uncertainties arise as to whether these same protective measures can be effectively maintained indefinitely. Such uncertainties relate to the durability of institutions to implement the S&M program and enforce the LUICs. Alternative A is unique among the four alternatives in this respect, and, because of this weakness, it is rated as MEDIUM under this criterion.

Alternatives B, C, and D all provide for the complete removal of all of the HFBR radioactive structures, systems, and components (with the possible exception of the subsurface concrete structures of the confinement building base mat and stack foundation). In all cases, S&M and LUICs will be required for finite but different durations:

- Alternative B involves the safe storage of the confinement building and the activated components for a period not to exceed 65 years. Following safe storage, these remaining structures and components would be removed over a three-year period. S&M and LUICs would be required through this 68 year period of time. Following the last phase of dismantlement the dose-based cleanup goal of 15 mrem/yr (above background) and the methodology specified in the OU I ROD would be achieved and there will be no further need for any additional period of LUICs.
- Alternative C includes the near-term removal of the CRBs and beam plugs by the end of 2020. However, this near-term action would not have any effect on the safe storage duration required for the other activated components. Therefore, S&M and LUICs are also required for the same durations as Alternative B.
- Alternative D results in the dismantlement and removal of the HFBR complex by the end of 2026. S&M would be required through this period. The entire radiological inventory would be removed in the near term, by FY2026, with the exception of residual contamination under the dose-based soil cleanup goal of 15 mrem/yr (above background) and methodology specified in the OU I ROD for residential use in 50 years. LUICs would be required for an additional 50 years following the last phase of dismantlement.

As shown, a finite period of S&M and LUICs is required for all three of these alternatives. The continuation of the HFBR S&M program and LUICs that are already in place for other remedies at BNL would ensure the protectiveness of these remedies during this interim period of time.

All three of these alternatives include the complete removal of the HFBR complex (with the possible exception of the subsurface concrete structures of the confinement building base mat and stack foundation). Therefore, from a long-term perspective, all three alternatives are protective of human health and the environment. Based on the foregoing, Alternatives B, C, and D were all rated as HIGH under this criterion.

9.2.2 Compliance with Applicable or Relevant and Appropriate Requirements

Alternative A involves the indefinite storage of the HFBR radiological inventory. The indefinite storage of these radioactive materials would be in conflict with New York State’s siting requirements for LLRW waste disposal facilities. There are statutory issues that would preclude the indefinite storage or entombment of these radioactive materials over Long Island’s sole source aquifer. Aside from this, all four alternatives comply with applicable or relevant and appropriate regulations. Therefore, Alternative A is rated as LOW and Alternatives B, C, and D are rated HIGH for compliance with ARARs.

9.2.3 Long-Term Effectiveness

Alternative A would leave the HFBR complex in its present physical state. Because of the stability of the radioactive materials and the protective barriers, this remedy is currently protective of human health and the environment. However, the remaining activated components constitute a radiation hazard that would have to be managed for what is essentially an indefinite period of time. In the absence of a plan to eventually remove these components, S&M and LUICs would likewise need to be maintained for this same indefinite period of time in order to ensure that this remedy remains protective. Although S&M can be provided and LUICs maintained for a finite duration, uncertainties arise as to whether these same protective measures can be effectively maintained indefinitely. Such uncertainties relate to the durability of institutions to implement the S&M program and enforce the LUICs. Alternative A is unique among the four alternatives in this respect, and because of this weakness, it is rated as MEDIUM under this criterion.

Alternatives B, C, and D all provide for the complete removal of all of the HFBR radioactive structures, systems, and components (with the possible exception of the subsurface concrete structures of the confinement building base mat and stack foundation). Based on the foregoing, Alternatives B, C, and D are all rated as HIGH under this criterion.

9.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

None of the four alternatives considered include treatment to reduce the toxicity, mobility, or volume of contaminants. Therefore, this criterion is not applicable to the analysis of the alternatives.

9.2.5 Short-Term Effectiveness

Alternative A, involving no further action other than control and monitoring, poses few uncertainties and implementation risks and is rated HIGH under the criterion of short-term effectiveness. This remedy is limited to the continued use of S&M and LUICs. As described under Criterion 1, above, the majority, more than 99 percent, of the remaining radiological inventory is in a physically safe and stable form. With no physical dismantlement activity, this remedial alternative would not involve disturbing these activated components. Therefore, Alternative A is rated HIGH in terms of short-term effectiveness.

Under Alternative B, all of the activated components with high dose rates would be removed only after they were allowed to decay to levels that would essentially eliminate their present-day radiological risks and hazards. These components would be maintained in their inherently stable form as the radiation levels are reduced through their radioactive decay. As in the case of Alternative A, this alternative would not involve implementation risks and hazards associated with segmenting, handling, packaging, and transporting activated components with high dose rates because they will have decayed to safe and manageable levels by the end of safe storage (decay) period. The radiological risks and hazards would be essentially eliminated at the time in which the HFBR confinement building and activated components are removed. The remaining project risks and hazards would be limited to those of a non-radiological nature that are germane to any large construction (i.e., demolition) project. Because Alternative B does not involve significant implementation risks, it was also rated as HIGH in terms of short-term effectiveness.

Under Alternative C, all of the dismantlement activities to remove and dispose of the activated structures, components, and the confinement building would involve standard and field proven nuclear reactor decommissioning and demolition techniques. The near-term CRB removal would involve underwater handling and packaging and would utilize available tools, equipment, and work processes. Since Alternative C does not involve significant radiological and transportation risks and hazards, it was also rated as HIGH in terms of short-term effectiveness.

In contrast to Alternatives A, B, and C, Alternative D involves the near-term segmentation, handling, packaging, transportation, and disposal of activated components with high dose rates. From a worker and transportation risk standpoint, this represents a significant difference from Alternatives A, B, and C. Alternative D would require more than 30 individual type A or B cask shipments resulting from activated component removal. The segmentation of these components would generate significant quantities of dispersible cutting fines with high dose rates. In a dispersible form, these secondary wastes pose additional personnel radiation exposure risks, and the potential risk of cross-contaminating the confinement building that is essentially free of contamination at this time. In summary, Alternative D involves considerable radiological and transportation risks and hazards in comparison with the other alternatives. Because of these radiological and transportation risks and hazards, the short-term effectiveness of Alternative D is rated as LOW.

9.2.6 Implementability

Remaining Alternative A activities include the continuation of S&M and LUICs. These protective measures involve field-proven work practices, engineered safeguards, and administrative controls. There are no implementability issues or concerns, and Alternative A is therefore rated as HIGH under this criterion.

Under Alternative B, the HFBR confinement building and additional components would be removed only after the high radiation dose rates have decayed to manageable levels during the safe storage (decay) period. The radiological risks and hazards under Alternative B would be essentially eliminated, and simple, field-proven construction (i.e., demolition) methods would be all that is required to complete the physical dismantlement of the HFBR complex. Therefore, Alternative B is also rated as HIGH under implementability.

Alternative C is comparable to Alternative B. Under Alternative C, the CRBs and beam plugs would be removed in the near term utilizing available tools, equipment, and work processes. CRB removal would be completed in one or two shipments and the remaining large activated components would be removed after the high radiation dose rates have declined to manageable levels. As with Alternative B, simple field-proven demolition methods would be all that is required to complete the dismantlement of the remaining activated structures, systems, and components and the confinement building. Because implementation of this alternative is comparable to that for Alternatives A and B, Alternative C is rated as HIGH under this criterion.

Alternative D includes the near-term decontamination, dismantlement, and disposal of the entire HFBR complex, including all structures, systems, and components. Unlike Alternatives A, B, and C, dismantling and disposing of the large activated components with high dose rates would involve significant implementation issues and challenges as summarized below:

- Workers cutting apart the activated components would not be able to come near them. In fact, at these dose rates, the work would need to be performed remotely and underwater. The water would serve both as a radiation shield and as a way to minimize the dispersion of radioactive material. Water containment structures would have to be designed and built around the existing contaminated structures and components. Special tools, processes, and equipment would need to be designed, fabricated, and tested. Workers would have to be trained and qualified to perform these activities. Controls would have to be established to monitor and limit the amount of contamination in the water so it would continue to function as a radiation shield. A system to control water contamination levels and clarity would also be needed. Although there is industry experience with this kind of work, each project is highly dependent on the specific site conditions.
- The underwater segmentation of activated components would generate significant quantities of dispersible fine particles with high dose rates as well as contaminated water requiring processing, transportation, and disposal. It is estimated that these segmentation activities would generate up to 100,000 gallons of contaminated water requiring processing and disposal as LLRW.
- The high dose rate wastes would require the use of special shipping casks for transportation to a disposal site. The capacity of these casks is limited, so the large activated components would need to be cut into small pieces. This would require the use of remotely operated tools and equipment and increase the amount of underwater material handling, further complicating the underwater work. More than 30 radioactive waste shipments would be required.

In summary, the implementation challenges and issues of Alternative D represent a significant increase over those described for Alternatives A, B and C. Therefore, the implementability of Alternative D is rated as LOW.

9.2.7 Cost

The estimated cost of each of the four alternatives is summarized as follows:

Alternatives' Costs, in Dollars

	A	B	C	D
Previous Expenditures	25M	25 M	25 M	25 M
Additional Capital Cost Estimate	1M	110 M	112 M	176 M
Total Capital Cost Estimate	26M	135 M	137 M	201 M
S&M and LUIC Cost Estimate	*	7 M	7 M	4 M
Total Estimated Cost	*	142 M	144 M	205 M

* Indeterminate

As expected, Alternative A is the least costly of the three HFBR cleanup alternatives in terms of capital costs. However, the total cost of Alternative A is indeterminate because the required duration of S&M and LUICs is not definable.

The total capital cost estimates of Alternatives B, C, and D are \$135 M, \$137 M, and \$201 M, respectively. These substantial increases over Alternative A are attributable to the extensive amount of HFBR dismantlement and waste disposal. The favorable impacts of radioactive decay in reducing dismantlement risks and project complexities are reflected in the large cost differential between Alternative D and the two phased decommissioning alternatives (i.e., Alternatives B and C). Near-term CRB and beam plug removal accounts for the \$2 M difference in capital cost estimates between Alternative B and Alternative C.

The 65-year period of radioactive decay has a significant impact on consolidated S&M and LUIC costs for Alternatives B and C. However, as shown, the S&M and LUIC cost differential is significantly less than the differences in capital cost estimates in comparison with Alternative D. Alternative B is the lowest cost alternative that removes the HFBR complex, with the possible exception of the subsurface concrete structures of the confinement building base mat and stack foundation. For a relatively small \$2 M incremental increase in cost, Alternative C also includes the near-term removal of control rod blades and beam plugs (containing 35 percent of the current HFBR radioactive material inventory)

9.2.8 State Acceptance

During the development of the Feasibility Study and the Proposed Plan, DOE worked closely with the New York State Department of Environmental Conservation (NYSDEC) representing the State of New York. The State of New York concurs with the selected remedy described in this ROD.

9.2.9 Community Acceptance

The community involvement process is an integral part of making cleanup decisions. Project staff made multiple presentations to the CAC, BER, and several local civic associations.

A public comment period for *The Proposed Remedial Action Plan for the High Flux Beam Reactor* extended from January 10 through March 17, 2008. Two information sessions were held on March 4, 2008, and a public meeting was held on March 6, 2008.

Comments submitted during the public comment period were compiled and reviewed. Copies of the comments received are presented in Appendix B. The transcript for the public meeting was placed in the Administrative Record. During the public comment period, DOE received written comments from the CAC and members of the public: Christopher Bobinger, Assemblyman Marc Alessi, and Bernadette Smith Budd. No comments were received during either of the March 4, 2008 information sessions, or during the March 6, 2008 public meeting.

Comments received during the public comment period and DOE responses are discussed in Section III, Responsiveness Summary.

9.3 Preferred Alternative

In the comparative evaluation of alternatives, Alternatives B and C were both rated High in terms of all five CERCLA criteria for which relative ratings were established: overall protection of human health and the environment, compliance with applicable or relevant and appropriate requirements, long-term effectiveness, short-term effectiveness, and implementability. Both alternatives include the near-term (by 2020) removal of the ancillary structures, contaminated underground ducts and piping, and associated soils; the complete removal of the HFBR complex (with the possible exception of the subsurface concrete structures of the confinement building base mat and stack foundation) after a decay period not to exceed 65 years; and the continuation of S&M and the use of LUICs during the decay period to ensure the protection of human health and the environment.

Alternative C also includes near-term removal of control rod blades and beam plugs (containing 35 percent of the current HFBR radioactive material inventory) at an incremental cost of $2 million ($144 million compared to $142 million for Alternative B). Therefore, Alternative C was chosen by DOE as the preferred alternative in the PRAP.

Table 9.1 Comparative Analysis of the Remedial Alternatives

	Alternatives			
Consideration	A	B	C	D
Total radiological inventory–2007	65,000 Ci	65,000 Ci	65,000 Ci	65,000 Ci
Total radiological inventory reduction	57,000 Ci*	65,000 Ci	65,000 Ci	65,000 Ci
Criterion 1: Overall protection of human health and the environment	Medium	High	High	High
Criterion 2: Compliance with applicable or relevant and appropriate requirements	Low**	High	High	High
Criterion 3: Long-term effectiveness and permanence	Medium	High	High	High
Criterion 4: Reduction of toxicity, mobility, or volume through treatment	NA	NA	NA	NA
Criterion 5: Short-term effectiveness	High	High	High	Low
Criterion 6: Implementability	High	High	High	Low
Criterion 7: Total estimated cost	Indeterminate	$142 M	$144 M	$205 M
Previous expenditures	$25 M	$25 M	$25 M	$25 M
Additional capital cost estimate***	$1 M	$110 M	$112 M	$176 M
S&M and LUIC cost estimate	Indeterminate	$7 M	$7 M	$4 M
Occupational Dose	Indeterminate	3 Person-rem	4 Person-rem	20 Person-rem

* This includes reductions from radioactive decay over a period of 68 years.
** Implementation of this alternative involves the indefinite storage of radioactive materials and would be in conflict with New York State regulations regarding the siting of LLRW disposal facilities.
*** Includes Waste Loading Area cleanup cost of $1 M.

SECTION 10 SELECTED REMEDY

After evaluating the remedial alternatives against the CERCLA criteria, ***Alternative C – Phased Decontamination and Dismantlement with Near-Term Control Rod Blade Removal***, with changes made in response to public comments (inclusion of five-year technical reviews as described in Section 10.3.7), is selected as the remedy for the HFBR complex.

In addition to the interim measures completed or underway, the remedy for the HFBR complex includes the near-term (by 2020) removal of the ancillary structures, contaminated underground ducts and piping, and associated soils; the complete removal of the HFBR complex (with the possible exception of the subsurface concrete structures of the confinement building base mat and stack foundation) after a decay period not to exceed 65 years; and the continuation of S&M and the use of LUICs during the decay period to ensure the protection of human health and the environment.

10.1 Completed Interim Actions

A number of interim actions have been completed. These interim actions, listed in Table 4.1, are consistent with the selected remedy for the HFBR complex. The completed interim actions are summarized below:

- The HFBR fuel was removed and sent to an off-site facility.
- The primary coolant was drained and sent to an off-site facility.
- Scientific equipment was removed and is being reused.
- Shielding and chemicals were removed and are being reused at BNL and other facilities.
- The cooling tower superstructure was dismantled and disposed.
- The confinement structure and spent fuel canal were modified to meet Suffolk County Article 12 requirements.
- The Stack Monitoring Facility (Building 715) was dismantled and disposed.
- The Cooling Tower Basin and Pump/Switchgear House (Building 707/707A) was dismantled and disposed.
- The Water Treatment House (Building 707B) was dismantled and disposed.
- The Cold Neutron Facility (Building 751) contaminated systems were removed and the clean building has been transferred to another organization for re-use.
- The Guard house (Building 753) was dismantled and disposed.

10.2 Interim Actions Currently Underway

The following are interim actions currently underway. These actions are consistent with the selected remedy for the HFBR complex.

10.2.1 Cleanup of the Waste Loading Area

The Waste Loading Area (WLA) is an area (about 2 acres) along the eastern boundary of the Former Hazardous Waste Management Facility (HWMF). The Former HWMF is located in the southeastern portion of BNL. It was used during the period between 1947 and 1997 as the central receiving facility for storage, processing, and limited treatment of waste generated at BNL. Soil contamination at the Former HWMF resulted from spills during past waste handling operations.

The cleanup of the WLA was transferred to the HFBR scope of work in September 2005 through a modification to the RDIP for the Former HWMF.

The cleanup of the WLA is currently in progress. It is being performed as a non-time-critical removal action authorized by the *Action Memorandum, High Flux Beam Reactor, Removal Action for Waste Loading Area* of October 2007. The remediation (by excavation) of this area is being performed using the same cleanup goals and methodology required for AOC 1 in the OU I ROD.

10.2.2 Removal and Disposal of the Control Rod Blades and Beam Plugs

The removal/disposal of the CRBs and beam plugs is being performed as a non-time-critical removal action authorized by the *Action Memorandum, High Flux Beam Reactor, Removal Action for Control Rod Blades and Beam Plugs* of July 2008.

10.3 Remaining Actions within the Scope of the Selected Remedy

In addition to the actions that have been or are being performed, the following additional remedial actions are included in the selected remedy.

10.3.1 Near-Term Decontamination and Dismantlement

The selected remedy includes the near-term dismantlement and removal of the remaining HFBR ancillary buildings, contaminated ducts, and underground piping systems; and the removal of contaminated yard area soils.

The HFBR ancillary buildings, including the structures, systems, and components (Figure 1.3) will be dismantled and removed in the near term, by FY2020, to at least 2 ft below grade. Sampling and analysis will be performed in accordance with the dose-based cleanup goal and methodology specified in the OU I ROD, to verify that the remaining soils meet the cleanup goal for residential use. To the extent required, contaminated soils will be removed to meet this cleanup goal. Ancillary buildings include the following:

- Stack (Building 705)
- Fan house including underground plenum (Building 704)
- Fan house (for Building 801) and tritium evaporator (Building 802)

Contaminated underground services and piping systems will be removed in the near term, by FY2020, including the confirmation and/or cleanup of soils to the extent required to meet the cleanup goal and methodology specified in the OU I ROD for residential use. The extent of underground service and duct and piping system removal is shown in Figure 5.6; Table 8.2 provides a description of this work. These ducts and piping systems include:

- Building exhaust ducts from Buildings 750, 801, and 802
- Sections of exhaust ducts from 815, 830, and the Tandem Van de Graaff generator

- Sanitary discharge line
- D/F waste line
- A/B waste line, along with other co-located piping (D waste, off-gas, and steam)

Confirmatory sampling and analysis will be conducted in accordance with the dose-based cleanup objective for radiological soil contamination, in order to confirm that HFBR yard area soils meet the cleanup goal specified in the OU I ROD for residential use. Contaminated soil will be removed in the near term, by FY2020, to the extent required to meet this goal.

10.3.2 Preparation of HFBR Confinement Building for Safe Storage

Subsequent to the completion of the near-term actions, the HFBR confinement building will be prepared for safe storage to allow for the radioactive decay. The safe storage physical preparations include:

- Modification of building ventilation exhaust system that ensure the atmosphere in the confinement is safe for personnel access for S&M activities
- Modification of security system and alarms on all entryways to confinement
- Installation of a water infiltration detection system with remote alarms
- Modification of confinement building lighting and electric power distribution to support S&M activities

Implementation of miscellaneous physical preparatory activities that will also be required include:

- Correction of any confinement building deficiencies
- Drain-down of mechanical systems including the removal of residual heavy water from the primary system piping and components
- Removal of miscellaneous waste and excess combustible materials
- Improvement to storm water drainage by adjustment of grades so it drains away from the HFBR in four areas outside the transformer room, north of the east truck lock, by the air conditioning cooling tower, and the entrance to the blower room.
- Modification to secure access/entry points from outside

Upon completion of the physical preparations, an S&M program for safe storage of the confinement building, as described in the S&M subsection below, will be deployed.

10.3.3 Decontamination and Dismantlement after Safe Storage (Decay) Period

The selected remedy includes the segmentation, removal, and disposal of the remaining structures, systems, and components after the safe storage (decay) period:

- Reactor vessel and internals
- Thermal shield
- Biological shield

Subsequent to activated structures and components removal, this will include the dismantlement and disposal of the reactor confinement building (Building 750), including:

- Building 750 structures, systems, and components
- Cleanup of remaining soils to the extent required to meet the cleanup goal and methodology specified in the OU I ROD for residential use

The structures will be removed to at least 2 ft below grade, with the possible exception of the subsurface concrete structures of the confinement building base mat and stack foundation.

10.3.4 Surveillance and Maintenance

An HFBR S&M plan will be developed by DOE in consultation with EPA and NYSDEC, to manage the inventory of radioisotopes that will remain during the safe storage (decay) period and subsequent decontamination and dismantlement. The HFBR S&M will be implemented to ensure that the inventory of stored radioisotopes and all residual contamination is maintained in a safe condition, and to preclude future human exposure pathways or migration from their locations within the HFBR complex. S&M activities include:

- Periodic physical examination of the confinement building and interior structures, including inspection for water infiltration
- Routine maintenance of the confinement building, and repair of deficiencies found during confinement building inspections, in order to preserve the physical barriers that contain the radioactive materials in the HFBR complex
- Continuation of air effluent monitoring
- Groundwater monitoring and other actions in accordance with the OU III ROD

10.3.5 Land Use and Institutional Controls

The selected remedy also includes the continued implementation of LUICs in accordance with the LUCMP. These include:

- Measures for controlling future excavation and other actions that could otherwise disturb residual subsurface contamination
- Land use restrictions and an acceptable method for evaluating potential impact that the remaining contaminants have on future development
- Periodic certification to EPA and NYSDEC stating that the institutional and engineering controls put in place are unchanged from the previous certification, and that nothing has occurred that would impair the ability of the control to protect public health or the environment or constitute a violation or failure to comply with the site management plan. This annual certification will be prepared and submitted by a professional engineer or environmental professional acceptable to NYSDEC.

DOE is currently responsible for implementing the land use controls with regard to the property which is the subject of the HFBR ROD. If the property is transferred out of federal ownership, it is DOE's intention that all continuing land use restrictions, reporting requirements, and any other obligations relating to the property of DOE (or any other successor federal entity on behalf of the United States) will be satisfied through the United States' conveyance of a deed restriction/ environmental easement prior to any such transfer of any deed(s) to the property.

While it is DOE's intention that any such deed restriction/environmental easement would require that the transferee (and subsequent transferees) would be required to satisfy all of DOE's obligations relating to the property, DOE acknowledges that, notwithstanding this intention, it (or any other successor federal entity on behalf of the United States) remains ultimately responsible for satisfying DOE's remedial obligations set forth in this ROD relating to the property if any subsequent transferee fails to satisfy the remedial obligations in this regard.

Figure 10-1 shows the area of the HFBR complex where land use and institutional controls will be implemented. Any activity that is inconsistent with the land use restrictions or actions that may interfere with the effectiveness of the institutional controls established for the HFBR complex will be addressed by DOE with EPA and NYSDEC, as outlined in the BNL LUCMP.

LUICs for the WLA will be similar to the existing controls for the FHWMF.

LUICs will be maintained until the hazardous substances reach levels that allow unlimited use and unrestricted exposure. The BNL LUCMP will be revised to include the HFBR complex and WLA within 90 days of ROD finalization, and submitted to EPA and NYSDEC for review and approval. The revision will include the appropriate LUICs and address implementation and maintenance actions, including periodic inspections of the HFBR complex and WLA.

10.3.6 CERCLA Five-Year Reviews

The purpose of the site-wide CERCLA five-year reviews is to determine whether the remedies implemented at BNL continue to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in Five-Year Review Reports. In addition, Five-Year Review Reports identify issues found during the review, if any, and recommendations to address them.

The HFBR complex will contain radioactive materials above unlimited use and unrestricted exposure levels during the safe storage (decay) period. Therefore, the HFBR complex will be included in the site-wide five-year reviews during this period.

10.3.7 Five-Year Technical Reviews

DOE will conduct five-year technical reviews of the remedy in accordance with DOE five-year review guidance to determine the feasibility of reducing the safe storage (decay) period and completing the HFBR cleanup earlier taking into consideration the following factors:

- Advancements in cleanup technologies and transportation methods
- Availability of waste disposal facilities
- Changes in standards and regulations for worker, public, and environmental protection
- Worker safety impacts
- Environmental impacts
- Public health impacts
- Economic impacts
- Land use

- Existing stabilization and safety of the facility and hazardous materials
- Projected future stability and safety of the facility and hazardous materials

If a five-year technical review identifies a remediation method that demonstrates the potential to reduce the decay period from 65 years, analysis of that potential method will be initiated and possibly implemented.

DOE will conduct the technical reviews as part of the site-wide CERCLA five-year reviews including community notification and outreach.

Recognizing that there are uncertainties inherent in activation analyses, DOE plans to conduct an additional investigation involving the following steps:

- Perform radiation surveys (measurements of radiation levels) after the removal of the CRBs from the reactor vessel. (Surveys before the removal of CRBs with high dose rates would not yield reliable results.)
- Reevaluate the dose rate at 1 ft from the large activated components (reactor vessel, thermal shield, and biological shield) based on the radiation surveys.
- Using the reevaluated dose rates, determine the decay period necessary for the dose rate at 1 ft to fall below 100 mrem/hr for the large activated components, including the limiting component.
- Use the results of the additional investigation in the first five-year review (scheduled for 2011) in assessing the feasibility of shortening the decay period.

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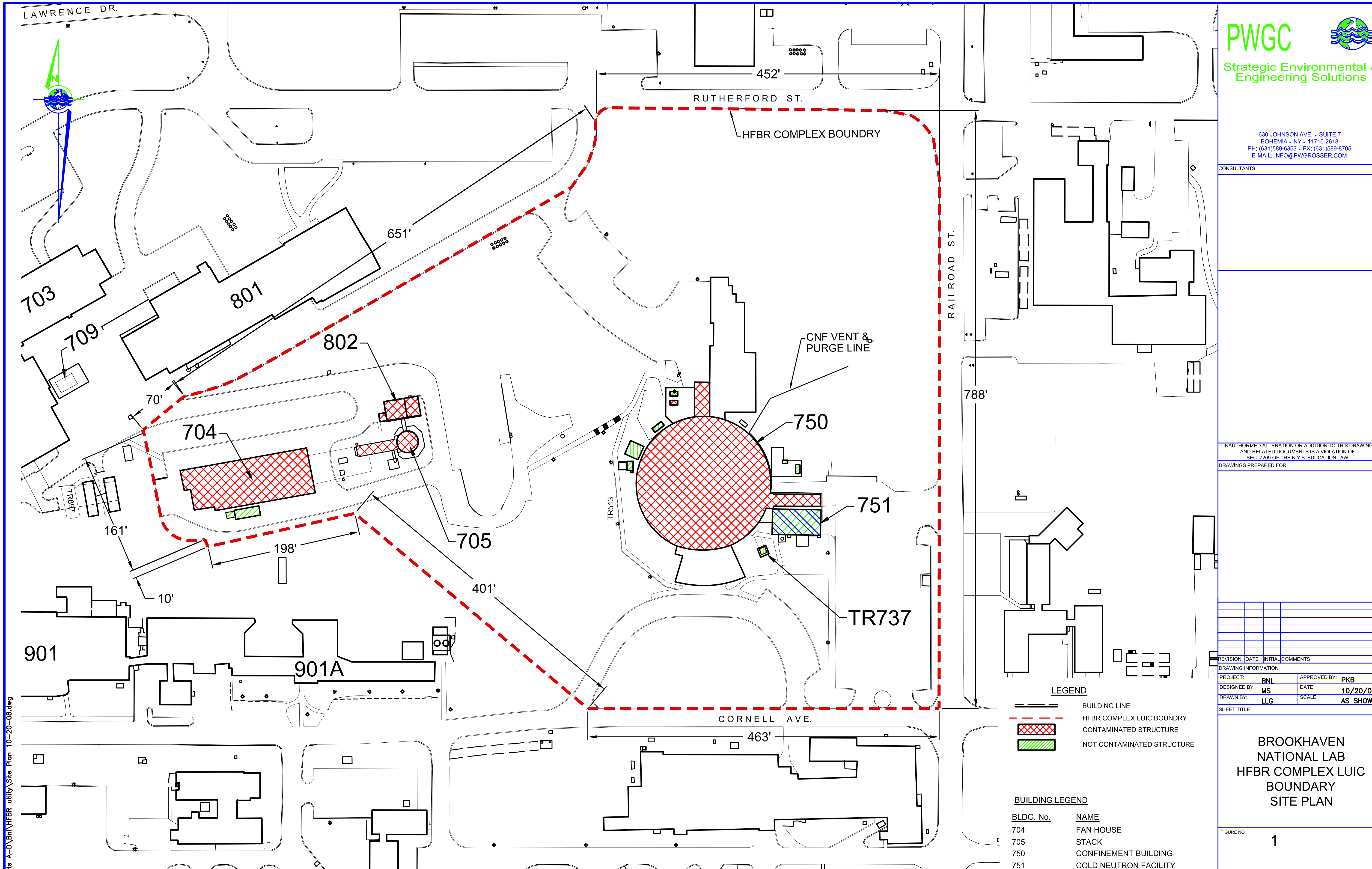

Figure 10.1 HFBR Complex - Land Use and Institutional Controls (LUIC) Area

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SECTION 11.0 STATUTORY DETERMINATIONS

Remedy selection is based on CERCLA and on the National Contingency Plan. All remedies must meet the threshold criteria: protection of human health and the environment, and compliance with ARARs. CERCLA also requires that the remedy use permanent solutions and alternative treatment technologies to the maximum extent practicable, and that the implemented action must be cost effective. Finally, the statute includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as their principal element. The following sections discuss how the selected remedy meets these statutory requirements.

11.1 Protection of Human Health and the Environment

This remedy removes the entire HFBR complex (with the possible exception of the subsurface concrete structures of the confinement building base mat and stack foundation) and essentially the entire radioactive material inventory. These remedial actions will be effective in protecting human health and the environment.

11.2 Compliance with the ARARs

The National Contingency Plan, Section 40CFR300.430 (f)(1)(ii)(B), requires that the selected remedy comply with federal and state ARARs unless a waiver is invoked. The ARARs are listed below:

11.2.1 Chemical-Specific ARARs

1. *6 New York Code, Rules and Regulations (NYCRR) part 212, General Process Emission Sources:* These state regulations will be followed to determine the need for air-emission control equipment. All remedial work will be performed in accordance with standards and procedures that will ensure compliance with these regulations.
2. *6 NYCRR Part 380, Rules and Regulations for Prevention and Control of Environmental Pollution by Radioactive Materials:* These regulations are the relevant and appropriate regulations for controlling radioactive emissions and liquid releases to the environment while completing the remedial action. Potential radioactive surface contamination release, airborne radioactivity generation and release, or radioactive liquid release will be controlled to eliminate emissions that would affect human health or the environment.
3. *Resource Conservation and Recovery Act (RCRA) (40CFR260-282):* These federal regulations define hazardous wastes. All wastes classified as hazardous will be handled, stored, and disposed of off site at a permitted facility in accordance with these regulations.
4. *New York State Hazardous Waste Management System Regulations (6 NYCRR 370 – 376):* These regulations define hazardous wastes in New York State. All wastes classified as hazardous will be handled, stored, and disposed of off-site at a permitted facility in accordance with these regulations.
5. *Safe Drinking Water Act (40CFR141.16):* Establishes maximum contaminant levels (MCLs) that are used as drinking water standards for sole source aquifers. BNL site-wide conformance with the ARAR is addressed in the Operable Unit III ROD.

6. *U.S. Department of Transportation Requirements for the Transportation of Hazardous Materials (49CFR Parts 100 to 170):* These regulations will apply to any wastes that are transported off site.

11.2.2 Location-Specific ARARs

1. *National Historic Preservation Act (36CFR800):* This Act requires federal agencies to take into account the effects of their actions on historic properties.
2. *New York State Low Level Radwaste Disposal Facilities (6 NYCRR Part 382-383)*: The regulations in these Parts establish requirements for land disposal of low-level radioactive waste including the siting, design, construction, operation, closure, post-closure monitoring and maintenance, and institutional control of land disposal facilities used for permanent disposal of low-level radioactive waste.

11.2.3 Action-Specific ARARs

1. *10CFR835, Occupational Radiation Protection:* These rules establish radiation protection standards for all DOE activities. Remedial actions and safe storage will be performed in accordance with the requirements of a DOE-approved radiation protection program and dosimetry program, and appropriate procedures will be established to ensure compliance with this regulation.
2. *10CFR830, Nuclear Safety Management:* These rules establish the minimum acceptable quality assurance and nuclear safety controls for all applicable DOE activities. All remedial action will be performed in accordance with the requirements of a DOE-approved quality assurance and nuclear safety control program and appropriate procedures will be established to ensure compliance with this regulation.
3. *RCRA (40CFR260-268):* As described in Section 11.2.1 above.
4. *New York State Hazardous Waste Regulations (6 NYCRR Parts 370 – 376):* As described in Section 11.2.1 above.
5. *Clean Air Act (42 United States Code [U.S.C.] Section 7401, et seq.) and National Emissions Standards for Hazardous Air Pollutants (NESHAP) (40CFR 61):* This Act regulates and limits the emissions of hazardous air pollutants, including radionuclides. All activities with the potential to create airborne emissions will require confinement or containment with confirmatory air sampling to verify compliance with these requirements and applicable standards.
6. *49CFR Sections 173.4 through 173.471, Packaging and Transportation of Radioactive Material:* These rules apply to the proper packaging and transportation of hazardous material, specifically Class 7, radioactive material. Packaging and transportation of all DOE generated waste will be performed in accordance with this regulation.

11.2.4 "To Be Considered" Guidance

1. *DOE Order 451.1B, National Environmental Policy Act Compliance Program:* This order requires that CERCLA actions address NEPA values.
2. *NYSDEC Technical and Administrative Guidance Memorandum Number 4003 (now DSHM-RAD-05-01), Cleanup Guidelines for Soils Contaminated with Radioactive Materials, September 1993:* This memorandum contains state guidance for remediating radiologically

contaminated soils. The state's value of 10 mrem/yr (above background) serves as an additional goal for remediation that will be evaluated during remedial action planning and implementation.

3. *NYSDEC's Division of Air Guidelines for Control of Toxic Ambient Air Contaminants, Air Guide 1:* This guide will be used to assess activities with the potential to create airborne radioactivity. Contents of this guide will aid in evaluating the need for air-emissions control equipment.

4. *DOE Order 5400.5, Radiation Protection of the Public and the Environment, including As Low As Reasonably Achievable (ALARA) Approach:* This order establishes the standards and requirements for protecting members of the public and the environment against undue risk from radiation. As with 10CFR835, remedial action will be performed in accordance with appropriate procedures that will be established to ensure continued protection of the public and the environment. ALARA is the practical approach to radiation protection, used to manage and control exposures (both individual and collective of the work force and the general public) and releases of radioactive material to the environment as low as is reasonable, taking into account social, technical, economic, practical, and public policy considerations. Technologies and techniques will be incorporated into this remedy so that radioactive waste is minimized and direct exposure to radiation sources is reduced to as low as is reasonably achievable.

5. *DOE Order 435.1, Radioactive Waste Management:* This order provides guidance and requirements for managing and disposing of radioactive waste generated at DOE facilities.

6. *40CFR300.440, Off-Site Rule (52FR49200):* The purpose of this rule is to avoid having wastes generated from response actions that are authorized or funded under CERCLA contribute to present or future environmental problems. This is accomplished by directing the waste to management units that have been determined to be environmentally sound. The rule establishes compliance and release criteria, and establishes a process for determining whether facilities are acceptable based on those criteria. The rule also establishes procedures for notifying waste management units of their unacceptability, for reconsidering unacceptability determinations, and for re-evaluating unacceptability determinations. In accordance with this rule, HFBR wastes will only be sent to off-site facilities that meet EPA acceptability criteria.

7. *Cultural Resource Management Plan for Brookhaven National Laboratory:* DOE determined that the HFBR is eligible for inclusion in the National Register of Historic Places in accordance with the National Historic Preservation Act of 1966. DOE also established a number of measures to mitigate the adverse impacts of decommissioning. These mitigating measures are identified in the Cultural Resources Management Plan for BNL (e.g., video taping the interior and exterior of the HFBR Confinement Building, photographing support structures and preservation of scale models and mock fuel elements) and will be carried out in consultation with the New York State Historic Preservation Officer (SHPO).

8. *Suffolk County Sanitary Code – Article 12 Toxic and Hazardous Materials Storage and Handling Controls:* This code requires the use of all available practical methods of preventing and controlling water pollution from toxic and hazardous materials. For the Article 12 registered components remaining, detailed surveillance and maintenance actions will be included in the S&M program.

9. *DOE Order 460.1B, Packaging and Transportation Safety:* This order establishes safety requirements for the proper packaging, transfer, and transportation of hazardous materials.
10. *DOE Order 460.2A, Departmental Materials Transportation and Packaging Management:* This order establishes requirements for management to ensure safe, secure, efficient packaging and transportation of materials, both hazardous and non-hazardous.
11. *EPA, OSWER Directive 9200.4-18, Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination*: This directive recommends an allowable exposure to radionuclides of 15 mrem/yr above background, as consistent with EPA's acceptable risk range.

11.3 Cost Effectiveness

Based on the expected performance standards, the selected remedy is cost effective. It effectively provides short and long-term protection of human health and the environment at an acceptable cost.

11.4 Use of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

The National Contingency Plan prefers a permanent solution whenever possible. Although the selected remedy requires continued monitoring, institutional controls, and reporting during the safe storage (decay) period, the selected remedial action involves the removal and disposal of contaminated components and soils that pose a potential risk to human health and the environment. Therefore, it is a permanent remedy with respect to risk reduction. The waste generated from this remedial action will be disposed of in off-site facilities that meet EPA's acceptability criteria.

11.5 Preference for Treatment as a Principal Element

This alternative does not meet the EPA's statutory preference for treatment as a principal component. The principal contaminants of concern are radioactive isotopes and there are no technologies to change the radioactive properties of these isotopes through the use of treatment systems. There will be no treatment to reduce the toxicity, mobility, or volume of the contaminants in soil.

11.6 Documentation of Significant Changes

The Proposed Plan for the remediation of the HFBR complex was released for public comment in January 2008. It identified Alternative C – Phased Decontamination and Dismantlement with Near-Term Removal of the Control Rod Blades. DOE reviewed comments submitted during the public comment period. It was determined that no significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate at this time.

Five-year technical reviews and removal of the A/B waste line, along with other co-located piping (D waste, off-gas, and steam) were added to the remedy, but are not considered significant changes.

11.7 Review/Certification

In addition to the five-year CERCLA reviews which are, among other things, necessary to evaluate the effectiveness of the institutional controls to restrict inappropriate land use, annual certification to EPA and NYSDEC will be required. This review will certify that the institutional controls and engineering controls put in place are unchanged from the previous certification, and nothing has occurred that would impair the ability of the controls to protect public health or the environment or constitute a violation or failure to comply with the site management plan. The annual certification will be prepared and submitted by a professional engineer or environmental professional acceptable to NYSDEC.

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SECTION III RESPONSIVENESS SUMMARY

The community involvement process is an integral part of making cleanup decisions. Project staff made multiple presentations to the CAC, BER, and several local civic associations.

A public comment period for *The Proposed Remedial Action Plan for the High Flux Beam Reactor* extended from January 10 through March 17, 2008. Two information sessions were held on March 4, 2008, and a public meeting was held on March 6, 2008.

Comments submitted during the public comment period were compiled and reviewed. Copies of the comments received are presented in Appendix B. The transcript for the public meeting was placed in the Administrative Record. During the public comment period, DOE received written comments from the CAC and members of the public: Christopher Bobinger, Assemblyman Marc Alessi, and Bernadette Smith Budd. No comments were received during either of the March 4, 2008 information sessions, or during the March 6, 2008 public meeting.

Comments received during the public comment period and DOE responses are discussed below:

During the March 13, 2008 CAC meeting, the CAC reached a consensus in support of the preferred alternative (Alternative C) for the HFBR. The CAC also proposed certain modifications to Alternative C.

1 Comments from the CAC

CAC Comment
The Community Advisory Council (CAC) supports Alternative C, the preferred alternative, as presented in the Proposed Remedial Action Plan for the High Flux Beam Reactor (HFBR) with the following modification:

- *Removed after a decay period not to exceed 50 years after finalization of the HFBR ROD.*
  - *Other activated components*
  - *Confinement building*
  - *HFBR complex contaminated soils*

Further, the CAC recommends that the Record of Decision (ROD) require substantive five-year reviews of the remedy (not to be confused with reviews required under CERCLA) to determine if the cleanup can be conducted more quickly, safely, or effectively than with the remedy specified in the ROD. Each review should specifically evaluate:

- *Advancements in cleanup technologies and transportation methods*
- *Changes in standards and regulations for worker, public, and environmental protection*
- *Worker safety impacts*
- *Environmental impacts*

- *Public health impacts*
- *Economic impacts*
- *Land use*
- *Existing stabilization and safety of the facility and hazardous materials*
- *Projected future stability and safety of the facility and hazardous materials*
- *Community interests through formal community involvement in the review*

Response
The CAC's comments are thoughtful and astute. How the Department of Energy will address these comments is discussed in detail below.

Because the Department of Energy will maintain the High Flux Beam Reactor in a "safe storage" (decay) state for a period not to exceed 65 years, the CAC's recommendation for reducing the safe storage period to no more than 50 years is inherent in the Preferred Alternative. In recognition of the CAC's recommendations, DOE will endeavor to reduce the safe storage period as much as possible.

Critical to reducing the safe storage period will be accommodation of another CAC recommendation. DOE agrees with the CAC's recommendation and plans to perform technical reviews of the remedy in accordance with DOE five-year review guidance to determine the feasibility of completing the HFBR cleanup earlier, taking into consideration the factors specified by the CAC. If a five-year technical review identifies a remediation method that demonstrates the potential to reduce the decay period of 65 years, analysis of the potential method will be initiated and possibly implemented.

In the first of the following two sections, the basis for DOE's establishment of the 65-year safe storage period is discussed in detail. Discussed in the second section are plans for additional investigation and activation analysis that should enhance the accuracy of the decay period estimation.

Basis for the 65-year safe storage (decay) period and the 100 mrem/hr dose rate

For activated components involving short-lived radioisotopes, decay-in-storage results in a substantial reduction in dismantlement and waste management risks, hazards, project complexity, and cost.

The duration of a decay period in Alternative C (as well as Alternative B) was selected based on the point in time when the radiation dose rates associated with the large components (reactor vessel, thermal shield, and biological shield) would be reduced below 100 mrem/hr at a distance of 1 ft in air from the component. These large components will need to be segmented because they are too large and too heavy to fit into transportation casks in one piece. Currently, because of the high radiation dose rates, these components would need to be segmented and handled under water. Several feet of water would be needed to serve as a radiation shield to protect the workers from the high radiation levels. Therefore, Alternatives B and C included a waiting period to allow radioactive decay to reduce the radiation dose rate to below 100 mrem/hr at a distance of 1 ft. At this dose rate, it would not be necessary to perform the segmentation and handling operations under water.

The 100 mrem/hr value was selected because it is the standard nuclear industry benchmark used to distinguish a “radiation area” from a “high radiation area.” More importantly, the segmentation of the large components could be carried out in “air” (i.e., without the need to perform the work under water).

Based on detailed activation analysis, the 100 mrem/hr dose rate for the limiting large component (the component with the highest dose rate, the thermal shield) will be reached after a decay period of approximately 65 years. Figures III.1 and III.2 show, in increasing detail, the dose rates for the large activated components from 2007 to 2072 and 2040 to 2090, respectively. As shown in Figures III.2 and III.3, the 100 mrem level for the thermal shield is reached after a decay period of approximately 65 years.

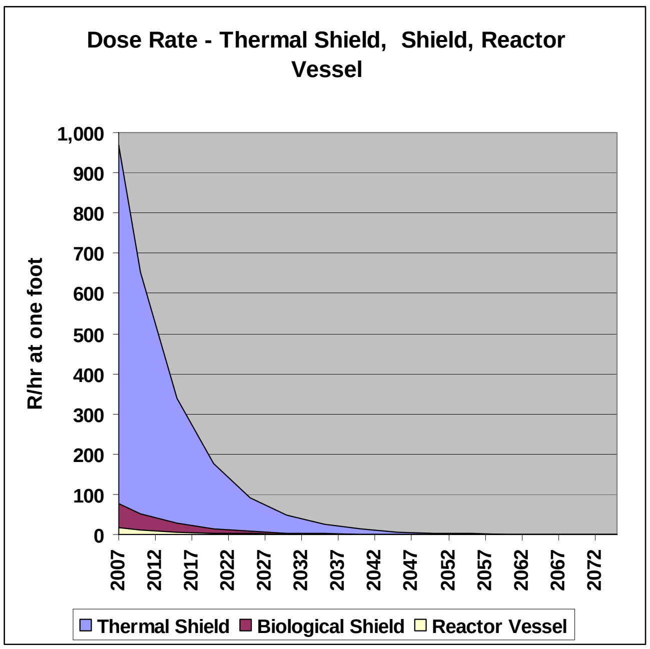

Figure III.1 Dose Rate 2007 – 2072

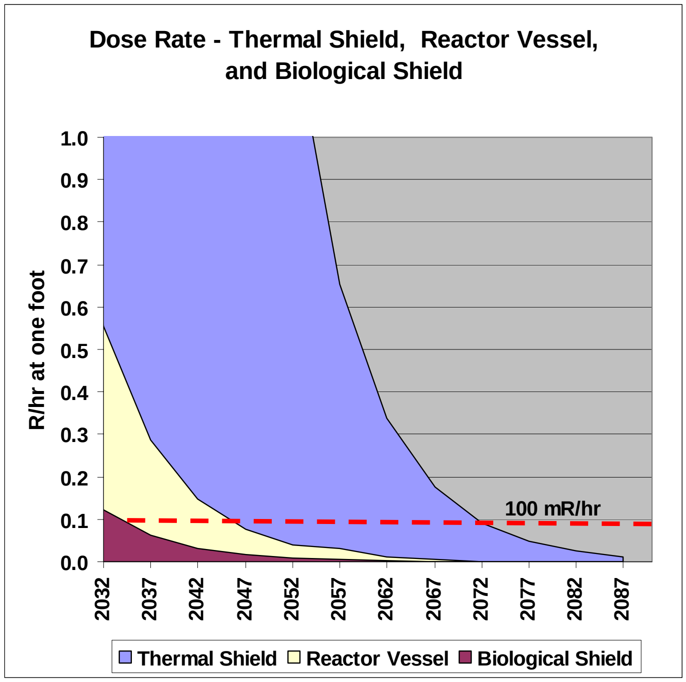

Figure III.2 Dose Rate (Detail) 2032 – 2087

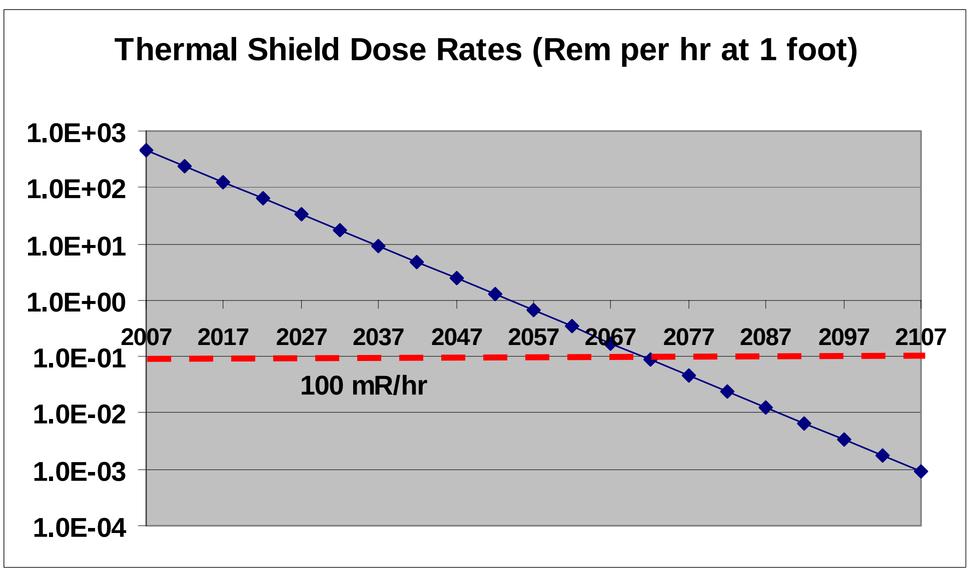

Figure III.3 Thermal Shield Dose Rates 2007 – 2107

Additional Investigations

Recognizing that there are uncertainties inherent in activation analyses, DOE plans to conduct an additional investigation involving the following steps:

- Perform radiation surveys (measurements of radiation levels) after the removal of the CRBs from the reactor vessel. (Surveys before the removal of CRBs with high dose rates would not yield reliable results.)
- Reevaluate the dose rate at 1 ft from the large activated components (reactor vessel, thermal shield, and biological shield) based on the radiation surveys.
- Using the reevaluated dose rates, determine the decay period necessary for the dose rate at 1 ft to fall below 100 mrem/hr for the large activated components, including the limiting component.
- Use the results of the additional investigation in the first five-year review (scheduled for 2011) in assessing the feasibility of shortening the decay period.

2 Comments from Christopher M. Bobinger

Comment

In regards to the clean up options that are provided for public comment, I feel that the DOE has chosen smartly to back Alternative C. Allowing shorter lived radioisotopes (like 5.27 yr $T_{1/2}$ Co-60) to decay greatly reduces personnel exposure, total job Man-Rem, and the possibility of an accidental release of contamination outside to the environment.

I personally feel that Alternative B is a better choice, for the reasons listed above. Allowing some - certainly not all - of the activity in the CRBs to decay, as well as the beam plugs, will again reduce total personal exposure and decrease the possibility of public exposure. However, Alternative C does provide some concession to the members of the public that want this facility removed as soon as possible, by declaring that the most highly radioactive and irradiated components will be removed quickly, and the rest of the activity is low level, moderately low risk contamination.

I believe that the public will push for Alternative D. I strongly oppose this idea, even though I no longer live on Long Island. The public, if they choose to back this Alternative, simply wants to push the "Not in my backyard" ideal, and want the HFBR removed immediately. What they don't understand is that by removing the buildings and equipment now, the possibility of public exposure is exponentially higher. I hope that an official or expert at these public meetings will provide the public with an explanation of half-lives and radioisotope decay. Thank you for your concern.

Response

Mr. Bobinger supports the preferred alternative, Alternative C, as described in the PRAP.

3 Comments from Assemblyman Marc Alessi

Comment

The cleanup remedy for the High Flux Beam Reactor (HFBR) must be approached with an unwavering commitment to the safety and the health of the public. The plan to decommission the HFBR and the associated ancillary buildings is a matter of extreme importance to the residents of Brookhaven and when successfully completed, the threat of radioactive materials infiltrating our groundwater or posing risks to public safety will be effectively eliminated. I applaud the U.S. Department of Energy (DOE) and the Brookhaven National Laboratory (BNL) for their recognition of the dangers posed by the HFBR and I appreciate their efforts to establish a plan that works in the best interest of the public. As they move forward with the cleanup process, I urge the entities to keep the following recommendations in mind.

I would advise the DOE and BNL to reject alternatives A and D, due to the risks and the monetary costs associated with those proposals. As the contamination of groundwater surrounding the site is of grave concern, Alternative A, which calls for no further action, would do nothing to mitigate this threat. It is understood that as time passes, the radiological inventory will undergo a slow, natural process of radioactive decay. Unfortunately, this option fails to address the problem of contaminated groundwater in the short term. Since Long Island residents rely heavily on groundwater as the principle source of our drinking water, it is imperative that we abandon this do-nothing approach. Also problematic are the unforeseen costs associated with Alternative A. As it is impossible to predict the future cost of surveillance, maintenance or land use institutional controls, this proposal could, in fact, become far more expensive than the other options as decades pass by. Without the ability to forecast costs, it would be unwise to pursue this proposal. We need to implement a plan with firm boundaries, a finite time table, and cost containment measures.

As risky as it would be to take no further action, it would be worse to pursue Alternative D, which calls for an immediate decontamination and dismantlement of the HFBR. To immediately remove components of the HFBR could cause more harm than good, as this action would pose the significant threat of disseminating radioactive dust into the air. Additionally, disturbing the dust that is, at this point, dormant, could cause toxins to seep into the ground water, further complicating the cleanup process. Not only is this option too harmful to the environment and too dangerous to the workers involved in the process, but the proposed cost is far too expensive, especially as more feasible, affordable alternatives have been suggested.

In light of the need to keep public safety a top priority while also keeping costs in check, Alternatives B and C should be considered the most viable options. Both alternatives call for a phased decontamination and dismantlement, offering a middle ground to the two extreme proposals discussed above. Both address the need to reduce the threat of contamination in the near term, by cleaning up ancillary buildings, underground ducts and piping and contaminated pockets of soil in a timely manner. As was mentioned before, the purity of our groundwater is of utmost importance to all Long Island residents, and an approach to allay any further contamination is vital. These alternatives, in addition to taking safety and environmental factors into consideration, also have clear-cut expenditures established, *which will prevent ballooning budgets and rein in spending. For all of these reasons, Alternatives B and C are the best presented options.*

Again, I would like to thank the DOE and the BNL for providing the opportunity for public comment and I appreciate the commitment they have shown to adapting to public sentiment. I strongly encourage the consideration of Alternative B – this option most strongly promises to alleviate any environmental and safety impacts while operating within a practical budget. I hope as the project progresses, the Brookhaven National Laboratory and the Department of Energy will keep the public apprised of its efforts.

Response

Assemblyman Alessi states that "Alternatives B and C should be considered the most viable options" and lists the reasons for concluding that "Alternatives B and C are the best presented options." This is consistent with DOE's conclusion based on a comparative evaluation of the remedial alternatives. He also encouraged "the consideration of Alternative B – this option most strongly promises to alleviate any environmental and safety impacts while operating within a practical budget."

Alternatives B and C only differ with respect to the timing of the removal and disposal of the CRBs and beam plugs. In DOE's comparative evaluation of alternatives, both alternatives were rated High in terms of all five CERCLA criteria for which relative ratings were established: overall protection of human health and the environment, compliance with applicable or relevant and appropriate requirements, long-term effectiveness, short-term effectiveness, and implementability. Both alternatives include the near-term (by 2020) removal of the ancillary structures, contaminated underground ducts and piping, and associated soils; the complete removal of the HFBR complex (with the possible exception of the subsurface concrete structures of the confinement building base mat and stack foundation) after a decay period not to exceed 65 years; and the continuation of S&M and the use of LUICs during the decay period to ensure the protection of human health and the environment.

Alternative C also includes near-term removal of control rod blades and beam plugs (containing 35 percent of the current HFBR radioactive material inventory) at an incremental cost of $2 million ($144 million compared to $142 million for Alternative B). Therefore, Alternative C was chosen by DOE as the preferred alternative.

It should also be noted that funding for the removal and disposal of the CRBs and beam plugs is included in DOE's budget for FY 2008.

As part of its public outreach effort, DOE will keep the public informed of the progress of the HFBR decommissioning project.

4 Comments from Bernadette Smith Budd

Comment

In response to your request for public comment on the decommissioning of the HFBR, we would like to submit our preference for ALTERNATIVE D.

We support the removal of the entire HFBR complex by the end of 2026, hopefully to commence as soon as possible.

Our reason is protection of human health and the environment, which is the most important of the criteria being used to evaluate the alternatives.

Even though the cost is estimated at $205 million, BNL is responsible for this blight and the entire site should be cleaned and not left to a decay period, which would affect our groundwater and health.

Hopefully, you will safeguard our future with Alternative D.

Response

Protection of human health and the environment are foremost considerations in any Department of Energy remediation project. While Alternative D, Near-Term Decontamination and Dismantlement, provides this protection, the Preferred Alternative, Alternative C, also does. It is important to note that the High Flux Beam Reactor poses no current or immediate threat to human health or the environment and a comprehensive surveillance and maintenance program is in place to monitor the facility.

In the comparative evaluation of alternatives, the Preferred Alternative C was rated High in terms of all five CERCLA criteria for which relative ratings were established: overall protection of human health and the environment, compliance with applicable or relevant and appropriate requirements, long-term effectiveness, short-term effectiveness, and implementability.

In the same comparative evaluation, Alternative D was rated High under CERCLA criterion associated with overall protection of human health and the environment. However, because of its complexity and high levels of risks and hazards, Alternative D was rated Low under two other CERCLA criteria: short-term effectiveness and implementability. The cost of Alternative D, $205 million compared to $144 million for Alternative C, is of lesser consideration than that Alternative D falls short of the mark in two of the five CERCLA criteria. The details of the comparative evaluation are included in Section 9.

The groundwater tritium plume resulting from the HFBR spent fuel pool leak is currently being addressed under the OU III ROD. An extensive groundwater monitoring network has been implemented and the portion of the plume containing the highest tritium concentrations has undergone low-flow pumping with disposal and treatment of the water at an approved off-site facility. There is also a contingency described in the ROD to ensure that the plume does not migrate further south than the central portion of the site at levels above the drinking water standard of 20,000 pCi/L and poses no public health risks. The plume will continue to be monitored until all tritium concentrations have attenuated to levels below the drinking water standard.

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APPENDIX A

Timeline of Community Involvement Activities

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April 13, 2000	Presentation to the CAC on the closure strategy steps that have been and will be taken for the HFBR.
June 8, 2000	Update to the CAC on funding for the HFBR and on the stabilization and decommissioning activities scheduled and completed.
January 11, 2001	CAC updated on stabilization activities at the HFBR.
February 13, 2003	CAC informed that HFBR is in surveillance and maintenance mode and that characterization is nearly complete.
June 8, 2005	Presentation to the Brookhaven Executive Roundtable on HFBR overview and planning.
June 9, 2005	CAC given a background presentation on HFBR history, purpose, and actions taken to -date.
July 13, 2005	Presentation on the characterization history of the HFBR was given to the BER.
July 14, 2005	Presentation on the characterization history of the HFBR was given to the CAC.
July 19, 2005	Phone calls made to local elected officials. Follow-up letters and fact sheets were sent, covering the status of the HFBR and an overview of the planning process.
August 11, 2005	Workshop on characterization and tour of the reactor Confinement Building was provided for the CAC.
October 20, 2005	Presentation on the comparison of the HFBR to the Brookhaven Graphite Research Reactor was given to the CAC.
March 9, 2006	A presentation on four draft remedial alternatives was given to the CAC.
April 6, 2006	A survey of interest in the BNL red-and-white exhaust stack was conducted from April 6 through May 24, 2006. Forty individuals or organizations with possible historic or navigational interests were identified and contacted. Thirteen expressed interest in the decision-making process.
April 14, 2006	Letters were sent to 26 civic associations informing them that the planning process for decommissioning the HFBR was underway. As a result the Lab made presentations to two local groups.

April 20, 2006	The discussion of the draft remedial alternatives continued from the previous meeting and a panel of Lab experts answered questions for the CAC.
May 4, 2006	Presentation on draft alternatives and planning process was made to the Manorville Taxpayers & Civic Association.
June 1, 2006	Presentation on draft alternatives and planning process was made to the East Yaphank Civic Association.
June 8, 2006	The CAC panel discussion continued from the April meeting and a presentation on security at the HFBR was given.
July 13, 2006	The CAC had a discussion on the draft alternatives and provided their input to the Lab.
March 8, 2007	The Lab updated the CAC on the activation re-analysis of the large components.
June 14, 2007	The CAC was updated on the HFBR schedule.
September 13, 2007	Updated the CAC on release of the Feasibility Study and Proposed Remedial Action Plan (PRAP).
January 7, 2008	Article on the PRAP and public comment period was included in the Lab's employee e-mail newsletter, *Monday Memo*.
January 8, 2008	PRAP fact sheet and letter mailed to 200 individuals—including civic associations, elected officials, and the individuals from the stack survey who had expressed interested in the process.
January 9, 2008	Notice of Availability (NOA) was published in the *Suffolk Life Newspapers* announcing the beginning of the public comment period on January 10.
	Overview of the PRAP was given to BER.
January 10, 2008	NOA was also published in the *Newsday*, Suffolk edition.
	A presentation on the final PRAP alternatives was given to the CAC.
January 11, 2008	Article on the PRAP, "DOE Seeks Comment on Reactor Cleanup," was published in the Lab employee newsletter, *The Bulletin*.
February 7, 2008	Presentations on the PRAP were made to the Manorville Taxpayers & Civic Association and the East Yaphank Civic Association. The PRAP fact sheet and comment cards were distributed.

February 14, 2008	HFBR project staff gave a presentation on the PRAP to the Lab's Envoy group. A panel of subject matter experts answered the CAC member's questions at their meeting.
February 18, 2008	A presentation on the PRAP was made to the Affiliated Brookhaven Civic Organizations. The fact sheet and comment cards were distributed
February 21, 2008	A presentation on the PRAP was given to the Middle Island Civic Association. The fact sheet and comment cards were distributed.
February 27 – 29, 2008	Display ads advertising the Information Sessions and Public Meeting were published in the *Suffolk Life, Newsda*y, the *North Shore Sun*, the *Port Times Record*, the *Riverhead News Review*, the *Long Island Advance*, and the *Southampton Press*.
March 4, 2008	Information sessions on the PRAP were held from noon to 2 p.m. and from 7 p.m. to 9 p.m. at BNL. No comments were received at either meeting.
March 6, 2008	Public meeting on PRAP was held from 7 p.m. to 9 p.m. at BNL. No public comments were received.
March 13, 2008	CAC meeting. The CAC was able to reach consensus to support the preferred alternative, Alternative C, with an amendment to the length of the decay period of 50 years instead of 65 years and with the addition of a substantive five-year review to evaluate issues such as new technologies, health and safety issues, environmental impact, and community interests.
March 17, 2008	End of public comment period. The CAC and three others, including NYS Assemblyman Marc Alessi, submitted comments on the HFBR PRAP.

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APPENDIX B
Comments Received by DOE during the Public Comment Period

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CAC

Community Advisory Council to Brookhaven National Laboratory
P.O. Box 898, Upton, New York 11973-0898

Community Advisory Council Consensus Recommendation
HFBR Proposed Remedial Action Plan
March 13, 2008

Consensus Recommendation:

The Community Advisory Council (CAC) supports Alternative C, the preferred alternative, as presented in the Proposed Remedial Action Plan for the High Flux Beam Reactor (HFBR) with the following modification:

- Removed after a decay period, not to exceed 50 years following the finalization of the HFBR ROD.
  - Other activated components
  - Confinement building
  - HFBR complex contaminated soils

Further, the CAC recommends that the Record of Decision (ROD) require substantive five-year reviews of the remedy (not to be confused with reviews required under CERCLA) to determine if the cleanup can be conducted more quickly, safely, or effectively than with the remedy specified in the ROD. Each review should specifically evaluate:

- Advancements in cleanup technologies and transportation methods
- Changes in standards and regulations for worker, public, and environmental protection
- Worker safety impacts
- Environmental impacts
- Public health impacts
- Economic impacts
- Land use
- Existing stabilization and safety of the facility and hazardous materials
- Projected future stability and safety of the facility and hazardous materials
- Community interests through formal community involvement in the review

Kumar, Siva

From: Carter, John T
Sent: Thursday, March 06, 2008 9:23 AM
To: Hill, Leslie; Kumar, Siva; Adey, Charles W; Lein, Bruce; Cava, George; DAscoli, Jeanne H; Johnson, Sherry A
Cc: Nelson, Lloyd
Subject: FW: HFBR Decommissioning

Our first comment ...

John Carter
DOE/BHSO
631-344-5195 (office)
631-708-6496 (cell)

From: Bobinger, Christopher M. [mailto:Christopher.M.Bobinger@ngc.com]
Sent: Thursday, March 06, 2008 7:47 AM
To: tellDOE@bnl.gov
Subject: HFBR Decommissioning

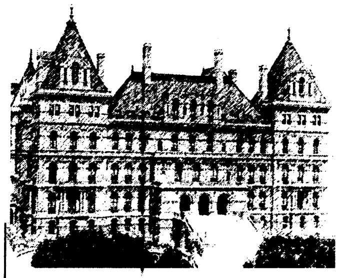
Dear Ma'am or Sir:

In regards to the clean up options that are provided for public comment, I feel that the DOE has chosen smartly to back Alternative C. Allowing shorter lived radioisotopes (Like 5.27 yr $T_{1/2}$ Co-60) to decay greatly reduces personel exposore, total job Man-Rem, and the possiblity of an accidental release of contamination outside to the environment.

I personally feel that Alternative B is a better choice, for the reasons listed above. Allowing some - certainly not all - of the activity in the CRBs to decay, as well as the beam plugs, will again reduce total personal exposure and decrease the possiblity of public exposure. However, Alternative C does provide some concession to the members of the public that want this facility removed as soon as possible, by declaring that the most highly radioactive and irradiated components will be removed quickly, and the rest of the activity is low level, moderately low risk contamination.

I believe that the public will push for Alternative D. I strongly oppose this idea, even though I no longer live on Long Island. The public, if they choose to back this Alternative, simply wants to push the "Not in my backyard" ideal, and want the HFBR removed immediately. What they don't understand is that by removing the buildings and equipment now, the possiblility of public exposure is exponentially higher. I hope that an official or expert at these public meetings will provide the public with an explanation of half-lives and radioisotope decay. Thank you for your concern.

Sincerely,
Christopher M. Bobinger
E82, Reactor Services Project
Northrop Grumman Shipbuilding
(757) 380-2329



NEWS From Assemblyman 1st Assembly District Marc Alessi

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Room 326, LOB Albany, NY 12248 • (518) 455-5294
DISTRICT OFFICE:
6144 Route 25 A, Building A, Suite 5, Wading River, NY 11792
(631) 929-5540

For Immediate Release
March 17, 2008

Contact: Marc Alessi
(631) 929-5540

RE: HFBR Cleanup Comments

The cleanup remedy for the High Flux Beam Reactor (HFBR) must be approached with an unwavering commitment to the safety and the health of the public. The plan to decommission the HFBR and the associated ancillary buildings is a matter of extreme importance to the residents of Brookhaven and when successfully completed, the threat of radioactive materials infiltrating our groundwater or posing risks to public safety will be effectively eliminated. I applaud the U.S. Department of Energy (DOE) and the Brookhaven National Laboratory (BNL) for their recognition of the dangers posed by the HFBR and I appreciate their efforts to establish a plan that works in the best interest of the public. As they move forward with the cleanup process, I urge the entities to keep the following recommendations in mind.

I would advise the DOE and BNL to reject alternatives A and D, due to the risks and the monetary costs associated with those proposals. As the contamination of groundwater surrounding the site is of grave concern, Alternative A, which calls for no further action, would do nothing to mitigate this threat. It is understood that as time passes, the radiological inventory will undergo a slow, natural process of radioactive decay. Unfortunately, this option fails to address the problem of contaminated groundwater in the short term. Since Long Island residents rely heavily on groundwater as the principle source of our drinking water, it is imperative that we abandon this do-nothing approach. Also problematic are the unforeseen costs associated with Alternative A. As it is impossible to predict the future cost of surveillance, maintenance or land use institutional controls, this proposal could, in fact, become far more expensive than the other options as decades pass by. Without the ability to forecast costs, it would be unwise to pursue this proposal. We need to implement a plan with firm boundaries, a finite time table, and cost containment measures.

As risky as it would be to take no further action, it would be worse to pursue Alternative D, which calls for an immediate decontamination and dismantlement of the HFBR. To immediately remove components of the HFBR could cause more harm than good, as this action would pose the significant threat of disseminating radioactive dust into the air. Additionally, disturbing the dust that is, at this point, dormant, could cause toxins to seep into the ground water, further complicating the cleanup process. Not only is this option too harmful to the environment and too dangerous to the workers involved in the process, but the proposed cost is far too expensive, especially as more feasible, affordable alternatives have been suggested.

In light of the need to keep public safety a top priority while also keeping costs in check, Alternatives B and C should be considered the most viable options. Both alternatives call for a phased decontamination and dismantlement, offering a middle ground to the two extreme proposals discussed above. Both address the need to reduce the threat of contamination in the near-term, by cleaning up ancillary buildings, underground ducts and piping and contaminated pockets of soil in a timely manner. As was mentioned before, the purity of our groundwater is of utmost importance to all Long Island residents, and an approach to allay any further contamination is vital. These alternatives, in addition to taking safety and environmental factors into consideration, also have clear-cut expenditures established, which will prevent ballooning budgets and rein in spending. For all of these reasons, Alternatives B and C are the best presented options.

Again, I would like to thank the DOE and the BNL for providing the opportunity for public comment and I appreciate the commitment they have shown to adapting to public sentiment. I strongly encourage the consideration of Alternative B – this option most strongly promises to alleviate any environmental and safety impacts while operating within a practical budget. I hope as the project progresses, the Brookhaven National Laboratory and the Department of Energy will keep the public apprised of its efforts.

The
Community Journal
Trusted & Read for 30 Years
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March 12, 2008

MICHAEL D. HOLLAND, MANAGER
U.S. DEPT OF ENERGY, BROOKHAVEN SIT OFFICE ATTN:
HFBR DECOMMISSIONING PROJECT BLDG 464
P.O. BOX 5000
UPTON, NY 11973-5000

Dear Mr. Holland:

In response to your request for public comment on the decommissioning of the HFBR, we would like to submit our preference for ALTERNATIVE D.

We support the removal of the entire HFBR complex by the end of 2026, hopefully to commence as soon as possible.

Our reason is protection of human health and the environment, which is the most important of the criteria being used to evaluate the alternatives.

Even though the cost is estimated at $205 million, BNL is responsible for this blight and the entire site should be cleaned and not left to a decay period, which would affect our groundwater and health.

Hopefully, you will safeguard our future with Alternative D.

Thank you for this opportunity.

Very truly yours,

Bernadette Smith Budd

Bernadette Smith Budd, Esq., editor and publisher