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Work Plan for the Remedial Investigation/Feasibility Study-Environmental Assessment for the Colonie Site, Colonie, New York

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NOTATION

The following is a list of the acronyms, initialisms, and abbreviations (including units of measure) used in this document.

ACRONYMS, INITIALISMS, AND ABBREVIATIONS

AEC	U.S. Atomic Energy Commission
ANL	Argonne National Laboratory
ARAR	applicable or relevant and appropriate requirement
BNI	Bechtel National, Inc.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	contract laboratory program
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
DOE-OR	U.S. Department of Energy, Oak Ridge Operations
EA	environmental assessment
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
FONSI	finding of no significant impact
FS	feasibility study
FUSRAP	Formerly Utilized Sites Remedial Action Program
HSL	Hazardous Substance List
NGVD	national geodetic vertical datum
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Policy Act
NL	National Lead (Industries)
NYSDEC	New York State Department of Environmental Conservation
ORNL	Oak Ridge National Laboratory
PCB	polychlorinated biphenyl
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
ROD	record of decision
SARA	Superfund Amendments and Reauthorization Act
TBC	to-be-considered (requirements)

UNITS OF MEASURE

°C	degrees Celsius
°F	degrees Fahrenheit
cfs	cubic foot (feet) per second
cm	centimeter(s)
cm ²	square centimeter(s)
dpm	disintegration(s) per minute

ft	foot (feet)
ft ²	square foot (feet)
ft ³	cubic foot (feet)
g	gram(s)
gpm	gallon(s) per minute
h	hour(s)
ha	hectare(s)
in.	inche(s)
km	kilometer(s)
km ²	square kilometer(s)
L	liter(s)
μCi	microcurie(s)
μg	microgram(s)
μR	microroentgen(s)
m	meter(s)
m ²	square meter(s)
m ³	cubic meter(s)
mg	milligram(s)
mi	mile(s)
mi ²	square mile(s)
min	minute(s)
mph	mile(s) per hour
mR	milliroentgen(s)
mrem	millirem(s)
pCi	picocurie(s)
ppb	parts per billion
ppm	parts per million
s	second(s)
yd ³	cubic yard(s)
yr	year(s)

FOREWORD

This work plan has been prepared to document the scoping and planning process performed by the U.S. Department of Energy (DOE) to support remedial action activities at the Colonie site. The site is located in eastern New York State in the town of Colonie near the city of Albany. Remedial action at the Colonie site is being planned as part of DOE's Formerly Utilized Sites Remedial Action Program. The DOE is responsible for controlling the release of all radioactive and chemical contaminants from the site.

Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), a remedial investigation/feasibility study (RI/FS) must be prepared to support the decision-making process for evaluating remedial action alternatives. Consistent with U.S. Environmental Protection Agency guidance for conducting an RI/FS, this work plan (1) contains a summary of information known about the site as of January 1988, (2) presents a conceptual site model that identifies potential routes of human exposure to site contaminants, (3) identifies data gaps, and (4) summarizes the process and proposed studies that will be used to fill the data gaps. In addition, DOE activities must be conducted in compliance with the National Environmental Policy Act (NEPA), which requires consideration of the environmental consequences of a proposed action as part of its decision-making process. It is DOE policy to integrate the requirements of the CERCLA and NEPA processes for remedial actions at sites for which it has responsibility. Under this policy, the CERCLA process is supplemented, as appropriate, to meet the procedural and documentary requirements of NEPA. This work plan also describes the approach that will be used to evaluate potential remedial action alternatives and includes a description of the organization, project controls, and task schedules that will be employed to fulfill the requirements of both CERCLA and NEPA.

1 INTRODUCTION

The U.S. Department of Energy (DOE) is proposing to conduct remedial action activities at the Colonie site, Colonie, New York, under its Formerly Utilized Sites Remedial Action Program (FUSRAP). This program was initiated in 1974 by the U.S. Atomic Energy Commission (AEC, a predecessor of DOE). The purpose of the program is to identify and clean up or otherwise control sites where residual radioactive contamination exceeding current guidelines remains from activities carried out under contract to the Manhattan Engineer District and the AEC. Under FUSRAP, DOE has also been assigned responsibility for the cleanup of selected sites where past commercial operations resulted in radioactive contamination that requires remediation. Responsibility for the Colonie site was assigned to DOE as part of a decontamination research and development project under the 1984 Energy and Water Appropriations Act. The Colonie site is contaminated with both radioactive and chemical contaminants. The DOE is responsible for controlling the release of all hazardous substances (i.e., radioactive and chemical contaminants) from the site.

Certain areas in the vicinity of the Colonie site also became radioactively contaminated as a result of previous on-site activities. These areas are termed vicinity properties. The DOE is responsible for remediating the contaminated vicinity properties associated with previous activities at the Colonie site related to the processing of radioactive materials. The DOE is also responsible for any chemical contamination at these properties that is either mixed with radioactive contamination or is directly related to the former processing of radioactive materials at the site. However, DOE is not responsible for off-site areas that are chemically contaminated only as a result of activities not associated with the processing of radioactive materials and that have no associated radioactive contamination.

1.1 GENERAL SITE INFORMATION

The main Colonie site is located in the town of Colonie, New York, approximately 6.4 km (4 mi) northwest of downtown Albany and about 4.8 km (3 mi) southeast of the village of Colonie (Figure 1). It covers approximately 4.5 ha (11.2 acres) and is situated in an urban area of mixed residential, commercial, and light industrial properties. The site contains three buildings: the processing plant (largest building), which housed the processing and milling operations, and two small concrete-block storage buildings along the southwestern boundary. The site itself is fenced and closed to the public. The boundary between the town of Colonie and the city of Albany is just south of the Colonie site. Therefore, vicinity properties -- those residential and small commercial properties near the Colonie site that became radioactively contaminated as a result of atmospheric dispersion of contaminants from the Colonie site -- are located in both the town of Colonie and the city of Albany. Remediation has been completed at all but three of the vicinity properties. For the purpose of this work plan, the three remaining vicinity properties at which remedial action has not been taken, together with the main site, comprise the Colonie site for which remedial actions are currently being planned. A detailed description of the site is presented in Sections 2.1 and 2.3.

FIGURE 1 Location of the Colonie Site, Colonie, New York (Source: Modified from Argonne National Laboratory [ANL] 1984)

The industrial history of the Colonie site began in 1923 with its purchase by the Embossing Company for the manufacture of wood products and toys. The site was subsequently purchased by the Mangus Company in 1927, at which time the facility was converted to a brass foundry for the production of railroad components. In 1937, the plant was sold to National Lead (NL) Industries, which continued operation of the brass foundry until 1960. In 1958, NL Industries also began manufacturing uranium products at the Colonie site, operating under a license issued by the AEC. Brass foundry operations ceased in 1960 as NL Industries shifted its focus to the processing of radioactive materials. Between 1958 and 1969, NL Industries held numerous AEC contracts for the fabrication of slightly enriched uranium fuel elements and the chemical processing of nonirradiated, slightly enriched uranium scrap. Limited work was also done with thorium. Between 1966 and 1972, NL Industries held several contracts for the manufacture of fuel from enriched uranium for experimental nuclear reactors. The production of enriched uranium products ended in 1972 and, after termination of the AEC contracts, work at the Colonie site was limited to the fabrication of shielding components, ballast weights, and projectiles from depleted uranium.

In 1980, plant operations were temporarily halted by a court order resulting from public concern regarding airborne releases of uranium compounds from the plant building's exhaust system. The temporary restraining order was amended on May 12, 1980, to allow NL Industries to continue operating on a limited basis. The amended order required the company to initiate an independent investigation to assess environmental conditions on-site and in the vicinity of the site that might have been affected by releases of radioactive particulates from the plant. Surveys conducted in 1980 and 1981 identified low levels of radioactive contamination on some nearby properties (primarily in the direction of prevailing winds) and on-site contamination in areas of the plant where uranium processing was carried out. Both uranium-238 and actinium-228 were measured on-site at levels elevated above background concentrations. (The presence of actinium-228 indicates that its precursors radium-228 and thorium-232 are probably present as well.)

On-site soil contamination was generally limited to the uppermost 8 cm (3 in.), but two locations of subsurface contamination were found northwest of the plant building. One of these areas is a closed on-site burial area that is radioactively contaminated to a depth of 8 m (26 ft); the second is located in a parking lot adjacent to the west wall of the plant building and extends to a depth of 0.6 m (2 ft). Off-site contamination consisted primarily of depleted uranium and was generally limited to roofing material and the upper 5 cm (2 in.) of soil. The state of New York initiated a groundwater monitoring program at the Colonie site in 1982; results indicated that uranium levels were within guidelines established by the U.S. Environmental Protection Agency (EPA) and the state of New York (ANL 1988).

In 1984, the Secretary of Energy accepted an offer by NL Industries to transfer to DOE the land, buildings, and equipment at the Colonie site. Operations at the plant ceased at the time of title transfer, February 29, 1984. In 1985, a contaminated portion of an adjacent commercial property was transferred to DOE and subsequently designated as part of the Colonie site. Radiological surveys were conducted at 219 vicinity properties from 1983 to 1987, and soils and other materials were subsequently removed

from 53 of these properties (during 1984, 1985, and 1988); these materials are currently stored on-site within the plant building (see Section 2.4.2). The plant also contains a number of drums of uranium oxide and other radioactive wastes resulting from past processing activities, as well as packaged chemicals and chemical wastes. A more detailed account of the site's history is presented in Section 2.2.

1.2 JUSTIFICATION AND OBJECTIVES OF THE PROPOSED ACTION

The primary threat to human health and the environment associated with the Colonie site is related to the potential for uncontrolled release or threat of release of contaminants from exposed surfaces and subsurface disposal areas. Contaminants could be released from these sources via precipitation/runoff, wind dispersal, leaching to groundwater, and disturbance by humans or animals (see Chapter 3). Releases from the materials currently being stored in the plant building could also occur, e.g., as a result of containment system failure due to a natural disaster or discontinuation of facility maintenance in the future. Therefore, the permanent disposition of stored materials and the cleanup and disposition of currently uncontained materials are essential for the long-term protection of public health and the environment in the area.

The overall objective of remedial action at the site is to eliminate, reduce, or otherwise mitigate the potential for exposure to radioactive and chemical contaminants in order to minimize threats to human health and the environment resulting from such exposure. Specific objectives of the remedial action process are as follows:

- Characterize radioactive and chemical contamination at the site,
- Assess potential risks to human health and the environment that could result from exposure to site contaminants,
- Ameliorate any immediate hazards associated with site conditions,
- Assess potential remedial action alternatives and select and implement a permanent remedy, and
- Minimize potential health hazards to personnel conducting the remedial action.

All remedial action activities at the Colonie site will be conducted in accordance with regulatory requirements (see Section 3.8).

1.3 ENVIRONMENTAL COMPLIANCE PROCESS

Remedial actions at the Colonie site are being conducted in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA). In addition, all DOE activities must be conducted in compliance with the National Environmental Policy

Act (NEPA), which requires that the environmental consequences of a proposed action be considered as part of the decision-making process for that action. It is DOE policy to integrate the requirements of the CERCLA and NEPA processes for remedial actions at sites for which it has responsibility. The remedial investigation/feasibility study (RI/FS) process under CERCLA forms the primary instrument for environmental compliance associated with DOE remedial actions. Under this integrated policy, the CERCLA process is supplemented, as appropriate, to meet the procedural and documentational requirements of NEPA. Hence, this work plan outlines the approach for remediating the Colonie site consistent with both CERCLA and NEPA requirements. Previous NEPA activities relevant to the Colonie site are addressed in Appendix C.

A key element of the integrated CERCLA/NEPA process is a determination of the level of environmental analysis appropriate under NEPA. This determination is a function of many factors, including the complexity of a proposed action, the likelihood for significant environmental impacts, and the potential for considerable public interest. The Council on Environmental Quality recommends that an environmental assessment (EA) be prepared when the EA can assist agency planning and decision making relative to NEPA compliance for a proposed action. Consistent with this recommendation, DOE is planning to assess potential environmental impacts associated with reasonable alternatives for remedial action at the Colonie site at a level equivalent to that required in an EA. The RI/FS process will be supplemented as needed with those elements required to satisfy NEPA. An overview of the integrated environmental compliance process for the Colonie site is presented in Figure 2.

When the RI/FS process for the proposed remedial action at the Colonie site has been completed through the screening of potential remedial alternatives (see Section 5.9), the environmental impacts that could result from implementing any of the screened (action) alternatives will be assessed. It will then be determined if a "finding of no significant impact" (FONSI) under NEPA can be issued on the basis of this assessment. If a FONSI is issued, the RI/FS process will be continued through completion. If a FONSI is not appropriate, efforts to initiate an environmental impact statement (EIS) will be undertaken and the RI/FS will be revised to address the increased level of environmental analysis necessary to support an EIS. Based on information currently available for the Colonie site, this work plan has been prepared on the assumption that a FONSI is likely for the Colonie site.

This RI/FS-EA work plan describes the Colonie site -- including its history, environmental setting, and nature and extent of contamination (Chapter 2) -- and presents an initial evaluation of site contamination (Chapter 3). This initial site evaluation addresses potential contaminant sources, environmental transport mechanisms, and receptors, as well as data gaps. In addition, the work plan identifies preliminary response objectives, technologies, and alternatives for site remediation (Chapter 3). Studies and procedures that are planned to obtain data that will support completion of the RI/FS process are also presented (Chapter 4), as are the 14 standard tasks for completing an RI/FS (Chapter 5). Finally, the work plan describes the organization, project controls, and schedules that will be employed to fulfill the requirements of the proposed studies (Chapters 6 and 7).

FIGURE 2 Overview of the Environmental Compliance Process for the Colonie Site

1.4 EXTERNAL INVOLVEMENT

1.4.1 Coordination with Other Agencies

Executive Order 12580 delegated to DOE the authority to conduct remedial actions at sites under its control. Consistent with this order, DOE is the lead agency for remedial actions at the Colonie site. The DOE plans and activities for the site are being coordinated with EPA Region II, but a formal interagency agreement has not been prepared because the site is not on the EPA's National Priorities List. Plans and activities for the site are also being coordinated with appropriate New York State agencies, including the New York State Department of Environmental Conservation (NYSDEC). The identification of federal and state regulations that may impact site remediation is being coordinated with EPA Region II and the NYSDEC, respectively. Through its community relations plan for the Colonie site, DOE also provides for the participation of federal and state legislators and local and county officials in the decision-making process for site remediation.

1.4.2 Public Participation

The DOE is committed to a program of public participation in the remedial action process for the Colonie site. A formal community relations program is in place for the site, the purpose of which is to gather information from the affected community, inform the public of ongoing and planned activities, and facilitate public input to remedial action decisions. Through this program, DOE interacts with the public using such mechanisms as news releases, public meetings, discussions with local interest groups, receipt of and response to public comments, and the maintenance of a public repository for documents and information related to the site and its cleanup. The Colonie community relations plan is discussed in Sections 4.4.2 and 5.2.

1.5 CURRENT STATUS OF SITE CHARACTERIZATION

In early 1988, a preliminary RI/FS-EIS work plan and related documents were prepared for a larger project that included four New York FUSRAP sites (i.e., Ashland 1, Ashland 2, Linde, and Colonie). Because of a number of developments since that time, DOE has decided to treat the Colonie site separately from the four sites located in Tonawanda, New York (i.e., Ashland 1, Ashland 2, Linde, and Seaway). (The Seaway site has recently been included in the RI/FS-EIS process for the Tonawanda sites; initially, it was planned as a separate action.) In particular, this decision was based on language in the fiscal year 1989 conference report for Department of Defense appropriations (House Resolution 4781) that states: "The conferees are aware that the Department of Energy (DOE) is conducting an environmental review and analysis of sites in New York State in the Formerly Utilized Sites Remedial Action Program (FUSRAP). The conferees agree that the DOE should not move or study the move of any FUSRAP waste within the state of New York to the town of Tonawanda, New York."

This work plan for the Colonie site has undergone extensive revision to address only the Colonie site. A separate work plan will be issued in the future for the four FUSRAP sites located in Tonawanda. In the meantime, the field investigations planned to begin in the summer of 1988 were initiated to take advantage of the field season and to utilize the resources allocated for this work. (These field activities are described in the draft sampling and analysis plan, which consists of a field sampling plan and a quality assurance project plan.) This characterization effort allowed DOE to maintain momentum in addressing the proposed cleanup of the Colonie site without unnecessary delay. The current work plan rationale and data gaps addressed in Chapter 4 are based on pre-1988 available data. The data resulting from field investigations conducted during 1988 and 1989 are currently being compiled. It is anticipated that as these results are evaluated and validated, additional data gaps could be identified. Further sampling and analysis would be performed to fill such gaps, as appropriate.

2 SITE BACKGROUND AND SETTING

Information on the history of site operations and disposal practices, physical characteristics of the site (including vicinity properties that still require remediation), land use, and environmental setting is provided in Sections 2.1 through 2.3. The nature and extent of contamination is discussed in Section 2.4; the response actions conducted to date are summarized in Section 2.5. To support remedial action decisions for the Colonie site, additional data have been collected and are currently being evaluated, as described in the sampling and analysis plan.

2.1 GENERAL SITE DESCRIPTION

The Colonie site is located at 1130 Central Avenue (State Route 5) in the town of Colonie, Albany County, New York, about 6.4 km (4 mi) northwest of downtown Albany and about 4.8 km (3 mi) southeast of the village of Colonie (see Figure 1). The boundary between the city of Albany and the town of Colonie is just south of the Colonie site. The site covers 4.5 ha (11.2 acres) and consists of the former NL Industries property, including the plant building and two storage buildings, and approximately 0.8 ha (2 acres) of land northwest of the original property that was acquired in 1985 from Niagara Mohawk Power Company (ANL 1988). Current land uses surrounding the Colonie site are described in Section 2.3.6.

The Colonie site is served by city water, electricity, and natural gas. The plant building was formerly served by a sanitary sewer that was connected with a main collector below Central Avenue, but this connection no longer exists. All sewage from the site is currently collected in a tank, sampled for uranium, and hauled to a sewage treatment facility. Underground storm drains control surface water drainage in the site area. Water enters the site through a small drainage channel from the northwest, flows beneath the site in an underground storm drain, and discharges into Patroon Creek (see Section 2.3.3). The Colonie site is enclosed by a chain-link fence and public access is restricted (ANL 1984). The main site features are shown in Figure 3.

Three vicinity properties still need to be remediated: (1) town of Colonie property, (2) Consolidated Rail Corporation (Conrail) property, and (3) Niagara Mohawk substation property (see Section 2.5). The town of Colonie property is a vacant lot covering an area of about 0.1 ha (0.3 acres). This property, overgrown with weeds and small trees, is located along the northwest boundary of the Colonie site and is adjacent to the southwest edge of the on-site burial area that partially filled in Patroon Lake. The Conrail property consists of two main-line tracks and an out-of-use siding track that are located immediately adjacent to the southern boundary of the site. The contamination occupies an area of about 50 m × 150 m (160 ft × 490 ft). The Niagara Mohawk substation property is located at the northwest corner of the Colonie site. This active substation occupies a 41 m × 52 m (140 ft × 170 ft) rectangular lot and is fenced.

Because these properties are not inhabited, the contamination poses little, if any, immediate risk to the public. In addition, risks to workers visiting the substation or railroad on a routine, but infrequent, basis is considered minimal. Remedial actions will

FIGURE 3 Existing Facilities at the Colonie Site

be undertaken at these properties once a decision is reached on final disposition of contaminated materials associated with remedial actions at the Colonie site.

2.2 SITE HISTORY

Operations at the Colonie site began in 1923 when the Embossing Company purchased a portion of the site to construct a facility for manufacturing wood products and toys. In 1927, Mangus Company, Inc., purchased the property and converted the facility into a brass foundry for manufacturing railroad components. Mangus cast the brass components in sand molds and also manufactured brass-bearing housings with babbitt metal surfaces. Babbitt metal (an alloy of lead, tin, copper, and antimony) was manufactured at the plant. Preparation of the bearing surfaces for bonding with the brass housings involved degreasing of the bearings by immersion in an acid bath.

In 1937, NL Industries purchased the facility and continued the brass foundry operations initiated by Mangus. At that time, NL Industries also bought an adjacent lot that contained a portion of Patroon Lake. Sometime before 1941, NL Industries began filling the lake with used casting sand that may have contained phenolic resins and possibly phenols; the lake was subsequently filled in, and only a small, closed depression remains. After World War II, the plant began casting aluminum mainframes for jet airplanes. Foundry operations were terminated by NL Industries in 1960.

From 1958 to 1984, NL Industries carried out a number of processes using radioactive materials. These activities started when the nuclear division of NL Industries began producing items manufactured from uranium and thorium under a license issued by the AEC. Between 1958 and 1968, NL Industries was engaged in a number of contracts and subcontracts with the AEC for fabrication of enriched uranium fuel elements and chemical processing of nonirradiated, enriched uranium scrap.

The plant handled enriched uranium from 1960 to 1972. From 1966 to 1972, NL Industries held several contracts to manufacture fuel from enriched uranium for experimental nuclear reactors. Operations were also conducted at the plant to separate uranium from depleted uranium tetrafluoride. The uranium tetrafluoride was reduced to uranium metal by heating it with magnesium metal in a reduction vessel. When the vessel reached a specific temperature, the magnesium reacted with the uranium tetrafluoride to form uranium metal and a magnesium fluoride slag. The depleted uranium metal was then fabricated into shielding components, ballast weights, and projectiles (ANL 1984). Table 1 summarizes the types of radioactive materials and approximate quantities handled at the Colonie site.

The various foundry operations at the site resulted in the generation of contaminated refractory, graphite, slag, and uranium oxide. In 1961, 42 m³ (55 yd³) of these wastes were buried on-site under an AEC license (Wilson 1962). As the plant was modified to its current configuration, several areas inside the plant were filled with used ceramics and trash, some of which may have been radioactively contaminated. As a result of NL Industries operations, the plant building, grounds, and vicinity properties became contaminated (Atcor 1978; Jeter and Eagleson 1980).

**TABLE 1 Summary of Radioactive Materials
Handled at the Colonie Site**

Material	Approximate Quantity (tons)
Depleted uranium tetrafluoride	5,000
Natural uranium	275
Material identified as radioactive (type not specified)	218
Enriched uranium (93%)	50
Thorium	16
Titanium/uranium alloy	1

Other processes conducted at the plant included an electroplating operation for plating of uranium with nickel and cadmium. Chemicals used in the plating operation included nickel sulfamate, sodium cyanide, ferric chloride, nitric acid, silicate phosphate, iridite (chromium brightener), cadmium metal, nickel metal, boric acid, and perchloroethylene. It is not known how or where these materials were disposed of. Chemical wastes and packaged chemicals present at the site include acids, bases, and degreasing agents; carbon tetrachloride, benzene, and polychlorinated biphenyls (PCBs); and cyanide, heavy metals, and asbestos. Some of the packaged chemicals have been removed as part of cleanup activities conducted at the site to date (see Section 2.5).

On February 15, 1980, the New York State Supreme Court issued a temporary restraining order barring NL Industries from operating because of airborne emissions of uranium oxide (State of New York 1980a); these emissions of fine-grained uranium resulted from the incineration of shavings and grindings produced as a result of shaping and machining of uranium. The temporary restraining order was amended on May 12, 1980, to allow NL Industries to continue limited operations (State of New York 1980b). The amended order also required the company to initiate an independent investigation to assess the level of contamination at the vicinity properties that could have resulted from airborne releases of radioactive materials from the plant (ANL 1984).

Responsibility for the Colonie site was assigned to DOE as part of a decontamination research and development project under the 1984 Energy and Water Appropriations Act. In February 1984, the Secretary of Energy accepted an offer from NL Industries to transfer to DOE the land, buildings, and equipment at the Colonie site, including radioactively contaminated wastes and residues on the property. The U.S. Army Corps of Engineers accepted the property on behalf of DOE on February 29, 1984, at which time title was transferred to DOE and plant operations ceased. In 1985,

DOE acquired a portion of the Niagara Mohawk property that borders the Colonie site to the north and northwest and subsequently designated it as part of the Colonie site.

Since 1984, the Colonie site has been managed by DOE under FUSRAP. The site is being used for interim storage of drums containing radioactive and chemical materials from the site and for storage of radioactively contaminated materials removed from the vicinity properties. The radioactively contaminated materials will remain in storage at the Colonie site until a decision is made regarding a permanent remedy.

2.3 ENVIRONMENTAL SETTING

2.3.1 Surface Features

The Colonie site lies on the eastern edge of the Central Plateau physiographic province, with the Adirondack province to the north and the northern extension of the Valley and Ridge province to the east (Hunt 1967). The site is located on relatively flat, slightly rolling terrain in the Pine Bush area within the Mohawk-Hudson lowland. Maximum topographic relief across the site is about 3 m (10 ft); elevation above national geodetic vertical datum (NGVD)* is approximately 69 m (230 ft) on the north end and southwest corner, 66 m (220 ft) at the low point along the northwest boundary, and 67 m (222 ft) along the south side.

Surface drainage is generally toward the south or southeast. Surface runoff is collected by subsurface storm drains along the southern portion of the site. A partially backfilled, closed depression occurs along the middle third of the northwest boundary of the site; this depression is part of the former natural lake (Patroon Lake) that was located northwest of the site. The surface runoff that enters this depression is transported off-site by a subsurface drain (see Figure 3).

About one-third of the site contains the building formerly used by NL Industries to manufacture a variety of products using uranium and thorium. Two small storage buildings are located along the southwest border of the site. Asphalt paving surrounds the plant building. Except for the decontamination facility located in the north-central portion of the site, the rest of the site is covered with grass and a few trees and shrubs. The Colonie site is surrounded by a woodlot along its northwest boundary, Conrail tracks on the southwest and south, commercial property on the east, Central Avenue along the northeast, and the Niagara Mohawk electrical substation on the north (see Figure 3).

2.3.2 Geology and Stratigraphy

Bedrock underlying the Colonie site is Ordovician shale of the Normanskill Formation (Figure 4) located at a depth of about 45 to 60 m (150 to 200 ft). The Normanskill Formation consists primarily of dark-gray to black argillaceous shales but

*National geodetic vertical datum is synonymous with mean sea level.

FIGURE 4 Geologic Map of the Albany Area (Source: Modified from Rickard and Fisher 1970)

also contains red and green shales and heavy beds of chert and grit (ANL 1984). Metamorphic material largely underlies the bedrock down to the Grenville basement complex that is located at a depth of 500 to 1,000 m (1,650 to 3,300 ft) below NGVD in the Albany area (Bird and Dewey 1970; Rowlen and Kidd 1981).

The bedrock is overlain by about 60 m (200 ft) of Quaternary glacial outwash sediments, some of which have been reworked and redeposited as lacustrine and lacustrine dune deposits. More recent deltaic sediments overlie the other surface deposits. Most of the surface material is unconsolidated. Regionally, the most important surface deposits are the buried preglacial river channels and the glacial basal gravels and outwash gravels. These deposits are considered important potential groundwater reservoirs (see Section 2.3.3).

Most of the surface materials at the Colonie site are composed of fill and graded or reworked in-situ soils. Weathered dune sand is exposed on the north end and in the southwest corner of the site. The near-surface material in areas adjacent to the Colonie site consists of layers of unconsolidated gray sand, silt, and clay, with several feet of fine brown sand composing the uppermost layer. The unconsolidated sediments below the near surface are lake bed and deltaic deposits derived from glacial streams emptying into glacial Lake Albany (extinct); beneath these are glacial tills and stratified glacial drift. The areal extent of some unconsolidated glacial deposits is believed to be controlled by channels formed during glacial drainage before the area was under ice cover (Dineen 1982; Weddendorf 1982).

A drilling program was conducted at the Colonie site in 1984. Overburden materials were examined to a depth of about 21 m (70 ft), but bedrock was not penetrated. Table 2 contains generalized lithologic descriptions of the overburden sediments at the Colonie site based on the findings of that investigation. One of the "stratified drift" units is referred to as the Elsemere Gravel Blanket, a potentially significant aquifer (Weddendorf 1982). It is not known whether this formation extends beneath the Colonie site. Table 3 contains a summary of the monitoring wells at the Colonie site and the stratigraphy encountered in the subsurface at the respective well locations (Bechtel National, Inc. [BNI] 1985b).

Bedding layers are nearly horizontal except at well 10 (now abandoned), where apparent dips of up to 60° from horizontal were noted in the upper 3 m (10 ft) of the lower clay unit. The short interval in well 10, where a dip was visible in the samples, may have resulted from differential compaction that occurred soon after deposition. The overall dip trend of the sediments is less than 5° southeasterly.

In summary, the following is known about the geology of the Colonie site:

- The general relationship of the Colonie site to the regional geologic history is understood, and
- The general geologic sequence of the unconsolidated glacial sediments at the Colonie site is generally understood to a depth of 21 m (70 ft). However, detailed information about the strata from the lower clay unit to bedrock is still needed.

TABLE 2 General Stratigraphy of the Colonie Site

Unit	Thickness ^a (ft)	Description
Dune sand	0-13.6	Light brown, uncemented, loose, well-sorted, fine-to-medium grained, subangular to rounded, frosted, quartzose sand
Upper sands	8-24.2	Light grayish brown to medium gray, uncemented, loose, poorly sorted, very fine to fine silty sand with moderate to high degree of dilatancy
Upper clay	2.5-10.7	Grayish brown, gray to dark gray, uncemented, soft, varved clay; silty sand; sandy silt; silt; and clayey silt
Lower sands	11-26	Grayish brown to medium gray, uncemented loose to medium-dense, poorly sorted, very fine to fine silty sand with moderate to high degree of dilatancy
Lower clay	30.4 to maximum depth drilled of 70 ft	Grayish brown, light to dark gray clay; soft, varved, sandy silt; silt; and silty clay
Elsemere Gravel Blanket	-	Not penetrated by borings at the Colonie site

^aThe thicknesses represent field interpretation of the shallow sediments encountered during drilling to install monitoring wells at the Colonie site.

Source: Based on data from BNI (1985b).

2.3.3 Hydrology and Water Quality

The Colonie site is located within the Patroon Creek drainage basin about 2.6 km (1.6 mi) east of Rensselaer Lake (Figure 5). A small, unnamed stream traverses the former lake bed (Patroon Lake) on the northwest edge of the site; the stream enters the site through a culvert, passes beneath the site in a concrete-lined storm drain, and exits the site through another culvert on the south side (Figure 3). The stream empties into Patroon Creek about 0.4 km (0.25 mi) south of the site. Patroon Creek, which flows to the east, is a tributary to the Hudson River and is fed directly by seepage from surficial

TABLE 3 Summary of Colonie Site Wells and Associated Stratigraphy

Well No. ^a	Surface Elevation (NGVD)	Screen Interval (ft)	Thickness of Stratigraphic Unit (ft)						Total Well Depth (ft)
			Fill	Dune Sand	Upper Sands	Upper Clay	Lower Sands	Lower Clay	
1	228.9	3.97-14.0	NA ^b	10.8	3.2 ^c	NA	NA	NA	14.0
2 ^d	228.5	NA	NA	10.2	14.8	6.0	26.0	13.0 ^c	70.0
3	228.5	32.6-42.7	NA	10.7	14.6	10.7	6.7 ^c	NA	42.7
4	222.9	31.0-47.0	NA	13.0	11.0	9.5	11.0	2.5 ^c	47.0
5	222.9	8.9-22.0	NA	13.6	8.4 ^c	NA	NA	NA	22.0
6	223.3	11.0-20.1	1.5	NA	20.5 ^c	NA	NA	NA	22.0
7	229.5	8.9-19.1	NA	10.0	8.0	2.0 ^c	NA	NA	20.0
7A ^d	224.4	NA	1.0	NA	NA	NA	NA	NA	1.0
7B ^d	225.4	NA	4.5	NA	NA	NA	NA	NA	4.5
8 ^d	228.5	NA	2.0	8.0	11.2	8.8	11.1	30.4 ^c	71.5
9 ^d	222.6	NA	1.5	NA	10.0 ^c	NA	NA	NA	11.5
10 ^d	222.1	NA	NA	11.5	17.5	3.5	13.5	19.0 ^c	65.0
11	223.1	10.0-19.9	8.5	NA	11.4 ^c	NA	NA	NA	19.9
12 ^d	229.7	NA	NA	10.8	24.2	2.5	12.0	22.0 ^c	71.5

^aWell locations are shown in Figure 10.

^bNA = not applicable.

^cBottom of hole; stratigraphic unit not completely penetrated.

^dAbandoned well.

Source: Data from BNI (1985b).

FIGURE 5 Surface Water Drainage System in the Vicinity of the Colonie Site
(Source: Modified from Snively 1983)

sands (Snively 1983). At the Albany gauging station on Central Avenue, Patroon Creek has a drainage area of about 19 km^2 (7.4 mi^2). Discharges measured on April 12 and August 28, 1979, were 402 and 169 L/s (14.2 and 5.97 cfs), respectively (Snively 1983). Water samples collected on April 12 and August 28, 1979, and on April 2, 1980, were analyzed for various parameters to determine if contamination was occurring from septic tank effluent or sewer pipe leakage (phosphorus, nitrogen, and chloride) or from road salt (chlorides). Results of the water quality analyses of Patroon Creek are given in Table 4. Nitrogen and phosphorus concentrations in Patroon Creek were in the range of most streams in the area whereas chloride concentrations were somewhat elevated, undoubtedly due to road salt (Snively 1983). Patroon Creek is not used as a source of potable water. The Colonie site receives Albany city water that is pumped from reservoirs located about 32 km (20 mi) south of the site (Snively 1984b).

TABLE 4 Water Quality of Patroon Creek at Central Avenue

Constituent	Concentration (mg/L)		
	04/12/79	08/28/79	04/02/80
Calcium	- ^a	-	62
Chloride	120	110	120
Hardness, total	-	-	200
Magnesium	-	-	11
Nitrogen as N	0.66	0.74	0.76
Nitrite + nitrate as N	0.43	0.43	0.47
Phosphorus as P	-	0.01	0
Potassium	-	-	2.5
Sodium	-	-	73

^aA hyphen indicates not sampled.

Source: Data from Snavely (1983).

The 100-year flood boundary of Patroon Creek is located south of Yardboro Avenue, with a water level of 61 m (200 ft) NGVD (Snavely 1984a). The Colonie site and vicinity properties are not located within the 100-year floodplain.

The primary source of groundwater recharge in the area is infiltration of rain and melting snow. About 38% of the precipitation recharges the surficial aquifers (Snavely 1983). Groundwater flows to the southeast or east in the vicinity of the site (Weddendorf 1982; Snavely 1983).

Groundwater wells in the Normanskill shale, a relatively impervious rock, yield only about 19 L/min (5 gpm) from joint and bedding planes (Heath 1964), and the water is of poor quality (ANL 1984). Moderate to large quantities of groundwater are available from the unconsolidated surficial deposits; the water generally has a lower mineral content than that from bedrock (Arnow 1949).

Based on information obtained from the installation of groundwater monitoring wells, it appears that two groundwater systems are present immediately beneath the site (BNI 1985b). The shallow groundwater zone (unconfined) is composed of aeolian and glaciolacustrine deposits (upper sands), and the next lower zone (semiconfined) is composed of lacustrine deposits (lower sands) (see Table 2). Another deep groundwater system may exist below the site in the Elsemere Gravel Blanket (Weddendorf 1982), which is composed of ice-contact deposits of sand and gravel (Wing 1985). This system

was not penetrated during investigations conducted at the site, but it is known to be a potentially important groundwater source where it is present near the Colonie site.

The potentiometric surface is the level to which water will rise in tightly cased wells, and it indicates the groundwater hydraulic gradient or slope and flow direction. The potentiometric surface of the upper sands groundwater system at the Colonie site is about 1.5 to 4.3 m (5 to 14 ft) below ground and that of the lower sands groundwater system is about 1.8 to 5.8 m (6 to 18 ft) below ground. Figures 6 and 7 show the potentiometric surface maps for the upper and lower sands groundwater systems, respectively, underlying the Colonie site during a seasonal high water table period (small seasonal variation has been observed). Based on the limited sampling locations available, the estimated contours for the upper sands system suggest a smooth hydraulic gradient from north to south, with a slope of about 0.01. A hydraulic gradient similar to that also occurs in the lower sands aquifer.

Based on a review of the existing information, the following conclusions may be drawn regarding characteristics of the groundwater system at the Colonie site:

- The lower sands potentiometric surface is 0.3 to 1.2 m (1 to 4 ft) below and parallel to the upper sands potentiometric surface, which suggests that the upper clay layer located between these systems acts as a leaky aquitard.
- The potentiometric maps for both sand aquifer systems highlight the lack of groundwater measurements upgradient of, on, and down-gradient of the site.
- Field tests (see Table 5) indicate that the hydraulic conductivity of the upper clay layer (about 1×10^{-4} cm/s) is higher than typical glacial clay values (e.g., $<1 \times 10^{-5}$ cm/s) and that the hydraulic conductivities of the sand layers are typical of values expected for sands (e.g., about 1×10^{-4} cm/s).
- The presence or absence of additional groundwater systems beneath the site, including the potentially significant Elsemere Gravel Blanket aquifer, has not been determined.

2.3.4 Ecology

The Colonie site lies within the northern hardwood forest section of the Laurentian mixed forest. Aspen, fire cherry, ash, and hawthorne trees are commonly found in old-field habitats and disturbed areas; oaks (chestnut, white, and red) are also common in the area. However, because the Colonie site is an industrial property located within an urban setting, little or no actual forest habitat is present on-site (ANL 1984).

The flora in residential areas near the site consists primarily of species common to landscaped lawns, such as grasses, evergreen shrubs, and trees (oak, maple, elm, and spruce). Residential vegetable gardens are not extensive in the area, although grapevines

FIGURE 6 Potentiometric Surface Map of the Upper Sands Groundwater System at the Colonie Site

FIGURE 7 Potentiometric Surface Map of the Lower Sands Groundwater System at the Colonie Site

**TABLE 5 Summary of Field Permeability Test Results
for the Colonie Site**

Well No.	Depth (ft)	Geologic Unit	Test Method ^a	Hydraulic Conductivity (1×10^{-4} ft/min)
1	5.97-10.97	Upper sands	fh ^b	14
1	5.97-10.97	Upper sands	rh	73
3	35.6-40.6	Lower sands	fh ^b	5.2
3	35.6-40.6	Lower sands	rh	2.0
4	34.4-39.4	Lower sands	fh ^b	3.3
4	34.4-39.4	Lower sands	rh	2.4
5	11.5-16.5	Upper sands	fh ^b	9.5
5	11.5-16.5	Upper sands	rh	35
6	13.13-18.13	Upper sands	fh ^b	12
6	13.13-18.13	Upper sands	rh	13
7	12.15-17.15	Upper sands	fh ^b	10
7	12.15-17.15	Upper sands	rh	18
11	12.65-17.65	Upper sands	fh ^b	6.3
11	12.65-17.65	Upper sands	rh	3.4
8	32	Upper clay	fh.oe	3.4
8	32-34	Upper clay	oh	2.0
8	47	Lower clay	fh.oe	6.7
8	47-49	Lower clay	oh	3.6
10	17	Upper sands	fh.oe	760
10	23	Upper sands	fh.oe	8.5
10	23-24.8	Upper sands	oh	2.7
10	57	Lower clay	fh.oe	5.6
10	57-59	Lower clay	oh	7.6
12	54.5	Lower clay	fh.oe	4.2
12	54.5-56.5	Lower clay	oh	1.2

^aTest methods include the rising head test (rh) and one of three falling head tests: falling head for installed well (fh), falling head in open-end pipe (fh.oe), and falling head in an open hole (fh.oh).

^bTest conducted in completed observation well.

Source: Data from BNI (1985b).

are common. At the industrial and railroad properties adjoining the Colonie site, the flora consists of grasses and weeds (such as aster, fescue, plantain, goldenrod, panic-grass, dandelion, smartweed, yarrow, thistle, and wild carrot) and scattered shrubs and trees (such as oak, maple, and aspen) (ANL 1984).

Wildlife inhabiting the area include commonly encountered species that have adapted to urban/suburban encroachment. Bird species include the blue jay, northern flicker, black-capped chickadee, killdeer, house sparrow, northern cardinal, American robin, pigeon (rock dove), mourning dove, European starling, and common grackle. Mammal species include the Norway rat, house mouse, eastern cottontail rabbit, and eastern gray squirrel. Larger mammals -- particularly raccoon, striped skunk, and Virginia opossum -- may also be present (DeGraaf and Rudis 1986).

Aquatic habitat is limited to a small, unnamed tributary stream that passes beneath the site (in a concrete-lined storm drain) and its receiving stream (Patroon Creek) located 0.4 km (0.25 mi) south of the site. The biota of the tributary creek is dominated by algae and invertebrate species typical of small, generally degraded streams located in urban areas. Patroon Creek contains similar species plus minnows, suckers, and other fish tolerant of water quality conditions often associated with urban streams, e.g., elevated concentrations of suspended sediments and chlorides (ANL 1984).

The bald eagle (*Haliaeetus leucocephalus*) and peregrine falcon (*Falco peregrinus*) are the only federally listed endangered species that may occur in the vicinity of the Colonie site. However, it is expected that they would pass over the area only as occasional transients (Gill 1989); no habitats critical for their survival (DeGraaf and Rudis 1986) occur in the site vicinity.

2.3.5 Climate and Air Quality

Climate. The climate of central New York is humid and is characterized by the cold winters and warm summers typical of the northeastern United States. The average annual daily maximum temperature for the Colonie area is 14.2°C (57.6°F), and the average annual daily minimum is 2.7°C (36.8°F). The highest average monthly temperature is 28.4°C (83.1°F) in July, and the lowest is -11.2°C (11.9°F) in January. Average annual precipitation is 89.4 cm (35.2 in.), with an average annual snowfall of 144 cm (56.6 in.). Winds are predominantly out of the south at a mean speed of 16 km/h (10 mph) (Gale Research Company 1980; National Oceanic and Atmospheric Administration 1983).

Air Quality. Air quality monitoring stations in the Hudson Valley air quality control region closest to the Colonie site are located in Albany, Loudonville, and Schenectady. Pollutants routinely measured include sulfur dioxide, total suspended particulates, carbon monoxide, ozone (photochemical oxidants), nitrogen dioxide, lead, sulfates, nitrates, and inhalable particulates (N.Y. State Department of Environmental Conservation 1988, 1989). Few air quality problems occur in the Colonie area, most parameters being well within New York State and federal ambient air quality standards.

Ozone levels exceeded New York and federal standards five times in 1988 (highest recorded 1-hour average was 0.148 ppm compared with the standard of 0.125 ppm). Total suspended particulates exceeded federal secondary standards on one occasion (maximum 24-hour average concentration measured was $172 \mu\text{g}/\text{m}^3$ compared with the secondary standard of $150 \mu\text{g}/\text{m}^3$).

2.3.6 Land Use

The Colonie site is situated in an urban area of mixed residential, commercial, and light industrial land use. Small business firms are concentrated along Central Avenue whereas land use to the north of the site is primarily residential. The area immediately south and east of the site consists of both residential and commercial properties, and zones of mixed commercial and industrial use lie to the west and east.

The Colonie site is owned by DOE and is currently being used to store radioactively contaminated materials resulting from cleanup of vicinity properties. It is also being used to store chemicals in accordance with a Part A permit issued under the Resource Conservation and Recovery Act (RCRA).

2.3.7 Historical, Archeological, and Cultural Resources

No structures are located on or in the vicinity of the Colonie site that might be eligible for inclusion in the *National Register of Historic Places* and could be impacted by any of the remedial activities being considered (Stokes 1988a). Because no archeological surveys have been conducted in the Colonie site area (Gobrecht 1988), any excavation activities could adversely affect archeological remains that may be contained in the soil. However, it is anticipated that no survey will be required because of the previous disturbance of topsoil, the limited depth of contamination, and the low probability of locating archeological remains on the site and three adjacent vicinity properties. Secondly, the New York State Historic Preservation Officer has determined that activities similar to those proposed would not affect significant historic structures or archeological sites, i.e., those that might be eligible for inclusion in the *National Register* (Stokes 1988b).

2.4 NATURE AND EXTENT OF CONTAMINATION

The following discussion of the origins and nature of radioactive and non-radioactive contamination at the Colonie site is based on information compiled by reviewing reports of previous surveys and historical information about operations conducted at the site.

2.4.1 Origins of the Contamination

The principal contaminants at the Colonie site are radioactive and originated from uranium-processing operations carried out at the site between 1958 and 1984 (see

Section 2.2). Four processes were conducted during this period that could have resulted in the production of radioactive and nonradioactive contaminants: (1) reduction of uranium fluoride with magnesium metal to produce uranium metal; (2) electroplating of uranium with nickel and cadmium; (3) production of fuel elements, and (4) shaping and machining of enriched and depleted uranium and natural thorium metals.

Depleted uranium was the most commonly used material; however, smaller amounts of thorium and enriched uranium were also used in processing operations. These activities resulted in liquid and solid wastes that were disposed of both on-site and off-site at commercial disposal locations. Radiological surveys of the site and historical records (BNI 1987) indicate that solid wastes were disposed of on-site in the area of Patroon Lake. An NL Industries interdepartmental letter (Huss 1959) indicates that certain residues were disposed of -- including graphite, insoluble oil, refractory material, metal scrap, and burnable trash -- all of which were labeled as contaminated. This correlates to another letter (Wilson 1962) indicating that under AEC license, NL Industries buried about 42 m³ (55 yd³) of contaminated graphite, slag, refractory, and uranium oxide in the Patroon Lake area in 1961. Some radioactively contaminated materials may also have been used as fill during modification of the site.

The uranium used for production of fuel elements was a powdered uranium oxide that was pressed into pellets. Because the uranium oxide was in a powdered form, it could easily have become airborne and spread throughout the building and onto the site. Shavings and grindings from shaping and machining of uranium were incinerated to oxidize the uranium and thereby prevent a fire hazard. The emissions from incinerating these materials resulted in surface contamination of the site and vicinity properties.

The foundry operations conducted at the Colonie site from the 1920s through 1960 included casting brass in sand molds and manufacturing babbitt metal (an alloy of lead, tin, copper, and antimony). Several possible sources of chemical contamination resulted from the foundry operations. Specifically, spent sand from molds was disposed of on-site, and these molds could have contained residual lead, tin, zinc, copper, and possibly phenols. The processing operations also included use of an organic degreaser.

Although little is known about waste disposal practices during the early operations at the foundry, there are indications that NL Industries began disposing of spent foundry sand in Patroon Lake sometime before 1941. Aerial photographs of the site taken in 1940, 1952, 1960, 1969, 1974, and 1977 show an accumulation of waste materials in Patroon Lake at both its northwest and southwest ends adjacent to the former NL Industries plant. During the late 1940s, jet mainframes were manufactured from aluminum at the plant, and aluminum wastes could be present at the site as a result.

2.4.2 Radiological Conditions

Main Colonie Site. In 1978, Atcor, Inc., conducted a radiological survey of the Colonie site to assess radiological conditions and to make recommendations regarding corrective action for any problems that might be identified (Atcor 1978). The survey

included measurements of external radiation levels and surface contamination; contaminated areas identified by the survey are shown in Figure 3. The results of the survey (Table 6) indicated that essentially all floor areas surveyed had elevated levels of beta-gamma and gamma radiation that exceed current DOE guidelines (the DOE guidelines for acceptable levels of residual contamination are reproduced in Appendix A).

Following the Atcor survey, a series of surveys was conducted by Teledyne Isotopes during 1980 and 1981. The purpose of the 1980 survey was to determine the extent of surface contamination at the Colonie site and in its vicinity that could have resulted from plant stack emissions. Samples were collected from various areas of the site and vicinity, to a radius of 0.6 km (0.4 mi), including low areas and areas where contamination could have accumulated -- such as along "drip lines" where contaminated runoff from the plant roof could have collected on the ground (Jeter and Eagleson 1980). The results of this survey indicated that the average on-site concentrations of uranium-235 and uranium-238 in the top 5 cm (2 in.) of soil were 6.2 pCi/g and 410 pCi/g, respectively. The maximum concentration of uranium-235 detected was 20 pCi/g and that of uranium-238 was 1,200 pCi/g. The survey also indicated that there was surface contamination (to an average depth of 5 cm [2 in.]) on all portions of the Colonie site that were surveyed (Jeter and Eagleson 1980). Off-site samples indicated that uranium concentrations above 20 pCi/g extended to 0.37 km (0.23 mi) from the Colonie site and that areas of highest concentrations were in the directions of prevailing winds; only three samples beyond this radius exceeded 20 pCi/g, with the highest measurement at 56 pCi/g (Jeter and Eagleson 1980). For comparison, the concentration of uranium-238 in soil is typically about 1 to 2 pCi/g. Teledyne also conducted a radiological survey of the plant building roof in 1980. The average level of radioactivity measured was 2,300 pCi/cm², and the maximum level was 38,400 pCi/cm² (Jeter and Eagleson 1980). These measurements substantially exceed DOE surface contamination guidelines* for uranium (see footnote b of Table 6).

In 1981, Teledyne conducted a second survey of the Colonie site to determine the extent of subsurface contamination (Jeter et al. 1981). A square grid was established on the site, and soil samples were obtained from boreholes drilled to a depth of 9.1 m (30 ft) at selected grid intersections. Analytical results of the 1981 Teledyne survey indicated the presence of subsurface contamination to a depth of 8.5 m (28 ft). Sampling locations and areas of subsurface contamination identified on the basis of this survey are shown in Figure 8. The largest of these areas lies about 61 m (200 ft) northwest of the plant building in the area once occupied by Patroon Lake; it measures roughly 30 m × 40 m (100 ft × 130 ft) at the surface and extends to a depth of 8.5 m (28 ft). The average concentration of uranium-238 measured in this area was 190 pCi/g, and the maximum concentration was about 1,800 pCi/g. In addition, actinium-228 was detected in two borehole locations at concentrations ranging from 13 to 740 pCi/g. Actinium-228 is the decay product of radium-228, which in turn is the decay product of thorium-232, and its detection suggests that radium-228 and thorium-232 are also present. For comparison, thorium-232 is typically present in soil at a concentration of about 1 to 2 pCi/g.

*To compare measurements with DOE guidelines, 1 pCi/cm² = 222 dpm/100 cm².

TABLE 6 Summary of Surface Contamination inside the Plant Building

Location ^a	Average Surface Contamination ^b			
	Beta-Gamma ^c (mR/h)	Gamma ^d (mR/h)	Total Alpha ^e (dpm/100 cm ²)	Removable Alpha ^f (dpm/100 cm ²)
Bay 1	0.6	0.06	7,500	1,100
Bay 2	1.7	0.09	4,600	900
Bay 3	3.1	0.13	11,600	2,100
Bay 3A	6.9	0.14	8,500	2,300
Bay 4	0.5	0.21	4,500	1,100
Bay 4A	3.5	0.13	5,200	2,800
Bay 5	0.7	0.29	2,000	700
Office/storage/boiler	0.2	0.10	1,500	400
Cafeteria/laboratory	0.2	0.02	1,200	300
Health physics/supply	0.1	0.02	800	200
Plating/painting	0.3	0.04	1,800	500
All areas	1.4	0.12	4,500	1,100

^aLocations are shown in Figure 3.

^bEach value represents the average of all measurements taken in the respective survey area. For perspective, the DOE guidelines for surface contamination for beta-gamma emitters are 0.2 mR/h, average, and 1.0 mR/h, maximum. The guidelines for alpha contamination (assumed to be uranium) are 5,000 dpm/100 cm², average; 15,000 dpm/100 cm², maximum; and 1,000 dpm/100 cm² removable (see Appendix A).

^cMeasured at grid intersections, floor level.

^dMeasured at grid points, 1 m (3 ft) from the floor.

^eAverage total surface alpha contamination on floors, walls, and overhead structures.

^fAverage removable surface alpha contamination (swipe samples) on floors, walls, and overhead structures.

Source: Data from Atcor (1978).

FIGURE 8 Approximate Areas of Subsurface Contamination at the Colonie Site
(Source: Modified from Jeter et al. 1981)

A smaller area of subsurface contamination, measuring about 30 m $\times$ 20 m (100 ft $\times$ 65 ft), was identified near the northwest side of the plant building in a grass-covered area between paved driveways. The contamination in this area was primarily detected in the upper 0.6 m (2 ft) of soil, with an average uranium-238 concentration of about 230 pCi/g and a maximum concentration of about 870 pCi/g. A small, isolated area of subsurface contamination was also identified in one borehole about 30 m (100 ft) south of the large area of subsurface contamination at the former edge of Patroon Lake. Uranium-238 concentrations in soil samples taken at 0 to 0.6 m (0 to 2 ft) and 0.6 to 1.2 m (2 to 4 ft) were about 150 and 230 pCi/g, respectively.

Additional information about radiological conditions at the Colonie site has been obtained through DOE's environmental monitoring program conducted by BNI since 1984 (BNI 1985a, 1986, 1987, 1988a, 1989a). The monitoring program has included quarterly collection of surface water samples from three off-site and two on-site locations, as shown in Figure 9. Sampling points were located both upstream of the site (locations 4 and 5) to establish background conditions and downstream of the site (locations 2 and 3) to determine the effect of runoff from the site on surface water in the vicinity. However, because contaminated vicinity properties are located upstream of the upstream sampling point, true background may not have been established. The results of surface water analyses are presented in Table 7. For comparison, the average concentration of total uranium in groundwater sources (which is expected to be higher than that in surface water) is about 2 pCi/L. Thus, concentrations of total uranium -- although fairly stable since 1984 (BNI 1989a) -- are somewhat elevated over background.

As part of the environmental monitoring program, sediment samples are also collected quarterly both upstream and downstream of the Colonie site. The sampling locations are shown in Figure 9. The results of sediment analyses for the period 1984-1988 are presented in Table 8; the measured values have been fairly consistent since 1985 (BNI 1989a). These values are higher than typical soil concentrations in which the concentration of uranium-238 is about 1 to 2 pCi/g.

Groundwater samples have also been collected quarterly from seven on-site monitoring wells since the environmental monitoring program was initiated. Figure 10 shows the locations of the groundwater monitoring wells. The results of groundwater analyses for the period 1984-1988 are presented in Table 9. For comparison, the concentration of total uranium in groundwater supplies is typically about 2 pCi/L. Hence, the measured values are comparable to those naturally occurring in groundwater. The measured values are consistent over the years and between wells, which suggests that either no horizontal migration of radionuclides in groundwater is occurring or that steady state has been reached. Downgradient wells are needed to investigate this further. Also, information is needed to investigate vertical migration and possible contamination below the lower sands unit.

Vicinity Properties. Three vicinity properties remain to be remediated at the Colonie site. These properties are the town of Colonie property adjacent to the west boundary of the site, the Conrail property immediately to the south of the site, and the Niagara-Mohawk substation property on the northwest corner of the site (see Figure 11).

FIGURE 9 Surface Water and Sediment Sampling Locations at the Colonie Site

TABLE 7 Average Concentrations of Total Uranium in Surface Water in the Vicinity of the Colonie Site, 1984-1988

Sampling Location ^a	Average Concentration of Total Uranium (pCi/L)					
	1984	1985	1986	1987	1988	1984-1988
1 ^b	880	34	60	73	39	262
2	9.0	16	14	9.3	7	12
3	5.0	8.0	13	7.1	6	8.3
4	1.5	4.0	5.0	2.2	5	3.2
5 ^c	-	3.4	3.4	5.2	2	4.0

^aSampling locations are shown in Figure 9.

^bLocation 1 is in an area known to be contaminated.

^cLocation 5 was added to the environmental monitoring program at the Colonie site in 1985 and is considered to represent background.

Sources: Data from BNI (1985a, 1986, 1987, 1988a, 1989a); Robertson (1988).

The town of Colonie property is a vacant lot of about 0.12 ha (0.3 acres) that is covered with weeds, brush, and small trees. The property is located at the edge of the on-site burial area that was formerly Patroon Lake. Contamination on the property has been measured to a depth of nearly 0.3 m (1 ft). Oak Ridge National Laboratory (ORNL) has performed a radiological survey of the property (Marley 1987), in which elevated gamma exposure rates were measured ranging from 6 to 24 μ R/h at 1 m (3 ft) and averaging 12 μ R/h. The background gamma radiation exposure rate in the Albany area averages 9 μ R/h at 1 m (3 ft). Soil samples taken at varying depths to 0.3 cm (1 ft) had the following concentrations of radionuclides: uranium-238 ranged from 20 to 350 pCi/g and averaged 130 pCi/g; thorium-232 ranged from 0.67 to 800 pCi/g and averaged 330 pCi/g; radium-228 ranged from 0.5 to 860 pCi/g and averaged 350 pCi/g; and radium-226 ranged from 0.6 to 0.88 pCi/g and averaged 0.82 Ci/g. All values, with the exception of radium-226, are elevated above background values.

The Conrail property consists of two active main-line tracks and one out-of-use siding track that previously served the Colonie site. The railroad property is

TABLE 8 Average Concentrations of Uranium in Sediments in the Vicinity of the Colonie Site, 1984-1988

Isotope and Sampling Location ^a	Average Uranium Concentration (pCi/g)					
	1984	1985	1986	1987	1988	1984-1988
Uranium-234						
1	1.0	6.0	-	-	-	3.5
2	1.2	10.0	2.7	4.0	2.7	4.1
3	3.2	4.0	-	-	3.2	3.5
Uranium-235						
1	0.06	0.6	-	-	-	0.33
2	0.06	0.8	0.2	0.2	0.1	0.27
3	0.1	0.2	-	-	0.2	0.15
Uranium-238						
1	3.8	30.0	-	-	-	16.9
2	5.4	17.0	12.8	8.7	8.7	10.5
3	4.2	2.0	-	-	8.6	4.9

^aSediment sampling locations are shown in Figure 9.

Sources: Data from BNI (1985a, 1986, 1987, 1988a, 1989a).

immediately adjacent to the southern boundary of the Colonie site. A chain-link fence separates the Colonie site from this property. A radiological survey of the site conducted by ORNL (Marley et al. 1988) indicates that contamination appears to be restricted to the top few centimeters of soil. Concentrations of uranium-238 in systematic soil samples ranged from 6.5 to 160 pCi/g and averaged 51 pCi/g. The concentrations in biased samples (taken from areas having elevated gamma exposure rates) averaged 420 pCi/g, with a maximum concentration of 1,100 pCi/g measured in one sample. The concentrations of radium-226 measured in two samples were 0.64 and 0.66 pCi/g.

The Niagara-Mohawk substation property at the northwest corner of the Colonie site is rectangular in shape and measures 41 m × 52 m (135 ft × 170 ft). It is an active power substation. To date, the property has not been surveyed radiologically. It is assumed to be contaminated because surface contamination was detected on properties adjacent to both sides of the substation. The property is completely fenced in and public access is prohibited.

FIGURE 10 Groundwater Sampling Locations at the Colonie Site

**TABLE 9 Average Concentrations of Total Uranium
in Groundwater at the Colonie Site, 1984-1988**

Sampling Location ^a	Average Concentration of Total Uranium (pCi/L)					
	1984	1985	1986	1987	1988	1984-1988
1 ^b	8.7	3.0 ^c	5.0	2.2	3.0	4.4
3 ^b	4.1	3.0 ^c	6.2	2.8	3.0	3.8
4	8.6	3.0 ^c	6.7	3.9	4.0	5.2
5	-	3.0 ^c	3.8	2.5	2.0	2.8
6	-	3.0 ^c	4.3	2.5	3.0	3.2
7	-	3.0 ^c	5.0	2.2	3.0	3.3
11	-	3.0 ^c	4.5	2.4	3.0	3.2

^aSampling locations are shown in Figure 10. Wells 5, 6, 7, and 11 were constructed and added to the program in 1985.

^bUpgradient well, considered to represent background; the background value has not been subtracted.

^cBelow detection limit. A change in the counting procedures was implemented in 1985, which resulted in lower detection limits in subsequent years.

Sources: Data from BNI (1985a, 1986, 1987, 1988a, 1989a).

2.4.3 Nonradiological Conditions

The former uses of the Colonie site indicate that chemical contaminants could be present both inside the building and in the soils outside the building. Sampling has been performed on-site to determine the presence of chemical contaminants exterior to the plant building, and the results are currently being evaluated. Inside the building, large amounts of asbestos and stored chemicals (e.g., electroplating process wastes and laboratory chemicals) have been identified. Specific information on the nature and extent of chemical contamination is being obtained as a part of ongoing site characterization activities.

2.4.4 Summary of Site Conditions

The following conclusions are based on historical surveys of the site and data from the ongoing environmental monitoring and site characterization activities:

- Potential contaminants at the Colonie site range from uranium and thorium to numerous metals, inorganic chemicals, and some listed RCRA hazardous wastes. Table 10 summarizes the contaminants present at the site, based on activities and historic surveys conducted there.
- Results of field investigations indicate that concentrations of uranium in surface water are somewhat elevated over typical background levels. The concentrations of uranium in groundwater are comparable with naturally occurring concentrations. No off-site or on-site monitoring of chemical contaminants has been performed for either surface water or groundwater. Information is needed regarding groundwater conditions below the lower sands unit.
- Essentially all of the former plant building and some of the site grounds are radioactively contaminated. Little information exists concerning indoor levels of chemical contaminants, except for asbestos and chemicals contained inside the plant building.
- Radioactive and, possibly, chemical contaminants have been introduced into the environment via past airborne releases and on-site burials. For the most part, the extent of radioactive contamination has been established as a result of previous surveys. Chemical characterization is currently being performed to define the nature and extent of chemical contaminants.
- Migration of radioactive contaminants via airborne particulate transport appears to have ceased. Air has not been monitored for chemical contaminants, and such monitoring may not be necessary as long as the site remains undisturbed.

2.5 RESPONSE ACTIONS CONDUCTED TO DATE

Following DOE acceptance of site ownership in 1984, ORNL performed detailed radiological surveys of 219 individual properties (including private residences) surrounding the Colonie site. These properties were identified in the 1980 Teledyne survey to define the locations where uranium contamination exceeded criteria. During the ORNL surveys, 54 vicinity properties were identified as containing elevated levels of radioactive contamination and were designated for remedial action. During 1984 and 1985, under a NEPA memo-to-file, remedial action (removal of contaminated materials) was conducted at 35 of these vicinity properties. In 1988, under CERCLA removal authority,

**TABLE 10 Summary of Contaminants Present at the
Colonie Site**

Type of Operation	Potential Contaminants
Uranium and thorium processing	Magnesium fluoride Thorium-232 and associated radioactive decay products ^a Uranium-238 and associated radioactive decay products ^a
Electroplating	Boric acid Cadmium Ferric chloride Iridite (chromium) Nickel Nickel sulfamate Nitric acid Perchloroethylene Silicate phosphate Sodium cyanide
Foundry	Antimony Copper Degreaser Lead Phenols Tin Zinc
Aluminum casting	Aluminum
Others	Asbestos Benzene Carbon tetrachloride PCBs

^aSee additional discussion in Section 3.1.2.

remedial action was conducted at 18 of the remaining properties, including two additional vicinity properties that were identified as being contaminated during remediation of the designated properties (Figure 11 and Table 11). The remaining three properties adjacent to the site will be included in the remedial action to be conducted at the main Colonie site.

A variety of equipment was used for removing contaminated materials according to the size and accessibility of the designated area. Shovels, gasoline-powered lawn tractors, sod cutters, and bulldozers were the primary equipment for removing soil. Concrete, bituminous, or cobblestone driveways were scrubbed clean. The decontamination team first located areas to be decontaminated based on the radiological survey data and cleanup guidelines discussed previously. After initial field preparation work, the team proceeded with the cleanup. In areas with concrete pavement, soils on top of the pavement were washed to the edge with water. The adjacent areas contaminated by wash water were excavated. In other areas, grass was tested to determine the level of contamination. Uncontaminated grass was mowed and disposed of off-site in a municipal landfill so that it would not become combustible material in the storage area. Approximately 5 cm (2 in.) of topsoil was scraped off the top of the area and loaded into trucks. Deeper excavation was performed as needed to meet the cleanup guidelines. All contaminated materials were transported to the Colonie site.

The radioactively contaminated materials removed during cleanup of vicinity properties were placed inside the plant building at the main Colonie site for temporary storage. These materials included rocks and dirt, tar-paper roofing material, grass and roots, surface material removed during the scabbling of asphalt, crushed stone, and gutters. Contaminated materials were spread out, and organic materials (grass and roots) were segregated, bagged, tied, and stored inside a concrete bunker (see Figure 3); the remaining waste materials were stacked inside Bay 4, behind sandbags to form a controlled area (ANL 1984). The storage pile is about 3 m (10 ft) high and is covered with griffolyn sheeting stabilized with additional sandbags. Approximately $1,200 \text{ m}^3$ ($1,500 \text{ yd}^3$) of wastes resulted from the cleanup of these vicinity properties.

The cleanup guideline for uranium at the Colonie site and vicinity properties was derived from site-specific information concerning the distribution of uranium-238 in the soil. Based on discussions with New York State and EPA officials, DOE agreed to clean the properties to a uranium-238 concentration of 35 pCi/g when averaged over any $10\text{-m} \times 10\text{-m}$ ($33\text{-ft} \times 33\text{-ft}$) area; further, the concentration should not exceed 100 pCi/g over an area of 1 m^2 (11 ft^2) averaged over 5 cm (2 in.) in depth (Delaney 1984). For isolated areas of residual contamination, the uranium-238 concentrations should not exceed 100 pCi/g averaged over a depth of 5 cm (2 in.) in any 1-m^2 (11-ft^2) area. In addition, to provide a cleanup standard for contamination on surfaces to which access was limited (such as roofs), a supplemental guideline was developed for selected vicinity properties (based on an annual committed effective dose equivalent not exceeding 100 mrem to an individual). Fifty-three vicinity properties have been remediated and verified for release without radiological restrictions; the certification documentation is in review and is expected to be released in the near future.

The DOE has also performed response actions for chemicals being stored at the Colonie site. In 1984, DOE assumed responsibility for the RCRA interim status Part A

FIGURE 11 Colonie Site Vicinity Properties Remediated in 1984, 1985, and 1988

TABLE 11 Colonie Site Vicinity Properties at Which Remedial Action Has Been Completed

1100 Central Avenue	5 Yardboro Avenue
1101 Central Avenue	16 Yardboro Avenue
1104 Central Avenue	20 Yardboro Avenue
1110 Central Avenue	24 Yardboro Avenue
1114 Central Avenue	25/27 Yardboro Avenue
1118 Central Avenue	27/29 Yardboro Avenue
1129 Central Avenue	50 Yardboro Avenue
1130 Central Avenue	52 Yardboro Avenue
1143 Central Avenue	68 Yardboro Avenue
1144 Central Avenue	74 Yardboro Avenue
1144-A Central Avenue	78 Yardboro Avenue
1145 Central Avenue	80 Yardboro Avenue
1146 Central Avenue	80-110 Yardboro Avenue
1147 Central Avenue	4 Maplewood Avenue
1148 Central Avenue	7 Palmer Avenue
1150 Central Avenue	33 Palmer Avenue
1152 Central Avenue	10 Garden Lane
1159 Central Avenue	10/14 Kraft Avenue
1160 Central Avenue	10 N. Elmhurst Avenue
1161/1163 Central Avenue	1 Reynolds Street
1160/1162 Central Avenue	Niagara-Mohawk Railroad
1166 Central Avenue	Avenue substation
1167 Central Avenue	property
1168 Central Avenue	I-90 Right-of-Way
1170 Central Avenue	Railroad Avenue
1177 Central Avenue	
1178 Central Avenue	
1185 Central Avenue	
1195 Central Avenue	
1200 Central Avenue	

permit obtained by NL Industries in 1980 because of the electroplating wastes remaining on-site after the transfer of ownership. Within the building, DOE has undertaken several actions to stabilize the identified chemicals. In 1986, each type of electroplating waste was evaluated and treated to reduce the hazardous nature of the waste; the cyanides in the wastes were destroyed and acidic wastes were neutralized. The resultant solutions were then solidified and stored on-site in accordance with the Part A permit. During 1987, residues remaining in the electroplating tanks after removal of the electroplating solutions were also solidified, placed in containers, and stored in accordance with the permit. Additional evaluation of these wastes is being conducted to determine the

impact of RCRA land disposal restrictions. Most of these wastes are also radioactively contaminated and, therefore, likely to be considered as mixed waste.

A portion of the chemicals that were not radioactively contaminated were shipped off-site for disposal. Chemicals that were not immediately identifiable, such as laboratory chemicals without labels, were intensively sampled to determine their type (e.g., aqueous acid). Chemicals of the same type were consolidated into containers and evaluated for RCRA characteristics and the level of radioactivity present. Such containers are being stored on-site in accordance with the Part A permit.

3 INITIAL SITE EVALUATION

3.1 CONCEPTUAL SITE MODEL

A conceptual site model was developed to describe current understanding of the contaminant sources, migration pathways, and potential receptors and routes of exposure associated with the radioactive and chemical contaminants at the Colonie site. This model is based on available site characterization data and will be revised, as needed, to reflect the findings of ongoing characterization activities. The conceptual site model is depicted in Figure 12, and each of its components is described in Sections 3.1.1 through 3.1.3. (The radioactive contamination on the three vicinity properties is discussed in Section 2.4.2.)

3.1.1 Contaminant Sources

The primary source areas at the Colonie site are (1) contaminated subsurface (buried) materials, (2) contaminated surface soils, and (3) contaminated structures, equipment, and other materials -- including drums, packaged process wastes and chemicals, and contaminated soils stored within the plant building. These source areas were identified based on a review of historical records and the results of radiological surveys conducted at the site (see Chapter 2).

Two contaminated subsurface areas occur at the Colonie site, both situated northwest of the plant building (see Figure 8). The first area is the portion of Patroon Lake located within the site boundary that was used for waste burial. Although little information is available concerning on-site disposal, plant records indicate that spent sand molds used in the brass casting operations were placed in the Patroon Lake area. These sand molds were probably formed with phenolic resins and may have contained residual metals such as copper, lead, tin, and zinc. Wastes generated during the processing of radioactive materials were also placed in this area, about 42 m³ (55 yd³) of radioactively contaminated refractory, graphite, slag, and uranium oxide. Site surveys indicate that the radiological contamination currently extends over an irregularly shaped area about 30 m (100 ft) wide and 40 m (130 ft) long at the surface and extends to a depth of about 8.5 m (28 ft), with most of the radioactivity present in the first 3.7 m (12 ft). The average concentration of uranium-238 detected in this area was 190 pCi/g, with a maximum concentration of about 1,800 pCi/g; concentrations of actinium-228 ranged from 13 to 740 pCi/g (Jeter et al. 1981). The portion of Patroon Lake located outside the site fence was filled with trash and debris generated by sources unrelated to the Colonie site, but no information is available regarding the types of materials and potential contaminants. The entire Patroon Lake area has been filled in by these various disposal activities, and only a small depression remains.

The second contaminated subsurface area identified during previous radiological surveys is situated adjacent to the west wall of the plant building in a grass-covered area between paved driveways. The radioactive contamination extends over an irregularly shaped area of about 600 m² (6,500 ft²) to a depth of about 0.6 m (2 ft). The average

FIGURE 12 Conceptual Site Model

concentration of uranium-238 measured in this area was 230 pCi/g, with a maximum concentration of about 870 pCi/g (Jeter et al. 1981).

Surface soils are also considered to be a primary contaminant source at the Colonie site. Airborne emissions from past plant operations resulted in uranium deposition on soils within the site, as well as on adjacent commercial and residential properties. In addition, historical records indicate that radioactively contaminated materials may have been used for fill during modification of the site by NL Industries. Radiological surveys detected elevated levels of uranium in surface soils on all areas of the site that were surveyed. The average concentrations of uranium-238 and uranium-235 in the top 5 cm (2 in.) of soil at the main Colonie site were 410 and 6.2 pCi/g, respectively. The maximum concentrations were 1,200 pCi/g for uranium-238 and 20 pCi/g for uranium-235 (Jeter and Eagleson 1980).

The third primary contaminant source is the plant building. Radiological surveys of the Colonie site determined that radioactive contamination is present in areas where uranium processing occurred and includes the foundation, walls, and roof of the plant building. The results of building surveys are given in Table 6. Materials stored in the building include approximately 1,200 m³ (1,500 yd³) of radioactively contaminated soils and other materials removed during cleanup of the vicinity properties and materials resulting from past processing activities, such as drums of uranium oxide and other radioactive wastes. The plant building has not yet been surveyed for chemical contamination. Chemical wastes and other packaged chemicals currently stored in the plant building include acids, bases, degreasing agents, cyanide, and asbestos; these materials have been packaged or placed in drums and stabilized for safe storage by solidification or other means.

Two potential secondary contaminant sources are identified in Figure 12. These are the sanitary sewers that received discharges of radioactive wastes during former plant operations and the storm sewers receiving contaminated surface runoff. Sediments in these sewer systems may be contaminated and will be surveyed, as needed, as part of ongoing site characterization activities.

3.1.2 Potential Contaminants of Concern

Radioactive Contaminants. Based on information concerning the processes carried out at the Colonie site, radionuclides are expected to be the principal contaminants present. The radioactivity at the Colonie site is due to naturally occurring radionuclides, mainly those resulting from the radioactive decay series of uranium-238 and thorium-232 (see Figures 13 and 14). Although uranium-235 is also present at the site, its concentration -- and therefore the hazards associated with it -- are much lower than those of uranium-238. Hence, the radiological risks associated with uranium-235 will not be explicitly evaluated in the RI/FS process.

In nature, the radionuclides in a decay series are in a state of secular equilibrium in which the activities of all radionuclides are equal. However, the processing of uranium and thorium ores alters this natural state, and deviation from secular

NOTES:

Only the dominant decay mode is shown.

The times shown are half-lives.

The symbols α and β indicate alpha and beta decay.

An asterisk indicates that the isotope is also a gamma emitter.

FIGURE 13 Uranium-238 Radioactive Decay Series

NOTES:

Only the dominant decay mode is shown.

The times shown are half-lives.

The symbols α and β indicate alpha and beta decay.

An asterisk indicates that the isotope is also a gamma emitter.

FIGURE 14 Thorium-232 Radioactive Decay Series

equilibrium is unavoidable. The rate at which secular equilibrium is reestablished depends on the half-lives of the decay products. Because operations at the Colonie site used primarily depleted uranium metal, the major radioactive contaminants associated with the uranium-238 decay series present at the Colonie site are uranium-238, thorium-234, protactinium-234, and uranium-234. Radioactive decay products from thorium-230 up to polonium-218 are not expected to be present at elevated levels due to the long half-lives of uranium-234 (240,000 years) and thorium-230 (77,000 years) and the relatively short time since the uranium metal was used at the site.

Natural uranium consists of three radionuclides: uranium-238, uranium-234, and uranium-235. The relative abundance of these radionuclides in nature is 1:1:0.046. Of the three, only uranium-235 is fissile. To use uranium-235 as a fuel in light-water nuclear reactors, the relative proportion of uranium-235 to uranium-238 must be increased over that found in nature. This is currently done in the United States by gaseous diffusion. The enrichment process produces two uranium products -- i.e., enriched uranium, which has a higher uranium-235 to uranium-238 ratio than that found in nature, and depleted uranium, which has a lower uranium-235 to uranium-238 ratio. The enriched uranium can be used as a nuclear fuel whereas depleted uranium can be used for a variety of non-nuclear purposes.

Because the gaseous diffusion process also alters the relative abundance of uranium-234, it is not possible to infer the relative abundance of these three uranium radionuclides simply based on a history of site activities. For the Colonie site, a ratio of uranium-238:uranium-234:uranium-235 for depleted uranium has been reported as 1:0.30:0.013 (BNI 1988b). (Note that uranium-235 accounts for only 1% of the total amount of uranium radionuclides.) This ratio will be used to evaluate the radiological risks associated with uranium compounds at the Colonie site. Although a limited amount of enriched uranium was processed at the site, the amount processed was small relative to the amount of depleted uranium utilized. Hence, use of the ratio for depleted uranium is valid for the uranium contamination at the Colonie site. The uranium concentrations for the Colonie site are generally reported as uranium-238 because this is the predominant uranium radionuclide.

A limited amount of thorium-232 was also processed at the Colonie site. Elevated levels of actinium-228 were measured during site surveys, indicative of radioactive contamination from the thorium-232 decay series. Given the relatively short half-lives of the decay product radionuclides in this decay series (see Figure 14) and the length of time since plant activities were terminated, it is likely that a significant amount of radionuclide ingrowth has occurred in this decay series. To assess the radiological risks associated with the thorium-232 decay series radionuclides at the Colonie site, it was assumed that secular equilibrium has been reestablished and that all radionuclides in this series are present and are at equal activity concentrations. Although one member of the thorium-232 decay series is a gas, radon-220, current levels of radon-220 are not expected to be elevated because the quantity of thorium-232 processed at the site was small and because the wastes are currently buried.

Chemical Contaminants. The preliminary site characterization studies did not include analyses for chemical contaminants at the Colonie site. Potential chemical contaminants were identified based on knowledge of the types of processes and materials used during the various activities carried out at the site. Chemicals associated with the various site operations are discussed in Section 2.4.1, and compounds potentially present at the site are listed in Table 10. These include metals (aluminum, antimony, cadmium, copper, lead, magnesium, nickel, tin, and zinc), cyanide, and inorganic anions (nitrates and fluorides). Records also indicate that spent sand molds were disposed of in the former Patroon Lake area along with graphite, refractory, and slag. Organic compounds (e.g., solvents and degreasing agents) were used in limited quantities during past operations and may be present in the buried wastes; however, there is no record of on-site disposal of organic compounds. Analyses for chemical constituents are being performed as a part of site characterization activities to identify chemical contaminants present at the Colonie site.

3.1.3 Contaminant Release and Transport

Contaminants may be released from primary contaminant sources into one of four environmental media: air, surface water and sediments, groundwater, and soil. The release and migration of radionuclides and chemicals in the environment is related to physical and chemical characteristics of the contaminants, local climate, chemistry of the local environment, and characteristics of groundwater and surface water movement. The release mechanisms and transport media associated with each contaminant source identified in Section 3.1.1 are discussed below.

The primary release mechanism associated with the subsurface materials is expected to be infiltration of water and the subsequent leaching of contaminants to groundwater. The subsurface materials are situated within the shallow groundwater zone, and portions of these wastes are probably below the water table. The potential for and extent of horizontal and vertical migration of contaminants present in the wastes have not yet been fully characterized. Since 1984, groundwater has been routinely monitored for radioactive contaminants as part of the environmental monitoring program. The average concentrations of total uranium have been comparable to those naturally occurring in groundwater (see Section 2.4.2). Groundwater has not been analyzed for chemical (i.e., nonradioactive) contaminants. The main chemical contaminants suspected of being present in the subsurface wastes are metals. The migration of metals into the groundwater depends on a number of factors, including speciation of the metal, pH of the waste materials, and local hydrogeology. Volatile organics, if present, would be expected to migrate more rapidly than metals. The potential for the migration of contaminants into groundwater will be assessed in the remedial investigation.

The primary release mechanisms associated with contaminated surface soils at the Colonie site (including the three vicinity properties) are expected to be (1) infiltration of water with subsequent leaching of contaminants to groundwater and (2) soil erosion and surface runoff into the creek exiting the site and flowing either directly into Patroon Creek or indirectly into surface water through storm drains. Elevated levels of uranium have been detected in sampling locations situated both upstream (but in an area

of known contamination) and downstream of the main Colonie site. Levels detected in the downstream locations were somewhat elevated above background concentrations. Fugitive dust emissions from contaminated surface soils are not considered to be an important release mechanism under current site conditions. No remedial action activities are currently taking place, and particulate emissions from surface soils should be very low because (1) the unpaved surface areas at the site are limited in extent and (2) these areas are generally vegetated with grass and small shrubs. The available monitoring data confirm that this pathway is not significant at this time.

During plant operations, atmospheric transport and deposition was an important release mechanism and was the major source of the current contamination of surface soils on-site and at the vicinity properties. Following cessation of plant operations, the air was monitored along the site perimeter at southeast and northwest locations (the prevailing wind directions), and only background levels of radionuclides were detected (BNI 1989b). (Contamination of nearby properties may also have resulted from the migration of uranium from the Colonie site along surface routes and from surface water runoff.)

No contaminant release is currently associated with materials stored in the plant building. The radioactive and chemical materials stored in the building during preliminary site cleanup activities (drums and packaged materials) and the soils resulting from removal actions at the vicinity properties are controlled to ensure that contaminants will not be released to the environment.

3.1.4 Potential Receptors and Routes of Exposure

The Colonie site is situated in a populated urban area of mixed residential, commercial, and light industrial land use. Area residents and persons employed in the commercial areas surrounding the site are potential receptors of any radioactive and chemical contaminants migrating from the Colonie site. The four environmental media constituting potential pathways for contaminant transport to a receptor are air, surface water and sediments, groundwater, and surface soils. In addition, persons entering the site may come into direct contact with the contaminant sources. Potential receptors of the radioactive and chemical contaminants present at or migrating from the Colonie site include:

- Area residents and employees at nearby commercial properties who drink water from local groundwater supplies,
- Persons who enter the uncontrolled Conrail vicinity property,
- Persons who swim in or drink water from nearby surface waters,
- Trespassers who gain entry to the site in spite of existing access restrictions,

- Persons who might use the site for residential or commercial uses in the future if the site were not remediated and DOE lost control of the site, and
- Nearby terrestrial and aquatic organisms.

The transport of contaminants via groundwater constitutes a potentially important pathway for release of contaminants at the Colonie site. If area residents and employees at nearby commercial properties obtained drinking water from local groundwater supplies, they could be exposed to site contaminants through the ingestion of contaminated water. However, the potential for exposure through this pathway is expected to be minimal because the drinking water supply for the Colonie area is currently pumped from a surface reservoir 32 km (20 mi) south of the Colonie site rather than from the local groundwater aquifer (ANL 1988). A well canvass has been conducted to confirm that no property in the surrounding area is supplied with water from a local well. The nature and extent of groundwater contamination and the potential for contaminant migration to groundwater will also be addressed during the remedial investigation.

Three vicinity properties have not yet been remediated, but access is restricted at two of these properties (the town of Colonie property and the Niagara-Mohawk substation), so direct contact with contaminated soils represents a potential exposure pathway only at the third property (Conrail). The uncontrolled Conrail property consists of two main-line railroad tracks still in use and one siding track no longer in use. Although the levels of radioactive contamination at this property exceed site-specific guidelines established for the Colonie vicinity properties (Delaney 1984), the current use of this property as a rail right-of-way precludes significant exposure of individuals.

Levels of radioactivity detected in the creek exiting the Colonie site are very low and are further diluted as this creek flows into Patroon Creek. Although direct contact with the water in these creeks is possible, the creeks are not used for drinking water and are generally not used for activities such as swimming or wading. These creeks have not been analyzed for potential chemical contaminants.

Trespassers entering the Colonie site would potentially be exposed to surface contamination and the contaminated materials stored in the plant building. Because access to the site is currently restricted by a chain-link fence, it is unlikely that any individual would enter the site frequently enough to incur a significant exposure. Potential doses to a trespasser will be assessed in the baseline risk assessment.

The presence of radioactive contaminants at the Colonie site and the potential for release of such contaminants to surface waters could impact local ecosystems. Transient or permanent populations of aquatic and terrestrial species that inhabit the site and nearby areas are currently being exposed to low levels of radioactivity from contaminated surface soils and surface waters through inhalation, direct contact, and ingestion. The potential impacts to local biota resulting from exposure to contamination present at the site will be assessed as part of the baseline risk assessment.

In summary, this preliminary and, by necessity, qualitative assessment of potential threats to human health and the environment suggests that, in the short term, no significant impacts would result under current land-use conditions. Although there is potential for contaminant release from the site, little or no potential currently exists for human receptor contact with contaminated areas. The extent of contamination at the Colonie site has not yet been fully characterized nor has the potential for contaminant migration in the future been determined. A quantitative assessment of the potential exposure pathways associated with the Colonie site will be carried out in the baseline risk assessment.

3.2 TOXICOLOGICAL AND ENVIRONMENTAL PROPERTIES OF SELECTED CONTAMINANTS

As background information for this work plan, a general description of the toxicological effects associated with radiation exposure and brief descriptions of the major toxicological effects of selected chemical contaminants associated with the Colonie site are presented in Sections 3.2.1 and 3.2.2. Potential transport pathways and the environmental fate of these contaminants are also discussed. For most of the contaminants identified at the site, there appears to be little potential for significant human exposure under current site conditions. An assessment of potential risks to human health and the environment from current site conditions will be carried out in the baseline risk assessment.

3.2.1 Radiation Toxicity

The potential health effects associated with exposure to low levels of radiation may include a small increase in the occurrence of cancer, depending on the organ irradiated, and possible genetic effects that may occur in future generations. The potential health impacts associated with radiation exposure can be divided into two categories: stochastic effects and nonstochastic effects. Stochastic effects are those for which only the probability of occurrence, not the severity, is related to the radiation dose received. The two principal stochastic effects are cancer induction and genetic defects in offspring. Nonstochastic effects are those for which both the probability of occurrence and the severity of the effect are a function of dose. Examples of nonstochastic effects include cataracts, nonmalignant damage to the skin, and gonadal cell damage leading to impairment of fertility. The major potential impact associated with radiation exposure resulting from radioactive contaminants at the Colonie site is the induction of cancer.

3.2.2 Chemical Toxicity

Metals. Uranium is the most widespread of the metal contaminants at the Colonie site. The two main hazards associated with exposure to uranium compounds are (1) kidney damage caused by the chemical toxicity of soluble uranium compounds and

(2) injury caused by the ionizing radiation resulting from radioactive decay of ingested or inhaled uranium isotopes. The main effect depends on a number of factors, including solubility of the compound, route of exposure, and relative composition of the isotopes. In addition to adverse effects on the kidney, the chemical toxicity of uranium can also affect the cardiovascular, endocrine, hematopoietic, and immunological systems. The extent of contamination by other metals at the Colonie site has not yet been characterized. Of the other metals identified as possible contaminants (see Table 10), certain compounds of cadmium, lead, and nickel are carcinogenic and may induce teratogenic and other reproductive effects.

Metal compounds can undergo a wide range of transformation processes, forming complexes with inorganic species or organic ligands that are present in the environment. These processes, collectively referred to as speciation, can occur in all environmental media. The speciation of a metal in a given environment affects its bioavailability, solubility, volatility, and sorptive properties. In addition to speciation, the fate of metals is affected by the properties of the environmental media. For example, properties affecting the mobility of a metal compound in soil include the cation-exchange capacity and pH of the soil, and the solubility of metals in water depends on the presence of other chemical species and on the pH.

Inorganic Ions. Inorganic anions that might be present at the Colonie site include nitrate and fluoride. The health hazards that are associated with nitrate result primarily from the bacterial conversion of ingested nitrate to nitrite. Nitrites can induce methemoglobinemia, a reduction in the oxygen-carrying capacity of the blood, especially in infants. Nitrites are also capable of reacting with other compounds, such as amines, to form N-nitroso compounds. Although most N-nitroso compounds are carcinogenic in experimental animals, the contribution of nitrate to a potential carcinogenic hazard for humans and the magnitude of the associated risk are unclear. Low levels of fluoride in drinking water are generally considered to have a beneficial effect on the rate and occurrence of dental carries. Ingestion of higher levels of fluorides can induce dental and skeletal fluoroses whereas inhalation of fluorides can irritate the respiratory system.

Inorganic anions such as nitrate and fluoride are highly water soluble and therefore very mobile in the environment. This mobility can result in significant leaching from soil and diffusion in soil and water. The extent of migration to groundwater depends primarily on the type of soil affected.

Organic Contaminants. Organic compounds were generally used in limited quantities during the foundry, electroplating, and uranium-processing operations at the Colonie site. Although organic chemicals were identified in the drums stored in the plant building, specific organic contaminants have not been identified, and are not expected to be, in the surface soils or subsurface wastes (with the possible exception of phenolic resins associated with the sand molds). For this reason, the toxic effects of potential organic contaminants are not discussed. However, if present in the buried wastes, volatile organic compounds would generally be relatively mobile and would be expected

to migrate to groundwater more rapidly than the radionuclides for which analyses were performed in the groundwater monitoring program. Phenolic resins, used as binders in the sand molds, are the only known organic compound present in the buried wastes. Once cured, these resins are highly resistant to biodegradation. In contrast, phenols are rapidly degraded in soils and water. The buried wastes and groundwater will be analyzed for the presence of organic contaminants during the site remedial investigation.

3.3 PRELIMINARY RESPONSE OBJECTIVES AND TECHNOLOGIES

The overall objective of remedial action at the Colonie site is to clean up, stabilize, or otherwise control contaminated materials to ensure protection of human health and the environment. Additional broad objectives, established on the basis of specific criteria identified in SARA, are presented in Section 3.3.1. Potential response actions and technologies are discussed in general in Section 3.3.2, and preliminary response action objectives that are specific to contaminated environmental media at the Colonie site are addressed in Section 3.3.3 and Appendix B. In Section 3.4, general response technologies are assembled into preliminary remedial action alternatives to fulfill the response objectives identified for the site. These objectives, technologies, and alternatives will continue to be developed during the RI/FS process.

3.3.1 Selection Criteria for Remedial Actions

Section 121 of SARA identifies a strong statutory preference for remedial actions that are reliable and provide long-term protection. The primary requirements for a final remedy are that it be both protective of human health and the environment and cost-effective. Additional selection criteria include the following:

- Preferred remedies are those in which the principal element is treatment to permanently or significantly reduce the toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants;
- Where practical treatment technologies are available, off-site transport and disposal without treatment is the least preferred alternative; and
- Permanent solutions and alternative treatment technologies or resource recovery technologies should be assessed and used to the maximum extent practicable.

These criteria for final remedies constitute the general objectives for remedial actions at the Colonie site. Long-term protection and permanence are the primary objectives in determining how the Colonie materials should be managed. Cost-effectiveness and practical treatment technologies that are applicable to these chemically and radioactively contaminated materials will also be considered during the development of remedial action alternatives.

3.3.2 General Response Actions and Technologies

The purpose of the remedy selection process is to select remedies that are protective of human health and the environment, that maintain protection over time, and that minimize the amount of untreated wastes and the need for long-term management. A broad overview of response actions and technologies that could be implemented to achieve the objectives of remedial action at the Colonie site, based on the current understanding of site contamination, is presented in this section. The discussion is divided into two general categories as prescribed in the newly revised National Oil and Hazardous Substances Pollution Contingency Plan (NCP): source control response actions and groundwater response actions.

Source Control. The objective of source control response actions, engineering controls and institutional controls, is to directly impact the source of contaminated material at a waste site to minimize the potential for population exposure. Engineering controls that may be applicable to managing the Colonie site include containment, removal, treatment, temporary storage, and disposal. Such actions can alter the nature of a waste source (i.e., the radioactively or chemically hazardous constituents) to reduce its toxicity, mobility, and/or volume. Institutional controls, i.e., access restrictions (physical barriers and ownership or deed restrictions) and monitoring are currently in place at the main Colonie site. These methods generally serve as a reliable means of protecting human health and the environment only when used as support for other active response actions.

Removal of contaminated materials can be achieved by excavation, decontamination and/or demolition, and collection/containment technologies. Contaminated soils and sludges can be excavated with standard construction equipment. Structural surfaces can be decontaminated by a number of conventional methods (e.g., aggressive vacuuming, high-pressure water washing, and abrasive grit blasting), and buildings can be demolished using standard construction equipment. Finally, contaminated groundwater can be collected using various conventional methods (e.g., extraction wells and gravity drain and pumping systems).

Treatment encompasses a wide range of chemical, physical, and biological technologies that address various types of contamination in different media. Contaminated materials associated with the Colonie site that contain chemicals and radionuclides include soils and sludges, mixed solids and process wastes, and groundwater. Only a limited number of technologies are effective when radionuclides are present because radioactivity cannot be destroyed by treatment. Technologies that can reduce the toxicity, mobility, and/or volume of radioactive wastes can be divided into two general categories: (1) those that remove radioactive constituents from the waste matrix and (2) those that change the form of the waste and/or matrix. The first category generally consists of chemical processes (although there are exceptions, such as physical separation techniques), and the second category generally consists of physical processes. Biological processes are typically used to treat chemical organic wastes rather than radioactive wastes.

Chemical treatment technologies alter the nature of hazardous chemical constituents in contaminated liquids, sludges, or solids and can reduce waste toxicity, mobility, and/or volume. When radioactive components are present, a chemical extraction or leaching process can be used to remove them from the waste matrix and reduce the volume and/or mobility of the waste; the liquid leachate can then be reprocessed to isolate the radioactive components. Chemical treatment of groundwater (e.g., by precipitation and adsorption) typically follows its collection and removal, although treatment can also be conducted in situ. Soils, sludges, and solid wastes can be chemically treated either in situ (e.g., with a lixiviant wash) or following removal/excavation (e.g., in an engineered system).

Physical treatment technologies can reduce the toxicity, mobility, and/or volume of waste material, although in certain cases (e.g., sludge stabilization), the total contaminated volume may increase. Physical treatment can be used to remove contaminants from groundwater (e.g., by sedimentation, filtration, and distillation) and is typically conducted following groundwater collection and removal. Physical treatment technologies can also alter the structure of contaminated solids to facilitate stabilization and handling, and they can be implemented in situ or following excavation. Contaminated sludges can be physically treated by dewatering technologies in situ (e.g., by gravity drainage trenches and pumping) or following excavation (e.g., by vacuum filtration or drying beds). Physical treatment technologies that could be considered for contaminated soils and sludges include solids separation, nonthermal and thermal extraction, and thermal destruction.

Biological treatment technologies can alter the nature of a waste and remove contaminants (typically organics) from a waste matrix; they can be implemented in situ or following the removal of contaminated materials. Biological processes are routinely employed in conventional wastewater treatment systems and can reduce waste toxicity, mobility, and/or volume. Such processes include trickling filters and surface impoundments (e.g., aerated lagoons). Organic debris and soils and sludges that contain nitrogen compounds and/or organic contaminants can also be treated by biological processes.

Temporary storage reduces waste mobility by isolating contaminated materials in a manner that protects human health and the environment during the short term until the ultimate disposition of the materials can be determined. (For example, this response technology can be used to manage materials that may result from general waste consolidation.) Temporary storage can involve the placement of contaminated materials in an existing engineered structure or in a structure newly constructed for containment purposes.

Containment can reduce waste mobility and the associated potential for contaminant migration and population exposure, and it can be achieved by media-specific in-situ techniques. For example, soils and sludges can be isolated with lateral and/or underlying grout or slurry seals or with a surface cap. Capping can reduce potential exposures by reducing the emanation of gaseous contaminants and the wind dispersal of contaminated particulates; such containment would also reduce potential exposure to external gamma radiation. Monitoring and maintenance of the containment system would be required to ensure its integrity, and access would typically be restricted to protect against human disturbances such as vandalism. Groundwater can be contained by

barriers to horizontal flow (e.g., slurry walls) and barriers to vertical flow (e.g., injected grout layers). The hydraulic gradient may also be controlled (e.g., by pumping systems) to limit groundwater migration. The groundwater system would require monitoring and maintenance to ensure system integrity.

Disposal typically reduces waste mobility through the permanent placement of contaminated materials in a manner that protects human health and the environment for the long term. Disposal options for soil/sludge include (1) on-site disposal in a land-based facility, (2) off-site disposal in a land-based facility, and (3) disposal in the ocean. The latter option is not currently viable due to such factors as regulatory restrictions, transportation impacts, costs, and public concern. For contaminated liquids, disposal is typically preceded by treatment; discharge options include land application and release to a surface water, either on-site or off-site.

Institutional controls can include the use of access restrictions, such as physical barriers and ownership or deed and water use restrictions, and/or monitoring. When used alone, physical barriers might reduce the potential for contaminant migration by human activities and limit contact with areas to which contaminants may already have migrated. However, ownership or deed restrictions alone are not generally effective in preventing contact with contaminants that have already migrated outside a controlled area, nor do they limit the effect of natural forces (e.g., wind and precipitation) on contaminant migration. Similarly, monitoring is ineffective when used alone as a control method and merely serves to identify the need for active controls or remediation, as appropriate. Thus, institutional controls generally serve as a reliable means of protecting human health and the environment only when used as support for other response actions. When institutional controls are used in conjunction with engineering control technologies, waste volume and toxicity can be reduced to protect human health and the environment and to ensure continued effectiveness of the response action.

Groundwater. Where appropriate for groundwater response actions, a limited number of remedial alternatives that attain site-specific remediation levels within different restoration time periods can be developed, using one or more different technologies.

3.3.3 Media-Specific Response Objectives and Technologies

Preliminary response objectives for remedial actions at the Colonie site have been identified for the following environmental media: soil/sludge, surface water, groundwater, and structural debris. Potential response actions and technologies associated with source control for these objectives (see Section 3.3.2) are summarized in Appendix B. Additional response objectives and technologies that may be appropriate for the proposed action will be identified and evaluated (screened) during the RI/FS process.

3.4. CONCEPTUAL REMEDIAL ACTION ALTERNATIVES

The EPA recently published revisions to the NCP (40 CFR Part 300; March 8, 1990). Preliminary alternatives for remedial actions at the Colonie site were developed according to the categories specified for final remedial actions in the revised NCP, as follows:

- No action;
- Alternatives for treatment, including one or more innovative technologies, as appropriate;
- Alternatives that protect human health and welfare and the environment with little or no treatment; and
- Alternatives that subject the principal threats posed by the site to varying degrees of treatment.

In order to address those requirements, the range of final remedial action alternatives that are recommended by the EPA in the final rule for the NCP and those in draft RI/FS guidance are considered in the current evaluation; these are:

- Containment -- involving little or no treatment, but protective of human health and the environment by reducing waste mobility and related exposure risks; and
- Treatment -- ranging from (a) treatment as the principal element of the alternative to reduce the primary threat(s) posed by the site (i.e., may not involve the highest degree of treatment or the treatment of all wastes) to (b) varying degrees of treatment that will minimize the amount of untreated wastes that must be managed.

A limited number of conceptual remedial action alternatives have been identified for the Colonie site on the basis of these categories and the preliminary response objectives and technologies presented in Appendix B. (Only a general discussion of ARARs is possible at this stage of the RI/FS process; see Section 3.8.) These conceptual alternatives address the radioactively and chemically contaminated materials -- including structures, soils, sludges, process wastes, and water -- at the Colonie site. The alternatives are:

- Alternative 1: No action,
- Alternative 2: On-site disposal,
- Alternative 3: Off-site disposal,
- Alternative 4: On-site treatment with on-site disposal,

- Alternative 5: On-site treatment with off-site disposal, and
- Alternative 6: Off-site treatment with off-site disposal.

These alternatives are briefly described in Sections 3.4.1 through 3.4.6 and represent basic combinations of potential response actions. Options may be identified within certain of the action alternatives -- i.e., Alternatives 2 through 6 -- to incorporate appropriate elements of other alternatives as the RI/FS process develops. For example, Alternative 4 might be varied to incorporate an element of Alternative 6 (off-site treatment and/or disposal) on a limited basis if a licensed facility were available for certain materials (e.g., those contaminated only with asbestos).

3.4.1 No Action

The no-action alternative is included pursuant to the requirements of NEPA and CERCLA to provide a baseline for comparison to other alternatives and to assess the impacts on human health and the environment from current and projected conditions at the Colonie site. If this option were selected, no reduction would occur in the toxicity, mobility, or volume of contaminated materials at the site. Potential exposure to radioactive and chemical contaminants would probably continue for the short term at current levels; over time, long-term exposure would likely increase -- in terms of both levels of exposure and size of potentially affected population. Based on currently available information, DOE does not intend to select this alternative for management of the Colonie site.

3.4.2 On-site Disposal

On-site disposal would reduce waste mobility and would require monitoring and maintenance, permanent access restrictions, and other institutional controls (e.g., management of a buffer zone between the facility and surrounding areas). On-site disposal could involve containment in-situ (e.g., with caps and slurry walls) and/or construction of an engineered facility to isolate materials following their removal (e.g., via building demolition, drum consolidation, or soil excavation). Most importantly, this alternative would involve a determination of site suitability -- including consideration of its location in an urbanized area -- prior to any waste removal or design and construction activities.

3.4.3 Off-site Disposal

Off-site disposal would reduce waste mobility and would require the siting and construction of a new facility if no existing facility were available to receive the radioactively and chemically contaminated wastes from the Colonie site. A canvass would be conducted of existing and proposed facilities that could satisfy criteria for the effective disposal of these wastes. This alternative would involve the removal of wastes and considerable transportation requirements, as well as general operational and

management requirements for the disposal facility (similar to those identified for the on-site disposal option in Section 3.4.2). The total waste volume, without treatment, is estimated to be about 21,000 m³ (27,000 yd³).

3.4.4 On-site Treatment with On-site Disposal

On-site treatment with on-site disposal would reduce the mobility and could reduce the toxicity and/or volume of contaminated materials. This alternative would involve issues similar to those identified for the on-site disposal alternative (see Section 3.4.2), in addition to issues related to the design, construction, and operation of various treatment systems to accommodate the site's contaminated materials. On-site treatment and disposal could be conducted in situ (e.g., using vitrification or cementation and capping/grouting technologies). Conversely, treatment could be conducted in an engineered facility following removal of the contaminated materials. Either method would require the implementation of institutional controls during treatment operations. With extensive treatment, it is estimated that the total waste volume could be reduced to less than half of the untreated volume, possibly to 8,000 m³ (10,000 yd³).

3.4.5 On-site Treatment with Off-site Disposal

On-site treatment with off-site disposal would reduce the mobility and could reduce the toxicity and/or volume of contaminated materials. This alternative would involve issues related to on-site treatment following excavation (similar to those identified in Section 3.4.4) and issues related to off-site disposal (similar to those identified in Section 3.4.3).

3.4.6 Off-site Treatment with Off-site Disposal

Off-site treatment with off-site disposal would reduce the mobility and could reduce the toxicity and/or volume of the contaminated materials. This alternative would involve general issues related to treatment (similar to those identified in Section 3.4.4) and issues related to off-site disposal (similar to those identified in Section 3.4.3). Siting, design, construction, and operation of treatment systems off-site would be required if existing facilities were unavailable to treat all of the site's contaminated materials (e.g., radioactive and mixed wastes).

3.5 OPERABLE UNITS AND REMOVAL ACTIONS

The Colonie site will be remediated in one comprehensive action under CERCLA. This includes planned activities at the main Colonie site and the three vicinity properties. There are no plans to conduct any response actions at this site as separate operable units or to conduct any removal actions prior to the record of decision (ROD), except for decontamination of the main on-site building and the on-site waste consolidation activities. However, corrective actions may be implemented under RCRA prior to the ROD, e.g., transport off-site of nonradioactively contaminated chemical process

wastes. The removal actions that have already been conducted at the site (notably the vicinity properties) are discussed in Section 2.5.

3.6 DATA GAPS

Although much is currently known about the general characteristics of the Colonie site, as well as the nature and extent of radioactive contamination at the site and in surrounding areas, important data gaps have been identified with respect to the physical characteristics of the site, source characterization, and the nature and extent of chemical contamination. The draft field sampling plan summarized in Section 4.3.1 has been prepared to obtain the data necessary to fill these gaps so that, when the RI phase is completed, sufficient data will exist to allow for preparation of the baseline risk assessment and for detailed assessment of remedial action alternatives in the FS. The current data gaps identified for completion of the RI are summarized in Sections 3.6.1 through 3.6.4.

3.6.1 Site Physical Characteristics

Information on the geology and hydrogeology of the region was presented in Sections 2.3.2 and 2.3.3. Additional studies are required to better define the on-site stratigraphy and to characterize the hydrogeology below the lower sands unit. The Elsemere Gravel Blanket aquifer may be present below the site; depths to this aquifer and the Normanskill shale aquifer below the site have not been determined. These aquifers form potentially important groundwater reservoirs and their characterization is important to determine whether a gradient for contaminant migration exists beneath the site.

3.6.2 Source Characteristics

The contaminant sources at the site were identified based primarily on the results of radiological surveys. Additional characterization efforts are required to determine whether chemical contaminants are also present in these, or other, areas of the site and to better define the horizontal and vertical extent of the contaminated subsurface materials. Chemical contaminants that may be present in these materials include cyanide, degreasing agents, and metals (see Table 10). Following a determination of the contaminants of concern in surface soils and subsurface materials, geochemical studies may be required to determine the potential for leaching of contaminants to surface water and groundwater.

The waste materials currently stored in the plant building will be fully characterized to allow for selection of an appropriate response action or treatment technology. Finally, site records will be reviewed and/or a survey performed to determine if underground storage tanks are present at the site.

3.6.3 Nature and Extent of Contamination

Surveys have been conducted to define the nature and extent of radioactive contamination in surface soils, surface water and sediments, and buildings at the Colonie site. Similar surveys will be carried out to determine the nature and extent of chemical contamination at the site, as well as to fully characterize the extent of radioactive contamination. The environmental media to be surveyed include soils and buildings at the site, soils beneath the buildings, and surface water and sediments (e.g., the former Patroon Lake area and drainageways). These studies will include the three remaining vicinity properties, which are planned to be remediated concurrently with the main Colonie site. Sampling will also be conducted to better establish the background levels of radionuclides and naturally occurring chemical contaminants (e.g., metals) in environmental media in the vicinity of the Colonie site.

Groundwater samples have been collected quarterly from monitoring wells at the site and analyzed for radioactive contaminants; appropriate chemical analyses will be added to this monitoring program. The current groundwater monitoring system lacks wells downgradient of the plant building, and additional monitoring wells will be installed. Finally, a well canvass has been conducted for properties within a 1.6-km (1-mi) radius of the site to determine if local groundwater is used as a source of water for domestic or other uses.

3.6.4 Treatability Studies

Additional data may be needed regarding the amenability of the various wastes materials present at the Colonie site to specific treatment technologies. Based on the results of the characterization studies, treatment technologies applicable to the chemically and radioactively contaminated materials present at the site will be identified and waste treatability studies initiated, as appropriate, to evaluate the feasibility and effectiveness of the technologies.

3.7 FEASIBILITY TESTING

Several potential remedial action technologies may require bench-scale or pilot-scale treatability studies. The remedial technologies that may warrant such testing for use at the Colonie site include:

- **Building decontamination:** on-site testing of various decontamination methods may be necessary to determine their effectiveness for specific application to the Colonie site. This information is needed to determine both feasibility and cost.
- **Solids separation:** historically, separation of soil and radioactive contaminants has been ineffective and also highly dependent on physical characteristics of the soil and the radionuclides of concern. Bench-scale testing may be needed to determine the

usefulness of this treatment approach for the Colonie soils and sediments.

- Chemical treatment: based on the results of the RI, it may be necessary to conduct treatability studies for removing specific chemical contaminants from the soil.
- In-situ tests: technologies to immobilize the wastes may need to be tested to determine applicability to the Colonie site. These may include surface spraying for contaminated buildings and equipment, cutoff walls and grouting/stabilization for groundwater protection, and vitrification for contaminated soils and sediments.

3.8 PRELIMINARY IDENTIFICATION OF REGULATORY REQUIREMENTS

Potential requirements for a proposed remedial action can be grouped into two general categories, (1) applicable or relevant and appropriate requirements (ARARs), and (2) to-be-considered requirements (TBCs). The first category consists of promulgated standards -- e.g., public laws codified at the state or federal level -- that may be applicable to a proposed action or relevant and appropriate to all or part of that action. The second category consists of standards or guidelines that have been published but not promulgated and that may have significance for all or part of the action (e.g., DOE Orders). Remedial actions at the Colonie site will be conducted in accordance with both ARARs and TBCs, as appropriate.

A potential ARAR is applicable if its jurisdictional prerequisites are specifically met by the conditions of the site (e.g., location in a floodplain) and/or proposed action; if the conditions of a requirement are not specifically applicable, then a determination must be made as to whether they are sufficiently similar to be considered both relevant and appropriate (e.g., in terms of contaminant similarities and the nature and setting of the proposed action). Potential TBCs are typically considered only if no promulgated requirements exist that are either applicable or relevant and appropriate. Thus, TBC requirements may be considered secondary to ARARs; in fact, they are often based on promulgated standards and can require the same degree of compliance as ARARs (e.g., DOE Orders).

In addressing each requirement that may affect a proposed action, a determination is made regarding its relationship to (1) the location of that action, (2) the contaminants involved, and (3) the specific activities that would be conducted. Location-specific requirements are based on the specific setting and nature of a site, e.g., its location in a floodplain and proximity to wetlands or the presence of archeological and cultural resources. Contaminant-specific requirements address certain chemical species or a class of contaminants, e.g., uranium or PCBs, respectively, and relate to the level of contamination allowed for a specific pollutant in soil, water, and/or air. Action-specific requirements relate to specific activities that are proposed to be implemented at a site, e.g., incineration of organically contaminated soil. Thus, the determination of potential

ARARs and TBCs for a site is based on factors specific to that site and the individual action(s) proposed for implementation.

Identification of potential location- and contaminant-specific requirements is initiated during the planning stage of the RI/FS process. This identification is refined during site characterization (the RI phase) as the nature and extent of contamination and the site setting become more fully understood. Action-specific requirements are identified as the potential alternatives for the proposed action are developed in the FS phase, i.e., as the specific components of these alternatives are assembled.

The preliminary identification of potential requirements for remedial action at the Colonie site is based on the current understanding of site contamination (e.g., soil and sediments, building materials, surface water, and groundwater potentially contaminated with radionuclides and chemicals) and the site's location (i.e., in an urbanized area). Potential federal and state requirements that may affect the proposed management of the Colonie site are listed in Tables 12 and 13, respectively. (The state requirements were provided by New York State (O'Toole 1988); these requirements will be evaluated as the RI/FS process proceeds.) Certain of these laws and orders are generically applicable to the authorization, objectives, planning, or implementation of policies or actions related to environmental response (e.g., the Atomic Energy Act and a number of federal orders). Because many of the components of this group have led to the establishment of standard policies and procedures for undertaking response actions, they are not generally discussed in detail (i.e., in an FS report). All aspects of the proposed action would fully comply with these laws and orders. Those requirements that may have specific significance to the proposed Colonie remedial action, e.g., RCRA and the Uranium Mill Tailings Radiation Control Act, will be summarized and evaluated in the FS phase of the remedial action process.

TABLE 12 Federal Requirements Potentially Applicable to the Proposed Remedial Action Project at the Colonie Site

Applicable or Relevant and Appropriate Requirements

Laws

Archeological and Historic Preservation Act of 1974
 Archeological Resources Protection Act of 1979
 Atomic Energy Act of 1954, as amended
 Clean Air Act of 1963, as amended
 Clean Water Act, as amended (also referred to as Federal Water Pollution Control Act of 1972, as amended)
 Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986
 Department of Energy Organization Act of 1977
 Endangered Species Act of 1973, as amended
 Fish and Wildlife Coordination Act of 1934, as amended
 Hazardous Materials Transportation Act of 1974, as amended
 National Historic Preservation Act of 1966, as amended
 Noise Control Act of 1972
 Noise Pollution and Abatement Act of 1970
 Occupational Safety and Health Act of 1970
 Safe Drinking Water Act of 1974, as amended
 Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976, as amended by the Hazardous and Solid Waste Amendments of 1984
 Toxic Substances Control Act of 1976
 Uranium Mill Tailings Radiation Control Act of 1978, as amended

Executive Orders

Executive Order 11490, Assigning Emergency Preparedness Functions to Federal Departments and Agencies
 Executive Order 11514, Protection and Enhancement of Environmental Quality
 Executive Order 11738, Providing for Administration of the Clean Air Act and the Federal Water Pollution Control Act with Respect to Federal Contracts, Grants, or Loans
 Executive Order 11807, Occupational Safety and Health Programs for Federal Employees
 Executive Order 11988, Floodplain Management
 Executive Order 11990, Protection of Wetlands
 Executive Order 11991, Relating to the Protection and Enhancement of Environmental Quality
 Executive Order 12088, Federal Compliance with Pollution Control Standards
 Executive Order 12146, Management of Federal Legal Resources
 Executive Order 12580, Superfund Implementation

TABLE 12 (Cont'd)

*To-Be-Considered Requirements*Department of Energy Orders

Order 1540.1	Materials Transportation and Traffic Management
Order 4240.1H	Designation of Major System Acquisition and Major Projects
Order 4320.1A	Site Development and Facility Utilization Planning
Order 4700.1	Project Management System
Order 5400.1	General Environmental Protection Program
Order 5440.1C	Implementation of the National Environmental Policy Act
Order 5480.1B	Environment, Safety, and Health Program for Department of Energy Operations -- Note: Chapter XI of Order 5480.1B has been amended (see Vaughan [1985] and subsequent updates of Derived Concentration Guides)
Order 5480.4	Environmental Protection, Safety, and Health Protection Standards
Order 5480.11	Radiation Protection for Occupational Workers
Order 5480.14	Comprehensive Environmental Response, Compensation, and Liability Act Program
Order 5481.1B	Safety Analysis Review System
Order 5482.1B	Environmental Protection, Safety, and Health Protection Appraisal Program
Order 5483.1A	Occupational Safety and Health Program for Government-Owned Contractor-Operated Facilities
Order 5484.1	Environmental Protection, Safety, and Health Protection Information Reporting Requirements
Order 5000.3	Unusual Occurrence Reporting System
Order 5500.2	Emergency Planning, Preparedness, and Response for Operations
Order 5700.6B	Quality Assurance
Order 5820.2	Radioactive Waste Management

TABLE 13 New York State Requirements Potentially Applicable to the Proposed Remedial Action Project at the Colonie Site^a

Applicable or Relevant and Appropriate Requirements

Department of Environmental Conservation

- 6 NYCRR Part 200 (2006) - General Provisions
- 6 NYCRR Part 201 - Permits and Certificates
- 6 NYCRR Part 211 (211.1) - General Prohibitions
- 6 NYCRR Part 212 - General Process Emission Sources
- 6 NYCRR Part 257 - Air Quality Standards
- 6 NYCRR Part 360 - Solid Waste Management Facilities (revised December 31, 1988)
- 6 NYCRR Part 364 - Waste Transporter Permits (revised December 31, 1986)
- 6 NYCRR Part 370 - Hazardous Waste Management System: General (revised December 25, 1988)
- 6 NYCRR Part 371 - Identification and Listing of Hazardous Wastes (revised December 25, 1988)
- 6 NYCRR Part 372 - Hazardous Waste Manifest System and Related Standards for Generators, Transporters and Facilities (revised December 25, 1988)
- 6 NYCRR Part 373-1 - Hazardous Waste Treatment, Storage and Disposal Facility Permitting Requirements (revised December 25, 1988)
- 6 NYCRR Part 373-2 - Final Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities (revised December 25, 1988)
- 6 NYCRR Part 373-3 - Interim Status Standards for Owners and Operators of Hazardous Waste Facilities (revised December 25, 1988)
- 6 NYCRR Part 374 - Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities (revised December 25, 1988)
- 6 NYCRR Part 703 - New York State Department of Environmental Conservation Groundwater Quality Regulation
- 6 NYCRR Part 750-757 - Implementation of National Pollutant Discharge Elimination System Program in New York State
- 6 NYCRR Part 701
- 6 NYCRR Part 702 - Surface Water Quality Standards
- 6 NYCRR Part 704
- 6 NYCRR Part 701.15(d) and (e) - Empowers Department of Environmental Conservation to Apply and Enforce Guidance Where There Are No Promulgated Standards

Department of Environmental Conservation

- ECL Article 24 and Article 71, Title 23 - Freshwater Wetlands Act
- ECL Article 27, Title II - Industrial Siting Hazardous Waste Facilities
- Title 27 - New York State Mined Land Reclamation Law

TABLE 13 (Cont'd)*Applicable or Relevant and Appropriate Requirements (Cont'd)*Department of Environmental Conservation (Cont'd)

- 6 NYCRR Part 182 - Endangered and Threatened Species of Fish and Wildlife
- 6 NYCRR Part 361 - Siting of Industrial Hazardous Waste Facilities
- 6 NYCRR Part 420 - General
- 6 NYCRR Part 421 - Permits
- 6 NYCRR Part 422 - Mined Land - Use Plan
- 6 NYCRR Part 423 - Reclamation Bond
- 6 NYCRR Part 424 - Enforcement
- 6 NYCRR Part 425 - Civil Penalties
- 6 NYCRR Part 426 - Hearings
- 6 NYCRR Part 608 - Use and Protection of Waters
- 6 NYCRR Part 621 - Uniform Procedures
- 6 NYCRR Part 624 - Permit Hearing Procedures
- 6 NYCRR Part 661, Chapter 10 - Tidal Wetlands - Land Use Regulations
- 6 NYCRR Part 662 - Freshwater Wetlands -- Interim Permits
- 6 NYCRR Part 663 - Freshwater Wetlands Permit Requirements
- 6 NYCRR Part 664 - Freshwater Wetlands Maps and Classifications
- 6 NYCRR Part 665 - Local Government Implementation of the Freshwater Wetlands Act and Statewide Minimum Land -- Use Regulations for Freshwater Wetlands

Department of Labor

- 12 NYCRR Part 38 -- Ionizing Radiation Protection
- 12 NYCRR Part 50 -- Lasers

Department of Agriculture and Markets

- 1 NYCRR Part 371 -- Notice of Intent

Department of Health

- Part 5 of the State Sanitary Code, Drinking Water Supplies
- Part 170 of Title 10 of the NYCRR, Water Supply Sources
- Appendix 5-A of Part 5 of the State Sanitary Code (Recommended Standards for Water Works)
- Appendix 5-B of Part 5 of the State Sanitary Code (Rural Water Supply)

*To-Be-Considered Requirements*Department of Environmental Conservation

- Description of Difference -- EPA/State Regulations
- Technical and Operations Guidance Series
 - 1.1.1 (April 1, 1987) - Ambient Water Quality Standards and Guidance Values

TABLE 13 (Cont'd)

*To-Be-Considered Requirements (Cont'd)*Department of Environmental Conservation (Cont'd)

Technical and Operations Guidance Series (Cont'd)

- 1.2.1 (May 19, 1987) - Industrial State Pollutant Discharge Elimination System Permit Drafting Strategy for Surface Waters
- 1.3.1 (May 22, 1987) - Waste Assimilative Capacity Analysis and Allocation for Setting Water Quality Based Effluent Limits
- 1.3.2 (May 1, 1989) - Toxicity Testing in the State Pollutant Discharge Elimination System Permit Program
- 1.3.4 (April 1, 1987) - Best Professional Judgment Methodologies
- 1.3.4.a (November 3, 1988) - Best Professional Judgment Methodologies/Amendments
- 1.3.7 (December 30, 1988) - Analytical Detectability and Quantitation Guidelines for Selected Environmental Parameters
- 2.1.2 (April 1, 1988) - Underground Injection/Recirculation at Groundwater Remediation Sites
- 2.1.3 (April 1, 1987) - Primary and Principal Aquifer Determinations
- Air Guide 1 - Guidelines for the Control of Toxic Ambient Air Contaminants

Department of Health

- NYSDOH PWS 68 - Blending Policy for Use of Sources of Drinking Water
 - NYSDOH PWS 69 - Organic Chemical Action Steps for Drinking Water
 - NYSDOH PWS 152 - Procedure for Handling Community Water System emergencies
 - NYSDOH PWS 159 - Responding to Organic Chemical Concerns at Public Water Systems
 - NYSDOH PWS 160 - Public Notification of Organic Chemical Incidents Regarding Public Water Supplies
 - The 10 Parts per Trillion Criterion for 2,3,7,8-Tetrachlorinated Dibenzodioxin in Fish Flesh
 - The Binghamton State Office Building Cleanup Criteria for Polychlorinated Dibenzodioxins, Polychlorinated Dibenzofurans, and Polychlorinated Biphenyls
 - NYSDOH Interim Report on Point-of-Use Activated Carbon Treatment Systems
 - Part 16 Draft Limits on the Disposal of Radioactive Materials into Sewer Systems
 - Criteria for the Development of Health Advisories for Sport Fish Consumption
 - Tolerance Levels for Ethylene Dibromide in Food
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^aNYCRR = New York Code of Rules and Regulations; NYSDOH PWS = New York State Department of Health, Public Water Supply.

4 WORK PLAN RATIONALE

4.1 OVERVIEW OF DATA OBJECTIVES AND PROPOSED ACTIVITIES

A major element of the RI/FS process is obtaining sufficient site-specific information to allow for an assessment of remedial action alternatives. Collection and documentation of data are conducted during the RI phase; analysis of alternatives is conducted in the FS phase. Considering the data gaps identified in Section 3.6, one of the major unknowns at the Colonie site prior to initiation of field characterization activities was the nature and extent of chemical contamination. Little information was available to confirm their presence or absence; therefore, a complete identification of contaminants of concern and subsequent selection of indicator chemicals could not be performed. To collect these data, as well as to fill the other data gaps identified in Section 3.6, a three-phased site characterization approach is being used. This approach, in which the results of each individual phase are used to define subsequent phases, provides for a systematic and cost-effective characterization program, the results of which will be given in the RI report.

The first two phases of this approach are essentially complete (see Chapter 6). Based on these results, it may not be necessary to complete Phase III because all relevant information may have been obtained during the first two phases. The results of these characterization activities are currently being evaluated. The three phases may be summarized as follows.

Phase I activities involved the collection of information needed to better understand the physical characteristics of the site, the chemical contaminants present, and the type and surficial extent of radioactive contamination. A complete description of the physical characteristics of the Colonie site must be obtained in order to fully assess migration pathways and remedial action alternatives. During Phase I, determination of physical characteristics included the following data objectives:

1. Investigate the hydrogeological relationship of the upper sands unit, upper clay unit, and lower sands unit to confirm or exclude the assumption that the upper clay unit is a "leaky" aquitard.
2. Construct and sample downgradient wells.
3. Review and investigate field values and typical values for glacial clay hydraulic conductivities.
4. Confirm understanding of the general geologic sequence of unconsolidated glacial sediments at the Colonie site by obtaining detailed information about strata from the lower clay unit to bedrock. Determine presence or absence of the Elsemere Gravel Blanket aquifer beneath the site. If present, determine its significance as a migration pathway.

Contaminants must also be identified to assess potential sources and migration routes. Related data objectives included in Phase I were:

1. Confirm presence or absence of potential contaminants (listed in Table 10) in each of the media and
2. Identify additional contaminants of concern and determine their concentrations, as well as the background concentrations of those contaminants in the Colonie, New York, area.

These objectives were accomplished, as described in the draft field sampling plan, by (1) surface walkover surveys and limited surface soil and sediment sampling; (2) deep geologic subsurface drilling accompanied by in-situ tests and the collection of soils for geophysical analyses; and (3) limited drilling within the known burial area in Patroon Lake to identify specific contaminants.

Information collected in Phase I helped focus Phase II activities to determine the boundaries of radioactive and chemical contaminant sources. Specifically, Phase I results provided information on the range of chemical contaminants present at the site. This information was used to select indicator chemicals (cadmium, copper, lead, and zinc) for which samples collected during Phase II will be analyzed. Phase II will utilize subsurface sampling to define the vertical and horizontal boundaries of radioactive and chemical contamination at the Colonie site. The subsurface sampling will be biased (i.e., emphasize areas of known contamination) to take advantage of existing knowledge and optimize the amount of sampling required. Data obtained during Phase II will be evaluated to determine the nature and extent of contamination on structures at the Colonie site.

Phase II data will be evaluated to define potential routes of contaminant migration. Surface water and groundwater samples will be collected, and wells within a 1.6-km (1-mi) radius of the Colonie site will be canvassed. The leachability of wastes will be investigated through various tests. The results of these investigations will be evaluated. Although the third phase of this program may not be necessary based on these results, Phase III is described in this work plan for completeness.

The Phase III effort would concentrate on gaining specific information needed to support technology evaluations for the FS. This would consist of additional building surveys, decontamination tests on various materials, and bench-scale tests of potentially applicable treatment technologies. Phase III activities might include:

- Performing bench-scale tests (as needed) of potentially applicable technologies (e.g., separation or crushing) to reduce the volume of radioactively contaminated materials,
- Conducting decontamination studies to determine if the plant building (or portions thereof) could be cleaned and released for use without radiological restrictions,

- Undertaking studies to evaluate treatment methods that would reduce toxicity, mobility, and/or volume of contaminated materials, and
- Conducting studies to determine the feasibility of source control technologies (e.g., for the in-situ stabilization of contaminated materials).

The RI field activities are summarized in Table 14. A detailed discussion of radiological and chemical characterization activities, approximate sampling locations, rationale for choosing those locations, and numbers of samples to be collected are presented in the draft sampling and analysis plan (see Section 4.3). At the completion of the RI, the analytical results will be integrated into the conceptual site model that will support the FS analyses.

4.2 DATA QUALITY OBJECTIVES

Data quality objectives are qualitative and quantitative statements that specify the quality of the data required to support decisions during remedial activities. Data quality objectives are applicable to all data collection activities, as well as to preliminary assessments/site inspections, remedial investigations, feasibility studies, remedial design, remedial action, and verification. The level of detail and the quality of data that are required vary based on the intended uses of the data.

The EPA guidance on data quality objectives (EPA 1987) establishes five levels of data quality applicable to various data gathering activities throughout the course of the RI/FS process. Table 15 summarizes the analytical levels and their uses. These levels apply only to chemical contaminants; there are no corresponding levels for radioactive contaminants. Table 16 provides EPA guidance on the appropriate level of data quality for the stages of an RI/FS. As shown, significant overlap can occur in the levels allowable for a certain activity. In general, however, the degree of data quality required increases as the risk associated with utilizing incorrect data increases.

The required analytical level can range from Level I to Level V; for the Colonie site, Level III is common to all data types and is sufficient to serve all future purposes for these data, up to and including engineering design. Level III provides detection limits and data quality similar to Level IV but with less rigorous quality assurance/quality control. Because determination of potentially responsible parties is not required for DOE at the Colonie site, data above Level IV are not required. Controls to ensure all data collected during the RI meet Level III are described in the draft field sampling plan and the draft quality assurance project plan. The analytical procedures used to evaluate chemical data were derived from those found in the contract laboratory program (CLP) as well as other EPA procedures. Standard industry methods were used to ensure the quality of the radiological analyses. For both the radiological and chemical analyses, these controls should be adequate to achieve an analytical level equivalent to Level III.

TABLE 14 Summary of Field Activities for the Colonie Site

Characterization Activity	Matrix	Phase	Survey Type/Approximate Number of Samples	
			Radiological Characterization	Chemical Characterization
<u>Physical Characterization</u>				
Collection of geological/hydro-geological data and construction of downgradient wells	Unconsolidated sediment, bedrock	I	5 geological boreholes; 13 monitoring well installations (2 of 13 are downgradient wells)	4 (of 5) geological boreholes; 1 (of 13) monitoring well installation
Literature search	Unconsolidated sediment	I	Not applicable	Not applicable
Hydraulic conductivity testing	Unconsolidated sediment	I	Not applicable (9 permeability tests)	Not applicable

<u>Contaminant Identification and Migration</u>				
Walkover radiological survey ^a	Soil	I	Gamma survey	Not applicable
Surface soil sampling ^b	Soil	I	90 samples	None
	Soil	II	45 samples	45 samples

TABLE 14 (Cont'd)

Characterization Activity	Matrix	Phase	Survey Type/Approximate Number of Samples	
			Radiological Characterization	Chemical Characterization
<u>Contaminant Identification and Migration (Cont'd)</u>				
Subsurface soil sampling				
Plant grounds	Soil	I	155 samples	55 samples
Plant grounds	Soil	II	490 samples	480 samples
Beneath the building floor (to 4.5 m)	Soil	II ^c	100 samples	100 samples
Radiological survey	Buildings, structures, equipment, sewer lines, storm drains	I, II ^c	Gamma survey; limited number of samples ^d	Not applicable
Chemical survey	Buildings, structures, sewer lines, storm drains	I, II ^c	Not applicable	Limited number of samples ^d
Literature search	Buildings, structures, sewer lines, storm drains	I, II	Not applicable	Not applicable
Groundwater sampling	Groundwater	I, II	40 samples (10 per quarter)	40 samples (10 per quarter)

TABLE 14 (Cont'd)

Characterization Activity	Matrix	Phase	Survey Type/Approximate Number of Samples	
			Radiological Characterization	Chemical Characterization
<u>Contaminant Identification and Migration (Cont'd)</u>				
Sediment sampling	Sediment	I	15 samples	15 samples
Surface water sampling	Water	I, II	15 samples	15 samples
Airborne particulate monitoring	Air	I	50 samples	Limited number of samples ^d
Groundwater well canvass	Groundwater	II	Not applicable	Not applicable
Leachability testing	Soil	II	As needed	As needed

<u>Contaminant Sources</u>				
Literature search	Soil	II	Not applicable	Not applicable
Walkover radiological survey ^a	Soil	I	Gamma survey	Not applicable
Geophysical survey	Soil	II	Not applicable	Not applicable

TABLE 14 (Cont'd)

Characterization Activity	Matrix	Phase	Survey Type/Approximate Number of Samples	
			Radiological Characterization	Chemical Characterization
<u>Contaminant Sources</u> (Cont'd)				
Downhole gamma logging	Soil	II	15 boreholes	Not applicable
Radiological survey	Buildings, structures, equipment, sewer lines, storm drains	II ^C	Gamma survey; limited number of samples ^d	Not applicable
Chemical survey	Buildings, structures, sewer lines, storm drains	II ^C	Not applicable	Limited number of samples ^d

<u>Treatability Studies</u>				
Literature search	Soil, sediment, groundwater	III	Not yet defined in detail	Not yet defined in detail
Bench-scale tests, as needed	Soil, sediment, groundwater	III	Not yet defined in detail	Not yet defined in detail

TABLE 14 (Cont'd)

Characterization Activity	Matrix	Phase	Survey Type/Approximate Number of Samples	
			Radiological Characterization	Chemical Characterization
<u>Treatability Studies</u> <u>(Cont'd)</u>				
Decontamination studies	Buildings, structures, equipment	III	Not yet defined in detail	Not yet defined in detail
Feasibility studies	Soil, sediment, groundwater	III	Not yet defined in detail	Not yet defined in detail

^aSame survey.

^bDoes not include surface samples where boreholes were drilled. Approximately 55 surface/vicinity properties samples (not listed here) were collected.

^cThis work in the latter part of Phase II corresponds to Phase III field activities in the draft field sampling plan.

^dThe number of samples required was determined in the field. The rationale for this sampling strategy will be described in the RI report.

TABLE 15 Summary of Analytical Levels Appropriate to Data Uses

Data Uses	Analytical Level	Type of Analysis	Limitations	Data Quality
Site characterization Monitoring during implementation	I	<ul style="list-style-type: none"> • Total organic/inorganic vapor detection using portable instruments • Field test kits 	<ul style="list-style-type: none"> • Instruments respond to naturally occurring compounds 	<ul style="list-style-type: none"> • If instruments calibrated and data interpreted correctly, can provide indication of contamination
Site characterization Evaluation of alternatives Engineering design Monitoring during implementation	II	<ul style="list-style-type: none"> • Variety of organics by gas chromatography; inorganics by atomic absorption; X-ray fluorescent analyzer • Tentative identification; analyte-specific • Detection limits vary from low ppm to low ppb 	<ul style="list-style-type: none"> • Tentative identification • Techniques/instruments limited mostly to volatiles, metals 	<ul style="list-style-type: none"> • Dependent on quality assurance/quality control steps employed • Data typically reported in concentration ranges
Risk assessment Determination of potentially responsible parties Site characterization Evaluation of alternatives Engineering design Monitoring during implementation	III	<ul style="list-style-type: none"> • Organics/inorganics using EPA procedures other than Contract Laboratory Program (CLP) procedures • Tests for RCRA hazardous waste characteristics, as given in 40 CFR Part 261, Subpart C 	<ul style="list-style-type: none"> • Tentative identification in some cases • Can provide data of same quality as Level IV 	<ul style="list-style-type: none"> • Similar detection limits to CLP • Less rigorous quality assurance/quality control
Risk assessment Determination of potentially responsible parties Evaluation of alternatives Engineering design	IV	<ul style="list-style-type: none"> • Organics/inorganics (Hazardous Substances List [HSL]) by gas chromatography/mass spectrometry; atomic absorption; inductively coupled plasma • Low ppb detection limit 	<ul style="list-style-type: none"> • Tentative identification of non-HSL parameters • Some time may be required for validation of packages 	<ul style="list-style-type: none"> • Goal is data of known quality • Rigorous quality assurance/quality control
Risk assessment Determination of potentially responsible parties	V	<ul style="list-style-type: none"> • Nonconventional parameters • Method-specific detection limits • Modification of existing methods • Hazardous constituents identified in 40 CFR Part 261, Appendix VIII 	<ul style="list-style-type: none"> • May require method development/modification • Mechanism to obtain services requires special lead time 	<ul style="list-style-type: none"> • Method-specific

Source: Adapted from EPA (1987).

TABLE 16 Appropriate Analytical Levels According to Data Uses

Data Uses	Appropriate Analytical Level				
	I	II	III	IV	V
Site characterization (including health and safety)	X	X	X	-	-
Risk assessment	-	-	X	X	X
Evaluation of alternatives	-	X	X	X	-
Engineering design of remedial action	-	X	X	X	-
Monitoring during implementation of remedial action	X	X	X	-	-
Determination of potentially responsible parties	-	-	X	X	X

Source: Adapted from EPA (1987).

4.3 SAMPLING AND ANALYSIS PLAN RATIONALE

The sampling and analysis plan for the Colonie site actually consists of two individual documents, the field sampling plan and the quality assurance project plan. The sampling and analysis plan provides detailed descriptions of how, when, and where samples are collected during the site investigation and describes the types of radiological and chemical analyses that are performed on the collected samples. The quality assurance project plan provides procedures undertaken to ensure the quality and integrity of the collected data. Brief summaries of the field sampling plan and quality assurance project plan for the Colonie site are presented in Sections 4.3.1 and 4.3.2. The field activities conducted to date were based on previously completed draft documents.

4.3.1 Field Sampling Plan

The field sampling plan documents the field activities for the Colonie site. It includes the site characterization rationale, a summary of existing data, RI data requirements, phases of the characterization activity, sample types and measurements, sampling frequency, analytical procedures, and an operating plan for the site. The field activities associated with the Colonie site were selected to address site characteristics and waste properties that would be useful in identifying permanent solutions and appropriate treatment technologies. The data collected from the field activities will also be used to

support data needs for the modeling effort for engineering analyses and for human health and environmental risk assessment. The field sampling plan is being issued as a separate document.

The field sampling plan identifies data gaps (summarized in Section 3.6) and describes proposed activities to accomplish data objectives. The data objectives for the Colonie site include a description of the physical characterization of the site, identification of contaminant sources and migration pathways, and determination of the applicability of various treatability studies. These data objectives are summarized in Section 4.1 of this work plan. The phased characterization approach and the sampling and analytical procedures are discussed in detail in the field sampling plan. The types of sampling and analyses for the Colonie site include radionuclides, metals, mobile ions, organic compounds, and geochemical and engineering parameters. The number of samples for various characterization activities are summarized in Table 14.

4.3.2 Quality Assurance Project Plan

The quality assurance project plan outlines the quality assurance/quality control requirements that were implemented to ensure the defensibility and integrity of analytical data collected for the Colonie site. The quality assurance project plan defines goals for the level of the quality assurance effort and data requirements in terms of precision, accuracy, representativeness, completeness, and comparability. The overall quality assurance objective is to develop and ensure implementation of procedures for field sampling, chain of custody, laboratory analysis, and reporting that will provide legally defensible data. The quality assurance objectives are categorized into analytical requirements, data quality objectives, and sample handling objectives. The quality assurance project plan is being issued as a separate document.

4.4 SUMMARY OF OTHER MAJOR PLANS

4.4.1 Health and Safety Plan

A health and safety plan has been developed for the Colonie site to ensure the health and safety of on-site personnel during the performance of site characterization and response action activities. The plan includes the safety standards that must be met by all personnel and subcontractors performing on-site activities. Addressing the health and safety of on-site personnel also serves to minimize any potential impacts to the general public and the nearby environment. Key elements of the health and safety program for the Colonie site include:

- Using appropriate protective equipment and safeguards;
- Identifying areas where specific safety hazards exist;

- Training on-site personnel in the proper use of safety equipment and adherence to written procedures;
- Performing medical surveillance of on-site personnel, including radiological and nonradiological bioassays;
- Developing standard operating procedures and procedures to be followed in emergency situations; and
- Holding periodic meetings to reemphasize the salient features of the health and safety program, existing site conditions, and any changes in site conditions.

The health and safety plan is being issued as a separate document.

4.4.2 Community Relations Plan

A community relations plan has been developed for the Colonie site to ensure effective exchange of information with the general public. This plan was developed using DOE's previous experience with the affected community, EPA guidance relative to community relations, and interviews conducted with key individuals in the affected community. The Colonie site community relations plan summarizes background information about the site, describes the history of community involvement, describes community relations strategies, provides a schedule of community relations activities, and lists affected and interested groups and individuals. This plan, which was tailored to the needs of the Colonie site, provides for meaningful exchange of information on such matters as potential health impacts, environmental issues, remedial action plans, project costs, and specific site activities. The community relations plan for the Colonie site is being issued as a separate document.

5 REMEDIAL INVESTIGATION/FEASIBILITY STUDY TASKS

Fourteen standard tasks have been defined by EPA as comprising the RI/FS process. This task structure will be used in implementing the RI/FS process for the Colonie site. This approach should enhance coordination with EPA Region II, the state of New York, and local citizens and officials. The RI/FS tasks and the phased approach suggested by EPA are shown in Figure 15 and are briefly described in Sections 5.1 through 5.14. Reference is included to other sections of this work plan or other project documents to explain the means by which these 14 tasks are being implemented for the Colonie site.

Most planned site characterization activities have been completed, and these data are currently undergoing evaluation and validation. Phase III characterization activities described in the draft field sampling plan will be conducted only if the results from Phases I and II indicate the need to do so (see Section 4.1). The scope of the field work for site characterization was based on information contained in a preliminary RI/FS work plan and a draft sampling and analysis plan. Additional field work will be performed only if additional data gaps are identified as the RI/FS process continues. Hence, Tasks 1 and 3 have largely been completed, and Tasks 2, 4, and 5 are currently in progress.

Discussion of the tasks associated with the FS portion of this process is somewhat limited in scope because it is not possible to define in detail this portion of the process until site characterization data have been evaluated and the results assembled in a draft RI report. However, the types of analyses that will be performed for the Colonie site are described to identify how the RI/FS process will be completed.

5.1 TASK 1: PROJECT PLANNING

The project planning task initiated the RI/FS process and established the project basis by:

- Collecting and documenting scoping information (Chapters 1 and 2),
- Collecting and evaluating existing data (Sections 2.1, 2.3, and 2.4),
- Developing a conceptual site model (Section 3.1),
- Identifying preliminary response objectives and potential remedial action alternatives (Sections 3.3 and 3.4),
- Identifying various feasibility studies to support the RI/FS process (Section 3.7),
- Compiling a list of potential federal and state ARARs and TBCs (Section 3.8),

FIGURE 15 Relationship of RI/FS Tasks to Phased RI/FS Approach

- Determining data needs and defining data quality objectives (Sections 3.6, 4.1, and 4.2),
- Identifying major project plans, including the field sampling plan and the quality assurance project plan (Sections 4.3 and 4.4),
- Documenting RI/FS tasks (Chapter 5),
- Developing schedules for completion of major project elements (Chapter 6), and
- Identifying project organization and project management (Chapter 7).

All of these elements are included in this work plan, which constitutes an overview of project planning for the Colonie site RI/FS. All project scoping required under NEPA and CERCLA has been completed. Many elements described in this work plan are summaries of more comprehensive documents. Each of the summaries contained in this work plan reflects the current status of the respective task. Information in this work plan will be updated in the future, as appropriate.

5.2 TASK 2: COMMUNITY RELATIONS

Task 2 incorporates all efforts related to the preparation and implementation of the community relations plan. Community relations were initiated for the Colonie site in 1984 when DOE assumed control of the site. These efforts have continued to date, and a community relations plan has been prepared consistent with EPA requirements. These efforts will continue until the RI/FS process has been completed and the selected remedy is implemented. The community relations plan for the Colonie site includes background information about the site, the history of community involvement, community relations strategies, a schedule of community relations activities, and a list of affected and interested groups and individuals. The plan also addresses interviews with members of the community to determine (1) citizen concerns, (2) information needs, and (3) how and when citizens wish to be involved in the RI/FS process. The community relations plan describes the activities that DOE will undertake to ensure a full program of public participation.

The DOE has been providing information about its remedial activities to officials, environmental groups, and the media in the Colonie area for several years through news releases, fact sheets, and briefings. These mechanisms will continue to be used to inform the public. An information repository has been established at the town of Colonie library located at 629 Albany-Shaker Road in Loudonville, New York, to provide the public with access to documentation relating to the RI/FS process, including transcripts of related public meetings.

5.3 TASK 3: FIELD INVESTIGATION

Task 3 includes all efforts related to field work performed to conduct the RI. Most planned field activities have been completed; additional field investigations will be conducted only to fill further data gaps identified as the RI/FS progresses. A phased approach was used to perform characterization activities. This approach (summarized in Section 4.1) was used to perform these investigations in a systematic and cost-effective manner. If additional data gaps are identified, the field sampling plan will be supplemented to identify the means by which to fill these gaps, and the work plan will also be supplemented, as appropriate.

5.4 TASK 4: SAMPLE ANALYSIS/VALIDATION

Sample analysis was performed by two independent laboratories subcontracted by BNI. Weston Analytical Laboratories (Weston) analyzed those samples requiring chemical analyses. Thermo Analytical/Eberline Laboratory performed the radiological analyses using standard industry practices and DOE-accepted methods. The chemical analyses were performed by Weston following the technical specifications set forth in the BNI/Weston subcontract. This subcontract specifies analytical methods, quality control measures, and data acceptability consistent with EPA guidelines. Quality control is accomplished by internal and external audits, analyses of quality control samples, and participation in laboratory intercomparison tests. These procedures provide for an analytical level equivalent to Level III (see Section 4.2).

Data validation includes all efforts related to ensuring that analytical data are sufficiently accurate and precise to meet the appropriate level of data quality objectives for a particular piece of information. The integrity of data is validated by checking the quality control data associated with the sample analysis. This activity is conducted in accordance with *Functional Guidelines for Evaluating Organics Analyses* (EPA 1988a) and *Functional Guidelines for Evaluating Inorganics Analyses* (EPA 1988b). In practice, data validation includes manual and/or computerized checking of the data against checklists. These checklists have been developed to guide the data reviewer through the validation process and to consistently recognize data that are suspect. Although the checking differs for each type of data generated (i.e., field gamma scans, radioisotopic analyses, volatile organics analyses, and RCRA characteristics tests), common elements include items such as completeness of data, acceptability of detection limits, indications of field or laboratory contamination of samples, and reproducibility of results. Plans for data validation have been prepared to assist in this activity.

5.5 TASK 5: DATA EVALUATION

Task 5 includes efforts related to evaluating the data after they have been validated under Task 4. The task begins when the first set of validated data is received and ends during preparation of the RI report when it is determined that no additional data are required. For the Colonie site, Task 5 is being performed concurrently with data validation.

Data evaluation tasks are intended to provide the information needed to complete the RI/FS process. For example, groundwater data collected during the RI that have been validated should complete the understanding of the groundwater system present at the Colonie site. The measured concentrations of uranium, thorium, and various chemical contaminants in the aquifers -- in conjunction with identified groundwater receptors -- will enable calculation of the potential health risk to members of the public who may drink this groundwater.

Typical products of the data evaluation task for the Colonie site will include drawings delineating the boundaries of contamination for the different contaminants present, tables listing contaminant concentrations for the various media, quantification of migration pathways as appropriate, and tabulation of engineering data (such as waste volume) necessary for evaluating the remedial action alternatives. All calculations will be documented in calculation logs and checked by an independent reviewer before sign-off. Where computations are performed with computer programs, either validated software will be used or the calculation methods will be hand-verified. These results will be provided in the RI report.

5.6 TASK 6: ASSESSMENT OF RISKS

Task 6 consists of efforts related to assessing potential risks to human health and the environment. It includes assessment of baseline risks during the RI, setting of preliminary performance goals for conducting the FS, and comparison of risks among evaluated alternatives. Work begins during the data evaluation task and ends during the evaluation of remedial action alternatives. Efforts on Task 6 have not yet been initiated but are scheduled to begin in the near future (see Chapter 6).

After the site characterization data have been validated and evaluated, a baseline risk assessment will be carried out to determine potential threats to human health and the environment in the absence of any remedial action at the Colonie site. To evaluate the hazards posed by current site conditions, the assessment will analyze the environmental transport pathways to potential receptors from areas where radioactive and chemical contaminants are currently located. The risk assessment will also be used to assist in screening alternatives and determining acceptable levels of residual contamination (i.e., cleanup limits) for radioactive and chemical species. An overview of the risk assessment process is shown in Figure 16.

The first step in the risk assessment process is the collection and evaluation of site data in order to identify the contaminants present at the site that would be the focus of the risk assessment. The second step is assessing exposure. This involves analyzing contaminant releases, identifying exposed populations, identifying all potential pathways of exposure, estimating exposure point concentrations for specific pathways, and estimating contaminant intakes for specific pathways. Possible pathways that will be evaluated for the Colonie site include dermal contact with soil/sludge and structural debris, dermal contact with or ingestion of groundwater or surface water, and direct exposure to external radiation (see Section 3.1). The exposure levels of the indicator chemicals and radionuclides at exposure points will be estimated using characterization

FIGURE 16 Overview of the Risk Assessment Process

and monitoring data and appropriate environmental fate and transport models. Information from the literature and earlier site studies regarding environmental chemistry and contaminant fates will be considered and incorporated, where valid and applicable, in all estimates of chemical and radionuclide exposure point concentrations. The baseline risk assessment will evaluate existing data to confirm that the pollutant transport models adequately reflect conditions at the site and to determine where additional data are needed to properly characterize risks.

Quantitative analyses will be performed following the general procedures outlined in EPA's *Risk Assessment Guidance for Superfund* (EPA 1989). (To the extent practicable, these same analyses will be applied for radionuclides; otherwise, methodologies generally accepted by health physics professionals will be applied.) Identification of sensitive receptors near the site will be based on demographic records and standard demographic statistical techniques. A population activity profile will be developed, based on area land use and population structure, to delineate exposure coefficients required for a quantitative evaluation of risks. The baseline risk assessment ends with the characterization of risks to human health and the environment in the absence of any remedial action at the site. The risk assessment process continues in the FS phase with an evaluation of risks associated with various remedial action alternatives.

In the risk assessment process for the Colonie site, the chemical and radiological risks will be analyzed separately to allow for a clear presentation of the source of risk, i.e., radiological or chemical. Combining the radiological and chemical risks could mask distinct information that would aid in the selection of the appropriate remedy. The total risk, which is the sum of the radiological and chemical risks, will also be provided.

5.7 TASK 7: TREATABILITY STUDIES/PILOT TESTING

Task 7 includes efforts related to the performance of pilot, bench-scale, and treatability studies. It also includes any post-screening investigations. Such studies will likely be necessary for the Colonie wastes to test volume reduction or treatment technologies that have not yet been proven reliable or effective in full-scale operation or to develop sufficient preliminary design information on which to base evaluations of various remedial action alternatives in the FS. Several potential remedial action technologies that may require bench-scale or pilot-scale treatability studies have been identified for the Colonie site (see Section 3.7). These will be performed, as needed, if the results of characterization and engineering studies indicate the need for them.

5.8 TASK 8: REMEDIAL INVESTIGATION REPORT

Task 8 covers all efforts related to the reporting of RI findings once the data have been evaluated under Tasks 5 and 6. Task 8 covers all draft and final RI reports and includes the following activities:

- Formatting data for reporting purposes,
- Preparing associated graphics,

- Writing the report,
- Printing and distributing the report,
- Holding review meetings, and
- Revising the report based on agency comments.

The proposed RI report outline is provided in Table 17. This outline, which is based on the EPA-recommended format given in their most recent guidance document (EPA 1988c), will be used to prepare the RI report for the Colonie site.

5.9 TASK 9: REMEDIAL ALTERNATIVES DEVELOPMENT/SCREENING

Task 9 involves the initial development and evaluation of remedial action alternatives that will be fully evaluated under Task 10. The objective of the Task 9 screening process is to narrow the range of alternatives that will undergo full evaluation. The process begins with the refinement of the remedial response objectives, proceeds through a narrowing of the potential technologies based on applicability and effectiveness, and ends with the identification of a set of remedial action alternatives. Each remedial action alternative may involve application of a single technology or a combination of two or more technologies. Task 9 consists of the following activities:

- Identifying response objectives and response actions,
- Listing potential remedial technologies,
- Screening remedial technologies based on site-specific criteria,
- Assembling potential remedial action alternatives from the screened technologies,
- Evaluating potential remedial action alternatives based on screening criteria (i.e., effectiveness, implementability, and cost), and
- Identifying candidate remedial action alternatives for detailed evaluation in Task 10.

Following this screening of potential remedial alternatives, a decision must be made regarding the level of analysis and documentation required for compliance with NEPA. For all of the alternatives still being considered following the screening process, an assessment of environmental impacts will be carried out. If the results of this assessment indicate that implementation of the preferred alternative would not result in significant environmental impacts, a FONSI would be issued and the NEPA process would be completed. If a FONSI could not be issued for the preferred alternative, efforts would be initiated to prepare an environmental impact statement. This work plan is based on the assumption that a FONSI is likely for the Colonie site.

TABLE 17 Proposed Outline of the RI Report

EXECUTIVE SUMMARY**1 INTRODUCTION**

- 1.1 Purpose of Report
- 1.2 Site Background
- 1.3 Report Organization

2 STUDY AREA INVESTIGATION

- 2.1 Site Description
- 2.2 Site History
- 2.3 Previous Investigations
 - 2.3.1 Surface Features
 - 2.3.2 Contaminant Sources
 - 2.3.3 Meteorology
 - 2.3.4 Surface Water and Sediments
 - 2.3.5 Geology
 - 2.3.6 Soil and Vadose Zone
 - 2.3.7 Groundwater
 - 2.3.8 Human Population
 - 2.3.9 Ecology

3 PHYSICAL CHARACTERISTICS OF THE STUDY AREA

- 3.1 Surface Features
- 3.2 Meteorology
- 3.3 Surface Water Hydrology
- 3.4 Geology
- 3.5 Soils
- 3.6 Hydrogeology
- 3.7 Demography and Land Use
- 3.8 Ecology

4 NATURE AND EXTENT OF CONTAMINATION

- 4.1 Potential Routes of Migration for Radioactive/
Chemical Contaminants
 - 4.1.1 Sources
 - 4.1.2 Soil and Vadose Zone
 - 4.1.3 Groundwater
 - 4.1.4 Surface Water and Sediments
 - 4.1.5 Air

TABLE 17 (Cont'd)

5 CONTAMINANT FATE AND TRANSPORT

- 5.1 Migration Routes
- 5.2 Contaminant Persistence
- 5.3 Contaminant Migration

6 BASELINE RISK ASSESSMENT

- 6.1 Human Health Evaluation
 - 6.1.1 Exposure Assessment
 - 6.1.2 Toxicity Assessment
 - 6.1.3 Risk Characterization
- 6.2 Environmental Evaluation

7 SUMMARY AND CONCLUSIONS

- 7.1 Summary
 - 7.1.1 Nature and Extent of Contamination
 - 7.1.2 Fate and Transport
 - 7.1.3 Risk Assessment
- 7.2 Conclusions
 - 7.2.1 Data Limitations (if any)
 - 7.2.2 Recommended Remedial Action Objectives

REFERENCES**APPENDIXES**

5.10 TASK 10: DETAILED ANALYSIS OF ALTERNATIVES

Task 10 involves detailed analysis and comparison of remedial alternatives. The following criteria are used to evaluate the candidate alternatives surviving from Task 9:

- Overall protection of human health and the environment,
- Compliance with ARARs,
- Long-term effectiveness and permanence,
- Reduction of toxicity, mobility, and volume,
- Short-term effectiveness,
- Implementability,
- Cost,
- State acceptance, and
- Community acceptance.

A summary for each alternative, including the no-action alternative, is prepared using these nine criteria. The relative advantages and disadvantages are then used to compare and evaluate the remedial action alternatives. Use of these nine criteria is consistent with the NCP.

5.11 TASK 11: FEASIBILITY STUDY REPORT

Similar to Task 8 (RI report task), Task 11 involves the coordination and preparation of the FS report. The task is complete when the FS report is released to the public. The following are Task 11 activities:

- Formatting data for reporting purposes,
- Preparing associated graphics,
- Writing the report,
- Printing and distributing the report,
- Holding review meetings, and
- Revising the report based on agency comments.

Table 18 is a proposed outline of the FS report. This outline, which is based on the EPA-recommended format given in their most recent guidance document (EPA 1988c), will be used to prepare the FS report for the Colonie site.

TABLE 18 Proposed Outline of the FS Report

EXECUTIVE SUMMARY**1 INTRODUCTION**

- 1.1 Purpose and Organization of Report
- 1.2 Background Information
 - 1.2.1 Description of Site and Nearby Environment
 - 1.2.2 Site History
 - 1.2.3 Nature and Extent of Contamination
 - 1.2.4 Contaminant Fate and Transport
 - 1.2.5 Baseline Risk Assessment

2 IDENTIFICATION AND SCREENING TECHNOLOGIES

- 2.1 Introduction
- 2.2 Remedial Action Objectives
 - 2.2.1 Identification of ARARs
 - 2.2.2 Identification of Acceptable Exposure Levels
 - 2.2.3 Development of Remedial Action Objectives
- 2.3 General Response Actions
- 2.4 Identification and Screening of Technology Types and Process Options
 - 2.4.1 Identification and Screening of Technologies
 - 2.4.2 Evaluation of Technologies and Selection of Representative Technologies

3 DEVELOPMENT AND SCREENING OF ALTERNATIVES

- 3.1 Development of Alternatives
 - 3.1.1 Alternative 1
 - 3.1.2 Alternative 2
 - 3.1.3 Alternative 3, etc.
- 3.2 Screening of Alternatives
 - 3.2.1 Alternative 1
 - 3.2.2 Alternative 2
 - 3.2.3 Alternative 3, etc.
- 3.3 Identification of Final Alternatives

TABLE 18 (Cont'd)

4 DETAILED ANALYSIS OF ALTERNATIVES

- 4.1 Alternative 1
 - 4.1.1 Description
 - 4.1.2 Evaluation^a
- 4.2 Alternative 2
 - 4.2.1 Description
 - 4.2.2 Evaluation^a
- 4.3 Alternative 3
 - 4.3.1 Description
 - 4.3.2 Evaluation^a
- 4.4 Summary

5 COMPARISON OF ALTERNATIVES

- 5.1 Overall Protection of Human Health and the Environment
- 5.2 Compliance with ARARs
- 5.3 Long-Term Effectiveness and Permanence
- 5.4 Reduction of Toxicity, Mobility, and Volume
- 5.5 Short-Term Effectiveness
- 5.6 Implementability
- 5.7 Cost
- 5.8 State Acceptance
- 5.9 Community Acceptance
- 5.10 Summary

6 RECOMMENDED REMEDIAL ACTION (Optional)**7 RESPONSIVENESS SUMMARY (Final Only)****REFERENCES****APPENDIXES**

^aIncludes analysis of environmental consequences such as radiological impacts, chemical impacts, surface water and groundwater impacts, socioeconomic and historical/cultural impacts, ecological impacts, cumulative impacts, mitigative measures, unavoidable adverse impacts, irreversible and irretrievable commitments of resources, relationship between local short-term use of the human environment and the maintenance and enhancement of long-term productivity.

5.12 TASK 12: POST-REMEDIAL INVESTIGATION/FEASIBILITY STUDY SUPPORT

Task 12 includes efforts to prepare the proposed plan and responsiveness summary, support development of the ROD, and conduct any predesign activities. Task 12 activities include:

- Preparing the proposed plan,
- Attending public meetings,
- Preparing the responsiveness summary and draft ROD,
- Finalizing documents in response to agency and public comments,
- Preparing the predesign report, and
- Completing the conceptual design.

The proposed plan is a summary document (typically fewer than 10 pages) that identifies the preferred remedial action alternative and the reasons for the preference, describes the alternatives evaluated in the RI/FS, and solicits public review and comment on all screened alternatives presented in the FS. An annotated outline for the proposed plan, which was developed from EPA guidance, is presented in Table 19. Preparation of the responsiveness summary and ROD will be initiated following the public review period of the RI/FS.

5.13 TASK 13: ENFORCEMENT SUPPORT

Task 13 includes RI/FS efforts associated with enforcement aspects of a project in terms of potentially responsible parties. Because DOE has assumed responsibility for the Colonie site, Task 13 is not applicable to this project.

5.14 TASK 14: MISCELLANEOUS SUPPORT

Task 14 is used to report on work that is associated with the project but does not fall under any of the other established RI/FS tasks. Task 14 activities will vary but may include the following:

- Special efforts related to public health assessments and
- Support for review of special state or local site-specific or related projects.

These activities will be performed, as needed, for the Colonie site.

TABLE 19 Annotated Outline of the Proposed Plan

Introduction

Provide site name and location.
Identify lead and support agencies.
Introduce document's purpose, which is to:
 Fulfill requirements of Section 117(a),
 Describe alternatives analyzed,
 Identify preferred alternative and explain rationale for preference,
 Serve as companion to the RI/FS and administrative record file, and
 Solicit public involvement in selection of a remedy.
Stress importance of public input on all alternatives.

Site Background

Provide brief overview of site.
Describe site history.

Scope and Role of Operable Unit or Response Action

Describe scope of problem that the action will address.
Describe role of action within site strategy.
Identify how action addresses principal threat(s).

Summary of Site Risks

Provide overview of baseline risk assessment, by describing the:
 Contaminated media,
 Chemicals of concern,
 Baseline exposure scenarios (e.g., routes of exposure, current and
 future land-use scenarios), and
 Current and potential site risks (including both carcinogenic and
 noncarcinogenic threats).
Discuss ecological risk(s), as appropriate.

Summary of Alternatives

Provide narrative description of alternatives evaluated in detailed
analysis of FS -- including engineering components, treatment components,
estimated present-worth cost, implementation time, and the major ARARs
associated with the alternative(s).

TABLE 19 (Cont'd)

Evaluation of Alternatives and the Preferred Alternative

Identify the preferred alternative.

Introduce the nine evaluation criteria and discuss how they are utilized in the Superfund program.

Provide the rationale for the preferred alternative by profiling it against the nine criteria and highlighting how it compares to the other alternatives (major advantages and disadvantages). State/support agency and community acceptance should be addressed to the extent adequate information is available at the time.

Discuss the lead agency's belief that the preferred alternative would satisfy the statutory findings, including the preference for treatment as a principal element.

When the support agency concurs with the preferred alternative, its recommendation that the alternative meets the statutory findings should also be included.

Community Participation^a

Provide notice of public comment period (written comments are encouraged). Note time and place for public meeting(s) (if scheduled) or offer opportunity for meeting(s).

Provide the location of administrative record files and information repositories

^aCommunity includes the general public and potentially responsible parties.

6 PROJECT SCHEDULE

The overall schedule for the environmental compliance activities planned for the Colonie site is shown in Figure 17. This schedule was developed in accordance with FUSRAP budget planning as of fiscal year 1989 and illustrates the projected schedules planned through the ROD. This schedule shows the relationship and projected durations of the tasks; however, specific dates beyond 1990 should not be considered as firmly established because funding is provided on the basis of an out-year budget cycle. The RI/FS process will address management of contaminated materials resulting from remedial action activities at the Colonie site, including the three adjacent vicinity properties. The project plan consists of the following major components:

- Completion of site characterization and data validation and evaluation activities. These activities were scheduled to be completed in September 1989.
- Completion of the RI/FS process, consisting of a baseline risk assessment and an RI/FS report. These documents will be prepared with data obtained from the site characterization activities. During the first two phases of the FS, technologies will be screened and alternatives will be developed and screened for evaluation in the third phase. The RI/FS will be supplemented as needed for NEPA purposes. It will then be determined if a FONSI under NEPA can be issued. If a FONSI is issued, no further NEPA review will be required and the RI/FS process will continue through completion. If a FONSI is not appropriate, efforts to initiate an EIS will be undertaken and the RI/FS will be revised to address the increased level of environmental analysis necessary to support an EIS. Based on information currently available for the Colonie site, the schedule presented in this work plan is based on the assumption that a FONSI is likely.
- Public comments on the draft RI/FS and proposed plan will be addressed in the final RI/FS and responsiveness summary, which will describe the selected remedy for the Colonie site. The ROD is projected to be issued in February 1993. Remedial action will be initiated following issuance of the ROD.
- Decontamination and demolition of buildings, with removal of decontaminated and clean rubble and bulk wastes, will be initiated in 1993 following issuance of the ROD.
- Remediation of adjacent vicinity properties will be included in and concurrent with remedial action activities scheduled for the Colonie site in 1993 following issuance of the ROD.

FIGURE 17 Schedule for the Colonie Site through Record of Decision

7 PROJECT MANAGEMENT

7.1 PROJECT ORGANIZATION

Remedial action at the Colonie site is being conducted by DOE under FUSRAP, which is administered by the Decontamination and Decommissioning Division within the Office of Environmental Restoration and Waste Management (Figure 18). This division is responsible for policy decisions related to conducting remedial actions at the site. Responsibility for management and technical direction of remedial action activities for FUSRAP has been delegated to DOE Oak Ridge Operations (DOE-OR). The Technical Services Division within DOE-OR manages the day-to-day activities for FUSRAP. The DOE-OR has functional responsibility for preparation of the environmental compliance documents, although various groups at DOE Headquarters have review and concurrence authority. The Assistant Secretary for the Environment, Safety and Health is responsible for approving publication of the RI/FS-EA.

Several organizations are under contract to DOE-OR to support implementation of FUSRAP. The two organizations responsible for preparation of the Colonie RI/FS-EA are Bechtel National, Inc. (BNI), and Argonne National Laboratory (ANL). The project management contractor for remedial action activities at the Colonie site is BNI. As such, BNI is responsible for the collection of all necessary site characterization and environmental data required for the RI report. The environmental compliance contractor for the Colonie site is ANL. In this role, ANL provides an independent analysis of the environmental impacts of alternatives proposed for the remedial action at the Colonie site, and ANL is responsible for preparation of this work plan, the baseline risk assessment, and the FS -- using information provided by BNI (e.g., the RI report and requisite technical, engineering, and cost studies to support the detailed analyses required in the FS). The information provided by BNI is supplemented, as necessary, by visiting the site, meeting and consulting with other agencies, performing technical analyses, and reviewing existing documents.

7.2 PROJECT COORDINATION AND RESPONSIBILITIES

Three organizations are under contract to DOE-OR to support the implementation of remedial actions at the Colonie site (Figure 18). The responsibilities of these organizations are as follows:

- Bechtel National, Inc.
 - Provides overall project management support to DOE for the Colonie site,
 - Administers procurement and quality assurance functions,
 - Performs general administrative functions,

- Administers all environmental, safety, and health programs at the site,
- Directs all engineering activities,
- Provides technical input to the preparation of environmental documents, and
- Performs community relations duties.

FIGURE 18 Project Organization

- Argonne National Laboratory
 - Performs health and environmental analyses for the RI/FS process,
 - Provides an independent analysis of environmental studies, engineering feasibility, and cost-effectiveness of response action alternatives performed by other DOE contractors, and
 - Prepares additional environmental compliance documentation as needed.
- Oak Ridge National Laboratory provides technical support on an as-needed basis.

Four organizations provide technical support for FUSRAP to the Decontamination and Decommissioning Division (Figure 18). These organizations provide the following functions:

- Conduct radiological surveys to identify and designate vicinity properties that require remedial action.
- Conduct post-response action radiological surveys to provide an independent verification of the adequacy of cleanup and prepare associated verification reports.
- Perform technical review of FUSRAP documents.

7.3 PROJECT CONTROLS

Project controls are implemented to provide detailed planning for cost, schedule, and technical performance. In this way, efforts toward achievement of project goals are maximized. Project controls are implemented for the FUSRAP project as a whole because there are 31 sites in 13 states for which costs and schedules must be tracked and controlled. To accomplish these controls, BNI has established a system that conforms with the criteria for cost and schedule control systems developed by the U.S. Department of Defense. The system used by BNI has been validated by DOE. This system provides a basis for assessing the quality of the cost and schedule controls used by the project participants; aids in ensuring effective planning, management, and control of project work; and provides a quick and effective means of measuring cost, schedule, and technical performance. This cost and schedule control system utilizes a work breakdown structure to divide the total FUSRAP project into sites and then into discrete work packages that can be effectively managed. The work breakdown structure also provides the framework for integrating budget requirements with schedule and technical performance. Finally, it establishes the management analysis and reporting structure to permit data presentation to various levels of management.

A project document control center is maintained at BNI's office in Oak Ridge, Tennessee, to collect, register, distribute, and retain all documents. All documents

related to the Colonie site are coded with work breakdown structure number 139 to associate them with the site. Subject codes are also assigned from predetermined categories that can be used to organize documents. The project document control center system provides for rapid identification and retrieval of all project documents by allowing documents to be searched/sorted by work breakdown structure number, subject code, author, recipient, transmittal date, a unique identification number, or any combination of the above.

All related information obtained during the RI/FS process for the Colonie site is being retained by the project document control center. This includes aerial photographs, topographic maps, reports on features of the site and its surrounding area, correspondence involving the site, findings of previous surveys, and analytical data obtained during site characterization. Types of characterization data on file include radiological and chemical data based on analyses of soil, groundwater, and surface water; borehole logging data; air sampling data; and information about geological and soil properties. Well construction data and field notebooks and documentation (e.g., chain-of-custody forms) are also on file. Additional information on the project document control center can be found in the quality assurance project plan.

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APPENDIX A:
DOE GUIDELINES FOR RESIDUAL RADIOACTIVE MATERIAL

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APPENDIX A:**DOE GUIDELINES FOR RESIDUAL RADIOACTIVE MATERIAL**

[reproduced from U.S. Department of Energy, 1987, *U.S. Department of Energy Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites* (Revision 2, March 1987)]

A. INTRODUCTION

This document presents U.S. Department of Energy (DOE) radiological protection guidelines for cleanup of residual radioactive material and management of the resulting wastes and residues. It is applicable to sites identified by the Formerly Utilized Sites Remedial Action Program (FUSRAP) and remote sites identified by the Surplus Facilities Management Program (SFMP).^{*} The topics covered are basic dose limits, guidelines and authorized limits for allowable levels of residual radioactive material, and requirements for control of the radioactive wastes and residues.

Protocols for identification, characterization, and designation of FUSRAP sites for remedial action; for implementation of the remedial action; and for certification of a FUSRAP site for release for unrestricted use are given in a separate document (U.S. Department of Energy 1986) and subsequent guidance. More detailed information on applications of the guidelines presented herein, including procedures for deriving site-specific guidelines for allowable levels of residual radioactive material from basic dose limits, is contained in "A Manual for Implementing Residual Radioactive Material Guidelines" (U.S. Department of Energy 1987), referred to herein as the "supplement".

"Residual radioactive material" is used in these guidelines to describe radioactive material derived from operations or sites over which DOE has authority. Guidelines or guidance to limit the levels of radioactive material and to protect the public and the environment are provided for (1) residual concentrations of radionuclides in soil,** (2) concentrations of airborne

^{*}A remote SFMP site is one that is excess to DOE programmatic needs and is located outside a major operating DOE research and development or production area.

^{**}"Soil" is defined herein as unconsolidated earth material, including rubble and debris that may be present in earth material.

radon decay products, (3) external gamma radiation levels, (4) surface contamination levels, and (5) radionuclide concentrations in air or water resulting from or associated with any of the above.

A "basic dose limit" is a prescribed standard from which limits for quantities that can be monitored and controlled are derived; it is specified in terms of the effective dose equivalent as defined by the International Commission on Radiological Protection (ICRP 1977, 1978). The basic dose limits are used for deriving guidelines for residual concentrations of radionuclides in soil. Guidelines for residual concentrations of thorium and radium in soil, concentrations of airborne radon decay products, allowable indoor external gamma radiation levels, and residual surface contamination concentrations are based on existing radiological protection standards (U.S. Environmental Protection Agency 1983; U.S. Nuclear Regulatory Commission 1982; and DOE Departmental Orders). Derived guidelines or limits based on the basic dose limits for those quantities are used only when the guidelines provided in the existing standards cited above are shown to be inappropriate.

A "guideline" for residual radioactive material is a level of radioactivity or radioactive material that is acceptable if use of the site is to be unrestricted. Guidelines for residual radioactive material presented herein are of two kinds: (1) generic, site-independent guidelines taken from existing radiation protection standards and (2) site-specific guidelines derived from basic dose limits using site-specific models and data. Generic guideline values are presented in this document. Procedures and data for deriving site-specific guideline values are given in the supplement. The basis for the guidelines is generally a presumed worst-case plausible-use scenario for the site.

An "authorized limit" is a level of residual radioactive material or radioactivity that must not be exceeded if the remedial action is to be considered completed and the site is to be released for unrestricted use. The authorized limits for a site will include (1) limits for each radionuclide or group of radionuclides, as appropriate, associated with residual radioactive material in soil or in surface contamination of structures and equipment, (2) limits for each radionuclide or group of radionuclides, as appropriate, in air or water, and, (3) where appropriate, a limit on external gamma radiation resulting from the residual material. Under normal circumstances, expected to occur at most sites, authorized limits for residual radioactive material or radioactivity are set equal to guideline values. Exceptional conditions for which authorized limits might differ from guideline values are specified in Sections D and F of this document. A site may be released for unrestricted use only if site conditions do not exceed the authorized limits or approved supplemental limits, as defined in Section F.1, at the time remedial action is completed. Restrictions and controls on use of the site must be established and enforced if site conditions exceed the approved limits, or if there is potential to exceed the basic dose limit if use of the site is not restricted (Section F.2). The applicable controls and restrictions are specified in Section E.

DOE policy requires that all exposures to radiation be limited to levels that are as low as reasonably achievable (ALARA). For sites to be released for unrestricted use, the intent is to reduce residual radioactive material to levels that are as far below authorized limits as reasonable considering technical, economic, and social factors. At sites where the residual material is not reduced to levels that permit release for unrestricted use, ALARA policy is implemented by establishing controls to reduce exposure to levels that are as low as reasonably achievable. Procedures for implementing ALARA policy are discussed in the supplement. ALARA policies, procedures, and actions shall be documented and filed as a permanent record upon completion of remedial action at a site.

B. BASIC DOSE LIMITS

The basic limit for the annual radiation dose received by an individual member of the general public is 100 mrem/yr. The internal committed effective dose equivalent, as defined in ICRP Publication 26 (ICRP 1977) and calculated by dosimetry models described in ICRP Publication 30 (ICRP 1978), plus the dose from penetrating radiation sources external to the body, shall be used for determining the dose. This dose shall be described as the "effective dose equivalent". Every effort shall be made to ensure that actual doses to the public are as far below the basic dose limit as is reasonably achievable.

Under unusual circumstances, it will be permissible to allow potential doses to exceed 100 mrem/yr where such exposures are based upon scenarios that do not persist for long periods and where the annual lifetime exposure to an individual from the subject residual radioactive material would be expected to be less than 100 mrem/yr. Examples of such situations include conditions that might exist at a site scheduled for remediation in the near future or a possible, but improbable, one-time scenario that might occur following remedial action. These levels should represent doses that are as low as reasonably achievable for the site. Further, no annual exposure should exceed 500 mrem.

C. GUIDELINES FOR RESIDUAL RADIOACTIVE MATERIAL

C.1 Residual Radionuclides in Soil

Residual concentrations of radionuclides in soil shall be specified as above-background concentrations averaged over an area of 100 m². Generic guidelines for thorium and radium are specified below. Guidelines for residual concentrations of other radionuclides shall be derived from the basic dose limits by means of an environmental pathway analysis using site-specific data where available. Procedures for these derivations are given in the supplement.

If the average concentration in any surface or below-surface area less than or equal to 25 m² exceeds the authorized limit or guideline by a factor of $(100/A)^{1/2}$, where A is the area of the elevated region in square meters,

limits for "hot spots" shall also be applicable. Procedures for calculating these hot spot limits, which depend on the extent of the elevated local concentrations, are given in the supplement. In addition, every reasonable effort shall be made to remove any source of radionuclide that exceeds 30 times the appropriate limit for soil, irrespective of the average concentration in the soil.

Two types of guidelines are provided, generic and derived. The generic guidelines for residual concentrations of Ra-226, Ra-228, Th-230, and Th-232 are:

- 5 pCi/g, averaged over the first 15 cm of soil below the surface
- 15 pCi/g, averaged over 15-cm-thick layers of soil more than 15 cm below the surface

These guidelines take into account ingrowth of Ra-226 from Th-230 and of Ra-228 from Th-232, and assume secular equilibrium. If either Th-230 and Ra-226 or Th-232 and Ra-228 are both present, not in secular equilibrium, the appropriate guideline is applied as a limit to the radionuclide with the higher concentration. If other mixtures of radionuclides occur, the concentrations of individual radionuclides shall be reduced so that (1) the dose for the mixtures will not exceed the basic dose limit or (2) the sum of the ratios of the soil concentration of each radionuclide to the allowable limit for that radionuclide will not exceed 1 ("unity"). Explicit formulas for calculating residual concentration guidelines for mixtures are given in the supplement.

C.2 Airborne Radon Decay Products

Generic guidelines for concentrations of airborne radon decay products shall apply to existing occupied or habitable structures on private property that are intended for unrestricted use; structures that will be demolished or buried are excluded. The applicable generic guideline (40 CFR Part 192) is: In any occupied or habitable building, the objective of remedial action shall be, and a reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL.* In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL. Remedial actions by DOE are not required in order to comply with this guideline when there is reasonable assurance that residual radioactive material is not the cause.

*A working level (WL) is any combination of short-lived radon decay products in one liter of air that will result in the ultimate emission of 1.3×10^5 MeV of potential alpha energy.

C.3 External Gamma Radiation

The average level of gamma radiation inside a building or habitable structure on a site to be released for unrestricted use shall not exceed the background level by more than 20 μ R/h and shall comply with the basic dose limit when an appropriate-use scenario is considered. This requirement shall not necessarily apply to structures scheduled for demolition or to buried foundations. External gamma radiation levels on open lands shall also comply with the basic dose limit, considering an appropriate-use scenario for the area.

C.4 Surface Contamination

The generic surface contamination guidelines provided in Table 1 are applicable to existing structures and equipment. These guidelines are adapted from standards of the U.S. Nuclear Regulatory Commission (NRC 1982)* and will be applied in a manner that provides a level of protection consistent with the Commission's guidance. These limits apply to both interior and exterior surfaces. They are not directly intended for use on structures to be demolished or buried, but should be applied to equipment or building components that are potentially salvageable or recoverable scrap. If a building is demolished, the guidelines in Section C.1 are applicable to the resulting contamination in the ground.

C.5 Residual Radionuclides in Air and Water

Residual concentrations of radionuclides in air and water shall be controlled to levels required by DOE Environmental Protection Guidance and Orders, specifically DOE Order 5480.1A and subsequent guidance. Other Federal and/or state standards shall apply when they are determined to be appropriate.

D. AUTHORIZED LIMITS FOR RESIDUAL RADIOACTIVE MATERIAL

Authorized limits shall be established to (1) ensure that, as a minimum, the basic dose limits specified in Section B will not be exceeded under the worst-case plausible-use scenario consistent with the procedures and guidance provided or (2) be consistent with applicable generic guidelines, where such guidelines are provided. The authorized limits for each site and its vicinity properties shall be set equal to the generic or derived guidelines except where it can be clearly established on the basis of site-specific data -- including health, safety, and socioeconomic considerations -- that the guidelines are not appropriate for use at the specific site. Consideration should also be given to ensure that the limits comply with or provide a level of protection equivalent to other appropriate limits and guidelines (i.e., state or

*These guidelines are functionally equivalent to Section 4 -- Decontamination for Release for Unrestricted Use -- of NRC Regulatory Guide 1.86 (U.S. Atomic Energy Commission 1974), but they are applicable to non-reactor facilities.

TABLE 1 SURFACE CONTAMINATION GUIDELINES

Radionuclides ^b	Allowable Total Residual Surface Contamination (dpm/100 cm ²) ^a		
	Average ^{c,d}	Maximum ^{d,e}	Removable ^{d,f}
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100	300	20
Th-Natural, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	3,000	200
U-Natural, U-235, U-238, and associated decay products	5,000 α	15,000 α	1,000 α
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000 β - γ	15,000 β - γ	1,000 β - γ

^a As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

^b Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides should apply independently.

^c Measurements of average contamination should not be averaged over an area of more than 1 m². For objects of less surface area, the average should be derived for each such object.

^d The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at 1 cm.

^e The maximum contamination level applies to an area of not more than 100 cm².

^f The amount of removable radioactive material per 100 cm² of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm² is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. The numbers in this column are maximum amounts.

other Federal). Documentation supporting such a decision should be similar to that required for supplemental limits and exceptions (Section F), but should be generally more detailed because the documentation covers the entire site.

Remedial action shall not be considered complete unless the residual radioactive material levels comply with the authorized limits. The only exception to this requirement will be for those special situations where the supplemental limits or exceptions are applicable and approved as specified in Section F. However, the use of supplemental limits and exceptions should be considered only if it is clearly demonstrated that it is not reasonable to decontaminate the area to the authorized limit or guideline value. The authorized limits are developed through the project offices in the field and are approved by the headquarters program office.

E. CONTROL OF RESIDUAL RADIOACTIVE MATERIAL AT FUSRAP AND REMOTE SFMP SITES

Residual radioactive material above the guidelines at FUSRAP and remote SFMP sites must be managed in accordance with applicable DOE Orders. The DOE Order 5480.1A and subsequent guidance or superceding Orders require compliance with applicable Federal and state environmental protection standards.

The operational and control requirements specified in the following DOE Orders shall apply to interim storage, interim management, and long-term management.

- a. 5000.3, Unusual Occurrence Reporting System
- b. 5440.1C, Implementation of the National Environmental Policy Act
- c. 5480.1A, Environmental Protection, Safety, and Health Protection Program for DOE Operations, as revised by DOE 5480.1 change orders and the 5 August 1985 memorandum from Vaughan to Distribution
- d. 5480.2, Hazardous and Radioactive Mixed Waste Management
- e. 5480.4, Environmental Protection, Safety, and Health Protection Standards
- f. 5482.1A, Environmental, Safety, and Health Appraisal Program
- g. 5483.1A, Occupational Safety and Health Program for Government-Owned Contractor-Operated Facilities
- h. 5484.1, Environmental Protection, Safety, and Health Protection Information Reporting Requirements
- i. 5820.2, Radioactive Waste Management

E.1 Interim Storage

- a. Control and stabilization features shall be designed to ensure, to the extent reasonably achievable, an effective life of 50 years and, in any case, at least 25 years.
- b. Above-background Rn-222 concentrations in the atmosphere above facility surfaces or openings shall not exceed (1) 100 pCi/L at any given point, (2) an annual average concentration of 30 pCi/L over the facility site, and (3) an annual average concentration of 3 pCi/L at or above any location outside the facility site (DOE Order 5480.1A, Attachment XI-1).
- c. Concentrations of radionuclides in the groundwater or quantities of residual radioactive material shall not exceed existing Federal or state standards.
- d. Access to a site shall be controlled and misuse of on-site material contaminated by residual radioactive material shall be prevented through appropriate administrative controls and physical barriers -- active and passive controls as described by the U.S. Environmental Protection Agency (1983--p. 595). These control features should be designed to ensure, to the extent reasonable, an effective life of at least 25 years. The Federal government shall have title to the property or shall have a long-term lease for exclusive use.

E.2 Interim Management

- a. A site may be released under interim management when the residual radioactive material exceeds guideline values if the residual radioactive material is in inaccessible locations and would be unreasonably costly to remove, provided that administrative controls are established to ensure that no member of the public shall receive a radiation dose exceeding the basic dose limit.
- b. The administrative controls, as approved by DOE, shall include but not be limited to periodic monitoring as appropriate, appropriate shielding, physical barriers to prevent access, and appropriate radiological safety measures during maintenance, renovation, demolition, or other activities that might disturb the residual radioactive material or cause it to migrate.
- c. The owner of the site or appropriate Federal, state, or local authorities shall be responsible for enforcing the administrative controls.

E.3 Long-Term Management

Uranium, Thorium, and Their Decay Products

- a. Control and stabilization features shall be designed to ensure, to the extent reasonably achievable, an effective life of 1,000 years and, in any case, at least 200 years.
- b. Control and stabilization features shall be designed to ensure that Rn-222 emanation to the atmosphere from the wastes shall not (1) exceed an annual average release rate of 20 pCi/m²/s and (2) increase the annual average Rn-222 concentration at or above any location outside the boundary of the contaminated area by more than 0.5 pCi/L. Field verification of emanation rates is not required.
- c. Prior to placement of any potentially biodegradable contaminated wastes in a long-term management facility, such wastes shall be properly conditioned to ensure that (1) the generation and escape of biogenic gases will not cause the requirement in paragraph b. of this section (E.3) to be exceeded and (2) biodegradation within the facility will not result in premature structural failure in violation of the requirements in paragraph a. of this section (E.3).
- d. Groundwater shall be protected in accordance with appropriate Departmental Orders and Federal and state standards, as applicable to FUSRAP and remote SFMP sites.
- e. Access to a site should be controlled and misuse of on-site material contaminated by residual radioactivity should be prevented through appropriate administrative controls and physical barriers -- active and passive controls as described by the U.S. Environmental Protection Agency (1983--p. 595). These controls should be designed to be effective to the extent reasonable for at least 200 years. The Federal government shall have title to the property.

Other Radionuclides

- f. Long-term management of other radionuclides shall be in accordance with Chapters 2, 3, and 5 of DOE Order 5820.2, as applicable.

F. SUPPLEMENTAL LIMITS AND EXCEPTIONS

If special site-specific circumstances indicate that the guidelines or authorized limits established for a given site are not appropriate for a portion of that site or for a vicinity property, then the field office may request that supplemental limits or an exception be applied. In either case, the field office must justify that the subject guidelines or authorized limits are not appropriate and that the alternative action will provide adequate

protection, giving due consideration to health and safety, the environment, and costs. The field office shall obtain approval for specific supplemental limits or exceptions from headquarters as specified in Section D of these guidelines and shall provide to headquarters those materials required for the justification as specified in this section (F) and in the FUSRAP and SFMP protocols and subsequent guidance documents. The field office shall also be responsible for coordination with the state or local government of the limits or exceptions and associated restrictions as appropriate. In the case of exceptions, the field office shall also work with the state and/or local governments to ensure that restrictions or conditions of release are adequate and mechanisms are in place for their enforcement.

F.1 Supplemental Limits

The supplemental limits must achieve the basic dose limits set forth in this guideline document for both current and potential unrestricted uses of a site and/or vicinity property. Supplemental limits may be applied to a vicinity property or a portion of a site if, on the basis of a site-specific analysis, it is determined that (1) certain aspects of the vicinity property or portion of the site were not considered in the development of the established authorized limits and associated guidelines for that vicinity property or site and, (2) as a result of these unique characteristics, the established limits or guidelines either do not provide adequate protection or are unnecessarily restrictive and costly.

F.2 Exceptions

Exceptions to the authorized limits defined for unrestricted use of a site or vicinity property may be applied to a vicinity property or a portion of a site when it is established that the authorized limits cannot be achieved and restrictions on use of the vicinity property or portion of the site are necessary to provide adequate protection of the public and the environment. The field office must clearly demonstrate that the exception is necessary and that the restrictions will provide the necessary degree of protection and will comply with the requirements for control of residual radioactive material as set forth in Section E of these guidelines.

F.3 Justification for Supplemental Limits and Exceptions

Supplemental limits and exceptions must be justified by the field office on a case-by-case basis using site-specific data. Every effort should be made to minimize use of the supplemental limits and exceptions. Examples of specific situations that warrant use of the supplemental standards and exceptions are:

- a. Where remedial action would pose a clear and present risk of injury to workers or members of the general public, notwithstanding reasonable measures to avoid or reduce risk.

- b. Where remedial action -- even after all reasonable mitigative measures have been taken -- would produce environmental harm that is clearly excessive compared to the health benefits to persons living on or near affected sites, now or in the future. A clear excess of environmental harm is harm that is long-term, manifest, and grossly disproportionate to health benefits that may reasonably be anticipated.
- c. Where it is clear that the scenarios or assumptions used to establish the authorized limits do not, under plausible current or future conditions, apply to the property or portion of the site identified and where more appropriate scenarios or assumptions indicate that other limits are applicable or necessary for protection of the public and the environment.
- d. Where the cost of remedial action for contaminated soil is unreasonably high relative to long-term benefits and where the residual radioactive material does not pose a clear present or future risk after taking necessary control measures. The likelihood that buildings will be erected or that people will spend long periods of time at such a site should be considered in evaluating this risk. Remedial action will generally not be necessary where only minor quantities of residual radioactive material are involved or where residual radioactive material occurs in an inaccessible location at which site-specific factors limit their hazard and from which they are costly or difficult to remove. Examples include residual radioactive material under hard-surface public roads and sidewalks, around public sewer lines, or in fence-post foundations. A site-specific analysis must be provided to establish that it would not cause an individual to receive a radiation dose in excess of the basic dose limits stated in Section B, and a statement specifying the level of residual radioactive material must be included in the appropriate state and local records.
- e. Where there is no feasible remedial action.

G. SOURCES

Limit or Guideline	Source
<u>Basic Dose Limits</u>	
Dosimetry model and dose limits	International Commission on Radiological Protection (1977, 1978)
<u>Generic Guidelines for Residual Radioactivity</u>	
Residual concentrations of radium and thorium in soil	40 CFR Part 192
Airborne radon decay products	40 CFR Part 192
External gamma radiation	40 CFR Part 192
Surface contamination	Adapted from U.S. Nuclear Regulatory Commission (1982)
<u>Control of Radioactive Wastes and Residues</u>	
Interim storage	DOE Order 5480.1A and subsequent guidance
Long-term management	DOE Order 5480.1A and subsequent guidance; 40 CFR Part 192; DOE Order 5820.2

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APPENDIX B:
POTENTIAL RESPONSE ACTIONS AND TECHNOLOGIES
FOR ENVIRONMENTAL MEDIA AT THE COLONIE SITE

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TABLE B.1 Potential Response Actions and Technologies for Soil/Sludge

Remedial Action Objectives	General Response Action	Potential Technology Type	Potential Process Option	Comments
No action	No action	Not applicable	Not applicable	This is retained as a potential response to provide a baseline for comparison with action alternatives.
Minimize potential exposure to external gamma radiation; minimize potential exposure to chemical contaminants via direct contact; minimize potential exposure to radioactive and chemical contaminants via ingestion; minimize potential exposure to radioactive and chemical contaminants via inhalation; minimize potential biouptake of radioactive and chemical contaminants; minimize potential migration of radioactive and chemical contaminants that could (further) contaminate surface water, groundwater, and other soils/sludges.	Institutional controls	Access restrictions Ownership and deed restrictions Monitoring	Fences and guards Legal titles and deeds Groundwater wells and air, surface water, and soil/sludge samplers	These varied institutional controls are not typically effective in controlling the source or migration of contaminants and are generally used only to support other response actions.

TABLE B.1 (Cont'd)

Remedial Action Objectives	General Response Action	Potential Technology Type	Potential Process Option	Comments
Minimize toxicity, mobility, and/or volume of contaminated material (and as for institutional controls)	In-situ containment	Surface controls/diversion	Graded contours, swales and berms, and vegetation	Surface controls and capping can limit contaminant mobility and can mitigate potential exposures, biouptake, and migration (via air, surface water, and groundwater) by attenuating gaseous emissions (e.g., radon) and controlling particulate resuspension, surface water runoff and runoff, and precipitation-enhanced percolation and leaching. These processes can be implemented with conventional equipment.
		Capping	Soil (clay) and vegetation or rip rap; asphalt or cement; synthetic membrane material; and multilayer, multimedia material	
		Lateral barriers	Slurry wall, grout curtain, and sheet piling	
		Bottom sealing	Grout layer injection and block displacement	
As for in-situ containment	Removal	Excavation	Dragline, backhoe, bulldozer, scraper, and front-end loader	Excavation and pumping can limit contaminant mobility and can mitigate potential exposures and biouptake by controlling the contaminant source. These technologies can be implemented with conventional equipment.
		Pumping (sludges or slurried soils)	Various pump types, including positive displacement and Moyno (progressing cavity) pumps	
		Injection and extraction	Injection/extraction wells	These technologies can limit the mobility of contaminated material (e.g., soil containing volatile organic compounds [VOCs]) and can mitigate potential exposures (e.g., via inhalation) and biouptake/biotranspiration by controlling the contaminant source. However, because they are typically considered together with treatment systems, they are discussed under the "Treatment/pretreatment" general response action in this table.

TABLE B.1 (Cont'd)

Remedial Action Objectives	General Response Action	Potential Technology Type	Potential Process Option	Comments
As for in-situ containment	Treatment/pretreatment:	Physical:		
	In situ	Dewatering/drying	Solar evaporation, pumping, and gravity drainage trenches	Dewatering/drying can limit the mobility and volume of contaminated materials and mitigate potential exposures, migration, and biouptake. These processes can be implemented using conventional methods.
		Nonthermal extraction	Air injection, vacuum extraction, and soil flushing (water only), using wells and surface application	Nonthermal extraction in situ can reduce the toxicity, mobility, and volume of contaminated soil/sludge and can limit potential exposures, biouptake, and migration by controlling the contaminant source. Air injection and vacuum extraction can be used to treat soil/sludge contaminated with VOCs but these processes are generally ineffective for treating low-volatile organics and cyanides, metals, and other inorganics. The primary action associated with soil flushing with water is a physical "sweeping" to accelerate contaminant migration by injection or spraying/ponding; hence it is being discussed as a physical technology. Water alone is typically a poor flushing solution, and this process is generally ineffective for complex wastes in soils of high organic content and low permeability.
		Thermal extraction	Steam/hot water injection, steam/hot air extraction, radio frequency (RF) heating, and electroacoustic soil decontamination (ESD), using wells, conductors, and electrodes	Thermal extraction in situ achieves remedial action objectives in a manner similar to non-thermal extraction under similar constraints. Steam and hot water can be injected into a soil/sludge contaminated with oils to enhance their displacement to the surface. Steam and hot air can be used to treat soil/sludge contaminated with VOCs by enhancing their evaporation and upward migration. The RF process can be used to treat soil/sludge contaminated with hydrocarbons. The ESD process enhances liquid transport (i.e., dewatering/leaching) via soil particle double layer boundary effects; heavy metals may also be leached or precipitated by this process, which has been demonstrated only on a pilot scale for waste treatment applications.

TABLE B.1 (Cont'd)

Remedial Action Objectives	General Response Action	Potential Technology Type	Potential Process Option	Comments
As for in-situ containment	Treatment/pretreatment (cont'd):	Physical (cont'd):		
	In situ (cont'd)	Thermal destruction	In-situ vitrification (ISV), using electrodes	Thermal destruction in situ can reduce the toxicity, mobility, and volume of contaminated soil/sludge and can limit potential exposures, biouptake, and migration by controlling the contaminant source. In ISV, an electric current is used to melt the soil/sludge and destroy organic compounds by pyrolysis and combustion; upon cooling, a glassy, durable matrix is formed that incorporates inorganic contaminants (including radionuclides) and other nonvolatile compounds. Field-scale demonstration of ISV has been limited, and it remains in the advanced developmental stage for waste treatment.
	Following removal	Dewatering/drying	Rotary drum, vacuum, and belt filtration; drying beds; filter press; automatic pressure filtration; gravity thickening; centrifugation; and evaporation	As for dewatering/drying in-situ.
		Solids separation	Classification (mechanical/nonmechanical); soil sorting, sand sifting (grizzlies) and screening (wet/dry); flotation and gravity concentration/centrifugation; magnetic and paramagnetic separation; and electrostatic separation	Solids separation processes can limit the toxicity, mobility, and volume of contaminated materials and mitigate potential exposures, migration, and biouptake. Although certain solids separation processes have been used to extract radionuclides from ores, they are generally ineffective for separating relatively low concentrations of contaminants from soil/sludge. This technology often serves as a pretreatment step for primary treatment processes and is considered developmental for waste treatment applications.

TABLE B.1 (Cont'd)

Remedial Action Objectives	General Response Action	Potential Technology Type	Potential Process Option	Comments
As for in-situ containment	Treatment/pretreatment (cont'd):	Physical (cont'd):		
	Following removal (cont'd)	Size reduction	Impact crushers, shredders, and tumbling hammer mills	These processes can reduce the size/volume of waste materials, which is often required as a pretreatment step for primary treatment processes (e.g., chemical extraction and thermal destruction processes). Size reduction can be achieved using conventional methods.
		Nonthermal extraction	Soil washing (water only), using a reactor vessel	Nonthermal extraction following removal achieves remedial action objectives in a manner similar to nonthermal extraction in situ. Soil/sludge can be mixed with water in a contact vessel to wash contaminants from the waste matrix but water alone is typically ineffective as a washing solution.
		Thermal extraction/destruction	Low-temperature thermal stripping; rotary kiln and fluidized bed incineration; pyrolytic incineration/ electric pyrolysis, advanced electric reactor, and high-temperature fluid wall reactor; circulating bed and molten salt combustion; plasma arc torch and infrared (IR) thermal destruction; wet air and supercritical water oxidation; and vitrification (joule-heated ceramic melter)	Thermal treatment following removal achieves remedial action objectives in a manner similar to thermal treatment in situ. The various process options typically produce a solid (e.g., ash, char, or glass), liquid (e.g., scrubbing water, brine, or condensate) and gaseous (e.g., volatilized organics and metals and innocuous gases) effluent. Thermal destruction processes are typically used to destroy organics, and while some are commonly used in waste treatment (e.g., incinerators), others are developmental (e.g., IR and supercritical water oxidation) and have been demonstrated only on a pilot scale.

TABLE B.1 (Cont'd)

Remedial Action Objectives	General Response Action	Potential Technology Type	Potential Process Option	Comments
As for in-situ containment	Treatment/prereatment (cont'd):	Chemical:		
	In situ	Soil flushing	Acid/base, surfactant, chelating agent, and organic solvent solutions via surface application and injection/extraction wells	In-situ flushing can reduce the toxicity, mobility, and volume of contaminated soil/sludge via desorptive reactions and can limit potential exposures, biouptake, and migration by controlling the contaminant source. This technology can remove VOCs from permeable soils (although migration control can be difficult), and it can be used as an initial treatment step to leach contaminants from a waste matrix (e.g., via solution mining). The solubility of hydrocarbons, metals, and radionuclides can be enhanced by solvent application, and the reagent solution can be sprinkled or ponded over the contaminated zone for aggressive treatment. Because this technology is very contaminant-specific and the selection of a suitable flushing fluid is difficult, it is ineffective for complex wastes. Mobile units are available, but full site cleanup has not yet been demonstrated by these processes.
		Chemical addition/detoxification	Hydrolysis, redox reactions, neutralization, precipitation, and solidification using drills, augers, and paddles for chemical addition	Chemical detoxification can achieve remedial action objectives in a manner similar to in-situ soil flushing via chemical reactions that alter the toxic nature of the contaminants or solidify them to limit mobility; however, in contrast to soil flushing, these reactions can increase the total volume of contaminated material following chemical addition (e.g., for precipitation and solidification processes). Chemical agents can be dispensed through a shaft and mixed via an up/down drill motion or by augers and hydraulically driven paddles; reagents are typically selected for treatment specificity. This technology is developmental for waste treatment applications and must be evaluated on a site-specific basis.

TABLE B.1 (Cont'd)

Remedial Action Objectives	General Response Action	Potential Technology Type	Potential Process Option	Comments
As for in-situ containment	Treatment/pretreatment (cont'd):	Chemical (cont'd):		
	In situ (cont'd)	Stabilization/fixation	Lime- and Portland cement-based pozzolanic reactions, asphalt-based thermoplastic microencapsulation, and catalyzed polymerization using drills, augers, and paddles for chemical introduction	In-situ stabilization/fixation processes can achieve remedial action objectives in a manner similar to in-situ chemical detoxification. This technology is typically used to treat soil/sludge contaminated with heavy metals and high molecular weight organics by binding the contaminants in place in an insoluble matrix or in a matrix that minimizes the surface exposed to potential solvents. Field demonstration of this technology in waste treatment applications has been limited.
	Following removal	Contact extraction	Soil washing (non-water), amine extraction, critical fluid (liquefied carbon dioxide and/or propane) solvent extraction, and other solution extractions (as for in-situ soil flushing) using a reactor vessel	Chemical extraction following removal achieves remedial action objectives in a manner similar to in-situ soil flushing. Various solutions can be used to separate oils, other organics, radionuclides, and metals from soil/sludge in an agitated reactor vessel. Amine extraction can be used to remove organics, and pH adjustment required for pretreatment may also precipitate heavy metals. Critical fluid solvent extraction can separate oils and organics from sludge/slurried soil and has been used to treat PCB-contaminated sludge but is inappropriate for removing heavy metals or inorganic compounds.
		Chemical-specific reaction	Glycolate dechlorination and redox reactions (which may be enhanced by electrolysis, catalysis, or irradiation) using a reactor vessel	Chemical-specific reactions following removal can achieve remedial action objectives in a manner similar to chemical detoxification in situ. Glycolate dechlorination can be used to dehalogenate volatile and semivolatile organics, PCBs, and pesticides by mixing contaminated soil/sludge with a glycolate solution in a heated reactor vessel; this process has been tested on PCB-contaminated soil. Redox (reduction and oxidation) processes can treat chlorinated organics and unsaturated hydrocarbons, metals, inorganic cyanides, and reactive contaminants in sludges/slurried soils. This process may be widely applicable as a treatment step, but care must be taken to select reagents specific to the reaction required and to avoid unwanted secondary reactions.

TABLE B.1 (Cont'd)

Remedial Action Objectives	General Response Action	Potential Technology Type	Potential Process Option	Comments
As for in-situ containment	Treatment/pretreatment (cont'd):	Chemical (cont'd):		
	Following removal (cont'd)	Stabilization/fixation	As for the in-situ application, but using a reactor vessel	As for the in-situ application, except that process effectiveness is less constrained because various pretreatment options are available (e.g., dewatering and crushing). Following implementation, the wastes could be replaced in the area from which they were removed. This technology has been demonstrated for hazardous waste treatment applications.
	Treatment/pretreatment (cont'd):	Biological:		
	In situ	Bioreclamation (enhanced biodegradation)	Nutrient/microbial injection and other system modifications	In-situ bioreclamation can reduce the mobility and volume of contaminated materials (and the toxicity of limited chemical contaminants) in a soil/sludge and can limit potential exposures, biouptake, and migration by controlling the contaminant source. In this process, oxygen, water, nutrients, and microbes can be applied to the surface of a contaminated soil/sludge or can be injected into the contaminated zone to enhance the natural biodegradation of contaminants. In addition, pH and temperature can be adjusted to improve reaction conditions. Bioreclamation can be used to treat highly biodegradable material but is generally ineffective for (and can be adversely affected by) inorganics, including heavy metals and radionuclides. This process is developmental for waste treatment applications (e.g., to treat pesticides and PCBs) and must be evaluated on a site-specific basis.
		Surface impoundment	Constructed stabilization pit, lagoon, or wetland	Surface impoundments can achieve remedial action objectives in a manner similar to in-situ bioreclamation under similar constraints. In this process, an impoundment can be constructed in situ to promote natural geochemical and biological reactions for removal of surface contamination (including metals). This technology is developmental for waste treatment applications and must be evaluated on a site-specific basis.

TABLE B.1 (Cont'd)

Remedial Action Objectives	General Response Action	Potential Technology Type	Potential Process Option	Comments
As for in-situ containment	Treatment/pretreatment (cont'd):	Biological (cont'd):		
	Following removal	Composting	Open and static windrows and reactor vessels	Composting following removal can achieve remedial action objectives in a manner similar to in-situ bioreclamation under similar constraints. Organic degradation can be achieved using open windrows, consisting of long piles of the waste that are aerated by tearing down and rebuilding; in static windrows that are aerated by forced air; and in reactor vessels that are aerated by tumbling, stirring, and forced air. Composting is not widely used but may be applicable to the treatment of highly biodegradable materials and structurally firm wastes (e.g., contaminated wood chips; see discussion for structural material/debris).
		Contact digestion	Activated sludge reactor and digestors	Digestion following removal can achieve remedial action objectives in a manner similar to in-situ bioreclamation under similar constraints. System conditions can be optimized (and co-metabolites can be added) more easily in a reactor vessel than in situ. These processes are commonly used in conventional wastewater/sludge treatment and are developmental for hazardous waste treatment applications but may be useful for treating pesticides and PCBs.
		Attached growth	Rotating biological contactor and trickling filter	Attached growth reactions following removal can achieve remedial action objectives in a manner similar to digestion following removal under similar constraints. These processes are not suitable for inorganic-contaminated material but have been demonstrated for sludges containing biodegradable organics.
		Surface impoundment	As for the in-situ application	As for the in-situ application, but system construction/control and optimization of treatment conditions is less constrained. For example, a lined treatment bed can be constructed with a leachate collection system and an overhead spray irrigation system to distribute nutrients and microbes. Although developmental for hazardous waste treatment applications, this technology could be used to treat wastes containing pesticides, PCBs, and oils.

TABLE B.1 (Cont'd)

Remedial Action Objectives	General Response Action	Potential Technology Type	Potential Process Option	Comments
As for in-situ containment	Treatment/pre-treatment (cont'd):	Biological (cont'd):		
	Following removal (cont'd)	Land application	Land farming	Land application can achieve remedial action objectives in a manner similar to composting under similar constraints. In this process, a waste is applied to and mixed with surface soil to enhance natural geochemical and biological processes. Although developmental for hazardous waste treatment applications, this technology could be used to treat wastes containing pesticides, PCBs, and oils.
As for in-situ containment	Temporary storage	On-site or off-site facility	Engineered structure	Temporary storage can reduce the mobility and volume of contaminated materials and can limit potential exposures, biouptake, and migration by controlling the contaminant source. This option requires the engineering of a storage facility and is implemented as an interim measure while a permanent remedy is developed. Constraints include technical (engineering) and socio-political (acceptability) issues.
As for in-situ containment	Disposal	On-site or off-site	Engineered structure (on land) or ocean disposal	Disposal can reduce the mobility and volume of contaminated materials and can limit potential exposures, biouptake, and migration by controlling the contaminant source. (Disposal often follows the treatment of contaminated materials, so toxicity reduction is often inherent in the overall management scheme.) This option requires either the engineering of a disposal facility (land-based) or the permission for implementing ocean disposal. In addition to engineering requirements, constraints include issues such as site suitability; transportation, including routes, risks, and costs (for the off-site options); and regulator/community acceptance.

TABLE B.2 Potential Response Actions and Technologies for Surface Water

Remedial Action Objectives	General Response Action	Potential Technology Type	Potential Process Option	Comments
No action	No action	Not applicable	Not applicable	This is retained as a potential response to provide a baseline for comparison with action alternatives.
As for soil/sludge under institutional controls	Institutional controls	Access restrictions	Fences and guards	These varied institutional controls are not typically effective in controlling the source or migration of contaminants and are generally used only to support other response actions.
		Ownership and deed restrictions	Legal titles and deeds	
		Monitoring	Groundwater wells and air, surface water, and soil/sludge samplers	
Minimize toxicity, mobility, and/or volume of contaminated material (and as for institutional controls)	In-situ containment	Surface controls/diversions	Graded contours, swales, dikes, and berms	Surface controls can limit contaminant mobility and can mitigate potential exposures, biouptake, and migration by controlling surface water runoff and runoff. These processes can be implemented with conventional equipment.
		Lateral barriers	Grout layer injection and block displacement	Lateral barriers and bottom sealing can limit contaminant mobility and can mitigate potential exposures by limiting migration to underlying soils, surface water, and groundwater. These processes can be implemented with conventional equipment, but field applications can be constrained by site-specific geologic conditions.
		Bottom sealing	Slurry wall, grout curtain, and sheet piling	
As for in-situ containment	Removal/collection	Interception and pumping	Interceptor channels and dynamic (centrifugal), reciprocating, and positive displacement pumps	Runoff interception and pumping can limit the toxicity, mobility and volume of contaminated material at the surface water location, thereby mitigating potential exposures, biouptake, and migration by controlling the contaminant source. This technology can be implemented with conventional equipment and is typically followed by a treatment scheme to reduce contaminant toxicity, mobility, and volume in the collected water.

TABLE B.2 (Cont'd)

Remedial Action Objectives	General Response Action	Potential Technology Type	Potential Process Option	Comments
As for in-situ containment	Removal/collection (cont'd):	Skimming and "sinker" collection	Floating boom and siphon dam	These in-situ processes can reduce the toxicity, mobility, and volume of contaminated surface water and can limit potential exposures, bio-uptake, and migration by controlling the contaminant source. They can be implemented with conventional methods and are typically used to remove floating oils or dense ("sinking") contaminants from surface waters (primarily streams).
As for in-situ containment	Treatment/pretreatment:	Physical:		
	In situ	Nonthermal extraction	Photolysis, density separation (clarification and flotation), and flocculation (via agitation)	These in-situ processes can reduce the toxicity, mobility, and volume of contaminated surface water and can limit potential exposures, bio-uptake, and contaminant migration by controlling the contaminant source. Such methods include ultraviolet irradiation, enhanced sedimentation (using a settling agent and air bubbling), and mixing with blades and air. They can be implemented with conventional methods and are typically used to treat suspended solids contamination, although dissolved organics and inorganics may also be treated by nonthermal extraction in situ.
		Thermal extraction	Solar evaporation	This thermal process can achieve remedial action objectives in a manner similar to nonthermal extraction in situ. Natural irradiation can be enhanced with covers and condensate collection to expedite treatment, and although this process can be implemented with conventional equipment, its application is constrained by site-specific climatic conditions.
	Following removal	Nonthermal extraction	Density separation (centrifugation), flocculation, filtration, adsorption, osmosis, reverse osmosis/ultrafiltration, electrolysis, electrodialysis, and freeze crystallization	These nonthermal extraction processes following removal can achieve remedial action objectives in a manner similar to nonthermal extraction in situ, but with fewer constraints and greater control of reactions and products. The processes can generally be implemented with conventional equipment, and many are used to treat suspended solids. Certain processes have been used in industrial wastewater treatment, but their demonstration in hazardous waste treatment has been limited.

TABLE B.2 (Cont'd)

Remedial Action Objectives	General Response Action	Potential Technology Type	Potential Process Option	Comments
As for in-situ containment	Treatment/pre-treatment (cont'd):	Physical (cont'd):		
	Following removal (cont'd)	Thermal extraction/destruction	Stripping, vapor recompression/distillation, wet air oxidation, supercritical water oxidation, liquid-injection incineration, and chlorinolysis	Thermal extraction and destruction processes can reduce the toxicity, mobility, and volume of contaminated surface water and can limit potential exposures, bio-uptake, and migration by controlling the contaminant source. These processes are typically used to destroy organics and can be operated with a liquid feed. Although certain destruction processes have been used in industrial applications, their demonstration for hazardous waste treatment has been limited.
	Treatment/pre-treatment (cont'd):	Chemical:		
	In situ	Chemical addition	Hydrolysis, redox reactions (including ozonation and chlorination), dechlorination, chelation, neutralization, and precipitation	Chemical addition can reduce the toxicity, mobility, and volume of contaminated surface water and can limit potential exposures, bio-uptake, and contaminant migration by controlling the contaminant source. This is achieved via chemical reactions that alter the toxic and/or physical nature of the contaminants. Chemical reagents such as surfactants, acids/bases, chelating agents, precipitants, and coagulant/flocculant aids can be mixed into a surface water by mechanical means (e.g., paddles and blades) or aeration. These processes can be implemented with conventional methods to treat both organics and inorganics and are common in wastewater treatment applications (although much more so following removal than in situ); their application for hazardous waste treatment has been limited.
	Following removal	Contact extraction	Solvent extraction	This process can reduce the toxicity, mobility, and volume of contaminated soil/sludge and can limit potential exposures, bio-uptake, and migration by controlling the contaminant source. Solvent extraction is typically used to remove organics from aqueous solutions and can be implemented with conventional methods. Application for hazardous waste treatment has been limited.

TABLE B.2 (Cont'd)

Remedial Action Objectives	General Response Action	Potential Technology Type	Potential Process Option	Comments
As for in-situ containment	Treatment/pretreatment (cont'd):	Chemical (cont'd):		
	Following removal (cont'd)	Chemical addition	As for the in-situ application, with additional processes (e.g., ion exchange and adsorption beds) and using a reactor vessel	As for the in-situ application, but the reaction system can be better controlled and process effectiveness can be optimized. Chemical addition can treat both organic and inorganic contaminants and can be implemented with conventional methods. Its use is common in wastewater treatment applications, but its application for hazardous waste treatment has been limited.
	Treatment/pretreatment (cont'd):	Biological:		
	In situ	Bioreclamation (enhanced biodegradation)	Nutrient/microbial injection and other system modifications	In-situ bioreclamation can reduce the mobility of contaminated materials (and the toxicity of limited chemical contaminants) in surface water and can limit potential exposures, biouptake, and migration by controlling the contaminant source. In this process, oxygen, nutrients, and microbes can be introduced to the water system and pH can be adjusted (with chemical addition) to improve reaction conditions. Mixing is typically required to enhance degradation. Bioreclamation can be used to treat highly biodegradable material but is generally ineffective for (and can be adversely affected by) inorganics, including heavy metals and radionuclides.
	Following removal	Contact digestion	Activated sludge reactor and digestors	As for soil/sludge following removal.
		Attached growth	Rotating biological contactor and trickling filter	Attached growth reactions following removal can achieve remedial action objectives in a manner similar to in-situ bioreclamation under similar constraints. These processes are not suitable for inorganic-contaminated material but could be useful for solutions containing biodegradable organics.

TABLE B.2 (Cont'd)

Remedial Action Objectives	General Response Action	Potential Technology Type	Potential Process Option	Comments
As for in-situ containment	Treatment/pretreatment (cont'd):	Biological:		
	Following removal (cont'd)	Surface impoundment	Constructed lagoon or wetland	Surface impoundments can achieve remedial action objectives in a manner similar to in-situ bio-reclamation under similar constraints. This process would be similar to the original condition of the surface water, except that the system could be constructed for better control and optimized for better removal efficiency. (See the related discussion for soil/sludge.)
		Land application	Spray irrigation	Spray irrigation can achieve remedial action objectives in a manner similar to surface impoundments and can be achieved using conventional equipment. This process can be used to treat organics but is generally ineffective for inorganics, and its implementation could be constrained by site-specific geological conditions.
As for in-situ containment	Disposal	On-site	Groundwater injection or discharge on land or to other surface water	On-site disposal can reduce the toxicity of contaminated surface water (by dilution) following direct discharge and can limit mobility, volume, potential exposures, bio-uptake, and migration at the original location by controlling the contaminant source. Surface water can be directly injected into the ground or discharged on land (e.g., via spraying) or to another surface water on-site (e.g., by pipe or gravity drainage) following collection, but it is not typically released before being treated. When used in conjunction with treatment, disposal can reduce the toxicity, mobility, and volume of contaminated surface water and limit overall exposures, bio-uptake, and migration.
		Off-site	Groundwater injection or discharge on land, to publicly owned treatment works (POTW), or to other surface water	Off-site disposal can achieve remedial action objectives in a manner similar to on-site disposal, with an additional option (i.e., piping to a POTW). This option must often be preceded by some type of treatment and requires permission from the operator. As for on-site disposal, surface water is not typically disposed of directly off-site; rather, it is often released only after being treated.

TABLE B.3 Potential Response Actions and Technologies for Groundwater

Remedial Action Objectives	General Response Action	Potential Technology Type	Potential Process Option	Comments
No action	No action	Not applicable	Not applicable	This is retained as a potential response to provide a baseline for comparison with action alternatives.
As for soil/sludge under institutional controls	Institutional controls	Access restrictions	Fences at well/point of recharge	These varied institutional controls are not typically effective in controlling the source or migration of contaminants and are generally used only to support other response actions. An alternate water supply is typically an interim measure used to ensure human health while a permanent remedy is developed.
		Ownership and deed/use restrictions	Legal titles and deeds/decrees	
		Monitoring (e.g., of natural attenuation)	Groundwater wells and air and surface water samplers	
		Alternate water supply	Piped/transported water or water from a separate (uncontaminated) source (groundwater aquifer or surface water/municipal supply)	
Minimize toxicity, mobility, and/or volume of contaminated material (and as for institutional controls)	In-situ containment	Lateral barriers	Slurry wall, grout curtain, and sheet piling	Lateral barriers can limit contaminant mobility and can mitigate potential exposures by limiting migration (e.g., to uncontaminated groundwater and to surface water via recharge). These processes can be implemented with conventional equipment, but their effectiveness is constrained by site-specific hydrogeological conditions. (Note that insofar as surface controls can limit contaminant migration to groundwater, they may be addressed for groundwater control; see discussion of surface controls for soil/sludge.)
		Bottom sealing	Grout layer injection and block displacement	Bottom sealing can achieve remedial action objectives in a manner similar to lateral barriers under similar constraints. This technology may be useful for containment of lenses or perched aquifers, but its application is constrained by site-specific geologic conditions and it is not typically effective for deep groundwater systems.

TABLE B.3 (Cont'd)

Remedial Action Objectives	General Response Action	Potential Technology Type	Potential Process Option	Comments
As for in-situ containment	Removal/collection	Interception and pumping	Subsurface drains and interceptor trenches; and wellpoints, suction wells, ejector wells, and deep wells	Groundwater removal by pumps and trenches can limit the toxicity, mobility, and volume of contaminated material at that location, thereby mitigating potential exposures, biouptake, and migration by controlling the contaminant source. This technology can be implemented with conventional equipment and is typically followed by a treatment scheme to reduce contaminant toxicity, mobility, and volume in the collected water.
As for in-situ containment	Treatment/pretreatment:	Physical:		
	In situ	Extraction	Air/steam stripping	This process can reduce the toxicity, mobility, and volume of contaminants in groundwater and can limit potential exposures, biouptake, and migration by controlling the contaminant source. Stripping can be used to remove VOCs from groundwater but is typically associated with a removal/collection system. Insofar as many other treatment systems also involve groundwater capture (and upgradient reinjection), see discussion of in-situ treatment for soil/sludge for related information.
	Following removal	Nonthermal extraction	As for surface water following removal	As for surface water following removal.
		Thermal extraction/destruction	As for surface water following removal, and solar evaporation (see discussion for surface impoundment following removal)	As for surface water following removal.
	Treatment/pretreatment (cont'd):	Chemical:		
	In situ	Chemical injection	As for chemical addition for surface water in situ	As for chemical addition for surface water in situ, except that mixing cannot be enhanced by mechanical means.

TABLE B.3 (Cont'd)

Remedial Action Objectives	General Response Action	Potential Technology Type	Potential Process Option	Comments
As for in-situ containment	Treatment/pretreatment (cont'd):	Chemical (cont'd):		
	In situ (cont'd)	Contact reaction system	Permeable treatment beds, with pumps or French drain systems	Permeable treatment beds can reduce the toxicity, mobility, and volume of contaminated groundwater and can limit potential exposures, biouptake, and migration by controlling the contaminant source. This process is used in conjunction with collection (e.g., pump/drain). Bed media can range from crushed limestone and activated carbon to glauconitic green sands and synthetic ion exchange resins. Implementation of this process is constrained by site-specific hydrogeologic conditions.
	Following removal	Extraction	As for surface water following removal	As for surface water following removal.
		Chemical addition	As for surface water following removal	As for surface water following removal.
	Treatment/pretreatment (cont'd):	Biological:		
	In situ	Bioreclamation (enhanced biodegradation)	Nutrient/microbial injection	As for surface water following removal, except that mechanical mixing is not an option.
	Following removal	Contact digestion	As for soil/sludge following removal	As for soil/sludge following removal.
		Attached growth	As for surface water following removal	As for surface water following removal.
		Land application		
		Surface impoundment	As for surface water following removal	As for surface water following removal (except that the process does not mimic original conditions).
As for in-situ containment	Disposal	On-site	Reinjection or discharge on land or to surface water	As for surface water following removal.
		Off-site	Reinjection or discharge on land, to POTW, or to surface water	As for surface water following removal.

TABLE B.4 Potential Response Actions and Technologies for Structural Debris

Remedial Action Objectives	General Response Action	Potential Technology Type	Potential Process Option	Comments
No action	No action	Not applicable	Not applicable	This is retained as a potential response to provide a baseline for comparison with action alternatives.
As for soil/sludge under institutional controls	Institutional controls	Access restrictions	Fences and guards	These varied institutional controls are not typically effective in controlling the source or migration of contaminants and are generally used only to support other response actions.
		Ownership and deed restrictions	Legal titles and deeds	
		Monitoring	Groundwater wells and air, surface water, and soil/sludge samplers	
Minimize toxicity, mobility, and/or volume of contaminated material (and as for institutional controls)	In-situ containment	Release controls	Surface sprays (sealer paints and emulsions)	Release controls can limit contaminant mobility and can mitigate potential exposures, biouptake, and migration by controlling the contaminant source. These processes can be implemented with conventional equipment.
As for in-situ containment	Removal	Demolition	Wrecking equipment (balls and cranes)	Demolition can remove a contaminated structure from its current location and can be implemented with conventional equipment. Decontamination processes can reduce the toxicity, mobility, and volume of contaminated structures (via transfer to the decontamination residue) and can limit potential exposures, biouptake, and migration by controlling the contaminant source. Decontamination can be used to remove organics and inorganics (including removable [i.e., non-fixed] radionuclides) from structural surfaces. These processes can be implemented with conventional equipment. (Insofar as decontamination removes contaminants from a medium, it is included in the "Removal" category; see also the "Treatment/pretreatment" discussion.)
		Decontamination	Aggressive vacuuming, solvent wiping, foam/emulsion application, steam and high-pressure water washing, and carbon dioxide pellet and abrasive grit blasting	
As for in-situ containment	Treatment/pretreatment:	Physical:		
	In situ	Decontamination/extraction	Vacuuming, wiping, washing, and blasting	As for decontamination under removal (because these processes can be considered under both removal and treatment, they are listed under both response actions).

TABLE B.4 (Cont'd)

Remedial Action Objectives	General Response Action	Potential Technology Type	Potential Process Option	Comments
As for in-situ containment	Treatment/pretreatment (cont'd):	Physical (cont'd):		
	Following removal	Size reduction	Impact crushers, shredders, and tumbling and hammer mills	These processes can reduce the size/volume of contaminated structures and debris and can be implemented with conventional equipment.
		Decontamination/extraction	As for the in-situ application	As for the in-situ application.
		Thermal treatment	Incineration and melting/thermal destruction in kilns and furnaces	Thermal treatment processes can reduce the toxicity, mobility, and volume of contaminated structural debris and can limit potential exposures, biouptake, and migration by controlling the contaminant source. These processes can destroy organics and retain inorganics in the solid residue. Although certain thermal processes have been used in industrial applications, their demonstration for structural debris contaminated with hazardous waste has been limited.
	Treatment/pretreatment (cont'd):	Chemical:		
	In situ	Decontamination/extraction	Solvent washing and foam/emulsion application	As for physical decontamination in situ.
	Following removal	Decontamination/extraction	Solvent washing, foam/emulsion application, and chemical (e.g., acid) bath extraction	As for physical decontamination in situ.
	Treatment/pretreatment (cont'd):	Biological:		
	Following removal	Composting	As for soil/sludge	As for composting of soil/sludge; may be effective for organic debris.
	Temporary storage	On-site or off-site facility	Engineered structure	As for temporary storage of soil/sludge.
As for in-situ containment	Disposal	On-site or off-site	Engineered structure (on land) or ocean disposal	As for disposal of soil/sludge.

APPENDIX C:
SUMMARY OF INITIAL NEPA SCOPING PROCESS:
COMMENTS AND RESPONSES

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APPENDIX C:**SUMMARY OF INITIAL NEPA SCOPING PROCESS:
COMMENTS AND RESPONSES****C.1 INTRODUCTION**

This appendix presents the results of a public scoping meeting held on April 27, 1988, in Colonie, New York, for the purpose of receiving public input to the proposed remedial action project for the Colonie site. Scoping meetings are usually held when there is potential for significant impacts to occur as a result of a major federal action. All New York FUSRAP sites except Seaway (i.e., Ashland 1, Ashland 2, Linde, and Colonie) were initially considered as part of one environmental review and analysis process, and a draft work plan was prepared in January 1988 by Bechtel National, Inc., the FUSRAP Project Management Contractor for the U.S. Department of Energy (DOE). A notice of intent (NOI) was published in the *Federal Register* on April 11, 1988. In addition to the 45-day formal comment period for the NOI, public comments were received by DOE during two public scoping meetings held on April 26, 1988, in Tonawanda and on April 27, 1988, in Colonie. Another public meeting was held on June 16, 1988, in Tonawanda. Because of the overwhelming public response at the Tonawanda meetings and the intense opposition from public and elected officials to the possible disposal of Colonie wastes in Tonawanda, DOE decided to treat the Colonie site in a separate action from the four FUSRAP sites in Tonawanda (i.e., Ashland 1, Ashland 2, Linde, and Seaway).

In compliance with the National Environmental Policy Act (NEPA), DOE believes that the proposed action for the Colonie site is more appropriately addressed by an environmental assessment (EA) than an environment impact statement (EIS). This is consistent with Council on Environmental Quality recommendations for agency planning and decision making relative to NEPA. The EA for the Colonie site will be conducted concurrently with the remedial investigation/feasibility study (RI/FS) that is prepared to support the evaluation of remedial action alternatives according to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The EA will be appended to the RI/FS report and made available for public comment as indicated in the project schedule presented in Chapter 6 of this work plan.

A summary of public scoping comments received as a result of the April 1988 scoping meeting held in Colonie is presented in Table C.1. In Section C.2, responses are provided to specific comments raised at that meeting in Colonie, as well as responses to some comments relevant to the Colonie site that were received at the April and June 1988 meetings in Tonawanda (the latter comments are provided for general information).

TABLE C.1 Summary of Public Comments at the April 1988 Scoping Meeting

Subject	Total Number of Comments
Alternatives (Siting and Transportation)	
Alternative sites outside New York	2
No additional wastes sent to Tonawanda	2
No additional wastes sent to Colonie	1
Design reliability/alternative containment designs	1
Technical and Institutional Issues	
Federal/state/local involvement on decisions	1
Past site owners' financial responsibilities	2
Liability/zoning ordinances/state regulations	1
Monitoring	1
Environmental Consequences	
Air quality	1
Water quality (including groundwater)	1

C.2 RESPONSES TO PUBLIC SCOPING COMMENTS

C.2.1 Issue 1

Comment. Please define decontamination. It appears that decontamination is different from in-situ stabilization. (Need to define terms.)

Response. Decontamination means removal of contamination and is one of the possible remedial actions that can be taken at a contaminated site. The DOE will perform response actions at the Colonie site so that, after cleanup, the site will meet the DOE criterion for release without radiological restrictions. This criterion specifies that the radiological risk to a hypothetical individual should be less than 100 mrem/yr and as low as reasonably achievable (ALARA). The remedial actions can range from in-situ stabilization (i.e., containing the radioactive contamination through application of appropriate engineering solutions so that it is isolated from the public and the environment) to excavation and removal of the material to an off-site location.

C.2.2 Issue 2

Comment. Identify the agency or agencies that are responsible for the ultimate decision to determine what remedial action will be taken.

Response. The CERCLA/NEPA process provides the means for an open decision-making process that involves the public, local and state agencies, and federal agencies. The process is documented in a series of reports and data bases that include a complete administrative record leading to a record of decision. Considerations include technical, cost, socioeconomic, and health and safety issues as well as regulatory requirements (applicable or relevant and appropriate requirements [ARARs] and to-be-considered [TBC] requirements). The DOE selects the remedial action alternative to be implemented. If the site were to be added to the National Priorities List of the U.S. Environmental Protection Agency (EPA), it would be necessary to have EPA concurrence in that selection.

C.2.3 Issue 3

Comment. Define the role of Bechtel Corporation in this process.

Response. Bechtel National, Inc., is an engineering and construction firm. Bechtel is the FUSRAP Project Management Contractor and assists DOE in planning and implementing FUSRAP activities under DOE direction. Bechtel analyzes site conditions and evaluates, recommends, and implements the appropriate remedial actions; it also conducts environmental monitoring before, during, and after remedial action, as appropriate. Bechtel administers subcontracts, coordinates the sequence of operations, controls the relationship among subcontractors, and ensures execution and documentation of project work in accordance with DOE guidance.

C.2.4 Issue 4

Comment. Discuss what DOE requires of the responsible parties (i.e., NL Industries) toward contributing to the cleanup of the sites.

Response. As part of the 1984 Energy and Water Resources Appropriations Act, Congress authorized DOE to conduct decontamination at the Colonie site. The property owner, NL Industries, donated the site to DOE to provide for interim storage of wastes from nearby privately owned properties. The DOE does not plan to request any further assistance from NL Industries toward cleaning up the site.

C.2.5 Issue 5

Comment. Has an an aboveground containment structure been considered?

Response. Assuming that the aboveground containment structure referred to is a man-made concrete containment vault and not a disposal cell constructed from natural materials, such a structure is not under consideration. The disposal cell constructed from natural materials is one of the options that DOE is pursuing.

For certain types of radioactive waste (such as reactor operating wastes containing radionuclides of low- or intermediate-level activity and relatively short half-

lives), an aboveground containment vault can provide an acceptable interim storage option. Currently, an aboveground man-made structure is not being considered as a permanent storage option for FUSRAP wastes. There are several reasons for this: (1) the volume of wastes is relatively large, (2) the wastes are primarily soil contaminated with radionuclides or residues left from uranium-processing operations, and (3) the radioactive contamination has a low specific activity. For such wastes, the alternatives considered range from in-situ stabilization to disposal at an existing or planned disposal facility. An aboveground concrete containment structure provides only a short-term solution and is not cost-effective because of the high capital costs, enhanced monitoring requirements, need for longer institutional controls, and the general concerns related to the long-term integrity of man-made (concrete) structures.

C.2.6 Issue 6

Comment. Long-term management of wastes at sites that cannot be reasonably predicted to contain the wastes should be stopped; the DOE proposal needs to be overhauled.

Response. The DOE is required to satisfy a wide range of federal, state, and local regulatory requirements in decontaminating sites and siting and operating long-term waste management facilities. Under no circumstances will DOE be allowed to use a site that cannot be demonstrated to contain/isolate the wastes in the manner prescribed to protect human health and the environment.

C.2.7 Issue 7

Comment. Air quality will be affected during cleanup and should be monitored. Does DOE have monitoring experience?

Response. Air monitoring will be performed before, during, and after remedial action at the site. This monitoring will measure the amount of radioactivity present in the air for both the occupationally exposed personnel at the site and the general public. In addition to monitoring, dust control methods will be employed during all phases of the work to protect the air quality. The DOE has performed air monitoring and implemented dust control methods at numerous FUSRAP sites.

C.2.8 Issue 8

Comment. Define what conclusion, if any, DOE has drawn regarding the disposition of the western New York sites.

Response. The DOE has not drawn any conclusions regarding disposition of the western New York sites. A comprehensive review process conforming to CERCLA/NEPA requirements has been carried out to characterize the site, perform analyses to determine risks (both current and future) of radioactive waste materials, and evaluate a full range of reasonable alternatives (in terms of protectiveness, technical feasibility,

and costs). The initial set of alternatives listed in the NOI, as published in the *Federal Register* (Vol. 53, No. 69, pages 11901-11904, April 11, 1988), includes (1) no action, (2) treatment with disposal of remaining wastes either on-site or off-site, and (3) containment or institutional control alternatives that control the threats posed by the hazardous substances and/or prevent exposure. At the present time, the remedial investigation is still in progress and the preferred alternative has not been selected.

C.2.9 Issue 9

Comment. It appears that as a government entity, DOE has chosen another short-range fix rather than seriously working on a long-range solution.

Response. The DOE intends to select a remedial action alternative that will provide for long-term control of the radioactive wastes. A complex three-year CERCLA/NEPA environmental review process is being conducted in order to develop the necessary data, analyses, assessment, documentation, and public/governmental reviews to facilitate the decision-making process. This process is required by law and is designed to ensure protection of human health and the environment.

C.2.10 Issue 10

Comment. If the sites currently pose a health problem, how can one consider moving the wastes a few hundred yards and piling them all up in one place?

Response. The sites do not pose a health problem under current use conditions. However, the sites or the wastes could pose a potential health risk if the sites were released for unrestricted use or if the radioactive wastes were removed from the site for improper use. Depending on site conditions, several alternatives are being considered for remedial action, including in-situ stabilization or decontaminating the sites through removal of the contaminated residues and emplacement in a disposal cell. The proposed remedial actions ensure that the potential risks to human health and the environment will be minimized.

C.2.11 Issue 11

Comment. It seems as if moving the wastes in would be equally as hazardous as moving the wastes out. Discuss the potential health hazards.

Response. There are health hazards associated with moving the wastes in or out. These risks will be examined in the environmental compliance documentation.

C.2.12 Issue 12

Comment. What we need is somebody to take time and do what they've done in Germany, store these wastes deep below the ground in a stable formation.

Response. Belowground storage or disposal in deep, stable formations (e.g., Asse salt formations in Germany, granitic rock in Canada and Sweden) is being studied for high-level wastes (such as spent nuclear fuel or wastes generated from spent fuel reprocessing), which have accumulated in relatively small volumes and which pose a much bigger human health risk. The costs associated with the development of such facilities are expected to be extremely high and most programs have experienced long delays in the development of new technologies.

The FUSRAP wastes, on the other hand, primarily consist of contaminated soil of low specific activity but large volume. These wastes pose a low human health risk and can be managed cost-effectively with technologies that are currently available and in use. The disposal cell can be located belowground at shallow depth or aboveground.

C.2.13 Issue 13

Comment. What is the half-life of uranium?

Response. The half-life of uranium-238 is 4.5 billion years. (See also Response to Issue 14.)

C.2.14 Issue 14

Comment. Radioactive waste -- you can't bury it, you can't neutralize it, you can't burn it. It has to burn itself out!

Response. It is true that the only way one can get rid of radioactivity is through the natural decay process of the various radionuclides. However, this process may take millions, even billions, of years for some radioisotopes such as those of uranium. Radioactive elements have always existed from the very beginning of the universe. Radioactive wastes originating from the processing of ore and from other activities involving the use of radioactive materials can be managed in a safe and effective manner so that there is little risk to human health and the environment. Various technologies are available to ensure that the wastes can be isolated from the human environment. Suitable and appropriate technologies are applied based on the type of radioactive waste, the risk it poses to human health and the environment, and the cost-effectiveness of the remedial action.

C.2.15 Issue 15

Comment. Discuss the opportunities for the public to make additional comments. Do we have to wait 2.5 years?

Response. No, it is not necessary to wait 2.5 years to make additional comments related to decisions regarding the final disposition of the Colonie wastes. Comment opportunities will be made available on a frequent basis (including public meetings) as the

remedial action process proceeds. Such opportunities will be in addition to those reviews required or otherwise provided for under CERCLA/NEPA (e.g., RI, FS-EA, and record of decision).

C.2.16 Issue 16

Comment. At NL Industries, levels of radiation were found at 95 times over the standards for radiation; that's not low level!

Response. The average uranium soil concentration (the major contaminant) on-site at the Colonie site is 185 pCi/g. The DOE guideline for uranium for the Colonie area, which was agreed to by the state of New York, is 35 pCi/g. Therefore, on the average, the levels of contamination are only approximately 5 times the DOE guideline for the Colonie area.

For comparative purposes, the U.S. Department of Transportation does not require a license to transport radioactive wastes over public roadways if the specific activity is less than 2,000 pCi/g quoted in the U.S. Nuclear Regulatory Commission's 10 CFR 71.10(a)]. The average on-site uranium soil concentration is less than one-tenth of this limit.

On-site surface water samples have also shown elevated levels of uranium. During 1984, on-site levels averaged 880 pCi/L. This is approximately 59 times the guideline given in the Safe Drinking Water Act for alpha radiation in water (15 pCi/L). None of the off-site surface water samples have shown elevated levels of uranium.

The contamination at the site exceeds the applicable criteria for remediation; however, the radioactive wastes are classified as low level.

C.2.17 Issue 17

Comment. The DOE should evaluate cumulative impacts for all FUSRAP sites in New York State!

Response. In order to comply with NEPA, the DOE is required to consider the cumulative impacts of its actions with any other major activities that can reasonably be expected to result in additional impacts in a regional context. In this case, all impacts related to potential remedial action alternatives for all New York FUSRAP sites will be addressed, including cumulative impacts.

C.2.18 Issue 18

Comment. The DOE should evaluate out-of-state disposal sites.

Response. See Issue 8 (Section C.2.8); Alternative 2 discussed in the response to Issue 8 includes out-of-state disposal as part of the off-site disposal option.

C.2.19 Issue 19

Comment. There are legal questions concerning the viability of DOE's informal policy of disposing of wastes in the state where they currently reside.

Response. The DOE favors but has no formal policy of disposing of wastes in the state where they currently reside because past experience has shown that other states often refuse to take any type of radioactive wastes for disposal, especially in the large volumes present at the New York sites. This preference for host state disposal is also expressed in CERCLA.

APPENDIX D:
ENGLISH/METRIC - METRIC/ENGLISH EQUIVALENTS

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TABLE D.1 English/Metric Equivalents

Multiply	By	To obtain
acres	0.4047	hectares (ha)
cubic feet (ft ³)	0.02832	cubic meters (m ³)
cubic yards (yd ³)	0.7646	cubic meters (m ³)
degrees Fahrenheit (°F) - 32	0.5555	degrees Celsius (°C)
feet (ft)	0.3048	meters (m)
gallons (gal)	3.785	liters (L)
gallons (gal)	0.003785	cubic meters (m ³)
inches (in.)	2.540	centimeters (cm)
miles (mi)	1.609	kilometers (km)
pounds (lb)	0.4536	kilograms (kg)
short tons (tons)	907.2	kilograms (kg)
square feet (ft ²)	0.09290	square meters (m ²)
square yards (yd ²)	0.8361	square meters (m ²)
square miles (mi ²)	2.590	square kilometers (km ²)

TABLE D.2 Metric/English Equivalents

Multiply	By	To obtain
centimeters (cm)	0.3937	inches (in.)
cubic meters (m ³)	35.31	cubic feet (ft ³)
cubic meters (m ³)	1.308	cubic yards (yd ³)
cubic meters (m ³)	264.2	gallons (gal)
degrees Celsius (°C) + 17.78	1.8	degrees Fahrenheit (°F)
hectares (ha)	2.471	acres
kilograms (kg)	2.205	pounds (lb)
kilograms (kg)	0.001102	short tons (tons)
kilometers (km)	0.6214	miles (mi)
liters (L)	0.2642	gallons (gal)
meters (m)	3.281	feet (ft)
square kilometers (km ²)	0.3861	square miles (mi ²)
square meters (m ²)	10.76	square feet (ft ²)
square meters (m ²)	1.196	square yards (yd ²)