BGRR Public Comment Period: August 2, 2004, to September 3, 2004

The Proposed Remedial Action Plan for the

Brookhaven Graphite Research Reactor

At Brookhaven National Laboratory

Operating from 1950 to 1968, the Brookhaven Graphite Research Reactor was the world's first reactor constructed solely for scientific research into the peaceful uses of the atom.

I. INTRODUCTION

The purpose of this Proposed Remedial Action Plan (Proposed Plan, or PRAP) is: to describe the preferred alternative for remediation of the Brookhaven Graphite Research Reactor (BGRR), to explain the basis for the preference of this remedy over the other alternatives considered, and to solicit public comment before the selection of the final remedy.

Operating from 1950 to 1968, the BGRR was the world's first reactor built solely for scientific research into the peaceful uses of the atom. Deactivation of the facility was initiated in September 1969. In March 1972, the BGRR's last fuel element was removed, and the fuel was shipped to the Savannah River Site of the U.S. Department of Energy (DOE) shortly thereafter. The BGRR complex was then granted shutdown status by the U.S. Atomic Energy Commission. From 1977 through 1997, portions of the building were used for BNL's science museum.

This PRAP is required as part of the ***Comprehensive Environmental Response, Compensation, and Liability Act*** (CERCLA, which is also known as the Superfund law). In 1980, Brookhaven National Laboratory (BNL), which is owned by DOE, was placed on the list of Inactive Hazardous Waste Disposal sites of the New York State Department of Environmental Conservation (NYSDEC). In 1989, BNL was included on the ***National Priorities List*** of the U.S. Environmental Protection Agency (EPA). Because of this designation, BNL is being cleaned up in accordance with the Superfund law under the oversight of EPA and NYSDEC through what is called an Interagency Agreement.

The community has played and continues to play an important role in selecting cleanup alternatives for Brookhaven Lab. Because the final remedy for the BGRR may be modified or a different alternative may be selected based on public input, the public is encouraged to comment on all the alternatives considered. Written comments on the BGRR Proposed Remedial Action Plan will be accepted during a public comment period of 30 days, lasting from August 2, 2004, through September 3, 2004. For your convenience in submitting your written comments, an addressed comment sheet is included on page 20.

During the public comment period, interested community members are invited to attend the two information sessions on August 17th or August 19th, to speak with project staff to learn

Inside This Plan

PLEASE NOTE: Technical and administrative terms are used throughout this Proposed Remedial Action Plan. When these terms are first used, they are printed in ***bold italics***. Explanations of these terms, document references, and other notes are provided in the margin.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA): the federal law that establishes a program to identify, evaluate, and remediate properties where hazardous substances may have been released, leaked, poured, spilled, or dumped into the environment.

National Priorities List: a formal listing of the properties that have been identified for possible cleanup. Properties are ranked by the EPA based on their potential for affecting human health and the environment.

Feasibility Study (FS): a process for developing, evaluating, and selecting remedial actions, using data gathered during the remedial investigation. An FS defines the objectives of the remedial program for the property and broadly develops remedial action alternatives, supplies an initial screening of these alternatives, and analyzes in detail the limited number of alternatives remaining after the initial screening stage.

Record of Decision (ROD): a document of the decision by the regulators on a selected remedial action, which includes the responsiveness summary and a bibliography of documents that were used to reach the remedial decision. When the ROD is finalized, remedial design and construction begin.

Administrative Record: the documents including correspondence, public comments, and technical reports upon which the agencies base their selection of a remedial action.

Radionuclide: an element, such as Cesium-137, which breaks down to form another element and thereby releases ionizing radiation due to its unstable nuclear structure.

more about the proposed remedy. DOE and BNL will also hold a formal public meeting on August 24th to present the conclusions of BGRR ***Feasibility Study*** and this Proposed Plan, and to receive public comments on the proposed remedy. For more information regarding the information sessions and public meeting, please see Section IX on page 16.

After the public comment period ends, DOE will select a final remedy for the BGRR, with EPA and NYSDEC concurrence. The decision will be formalized in a document called the ***Record of Decision*** (ROD). The ROD will contain what is called a Responsiveness Summary, which will include all formal public comments and provide the responses to them. These documents will be available for public review at the ***Administrative Record*** repository locations, which are listed in Section X on page 17.

II. BACKGROUND

Established in 1947, Brookhaven Lab is now operated and managed for DOE's Office of Science by Brookhaven Science Associates, a limited-liability company founded by Stony Brook University, the largest academic user of Laboratory facilities, and Battelle, a nonprofit, applied science and technology organization. One of the ten DOE national laboratories, Brookhaven Lab 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. For more information about BNL, go to www.bnl.gov on the World Wide Web.

The Laboratory is located in the Town of Brookhaven in Suffolk County on Long Island, approximately 60 miles east of New York City as shown in Figure 1 below. Approximately 1.32 million people reside in Suffolk County, and a little over 400,000 people reside in the Town of Brookhaven. The BNL site occupies about 5,300 acres in central Suffolk, much of which is wooded. Most of the Laboratory's facilities are located near the center of the site, in a developed portion that covers about 1,700 acres. As shown in Figure 2 on the opposite page, the BGRR is within this central portion of the BNL property. The reactor complex covers about 3.8 acres, which is less than 0.1 percent of BNL's site.

The BGRR complex, seen in Figure 3 on page 4, consists of multiple structures, support systems, and auxiliaries that historically were used to operate and maintain the reactor. Portions of the reactor building and associated equipment and structures, some of which are underground, are still contaminated with ***radionuclides*** and chemicals from past activities.

During its past operations, the BGRR contained fuel within the graphite "pile," which is located inside Building 701. A five-foot thick biological shield that was used to minimize radiation within the building during reactor operations surrounds the pile. Outside air was pulled through two large intake ducts through the pile to cool the reactor. Cooling air then exited through below-ground and above-ground ducts. Spent fuel was transferred from the pile to a canal before its disposal off site.

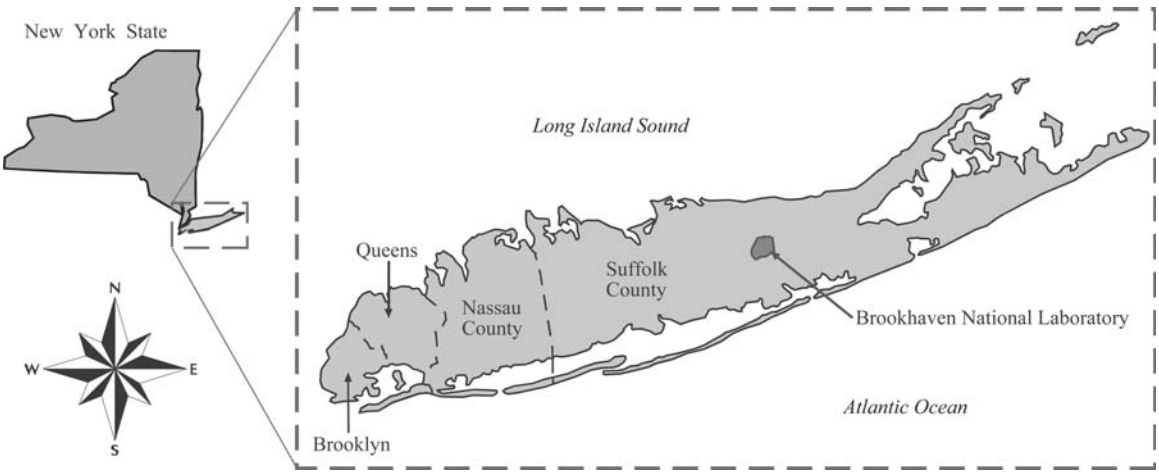


FIGURE 1. A map of Long Island, New York, showing where Brookhaven National Laboratory is located in Suffolk County

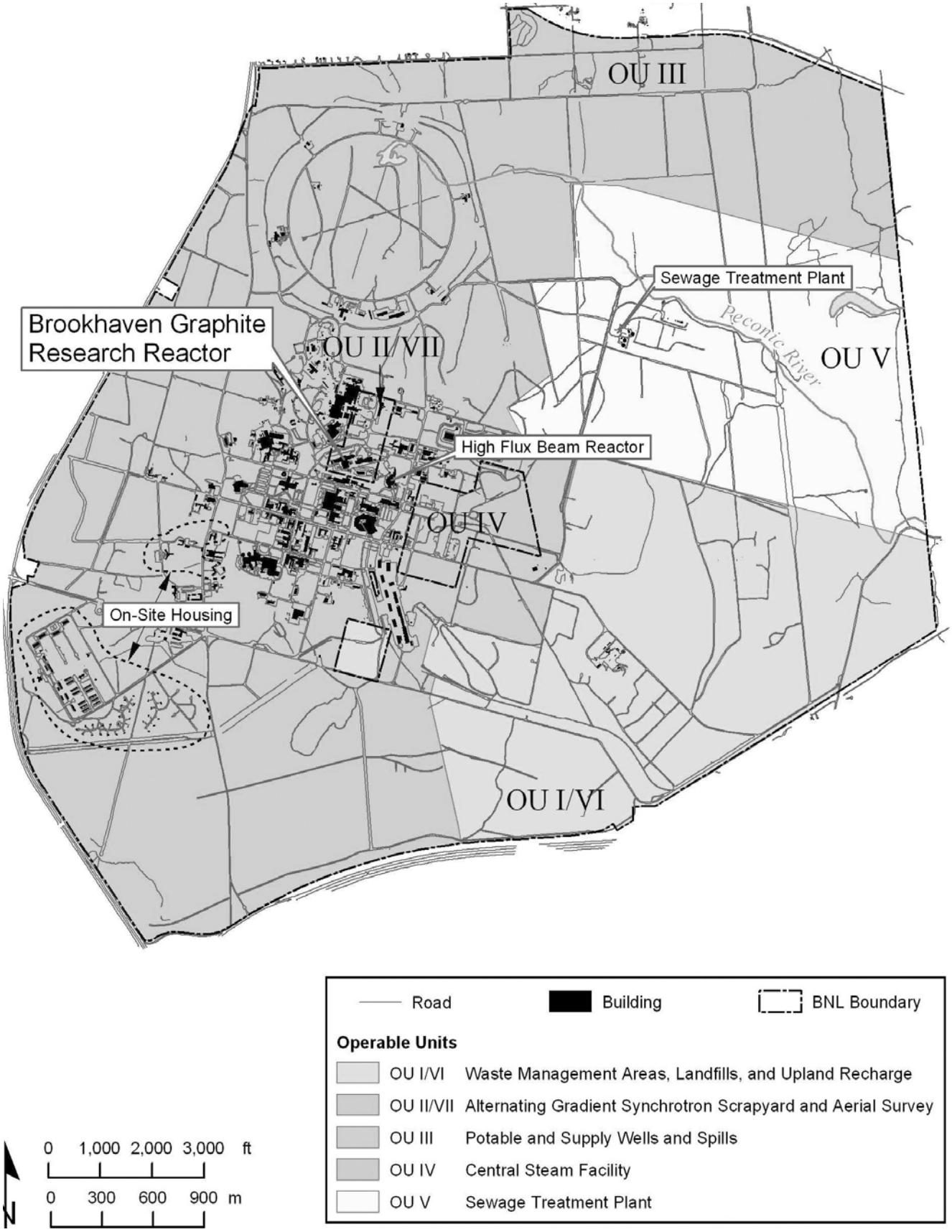


FIGURE 2. A map of Brookhaven Lab's site, showing the location of the Brookhaven Graphite Research Reactor

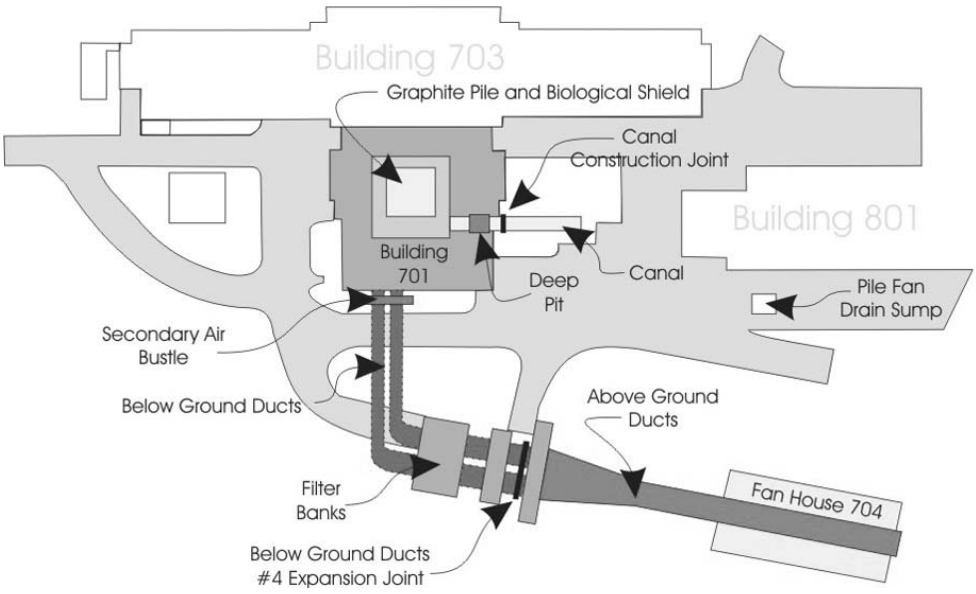


FIGURE 3. The Brookhaven Graphite Research Reactor complex

III. SITE CHARACTERISTICS

As the result of its past operations, the BGRR currently contains approximately 8,047 ***Curies*** of radioactive contaminants. These radionuclides consist of primarily nuclear activation products, such as hydrogen-3 (tritium) and carbon-14, and fission products cesium-137 (Cs-137) and strontium-90 (Sr-90). Actions completed or planned for completion account for an additional 47 Curies of contaminants.

The nature and extent of contamination varies by location, depending upon the historic uses of the systems and components, and upon releases. The majority of the radioactive contaminants, some 8,044 Curies, is bound within the graphite pile and biological shield. In fact, the pile and biological shield contain more than 99 percent of the BGRR complex's remaining radiological inventory.

Fission and activation products generated from the use of nuclear fuel are present within the reactor graphite core, the pile air-cooling system, and the spent-fuel handling system. Also present are uranium and plutonium, as well as relatively small amounts of other radionuclides. There are also some underground pockets of soil contamination near concrete expansion joints used in constructing the subterranean systems and support structures.

This Proposed Plan addresses only the BGRR's contaminated structures and soils. Impact to groundwater by contaminants that potentially originated from the BGRR are being addressed under what is called the ***Operable Unit*** (OU)-III Groundwater Monitoring ROD. To help understand potential ***risks*** and pathways, the BGRR's remaining contaminants are categorized as either contaminated structures or contaminated soil. A description of these can be found in Table 1 page 5, opposite.

Removal Actions to Date

During the last several years, a number of ***removal actions*** and other interim measures have been taken to reduce the radiological footprint of the BGRR complex and reduce the potential threat of leakage to the environment. As shown in Table 2 on page 6, these actions account for approximately 47 Curies of radioactivity, which is more than 90 percent of the contaminants not contained within the graphite pile and biological shield.

IV. BASIS FOR REMEDIAL ACTION

The majority, or greater than 99 percent of the radiological inventory is contained in the pile and biological shield. Essentially all of the long-lived radioisotopes are also contained in these structures. As expected, contamination has been found in the fuel-handling system deep pit and canal, and in the steel and concrete within below-ground ducts.

Extensive characterization has determined that the reactor building's exterior and interior structures, systems, and components, with limited exceptions, are relatively free of contamination. However, because of historic contamination within Building 701, the area remains posted as a radiologically controlled area, requiring all work within the facility be controlled for radiological protection purposes.

Because of leakage during and after reactor operations, contamination has also been found in pockets of soil located under certain BGRR structures. Pockets of deep, subsurface contaminated soils have been found in a number of locations around and under the reactor building, below-ground ducts, and canal.

Curie: a unit of measure for radioactive materials based on the number of disintegrations per second (3.700×10^{10} per second).

Operable Unit (OU): the grouping of areas within a property based upon the contamination to be remediated. The remedial actions to be performed initially or over time, or remedial actions that take place at the same time but in different parts of a property. For instance, six Operable Units have been designated at Brookhaven Lab.

Risk: an estimate of the probability that exposure to contamination at a Laboratory property will cause cancer development or noncarcinogenic health effects.

Removal actions: measures taken early and/or quickly to prevent, minimize, or mitigate the potential threat to public health or the environment that may otherwise result from a release or possible release of hazardous substances, pollutants, or contaminants.

TABLE 1. BGRR CONTAMINATED STRUCTURES AND SOILS

CONTAMINATED STRUCTURE	DESCRIPTION	RADIOACTIVITY
Biological shield	High-density concrete encased in steel contaminated as a result of exposure to neutron flux of the operating reactor.	4,805 Curies
Graphite pile	Graphite and structural steel contaminated as a result of exposure to the neutron flux of the operating reactor and additional fission-product radioactivity from early fuel failures.	3,239 Curies
Deep pit/fuel canal under Bldg. 701	Concrete floor of deep pit/fuel canal that was soaked and penetrated with contaminated water containing high levels of fission products and fuel-related materials created during the processing of fuel for shipment	0.168 Curies
Canal outside Bldg. 701	The spent-fuel canal was partially cleaned under an earlier removal action. The remaining contamination exists on the walls and floors of the canal structure outside the footprint of the Bldg. 701 foundation	0.022 Curies
Below-ground duct concrete and steel	Remaining contamination existing in below-ground duct's concrete and steel, both below Bldg. 701, and south and southeast of the building foundation's footprint.	0.85 Curies
Balance of Bldg. 701	Surface contamination in isolated areas within Bldg. 701.	0.001 Curies
CONTAMINATED SOIL	**DESCRIPTION**	**RADIOACTIVITY**
Accessible soils at the secondary air bustle	Soils next to the secondary air bustle where the exhaust duct exits Bldg. 701. These soils are outside Bldg. 701's foundation footprint, so can be reasonably removed without jeopardizing Bldg. 701's structural integrity.	1.272 Curies
Inaccessible soils at the secondary air bustle	Soils next to the secondary air bustle located under Bldg. 701's foundation footprint or adjacent to its foundation columns. These soils cannot reasonably be removed without jeopardizing Bldg. 701's structural integrity.	0.424 Curies
Canal outer wall	Soil adjacent to the outside canal walls, including the soil under the canal-walkway sump at the southeast corner of the canal.	0.0048 Curies
Accessible soils at the canal construction joint	Soil under the canal floor near the canal construction joint outside Bldg. 701's foundation footprint. These soils can be removed reasonably without affecting Bldg. 701's integrity.	0.004 Curies
Inaccessible soils at the canal construction joint	Soil under the canal floor near the canal construction joint under Bldg. 701's foundation footprint or adjacent to foundation columns that cannot be removed without jeopardizing Bldg. 701's structural integrity.	0.004 Curies
Accessible soils at the below-ground duct expansion joint #4	Soil adjacent to the main expansion joints at the north and south reactor exhaust-air ducts. These soils can be removed without diminishing the structural integrity of the concrete duct.	0.0135 Curies
Inaccessible soils at the below-ground duct expansion joint #4	Soil adjacent to the main expansion joints at the north and south reactor exhaust-air ducts that cannot be removed without diminishing the structural integrity of the concrete duct.	0.0407 Curies
Drains and drywells outside Bldg. 701	Soil within and adjacent to the drain-system drywells outside Bldg. 701's foundation footprint.	0.00004 Curies
Drains and drywells under Bldg. 701	Soil within drywells that is located under Bldg. 701's foundation footprint and cannot reasonably be accessed for removal.	0.0024 Curies
Reactor Bldg. pipe trench	Contaminated surface soil located in the pipe trench on the north end of the reactor building.	0.0043 Curies
Below-ground duct under Bldg. 701	Soil beneath the north duct near the south plenum of the reactor pile. These soils cannot reasonably be accessed without jeopardizing Bldg. 701's structural integrity.	0.360 Curies
Deep pit/canal under Bldg. 701	Soil located below the fuel canal's deep pit that cannot reasonably be accessed for removal.	0.0034 Curies

Institutional controls: procedures established to prevent exposure of workers or the public to hazards. These may include the establishment of fencing, posting of signs, the requirement to sign in to a logbook before accessing a restricted area, etc.

Monitoring down-gradient of the BGRR indicates that the reactor facility has been a source of Sr-90 groundwater contamination. Control of potential sources to groundwater was the reason for many of the removal actions and other interim measures that are described in Table 2 below. This groundwater contamination is being addressed under the OU-III ROD. While the use of ***institutional controls*** is effective, there are uncertainties that unfavorably impact the use of institutional controls as a sole means of source-control. The inventory of long-lived radionuclides contained within the pile and biological shield warrant consideration for removal as the remedial action. This would eliminate the uncertainty involved with the indefinite use of institutional controls to protect human health and the environment.

In addition, the presence of pockets of contamination in soil outside the BGRR building and in groundwater is clear evidence of previous releases to the environment. Based on this, consideration should be given to reducing this potential threat to human health and the environment.

V. REMEDIAL ACTION OBJECTIVES

The remedial action objectives (RAOs) used to evaluate the BGRR's remedial action alternatives were developed considering: land use, contaminants of potential concern, applicable or relevant and appropriate requirements, and exposure pathways.

The three RAOs for the BGRR project are:

1. Through prudent remedial actions, ensure the protection of human health and the environment from the potential hazards posed by the radiological inventory that resides in the BGRR complex. Remedial actions should ensure protection of human health and the environment without undue uncertainties.
2. While completing the remedial actions, utilize ALARA ("as low as reasonably achievable") principles to reduce potential risks to human health, including exposure to workers and the public, and to the environment posed by the BGRR's considerable radiological inventory. Effectively more than 99 percent of the BGRR's radiological inventory will be removed.
3. Following completion of the remedial activities, implement long-term monitoring, maintenance, and institutional controls that are necessary to eliminate potential hazards to human health and the environment.

TABLE 2. BGRR INTERIM CLEANUP ACTIONS

YEAR	MATERIAL ADDRESSED	ACTION TAKEN	WASTE GENERATED
1997-99	water in below-ground ducts	pumped out water and repaired ducts	58,000 gallons of contaminated water
1999-2000	equipment pipes and other material at the graphite pile	removed from reactor bldg.	3 cubic meters of contaminated debris and 39 metric tons of contaminated shielding
	fan-house fans, motors, valves, and instruments	removed from fan house	68 metric tons of contaminated debris
	concrete pile-fan sump, pipes, and soil	removed old sump and diverted drain lines	240 cubic meters of contaminated debris and soil
2000-02	above-ground concrete ducts, and instrument-house pipes and equipment	removed ducts, sealed duct openings, and removed material from instrument house	250 cubic meters of contaminated debris
2001-02	equipment, pipes, structural material, asphalt, concrete, and soil	removed material from canal and water-treatment houses	2,200 cubic meters of contaminated debris and soil
2002-04	below-ground duct-cooling coils, exhaust filters, and primary liner system*	remove from the two ducts and compact on site	8.2 cubic meters of contaminated metal debris, 880 cubic meters of primary liner-system debris, and 24 cubic meters of exhaust filers

*Removal of the filter elements and contaminated steel in the below ground ducts is ongoing and expected to be completed by October 2004.

In October 1948, the construction site of the Brookhaven Graphite Research Reactor was visited by, among others, Dwight Eisenhower (seventh from left), who was then president of Columbia University.

VI. REMEDIAL ACTION ALTERNATIVES

Four BGRR end-state, remedial action alternatives have been identified, ranging from stabilization and source management to the complete removal of the BGRR reactor facility, above- and below-ground structures, and contaminated soils.

The four remedial action alternatives described below were developed with involvement of representatives from DOE, EPA, NYSDEC, New York State Department of Health, and Suffolk County Department of Health Services. In addition, community feedback that was solicited at the regular meetings of Brookhaven Lab's Community Advisory Council (CAC) and the BGRR Working Group was also considered.

A comparison of the four alternatives is found in Table 3 on page 12, and the preferred alternative is discussed in Section VIII beginning on page 16. The public is invited to comment upon the preferred alternative, as well as the other alternatives discussed below. Additional detail can be found in the *Feasibility Study for the BGRR* (BNL-BGRR-060) and other documents contained in the BGRR's administrative record found in repositories listed on page 17.

Alternative A: Stabilization and Source Management

Alternative A, Stabilization and Source Management, relies on several actions already taken and additional actions now in progress or planned to reduce the radiological footprint of the BGRR complex. This alternative relies heavily on infiltration management, surveillance and monitoring, and institutional controls to manage the residual radioactive materials, including the reactor pile and biological shield.

Upon completion, this alternative will remove a total of 47 Curies of radioactivity from the

BGRR complex, while approximately 8,047 Curies will remain. The majority, or some 8,044 Curies, of the remaining radioactivity is contained within the graphite pile and biological shield. It will be isolated from the environment by the biological shield itself and Building 701's superstructure and massive concrete foundation.

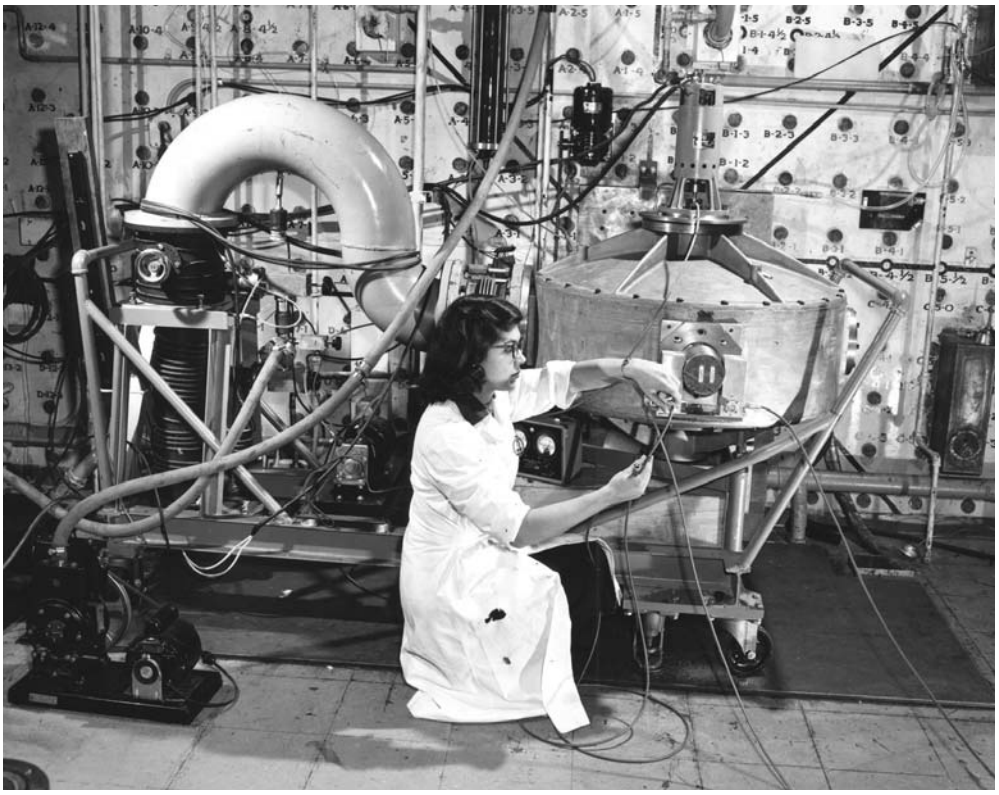
Approximately 3 Curies are contained within underground structures and deep pockets of contaminated soil, which will be monitored and controlled through the installation of an impermeable barrier and infiltration-management system. Because of the large quantity of long-lived radioactivity within the pile and biological shield, institutional controls would be required for an indefinite period.

Using conservative assumptions, it was calculated that it would take the long-lived radioactive isotopes within the pile approximately 87,000 years to decay to unrestricted levels. This calculation was performed to allow for a comparative analysis of the BGRR remedial action alternatives discussed herein. It was not intended to establish definitive institutional control durations.

However, institutional controls, including land-use restrictions, would help to ensure that the remaining radioactive materials can be managed to prevent inadvertent direct exposure and future migration to the soil regardless of the calculated durations. Institutional controls will include routine inspection and surveillance of the BGRR facility, scheduled upkeep and maintenance of Building 701, and infiltration management and monitoring. Additionally, controls for this alternative would specify land-use restrictions and reporting requirements.

At a minimum, these controls would:

- establish measures for future excavation of residual subsurface contamination, including characterization and limitations on use/reuse, according to NYSDEC regulations
- provide land-use restrictions and an acceptable method for evaluating the potential impact that the remaining contaminants could have on future development
- establish a restriction that the property's future use and development are limited to commercial or industrial uses only



Operated at the north face of the Brookhaven Graphite Research Reactor, the neutron sorting device seen in this historic photo was used to study the nucleus of the atom.

- specify requirements to provide annual certification to the NYSDEC, which would confirm that the institutional controls and engineering controls put in place are unchanged from the previous certification, that nothing has occurred to impair the ability of the controls to protect public health or the environment, and that nothing has occurred to constitute a violation or failure to comply with the site-management plan. This annual certification would be prepared and submitted by an engineering or environmental professional acceptable to NYSDEC.
- specify that land-use restriction and reporting requirements must be passed on to any/all future landowners through an environmental easement on the deed to the property.

Given 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 is owned by DOE. If the property is transferred to a non-fed-

eral entity, then a deed will be established and an environmental easement will be added to the deed.

Groundwater monitoring in the vicinity of the BGRR complex will continue throughout the institutional control period considered in the OU-III ROD. Results of the OU-III monitoring will be used to ensure the effectiveness of this remedy.

As of the end of fiscal year 2003, BGRR removal actions have cost $39.3 million. The remaining ongoing and scheduled activities are estimated to take 18 months, at a cost of $14.2 million, resulting in a total project cost to complete this alternative of $53.5 million.

Alternative B: Pile and Biological Shield Removal

As with all of the alternatives within this PRAP, this alternative includes the completion of actions that are currently underway or planned, followed by long-term response actions, including infiltration management, surveillance and maintenance, and institutional controls. Alternative B, Pile and Biological Shield Removal, includes not only the scope of Alternative A, but also the removal of the pile and biological shield.

Upon completion, this alternative will result in the removal of 8,091 Curies from the BGRR complex. Building 701 will remain intact, but with a steel plate installed over the open floor created by removing the pile and biological shield. To stabilize residual surface radioactivity, a fixative will be applied to the exposed surfaces of the reactor-pile foundation, support structure, and deep pit, before sealing the opening from Building 701's main-floor level.

Removal of the pile and biological shield will yield approximately 144,000 cubic feet of low-level radioactive waste. Essentially all of the long-lived radioisotopes will be removed with the graphite pile and biological shield, with the exception of trace concentrations within isolated pockets of soil near the canal outer walls and the deep pit. Characterization data indicate that the soil concentrations are less than the cleanup goals for these radionuclides within soil.

Approximately 3 Curies, predominantly Cs-137 and Sr-90, will remain in contaminated structures below Building 701's footprint, the canal, the below-ground ducts' concrete and steel, and the contaminated subsurface soils. With the removal of the long-lived radioactive isotopes, the residual contamination remaining in the deep, inaccessible pockets of soil will require institutional controls to manage the remaining short-lived radioisotopes.

Using conservative assumptions, it was calculated that it would require approximately 266 years for radioisotopes to decay to the OU-I soil-cleanup standards for industrial land use of 67 pico-Curies per gram (pCi/gm) of Cs-137 and 15 pCi/gm of Sr-90. Another 100 years would be necessary for the radioactivity to decay to acceptable levels for unrestricted-land use. This calculation was performed to allow for a comparative analysis of the BGRR remedial action alternatives discussed herein. It was not intended to establish definitive institutional-control durations.

However, institutional controls, including land-use restrictions, would help ensure that the remaining contaminated structures and soils can be managed to prevent inadvertent direct exposure and future migration to the soil regardless of these calculated durations. If necessary, excavation of these soils at some time in the future would be evaluated based on the actual distribution, depth, and concentrations of the residual radioactive material encountered. Given the depth of these soils and the clean overburden, the concentrations of Cs-137 and Sr-90 would be significantly reduced when mixed with the clean overburden. Institutional controls are highly effective in managing this residual contamination for this finite period of time.

Institutional controls will include: routine inspection and surveillance of the BGRR facility, scheduled upkeep and maintenance of Building 701, and infiltration management and monitoring. Additionally, controls for this alternative would specify land-use restrictions and reporting requirements.

At a minimum, these controls would:

- establish measures for future excavation of residual subsurface contamination, including characterization and limitations on use/reuse, according to NYSDEC regulations
- provide land-use restrictions and an acceptable method for evaluating the potential

impact that the remaining contaminants could have on future development

- establish a restriction that the property's future use and development are limited to commercial or industrial uses only
- specify requirements to provide annual certification to the NYSDEC, which would confirm that the institutional controls and engineering controls put in place are unchanged from the previous certification, that nothing has occurred to impair the ability of the controls to protect public health or the environment, and that nothing has occurred to constitute a violation or failure to comply with the site-management plan. This annual certification would be prepared and submitted by an engineering or environmental professional acceptable to NYSDEC.
- specify that land-use restriction and reporting requirements must be passed on to any/all future landowners through an environmental easement on the deed to the property.

Given 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 is owned by DOE. If the property is transferred to a non-federal entity, then a deed will be established and an environmental easement will be added to the deed.

Groundwater monitoring in the vicinity of the BGRR complex will continue throughout the institutional control period considered in the OU-III ROD. Results of the OU-III monitoring will be used to ensure the effectiveness of this remedy.

As of the end of fiscal year 2003, BGRR removal actions have cost $39.3 million. Depending on the availability of funds, completing the remaining activities, including the removal of the graphite pile and biological shield is expected to take 30 months at a cost of $54 million. This would result in a total project cost of $93.3 million.

Alternative C: Removal of the Pile, Biological Shield, Fuel-Canal Structure, and Reasonably Accessible Soils

Alternative C includes all of the work within Alternative B plus the removal of accessible pockets of contaminated soil and the canal structure. Because of the complexity of the Building 701 foundation and the potential for disrupting the structural integrity of the building, soils located within or below Building 701's foundation will not be removed.

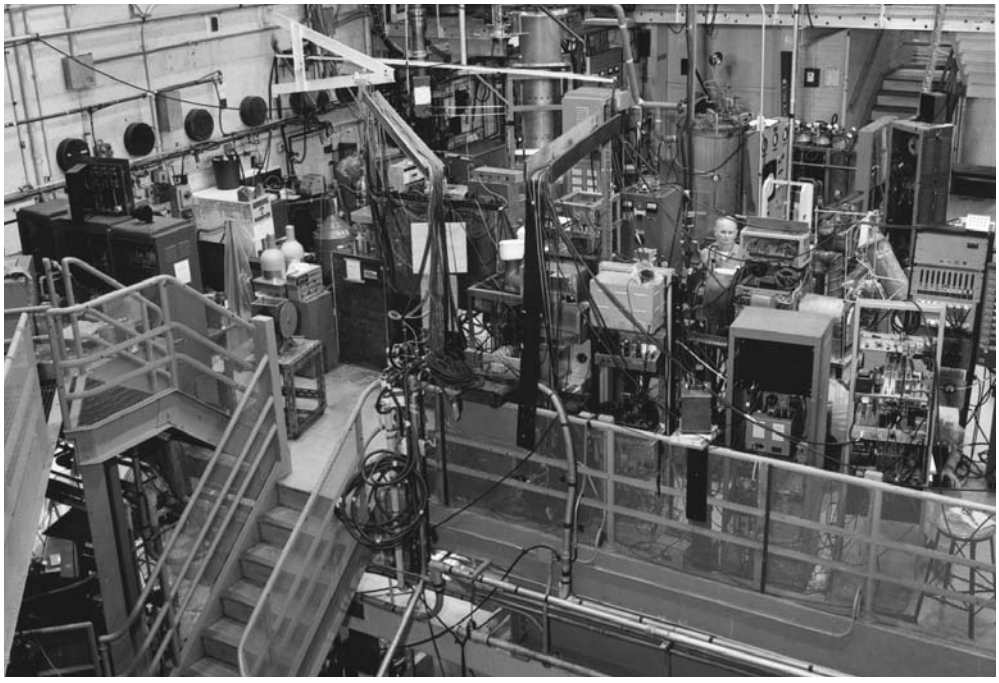
Upon completion, this alternative will remove a total of 8,093 Curies from the BGRR complex. Essentially all of the long-lived radioisotopes will be removed with the graphite pile and biological shield, with the exception of trace concentrations within isolated pockets of soil near the deep pit under Bldg. 701's foundation footprint. Characterization data indicate that the concentrations within these soils are less than the cleanup goals for these radionuclides within soil.

Approximately one and one half Curies, predominantly Cs-137 and Sr-90, will remain in contaminated structures below Building 701 and within below-ground ducts. These contaminants are bound within concrete, embedded within steel, or located within areas that are currently inaccessible and can be effectively managed through institutional controls. In the event that future activities cause the contaminated deep soils to become readily accessible, efforts will be made to remediate the soils.

Using conservative assumptions, it was calculated that it would require approximately 180 years to decay to the OU-I soil cleanup standards for industrial land use of 67 pCi/gm of Cs-137 and 15 pCi/gm of Sr-90, plus an additional 100 years to decay to the acceptable levels for unrestricted, residential land use. This calculation was performed to allow for a comparative analysis of the BGRR remedial action alternatives discussed herein. It was not intended to establish definitive institutional-control durations.

However, institutional controls, including land-use restrictions, would help ensure that the remaining contaminated structures and soils can be managed to prevent inadvertent direct exposure and future migration to the soil regardless of the calculated durations. If necessary, excavation of these soils at some time in the future would be evaluated based on the actual distribution, depth, and concentrations of the residual radioactive material encountered.

Given the depth of these soils and the clean overburden, the concentrations of Cs-137 and Sr-90 would be significantly reduced when mixed with the clean overburden. Institutional controls are highly effective in managing this residual contamination for this finite period of time. Institutional controls will include routine inspection and surveillance of the BGRR facility, scheduled upkeep and maintenance of Building 701, and infiltration management and monitoring. In addition, controls for this alternative would specify land-use restrictions and reporting requirements.



This historic photograph of the balcony of the east face of the Brookhaven Graphite Research Reactor shows some of the experimental equipment for studies of materials and other research using reactor-produced neutrons.

At a minimum, these controls would:

- establish measures for future excavation of residual subsurface contamination, including characterization and limitations on use/reuse, according to NYSDEC regulations
- provide land-use restrictions and an acceptable method for evaluating the potential impact that the remaining contaminants could have on future development
- establish a restriction that the property's future use and development are limited to commercial or industrial uses only
- specify requirements to provide annual certification to the NYSDEC, which would confirm that the institutional controls and engineering controls put in place are unchanged from the previous certification, that nothing has occurred to impair the ability of the controls to protect public health or the environment, and that nothing has occurred to constitute a violation or failure to comply with the site-management plan. This annual certification would be prepared and submitted by an engineering or environmental professional acceptable to NYSDEC.
- specify that land-use restriction and reporting requirements must be passed on to any/all future landowners through an environmental easement on the deed to the property.

Given 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 is owned by DOE. If the property is transferred to a non-federal entity, then a deed will be established and an environmental easement will be added to the deed.

Groundwater monitoring in the vicinity of the BGRR complex will continue throughout the institutional control period considered in the OU-III ROD. Results of the OU-III monitoring will be used to ensure the effectiveness of this remedy.

As of the end of fiscal year 2003, completion of BGRR removal actions have cost $39.3 million. Completion of Alternative C will cost an additional $57.7 million. Depending on the availability of funds, completion of this alternative is expected to take approximately 30 months, at a total cost of $96.8 million.

Alternative D: Greenfield

Alternative D, Greenfield, includes the complete removal of the BGRR structure, systems, and components, plus the removal of underlying soils necessary so as to reach the soil-cleanup levels of 67 pCi/gm Cs-137 and 15 pCi/gm Sr-90 established for industrial-land use in the OU-I ROD. However, because of the potential for residual radioactivity within deep soils,

institutional controls will be included to ensure the effectiveness of this remedy.

This alternative includes completion of all Alternative C activities plus the full removal of the Building 701 superstructure, underground foundations, deep pockets of soil below the foundation footprint, and remaining underground structures, including the remainder of the canal, deep pit, and below-ground duct concrete and steel. Although characterization indicated the superstructure and components are relatively free of radioactive contamination, all debris removed from a radiologically controlled area must be considered as potentially contaminated and so disposed of as low-level radioactive waste. Upon completion, Alternative D will result in the removal of all radioactivity, with the exception of residual contamination intermixed within deep soils.

Using conservative assumptions, it was calculated that, if the remaining contaminated soils within the BGRR complex were remediated to the OU-I soil-cleanup standards of 67 pCi/gm for Cs-137 and 15 pCi/gm for Sr-90, then it would take approximately 100 years to allow the contaminants to decay to acceptable levels for unrestricted-land use. This calculation was performed to allow for a comparative analysis of the BGRR remedial action alternatives discussed herein. It was not intended to establish definitive institutional-control durations.

However, following the excavation of the remaining contaminated soils, the risk to human health and the environment would be evaluated based on the actual distribution, depth, and concentrations of the residual radioactive material encountered. The duration and need for institutional controls would be determined based on the results of this evaluation. If determined to be necessary, institutional controls will include: routine inspection and surveillance of the BGRR grounds, and maintenance of an infiltration-management and monitoring system. In addition, controls for this alternative will specify land-use restrictions and reporting requirements.

TABLE 3. COMPARISON OF REMEDIAL ALTERNATIVES

	ALTERNATIVE A	ALTERNATIVE B	ALTERNATIVE C	ALTERNATIVE D
total radiological inventory removed	47 Curies	8,091 Curies	8,093 Curies	8,094 Curies
total radiological inventory remaining	8,047 Curies	3 Curies	1.5 Curies	<1 Curie
overall protection of human health and the environment	medium	high	high	high
compliance with applicable or relevant and appropriate requirements	questionable*	yes	yes	yes
long-term effectiveness	medium	high	high	high
reduction of toxicity, mobility, or volume	not applicable	not applicable	not applicable	not applicable
short-term effectiveness	high	medium	medium	medium
implementability	high	high	high	high
total cost	$53.5 million	$93.3 million	$96.8 million	$149.3 million
implementation of institutional controls and long-term response action	$276k annually $10k per 10 year $700k per 20 year	$276k annually $10k per 10 year $700k per 20 year	$276k annually $10k per 10 year $700k per 20 year	$1k annually

*The indefinite storage or entombment of these radioactive structures may be in conflict with New York State regulations regarding the siting of low-level radiological waste-disposal facilities. There may be a prohibition precluding this course of action for the pile and biological shield. This issue would have to be resolved before Alternative A could be implemented.

At a minimum, these controls would:

- establish measures for future excavation of residual subsurface contamination including characterization and limitations on use/reuse in accordance with NYSDEC regulations.
- provide land-use restrictions and an acceptable method for evaluating potential impact that the remaining contaminants have on future development.
- establish a restriction that the property's future use and development are limited to commercial or industrial uses only
- specify requirements to provide annual certification to the NYSDEC, which would confirm that the institutional controls and engineering controls put in place are unchanged from the previous certification, that nothing has occurred to impair the ability of the controls to protect public health or the environment, and that nothing has occurred to constitute a violation or failure to comply with the site-management plan. This annual certification would be prepared and submitted by an engineering or environmental professional acceptable to NYSDEC.
- specify that land-use restriction and reporting requirements must be passed on to any/all future landowners through an environmental easement on the deed to the property.

SUMMARY OF CERCLA EVALUATION CRITERIA

Criterion 1: Overall Protection of Human Health and the Environment is the primary objective of the remedial action and addresses whether or not 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 Applicable or Relevant and Appropriate Requirements addresses whether or not a remedial action will meet all the applicable or relevant and appropriate requirements, and other federal and state environmental statutes, or provides 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 refers to the magnitude of the residual risk and the ability of a remedial action 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 the 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 the implementation of the remedial action.

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

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

Criterion 7: New York State Acceptance indicates whether or not New York State concurs with, opposes, or has no comment on the preferred alternative based on a review of the Feasibility Study and the Proposed Remedial Action Plan.

Criterion 7: Community Acceptance assesses the response of the general public to the Proposed Plan, based on a review of the public comments received during the public comment period, and at the information sessions and public meeting. The remedial action can be selected only after consideration of this criterion.

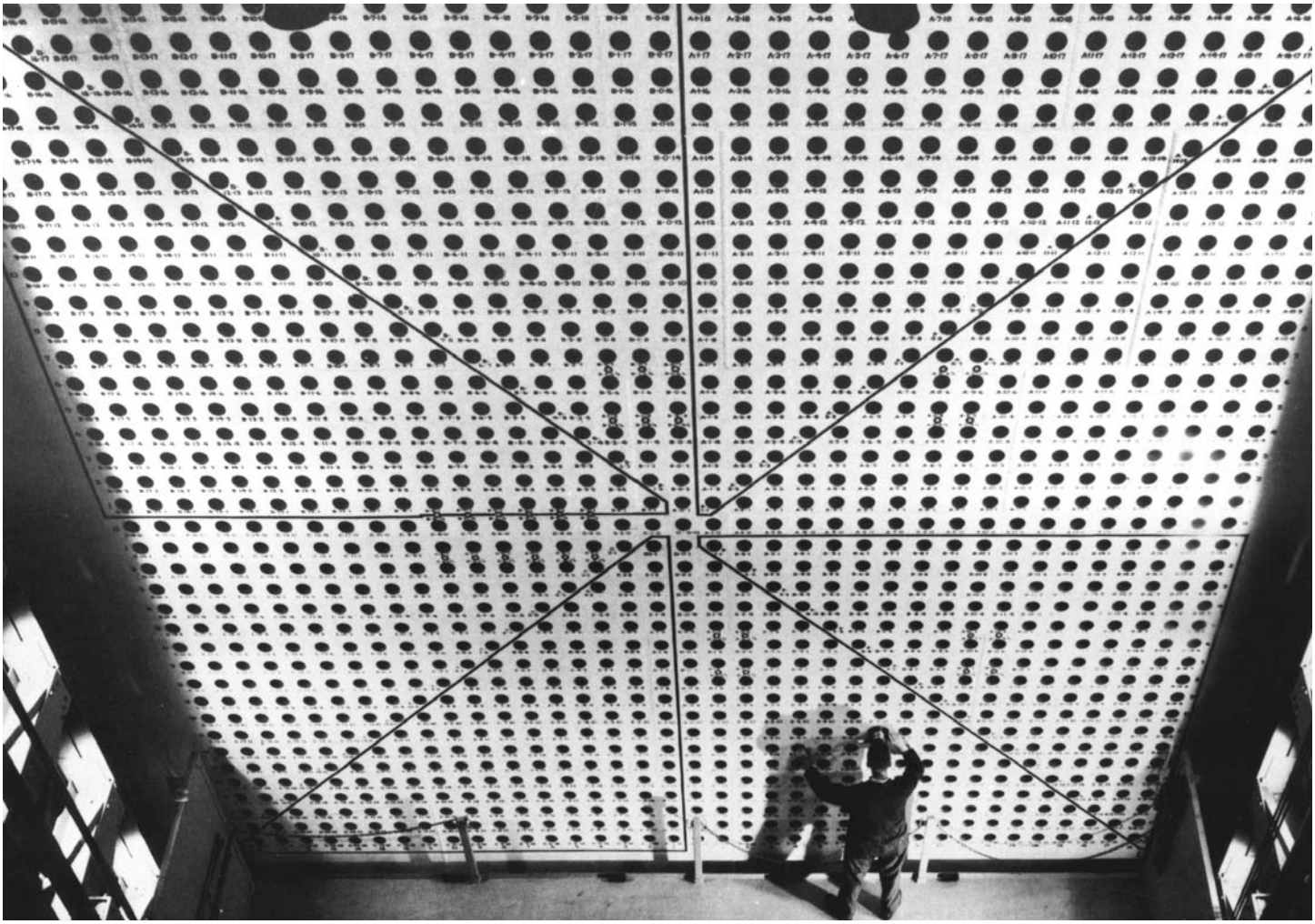
Given the fact that a deed does not exist for property owned by a federal entity, DOE will be responsible for implementing these controls as long as the property is owned by DOE. If the property is transferred to a non-federal entity, a deed will be established and an environmental easement will be added to the deed.

Groundwater monitoring in the vicinity of the BGRR complex will continue throughout the institutional control period considered in the OU-III ROD. Results of the OU-III monitoring will be used to ensure the effectiveness of this remedy.

As of the end of fiscal year 2003, completion of BGRR removal actions have cost $39.3 million. Depending on the availability of funds, completing the activities identified within this alternative is expected to take 56 months at an additional cost of $110 million, for a total cost of approximately $150 million.

VII. EVALUATION OF ALTERNATIVES

The EPA has established nine CERCLA evaluation criteria that must be considered in the selection of a remedial action alternative. These evaluation criteria are summarized above. The last two of the nine criteria, New York State acceptance and community acceptance, are



The south face of the Brookhaven Graphite Research Reactor is seen in this historic photograph.

not included within the following evaluation of BGRR alternatives. Instead, comments received during BGRR public comment period will be used to assist in evaluating each of the removal action alternatives against these two criteria.

Criterion 1: Overall Protection of Human Health and the Environment

All four alternatives provide for varying degrees of contamination removal and include measures such as infiltration management and/or institutional controls to manage any residual contamination. The removal actions under these measures are fully capable of preventing direct exposure to human beings and/or the spread of contamination to the environment for some long-term, but finite period of time. However, the need for institutional controls for the indefinite future sets Alternative A apart from the other three alternatives.

Alternative A would leave the pile and biological shield in place at the BGRR complex. These structures contain long-lived radioisotopes that would remain as a potential threat for thousands of years. Infiltration management and institutional controls would be required for what is essentially an indefinite period of time. Alternatively, a schedule would need to be established for the removal of these structures within some finite time. Infiltration management and institutional controls can be effectively maintained for a finite duration. However, serious questions arise over the sustainability of these same protective measures over an indefinite amount of time. This is the biggest single difference among the four BGRR cleanup alternatives.

Alternatives B, C, and D require institutional controls for a finite period of time. In the case of these alternatives, the long-lived radionuclides would be removed with the removal of the pile and biological shield. From an overall perspective, Alternatives B, C, and D provide similar protection of human health and the environment.

Criterion 2: Compliance With Applicable or Relevant and Appropriate Requirements

Alternative A involves the storage of the long-lived radioactive contaminants in the pile and biological shield. The indefinite storage of these radioactive structures may invoke New York State's siting requirements for low-level radiological waste-disposal facilities. There are several statutory issues that may preclude the indefinite storage or entombment of the pile and biological shield over Long Island's sole source aquifer. This is a material question that would need to be resolved before proceeding with Alternative A.

With the exception of the above, the alternatives are otherwise in compliance with applicable or relevant and appropriate requirements.

Criterion 3: Long-Term Effectiveness

Pile and biological shield removal set Alternative A apart from the other three BGRR cleanup alternatives. Alternative A would leave the pile and biological shield in place at the BGRR complex. Because these structures contain significant quantities of long-lived radioisotopes, DOE would be required to implement infiltration management and institutional controls for an indefinite duration. The longevity of this potential threat creates uncertainties over the sustainability of institutional controls over such an undefined period of time.

Alternatives B, C, and D all include the removal of the pile and biological shield. All three result in the removal of essentially all of the long-lived contaminants from the BGRR complex, with the exception of trace concentrations located within soils under the deep pit, the fuel-canal outer walls, and the pipe-trench area. For all three, residual contamination would require infiltration management and/or institutional controls. However, because the duration of these measures would be for a finite period of time, they would not involve the same issues and uncertainties as Alternative A. Alternatives B, C, and D are similar in terms of long-term effectiveness.

Criterion 4: Reduction of Toxicity, Mobility, or Volume Through Treatment

None of the alternatives considered include treatment to reduce the toxicity, mobility or volume of contaminants.

Criterion 5: Short-Term Effectiveness

Alternative A has a relatively small scope of work in a radiologically harsh environment. Given the diminished risk of contamination dispersion to the environment and of transportation incidents, this alternative poses the least uncertainties in the area and thus is rated as high.

The removal of the pile and biological shield set Alternatives B, C, and D apart from Alternative A. In taking out the pile and biological shield from the BGRR complex, over 8,000 Curies of contaminated material would be removed, which involves a significant amount of work in a radiologically harsh environment. While not extraordinary from a waste-form and activity standpoint, the waste resulting from pile and biological shield removal would have to be carefully managed. Existing work-controls and procedures will mitigate the risks of potential threats to human beings and the environment.

The ALARA principle would be used to minimize direct worker exposure throughout all phases of pile and biological shield removal. Nonetheless, these removal actions pose potential threats and uncertainties to short-term effectiveness. While the scope of work varies significantly among Alternatives B, C, and D, the relative complexity and challenges are minor in comparison to pile and biological shield removal. Hence, Alternatives B, C, and D are similar and so are all rated "medium."

Criterion 6: Implementability

All four BGRR cleanup alternatives will rely on field-proven techniques and practices. Most of these techniques and practices have been previously demonstrated at Brookhaven, elsewhere in the DOE complex, or in the commercial nuclear power industry. These proven techniques and practices encompass all elements of cleanup, through and including waste-handling, packaging, transportation, and disposal. All four alternatives are similar from an implementability standpoint, and so all are rated "high."

Criterion 7: Cost

Alternative A is the least costly of the four BGRR cleanup alternatives. There is a large incremental increase of $40.2 million for Alternative B because of pile and biological shield removal. The removal of the accessible pockets of deep, subsurface contaminated soils in Alternative C results in an incremental increase of $3.5 million. Alternative D results in another large incremental cost of $52.5 million because of the enormous scope of work and the waste transportation and disposal involved with the demolition of Building 701's superstructure and foundation.

VIII. PREFERRED ALTERNATIVE

There are advantages and disadvantages to each of the alternative remedial actions. After evaluating the likely alternatives against the CERCLA evaluation criteria, Alternative C: Removal of the Pile, Biological Shield, Fuel-Canal Structure, and Reasonably Accessible Soils is proposed as the preferred approach to achieve a final, end-state remediation of the BGRR.

This alternative addresses the removal of the pile, biological shield, and contaminants that pose a threat of exposure through excavation of soils and potential migration to groundwater. A significant reduction in threat to human health and the environment can be achieved at a relatively low incremental increase in the cost and schedule compared to that of the removal of the graphite pile and biological shield alone.

IX. COMMUNITY PARTICIPATION: PUBLIC MEETINGS & COMMENT

To ensure that community expectations are considered in selecting the remedy for the BGRR, DOE encourages the public to submit its comments on the Proposed Plan during the formal public comment period, which runs for 30 days from August 2, 2004, through September 3, 2004.

If you wish to learn more about the Proposed Plan, to meet the project staff and ask questions, or to submit your written input on the plan in person, then please join us at one of the following gatherings. At the public meeting, the conclusions of the BGRR Feasibility Study and the Proposed Plan will be presented.

Information Sessions
August 17, 2004 2-4 p.m.
Brookhaven National Laboratory
Berkner Hall

August 19, 2004 7-9 p.m.
Brookhaven National Laboratory
Berkner Hall

Public Meeting
August 24, 2004 7-9 p.m.
Brookhaven National Laboratory
Berkner Hall

To submit your written comments before the end of the formal public comment period on September 3rd, please do one of the following:

e-mail: tellDOE@bnl.gov

fax: (631) 344-3444

mail: Mr. Michael Holland, Site Manager
U.S. Department of Energy
Brookhaven Site Office
P.O. Box 5000
Upton NY 11973

For your convenience in mailing in your comments, an addressed comment sheet is included on page 20 of this document.

X. ADMINISTRATIVE RECORD REPOSITORY LOCATIONS

The Brookhaven Graphite Research Reactor Characterization Reports, Feasibility Study, and all Administrative Record documents can be found at the following locations:

Mastics-Moriches-Shirley
Community Library
407 William Floyd Parkway
Shirley NY 11967
(631) 399-1511

Brookhaven National Laboratory
Research Library
Building 477
Upton NY 11973
(631) 344-3483

U.S. EPA Region II
Administrative Records Room
290 Broadway, 16th floor
New York NY 10007
(212) 637-3185

XI. REFERENCES

- BNL, 2002a, Draft Characterization Report for the Below Ground Ducts and Associated Soils, Brookhaven Graphite Research Reactor Decommissioning Project, BGRR-049, Rev. E, prepared by Brookhaven Science Associates for the U.S. Department of Energy, Brookhaven Area Office, Upton, New York, January 30.
- BNL, 2002b, Characterization Report for Building 701 Above Ground Surfaces, Systems, and Structures, Brookhaven Graphite Research Reactor (BGRR) Decommissioning Project, BGRR-054, Rev. A, Draft, prepared by Brookhaven Science Associates for the U.S. Department of Energy, Brookhaven Area Office, Upton, New York, November.
- BNL 2002c Decommissioning Engineering Studies for the Brookhaven Graphite Research Reactor, prepared by Burns and Roe Enterprises, Inc. for the U.S. Department of Energy, Brookhaven Area Office, Upton, New York, February 28.
- BNL, 2003a, Characterization Report for the 701 Below-Ground Structures, 702 Pile, and Remaining Soils, Brookhaven Graphite Research Reactor Decommissioning Project, BGRR-055, Rev. B, Draft, prepared by Brookhaven Science Associates for the U.S. Department of Energy, Brookhaven Area Office, Upton, New York, January.
- BNL, 2004, Feasibility Study, Brookhaven Graphite Research Reactor Decommissioning Project, prepared by Brookhaven Science Associates for the U.S. Department of Energy, Brookhaven Site Office, Upton, New York, issued concurrent with this PRAP.

XII. WHAT CAN YOU DO NEXT ?

To ensure that you have the information that you need to understand the Proposed Plan for the Brookhaven Graphite Research Reactor and to submit your comments on it, you are invited to:

- Review the Feasibility Study and other relevant documents in the Administrative Record at repository locations listed in Section X, above.
- Use the World Wide Web to access the fact sheet on the Brookhaven Graphite Research Reactor cleanup and other information about environmental restoration activities at the Laboratory at www.bnl.gov/erd, as well as to find other information about the Laboratory at www.bnl.gov, which is Brookhaven Lab's homepage.
- Call the Community Relations Office at Brookhaven National Laboratory, (631) 344-2489, to ask questions, request more information, or make arrangements for a briefing.
- Attend one of the information sessions and/or the public meeting described in Section IX on page 16.
- Contact the project managers at the U.S. Department of Energy, U.S. Environmental Protection Agency Region II, and/or the New York State Department of Environmental Conservation listed on page 18.
- Comment on this plan at the public meeting or submit your written comments by e-mail, fax, or mail to the addresses listed on the opposite page before the end of the formal public comment period on September 3, 2004.

For more information on the BGRR cleanup or the Superfund process at Brookhaven Lab, please contact:

JEN CLODIUS
Community Relations Office
Building 130
Brookhaven National Laboratory
P.O. Box 5000
Upton NY 11973

(631) 344-2489

clodius@bnl.gov

XIII. CONTACT INFORMATION

UNITED STATES DEPARTMENT OF ENERGY

The U.S. Department of Energy (DOE) is one of the three agencies identified in the Interagency Agreement, which establishes the scope and schedule of remedial investigations at BNL. Correspondence with DOE staff concerning this project can be found in the Administrative Record under BGRR. For additional information concerning DOE's role in preparing this Proposed Plan, contact:

JOHN CARTER
Brookhaven Site Office
U.S. Department of Energy
Brookhaven National Laboratory
P.O. Box 5000
Upton NY 11973-5000

(631) 344-519
jcarter@bnl.gov

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

The U.S. Environmental Protection Agency (EPA) is one of the three agencies identified in the Interagency Agreement which establishes the scope and schedule of remedial investigations at BNL. Correspondence with EPA Region II staff concerning this project can be found in the Administrative Record under BGRR. For additional information concerning the EPA's role in preparing this Proposed Plan, contact:

DOUG POCZE
U.S. Environmental Protection Agency
Region II
290 Broadway
New York NY 10007-1866

(212) 637-4432

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

The New York State Department of Environmental Conservation (NYSDEC) is one of the three agencies which are partner to the Interagency Agreement establishing the scope and schedule of remedial investigations and actions at Brookhaven Lab. Correspondence with the NYSDEC concerning this project can be found in the Administrative Record under BGRR. For additional information concerning the state's role in preparing this Proposed Plan, contact:

JAMES LISTER
New York State
Department of Environmental Conservation
625 Broadway
Albany NY 12233-7015

(518) 402-9620

BROOKHAVEN NATIONAL LABORATORY

managed for the U.S. Department of Energy
by Brookhaven Science Associates,
a company founded by Stony Brook University and Battelle

Before mailing this comment sheet, please fold here and use clear tape to seal it closed. Thanks!

FROM:

Please place postage here and ensure that you mail your comments so that they are received before the end of the public comment period on September 3, 2004

TO: Mr. Michael Holland
Site Manager
Brookhaven Site Office
U.S. Department of Energy
Brookhaven National Laboratory
P.O. Box 5000
Upton NY 11973-5000

BGRR Public Comment Period: August 2, 2004, to September 3, 2004

You Are Invited to Submit Your Comments

on the Proposed Remedial Action Plan for the Brookhaven Graphite Research Reactor

at Brookhaven National Laboratory

INSTRUCTIONS: To select the final remedy for the Brookhaven Graphite Research Reactor at Brookhaven National Laboratory, the U.S. Department of Energy, U.S. Environmental Protection Agency, and the New York State Department of Environmental Conservation need your comments on the Proposed Remedial Action Plan discussed in this document. Therefore, please take a moment to note your comments on this form and return them by e-mail to tellDOE@bnl.gov, by fax to (631) 344-3444, or by mail to the address on the other side. Before you submit your comments, please don't forget to sign and date the form, and to print your name and address at the bottom. And please make sure that your comments are received before the end of the formal public comment period on September 3, 2004. Thanks for your participation in this process!

please sign your name:

print your name:

street address:

town, state, and zip code:

date:

Submit your comment by • e-mail to tellDOE@bnl.gov • fax to (631) 344-3444 • or mail to the address on the reverse side