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March 16, 2000

VIA OVERNIGHT MAIL

Mr. Thomas H. Essig, Branch Chief
High Level Waste and Uranium Recovery
Projects Branch
Division of Waste Management
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
2 White Flint North, Mail Stop T-7J9
11545 Rockville Pike
Rockville, MD 20852

Re: Amendment Request to Process an Alternate Feed Material from the Linde FUSRAP Site at the White Mesa Uranium Mill
Source Material License SUA-1358

Dear Mr. Essig:

International Uranium (USA) Corporation ("IUSA") hereby submits the enclosed request to amend Source Material License SUA-1358 to authorize receipt and processing of a uranium-bearing alternate feed material. For ease of reference, this material is referred to herein as the "Uranium Material". The Uranium Material will be removed by a U.S. Army Corps of Engineers ("USACE", or the "Corps") contractor from the Linde site in Tonawanda, New York, which is being managed under the Formerly Utilized Sites Remedial Action Program ("FUSRAP").

NRC has already approved two license amendments authorizing IUSA's acceptance of Uranium Material from the same process source as the Linde Uranium Material. The Linde Site is the source of the Uranium Material that was eventually deposited at both the Ashland 1 and Ashland 2 sites. IUSA's license amendment dated October 15, 1998 granted approval for processing the portion of the Linde Material that had been deposited at Ashland 1. IUSA's license amendment dated June 23, 1998 granted approval for processing the portion of Linde Material that had been transferred from Ashland 1 to Ashland 2. This amendment request seeks authorization to process the remainder of the Uranium Material at the original generation and storage site at Linde.

Based on information available, the approximate volume of Uranium Material to be removed and shipped from the Linde Site is expected to be approximately 70,000 cubic yards ("CY"), although this amount could significantly increase during the excavation process. As a result, to

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ensure that IUSA will not have to reapply for an increased Uranium Material volume, this amendment request is for up to 100,000 CY of Uranium Material.

Average uranium content is difficult to estimate, although site history and available data suggest that recoverable uranium is present. Analytical data provided to IUSA indicate uranium content ranging from non-detectable to approximately 0.3 weight percent, or greater, with an estimated average grade of 0.07 percent uranium for the entire Linde Site.

At this time, IUSA does not have a subcontract with the USACE prime contractor for receipt of the Uranium Material. IUSA is requesting this license amendment in order to qualify to bid on and receive some or all of the Uranium Material from this site. The USACE bidding schedule for this site requires that IUSA receive license amendment approval as soon as possible in order to demonstrate qualification to accept the Uranium Material before proposed initial shipments from the Linde Site begin in 2000.

It is our understanding that for the Linde Site, USACE could be expected to ship the Uranium Material to one or more facilities licensed either to recycle Uranium Material for the extraction of uranium and disposal of resulting byproduct, or to directly dispose of Uranium Material. If IUSA were selected by USACE to receive the Uranium Material, it would be processed in a similar manner as our conventional ores, for the extraction of uranium.

The processing of the Uranium Material will not cause the Mill's production to exceed the License Condition No. 10.1 limit of 4,380 tons of U_3O_8 per calendar year. As production will remain within the limits assessed in the original Environmental Assessment, and the process will be essentially unchanged, and as the Uranium Material is similar in content to the Mill's existing tailings, this amendment will result in no significant environmental impacts beyond those originally evaluated.

The disposal of the 11e.(2) byproduct material resulting from processing the Uranium Material will not change the characteristics of the Mill tailings from the characteristics associated with normal milling operations.

Complete details are provided in the attached request to amend, which includes the following sections:

To ensure that all pertinent information is included in this and anticipated supplemental submittals, the following guidelines were used in preparing this request to amend:

- U.S. Nuclear Regulatory Commission ("NRC") *Final Position and Guidance on the Use of Uranium Mill Feed Material Other Than Natural Ores* (Federal Register Volume 60, No. 184, September 22, 1995).

- Energy Fuels Nuclear ("EFN") request to the NRC for the amendment to process uranium-bearing potassium diuranate ($K_2U_2O_7$) in a solution of potassium hydroxide/potassium fluoride in water ("KOH Amendment").

- NRC and State of Utah comments and requests for information relative to the KOH Amendment.

- EFN request to NRC for the Rhone-Poulenc alternate feed amendment.

- NRC and State of Utah comments and requests for information relative to the EFN request for the Rhone-Poulenc alternate feed amendment.

- EFN request to the NRC for the amendment to process uranium-bearing material owned by the Cabot Corporation.

- EFN request to the NRC for the amendment to process uranium-bearing material owned by the U.S. Department of Energy.

- IUSA request to the NRC for the amendment to process uranium-bearing material from U.S. Army Corps of Engineers Ashland 2 Site.

- NRC and State of Utah comments and requests for information relative to the IUSA request for the Ashland 2 Site alternate feed amendment, and procedures for determining whether or not the materials contain listed hazardous wastes.

- IUSA request to the NRC for license amendment to process uranium bearing material from US Army Corps of Engineers Ashland 1 Site.

- IUSA request to the NRC for license amendment to process uranium bearing material from US Army Corps of Engineers St. Louis Site.

- Protocol for Determining Whether Alternate Feed Materials Are Listed Hazardous Wastes, developed by IUSA with the concurrence of Utah DEQ, November 1999.

- NRC Initial Decision, February 9, 1999, in the Matter of IUSA Receipt of Material from Tonawanda, New York.

- NRC Memorandum and Order, February 14, 2000, in the Matter of IUSA Receipt of Material from Tonawanda, New York, Affirming the Presiding Officers' Initial Decision to Uphold the Ashland 2 License Amendment.

We believe that use of these guidance materials, supported by our discussions with the NRC concerning these amendment requests, has allowed us to prepare a complete, concise submittal. Therefore, IUSA requests that the NRC please review the enclosed information, and then attempt to reply to this request within 30 days of submittal of today's date.

IUSA understands that the established schedule calls for removal actions at the Linde Site to begin in 2000. The contractor plans to begin excavations in the second quarter of 2000. Although IUSA does not have a subcontract with the USACE contractor at this time, if this request is approved, shipments to the Mill could be expected to begin as soon as the second quarter of 2000.

As described above, prompt review of this submittal will allow USACE to consider IUSA to reprocess Uranium Material that would otherwise require direct disposal at other facilities. I can be reached at (303) 389.4131

Sincerely,

for Michelle R. Rehmann
Environmental Manager

MRR/smc

Attachments

cc: William Von Till/NRC
Earl E. Hoellen
Ronald F. Hochstein
David C. Frydenlund
William N. Deal
Ronald E. Berg
William Sinclair/UDEQ
Don Verbica/UDEQ

Request to Amend
Source Material License SUA-1358
White Mesa Mill
Docket No. 40-8681

March 16, 2000

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TABLE OF CONTENTS

INTRODUCTION

CERTIFICATION

List of Attachments

Attachment 1	Linde Site Location Maps, Volume Estimates and Process History
Attachment 2	Uranium Content Estimates, Material Description, Analytical Data, and Preliminary Material Characterization Report for the Linde Site
Attachment 3	IUSA/UDEQ Hazardous Waste Protocol
Attachment 4	Review of Constituents in Linde Site Uranium Materials to Determine Potential Presence of Listed Hazardous Waste
Attachment 5	New York State Technical Administrative Guidance Memorandum on "Contained-In" Criteria for Environmental Media
Attachment 6	White Mesa Mill Equipment Release/Radiological Survey Procedure
Attachment 7	USACE Value Engineering Proposal for Ashland 1 and Ashland 2.
Attachment 8	Classification of Uranium Material as 11e.(2) Byproduct Material

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INTRODUCTION

International Uranium (USA) Corporation ("IUSA") operates the NRC-licensed White Mesa uranium mill (the "Mill") located approximately six miles south of Blanding, Utah. The mill processes natural (native, raw) uranium ores and feed materials other than natural ores. These alternate feed materials are generally processing byproducts from other extraction procedures, which IUSA processes at IUSA's licensed uranium mill, primarily for their source material content. All waste associated with IUSA's processing is therefore 11e.(2) byproduct material.

This application to amend NRC Source Material License SUA-1358 requests an amendment to allow IUSA to process a specific alternate feed, and to dispose of the resulting 11e.(2) byproduct material in accordance with the Mill operating procedures.

Yellowcake produced from the processing of this material will not cause the currently-approved yellowcake production limit of 4,380 tons per year ("TPY") to be exceeded. In addition, and as a result, radiological doses to members of the public in the vicinity of the Mill will not be elevated above levels previously assessed and approved.

1.0 MATERIAL COMPOSITION AND VOLUME

IUSA is requesting an amendment to Source Material License SUA-1358 to authorize receipt and processing of certain uranium-bearing byproducts, which byproducts originally resulted from the processing of natural ore for the extraction of uranium. For ease of reference, this byproduct material is referred to herein as the "Uranium Material". The Uranium Material is located at a property being managed under the Formerly Utilized Sites Remedial Action Program ("FUSRAP") in Tonawanda, New York, known as the Linde property. The Linde property is one of four properties that comprise the Tonawanda Site. NRC has already granted license amendments to IUSA to process material from two of the other properties within the Tonawanda site, Ashland 1 and Ashland 2 which contained uranium byproduct material originally generated at the Linde property. The Uranium Material is not a residue from a water treatment process.

The Uranium Material will be transported by a U.S. Army Corps of Engineers ("USACE", or the "Corps") contractor, as part of the FUSRAP Program, from the Linde property to the Mill. A historic summary of the sources of the Uranium Material is provided below. This history was derived from the documents listed on page 4 of this Amendment Request.

1.1 Historical Summary of Sources

As described above, the Linde property is one of several properties within the Tonawanda, New York FUSRAP site, which includes Linde, Ashland 1, Ashland 2, and Seaway. The regional setting of Linde, Ashland 1, Ashland 2, and Seaway is shown in Figure 1-2 of Attachment 1. Figure 1-3 shows the specific locations of the Linde, Ashland 1, Ashland 2, and Seaway properties.

Union Carbide Corporation's former Linde Air Products Division purchased the Linde property and constructed a ceramics plant at the location in 1942. One of the ceramics processes conducted by Union Carbide Linde Division at this location consisted of extraction of uranium from ores to produce uranium salts, for coloration of product glasses. Based on their experience, Union Carbide was placed under contract with the Manhattan Engineering District ("MED") from 1942 to 1946 to extract uranium from seven different ore sources: four African pitchblende ores and three domestic ores. Laboratory and pilot plant studies were conducted from 1942 to 1943. From 1943 to 1946, Linde conducted full scale processing of 28,300 tons of ore. The Linde Division contract with the MED ended in the early 1950's.

The domestic ores processed at Linde were in fact residuals from commercial processing at other facilities which removed vanadium. The vanadium removal process also removed radium and other daughter products in the decay chain. As a result, the domestic uranium ores supplied to Linde had reduced concentrations of radium relative to the uranium and thorium levels. The African ores contained uranium in equilibrium with all the daughter products in its decay chain.

Figures D-1 through D-4, of the United States Department of Energy ("USDOE") Preliminary Site Assessment in Attachment 1, show the three-phase processes used for domestic and foreign ores. Triuranium octoxide ("U_3O_8") was separated from the feedstock by acid digestion, precipitation, and filtration. The solid, gelatinous filter cake from this step was discarded as solid waste in a temporary tailings pile on the Linde site. Insoluble precipitates from the solution steps were combined with the filter cake for disposal on site. Approximately 8,000 tons of filter cake and precipitates were later relocated to Ashland 1. U_3O_8 was converted to uranium dioxide and uranium tetrafluoride at the Linde site. Residuals from these two steps were reprocessed. A more detailed discussion of the ore composition, recovery processes, and waste disposal practices is provided in Attachment 1.

Five buildings at the site were involved in MED activities. Building 14 had been constructed by Union Carbide in the mid-1930's. Buildings 30, 31, 37, and 38 were constructed at the location by MED, and their ownership was transferred to Linde when the MED contract ended.

Residues from uranium ore processing at the Linde facility were disposed of and/or stored at the Ashland 1, Ashland 2 and Seaway properties. The majority of Linde facility residues were disposed of on the Ashland 1 property between 1944 and 1946. No material was transferred from Linde to Ashland 1 after this period. In 1974, the subsequent owner of the Ashland 1 property excavated a portion of the Linde residues and soils from the Ashland 1 site, and relocated them to the Ashland 2 property. NRC has already approved amendments to IUSA's license for processing of the portion of the Linde residues and soil moved to Ashland 1 and Ashland 2.

After transfer of residues to Ashland 1 was completed, Linde added manufacturing operations at the Linde facility that very likely contributed additional contaminants to materials remaining on the Linde site, but would not have affected materials already transferred to Ashland 1 and/or Ashland 2.

From 1955 to 1991, the Linde Division operated a gas equipment design and manufacturing facility on the property. The operation included design, manufacture, testing, and repair of gas compressors, chillers, filters and other equipment for installation at customer sites. The Linde Division was divested from Union Carbide in 1991, and changed its name to Praxair. Praxair discontinued manufacturing operations in 1991 but maintained engineering design offices on the property. There is no record of any processing activities other than uranium processing, occurring on the property, either before or after the MED activities.

Renovation of the facility over the years has resulted in consolidation of the MED wastes and radioactively contaminated soils remaining at the property. In 1977, MED contaminated soil was removed from the construction area for the new building 90, and placed in two windrows along the northern property line. The windrows were consolidated into one pile between 1979 and 1982, and covered in 1992.

The USDOE and the U.S. Environmental Protection Agency ("EPA") negotiated a Federal Facilities Agreement ("FFA") governing remediation of the Linde property. In 1997, Congress transferred management responsibility for the sites in the FUSRAP program, including the Linde Site, to the USACE. All actions by the USACE at the Linde Site are being conducted subject to the administrative, procedural and regulatory provisions of the Comprehensive Environmental Response Compensation and Liability Act ("CERCLA") and the existing FFA.

USACE issued a Proposed Plan for the Linde Property in 1999 (USACE, March 1999) and a Final Record of Decision ("ROD") in 2000 (USACE, March 2000). As a result, sufficient characterization information on the nature and extent of contamination is already available to assess the composition and sources of Uranium Material to be excavated.

Over the years, erosion and weathering have spread contamination from the residuals handled and disposed of at Linde to adjacent soils, increasing the volume of Uranium Materials to be removed during the remedial excavation. Physically, the Uranium Material is a moist material consisting of byproducts from uranium processing operations (i.e., "tailings"), mixed with site soils (Remedial Investigation ("RI") Report USDOE, 1992). According to the USACE Buffalo District, the USACE estimates the volume of soil to be excavated from the entire Linde property to range from approximately 35,000 to 70,000 cubic yards ("CY") or somewhat more, depending on conditions encountered during excavation. These volumes are estimates only. It is difficult to estimate the extent to which surrounding soils have been contaminated by the tailings, and hence the potential volumes, with precision. Pre-excavation estimates at other FUSRAP sites in Tonawanda have been as low as one-half the actual excavated volume. Therefore, to ensure that IUSA will not have to reapply for an increased volume from this site in the future, this request is for up to 100,000 CY of Uranium Material.

As described in detail below, 100,000 CY would not come near the Mill's currently approved yellowcake production limit of 4,380 TPY, and as, even without reprocessing, the composition of the Uranium Materials is very similar to the Mill's existing tailings, added volumes of Uranium Material will have no adverse effect on public health, safety, and the environment.

USACE expects to excavate and deliver the Linde Site materials over a period of ten to fourteen months or longer. IUSA has previously received NRC approval for a license amendment to process Uranium Material from the St, Louis FUSRAP site. As described in the IUSA Request for Amendment for the St. Louis material, the USACE may be expected to excavate and ship approximately 20,000 to 80,000 CY per year of Uranium Material from the St. Louis Site, and IUSA would expect to process this material over several years. If the entire volume of Linde material were received during a period that overlapped with shipments of the St. Louis material, the processing of the total estimated volume of 180,000 CY in one year would not come near the Mill's currently approved yellowcake production limit of 4,380 TPY.

Additional information on the Linde property is contained in Attachments 1 and 2. Attachment 1 includes the following items describing the Uranium Materials and the Linde property operational history:

1. A detailed site history of the Tonawanda Site, including the Linde property, is provided in Chapter 1 of the Remedial Investigation Report for the Tonawanda Site (USDOE, December 1992) (the "RI").

2. Additional detail on the uranium extraction process is provided in Section 7.0 of the Preliminary Assessment and Site Investigation for Linde Air Products Division of Union Carbide (USDOE, September 1987).

Attachment 2 includes the following items describing the composition of the Uranium Materials:

1. Chapters 3 and 4 of the Remedial Investigation Report for the Tonawanda Site (USDOE, December, 1992) describe uranium concentrations and metals and organic contaminant concentrations in surface and subsurface samples at the Linde property.

2. Portions of the Radiological Survey of the Ashland Oil Company (Former Haist Property), Tonawanda, New York (U.S. Department of Energy, May 1978) describe uranium concentrations in core samples and approximate distributions of tailings stored on the Linde property.

3. A summary of the concentrations of chemical contaminants is provided in the Linde Site Preliminary Material Characterization Report (USACE/IT, February 2000).

4. Portions of the Preliminary Plan for the Linde Site (USACE, March 1999) describe site history and radiological contamination.

5. Portions of the Record of Decision for the Linde Site (USACE, March 2000) describe the regulatory framework and remediation goals relative to the radiological and chemical contamination at the site.

1.2 Radiochemical Data

Process history demonstrates that the Uranium Material at the Linde property resulted from the processing of natural, mined uranium-bearing ores, and from the processing of uranium-bearing residuals from natural ores originally processed at other facilities for vanadium. The USACE has classified the portions of the Linde Uranium Material which were disposed of at and later excavated from the Ashland 1 and Ashland 2 Sites, as 11e.(2) byproduct material. It is IUSA's understanding, from discussions with USACE's contractor, IT Corporation ("IT"), that USACE/IT also plan to classify the Linde Uranium Material as pre-1978 11e.(2) byproduct material.

Three radiological surveys have been conducted at Linde, which included evaluation of radiological contamination in soils:

- Oak Ridge National Laboratory, November 1976
- Ford, Bacon, and Davis, December 1981, and
- Oak Ridge Associated Universities, 1981.

Results of all three studies were summarized in the Remedial Investigation Report for the Tonawanda Site.

Average uranium content is difficult to estimate, although site history and available data indicate that recoverable uranium is present. Analytical data provided to IUSA indicate that potential uranium concentrations at Linde range in samples from nondetectable to 0.3 percent. Based on these available data, the weighted average grade of uranium for the entire Linde Site is estimated by IUSA to be approximately 0.07 percent. As stated above, the material containing nondetectable levels is not likely to be excavated and hence is not likely to be included in the material shipped to the Mill. Indeed, there is a financial disincentive to the government to excavate material that is lower in radioactivity levels than the specific cleanup levels.

The ROD for the Linde Site indicates that on this property, soils will be excavated which exceed the cleanup criteria of 5 piC/g radium for surface soils, 15 pCi/g radium for shallow soils, and a standard based on a "sum of the ratios" method for three other radioactive contaminants including total uranium, Ra-226, Th-230. The cleanup criteria are described in detail in Section 9 of the ROD, provided in Attachment 2. Based on the RI characterization data and ROD, it appears that an average uranium concentration in soils to be excavated per this guideline may be approximately 0.07 percent, with hot spots ranging up to 0.3 percent, as stated above.

1.3 Hazardous Constituent Data

NRC guidance suggests that if a proposed feed material consists of hazardous waste, listed under subpart D Section 261.30-33 of 40 CFR (or comparable Resource Conservation and Recovery Act ("RCRA") authorized state regulations), it would be subject to EPA (or state) regulation under

RCRA. To avoid the complexities of NRC/EPA dual regulation, such feed material may not be approved for processing at a licensed mill. If the licensee can show that the proposed feed material does not consist of a listed hazardous waste, this issue is resolved. NRC guidance further states that feed material exhibiting only a characteristic of hazardous waste (ignitable, corrosive, reactive, toxic) would not be regulated as hazardous waste and could therefore be approved for recycling and extraction of source material. The NRC Alternate Feed Guidance also states that NRC staff may consult with EPA (or the state) before making a determination on whether the feed material contains hazardous waste.

1.3.1 IUSA/UDEQ Hazardous Waste Protocol

In a recent decision regarding the Mill, the Atomic Safety and Licensing Board Presiding Officer suggested there was a general need for more specific protocols for determining if alternate feed materials contain hazardous components. In their Memorandum and Order of February 14, 2000, the Commission concluded that this issue warranted further staff refinement and standardization.

IUSA has been cognizant of the need for specific protocols to be used in making determinations as to whether or not any alternate feeds considered for processing at the Mill contain listed hazardous wastes, and has taken a pro-active role in the development of such a protocol. IUSA has established a "Protocol for Determining Whether Alternate Feed Materials are Listed Hazardous Wastes" (November 22, 1999). This Protocol has been developed in conjunction with, and accepted by, the State of Utah Department of Environmental Quality ("UDEQ") (Letter of December 7, 1999). Copies of the Protocol and UDEQ letter are provided in Attachment 3. The provisions of the protocol can be summarized as follows:

- In all cases, the protocol requires that IUSA perform a source investigation to collect information regarding the composition and history of the material, and any existing generator or agency determinations regarding its regulatory status.

- The protocol states that if the material is known -- by means of chemical data or site history -- to contain no listed hazardous waste, or if an agency has agreed with a generator that the material is not RCRA listed waste, or made a contained-out determination, IUSA and UDEQ will agree that the material is not a listed hazardous waste. (The contained-out determination specified in the protocol is designated by various state agencies as a "contained-in policy", a "contained-out decision", or both).

- If such a direct confirmation is not available, the protocol describes the additional chemical process and material handling history information that IUSA will collect and evaluate to assess whether the chemical contaminants in the material resulted from listed or non-listed sources.

- The protocol also specifies the situations in which ongoing confirmation/acceptance sampling will be used, in addition to the chemical process and handling history, to make a listed waste evaluation.

- If the results from any of the decision steps indicate that the material or a constituent of the material did result, or most likely resulted, from a RCRA listed hazardous waste or RCRA listed process, the material is rejected.

- The protocol also identifies the types of documentation that IUSA will obtain and maintain on file, to support the assessment for each different decision scenario.

The above components and conditions of the Protocol are summarized in a decision tree diagram, or logic flow diagram, included in Attachment 3, and hereinafter referred to as the "Protocol Diagram". IUSA's evaluations of chemical constituents in the Uranium Material have been conducted in conformance with this protocol. The discussion of this evaluation, below, will refer to action boxes and decision diamonds in the Protocol Diagram.

1.3.2 Historic Data Review

In accordance with Box 1 of the Protocol Diagram, IUSA conducted a Source Investigation of chemical contamination information and agency determinations available to date. The information reviewed is described in this section.

A detailed site characterization of the Linde property was conducted by USDOE and described in the RI. Chemical data from the RI have been provided in Attachment 2. Additional information relating to the Linde property was presented in the Proposed Plan for the Linde Site (USACE, 1999), and the Linde Site Preliminary Material Characterization Report (USACE, February 2,000). The studies include a detailed site and area history; uranium activity data; and metals and organic contaminant concentration data.

Thirteen of the contaminant compounds identified at Linde have been determined by USACE, their contractor, IT, and New York State Department of Environmental Conservation ("NYSDEC") to result from potentially listed waste sources. These consist of toluene and twelve halogenated volatile organic compounds ("VOCs") which are present at very low concentrations. IUSA and IUSA's independent consultant also agree that although there are also potential non-listed sources for several of these VOCs, RCRA listed sources arising from post-MED manufacturing activities at the site most likely contributed to the presence of most or all of these compounds.

The remainder of the contaminants – Semi-Volatile Organic Compounds ("SVOCs") (specifically PAHs and phthalates), and metals, have been determined in the Linde Site Preliminary Material Characterization Report not to result from RCRA listed wastes. This determination was based on evaluating the same type of process and material handling information that IUSA evaluated in accordance with Box 8 and Decision Diamond 9 of the Protocol Diagram. IUSA and IUSA's independent consultant agree with USACE/IT's determination. The conclusions of IUSA's independent consultant regarding all identified contaminants at Linde are provided in Attachment 4.

1.3.3 Contained-In/Contained-Out Considerations

The IUSA/UDEQ Protocol Diagram states, in Decision Diamond 2, that if a "regulatory authority with RCRA jurisdiction over the site agreed with [the] generator's determination that Material is not listed hazardous waste, made a "contained-out" determination, or determined that the material or site is not subject to RCRA" then IUSA and UDEQ will consider the material not to be listed hazardous waste.

The NYSDEC has published a Technical Administrative Guidance Memorandum ("TAGM") addressing contaminants contained in environmental media (NYSDEC, November 1992). This TAGM defines NYSDEC's policy regarding contaminants (chemicals, compounds, and compound groups) associated with RCRA listed hazardous wastes detected in environmental media (soil sediment and water). The TAGM provides specific action levels (concentrations) for each contaminant. If all contaminants in a given media are present at levels lower than the specified action levels, then the media does not "contain" RCRA listed hazardous waste. Based on the extremely low concentrations of VOCs in the Linde site samples, it is IUSA's understanding that NYSDEC has agreed to allow USACE/IT to apply the TAGM approach to the thirteen VOCs in Linde materials. As a result, any soils excavated at Linde that contain these VOCs at concentrations less than the contained-in action levels in the TAGM will not be RCRA listed hazardous waste. A copy of the NYSDEC TAGM is provided in Attachment 5.

NYSDEC will make a contained-in/contained-out determination for the thirteen VOCs in the Uranium Material, on a batch by batch basis, subject to the NYSDEC TAGM. This authorization satisfies the requirements agreed upon by IUSA and UDEQ as documented in the Protocol Diagram and supporting text. Hence, a contained-out determination made by the NYSDEC would be sufficient basis for IUSA to consider Uranium Material not to be RCRA-listed hazardous waste with respect to these thirteen compounds, and to accept such material at the Mill. The remaining contaminants have already been determined not to result from RCRA listed sources. The evaluation by IUSA's independent consultant, in Attachment 4, explains why this determination is justified.

USACE and their contractor, IT, prepared a Linde Site Preliminary Material Characterization Report (USACE, February 2,000), which compares the levels of the thirteen VOC contaminants reported in the RI to their respective TAGM action levels. A copy of the Report is provided in Attachment 3. This evaluation of the RI data indicates that USACE/IT have determined that twelve of the thirteen VOC contaminants, as described in Section 1.5, below, were well below (from 5 to 3 million times) their respective TAGM action levels in every sample where they were detected. One of the contaminants, pentachlorophenol, exceeded the TAGM action level in one or more samples. Based on these findings, USACE/IT have determined that the majority of Linde site soils should not be RCRA hazardous waste with respect to these twelve halogenated VOCs. A few areas of soil may be expected to contain pentachlorophenol at or above the TAGM action level. Any soils which exceed the TAGM for pentachlorophenol, or any other VOC contaminant, will be managed as RCRA listed hazardous waste and will not be shipped to IUSA, unless treated on site in accordance with the TAGM and the treated material meets the TAGM action levels, as discussed below.

To supplement the preliminary TAGM determinations, as described below, IT is developing a pre-excavation profile sampling plan to confirm the VOC levels reported in the RI. IT plans to complete this sampling and report results to USACE and NYSDEC during the second quarter of 2000. IUSA will provide a copy of these results to NRC when they are published.

Further, NYSDEC's TAGM specifies that for the contained-in/contained-out determination to be applied to excavated media from any site, the owner must prepare a TAGM Sampling Work Plan, ("TAGM SWP") to be approved by NYSDEC, specifying how the media will be sampled and analyzed during excavation/remediation to confirm that no contaminant exceeds any action level in the TAGM. IT is currently preparing a draft Sample Work Plan for NYSDEC review. In accordance with NYSDEC policy, this plan will specify that any material that exceeds any TAGM action level will either:

1. be considered RCRA listed hazardous waste and shipped to a disposal facility licensed to receive RCRA hazardous wastes; or

2. may be treated on site at Linde until the concentrations of all chemicals, compounds or groups are below all TAGM action levels, then shipped off site, to the Mill or other location, as non-hazardous waste.

In no case will material with any of the thirteen identified contaminants that exceeds a NYSDEC TAGM action level or TCLP level for the TAGM contaminants be managed as a non-hazardous waste. IUSA's potential contract with IT will also specify that no material will be shipped to the Mill with any of the thirteen identified contaminants that exceeds a NYSDEC TAGM action level.

1.3.4 Consistency of NYSDEC Approach with IUSA/UDEQ Hazardous Waste Protocol

IUSA has determined that the NYSDEC contained-in/contained-out decision process and development of an IT/NYSDEC Sampling Work Plan are consistent with Decision Diamond 2 in the IUSA/UDEQ Protocol, with respect to the thirteen VOC contaminants. IT is developing the TAGM Sampling Work Plan, which will provide the analytical criteria for this determination. IUSA will provide NRC a copy of this plan and NYSDEC letter of acceptance when USACE/IT provide IUSA a final approved copy.

1.3.5 Review by IUSA Independent Consultant

In addition, as discussed above, IUSA engaged an independent consultant, experienced in chemical process engineering, to review the site history, characterization information, NYSDEC TAGM, and IUSA protocol, and to make an independent assessment regarding the regulatory determinations made on the Uranium Material. In addition to review of the documents identified above, this evaluation has also included a review of publicly available information on Linde and

Praxair operations, and interviews with IT and subcontractor personnel familiar with the site. The process source evaluation performed by IUSA's independent consultant is provided in Attachment 4. The consultant has concluded that based on the contamination information currently available:

1. NYSDEC's application of the TAGM is consistent with the IUSA Protocol for determining that Uranium Material to be shipped to the Mill is not RCRA listed hazardous waste.

2. The thirteen compounds identified in the IT Sampling Work Plan should not be considered RCRA listed hazardous waste whenever their concentrations are below the action levels in NYSDEC's "contained-in/contained-out" TAGM.

3. All other organic compounds detected to date at Linde and all metals detected to date at Linde are not associated with RCRA listed wastes.

1.3.6 Proposed Confirmatory Sampling and Analysis

In addition to the chemical sampling reported in the RI documents, in order to confirm that material shipped to the Mill complies with the NYSDEC TAGM, that is, contains no RCRA listed wastes, the USACE contractor will perform three levels of sampling on soils from the Linde property excavation areas as described below.

Pre-Excavation Profile Sampling

First, prior to development of their site Excavation and Restoration Plan, the USACE contractor will perform pre-excavation sampling ("profile sampling") within the area determined in the USDOE RI report to contain radiological contamination. The main purpose of the profile sampling is to confirm the extent of radiologic contamination and the boundaries of the remedial excavation. However, samples from within the radiologically contaminated area will also be analyzed according to methods outlined in EPA Guidance SW846 for total Volatile Organic Compounds ("VOCs") and Semivolatile Organic Compounds ("SVOCs"), as well as hazardous characteristics including TCLP. The USACE contractor will use the profile sampling results, together with other site characterization data,

1. to determine whether or not any of the thirteen compounds referred to above are present in the zone of excavation;

2. to confirm whether or not the detected compounds are below each of their respective TAGM action levels;

3. to determine whether or not any new chemical components are identified within the zone of excavation.

If any new compounds are detected, IT will assess, with NYSDEC's concurrence, whether or not they are from RCRA listed sources. If they are determined to be from potentially listed sources, USACE/IT will evaluate whether they are present at concentrations below their respective TAGM action levels. This data will be provided to IUSA as part of the material profile that will be required by IUSA's subcontract with the USACE prime contractor.

Post-Excavation and TAGM Sampling

Second, as described above, the USACE contractor will have an approved TAGM SWP in place prior to start of excavation. Upon excavation of the radiologically contaminated material, the USACE contractor will perform additional chemical analyses in accordance with the TAGM SWP. According to the USACE contractor, IT, the TAGM sampling will be considerably more extensive than the post-excavation sampling performed by IT at the Ashland 1 and Ashland 2 sites, involving both a greater frequency of samples and a broader spectrum of analyses. In order to meet the expanded analytical requirements, IT plans to establish an on-site laboratory.

Sampling locations and frequency have not been determined; however, the TAGM requires that the sampling be statistically representative of all varieties of media and contaminant sources encountered in the remedial action. IT anticipates that the frequency will exceed the single composite of six random grabs per 500 CY performed on site at Ashland 1 and Ashland 2. The on-site samples will also be analyzed for a greater number of potential contaminants. In addition to the total VOC and total SVOC analyses performed for Ashland 1 and 2 material, the TAGM SWP will require analyses for one or more pesticide suites, TCLP, and other hazardous characteristics. With the use of the onsite laboratory, IT anticipates that results will be available to IUSA more quickly than post-excavation results from Ashland 1 or Ashland 2. Due to the need to evaluate every excavated batch, IT plans to have analytical results available before material is loaded for shipping. IUSA will require that IT provide the post-excavation TAGM SWP results to IUSA by fax or email prior to receipt of the Uranium Material at the Mill.

Sampling of Visible Contamination

As a precautionary measure, the excavated material may undergo a third type of sampling. If any excavated pile shows visible indications of organic contamination, such as staining or chemical odor, or which indicates the presence of organics when scanned by a photoionization detector ("PID") IT will, if it has not done so otherwise under the TAGM SWP, collect a random sample in the most visibly contaminated part of the pile, and perform similar analyses in conformance with the TAGM SWP.

In addition to results from the profile sampling required by IUSA, IT will also provide IUSA the results from IT's TAGM SWP analytical program before Uranium Material is received at the Mill. If any new chemical constituents are identified during the TAGM SWP sampling, USACE/IT will use site history and analyzed concentrations to perform an evaluation, subject to NYSDEC's approval, to determine whether they are:

1. not from RCRA listed sources

2. potentially from RCRA listed sources but below the TAGM action level(s), or
3. RCRA listed hazardous waste.

As described above, any material containing any constituent above its respective TAGM action level, whether identified in the RI, pre-excavation sampling, or TAGM SWP sampling will be managed as RCRA listed hazardous waste and will not be included in the Uranium Material to be shipped to the Mill, unless and until it meets the TAGM action levels. IUSA will require contractually that the USACE make the TAGM SWP and resulting analytical data available to the NRC at the NRC's request.

IUSA is considering whether to implement an acceptance sampling program at the Mill for the Linde material. At this time, IUSA does not propose to perform on-site acceptance sampling of Linde Uranium Material received at the Mill for the following reasons.

- First, the determination regarding RCRA listed waste will be made by the generator (USACE/IT) in conjunction with, and based on regulatory standards established by, the NYSDEC, which has RCRA authority over the Linde site. Material will be RCRA classified and segregated by IT on a batch by batch basis, subject to NYSDEC approval of analytical results. As described in Section 1.3 above, according to the IUSA/UDEQ Protocol, if NYSDEC, which has RCRA jurisdiction over the site, has agreed with a generator's determination that the material is not listed hazardous waste, or made a "contained-out" determination for specific contaminants, IUSA and UDEQ will consider the material not to be listed hazardous waste with respect to those contaminants.

- Second, IUSA understands from discussions with IT staff that the sampling frequency to be performed by IT for both TAGM contaminants (VOCs) and other contaminants (SVOCs) is expected to exceed the Mill sampling frequency for the Uranium Material at Ashland 1 and Ashland 2 of one sample per 500 CY lot, and will better statistically characterize the material. That is, with respect to the IUSA/UDEQ protocol, the sampling results for both the TAGM and other constituents can be expected to be very representative. As a result, the increased sampling at the Linde site will result in more frequent and better sampling than was performed for either Ashland 1 or Ashland 2 at the Mill; therefore redundant sampling at the Mill is not necessary.

- Third, the IT TAGM SWP program will use analytical limits of detection for TAGM contaminants and other contaminants three orders of magnitude lower (more sensitive) than what has been achieved by the Mill's contract laboratory for Mill samples. Adding additional samples from the Mill will likely result in unnecessary and avoidable data comparison issues.

- Fourth, the primary TAGM contaminants at Linde are VOCs. It has been IUSA's experience, documented by nearly 200 Mill samples from Ashland 2 material and over 160 Mill samples to date of Ashland 1 material, that these compounds, if present at the excavation site, are volatilized during stockpiling, loading, transport, and unloading, and are consistently non-detectable in samples collected at the Mill.

- Fifth, due to logistical constraints such as limited staging and storage areas on site, and the need to make a large number of batch by batch hazardous waste determinations, IT plans to use an onsite laboratory to produce chemical characterization results with fast turnaround (while material is still on site at Linde). IUSA will require contractually that IT make those results available to IUSA before material is received at the Mill, and to the extent practical, prior to its being shipped from Linde. IUSA plans to work closely with IT, and to make acceptance/rejection decisions as soon as possible after the USACE/IT make their hazardous waste determinations, and based on the same data. This will allow excavated material to be immediately segregated to the proper on-site staging area (at Linde) – either for loading and shipment to IUSA, or into a specially controlled mixed hazardous waste staging area either for on-site treatment or for shipment to a licensed hazardous waste facility.

It is of paramount importance to IUSA that the Uranium Material does not contain any RCRA listed hazardous wastes that could lead to potential jurisdictional issues relating to the Mill's tailings impoundments. If the final TAGM SWP indicates that IT will use a sampling frequency less than one composite sample per 500 CY for either VOC or SVOC analyses, IUSA will propose to the NRC a Mill sampling program to supplement the IT on-site sampling program. If results from any of the above IT analyses indicate that Uranium Material to be shipped contains RCRA listed waste, the material will be rejected, and will not be shipped to IUSA. If IUSA develops a supplementary Mill sampling program, and results from any of the Mill analyses indicate that the Uranium Material contains RCRA listed waste, the material will be rejected and NRC will be notified immediately.

1.3.7 Compatibility with IUSA Mill Tailings

The Uranium Material contains metals and other constituents that are already present in the Mill tailings disposed of in the Cell 3 impoundment. Generally, even without reprocessing, the composition of the Uranium Material is very similar to the composition of the materials currently present in the Mill's tailings impoundments, because the Uranium Material resulted from the processing of uranium-bearing ores for the extraction of uranium. Hence, the Uranium Material should not have an adverse impact on the overall Cell 3 tailings composition.

The Environmental Statement ("ES") for the Mill (USNRC, 1979) assumed that tailings slurry would have an organic content of 0.2 gallons of organics per 1,000 gallons of tailings slurry. Further, the ES assumes the organics in tailings would consist primarily of residual kerosene and some alcohols. The Linde property organics consist primarily of PAH compounds from used oil and/or paving materials. The PAHs are substantially less volatile and less mobile than kerosene or alcohols assumed in the ES. Halogenated VOCs were detected at several of the samples, but at very low levels. Based on IUSA's experience with low levels of halogenated VOCs in the material previously received from the Ashland 1 and Ashland 2 FUSRAP sites, regardless of the initial concentration of VOCs reported in the excavation area soils, these compounds were volatilized by excavation, loading, transport and unloading to nondetectable levels before the material reached the Mill. Even without this volatilization, the halogenated VOCs are at such low levels as to have virtually no effect on the tailings impoundments. In other words, the environmental impact from organic compounds in the Uranium Material is well within the parameters assumed in the NRC Environmental Statement for the Site.

Furthermore, the volume of tailings that would potentially be generated by processing of the Uranium Material is comparable to the volume that would be generated from processing an equivalent volume of ore. The USACE, as described above, may be expected to excavate and ship up to 100,000 CY (approximately 120,000 tons) of Uranium Material from Linde. This additional volume is well within the maximum annual throughput rate and tailings generation rate for the Mill of 680,000 tons per year. Additionally, IUSA is required to conduct regular monitoring of the impoundment leak detection systems and of the groundwater in the vicinity of the impoundments to detect leakage if it should occur.

1.4 Regulatory Considerations

Uranium Material Qualifies as "Ore"

According to NRC guidance, for the tailings and wastes from the proposed processing to qualify as 11e.(2) byproduct material, the feed material must qualify as "ore." NRC has established the following definition of ore:

> "Ore is a natural or native matter that may be mined and treated for the extraction of any of its constituents or any other matter from which source material is extracted in a licensed uranium or thorium mill."

The Uranium Material is a matter from which source material will be extracted in a licensed uranium mill, and therefore qualifies as "ore" under this definition.

Uranium Material Not Subject to RCRA

The USDOE, as predecessor to USACE in managing the FUSRAP sites, has consistently classified certain FUSRAP materials, including the Uranium Material at the Linde property, as 11e.(2) byproduct material. As mentioned in Section 1.2, above, USACE/IT plan to classify the Uranium Material as pre-1978 11e.(2) byproduct material.

According to the Linde Site Preliminary Material Characterization Report, USACE/IT will prepare a Radioactive Material Profile Record ("RMPR") for all material that does not exceed the TAGM action level for any contaminant potentially from RCRA listed sources (SVOCs and metals at Linde have already been determined not to be from RCRA listed sources). Material that exceeds the TAGM action level for any contaminant may need to be managed under a separate RMPR, possibly as both a radioactive and hazardous waste. In any event, such material will not be shipped to IUSA, unless and until it meets the TAGM action levels.

As described in Section 1.3 above, USACE and IT are developing a TAGM SWP to confirm that the Uranium Material will not be RCRA listed hazardous waste, in accordance with the NYSDEC TAGM. Material (if any) that does not meet the TAGM action levels, that is, contains RCRA listed hazardous waste, will not be shipped to the Mill.

Further, as discussed above, IUSA has also engaged an independent expert consultant to perform a RCRA status evaluation of the Linde Site. This evaluation is provided in Attachment 4, and summarized below.

Only four classes of organic compounds were detected at Linde. Polynuclear Aromatic Hydrocarbons ("PAHs"), and phthalates, which resulted from the background fill at the site; toluene; and twelve halogenated VOCs.

According to the RI, the PAHs resulted from spills or draining of used motor oil, which was detected in visible quantities on the site, The presence of asphalt paving would also likely contribute to the detection of PAHs in the shallow soils. Both of the phthalates are natural degradation products of the PAHs and are plasticizers present in polymer gloves, personnel protective equipment, and other sampling equipment. None of the above are RCRA listed sources.

One brominated and eleven chlorinated VOCs were reported in the RI at very low levels, specifically: bromoform; chloroform; methylene chloride; 1,2 dichloroethane (1,2 DCA); cis- plus trans- isomers of 1,2 dichloroethane (1,2 DCE); trans 1,2 dichloroethene (trans 1,2 DCE); 1,1,1 trichloroethane (TCA); trichloroethene (TCE); 1,1,2,2 tetrachloroethane; tetrachloroethene (PCE); pentachlorophenol; and hexachloroethane. The majority of these compounds were detected at 50 parts per billion or less. Two detections of 1,1,2,2 tetrachloroethane and several detections of pentachlorophenol and hexachloroethane were at higher levels. The maximum concentrations of 1,1,2,2 tetrachloroethane (2.3 ug/kg) and hexachloroethane (2,100 ug.kg) were below their respective TAGMs. The maximum concenetration of pentachlorophenol (4,700 ug/kg) exceeded its TAGM action level of 3,000 ug/kg. Overall, the organic concentrations were so low that USACE excluded them from the health risk assessment for the site on the basis that they were too low to contribute to human health risk. NYSDEC has concurred that at least some of the sources of halogenated VOCs may be RCRA listed hazardous wastes. IUSA and IUSA's independent consultant agree with this determination. However, based on the RI data as summarized in the Preliminary Characterization Report, the reported detections of chlorinated VOCs were few and the reported concentrations were lower than their respective TAGMs. As a result, NYSDEC and USACE/IT have agreed on use of a state approved TAGM for determining that soil with halogenated VOC concentrations below the contained-in action levels in the guidance will not be RCRA listed hazardous waste.

Toluene was also present at low levels. All toluene detections reported were less than 300 parts per billion; the majority were less than 50 parts per billion. The RI also reports that toluene was detected at shallow depths, of 6 feet or less, and in general, its concentration decreased with depth, indicating a relatively recent source. The more recent operations at Linde included both potentially listed sources—solvent and paint thinner—and non-listed sources–paints, coatings, metal preparation, and finishing. NYSDEC has determined that at least some of the sources of toluene may be RCRA listed hazardous wastes. IUSA and IUSA's independent consultant concur with this determination. Based on the RI data as summarized in the Preliminary Characterization Report, the reported detections of toluene were few and the reported concentrations extremely low. As a result, NYSDEC and USACE/IT have agreed on use of a state approved TAGM for determining that soil with less than 1,600,000 ug/kg (ppb) toluene will not be RCRA listed hazardous waste. All the toluene concentrations reported in the RI were below this level.

As described above, the Linde site was filled and graded with a combination of fly-ash, slag, gravel and clay fill. The fill has been determined to be a source of thorium-232 and arsenic, as well as a contributor to the elevated levels of cadmium, chromium, copper, lead and silver. The RI attributes all the elevated metals at the site either to MED waste, fill, or combinations of the two. The RI does not attribute any of the metals to Linde site manufacturing activities or to any RCRA listed process sources.

Chemical data was not collected on the portions of the site that were not occupied by MED, which are currently utilized in Praxair's manufacturing activities, and will not be shipped to the Mill.

As described above, IUSA will continue to review chemical data provided by USACE prior to and for the duration of the excavation activities at the site, to confirm that no RCRA wastes are included in material shipped to the Mill.

Justification of Certification Under Certification Test

In the Licensee Certification and Justification test set out in the NRC's *Final Position and Guidance on the Use of Uranium Mill Feed Material Other Than Natural Ores*, the licensee must certify under oath or affirmation that the feed material is to be processed primarily for the recovery of uranium and for no other primary purpose. IUSA makes this certification below.

Under this *Guidance*, the licensee must also justify, with reasonable documentation, the certification. The justification can be based on financial considerations, the high uranium content of the feed material, or other grounds.

Uranium Content

As stated above, average uranium content is difficult to estimate, although site history and available data suggest that recoverable uranium is present. For example, analytical data provided to IUSA indicate uranium content in discrete samples ranging from non-detectable to approximately 0.3 weight percent, or greater, with an average uranium content for the entire Linde Site of approximately 0.07 weight percent uranium. It should be noted that:

1) The radionuclide content of the storage pile was not characterized during the RI, since it was known to contain uranium wastes and to require remediation.

2) Material containing nondetectable levels is not likely to be included in the material shipped to the Mill.

Considering both of the above factors, the estimate of 0.07 percent uranium, which was based on the RI data, could be relatively conservative, and overall average uranium values may be somewhat higher.

Historic reports indicate that uranium ore and residues were stored, consolidated, excavated, and relocated during various post-MED construction activities at the Linde site, and a portion of the residues and contaminated soil moved from the Linde Site to the Ashland 1 Site. As a result, the radionuclide activities and concentrations are highly variable. Over time, the radionuclides from the disposed of process residues migrated into the surrounding soils. These residues and contaminated soil comprise the Uranium Material to be shipped to the Mill.

By comparison, the estimated average uranium concentrations in Ashland 2 and Ashland 1 materials, as set out in their respective license amendment applications, were 0.05 and 0.06 weight percent uranium.

Financial Considerations

In addition to other financial considerations, if awarded a contract to accept Uranium material, IUSA will commit contractually, as it did with respect to the Ashland 2, Ashland 1, and St. Louis Materials, to process the Uranium Material at the Mill for recycling of uranium in consideration of receiving a recycling fee.

Other Considerations

There are several other grounds to support the certification text, two of which are discussed here.

IUSA has a history of successfully extracting uranium from alternate feed materials, including from the very similar Ashland 2 materials, and should be considered developed credibility with the NRC, not only for being technically competent, but also for fulfilling its proposals to recover uranium from alternate feeds.

In addition, the USDOE, which managed the FUSRAP sites prior to the USACE, determined that the Uranium Material meets the definition of 11e.(2) byproduct material under the Atomic Energy Act (the "AEA"). Because of its classification, the Uranium Material could be placed directly in the Mill's tailings impoundment. Therefore, the fact that IUSA plans to process the Uranium Material is further evidence that IUSA is primarily processing the Uranium Material for its source material content, since processing the material would not be necessary to dispose of the material in the impoundment. This reasoning was applied by the NRC in approving IUSA's application to amend the Mill's license to allow for the processing of the very similar Ashland 1 FUSRAP materials, and is consistent with the rationale underlying the co-disposal test in the Alternate Feed Guidance, that if material could be placed in the tailings impoundment for disposal without processing, the licensee is processing the material primarily to extract the source material, and not to change the legal definition of the material. As Joseph H. Holonich, former Branch Chief of the Uranium Recovery Branch of the NRC, stated in an affidavit dated January 29, 1999 filed in connection with the Ashland 2 proceedings:

> "This direct disposal test clearly satisfies the 'other grounds' test given in Criteria 3(b) of the Alternate Feed Guidance."

Conclusion

As a result of the above factors, and based on the Commission's reasoning in the NRC Memorandum and Order, February 14, 2000, In the Matter of International Uranium (USA) Corporation (Request for Materials License Amendment), Docket No. 40-8681-MLA-4, it is reasonable for the NRC staff to conclude that uranium can be recovered from the Uranium Material and that the processing will indeed occur. As a result, this license amendment satisfies the Certification Test, and the tailings resulting from the processing of the Uranium Material will be 11e.(2) byproduct material.

2.0 TRANSPORTATION CONSIDERATIONS

IUSA does not have a subcontract in place at this time with IT, the USACE remediation contractor. As a result, it has not been determined whether Uranium Material transferred to the Mill would be shipped by truck or by rail in intermodal containers. If intermodal containers are to be used, the Uranium Material would be loaded into covered, exclusive-use containers at the Linde Site. The covered containers would be loaded onto railcars and transported cross-country to the final rail destination (expected to be either near Grand Junction, Colorado; Cisco, Utah; Green River, Utah; or East Carbon, Utah), where they will be transferred to trucks for the final leg of the journey to the Mill. It is expected that four containers will be shipped per rail car, for a total of up to approximately 1250 cars. The contractor expects that an average of 120 truckloads per week will be used to transport Uranium Material from the rail transfer site to the Mill. If USACE ships 100,000 CY to IUSA, IUSA expects that an average of 120 truckloads per week will be used to transport Uranium Material from the rail transfer site to the Mill for a period of up to ten to fourteen months.

Alternatively, if truck transport is selected, approximately 120 trucks per week would be loaded at the Linde Site, and the Uranium Material would be transported by a predetermined surface route directly to the Mill for a period of up to ten to fourteen months.

The USACE contractor will arrange with a material handling contractor for the proper labeling, placarding, manifesting and transport of each shipment of the Uranium Material. Each shipment will be "exclusive use" (i.e., the only material in each container will be the Uranium Material).

For the following reasons, it is not expected that transportation impacts associated with the movement of the Uranium Material by train and truck from Linde to the Mill will be significant:

- The material will be shipped in exclusive-use containers (i.e., no other material will be in the containers with the Uranium Material). The containers will be appropriately labeled, placarded, and manifested, and the shipping company will track shipments from the Linde Site until they reach the Mill.

- On average during 1998, 385 trucks per day traveled the stretch of State Road 191 between Monticello, UT and Blanding, UT (1997 NRC personal communication with the State of Utah Department of Transportation). An average of 120 additional trucks per week traveling this route to the Mill represents an increased traffic load of only 6.2 percent. The Environmental Statement (NRC, 1979) which provides the environmental assumptions upon which IUSA's current license is based, assumed a maximum of up to 53 truck round trips per day associated with the Blanding ore buying station, and 32 truck round trips per day associated with the Hanksville ore buying station, or a total of nearly five times as much traffic as would be generated by transport of the Uranium Material. Shipments are expected to be completed in a period of fourteen months.

- The containers and trucks involved in transporting the material to the Mill site will be surveyed and decontaminated, as necessary, prior to leaving the Linde Site for the Mill and again prior to leaving the Mill site for the return trip.

3.0 PROCESS

The Uranium Material will be added to the Mill circuit in a manner similar to that used for the normal processing of conventional ore, either alone or in combination with other approved alternate feed materials. The Uranium Material will either be dumped into the ore receiving hopper and fed to the SAG mill, or run through an existing trommel, before being pumped to Pulp Storage. The leaching process may begin in Pulp Storage with the addition of sulfuric acid.

The solution will be advanced through the remainder of the Mill circuitry with no anticipated modifications of any significance to either the circuit or recovery process. Since no physical changes to the Mill circuit of any significance will be necessary to process this Material, no construction impacts of any significance beyond those previously assessed will be involved.

Tailings produced by the processing of this material will be disposed of on-site in an existing lined tailings impoundment (Cell 3). The volume of tailings that would potentially be generated by processing of the Uranium Material is comparable to the volume that would be generated from processing an equivalent amount of ore. The USACE, as described above, may be expected to excavate and ship a total of up to 100,000 CY (approximately 120,000 tons) of Uranium Material from the Linde Site. The addition to Cell 3 of tailings from the processing of 100,000 tons of Uranium Material will increase the total amount of tailings in Cell 3 by approximately ten percent, the same increase expected if an equivalent amount of ore were processed. The design of the existing impoundments has previously been approved by the NRC, and IUSA is required by its NRC license to conduct regular monitoring of the impoundment liners and of the groundwater around the impoundments to detect leakage if it should occur. Additional tailings cells will also require NRC approval and similar monitoring.

IUSA has previously received NRC approval for a license amendment to process material from the St. Louis FUSRAP site. As described in the IUSA Request for Amendment for the St. Louis material, the USACE may be expected to excavate and ship approximately 20,000 to 80,000 tons per year of material from the St. Louis Site, and IUSA would expect to process this material over several years. If the entire volume of Linde material were received during a period that overlapped with shipments of the St. Louis material, the maximum amount of tailings that may be added to Cell 3 in any one year would be approximately 180,000 tons. This would increase the amount of tailings in Cell 3 by a total of approximately 15 percent in one year, the same amount as would be expected if a comparable amount of natural ore were processed.

The remaining capacity in the existing Cell 3 is expected to be sufficient for all of the tailings from the processing of Linde Uranium Material. Since the St. Louis material is expected to be received and processed over a period of several years, some of the tailings from the St. Louis materials will probably be disposed of on site in additional NRC approved tailings impoundments. The design of the existing impoundments has previously been approved by the NRC, and IUSA is required by its NRC license to conduct regular monitoring of the impoundment liners and of the groundwater around the impoundments to detect leakage if it should occur. Additional tailings cells will also require NRC approval and similar monitoring.

4.0 SAFETY MEASURES

Mill employees involved in handling the Uranium Material will be provided with personal protective equipment, including respiratory protection, as required. Airborne particulate and breathing zone sampling results will be used to establish health and safety guidelines to be implemented throughout the processing operations.

The Uranium Material will be delivered to the Mill in closed containers via truck. The Uranium Material will be processed in the Mill circuit in virtually the same manner as conventional ore. The material will proceed through the leach circuit, CCD circuit, and into the solvent extraction circuit or ion exchange circuit, in normal process fashion as detailed in Section 3.0 above. Since there are no major process changes to the Mill circuit, and since the extraction process sequence is very similar to processing conventional uranium solutions, it is anticipated that no extraordinary safety hazards will be encountered.

Employee exposure potential during initial material handling operations is expected to be no more significant than what is normally encountered during conventional milling operations. Employees will be provided with personal protective equipment including full-face respirators, if required.

Airborne particulate samples will be collected and analyzed for gross alpha concentrations. If uranium airborne concentrations exceed 25 percent of the DAC, full-face respiratory protection will be implemented during the entire sequence of material dumping operations. Spills and splashed material that may be encountered during this initial material processing will be wetted and collected during routine work activity. Samples of the Uranium Material indicate it is a neutral material. Therefore, it is anticipated that no unusual PPE apparel will be required other than coveralls and rubber gloves during material handling activities. Respiratory protection will be implemented as determined.

4.1 Control of Airborne Contamination

IUSA does not anticipate any unusual or airborne contamination dispersion when processing the Uranium Material. The contamination potential is expected to be no more than what is normally encountered when processing conventional uranium ore. The successive extraction process circuitry from grinding or washing, leaching, and CCD through solvent extraction and into precipitation are all liquid processes, and the potential for airborne contamination dispersion is minimal. Uranium extraction will proceed through the Mill circuit as if the Uranium Material were conventional uranium ore. The material is a moist solid or in a slurry form once it has been introduced into the SAG mill or pulp storage tanks. Normal dust control measures will be utilized prior to the SAG mill.

The efficiency of airborne contamination control measures during the material handling operations will be assessed while the ore is in stockpile. Airborne particulate samples and breathing zone samples will be collected in those areas during initial material processing activities and analyzed for gross alpha. The results will establish health and safety guidelines that will be implemented throughout the material processing operations.

Personal protective equipment, including respiratory protection as required, will be provided to those individuals engaged in material processing. Additional environmental air samples will be taken at nearby locations in the vicinity of material processing activities to ensure adequate contamination control measures are effective and that the spread of uranium airborne particulates has been prevented.

4.2 Radiation Safety

The radiation safety program which exists at the Mill, pursuant to the conditions and provisions of NRC License Number SUA-1358, and applicable Regulations of the Code of Federal Regulations, Title 10, is adequate to ensure the maximum protection of the worker and environment, and is consistent with the principle of maintaining exposures of radiation to individual workers and to the general public to levels As Low As Reasonably Achievable (ALARA).

4.3 Vehicle Scan

After the cargo has been offloaded at the Mill site, a radiation survey of the vehicle (and intermodal bin, if used) will be performed consistent with standard Mill procedures (Attachment 6). In general, radiation levels are in accordance with applicable values contained in the NRC Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material, U.S. NRC, May, 1987. If radiation levels indicate values in excess of the above limits, appropriate decontamination procedures would be implemented. However, these limits are appropriate for materials and equipment released for unrestricted use only, and do not apply to restricted exclusive use shipments. As stated in Section 2.0 above, the shipments of uranium material to and from the Mill will be dedicated, exclusive loads; therefore, radiation surveys and radiation levels consistent with DOT requirements will be applied to returning vehicles and cargo.

5.0 OTHER INFORMATION

5.1 Added Advantage of Recycling

The Value Engineering Study Team of the USACE has proposed that the Corps use recycling and mineral recovery technologies at a uranium mill to reduce radioactive material disposal costs (See Attachment 7). The Corps notes that the Mill has the technology necessary to recycle materials for extraction of uranium, vanadium, rare earth minerals, and other metals, and to provide for disposal of waste generated as 11e.(2) in the Mill's fully lined and NRC-compliant existing tailings impoundments.

The Corps has found that recycling will add value to the FUSRAP program, and lists the following advantages of recycling, over disposal:

1. Conforms to Congressional and regulatory mandates that encourage use of recycling.
2. Reduces radioactivity of the material to be disposed of.
3. Recycles uranium and other minerals.
4. Reduces cost of disposal of byproduct from recycling operation.
5. Treatment and disposal are performed at one location, and by-product from recycling is disposed of in an NRC-compliant disposal system, meeting 10 CFR 40 design criteria.
6. 11e.(2) by-product is disposed of in existing tailings impoundment which is consistent with 10 CFR 40 Appendix A, Criterion 2 intent for nonproliferation of small sites.
7. Actual cost savings for treatment and disposal versus cost of direct disposal only could be greater than projected, depending upon quantities of recoverable uranium or other minerals.
8. This technology has been demonstrated on multiple waste streams, and has potential applicability to other FUSRAP sites.

5.2 Classification of Uranium Material as 11e.(2) Byproduct Material

As discussed above, USDOE, which managed the Linde Site prior to USACE, determined that the Linde Site material meets the definition of 11e.(2) byproduct material. There is ample authority under the AEA as amended by UMTRCA for USDOE to classify the Uranium Material as 11e.(2) byproduct material. USDOE made that determination with respect to the Uranium Material, and as a result the Uranium Material is 11e.(2) byproduct material. While the Uranium Material is at the Linde Site it is 11e.(2) byproduct material regulated by USDOE. When the Uranium Material enters the Mill site it becomes 11e.(2) byproduct material regulated by NRC. This issue is discussed more fully in the memorandum attached hereto as Attachment 8.

Certification of International Uranium (USA) Corporation
(The "Licensee")

I, David C. Frydenlund, the undersigned, for and on behalf of the Licensee, do hereby certify as follows:

1. The Licensee intends to enter into a contract with the prime contractor for the FUSRAP Linde Site remediation, on behalf of the United States Army Corps. Of Engineers (the "Material Supplier") under which the Licensee will process certain alternate feed material (the "Material") at the White Mesa Uranium Mill for the recovery of uranium. As demonstrated in the foregoing amendment application, based on the uranium content, financial considerations, and other considerations surrounding the Material and the processing transaction, the Licensee hereby certifies and affirms that the Material is being processed primarily for the recovery of uranium and for no other primary purpose.

2. The Licensee further certifies and affirms that the Material, as alternate feed to a licensed uranium mill, is not subject to regulation as a listed hazardous waste as defined in the Resource Conservation and Recovery Act, as amended, 42 U.S.C. Section 6901-6991 and its implementing regulations, or comparable State laws or regulations governing the regulation of listed hazardous wastes. The Licensee is obtaining the Material as an alternate feed, consistent with NRC guidance, for the uranium recovery process being conducted at the White Mesa Mill.

______________________________ Signature

March 16, 2000 Date

David C. Frydenlund
Vice President and General Counsel
International Uranium (USA) Corporation

ATTACHMENT 1

Linde Site Location Maps, Volume Estimates, and Process History

US Army Corps of Engineers
Buffalo District

FUSRAP

PROPOSED PLAN

FOR THE LINDE SITE

TONAWANDA, NEW YORK

MARCH 1999

UNITED STATES ARMY CORPS OF ENGINEERS
PROPOSED PLAN FOR THE LINDE SITE
TONAWANDA, NEW YORK

A Proposed Plan for the Tonawanda Site in Tonawanda, New York was prepared by the United States Department of Energy (DOE) in September 1993 under its authority to conduct the Formerly Utilized Sites Remedial Action Program (FUSRAP). The 1993 Proposed Plan for the Tonawanda Site addressed remediation of radioactive contamination at the four (4) locations in the Town of Tonawanda that comprised the Tonawanda Site as defined at that time: the Linde (now Praxair) Site; the Ashland 1 Site; the Ashland 2 Site; and the Seaway Site.

On October 13, 1997, the Energy and Water Development Appropriations Act, 1998 was signed into law as Public Law 105-62. Pursuant to this law, FUSRAP was transferred from the DOE to the United States Army Corps of Engineers (USACE). As a result of this transfer the responsibility for this project was transferred to USACE and USACE has prepared proposed plans for and is remediating the Tonawanda Site properties. This Proposed Plan addresses the Linde Site.

The Energy and Water Development Appropriation Act for Fiscal Year 1999, Public Law 105-245, requires that USACE comply with the Comprehensive Environmental Response, Compensation, and Liability Act, 42 United States Code 9601 et seq., as amended, in conducting FUSRAP cleanup work. Therefore, USACE is conducting this project in accordance with CERCLA.

USACE reviewed the response action recommended in the 1993 Proposed Plan, supplemental information contained in the Addendum to the Feasibility Study for the Linde Site, other relevant documents, and the records of public meetings conducted following preparation of the 1993 Proposed Plan.

USACE does hereby propose that the final remedial action for the Linde Site be the alternative designated as Alternative 4, Excavation, Decontamination and Institutional Controls, described in the Proposed Plan. After evaluating this alternative pursuant to the nine criteria described in the National Contingency Plan (NCP), 40 Code of Federal Regulations part 300.430(e)(9)(iii), USACE considers it to be protective of human health and the environment and cost effective.

USACE invites members of the public to review the proposed plan and the supporting documents which further describe the conditions at the Linde Site and the basis for this proposal. Those documents may be found in the Administrative Record for the Linde Site at the USACE Public Information Center, 1776 Niagara Street, Buffalo, NY 14207 or the Tonawanda Public Library, in Tonawanda, NY. Members of the public who wish to comment upon this proposed plan may submit their comments in writing to USACE at the following address:

U.S. Army Corps of Engineers
Buffalo District
FUSRAP Information Center
1776 Niagara Street
Buffalo, NY 14207-3199

Please refer to this proposed plan or to the Linde Site in any comments. All comments will be reviewed and considered by USACE in making its final decision on remedial actions to be conducted at the Linde Site. Comments should be submitted no later than 30 days after the date of this proposed plan.

After the close of the public comment period, USACE will review all public comments, as well as the information contained in the Administrative Record for this site, and any new information developed or received during the course of this public comment period, in light of the requirements of CERCLA and the NCP. An authorized official of USACE will then make a final selection of the remedial action to be conducted at this site. This decision will be documented in a Record of Decision, which will be issued to the public, along with a response to all comments submitted regarding this proposed plan.

If there are any questions regarding the comment process, or the proposed plan, please direct them to the address noted above, or telephone (716) 879-4438 or 1 (800) 833-6390.

Kelly L. Eastman
Major
Acting Commander
U.S. Army Engineer District, Buffalo

24 March 1999
Date

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

UNITED STATES ARMY CORPS OF ENGINEERS
PROPOSED PLAN FOR THE LINDE SITE
TONAWANDA, NEW YORK

1. PROPOSED PLAN

A Proposed Plan (DOE 1993a) for the Tonawanda Site in Tonawanda, New York was prepared by the Department of Energy (DOE) in September 1993 under its authority to conduct the Formerly Utilized Sites Remedial Action Program (FUSRAP). The 1993 Proposed Plan for the Tonawanda Site addressed remediation of radioactive contamination at the four (4) locations in the Town of Tonawanda that comprised the Tonawanda Site as defined at that time: the Linde (now Praxair) Site; the Ashland 1 Site; the Ashland 2 Site; and the Seaway Site.

In October 1997, responsibility for FUSRAP was transferred to the United States Army Corps of Engineers (USACE). As a result of this transfer, responsibility for remediation of the Tonawanda Site properties was transferred to USACE and USACE has prepared proposed plans for and is remediating the Tonawanda Site properties. This Proposed Plan addresses the Linde Site.

Numerous concerns and comments were raised by the community and their representatives regarding the preferred alternative described in DOE's 1993 Proposed Plan, which included the disposal of remediation wastes from the Tonawanda Site properties in an on-site engineered disposal facility to be located at Ashland 1, Ashland 2, or Seaway. In 1994, DOE suspended the decision-making process on the 1993 Proposed Plan and re-evaluated the alternatives that were proposed.

This Proposed Plan addresses the Linde Site and adjacent areas. A Proposed Plan for the Ashland 1 (including Seaway Area D) and Ashland 2 sites, commonly referred to as the Ashland Sites, was issued by USACE in November 1997 (USACE 1997) and a Record of Decision (ROD) for the Ashland Sites was issued by USACE in April 1998 (USACE 1998a). Remediation of the Ashland Sites was initiated by USACE in June 1998. The Seaway Site, Areas A, B and C, is being addressed separately.

The remedial action for the Linde Site proposed in 1993 included the removal of radioactively contaminated soil that was determined to be accessible and not under buildings or structures that would require demolition prior to excavation. The 1993 Proposed Plan indicates that inaccessible or access-restricted contaminated soils were to be removed later. Decontamination of Linde buildings determined to be contaminated with radioactivity in excess of guideline values was also included in the plan proposed in 1993.

Subsequent to the issuance of the Proposed Plan for Linde in 1993, and in accordance with Engineering Evaluation/Cost Analysis (EE/CA) documentation and public reviews, Buildings 30 and 38 have been demolished and Buildings 14 and 31 have been decontaminated.

With the completion of the removal of Buildings 30 and 38 from the Linde Site and the decontamination of Building 31, no further remediation is required for those building structures. The remaining radioactive contamination at Linde is limited to soils and to sediments contained in Site drainlines, except: at Building 14, where some radioactive contamination has been detected on exterior walls, some radioactive contamination remains after decontamination at inaccessible interior locations; and some inaccessible contaminated soils remain under the building; at the tank saddles located north of Building 30, where limited surface area radioactive contamination was detected; in soils in a timber blast wall structure located east of Building 58; and at a subsurface vault structure, located just west of Building 73, where radioactive waste may be present.

The data on radioactive contamination of soils remaining at the Linde Site has been updated to reflect additional findings during the course of removal of Buildings 38 and 30 and additional investigations in Building 14 conducted during building decontamination. Additional contaminated soil has also been found under Building 57. This Proposed Plan includes demolishing Building 57 and attached buildings to gain access to soils under the slab. (See Section 7 for details of buildings and structures included in the Proposed Plan.)

Accordingly, the plan described herein identifies options for both accessible and a limited quantity of currently inaccessible contaminated soils under Building 14 and includes additional decontamination of areas of buildings and structures that have recently been determined to be contaminated.

The plan also proposes remediation of adjacent properties, such as the Niagara Mohawk and Conrail properties, where radioactive contamination has already been identified or may be identified as the remediation work is implemented.

This plan provides background information on the Linde Site, describes the alternatives considered in the original November 1993 Proposed Plan and revised alternatives developed by USACE to clean up the Linde Site, presents the rationale for the selection of the preferred alternative, and outlines the public's role in helping USACE make a decision on a cleanup approach.

The 1993 preferred alternative for the Linde Site has been revised based on the following: input from the community after issuance of the previous draft Proposed Plan; discussions with the community's representatives; three key documents associated with the original Proposed Plan; and four recently prepared documents. The three key documents associated with the original Proposed Plan were the Remedial Investigation (RI) report (BNI 1993) which describes the nature and extent of areas with elevated levels of radionuclides; the Baseline Risk Assessment (BRA) (DOE 1993b) which assesses the risks to public health and the environment posed by the site; and the Feasibility Study (FS) (DOE 1993c) which describes how the cleanup options discussed in the original Proposed Plan were developed and evaluated.

The four recently prepared USACE documents are:

- "Technical Memorandum: Linde Site Radiological Assessment" (USACE 1999a). This document evaluates current radiological risks at the Linde Site and future risks, with and without cleanup, based on updated information. The assessment concludes that cleanup to the criteria of 40 CFR Part 192, the cleanup criteria used at uranium mill sites, would reduce radiological risks at Linde to acceptable levels. Additional details of proposed cleanup levels and risks at Linde are described in subsequent sections of this Proposed Plan.

- "Synopsis of Historical Information on Linde Effluent Injection Wells" (USACE 1999b). This document is a review and reassessment of existing information concerning the effects on groundwater quality resulting from the injection of process wastes to the subsurface during uranium processing conducted at Linde from 1943 to 1946. This document concludes, as also concluded in the 1993 Proposed Plan, that groundwater remediation at Linde is not required.

- "Addendum to the Feasibility Study for the Linde Site" (USACE 1999c). The Addendum to the FS for the Linde Site focuses on the Linde Site and summarizes findings and assessments not available at the time the 1993 DOE FS (DOE 1993c) was prepared. Key findings of the 1993 DOE documents pertaining to the Linde Site and findings of the recent USACE Linde documents are included. The status of building demolition and decontamination at Linde is updated, and updated information on radiological contamination is summarized. The proposed cleanup criteria for Linde Site remediation are identified and assessed. The remedial alternatives currently being considered for the Linde Site are described and evaluated, including risks and costs.

- "Post Remedial Action Report for Building 14 at the Linde Site, Tonawanda, New York" (USACE 1998b). This report provides details of efforts initiated under DOE to decontaminate Building 14 interior surface and subsurface soils beneath slabs inside the building where MED-related activities occurred. These decontamination efforts were completed by USACE in 1998. The decontamination criteria for the soils and surfaces used during this effort were established by DOE. The decontamination efforts were completed by USACE and a few currently inaccessible areas were identified where removal to the criteria established by DOE was not possible.

  The report indicates that risks from residual materials remaining in currently inaccessible areas would be acceptable under current circumstances and building uses and controls. As detailed in this Proposed Plan, one of the alternatives evaluated, and the one that is identified as the preferred alternative, involves leaving areas of inaccessible contamination at Building 14 in place, with institutional controls to ensure that risks remain acceptable.

This Proposed Plan summarizes information that can be found in greater detail in the reports named above and in other documents contained in the administrative record file for the site which can be found at the Public Information Center and the Tonawanda Public Library. USACE encourages the public to review these documents for a more comprehensive discussion of the alternatives that were considered in the original Proposed Plan.

The final decision on the remedy to be implemented will be documented in the ROD for the Linde Site, only after consideration of all comments received and any new information presented. USACE may modify the preferred alternative presented here or select another option from this Proposed Plan based on new information or public and/or regulatory agency comments. Therefore, the public is encouraged to review and comment on all of the alternatives identified.

2. SITE BACKGROUND

From 1942 to 1946, portions of the Linde site (currently Praxair) and a few select buildings located at Linde in the Town of Tonawanda, New York, were used for separation of uranium ores. These processing activities, conducted under a Manhattan Engineering District (MED) contract, resulted in elevated levels of radionuclides in portions of the property and buildings. Subsequent disposal and relocation of processing wastes from the Linde property resulted in elevated levels of radionuclides at three nearby properties in the Town of Tonawanda: the Ashland 1 property, the Seaway property, and the Ashland 2 property. Together these four properties are referred to as the Tonawanda Site. The locations of the Tonawanda Site properties are shown in Figures 1 and 2.

2.1 Description of the Impacted Property

The Linde Site is now owned by Praxair and comprises about 135 acres located at East Park Drive and Woodward Avenue in the Town of Tonawanda. The Site is bounded on the north and south by other industry and small businesses, on the east by the Consolidated Rail Corporation (Conrail) railroad tracks and Niagara Mohawk property and easements, and on the west by a park owned by Praxair which is open to the public. The regional and vicinity locations of the Linde Site are shown in Figures 1 and 2, respectively. Linde Site locations are shown in Figure 3.

The property contains office buildings, fabrication facilities, warehouse storage areas, material laydown areas and parking lots. Access to the property is controlled by Praxair. Approximately 1,400 employees work at the Praxair facilities.

Elevated levels of radionuclides at the Linde Site and some adjacent areas resulted from the separation of uranium ores at the property from 1942 to 1946 under a MED contract. As discussed in the RI report, there were three phases to the processing conducted at Linde - Phase 1: uranium separation from the ore; Phase 2: conversion of U_3O_8 to uranium dioxide; and Phase 3: conversion of uranium dioxide to uranium tetrafluoride. The RI report, as well as other reports (e.g., Aerospace 1981), state that the contaminants of concern at the Linde Site were primarily associated with the waste streams and residues of the Phase 1 operation and that any residues from the Phase 2 and 3 operations were reprocessed, which is discussed in more detail in Section 2.3. All phases of operation have been reported to have occurred during the 1942 to 1946 period. A review of historical and recent documents indicates that the operations may have extended to the year 1948, particularly the Phase 2 and 3 operations (DOE 1997). Regardless of the actual duration of operations, the primary activity over most, if not all of the period during which MED-related activities occurred at the Linde Site was the separation of uranium from the ore; and the principal contaminants of concern were from the processing of wastes and residues from that operation since the residues from the other two phases were reported to have been recycled (Aerospace 1981).

The 1993 Proposed Plan (DOE 1993a) identified three sources of radioactive contamination at Linde, the uranium processing buildings, surface and subsurface soils, and sediments in sumps and storm and sanitary sewers. The primary radioactive contaminants in the soils and sediments are Uranium-238 (U-238), Radium-226 (Ra-226), Thorium-230 (Th-230), and their respective radioactive decay products (DOE 1993c). MED-related chemical contaminants are comingled with the radiologically contaminated soils (DOE 1993a).

As described in Section 1, above, additional characterization of radioactive contamination at the Linde Site has been conducted since the RI report was prepared in 1993. The findings of these characterization activities have been incorporated into the site database and were used, along with the data available in 1993, to assess needs for remediation and to formulate the remedial alternatives described in this Proposed Plan.

The 1993 Remedial Investigation (RI) report for the Tonawanda Site (BNI 1993) indicated that approximately 55 million gallons of waste effluent containing dissolved uranium oxide was injected into the subsurface at Linde through seven (7) wells over a period of three years beginning in 1944. The RI report further indicated that precipitates were formed in the bedrock formation where injection occurred. The RI report concluded that the subsurface radioactive contamination probably occurs in the subsurface at Linde as minor percentages of uranyl sulfates and carbonates precipitated in the shale under the Linde site where they are presumed to be immobile (BNI 1993). No remedial action for groundwater at Linde was proposed in the 1993 Proposed Plan (1993a).

As described in Section 1, USACE has conducted a review and reassessment of existing information concerning groundwater conditions at Linde (USACE 1999b). As was concluded in the RI report, USACE has concluded that due to the high temperatures and high pH of the effluents injected into the subsurface at Linde, most of the heavy metals (including uranium and thorium) would have precipitated when contacting the natural groundwater present in the shallow bedrock and the contact zone aquifer below the site where the effluents were injected. Also reviewed in the reassessment were the findings of groundwater sampling at the site in 1981 by Linde, with analysis by Argonne National Laboratory (ANL), and 1981 sampling by Oak Ridge Associated Universities, and Ford, Bacon & Davis Utah (FBDU). The results of the sampling in 1981 were compiled and assessed by the Aerospace Corporation (Aerospace 1981).

The USACE review and reassessment compared the 1981 groundwater sampling results summarized in the Aerospace report and the results of one validated groundwater sample collected during the RI in 1992, to current standards for groundwater protection that are applicable at uranium mill tailings sites. These standards, found in 40 CFR Part 192, Table 1, Subpart A, the Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings, while not directly applicable to Linde, are considered to be relevant and appropriate in considering cleanup of the Linde Site. A more detailed discussion of these regulations and their relevance to Linde Site cleanup is provided in Section 4.2 of this Proposed Plan. The comparison of the 1981 and 1992 groundwater results to the 40 CFR Part 192 standards shows radionuclide concentrations below the standards.

USACE also reviewed information showing that groundwater at the Linde Site and its vicinity contains high concentrations of dissolved solids and salinity, which precludes its use for potable consumption without costly treatment and also noted that the Linde Site and its vicinity are serviced by municipal sources of drinking water. Therefore, the groundwater is not considered to be an actual or potential source of drinking water.

Based on the review and reassessment, USACE concurs with the findings of the earlier documents and concludes that groundwater at the Linde Site does not require remediation (USACE 1999b).

3. SUMMARY OF SITE RISKS

The 1993 BRA (DOE 1993b) was prepared to evaluate the risk to human health and the environment from the radioactive and chemical constituents at the site. In accordance with Environmental Protection Agency (EPA) guidance, the primary health risks investigated were cancer and other chemical-related illnesses as well as the ecological risks. This assessment evaluated the potential risks that could develop in the absence of cleanup and assumes that no controls (e.g., fencing, maintenance, protective clothing, etc.) are, or will be, in place. The purpose of the BRA was to determine the need for cleanup and provide a baseline against which the remedial action alternatives were compared. The complete report is in the administrative record file and a brief summary of the radiological and chemical health risks as well as the ecological risks is provided herein.

The BRA identified the means by which people and the environment may be exposed to constituents present at the Tonawanda site. Mathematical models were used to predict the possible effects on human health and the environment from exposure to elevated levels of radionuclides and chemicals for both present and future uses at the site. Under Section 300.400(e)(2)(i)(A)(2) of the NCP "acceptable exposure levels are generally concentration levels that represent an excess upper bound life-time cancer risk to an individual of between 10^{-4} and 10^{-6} using information on the relationship between dose and response." "The 10^{-6} risk level shall be used as the point of departure for determining remediation goals for alternatives when Applicable or Relevant and Appropriate Requirements (ARARs) are not available or not sufficiently protective because of the presence of multiple pathways of exposure."

The modeled risk estimates in the BRA were then compared to the NCP's risk criteria. The findings of these comparisons and USACE's updated risk characterization for the site are described below.

3.1 Radiological Health Risk

The 1993 BRA provides risk estimates for average (mean) exposure conditions under hypothetical scenarios for current and projected future land use. These estimated risks are calculated using the average radionuclide concentrations present at the properties. The results predicted that, for the current land uses, no one would be exposed to unacceptable risks. For assumed future land uses, the mean radiological risk, as was reported in the original 1993 Proposed Plan, was predicted to be within the NCP's range of acceptability at Linde.

EPA's guidance for risk characterization requires that the modeling to estimate risks also include what is called a Reasonable Maximum Exposure (RME) scenario. RME calculations assume that a worker at the site for a longer period of time than the average worker (30 years for the RME worker and 22 years for the average worker), would be exposed to higher concentrations of dust than the average worker, would inhale more air than the average worker, would spend more time each day outside than the average worker, and would ingest more soil each day than the average worker. Using these higher RME exposure assumptions, the BRA reported that RME risks to workers in some Linde Site areas slightly exceed the NCP's target risk range under current conditions. The BRA assumed that future use of the Linde Site will be commercial/industrial.

As briefly described in Section 1, USACE prepared a Technical Memorandum (USACE 1999a) evaluating radiological risks at the Linde Site assuming no action is taken and also assessing risks after cleanup.

The 1999 USACE assessment of radiological risks at the Linde Site used updated information on the location of radiologically contaminated soils. The Linde Site currently is used for commercial and industrial purposes, and industrial facilities have been present at the site for more than 60 years. Given the past and current use of the Linde Site for industrial and commercial uses over more than 60 years, including the ownership of part of the property by the Erie County Industrial Development Authority (ECIDA) to promote industrial use and the zoning restrictions on the property, USACE has concluded that the reasonably anticipated future land use of the property will be for commercial/industrial purposes (USACE 1999c). The assessment considered the most likely future land use of the Linde Site to be its current commercial/industrial use.

The results of the 1999 USACE assessment show current risks to commercial/industrial workers at the site to be higher than the NCP's target risk range for several areas of the Linde Site. The assessment also showed that cleanup to the criteria of 40 CFR Part 192 and the site-specific criteria for uranium, in these areas, would result in acceptable risks. Details of the 40 CFR Part 192 and site-specific criteria and the rationale for selecting those criteria for Linde Site cleanup are addressed in Section 4 of this Proposed Plan.

3.2 Chemical Health Risk

The 1993 BRA also evaluated cancer and chemical toxicity risks. The risk of developing cancer over a 70-year lifetime from chemical carcinogens at the site was evaluated for both average (mean) exposure and for RME. None of the estimated cancer risks exceeded the EPA risk range of acceptability for current or future land uses. In addition, no unacceptable effects would be expected for non-cancer chemical illnesses under current land uses.

The potential for chemical noncarcinogenic health effects is expressed as chemical-specific hazard quotients (HQs). HQs were tabulated for all chemicals of concern where reference doses or reference concentrations are currently available. HQs are summed for each pathway to provide a total hazard index (HI) for the pathway. The calculated HIs for all exposure pathways for all scenarios evaluated at the Tonawanda Site properties are much less than 1 thus indicating that no unacceptable effects would be expected.

3.3 Ecological Risk

The Ecological Risk Assessment included in the 1993 BRA follows EPA's general procedures for ecological assessments in the Superfund program. The characterization of habitats and biota at risk are semiqualitative, and screening of contaminants and assessment of potential impacts to biota are based on measured environmental concentrations of the constituents and toxicological effects reported in the literature.

The Linde Site is located in a highly modified urban, industrial area and provides minimal urban wildlife habitat supporting only cosmopolitan species of birds and small mammals. No threatened or endangered species exist on the Linde Site and ecological risks are minimal. USACE has concluded that no significant impact will result from any of the Linde remedial alternatives (USACE 1999c).

4. APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs) AND CLEANUP GUIDELINES

4.1 ARARs

When remediation of a site is being conducted in accordance with CERCLA and the NCP, selected remedies must comply with ARARs and be protective of human health and the environment.

Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a CERCLA site. An applicable requirement directly and fully addresses an element of the remedial action.

Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is suited to the particular site.

Only those state standards that are promulgated, are identified by the state in a timely manner, and are more stringent than federal requirements may be applicable or relevant and appropriate. USACE has determined that the following are the cleanup ARARs for the remedial activities at the Linde Site.

4.2 ARARs and Site Specific Standards for the Linde Site

The standards found in 40 CFR Part 192 are not considered applicable because the regulation is only applicable to specific sites designated under the Uranium Mill Tailings Radiation Control Act (UMTRCA). However, USACE has determined that 40 CFR Part 192 is relevant and appropriate to the cleanup of the Linde Site. This determination was made based on the similarity of the uranium processing activities and resulting radionuclides found in the waste after processing at uranium mill sites where the regulation is applicable. In addition, the requirements are well suited to the site.

Subpart A of 40 CFR Part 192 is relevant and appropriate to the Linde Site cleanup, because Subpart A establishes groundwater standards that are cross-referenced from Subpart B of 40 CFR Part 192. These standards include maximum concentrations for radionuclides in groundwater as follows:

- Combined radium-226 and radium-228 – 5 pCi/liter (L)
- Combined uranium-234 and uranium-238 – 30 pCi/L
- Gross alpha particle activity (excluding radon and uranium) – 15 pCi/L

As described in Section 2.1, a review of groundwater sampling results from the Linde Site shows that these standards are not exceeded. These findings, along with the other findings described in Section 2.1, are the basis for concluding that remediation of groundwater is not required at the Linde Site.

Subpart B of 40 CFR Part 192 addresses cleanup of land and buildings contaminated with residual radioactive material from inactive uranium processing sites, and sets standards for residual concentrations of Ra-226 in soil. It requires that radium concentrations shall not exceed background by more than 5 pCi/g in the top 15 cm of soil or 15 pCi/g in any 15 cm layer below the top layer, averaged over an area of 100 m^2.

Subpart B also provides standards for any occupied or habitable building. These standards require that the remedial action shall be and reasonable effort shall be made to:

- achieve an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 Working Level (WL). In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL, and

- the level of gamma radiation shall not exceed the background level by more than 20 microroentgens per hour.

These 40 CFR Part 192, Subpart B requirements are considered relevant and appropriate to the cleanup of the Linde Site and buildings.

Subpart D of 40 CFR Part 192 applies to UMTRCA sites and requires that releases of radon-222 (Rn-222) and Rn-220 into the atmosphere resulting from the management of uranium and thorium byproduct materials shall not exceed an average release rate of 20 pCi/meter^2-second (m^2-s). This requirement is considered relevant and appropriate to the remedial action at the Linde Site. Implementation of the proposed plan will result in radon releases below the stated limits.

In addition to the 40 CFR Part 192 criteria, USACE's 1999 radiological assessment of the Linde Site (USACE 1999a) also addresses a cleanup guideline for total uranium at the Linde Site because 40 CFR Part 192 does not address uranium in situations where there are specific areas of elevated concentrations. USACE determined that a uranium cleanup level that would meet the CERCLA acceptable risk range was needed to enable USACE to address possible areas during remediation where soils are contaminated predominantly with uranium and very little radium and thorium. Testing has indicated that there are some possible areas of elevated concentration possibly due to accidental spills of product (e.g., U_3O_8, Uranium dioxide, and UF_4) during MED operations. The USACE assessment considered the radiological risk associated with the presence of uranium in Linde Site soils and also the risks associated with uranium due to its chemical toxicity. As described in the assessment report (USACE 1999a), a uranium cleanup level for Linde Site soils based on limiting radiological risks was determined to be more restrictive than the cleanup level based on the chemical toxicity of uranium. A uranium cleanup guideline of 600 pCi/g was established based on limiting potential radiological risks due to uranium in Linde Site soils to 1×10^{-5}. Together, the 40 CFR Part 192 criteria and the uranium cleanup level of 600 pCi/g, are the cleanup criteria being proposed for remediation of the Linde Site.

5. SUMMARY OF REMEDIAL ALTERNATIVES

5.1 Remedial Action Alternatives Evaluated in the 1993 FS and PP and Updated Description of Linde Alternatives

Detailed descriptions of the remedial alternatives considered for the Tonawanda site in 1993, including the Linde Site, can be found in the FS (DOE 1993c), which is available in the administrative record. A total of 6 alternatives were considered in the FS. The following section describes the 1993 alternatives and updates the descriptions of alternatives being considered by USACE for the Linde Site.

5.1 Linde Site Alternatives

Alternative 1: No Action. The no-action alternative is required under CERCLA regulations to provide a baseline for comparison with other alternatives. Under this alternative, no action is taken to implement remedial activities. Periodic monitoring of the Site as appropriate would be continued. This alternative was evaluated in the 1993 FS and is the baseline for comparison with other alternatives for the Linde Site.

Alternative 2: Complete Excavation and Decontamination with Offsite Disposal. This alternative was evaluated in the 1993 FS. Complete excavation of MED-contaminated soils containing radionuclides above guidelines and offsite disposal and decontamination of the surfaces of structures exceeding guidelines would remove the source of elevated levels of radionuclides from the Linde Site. Section 4 addresses the cleanup guidelines proposed by USACE for Linde.

Alternative 3: Complete Excavation with Onsite Disposal. This alternative is similar to Alternative 2 regarding excavation of soils, however, all excavated soils would be placed in an on-site engineered disposal cell to be located on Ashland 1, Ashland 2 or Seaway. Institutional controls would be imposed to control access to the onsite engineered disposal cell and the cell would be designed to minimize future exposures or releases to the environment. Because this alternative originally envisioned the excavation and consolidation of all MED-related contaminated soils from the four Tonawanda FUSRAP sites, it is no longer being considered for remediation of the Linde Site, and has, therefore, been eliminated.

Alternative 4: Partial Excavation with Offsite Disposal. In the 1993 FS, this alternative included the excavation of accessible contaminated soils, institutional controls and containment for "access-restricted" soils, demolition of Buildings 14, 31 and 38, decontamination of Building 30 and offsite disposal. Soils covered by buildings or structures were determined to be access-restricted. Under this alternative, the soils were to be left in place until the buildings or structures were abandoned and demolished.

Given the demolition of Buildings 38 and 30 and the decontamination of Building 14, including removal of all but a limited volume of contaminated soil beneath Building 14 that is considered inaccessible due to structural considerations, only a limited quantity of contaminated soil is currently considered inaccessible at the Linde Site. Accordingly, **Alternative 4** has been redefined as **Excavation, Decontamination and Institutional Controls**. Under this alternative, surfaces and soil with contamination exceeding cleanup guidelines would be either decontaminated or removed from the site at all locations except the limited quantity that may exist at Building 14. Institutional Controls would be placed on the use of Building 14 to preclude future exposure to MED-related radionuclides that could exceed acceptable risk levels. The controls could include measures such as deed restrictions, prohibiting intrusion into building areas or subsurface areas without imposing restrictive conditions, restricting use of areas, employee training, posting warnings and similar measures.

Alternative 5: Partial Excavation With On-Site Disposal. Alternative 5 was the same as Alternative 4 in the 1993 FS and PP, except contaminated soils removed from Linde would be disposed in an on-site engineered disposal cell to be located at Ashland 1, Ashland 2, or Seaway. After reviewing the concerns expressed by the community regarding the creation of the proposed cell, USACE eliminated this option from further consideration.

Alternative 6: Containment with Institutional Controls. Containment for the Linde Site would involve capping of areas exceeding guidelines for radiological contamination. Because this alternative, when applied to the Linde Site, is basically an on-site disposal action, it is no longer being considered for the remediation of the Linde Site.

5.2 Summary of Current Alternatives

As described above, the remedial alternatives currently being considered by USACE for the Linde Site are:

- Alternative 1 - No Action.
- Alternative 2 - Complete Excavation and Decontamination with Off-Site Disposal.
- Alternative 4 - Excavation, Decontamination and Institutional Controls

6. ANALYSIS OF ALTERNATIVES FOR LINDE

The alternatives described above were evaluated using CERCLA criteria to determine the most favorable actions for cleanup of the Linde Site. These criteria are described below. They were established to ensure that the remedy is protective of human health and the environment, meets regulatory requirements, is cost effective, and utilizes permanent solutions and treatment to the maximum extent practicable. The results of the detailed evaluation of alternatives to remediate the Linde Site are summarized in the following section. Key elements of the evaluation are described below.

Glossary of Evaluation Criteria

- **Overall Protection of Human Health and the Environment** - addresses whether an alternative provides adequate protection and describes how risks are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

- **Compliance with Federal and State Environmental Regulations** - addresses if a remedy would meet all of the ARARs of other Federal and State environmental laws.

- **Long-Term Effectiveness and Permanence** - addresses the remaining risk and the ability of an alternative to protect human health and the environment over time, once cleanup goals have been met.

- **Short-Term Effectiveness and Environmental Impacts** - addresses the impacts to the community and site workers during cleanup including the amount of time it takes to complete the action.

- **Reduction in Toxicity, Mobility, or Volume through Treatment** - addresses the anticipated performance of treatment that permanently and significantly reduces toxicity, mobility, or volume of waste.

- **Implementability** - addresses the technical and administrative feasibility of an alternative, including the availability of materials and services required for cleanup.

- **Cost** - compares the differences in cost, including capital, operation, and maintenance costs.

- **State Acceptance** - evaluates whether the State agrees with, opposes, or has no comment on the preferred alternative.

- **Community Acceptance** - addresses the issues and concerns the public may have regarding each of the alternatives.

7. ALTERNATIVE COMPARISON - LINDE

The purpose of the following analysis is to weigh the advantages and disadvantages of each alternative, when compared with each other, based on the evaluation criteria. This information is used to select a preferred alternative.

The alternatives considered in the evaluation, Alternatives 1, 2 and 4, would involve the following:

- **Alternative 1, No Action.** This alternative would involve no remediation of the Linde Site. Periodic monitoring would be required.

- **Alternative 2, Complete Excavation and Decontamination with Offsite Disposal.** This alternative would involve the demolition of buildings necessary to remediate the site with either acquisition of or compensation for those buildings. These buildings include Buildings 14, 57, 67, 73, 73B, 75, and 76 and would also include the building slabs and foundations. The slabs that are now remaining after the demolition of Buildings 30 and 38 would be removed. A wall in Building 31 would be removed to access sub-slab and sub-footing soil exceeding criteria. Contaminated sediments in drainlines and contaminated soils in the blast wall structure east of Building 58 would be removed. The subsurface vault west of Building 73 would be investigated and removed if found to be contaminated. MED-related soils exceeding the 40 CFR Part 192 criteria, including the uranium cleanup guideline of 600 pCi/g, would be removed from the site. The volume of soil to be removed is estimated to be 18,000 cy (USACE 1999c). The tank saddles north of Building 30 would be remediated in accordance with 40 CFR Part 192 standards.

- **Alternative 4, Excavation, Decontamination and Institutional Controls.** Alternative 4 is similar to Alternative 2 except that Building 14 would not be demolished. Currently inaccessible soils under the foundation and supporting structures at Building 14 would also be left in place. An estimated 60 cy of soils exceeding the removal criteria existed under the building slab and foundation. prior to recently conducted remediation within Building 14 (USACE 1999c). Currently inaccessible surface contamination in the interior of Building 14 would be left in place. Areas determined to be contaminated on the exterior of Building 14 would be decontaminated in accordance with 40 CFR Part 192 standards. Institutional controls would be implemented in Building 14 to preclude exposures to MED-related radiological contaminants in excess of acceptable limits. These controls could include measures such as deed restrictions, prohibiting intrusion into building areas or subsurface areas without imposing restrictive conditions, restricting use of areas, employee training, posting warnings, and similar measures. Periodic reviews, every five years, would be conducted to ensure the effectiveness of the institutional controls.

The results of the evaluation are summarized in the following sections.

Overall Protection of Human Health and the Environment. The alternative providing complete excavation of soils containing radionuclides above guidelines and decontamination of surfaces, specifically Alternative 2, provides the greatest degree of protection to human health and the environment, because the materials containing radionuclides above guidelines are removed from the site and are permanently isolated in a disposal facility. A degree of risk to workers is involved with implementing this alternative, as well as Alternative 4, because the associated work involves intrusive activities for handling and moving all materials containing radionuclides above guidelines. These risks can be minimized by using safety procedures and equipment. Alternative 4 is also protective of human health and the environment because institutional controls in Building 14 would preclude exposures to contaminated building areas. Alternative 1 provides no increased protection over the current site conditions and would not be protective of human health if current restrictions on exposure to areas containing contamination were to be discontinued.

Compliance with ARARs. Alternative 2 meets the ARARs because all soil containing MED-related radionuclides exceeding the cleanup guideline would be excavated and permanently isolated in an off-site disposal cell or facility and all surface contamination would be remediated or eliminated by demolition and isolated in an off-site disposal cell or facility. Alternative 4 could involve leaving in place some surface contamination inside Building 14 and some soil above the cleanup criteria beneath Building 14. As indicated above, decontamination efforts have already occurred within Building 14 and the soils beneath the interior slabs. Accessible soils and surfaces were decontaminated to the criteria established by DOE and currently inaccessible areas clearly identified (USACE 1998c). All areas, both currently accessible and inaccessible, will be assessed in terms of the final site cleanup criteria to be established in the ROD. Areas where soil is currently accessible, both within Building 14 and throughout the site, will be remediated and will meet the ARARs. The inaccessible soils and surface contamination remaining in place will also meet the ARARs with the imposition of institutional controls. The controls will insure the continuance of conditions that meet the surface criteria of 40 CFR Part 192. Alternative 1, however, is noncompliant with the ARARs because all of the waste on the Linde Site containing radionuclides above the guideline, remains on-site with no additional protection provided.

Long-term Effectiveness and Permanence. A primary measure of the long-term effectiveness of an alternative is the magnitude of residual risk to human health after remediation. The adequacy and reliability of engineering and/or institutional controls used to manage residual materials that remain onsite must also be considered.

Alternative 2 has the highest degree of long-term effectiveness and permanence because all soils containing radionuclides above guideline are excavated and removed from the site.

Alternative 4 has a high degree of effectiveness, but relies on long-term institutional controls to ensure that exposure pathways remain blocked. The magnitude of residual risk and exposures to human health and the environment is directly related to the adequacy and reliability of institutional controls. However, it is reasonably expected that institutional controls can be effectively implemented.

For all the alternatives, except Alternative 1, the risk calculated for an industrial/commercial worker at the Site, is within acceptable levels.

Alternative 1, no action, has low long-term effectiveness because the post-implementation remedial risks equal those now at the site.

Short-term Effectiveness and Environmental Impacts. Short-term effectiveness is measured with respect to protection of community and workers as well as short-term environmental impacts during remedial actions and time until remedial action objectives are achieved. An increase in the complexity of an alternative typically results in a decrease in short-term effectiveness because of increased handling and processing. Also, alternatives involving offsite disposal of wastes would result in a decrease in short-term effectiveness because of the increased time required and transportation-related risks.

Alternative 1, no action, is the most effective in protecting the community and workers and controlling impacts during implementation since no actions that could create impacts are undertaken. Alternative 1 requires the shortest time to implement. The short-term effectiveness of the other alternatives rank in the following order: Alternative 4 (Excavation, Decontamination, and Institutional Controls), and Alternative 2 (Complete Excavation and Decontamination With Off-Site Disposal).

Reduction in Toxicity, Mobility, or Volume through Treatment. None of the alternatives provides treatment on site for the materials to be removed. Alternatives 2 and 4, which provide for offsite disposal, will include containment at the final disposal location and any treatment which is required to meet the standards of the offsite facility. These alternatives thus will achieve reduction in mobility, although no treatment is planned which will reduce the toxicity or volume of the disposed materials. The remaining alternative, no action, would provide no removal of materials. The 1993 Feasibility Study (DOE 1993c) evaluated currently available treatment technologies for treatment in the course of removal and found none are economically and technologically feasible at this time.

Implementability. In regard to implementability, the alternatives were evaluated with respect to the following:

- ability to construct and operate the technology,
- reliability of the technology,
- ease of undertaking additional remedial actions,
- ability to monitor effectiveness,
- ability to obtain approvals and coordinate with regulatory agencies,
- availability of offsite disposal services and capacity, and
- availability of necessary equipment and specialists.

The degree of difficulty in implementing an alternative increases with the complexity of the remediation activity. The design, engineering, and administrative requirements of Alternative 1, no action, are essentially negligible. The remaining alternatives are all technically and administratively feasible. The engineering, design, and administrative requirements increase with the complexity of the alternatives in the following order: Alternative 4 (Excavation, Decontamination and Institutional Controls); and Alternative 2 (Complete Excavation and Decontamination with Off-Site Disposal). Materials and services for the various alternatives are readily available. The degree of difficulty in implementing these alternatives increases with the amount and type of soils to be excavated and the distance to the selected disposal facility. The implementation of institutional controls (Alternative 4) is considered to be feasible and implementable given controls that have already been implemented over the years at Linde. The controls could include measures such as deed restrictions, prohibiting intrusion into building areas without imposing restrictive conditions, restricting use of areas, employee training, posting warnings, and similar measures.

Cost. The comparative analysis of costs compares the differences in capital, operations and maintenance (O&M), and present worth values. Costs for each of the alternatives presented in the original plan were provided in detail in Appendix G of the 1993 Feasibility Study. These costs were for the entire Tonawanda Site, not just Linde. Since the completion of the original Proposed Plan, the costing methodology has changed, primarily in the area of assessing program management costs. Additionally, remediation of buildings at the Linde Site has changed the components of the assessed alternatives and a more detailed analysis of volumes of soils containing radionuclides above guidelines has been conducted using three-dimensional modeling. These new cost estimates, based on 1998 dollars, have been made for the Linde Site. Table 1 presents the current cost estimates for the Linde Site alternatives using total 1998 dollars as well as the 30-year present worth estimates, assuming a net 5% growth. Alternatives 3 and 5 are not included in the Table as they are no longer being considered, as discussed in Section 5.1.

Table 1. Implementation Costs for Linde

Alternative	Description	Cost (1998 $)	Present Worth at 5%
1	No Action	$902,000	$461,000
2	Complete Excavation and Decontamination With Off-Site Disposal	$43,231,000	$41,533,000
4	Excavation, Decontamination and Institutional Controls	$28,217,000	$25,766,000

7.1 State Acceptance and Community Acceptance

These criteria are not evaluated formally until comments from state regulators and community members on the Proposed Plan are reviewed.

State and community input received during the 1993 public comment process on the 1993 Tonawanda PP resulted in the elimination of Alternatives 3 and 5 from consideration as discussed in Section 5.1.

8. LINDE SITE PREFERRED ALTERNATIVE

USACE prefers Alternative 4, Excavation, Decontamination and Institutional Controls. This alternative is believed to provide the best balance among the considered alternatives with respect to the evaluation criteria, will protect human health and the environment, will comply with ARARs, and is considered cost effective. This alternative would involve excavation and off-site disposal of MED-contaminated soils exceeding 40 CFR Part 192 criteria and uranium above 600 pCi/g, except in inaccessible areas under Building 14, where soils with MED-related contamination exceeding guidelines could be left in place. Contaminated sediments in drainlines would be removed. The subsurface vault west of Building 73 would be investigated and removed if found to be contaminated. Surficial contamination exceeding guidelines at locations determined to be inaccessible would also be left in place within Building 14. Decontamination of the exterior of Building 14 and the tank saddles north of Building 30 will be performed in accordance with 40 CFR Part 192 criteria. Institutional controls would be implemented in Building 14 to preclude unacceptable exposures to contaminants. Periodic reviews, every five years, would be conducted to ensure the effectiveness of the institutional controls.

9. COMMUNITY ROLE IN SELECTION PROCESS

Public input is encouraged by USACE to ensure that the remedy selected for the Linde Site meets the needs of the local community in addition to being an effective solution to the problem.

The administrative record file contains all of the documentation used to support the preferred remedy, and is available at the following locations:

USACE FUSRAP Public Information Center
1776 Niagara Street
Buffalo, NY 14207

Tonawanda Public Library
333 Main Street
Tonawanda, NY 14150

The public is encouraged to review and comment on all alternatives described in this Proposed Plan and the supporting Feasibility Study and Addendum to the Feasibility Study.

Comments on the proposed remedial action at the Linde Site will be accepted for 30 days following issuance of the Proposed Plan in accordance with CERCLA "as amended," and the NCP. A public meeting will be held during the comment period to receive any verbal comments the public wishes to make. Written comments the public wishes to make or submit regarding the preferred remedy will be received at the meeting or during the 30-day period. Responses to public comments will be presented in a response to comments in the ROD, which will document the final remedy selected for Linde Site.

All written comments should be addressed to:

U.S. Army Corps of Engineers
Buffalo District
FUSRAP Information Center
1776 Niagara Street
Buffalo, NY 14207

10. REFERENCES

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United States Army Corps of Engineers (USACE) 1998a. *Record of Decision for the Ashland 1 (including Seaway Area D) and Ashland 2 Sites, Tonawanda, New York.* April.

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United States Army Corps of Engineers (USACE) 1999c. *Addendum to the Feasibility Study for the Linde Site.* March.

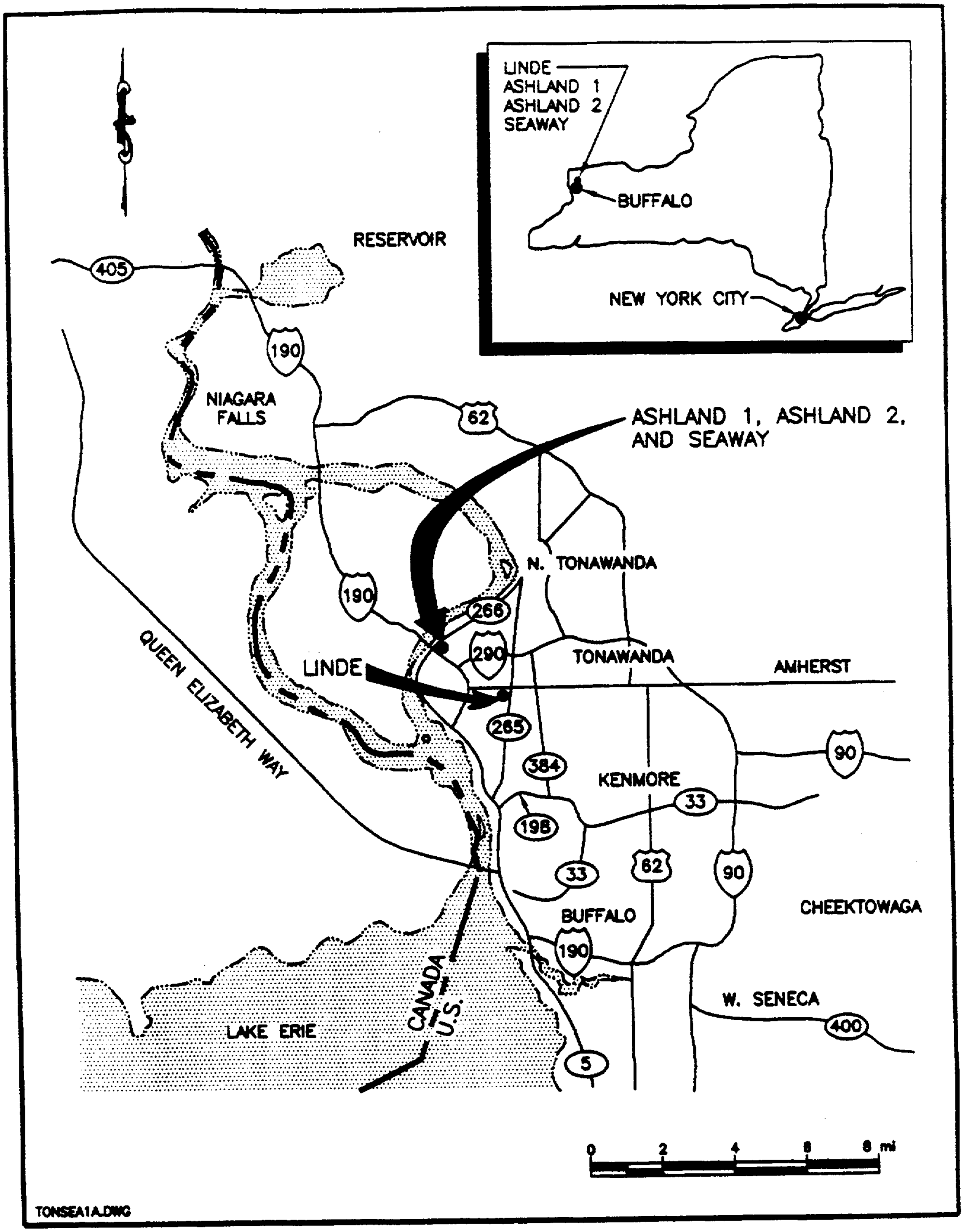
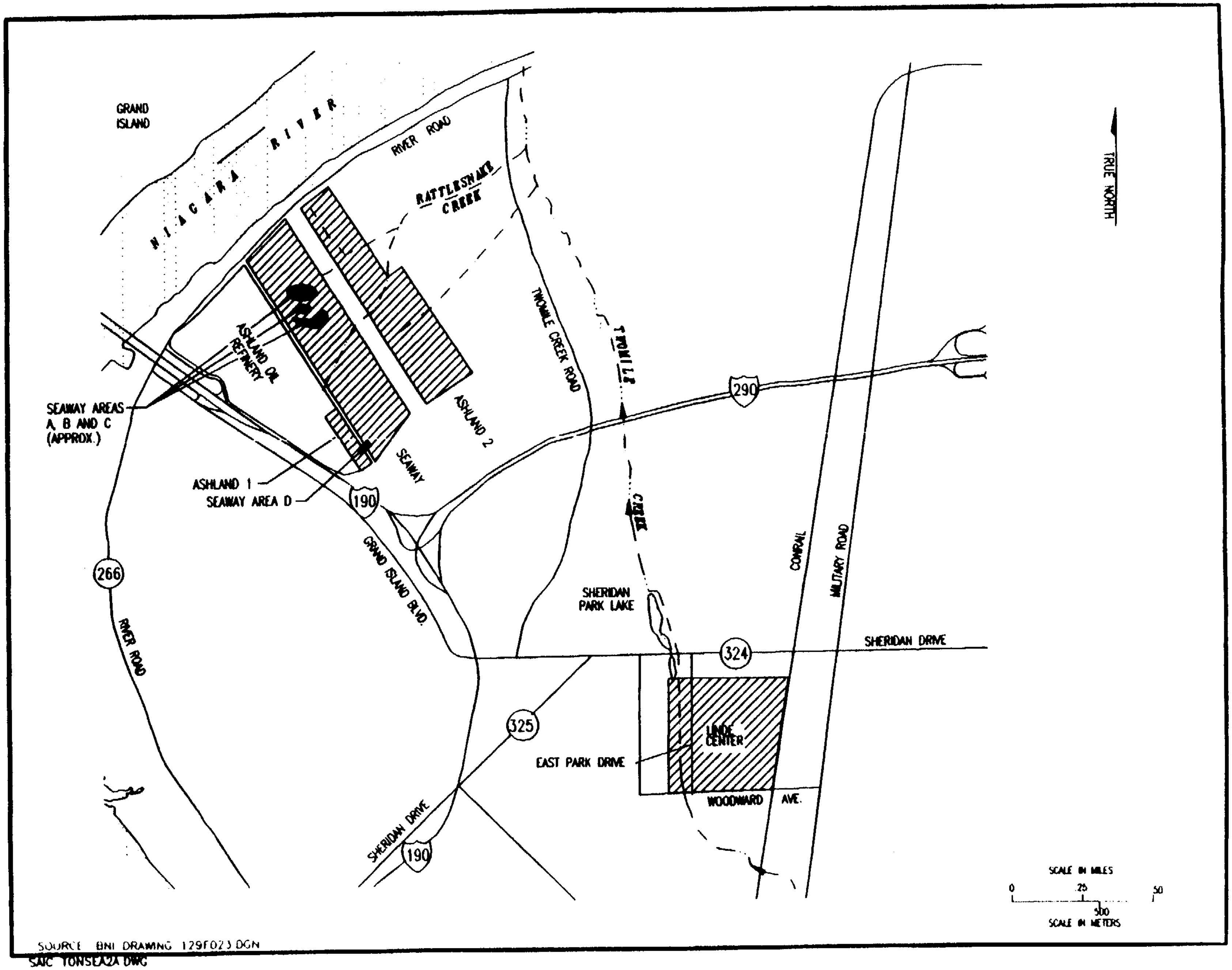


FIGURE 1
LOCATION OF THE TOWN OF TONAWANDA, NEW YORK AND ASHLAND 1, ASHLAND 2, SEAWAY AND LINDE SITES



SOURCE BNI DRAWING 129F023.DGN
SAIC TONSEA2A.DWG

FIGURE 2
LOCATIONS OF THE ASHLAND 1, ASHLAND 2, SEAWAY AND LINDE SITES

PRELIMINARY ASSESSMENT AND
SITE INVESTIGATION
FOR
LINDE AIR PRODUCTS
DIVISION OF UNION CARBIDE
TONAWANDA, NY

SEPTEMBER 1987

Prepared for
UNITED STATES DEPARTMENT OF ENERGY
OAK RIDGE OPERATIONS OFFICE
Under Contract No. DE-AC05-81OR20722

By
Bechtel National, Inc.
Oak Ridge, Tennessee

Bechtel Job No. 14501

2,000 mg/l. These high levels of total dissolved solids and salinity preclude the use of this water for potable consumption without extensive and costly treatment. Its use is restricted to certain industries that can tolerate the high salinity and total dissolved solids. (Ref. 2) The nearest residential well is 1.25 miles from the site. (Ref.1)

7.0 LINDE AIR PRODUCTS OPERATIONS

7.1 Background

The Linde Air Products company operated, for the MED, a facility known as the Ceramics Plant. The plant performed three processes: in the Step I process, ores and, occasionally, residues from the Step II operation were processed to produce uranium oxide; in the Step II process, uranium oxide was converted into uranium dioxide; and in the Step III process, uranium dioxide was converted into uranium tetrafluoride. Process flow sheets and uranium mass balances for both the African ore and the Domestic ore are shown in Attachments D-1 through D-4. The discussion here will consider only the Step I process since it was this process which generated the wastes. Residues from Step II process and Step III process were recycled. (Ref. 1)

7.2 Step I Process

Step I began shakedown operations in June/July 1943 and continued operations until mid-July 1946. (Ref. 1)

Sulfuric acid was added to the ore slurry until a pH of 0.7 to 0.8 was reached. Pyrolucite or magnesite (MnO_2) was added to oxidize any reduced uranium. The mixture was digested at 90°C for 3 hours and then cooled with weak wash solution at 60°C.

The uranium was in solution as uranyl sulfate, and many of the impurities (iron, silica, phosphorous, vanadium, alumina) were also partially in solution. (Ref. 1)

Soda ash was added until the pH reached about 9.2. Some of the sodium bicarbonate was also added, which precipitated most of the impurities and left the uranium in solution as sodium uranyl tricarbonate. The slurry was filtered in the Moore filters, and the cake hauled to the tailings pile. (Ref. 1)

The liquors contained vanadium and phosphorous as objectionable impurities. These were removed by the addition of ferrous and ferric sulfates, respectively. The resultant iron cake was filtered off in plate and frame presses and hauled to the tailings pile. The liquors were treated with caustic soda which resulted in the precipitation of the uranium as sodium diuranate. The filtrate from this step was dicharged as waste effluent. (Ref. 1)

The phosphate cake was a similar cake that resulted from the precipitation of phosphorous and lead (during the processing of 3% pitchblende ores) by the addition of sodium sulfide and ferric sulfate. Cobalt, nickel, and molybdenum compounds and small amounts of radium were present in the cake in addition to the phosphate. (Ref. 1)

The vanadium cake (domestic ore processing) was produced from the addition of lead sulfate to precipitate the vanadium as lead vanadate. Liquids (containing the uranium) from the precipitation went to the lead removal tanks, and the slurry was transferred to the lead recovery tanks before disposal. The process was revised in 1945, when ferrous and ferric sulfate were added to the domestic ore soutions to remove the vanadium and phosphorous. These wastes were stored at the Haist property. (Ref. 1)

The sodium diuranate cake was treated with sulfuric acid and ammonium sulfate and was converted to an ammonium uranyl sulfate complex. This was removed in a filter press. The cake (acid leach cake) was fed to a calciner to drive off the ammonia, sulfur dioxide and trioxide, and water, leaving the black oxide of uranium. (Ref. 1)

The treatment of African ore was very similar to that of domestic ore, which is described above. The digestion step required more pyrolucite because more of the uranium was in a reduced state. Also, barium chloride had to be added to act as a "gatherer" for the radium. The African ore contained little vanadium or phosphorous, so the iron sulfate step was omitted. Instead, sodium sulfide was added to remove the lead. The remainder of the process was the same. The molybdenum stayed in solution when the uranium was precipitated. (Ref. 1)

Tables 2 through 4 present the results of the assay of typical ores and products from the Linde plant as wells as the results of selected analyses of residues. These values are from historical records and are all pre-1955. The analysis of solids from the liquid effluent gave the following values (based on one set of samples): (Ref. 1)

Sodium	43.64%
Sulfates	37.21%
Calcium	1.05%
Carbon Dioxide	6.74%
Iron	0.67%
Water	9.04%

7.3 Liquid Effluents in the Step I Process

During the initial operations, uranium was precipitated from

Table 2 : Typical* Analyses of Selected Ores Processed by Linde

Percent of Compound	Domestic Ores		Foreign Ores Pitchblende			Torbernite Q-20
	L-19	GUI	L-30	L-50	R-10	
U_3O_8	15.8	12.5-2.0	10.54	6.7	3.53	17.72
Y_2O_5	2.5	2.35	0.2	2.2	0.26	0.40
MoO_3	0.02		0.35	0.3	0.3	0.31
PbO	0.01		0.9			
P_2O_5	2.5	2.65	0.2	0.14	0.1	4.62
SiO_2	13.0	28.6	50.0	51.4	55.8	51.14
CaO	17.0		1.0	1.0	.52	
NiO						
MgO	0.3		13.0	13.53	11.41	5.16
CoO				0.56	0.2	0.23
Fe_2O_3	12.0	20.2	2.2	1.97	1.74	1.92
Al_2O_3	5.0		9.0	9.42	13.61	6.45
CuO						2.78
CO_2				2.88	2.29	
Na_2O				Nil	0.25	
Ra			(23.7 mg/ton)			

* These values are typical assays and do not necessarily indicate an average. The L-30 and L-50 are very similar ores and as such were not separated in the tables in Appendix B. Similarly, L-19 and GUI are not separated.

Ref. 1

Table 3: Typical Analyses of Product From the Linde Step I Operation

Percent of Compound	Product From Processing		
	L-19 (1943)*	L-19 (1944)**	L-30**
U_3O_8	97.0 (min)	98.2	97.7
Acid Solubles	0.5 (max)		
SiO_2	0.05 (max)	0.52	
Acid Sulfide Metals	0.6 (max)		0.058
$(NH_4)_2CO_3$ Insoluble	0.5 (max)		.027
HNO_3 Insoluble			0.42
Al_2O_3	0.3 (max)		0.1
Fe_2O_3	0.2 (max)	0.31	
P_2O_5	0.3 (max)	0.3	0.63
Na_2O		0.08	0.24
V_2O_5	0.05 (max)	0.11	0.054
SO_4	0.05 (max)	0.036	0.29 (SO_3)
Ag	0.0010 (max)		
B	0.0002 (max)		
Cd	0.0005 (max)		
Cl	0.05 (max)		
Mn	0.005 (max)		
Rare Earths	0.0015 (max)		

* The values of L-19 (1943) are specifications for the product while the other two are "typical" values that may not represent an average.

** L-19 was not differentiated from GUI, and L-30 was typical of L-50.

Ref. 1

Table 4: Typical Analyses of Residues at Lake Ontario Ordnance Works and Haist Property*

Ore Residues	Concentrations in g/g of Residues of Uranium Oxide	Cobalt	Nickel	Copper	Radium	Vanadium Oxide
L-19 (Haist) Actual Dry	1.1×10^{-3} (2.8×10^{-3})** 2.5×10^{-3} (6.3×10^{-3})	-	-	1.3×10^{-3} 2.8×10^{-3}		
L-30 Actual Dry	1.4×10^{-3} (2.2×10^{-3}) 2.5×10^{-3} (4×10^{-3})	3.4×10^{-3} 6.2×10^{-3}	1.1×10^{-2} 2×10^{-2}	1.1×10^{-3} 2×10^{-3}	1.6×10^{-5} 3×10^{-5}	
L-50 Actual Dry	0.7×10^{-3} (1.3×10^{-3}) 1.1×10^{-3} (2×10^{-3})	3.7×10^{-3} 5.9×10^{-3}	1.2×10^{-2} 1.9×10^{-2}	1.5×10^{-3} 2.4×10^{-3}	2.1×10^{-5} 1.9×10^{-5}	
R-10 Actual Dry	0.9×10^{-3} (1.8×10^{-3}) 1.2×10^{-3} (2.3×10^{-3})	3.9×10^{-3} 5.3×10^{-3}	1.0×10^{-2} 1.3×10^{-2}	2.7×10^{-3} 3.7×10^{-3}	7.0×10^{-6} 9.6×10^{-6}	
R-10 Iron Cake (Phosphate Cake) Actual Dry	1.6×10^{-3} (4.3×10^{-3}) 3.4×10^{-3} (9.1×10^{-3})	1.9×10^{-3} 4×10^{-3}	3.1×10^{-2} 6.5×10^{-2}	- -		
P-78 (Haist) (Phosphate & Vanadium Cake) Actual Dry	1.5×10^{-3} (3×10^{-3}) 3.4×10^{-3} (6.7×10^{-3})	-	-	1.2×10^{-3} 2.5×10^{-3}		($4-7\times10^{-2}$)

* Values in this table are based on 1953 data collected to evaluate reprocessing feasibility and operating data. Data from recent surveys have not been presented.

** The first value is an estimate made for the reprocessing study, the second is based on initial analyses from the operating records.

Ref. 1

solution using a procedure that involved adding sulfuric acid to the uranium tricarbonate-rich solution and heating it to drive off carbon dioxide; this was followed by adding relatively small amounts of caustic to cause this precipitation. The effluent from this procedure had a pH that allowed its disposal into the sanitary sewer. This method of precipitation was abandoned in 1943, however, because it was relatively slow and allowed more molybdenum and other impurities to contaminate the product than the direct caustic method of precipitation. Linde developed the direct caustic method, which resulted in a better product in less time. The method was essentially a brute-force removal of uranium through the direct addition of caustic to the pregnant solution, driving the pH to levels as high as 11.5. As a result, the uranium precipitated as diuranate, despite the presence of the carbonate. (Ref. 1)

One drawback to this method was that the effluent had a high pH and was no longer acceptable for direct disposal into the sanitary sewer. As an alternative, two options considered were the use of disposal wells or discharge into Two-Mile Creek. Although the discharge into the creek was approved by the State of New York, a decision was make to use disposal wells whenever possible and to rely on the Two-Mile Creek option only when necessary. (Ref. 1)

The effluent disposal wells were approximately 40 m (150 feet) deep and pass through a clay formation, into a gravel and sand layer and a varigated carbonate formation, possibly a mixture of magnesite, and dolomite or limestone. Well logs for three of the disposal wells are presented in Attachment F-5 through F-7. The groundwater in a section of the carbonate formation was identified as saltwater, and the water from the particular aquifer involved was found to be unacceptable for use by Linde. It was believed by the company to have been contaminated prior to 1944 and before the injection of any Step I effluent. The aquifer which Linde injected its waste into is the Camillus Shale as discussed above. It appears that the quality of the water in the Camillus Shale in 1944may have been similar to current conditions. (Ref. 1)

Two-Mile Creek flows through the Linde facility and a park, where it is dammed to create a pond, and then into the Niagara River. The storm sewer discharged into the creek via a storm drainage ditch that entered the creek downstream of the dam (Attachment F-3). One memorandum suggests that the creek may have diluted the effluent 10 to 1; however, analysis of pH data from other memoranda suggest that the creek may have had a flow rate up to 100 times greater than that of the effluent drainage rate. The average pH of the creek, measured over an 8-day period in March 1946, was about 8.3 upstream of the storm sewer discharge and 10.3 downstream of the discharge. Recent estimates of creek flow rates during the summer suggest that, at a minimium, creek flow rates would have been 15 to 40 times the average effluent discharge rates; the flow rates in the creek were much greater in the 1940's because industrial operations discharged plant water into the creek. (Ref. 1)

7.4 Characteristics of the Filtrate

The filtrate discharged to the sewers or wells was a high-pH solution (usually above pH of 10, however, during June 1943 and December 1943 the pH was probably closer to 7) consisting mainly of ions from excess sodium sulfate, sodium carbonate, and sodium hydroxide. In addition, some chloride ions, from the barium chloride added to enhance radium recovery, would also have been present, along with a small amount of a variety of complex anions of many minor elements such as vanadium, nickel, and cobalt (Table 2 lists the constituents of the ores). Ammonium sulfate from the wash of the uranium precipitate would be expected to react rapidly with the caustic and release some ammonia. This was probably the cause of the incidents in which pump house operators were bothered by ammonia emissions from the wells located in the pump house. (Ref. 1)

This complex solution would also contain small quantities of uranium and radium. At the low concentration found in these effluents, it is difficult to project which uranium and radium species would be favored and what their solubility would be. The uranium and radium would be present in solution as well as in colloidal form, and the relative amount of each is difficult to assess. The impact of this is not significant for uranium because standards for insoluble and soluble uranium are the same. However, standards for soluble and insoluble radium differ by a factor of 1000. It is believed that the analytical techniques used at that time would not have differentiated between the soluble and insoluble fractions; hence, the concentrations of uranium and radium in the effluents (based on the techniques used) would be total uranium and radium. An analysis of the solubility of various radium compounds suggests that a significant portion of the radium and probably uranium in the effluent would be soluble. (Ref. 1)

7.5 Volume of Effluents

As indicated previously, the liquid waste from the Step I process, the filtrate from the precipitation of the sodium diuranate which followed the addition of caustic soda, sodium hydroxide (Attachment D-1), was initiallly discharged into the sanitary sewer system. It appears that Linde began disposing of the effluents in onsite wells during or after April 1944 and that, from 1944 to 1946, three wells located in the area of Plant No. 1 and four wells located near the Ceramics Plant were used during various periods for this purpose. From time to time, the wells would become clogged, overflow, and have to be cleaned. During these periods, the effluents would be diverted to a storm sewer that connected with the Niagara River through Two-Mile Creek. Based on the information in progress reports and various operating memoranda, it is estimated that liquid waste volumes generated by the process during the period the wells were in use was as follows:

April to December 1944	121 x 10^6 l (32 x 10^6 gal)
Januray to December 1945	193 x 10^6 l (51 x 10^6 gal)
January to July 1946	108 x 10^6 l (28 x 10^6 gal)
Total	422 x 10^6 l (111 x 10^6 gal)

Based on the estimates of liquid effluent from the ore processing from 1945 to 1946, it appears that about 50% of the effluent was injected into the wells and the remainder into the storm sewer. Assuming that a simular dumping ratio existing in 1944 and early 1945, it appears that an additional 70 x 10^6 l (18 x 10^6 gal) may have been disposed of in the wells. It is therefore assumed that, during the period from April 1944 to July 1946, about 210 x 10^6 l (55 x 10^6 gal) of waste was disposed of in the wells and the remainder in the storm sewer to Two-Mile Creek. All effluents prior to April 1944 (80 - 100 x 10^6 l or 20 - 30 x 10^6 gal) are assumed to have been discharged to the sanitary sewer.

(Ref. 1)

7.6 Uranium Concentration in the Effluents

The concentration of uranium in the effluent or the percent of uranium lost varied depending on extraction efficiency; production rate (wash rates, filtering rates); and, to some extent, the type of ore processed. (Ref. 1)

During 1943 and the first two months of 1944, uranium extraction efficiencies generally ranged around 93 to 94 percent. Through the remainder of 1944, efficiencies generally exceeded a 96% uranium recovery rate and occasionally were as high as 98%. Extraction efficencies over 1945 averaged about 98% and were somewhat lower in 1946, probably due to the lower grade material being processed. (Ref. 1)

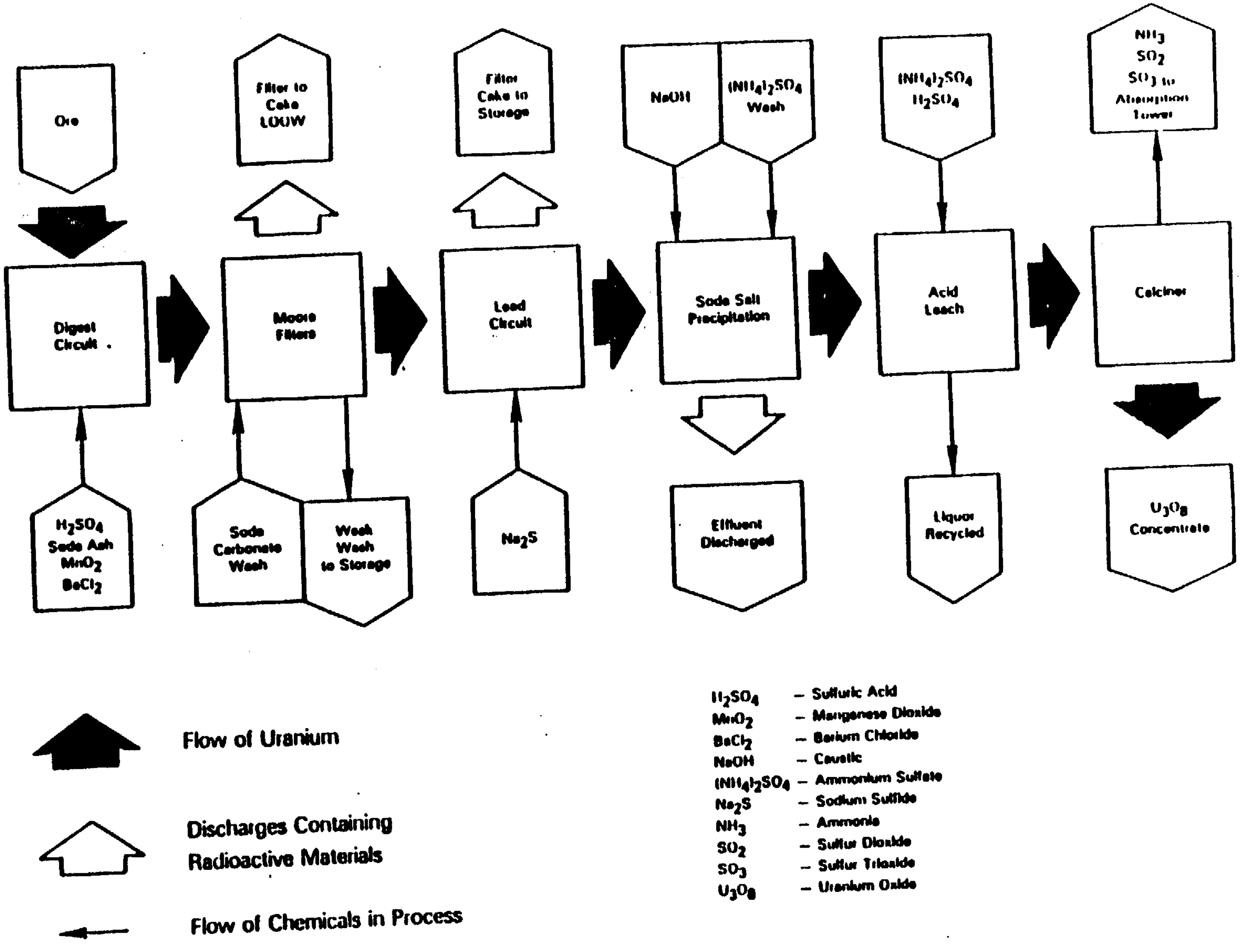
Uranium losses in the effluents in 1943 (during the lower extraction efficiency period) appear to be on the order of 2 to 3 percent of the uranium in the ore. This material was lost to the sewer system. In 1944, however, the data indicate that losses were generally available progress reports indicate that later losses were maintained below 0.5% of the uranium in the ore. (Ref. 1)

The weekly averages of uranium oxide concentrations in the effluents analyzed from April 1944 to July 1946 ranged between 0.011 and 0.064 gram of uranium oxide per liter of effluent, with the average being about 0.026 gram per liter (g/l). This would imply that the process lost an average of about 26 kg of uranium oxide per million liters or 220 lb of uranium oxide per million gallons of effluent during the period when the wells and storm sewer were being used. Concentrations of uranium oxide in the effluent during the period when the sanitary sewer was used for disposal of the effluent was somewhat higher. It is estimated that the concentrations average 0.15 g/l in 1943 and 0.03 g/l during the first three months of 1944, or about 1200 and 250 lb of uranium oxide per million gallons, respectively. (Ref. 1)

Assuming these loss rates and from 210 x 10^6 l of effluent disposed of in the wells, about 5.4 x 10^3 kg of uranium oxide (about 3 Ci of natural uranium) were discharged to the wells. The remainder of the process effluents discharged to the storm sewer during this period, about 212 x 10^6 l would have contained about 5.6 x 10^3 kg of uranium oxide. Therefore, based on the available data, the total uranium oxide contained in the effluent released from April 1944 to July 1946 was about 11 x 10^3 kg, or about 6 Ci of natural uranium. (Ref. 1)

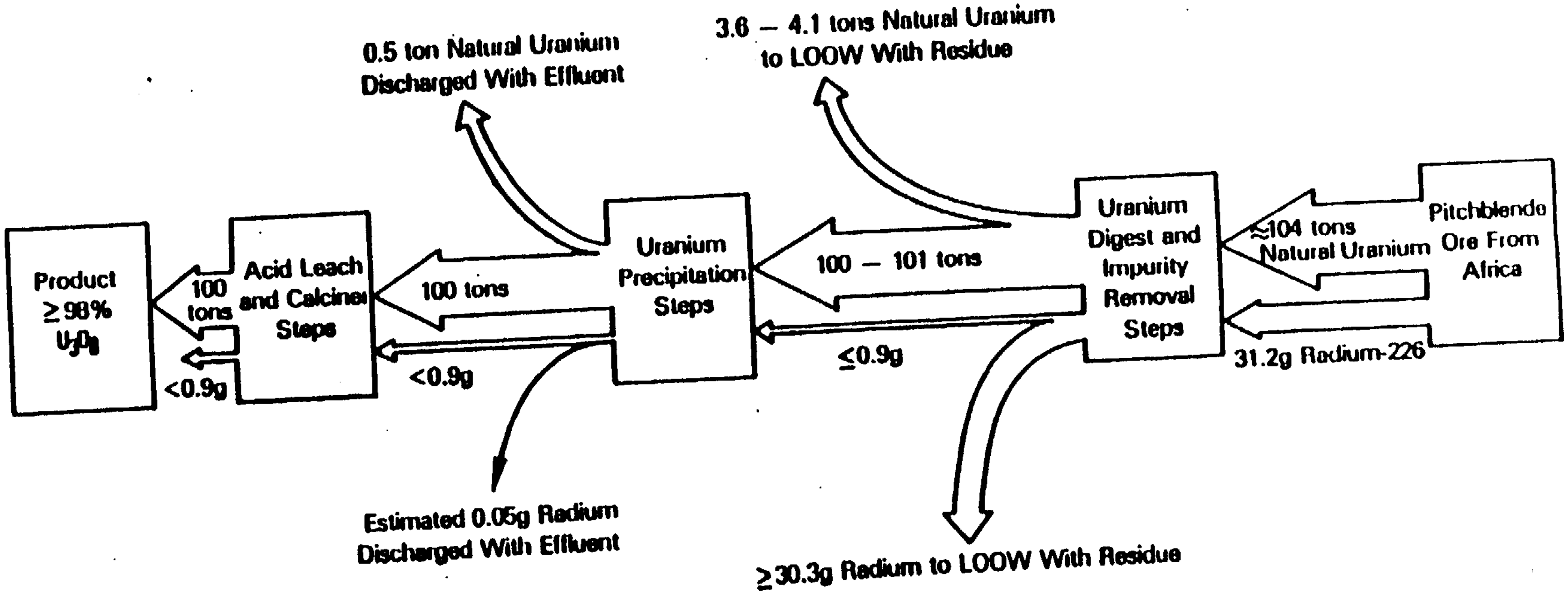
7.7 Radium Concentration in the Effluents

Some estimates of the maximum amount of radium discharged during the processing of the L-30 and L-50 ores can be made, based on the fact that contracts with African Metals called for the return of at least 95% of the radium in the processed ore. Actual processing operations supposedly held the losses to less than 3% (97% of the radium remained in the residues). Assuming a total of 986 metric tons of U_3O_8 produced from the L-30 and L-50 ores and a uranium extraction efficiency of about 97%, there were 862 metric tons of uranium, or less than 595 Ci of natural uranium (about 290 Ci of ^{238}U) in the ore. This would imply about 290 Ci of ^{226}Ra (in equilibrium with ^{238}U) and maximum effluent losses amounting to 8.5 Ci of ^{226}Ra. A similar analysis for th R-10 ore, but assuming a 95% extraction efficiency, would suggest that a maximum of 2.7 Ci of radium was lost during the processing of the ore. (Ref. 1)

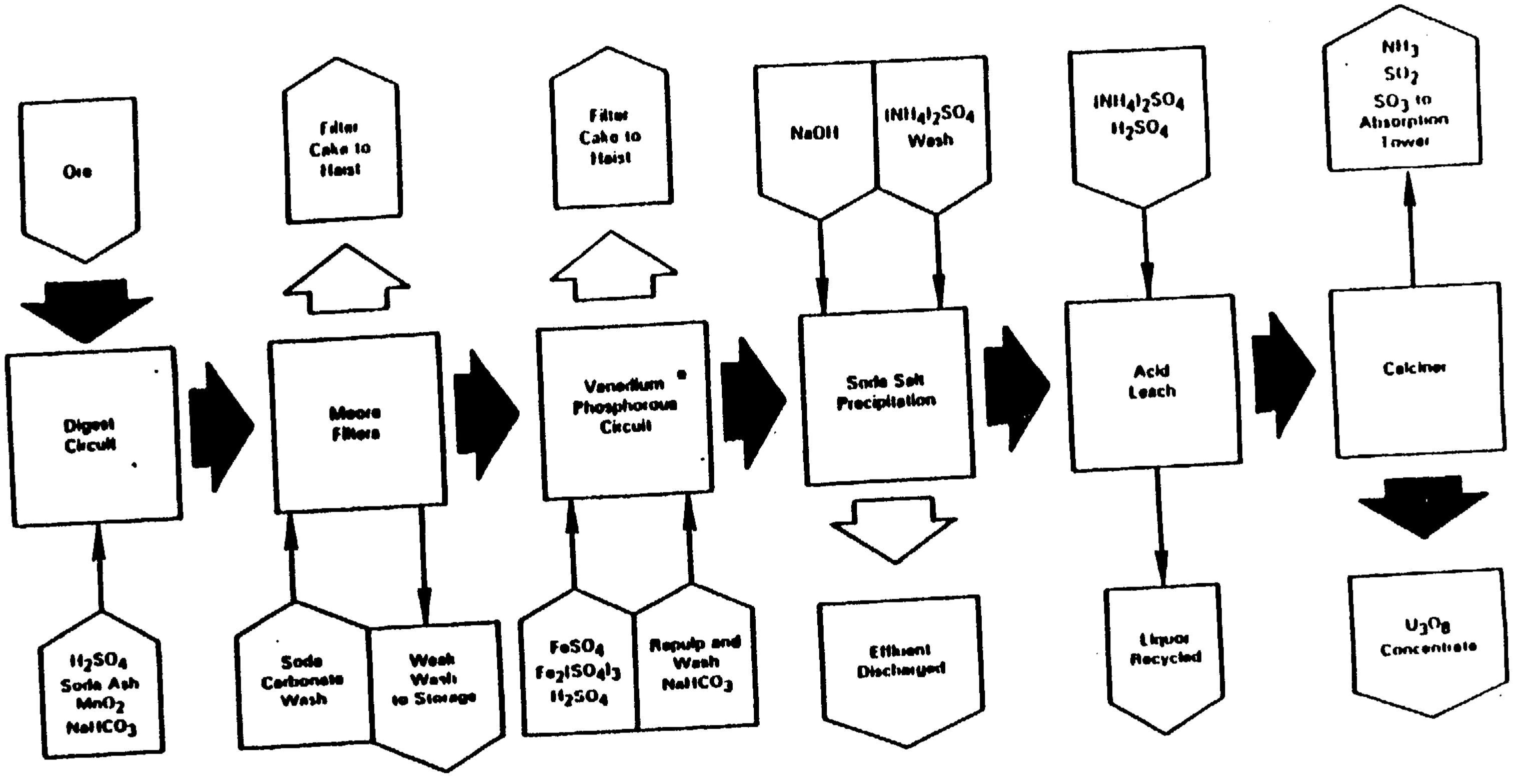


Sample Processing Flow Sheet (African Ore)

Ref. 1



Uranium and Radium Mass Balance for Processing Belgium Congo Pitchblende Ores at the Linde Step I Facility



▲ Flow of Uranium

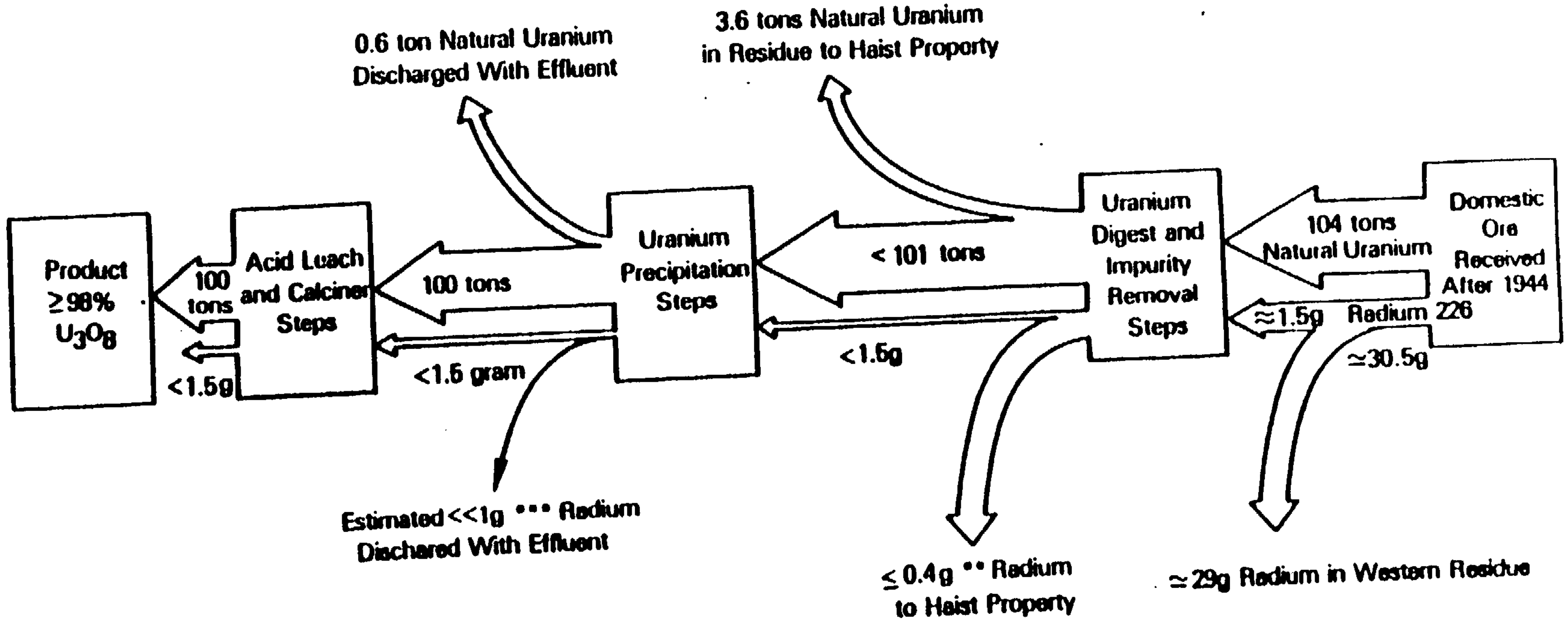
△ Discharges Containing Radioactive Materials

← Flow of Chemicals in Process

H_2SO_4	– Sulfuric Acid	Na_2CO_3	– Sodium Carbonate (soda ash)
MnO_2	– Manganese Dioxide	NH_3	– Ammonia
$BaCl_2$	– Barium Chloride	SO_2	– Sulfur Dioxide
$NaOH$	– Caustic	SO_3	– Sulfur Trioxide
$(NH_4)_2SO_4$	– Ammonium Sulfate	U_3O_8	– Uranium Oxide
Na_2S	– Sodium Sulfide	$FeSO_4$	– Ferrous Sulfate
$NaHCO_3$	– Sodium Bicarbonate	$Fe_2(SO_4)_3$	Ferric Sulfate

- Initially, vanadium was removed by adding lead sulfate, and the soda salt precipitation was an acid-caustic method that involved the addition of H_2SO_4 prior to the caustic; the revised procedure used the direct caustic method.

Sample Processing Flow Sheet (Domestic Ore Revised)*
Ref. 1



*The mass balance for radium in these ores is very uncertain.

**Based on radium in residue samples from the former Haist property; however, this maximum could be higher if there was any dilution with soil or significant dissolution by rainwater of the radium in material stored at Haist.

***This was probably much less than 0.5g, which is the maximum level allowable by a Linde action point for radium. W. Thomas (Corps of Engineers, 1946) suggested that radium in the American ore processing effluent was much less than the concentration in the African ore processing effluent.

Uranium Mass Balance for Domestic Ore Processed at the Linde Step I Facility After November 1944

Ref. 1

The Linde, Ashland 1, Ashland 2, and Seaway properties are located in the Town of Tonawanda, Erie County, New York. Tonawanda is immediately north of Buffalo, New York, and is bounded on the west by the Niagara River, which flows northwest by the site toward Lake Ontario at an average of 11.3 km/h (7 mph). Lake Erie is less than 16 km (10 mi) to the southwest, and Lake Ontario is 34 km (21 mi) to the north. The following sections provide a description of each property, a historical overview of surveys, and a summary of previous investigations.

1.3.1 Summary of Technical Memoranda

Data for the Tonawanda site RI were collected in two phases. The first phase of data collection activities was limited to developing a general understanding of the site. As a basic understanding of the site was achieved, subsequent selective investigations focused on gathering sufficient additional information to support evaluation of remedial action alternatives. The technical memoranda listed below document earlier investigations. The background information they contain was used to determine the scope of the RI activities discussed in this report.

- <u>Formerly Utilized MED/AEC Sites Remedial Action Program, Radiological Survey of the Former Linde Uranium Refinery, Tonawanda, New York</u> (ORNL 1978a).

- <u>Radiological Survey of the Ashland Oil Company (Former Haist Property), Tonawanda, New York</u> (ORNL 1978b).

- <u>Radiological Survey of the Seaway Industrial Park, Tonawanda, New York</u> (ORNL 1978c).

- <u>Preliminary Engineering and Environmental Evaluation of the Remedial Action Alternatives for the Linde Air Products Site, Tonawanda, New York</u> (FBDU 1981a).

- Preliminary Geological and Hydrogeological Characterization Report for the Southern Portion of the Ashland 2 Site (BNI 1987).

- Hydrogeologic Investigation, Seaway Industrial Park Sanitary Landfill, Tonawanda, New York (Wehran 1979).

1.3.2 Linde

Description

Linde is located at East Park Drive and Woodward Avenue, approximately 2.5 km (1.5 mi) from the Niagara River. Figure 1-4 is an aerial view of the property. Several buildings on the 55-ha (135-acre) property (Figure 1-5) are currently used as offices, research laboratories, fabrication facilities, and storage areas; access to the property is controlled. Approximately 1,700 employees work at the onsite facilities (Union Carbide Industrial Gases). The property is bounded on the north and south by other industries and small businesses, on the east by Consolidated Rail Corporation (Conrail) railroad tracks and an open area, and on the west by a park (part of the former Sheridan Park Golf Course) that is now owned by Linde and is open to the public. A number of residential properties are located within several hundred feet of Linde.

Utilities

The Linde property is served by city water, electricity, natural gas, and sewage systems. It is underlain by a series of utility tunnels that interconnect some of the main buildings and house distribution lines for compressed air, electricity, oxygen, nitrogen, natural gas, and telephone services; the tunnels are also used to collect condensation. Extensive networks of storm sewers, sanitary sewers, potable water lines, and natural gas lines also underlie the property. An isolated area in the southern portion of the property contains underground hydrogen lines. Figures 1-6 and 1-7 show the locations of major storm and sanitary sewers, respectively.

Stormwater drains to the west and south and discharges at seven main outlets (see Figure 1-6). Runoff from the extreme southern portion of the property drains to a 1-m (3-ft) storm drain line in the center of Woodward Avenue, 3.3 m (11 ft) below grade. Most of the stormwater drains to the west and discharges into a twin-cell, 2.3- by 3-m (7- by 9-ft) conduit running along the western side of the property; the discharge flows into Twomile Creek downstream of Sheridan Lake.

The sanitary sewer system at Linde consists of two major branches. The northern sanitary sewer branch serves Buildings 30, 31, 38, 90, and other buildings to the north; the southern branch serves Buildings 2, 8, 14, 100, and others to the south. Both branches drain to the west and empty into a 1.1-m (3.5-ft) sanitary sewer main.

History

Five Linde buildings were involved in MED activities between 1942 and 1946: Building 14 (built by Union Carbide in the mid-1930s) and Buildings 30, 31, 37, and 38 (built by MED on land owned by Union Carbide). Ownership of Buildings 30, 31, 37, and 38 was transferred to Linde when the MED contract was terminated. Table 1-1 describes activities and operations that took place in these buildings and their current uses.

Linde was selected because of the company's experience in the ceramics business, which involved processing uranium to produce the salts used to color ceramic glazes. Under the MED contract, uranium from seven different sources was processed at Linde: four African ores (three low-grade pitchblendes and a torbernite) and three domestic ores (carnotite from Colorado).

The domestic ore tailings sent to Linde resulted from commercial processing, conducted primarily in the western United States, to remove vanadium. The vanadium removal process resulted in disruption of the uranium decay chain and the removal of radium. For this reason, the domestic uranium supplied to Linde had low concentrations of radium compared with the natural uranium and thorium-230 concentrations. The following are typical constituents of the domestic ores processed at Linde (Aerospace 1981):

Compound	Percentage by Weight
Triuranium octoxide (U_3O_8)	15.8
Yttrium oxide (Y_2O_5)	2.5
Molybdenum trioxide (MoO_3)	0.02
Lead monoxide (PbO)	0.01
Phosphorous pentoxide (P_2O_5)	2.5
Silicon dioxide (SiO_2)	13.0
Calcium oxide (CaO)	17.0
Magnesium oxide (MgO)	0.3
Iron(III) oxide (Fe_2O_3)	12.0
Aluminum oxide (Al_2O_3)	5.0

The African ores shipped to Linde as unprocessed mining ores contained uranium in equilibrium with all of the daughter products in its decay chain (e.g., thorium-230 and radium-226). The other constituents of the ores were similar to those of the domestic ores. Following laboratory and pilot plant studies (conducted from 1942 to 1943), uranium processing began at Linde in 1943. From July 1943 to July 1946, the period in which Linde processed uranium for MED, a total of 25,700 metric tonnes (28,300 tons) of ore was processed (ORNL 1978a).

A three-phase process was used to separate uranium from the uranium ores and tailings. Phase 1 (conducted in Building 30) consisted of separating triuranium octoxide (U_3O_8) from the feedstock materials by a series of process steps consisting of acid digestion, precipitation, and filtration. The filtrate (liquid remaining from the processing operations) from this step was discarded as liquid waste into the injection wells, storm sewers, or sanitary sewers, and the filter cake was discarded as solid waste and was ultimately taken to Ashland 1. The triuranium octoxide from Phase 1 was processed into uranium dioxide (UO_2) in Phase 2 (Building 30). In Phase 3 (Buildings 31 and 38), the uranium dioxide was converted to uranium tetrafluoride (UF_4). Residues from Phases 2 and 3 were reprocessed (Aerospace 1981).

Because the first phase of uranium processing operations was the source of the waste, that phase is examined in detail to provide a description of the types of waste that were produced. Figure 1-8 is a flow diagram of Phase 1, which consisted of the following steps:

1. Sulfuric acid was added to the ore slurry until the pH of the mixture reached 0.7 to 0.8. All components of the ores (radioactive and chemical) became partially dissolved during this acid extraction process.

2. Pyrolucite or braunite was added to the ore slurry solution to oxidize any reduced uranium present.

3. The solution was digested at 90°C (194°F) for 3 hours.

4. After the digestion process was completed, the solution was cooled with a weak wash solution at 60°C (140°F). At this point, the uranium was in solution as uranyl sulfate.

5. After the solution cooled, soda ash was added until the solution reached a pH of 9.2.

6. At this point, sodium bicarbonate was added to the solution. This step precipitated most of the impurities and left the uranium in solution as sodium uranyl tricarbonate.

7. The solution was filtered with Moore filters. The resulting residues were considered solid waste and were taken to a temporary tailings pile north of Buildings 30, 38, 39, and 58.

8. The procedure used for the next task depended on the type of ore being processed. If the ore was domestic, ferrous and ferric sulfates were added to remove the vanadium and phosphorous. If the ore was African, barium chloride was added to remove the radium.

9. For the domestic ores, the resultant iron cake residues were filtered off in plate and frame presses and taken to a temporary tailings pile north of Buildings 30, 38, 39, and 58.

10. The liquors were treated with caustic soda, causing precipitation of the uranium as sodium diuranate. The filtrate was discharged as a waste effluent into the sanitary sewers, storm sewers, or onsite disposal wells.

11. The sodium diuranate cake from Step 10 was treated with sulfuric acid and ammonium sulfate to produce an ammonium uranyl sulfate complex.

12. The ammonium uranyl sulfate complex was removed in a filter press and fed to a calciner to drive off the ammonia, sulfur dioxide, sulfur trioxide, and water, leaving uranium oxide to be processed in Phase 2.

The principal solid waste resulting from Phase 1 was a solid, gelatinous filter cake consisting of impurities remaining after filtration of the uranium carbonate solutions. Phase I also produced insoluble precipitates of the dissolved constituents, which were combined with the tailings. The precipitated species included large quantities of silicon dioxide, iron hydroxide, calcium hydroxide, calcium carbonate, aluminum hydroxide, lead sulfate, lead vanadate, barium sulfate, barium carbonate, magnesium hydroxide, magnesium carbonate, and iron complexes of vanadium and phosphorus (Aerospace 1981).

Between 1943 and 1946, approximately 7,250 metric tonnes (8,000 tons) of filter cake from the Phase I processing of domestic ores were taken from the temporary tailings pile at Linde and transported to the former Haist property (Ashland 1) in Tonawanda (ORNL 1978b). These residues contained approximately 0.54 percent uranium oxide [39,100 kg (86,100 lb) of natural uranium], which corresponds to 26.5 Ci of natural uranium (ORNL 1978b). Because the residues from the African ore were relatively high in radium content compared with the processed domestic ore residues, the African ore supplier required that the African ore residues be stored separately so that the radium could be extracted. Between 1943 and 1946, approximately 18,600 metric tonnes (20,500 tons) of residues were shipped to the former Lake Ontario Ordnance Works in Lewiston, New York, where they could be isolated and stored in a secure area (Aerospace 1981). The production progress reports also showed that approximately 140 metric tonnes (154 tons) of African ore residues were shipped to Middlesex, New Jersey (Aerospace 1981).

The radioactive liquid effluent resulting from filtration of the sodium diuranate cake (Step 10) was initially discharged to the sanitary sewer system; by December 1943, approximately 55 x 10^6 L (14.5 x 10^6 gal) had been discharged. By April 1944, a total of approximately 100 x 10^6 L (26.4 x 10^6 gal) had been discharged into the sanitary sewer system (Aerospace 1981). Concentrations of uranium oxide in the effluents averaged 0.15 g/L in 1943 and 0.03 g/L during the first three months of 1944 (Aerospace 1981). Therefore, approximately 9,600 kg (21,000 lb) of uranium oxide (i.e., 6.5 Ci of natural uranium) was released into the sanitary sewer system (Aerospace 1981).

Because process changes increased the pH of the effluent (less than 11.5), discharge to the sanitary sewer was halted in April 1944, and onsite, deep-well injection of liquid effluent was implemented. Between June 1944 and July 1946, Linde disposed of liquid waste in seven wells: one group of three wells east of Building 14 and another group of four near Buildings 30 and 38 (Figure 1-5). The disposal wells ranged from 28 to 46 m (90 to 150 ft) deep; some were drilled 9 to 12 m (30 to 40 ft) into bedrock (Aerospace 1981). These wells have been backfilled with trash (e.g., metal debris) by Linde and are not available for sampling. The injection wells do not appear to be filled with grout.

When the injection wells became blocked and backed-up, the effluent was discharged into a drainage ditch along the northern property boundary that discharged into a storm sewer conduit; the conduit emptied into Twomile Creek downstream of the dam that creates the Linde pond. Approximately 208 x 10^6 L (55 x 10^6 gal) of effluent was discharged into the seven disposal wells, and 212 x 10^6 L (56 x 10^6 gal) of effluent was discharged into Twomile Creek via the storm sewer between June 1944 and July 1946 (Aerospace 1981). Historical records indicate that radium-226 and uranium-238 were the principal radioactive materials in the liquid effluent.

From April 1944 to July 1946, the average concentration of uranium oxide in the liquid effluent was 0.026 g/L (Aerospace 1981). This concentration would imply that 5,600 kg (12,300 lb) of uranium oxide (i.e., 3.8 Ci of natural uranium) was released into the storm sewer leading to Twomile Creek, and 5,400 kg (11,900 lb) of uranium oxide (i.e., 3.7 Ci of natural uranium) were injected into the onsite wells.

The amount of radium disposed of with the liquid effluent can be estimated based on the knowledge that the effluent was discharged when the radium-226 concentration in the waste reached a maximum of 2.6 x 10^{-8} g/L (2.2 x 10^{-10} lb/gal) (Aerospace 1981); however, the radium-226 concentration usually did not reach this level. Conservatively high estimates based on the total amount of liquid effluent discharged from both the domestic ores (low in radium) and the African ores (high in radium) indicated that the amount of radium-226 released into the sanitary sewer was approximately 2.6 Ci, the amount released into the storm drain was approximately 5.5 Ci, and the amount injected into the wells was approximately 5.5 Ci. Because the mass of 1 Ci of radium-226 is equal to 1 g, the mass of radium released could have been 10 to 15 g over a period of several years. Tests performed by the University of Rochester in 1945 indicate that the total amount of radium-226 disposed of with the liquid effluent could be as low as approximately 0.6 Ci (Aerospace 1981).

Renovation of the entire facility over the years has prompted the consolidation of contaminated materials. In 1977, before the construction of Building 90 began, soil contaminated during MED operations was removed from the construction area and placed in two windrows along the northern and eastern fences of the property and in the tailings pile on the northern portion of the property (see Figure 1-5). Between 1979 and 1982, the windrows and pile of contaminated material were consolidated into one uncovered pile west of Building 90. The pile of consolidated materials was covered in 1992.

Previous Surveys

Three radiological surveys have been performed at Linde to determine whether radioactive contaminants were present in excess of existing guidelines. The first was conducted by Oak Ridge National Laboratory (ORNL) during October and November 1976 (ORNL 1978a). The survey included the following measurements: residual alpha and beta-gamma contamination levels in Buildings 30, 31, 37, 38, and 14; external gamma radiation levels at 1 m (3 ft) above the surface in these buildings and outdoors throughout the Linde property; radon and radon daughter concentrations in the air in these buildings; uranium-238, radium-226, actinium-227, and thorium-232 concentrations in the soil samples taken both onsite and offsite; uranium-235, uranium-234, radium-226, and thorium-230 in surface water on and near the property; and airborne concentrations of uranium-238, radium-226, and thorium-232 in Building 30.

The second survey was conducted by Ford, Bacon, & Davis Utah, Inc. (FBDU) in December 1981 (FBDU 1981a). The survey included the following measurements: residual alpha and beta-gamma contamination levels in Buildings 30, 31, 37, 38, and 14; external gamma radiation levels at 1 m (3 ft) above the surface in these buildings and outdoors throughout the Linde property; radon and radon daughter concentrations in the air in these buildings; uranium-238, radium-226, and thorium-232 concentrations in onsite soil, surface water, and groundwater samples.

The third survey, conducted in 1981 by Oak Ridge Associated Universities (ORAU), consisted of the following measurements: uranium-238, uranium-235, radium-226, potassium-40, cesium-137, thorium-230, and thorium-232 concentrations in onsite and offsite soil, sediments, surface water (including a private well and city water), groundwater and onsite disposal/test wells, and sanitary and storm sewers (ORAU 1981). This section summarizes the combined findings of all surveys.

Surface water. Background surface water samples were collected by ORAU at the five locations shown in Figure 1-9, at location W7 in Figure 1-10, and from the Tonawanda municipal water supply (ORAU 1981). Additional offsite water samples were collected by ORNL and ORAU from Twomile Creek; ORNL collected one background sample (W8) upstream of the Linde outfall. ORAU also sampled a private well at 538 Twomile Creek Road (W13). The offsite sampling locations are shown in Figures 1-9 and 1-10. Onsite water samples were collected by ORNL, FBDU, and ORAU from the storm and sanitary sewer systems, surface water, boreholes, a conveyor pit in Building 30, and two test wells developed near two of the original disposal wells (see Figures 1-5 and 1-11).

The radium concentration found in the conveyor pit (Table 1-2) may be the result of ore material from the conveyor that moved the ore from one location to another inside Building 30.

Sediment. ORAU and ORNL collected sediment samples around Tonawanda to determine background levels for this area (see Figure 1-9). Offsite sediment samples were collected from Twomile Creek at points upstream, downstream, and at the Linde discharge point (see Figure 1-10). ORAU collected onsite sediment samples from five storm sewers and two sanitary sewers that were part of the original sewer system that existed in the vicinity of the disposal wells (see Figures 1-5 and 1-12). Radionuclide concentrations in all sediment samples collected offsite were near background levels, except for uranium-238 at sampling locations M3 and M5 and thorium-232 at M5 (Table 1-3).

Although the sewers have undergone periodic cleanings since 1946 (ORAU 1981), samples from the storm and sanitary sewers showed above-background levels for all radionuclides.

Soil. The soil sampling program conducted by ORNL at the Linde property involved collecting 5 offsite samples (Figure 1-10) and drilling 35 boreholes around Buildings 14, 30, 31, 37, and 38 in the northwestern corner of the parking area and along a section of the Conrail line used to ship the ore. ORNL also drilled seven boreholes inside Building 30. To verify the ORNL results, FBDU drilled 20 boreholes in the same outside areas as ORNL and also drilled boreholes in Buildings 30 and 31. ORAU collected soil samples during the development of two new wells near two of the injection wells.

Onsite soil samples collected in the ORNL, FBDU, and ORAU surveys (Figure 1-13) were analyzed for radium-226, uranium-235, uranium-238, and thorium-232. On the basis of these surveys (which did not take into account the possible presence of thorium-230), the following principal areas of contamination were identified:

- The northwestern corner of the main parking area
- The northeastern corner of the plant and the Linde spur of the Conrail line
- The soil beneath Building 30, within 6.1 m (20 ft) of Building 30 on the western and southern sides, and within 12 m (40 ft) of the eastern side of the building

The northwestern corner of the parking area was contaminated with radium-226 and uranium-238 to an average depth of 0.9 m (3 ft); the highest concentrations were 13 and 4,500 pCi/g, respectively (ORNL 1978a). The northeastern corner of the property was contaminated with radium-226 and uranium-238 at maximum concentrations of 6.9 and 139 pCi/g, respectively; the average depth of contamination was estimated to be 0.3 m (1 ft). The principal contaminants in the soil beneath and around Building 30 were radium-226 and uranium-238. The maximum concentrations (based on the ORNL survey) were 813 and 1,370 pCi/g, respectively, and the average depth of contamination was given as 0.3 m (1 ft); however, the FBDU survey (FBDU 1981a) indicated contamination as deep as 2.4 m (8 ft).

Buildings. The 1976 survey found the interior surfaces of Buildings 14, 30, 31, 37, and 38 to be radioactively contaminated (ORNL 1978a). In 1980 the property owner decontaminated Buildings 14 and 37 by removing the contaminated cement flooring and cement wall surfaces until levels below twice the background level were reached. Contaminated material was temporary placed in the tailings pile until consolidated into the pile west of Building 90 (BNI 1992a). During the 1981 survey, Buildings 30, 31, and 38 were spot-surveyed to verify the results of the 1976 survey, and Buildings 14 and 37 were resurveyed (FBDU 1981a). FBDU also surveyed Building 90, which was constructed between 1977 and 1981. After the survey in 1981, Building 37 was demolished. Debris showing radioactivity exceeding twice the background level was placed on the tailings pile until moved to the pile west of Building 90; uncontaminated debris was disposed of conventionally (i.e., taken to the Town of Tonawanda landfill) (BNI 1992a).

Building 14: Building 14 was used as a pilot plant during the early part of the uranium operations. Because it had been decontaminated by the site owner after the ORNL survey, FBDU made a complete radiological survey of the building in 1981. The maximum external gamma radiation reading from this survey was 20 μR/h, including background. The maximum observed direct (fixed) alpha contamination level was 120 dpm/100 cm^2 at one location; all other readings were less than the DOE guideline of 100 dpm/100 cm^2. Transferable alpha contamination was less than 20 dpm/100 cm^2 throughout the building, and beta-gamma contamination at all locations was less than 0.2 mrad/h. Radon daughter concentrations were measured at less than 0.015 WL. The building was considered by FBDU to be free of contamination.

Building 30: The FBDU survey found that most of the floor area, rafters, walls, and ceilings of Building 30 exceeded DOE guidelines for both fixed and transferable contamination. Fixed radioactivity on exhaust fans was also above guidelines.

Building 30 may originally have had a dirt floor that became radioactively contaminated during uranium processing. Later, a concrete floor was poured over the dirt floor, leaving subsurface radioactive contamination in the soil beneath the concrete.

Building 31: The FBDU survey found that surface contamination in Building 31 was below DOE criteria at all measurement locations; ORNL reported removable alpha levels of 300 dpm/100 cm^2 in the roof vents. Because these roof vents were normally inaccessible and the readings do not exceed guidelines, they were not considered to be a problem (ORNL 1978a).

FBDU personnel measured radon daughter concentrations above 0.03 WL at two different locations in Building 31 and during two different time periods. This finding was not explained or confirmed by other surveys.

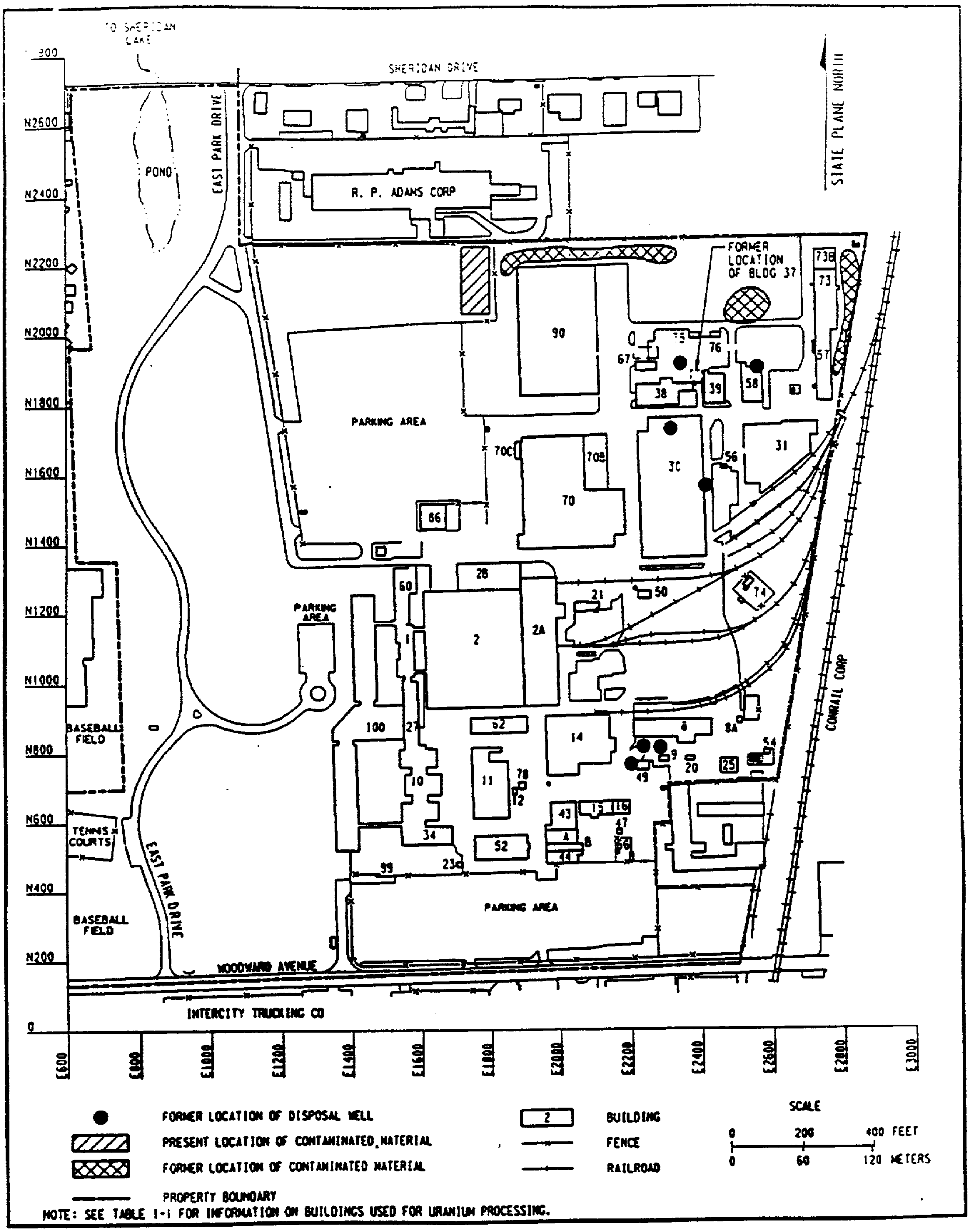
Building 37: This very small building was decontaminated in 1980 following the 1976 ORNL survey, and no radioactive material exceeding DOE criteria was detected by the FBDU survey. There is no documentation of the procedures used for decontamination.

Building 38: Alpha contamination exceeding DOE guidelines was found by the FBDU survey at several locations on the rafters and ceiling. Beta-gamma readings exceeded 0.2 mrad/h at most points on the floor where measurements were possible; equipment stored in some areas restricted the surveys. Building 38 is considered to be radioactively contaminated.

Building 90: Before Building 90 was constructed, residual low-level contaminated soil was removed from the construction area and placed in two windrows along the northern and eastern fences and in one small pile in the northern part of the property. The FBDU survey found no radiation readings above natural background in Building 90, and radon flux through the floor of the building was less than 0.1 pCi/m^2/s (ORNL 1978a).

In summary, the building surveys determined that the radiological conditions of the buildings were as follows:

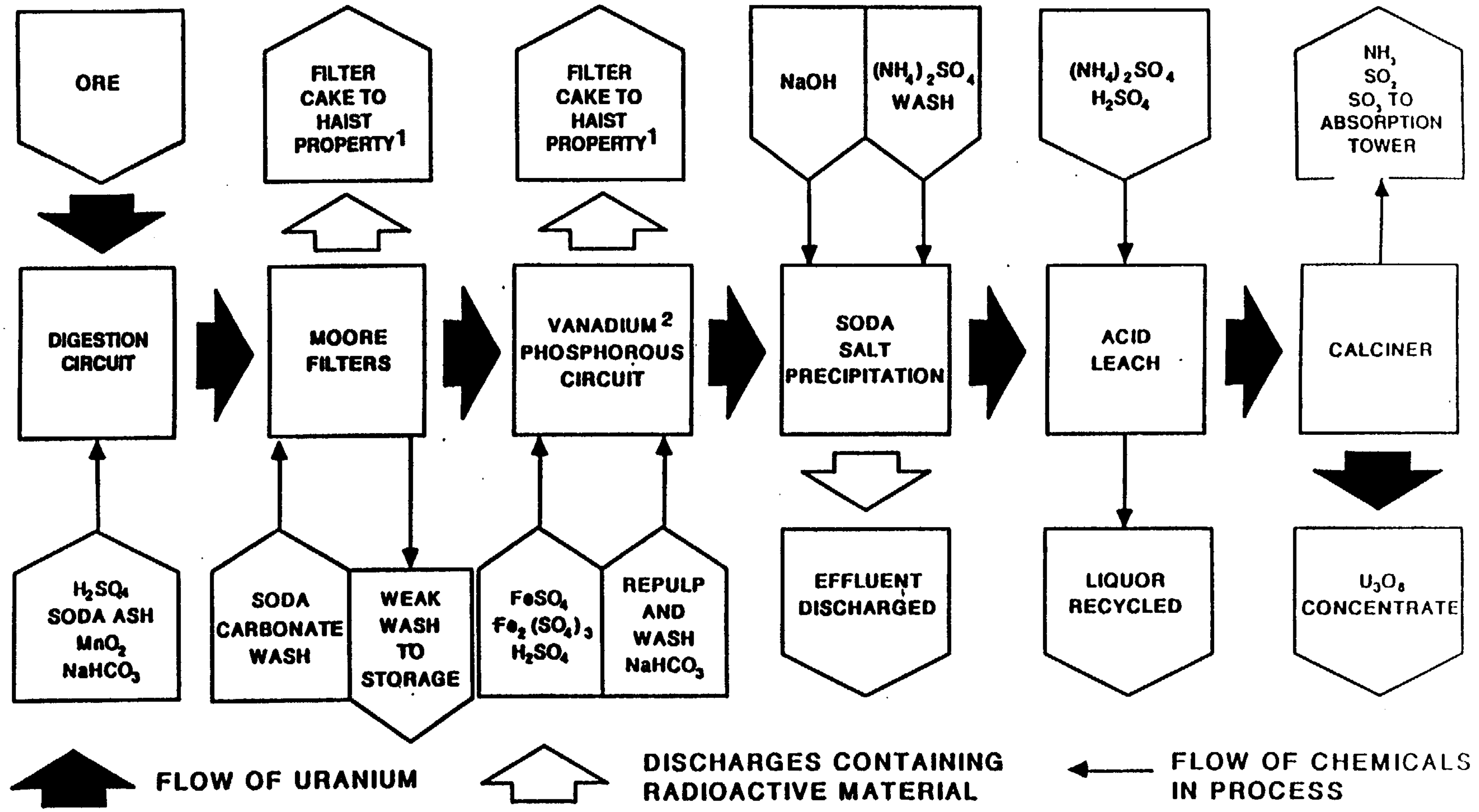
- Building 14: free of contamination
- Building 30: elevated levels of alpha, beta, and gamma activity on the walls and ceiling and beneath the concrete floor
- Building 31: free of contamination
- Building 37: free of contamination
- Building 38: elevated levels of alpha, beta, and gamma activity on the floor, walls, and ceiling
- Building 90: free of contamination



NOTE: SEE TABLE 1-1 FOR INFORMATION ON BUILDINGS USED FOR URANIUM PROCESSING.

129 R1SF059.DGN

Figure 1-5
Plan View of Linde



1. For the African ores, filter cake was taken to Lake Ontario Ordnance Works.
2. Initially, vanadium was removed by adding lead sulfate, and the soda salt precipitation was performed using an acid - caustic method that involved the addition of H_2SO_4 before the caustic was added. Later, the direct caustic method was used. For the African ores, a lead circuit was used instead of a vanadium/phosphorus circuit.

Source: The Aerospace Corporation. *Evaluation of the 1943-to-1946 Liquid Effluent Discharge from the Linde Air Products Company Ceramics Plant*, ATR-82(7963-04)-2, Germantown, Md. December 1981.

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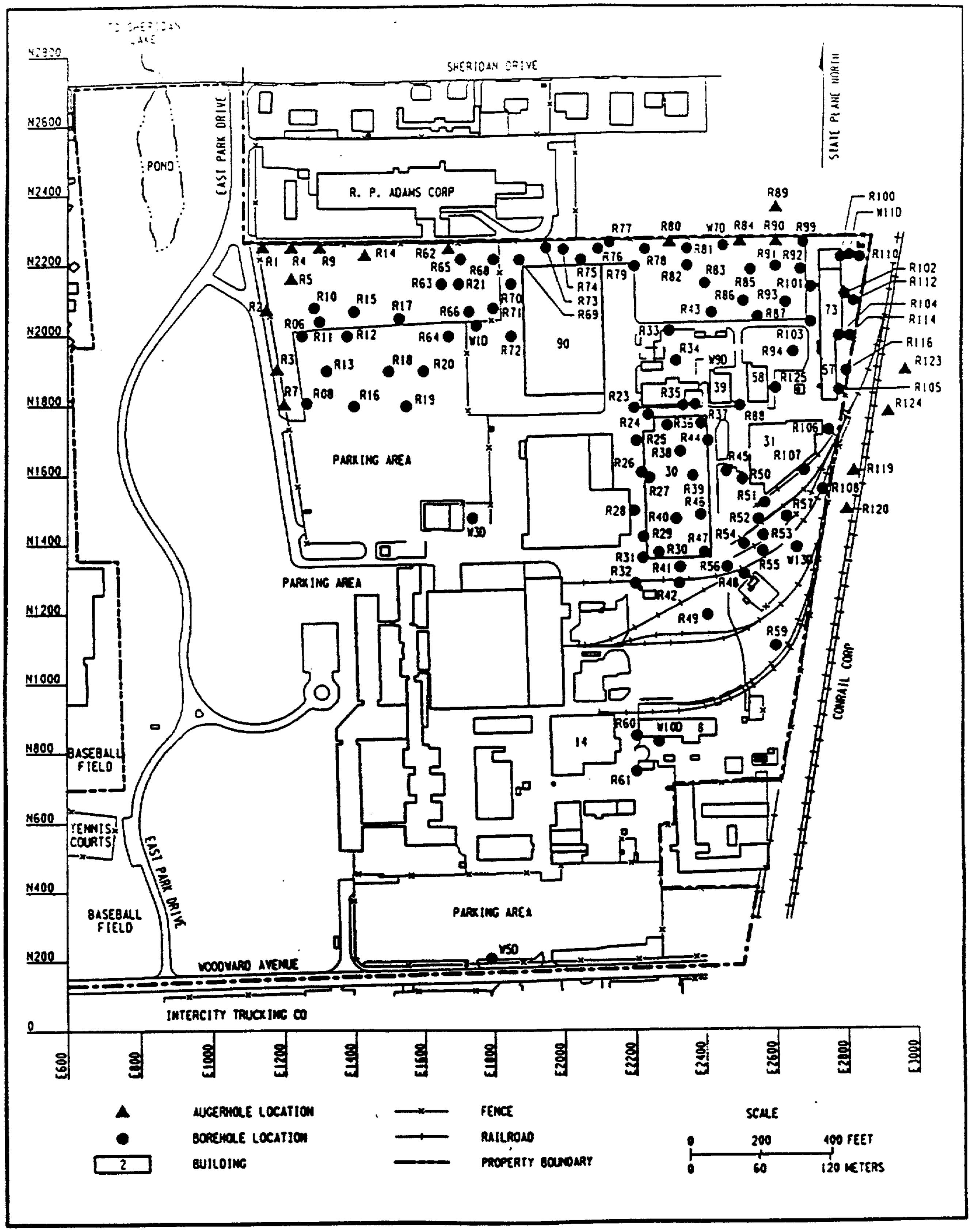
Figure 1-8
Processing of Domestic Urar[illegible] Ores at the Linde Ceramics Plant

Table 1-1

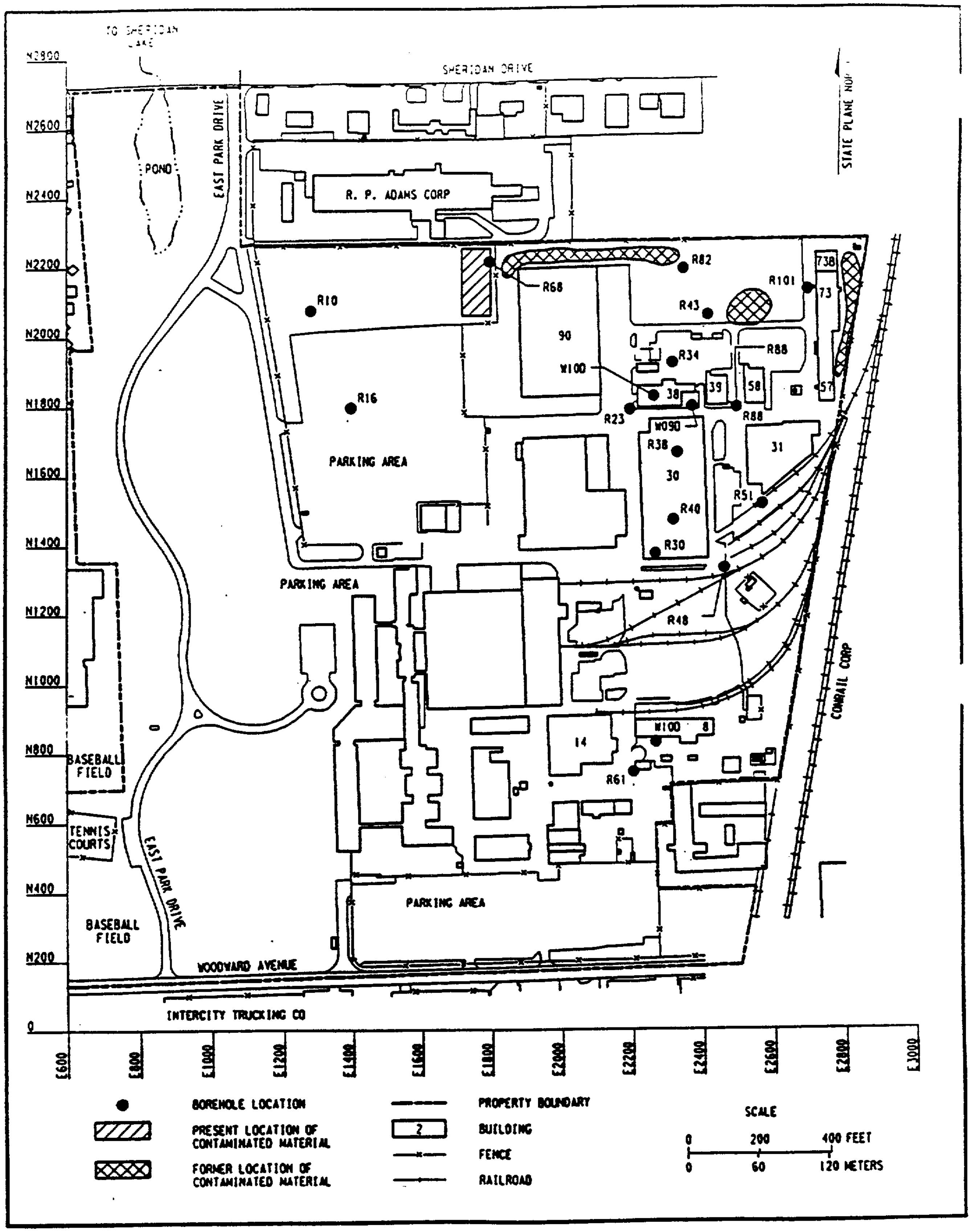
Activities and Operations in Linde Buildings

Constructed in 1930s by Union Carbide	
Building 14	Used for laboratory and pilot plant studies for uranium separation in early part of MED operations. Currently used for offices, research laboratories, and fabrication facilities.
Constructed by MED on Union Carbide property; ownership transferred to Linde at a later date	
Building 30	Used as primary process building for uranium processing (Step 1: ores to U_3O_8; Step 2: U_3O_8 to UO_2) during MED operations and some processing of metallic nickel with nitric acid to produce nickel salt. Currently used as a shipping and receiving warehouse.
Building 31	Used in uranium separation process (Step 3: fluorination of UO_2 to UF_4) during MED operations. Currently used for maintenance and offices.
Building 37	Used in uranium separation process during MED operations. Demolished in 1981.
Building 38	Used in uranium separation process (Step 3: fluorination of UO_2 to UF_4) during MED operations. Currently not in use; access is restricted.
Constructed after uranium processing operations ceased	
Building 90	Built in an area where tailings accumulated during MED operations. Tailings were removed from the site when operations ceased in 1946. Before construction, soil contaminated with low-level radioactivity was removed from the construction area and stored in a pile west of the building. Currently used as a warehouse and for general shipping and receiving.



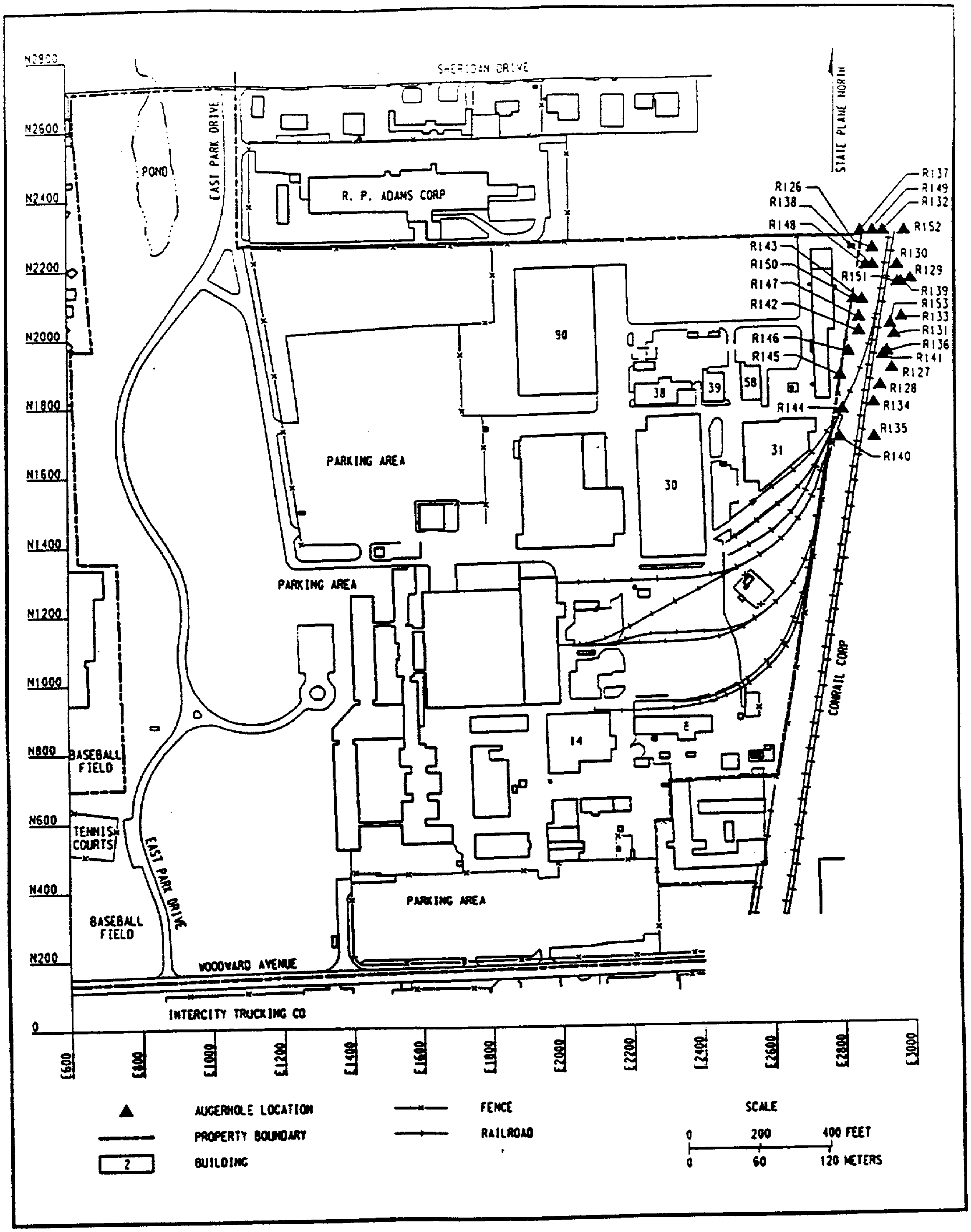
129 RI5F066.DGN

Figure 2-1
First-Phase Radiological Soil Sampling Locations at Linde



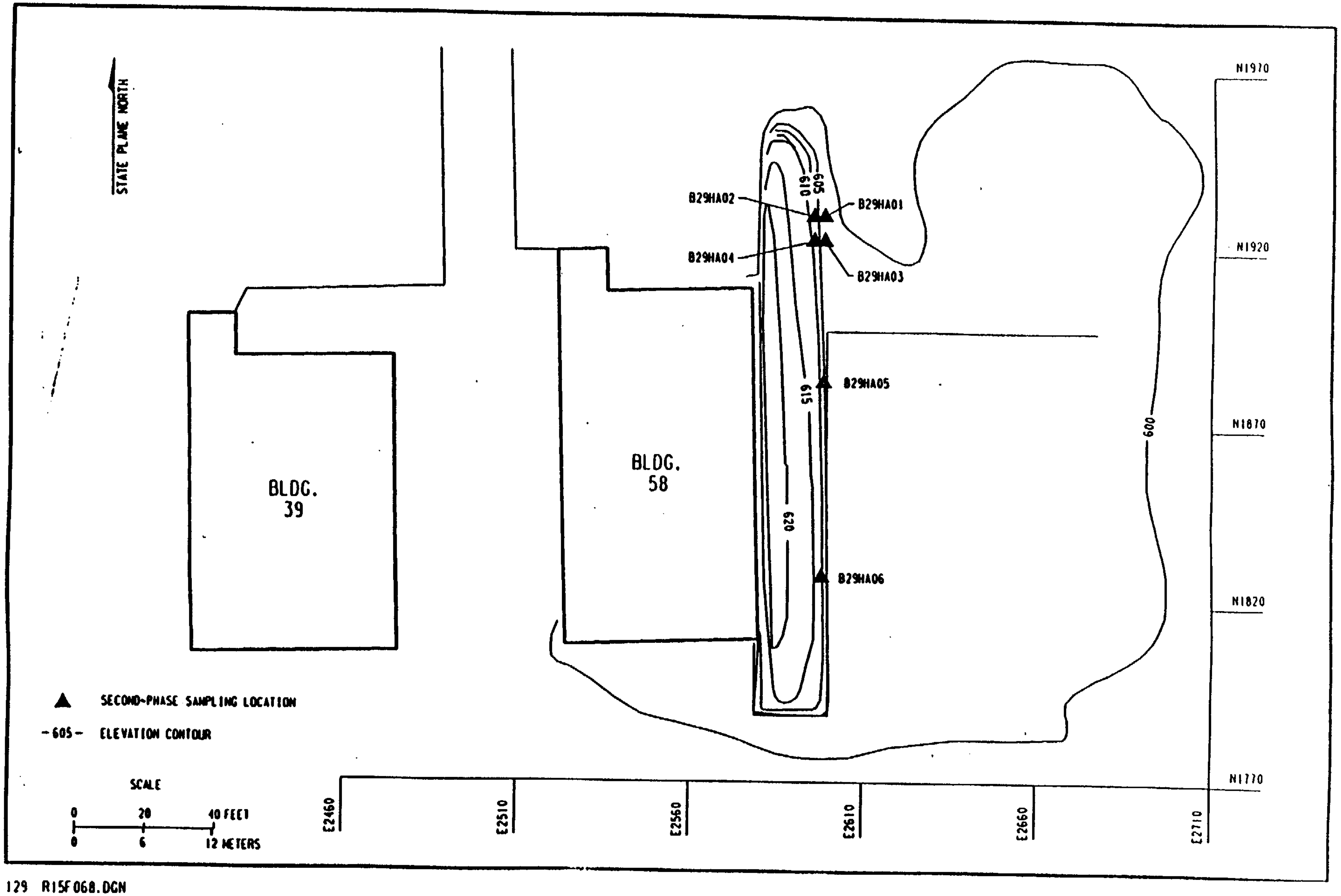
129 R15F067.DGN

Figure 2-2
First-Phase Chemical Soil Sampling Locations at Linde



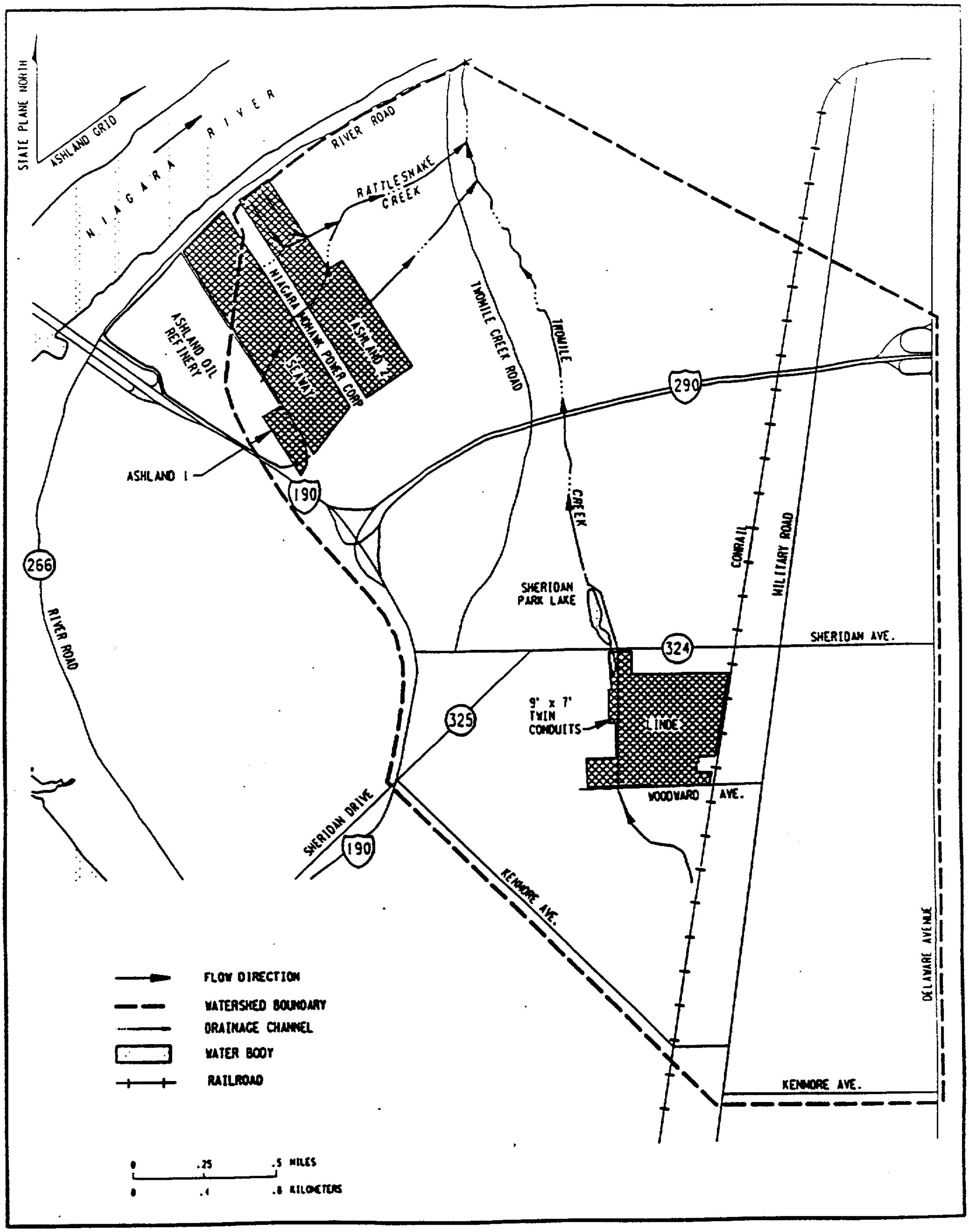
129 R15F091.DGN

Figure 2-3
Second-Phase Radiological Soil Sampling Locations Along Northeastern Fenceline at Linde



129 R15F068.DGN

Figure 2-4
Second-Phase Radiological Soil Sampling Locations in the
Blast Wall Adjacent to Building 58 at Linde



129 R15F055.DGN GIGO

Figure 3-1
Drainage Area of Twomile Creek

3.0 PHYSICAL CHARACTERISTICS OF THE STUDY AREA

The following sections describe the physical and environmental characteristics of the site that are relevant to identifying and evaluating potential transport pathways, mechanisms, and receptors. The information presented here provides a foundation for the discussions of the nature and extent of contamination and contaminant fate and transport in Sections 4.0 and 5.0, respectively.

3.1 SURFACE FEATURES

The Tonawanda site is located in the Eastern Lake Section of the Central Lowland physiographic province (Fenneman 1946). The characteristic landscape of this section consists of dissected and glaciated lowlands and escarpments. The specific physical surface features of the Tonawanda properties are described in the following sections.

3.1.1 Linde

Linde is situated on a broad lowland east of Twomile Creek, a tributary of the Niagara River. The elevation of the property is approximately 180 m (600 ft) above MSL (FBDU 1981a). The property contains office buildings, fabrication facilities, warehouse storage areas, material laydown areas, and parking lots (see Figure 1-5). The property is underlain by a series of utility tunnels that interconnect some of the main buildings and by an extensive network of storm and sanitary sewers. Storm runoff is collected and channeled to the western portion of the property, where it is discharged into a 2.1- by 2.7-m (7- by 9-ft) twin cell conduit built by the Town of Tonawanda (Figure 1-6).

The Linde property is generally flat because the surface soil has been graded. The main parking lot in the northwestern corner of the property is covered with packed gravel (soil is exposed where gravel does not exist). Most areas around the buildings are paved with concrete. Several railroad spurs extend onto the property from the Conrail railroad located outside the eastern property boundary. The soil in the area of the railroad tracks is hard, packed gravel. The soil along the fence bordering the boundary is vegetated with native grasses.

A soil and timber blast wall is located east of Building 58. The blast wall consists of soil piled next to the building wall and held in place with wooden planks. The soil in this area is also vegetated with native grasses.

Contaminated soil was removed from the Building 90 area before construction of the building. The soil was placed in two windrows, one between Buildings 73 and 73B and the eastern property boundary and the other north of Building 90 along the northern property boundary (see Figure 1-5). Soil removed from the Building 90 area was also placed in a third pile on the northern portion of the property. The three piles were subsequently consolidated into one uncovered pile west of Building 90. A pile of contaminated waste material formerly located north of Building 38 (FBDU 1981a) may have been included in the waste consolidation; however, the exact disposition of this material is unknown.

3.1.2 Ashland 1

Ashland 1 is currently being used for disassembly of Ashland Oil Refinery equipment. The property is roughly rectangular in shape, approximately 358 m (1,175 ft) long and 122 m (400 ft) wide. Two large petroleum product storage tanks were formerly located at Ashland 1. Construction of the tanks involved excavation and removal of approximately 4,600 m^2 (6,000 yd^3) of contaminated material. Some of the contaminated soil was used to build earthen berms surrounding the storage tanks. The bermed area is equipped with a sump pump system to pump runoff into an open ditch and then to an RCP beneath the Seaway landfill, which empties into Rattlesnake Creek and then into Twomile Creek. The tanks were removed in 1989. Native grasses, weeds, and shrubs make up the site vegetation. The area inside the berms and the inner area of the northern part of the property are mostly bare soil.

3.3.2 Site Drainage Characteristics

Linde

Linde is a heavily industrialized property, and most of the area is impervious to infiltration of stormwater. The property covers a total area of 54.6 ha (135 acres). The actual plant area (buildings, pavement, and compacted gravel surfaces) covers 26.7 ha (66 acres), representing approximately 50 percent of the property. The average basin slope is 0.63 percent.

All runoff collects in the plant's storm sewer system and drains into Twomile Creek; there are seven storm sewer outfalls (see Figure 1-6). Outfalls 1 and 2 drain stormwater runoff from the southern end of the property, and both empty into a 91-cm (36-in.) municipal storm sewer line under Woodward Avenue. The municipal line joins the Twomile Creek twin conduits.

The third outfall drains a small area in front of the main office building and runoff from the building roofs. The runoff enters a 91-cm (36-in.) culvert that connects to the Twomile Creek twin conduits.

The fourth outfall drains the middle portion of the property. Storm runoff collects in a 91-cm (36-in.) culvert that connects directly with the Twomile Creek twin conduits.

The fifth outfall collects runoff from a very small area in the western part of the property and connects with the Twomile Creek twin conduits through a 51-cm (20-in.) culvert.

The sixth outfall collects runoff from most of the northern end of the property and also collects shallow groundwater in agricultural tile beneath the gravel-packed parking areas. A 76-cm (30-in.) conduit conveys the runoff and groundwater from this area into the Twomile Creek twin conduits.

The seventh outfall collects runoff from the extreme northern section of Linde. This drainage system also includes underground agricultural tiles. Surface runoff from the northwestern corner of the plant area is collected by a drainage ditch just outside the Linde fence; flow in this ditch is conveyed into the Twomile Creek twin conduit by a 76-cm (30-in.) culvert.

All conduits in the sewer system that are larger than 30 cm (12 in.) in diameter are reinforced concrete culverts. Conduits that are 30 cm (12 in.) or smaller are made of vitrified tile unless they are under buildings or driveways, where the loads require heavy cast iron.

Because Linde is an industrial property with a significant portion of the surface area paved and covered by buildings, little erosion is evident.

Ashland 1

Ashland 1 is located on the grounds of the Ashland Oil Company refinery beside the Niagara River. Ashland 1 has a drainage area of 4.4 ha (10.8 acres) that closely follows the property boundary, as shown in Figure 3-3; the figure also shows flow paths on the property.

The topography of the property is flat except where the ground has been altered by construction activities of the oil company. The average basin slope is only 3.3 percent.

The section of the property to the east of the bermed area is flat and covered with grass except for some unpaved roads, an electrical station, and a small building. Drainage from this section is directed toward the ditch that runs along the boundary between Ashland Oil and Seaway (see Figure 3-3).

In the middle of the property, a 1.2-ha (3-acre) area was enclosed by a large berm constructed in 1974 to capture spills from two large petroleum product storage tanks; the tanks have been removed. The berm is approximately 2.1 m (7 ft) high at its highest point. Water from precipitation collects in the bermed area and infiltrates the berm, evaporates, or is pumped over the berm by means of a small pump in the southeastern corner of the area. The water pumped from the bermed area flows into an open channel and travels northwestward to the drainage ditch along the Ashland 1/Seaway boundary.

The western section of Ashland 1 is relatively low-lying and is covered with tall grass and large bushes. Overland runoff from this area collects in a small ditch running to the west; flow in this ditch goes through a 30-cm (12-in.) steel pipe and into the main ditch along the Seaway boundary.

All of the drainage from Ashland 1 is directed into the ditch (described in Section 3.1) that forms the headwaters of Rattlesnake Creek. This ditch (see Figure 3-3) flows to the west along the Seaway boundary into a low marshy area drained by a 0.9-m- (3-ft-) diameter RCP that runs diagonally under Seaway.

There is little evidence of erosion on Ashland 1; the only exposed ground is the unpaved roads. Sediment settles out in the bermed area (one-third of the property), and water that is pumped out contains only small amounts of sediment. The drainage ditch along the Seaway fence has a slope of approximately 1.5 percent and contains thick vegetation; most sediment reaching the ditch should settle out before reaching the Seaway pipe.

Ashland 2

The Ashland 2 area is approximately 43 ha (107 acres) and is flat with small depressions. The average basin slope is 2 percent.

Storm runoff leaves the property through the five channels shown in Figure 3-4. Channel 1 drains the eastern portion of Ashland 2; approximately 38 percent of the total area of the property is in the eastern drainage area. The ditch is about 0.9 m (3 ft) wide and 0.3 m (1 ft) deep; as shown in Figure 3-4, drainage is toward the northeast. After crossing the Ashland 2 boundary, the ditch runs 793 m (2,600 ft) northward before it empties into Twomile Creek approximately 6 m (20 ft) below the Fletcher Street bridge over Twomile Creek. The channel is directed under Twomile Creek Road through a 76-cm (30-in.) culvert.

Channel 2, Rattlesnake Creek, is the main channel for runoff from the property (see Figure 3-4). Approximately 59 percent of Ashland 2 overland runoff empties into Rattlesnake Creek. The creek enters the Niagara Mohawk property at the outlet of the 0.9-m- (3-ft-) diameter RCP and crosses Ashland 2 through a wide, 0.9-m- (3-ft-) deep channel. Another drainage ditch in the western portion of the property joins Rattlesnake Creek just across the Benson Development Company property line. This drainage ditch approaching future commercial and industrial uses unhampered by restrictive categorizing, thus extending the desirability of flexible zoning, subject to change with changing condition" (Town of Tonawanda 1989).

Linde

Present land use at Linde is strictly industrial. The Linde Gas Products Company, Incorporated, operates an industrial gas production facility there. Although portions of the property were previously owned by the Town of Tonawanda, Excelsior Steel Ball Company, Metropolitan Commercial Corporation, and the Pullman Trolley Land Company, the land was not used by any of these owners (FBDU 1981a). The land may have been used as farmland in the past. The western side of the property, where the main office building is located, includes a portion of the former Sheridan Park Golf Course, which Linde purchased from the Town of Tonawanda (SAIC 1992a).

The area near Linde is used for a mixture of industrial, commercial, recreational, public, and residential purposes (Figure 3-45). A public park west of the property is owned by Linde; beyond the park is a residential area. The closest residential area is west of East Park Drive on the western boundary of Linde. An elementary school is located at the southern end of the park; beyond the school are buildings associated with the local recreation and highway departments. Linde is bounded on the north and south by other industries and small businesses, on the east by an open area with railroad tracks owned and operated by Conrail, and on the west by the former Sheridan Park Golf Course, now owned by Linde. The areas east and north of Linde across Military Road and Sheridan Drive, respectively, are also residential. The Kenmore Sister of Mercy Hospital is approximately 0.8 km (0.5 mi) from Linde. In summary, there are six schools, a hospital, two recreational areas, two community buildings, and a senior citizens center within 1.6 km (1 mi) of Linde (SAIC 1992a).

buildings and beneath Building 30, and (2) portions of Buildings 14, 30, 31, and 38 to confirm previous survey results.

Supplemental investigations were conducted from November 1990 through May 1991 to investigate four potential contaminant sources: (1) contaminated soil beyond the northeastern corner fenceline, (2) contaminated soil in the blast wall adjacent to Building 58, (3) effluents injected into the subsurface bedrock and basal contact zone, and (4) a subsurface vault potentially containing radioactive materials.

Soil Characteristics at Linde

To determine the nature and extent of contamination at Linde, the nature of the construction materials used as fill at the property must be considered. The natural soils at Linde appear to have been covered by a fill layer ranging in thickness from 0 to 5.1 m (0 to 17 ft). This fill, as noted in borehole logs, contains substantial quantities of slag and fly ash that was apparently brought onsite from local sources for grading purposes during construction of the Linde facility. Both of these materials are known to contain heavy metals at concentrations above naturally occurring levels, and fly ash is also reported to contain radionuclides, including thorium-232 (Lim 1979). Thorium-232 was not present in the MED ores, and its presence in a sample can suggest the presence of fly ash; however, the absence of thorium-232 does not constitute proof that the material being analyzed is MED related.

Because slag and fly ash are specifically exempted from RCRA regulation [40 CFR 261.4(b)(7) and 40 CFR 261.4(b)(4)], the background values for heavy metals and radionuclides should be adjusted to account for their influence. This is essential for purposes of this study because a prime objective of the RI is to identify the nature and extent of any hazardous materials (radioactive or otherwise) associated with MED activities. The effect of fly ash on the sampling results has been evaluated by sampling boreholes that are outside areas of radioactive contamination where the field geologist has specifically identified fly ash in the borehole log. Boreholes that meet these criteria a B29R19, B29R20, B29R49 B29R59, and B29R61. Chemical data are available only for B29R61.

The data for B29R61 (Table 4-5) indicate that the shallow soil [0 to 0.6 m (0 to 2 ft)] contains above-background levels of arsenic (62.6 ppm), cadmium (1.4 ppm), chromium (35.1 ppm), copper (151 ppm), lead (121 ppm), and silver (3.7 ppm). The vanadium concentration (22.2 ppm) is within the native background range (19.5 to 31.8 ppm); the concentration of thorium-232 is greater than 1 pCi/g, while the uranium-238 concentration is less than 10 pCi/g. Additionally, the sample is identified in the borehole log as consisting of slag and 40 percent clay and fly ash. The concentrations of metals detected in the natural soils beneath this horizon are very similar to those published by the State of New York and USGS as background for clays in Erie County. The only above-background values are those for arsenic and zinc, both of which are fairly mobile in the subsurface and may have originated in the overlying fill materials. (The arsenic concentrations are probably overestimated because of interferant problems in the analysis.) The potential for MED-related contamination at this location is from effluent injection wells; however, because of the pH stages and addition of carbonates and hydroxides, the effluent should not contain copper, lead, or chromium. Therefore, these constituents are much more likely to have originated from waste motor oil in the sample and a mixture of fly ash and slag. MED-associated material does not appear to be present at this sampling location.

Surface and Subsurface Soil Outside of Buildings at Linde

Radionuclides. The primary radioactive contaminants in soil at Linde are uranium-238, radium-226, and thorium-230, which appear to be concentrated in four areas (Figures 4-1 through 4-3). Radiological data for contaminated soil in these four areas are summarized in Table 4-6; radiological data for all soil sampling locations at Linde are presented in Appendix A.

Area 1. According to Linde personnel, soil was probably brought into Area 1, in the northwestern corner of the main parking area, as fill and grading material (Figure 4-1). The ground surface of the parking lot is several feet above the ground surface of the R. P. Adams property immediately to the north; the difference in elevation supports the theory that fill material was placed in Area 1.

The maximum depth of radioactive contamination is 1.2 m (4 ft) found in B29R10. Only two subsurface samples exceeded the DOE guideline of 15 pCi/g for thorium-230: one in B29R05 (23 pCi/g) and one in B29R07 (30 pCi/g).

Chemical data exist for two boreholes (B29R10 and B29R16) in Area 1. The lead-vanadium relationship is weak yet discernible at B29R10, and the radium-226 (5 pCi/g) and thorium-230 (5.9 pCi/g) concentrations are above guidelines in the surface soil sample. The lead-vanadium relationship is not present in B29R16. Because the radionuclides are not above guidelines and the vanadium concentrations are relatively low in B29R16, the activity is caused by the presence of slag and fly ash, not Stage 2 filter cake.

Area 2. Area 2 is along the northern boundary of the property in the northeastern corner of the parking area (Figure 4-1). Contaminated residues were brought into Area 2 before the construction of Building 90. Contaminated soils were removed from the construction area of Building 90 and placed in a windrow between the location for Building 90 and the northern property line (see Figure 1-5). Between 1979 and 1982, the materials in the windrow were moved to a pile beside the northern end of Building 90. The pile, approximately 5 m (15 ft) high (Figure 4-4), was not sampled during the RI because the material is known to be radioactively contaminated.

Some samples were collected to a depth of 1.2 m (4 ft), and gamma log readings indicated that radioactive contamination may reach a depth of 1.2 m (4 ft) in only one borehole (B29R66). This borehole contains uranium-238 contamination (40 pCi/g) between 0.6 and 1.2 m (2 and 4 ft), but no other radionuclides in the borehole are above guidelines.

Only one sample collected in Area 2 was analyzed for the presence of chemicals (B29R68). This borehole has elevated uranium-238 (14.0 pCi/g) and radium-226 (3.1 pCi/g) concentrations and a thorium-230 concentration (6.3 pCi/g) above the DOE guideline. The sample from this borehole does not have the elevated lead and vanadium levels characteristic of Stage 2 filter cake, but elevated zinc, arsenic, manganese, calcium, and copper are present. The elevated levels of manganese, calcium, copper, and radionuclides indicate that Stage 1 filter cake may have been mixed with the natural materials in this area. The borehole log for B29R68 describes a clay fill with slag. The results for individual locations in Area 2 indicate that the most likely location of MED-related material is in the area just south of the pile (B29R66 and B29R71), but there may be minor mixing such as that indicated in B29R68 and B29R65.

The remainder of the area exhibiting radionuclide concentrations above DOE guidelines appears to have fly ash in the fill, mixed with MED material. The fly ash is confirmed by the presence of thorium-232 at concentrations greater than 1 pCi/g and borehole log observations noting high percentages of fly ash (e.g., B29R69, with a 50-percent fly ash estimate and thorium-232 concentration of 3 pCi/g). The area previously contained MED-related materials in a windrow; some of these materials are probably still mixed with the soils.

Area 3. Area 3, along the northeastern corner fenceline, encompasses a spur of the railroad (Figure 4-2). Some samples were collected to a depth of 1.5 m (5 ft); radioactive contamination reached a depth of 1.2 m (4 ft). Samples collected from B29R116 contained concentrations of uranium-238 (170 pCi/g), radium-226 (240 pCi/g), and thorium-230 (710 pCi/g) that exceeded DOE guidelines. The borehole was sampled to a depth of 0.9 m (3 ft), and gamma log readings confirm that radioactive contamination does not extend beyond that depth. The surface sample collected from B29R116 during the site characterization was the only sample that showed thorium-232 above the DOE guideline.

Because sampling in Area 3 indicated that radioactive contamination extended beyond the property boundary, additional samples were collected during the 1990-91 investigation. The second-phase investigation results indicate that the primary contaminants west of the railroad spur are uranium-238 and thorium-230 at depths of less than 1.2 m (4 ft) and that the primary contaminant east of the railroad spur is thorium-230 at depths of less than 0.6 m (2 ft). Results are presented in Appendix A.

Radioactive contamination was detected in 18 auger holes drilled during the second-phase investigation; Figure 4-2 shows the approximate depths and extent of radioactive contamination in soil. Samples collected from B29R145 had the highest concentrations of uranium-238 (100 pCi/g), radium-226 (43 pCi/g), and thorium-230 (110 pCi/g), all of which are above DOE guidelines. These samples were collected to a depth of 0.9 m (3 ft).

Three types of activities associated with MED processes were conducted in the area designated as contaminated in Figure 4-2. During the years of uranium processing, uranium ore was transported to Linde on the Conrail railroad spurs, and solid processing residues were piled in the area north of Buildings 30, 38, 39, and 58. Before Building 90 was constructed, soil contaminated during MED operations was excavated from the construction area and placed in two windrows, one of which was located between Buildings 73 and 73B and the property boundary (Figures 1-5 and 4-2).

Building 73 and 73B were constructed in 1963 and 1976, respectively. Contaminated soils from the construction of Building 90 were not placed in the area between Buildings 73 and 73B and the property boundary until after 1976; therefore, these soils could not have contaminated the area beneath Buildings 73 and 73B. No contamination was known to have been placed in the area before the building was constructed, and no samples were collected beneath the buildings because no historical evidence showed reason to suspect the presence of contamination. B29R103 and B29R101 are known to be contaminated. The materials found in B29R101 (i.e., uranium-238, radium-226, and thorium-230 above DOE guidelines) appear to be MED related, while those found in B29R103, which has substantial amounts of slag and very little (less than 7.0 pCi/g) uranium, may not be. To give a conservative estimate for the contaminated soil volume, contamination is presently considered to exist beneath the buildings.

No soil samples were taken from directly beneath the railroad spur because an access agreement could not be obtained. However, to give a conservative estimate for the contaminated soil volume, contamination is presently considered to exist beneath the spur because shallow contamination at depths of less than 1 m (3 ft) exists on both sides of the spur.

Only one borehole (B29R101) was sampled for analysis of chemical constituents in Area 3. The sample contained moderately high levels of lead (42.9 ppm) and vanadium (50 ppm). The lead-vanadium relationship indicates the presence of MED-related materials. The source of contamination (i.e., Stage 2 filter cake) is confirmed by the radionuclide concentrations [uranium-238 (54.0 pCi/g), radium-226 (12.0 pCi/g), and thorium-230 (23.0 pCi/g)] above DOE guidelines.

Area 4. Area 4 is around Buildings 38 and 58 and in and around Building 30 (Figure 4-3). Samples collected from B29R38 inside Building 30 contained concentrations (above DOE guidelines) of uranium-238 (930 pCi/g), radium-226 (150 pCi/g), and thorium-230 (820 pCi/g) between depths of 0.3 and 0.9 m (1 and 3 ft). Both lead (1,120 ppm) and vanadium (437 ppm) concentrations were elevated in this interval, positively identifying Stage 2 filter cake. The 0- to 0.3-m (0- to 1-ft) interval is concrete. The borehole gamma-log readings show that radioactive contamination may extend to a depth of 2.4 m (8 ft), but the field log indicates that the radioactive contamination was moved to this depth during installation of the PVC pipe prior to gamma logging the borehole. The metals results confirm that radioactive contamination in the area of B29R38 does not extend to depths greater than 1.2 m (4.1 ft) [i.e., the depth of fill material].

Samples collected from B29R46 (to the east of Building 30) also contained elevated concentrations of uranium-238 (170 pCi/g) between the surface and 0.3 m (1 ft) and between 0.3 and 0.6 m (1 and 2 ft) (100 pCi/g). Although the borehole was sampled to a depth of 0.9 m (3 ft), gamma-log readings indicated that the radioactive contamination may extend to 1.2 m (4 ft).

During the 1988-89 site characterization, a borehole was drilled into the soil and timber blast wall east of Building 58 to determine whether the soil was radioactively contaminated. Only one borehole was drilled because of the steep slope of the blast wall and because only representative samples were necessary to determine whether radioactive contamination is present. The borehole contained high concentrations of uranium-238 (100 pCi/g), radium-226 (30 pCi/g), and thorium-230 (27 pCi/g) at a depth of 0.9 to 1.8 m (3 to 6 ft).

Because the site characterization sampling was intended as an initial screening, additional samples were collected during the 1990-91 investigations. The primary contaminants in the blast wall soil are uranium-238, radium-226, and thorium-230; results are presented in Appendix A. No thorium-232 concentrations were above guidelines. Uranium-238, radium-226, and thorium-230 in excess of DOE guidelines were detected in boreholes B29HA01, B29HA02, and B29HA03; subsurface gamma logs and sampling results were in agreement on the depths of contamination. Figure 4-5 shows the approximate depths of contamination. Surface contamination [ground surface to 15 cm (6 in.)] was found only in B29HA02; subsurface contamination [deeper than 15 cm (6 in.)] was found in all three boreholes. No contamination was found in B29HA04 through B29HA06. During the RI, only one area of the northern end of the blast wall was found to be contaminated. For purposes of a conservative volume estimate of contaminated soil, the northern end of the blast wall is considered to be contaminated.

The maximum depth of radioactive contamination in Area 4 is 2.7 m (9 ft) in B29R36 beneath Building 30 (which was constructed to accommodate MED activities).

RCRA-characteristic waste. None of the soil samples failed RCRA characteristics criteria [corrosivity, ignitability, reactivity, or EP toxicity] as defined under RCRA (40 CFR 261). EPA has replaced the EP toxicity test with the TCLP and included additional organic constituents in the list of analytes. Analytical results for both the EP toxicity characteristics and total volatile and BNAE concentrations in Linde samples are in the low ppb range; therefore, TCLP analysis will not be needed because the concentrations will not exceed regulatory criteria if additionally evaluated using TCLP (see Federal Register, Vol. 55, No. 61, March 29, 1990, pg. 11863).

Organics. Seventeen locations were sampled for the presence of VOCs in the shallow soil (see Figure 2-2). Additionally, samples from nine of these locations were analyzed for BNAEs. Results are summarized in Table 4-7. The data for VOCs can be broadly grouped into three categories: samples that are relatively free of VOCs other than toluene (B29R101, B29R68, B29W9D, B29R30, B29R10, and B29R88); samples that contain primarily chlorinated ethenes and toluene (B29R34, B29R43, B29R16, B29R23, B29R61, and B29W10D); and samples that contain toluene and a mixture of chlorinated ethenes and ethanes (B29R51, B29R48, B29R40, B29R82, and B29R38).

Toluene appears to be an ubiquitous chemical at Linde; it was detected in all soil samples analyzed for VOCs. With the exception of B29R30, B29R38, and B29R40 [beneath Building 30, which has a 0.3- to 0.6-m (1- to 2-ft) thick concrete floor], the presence of toluene (which is both biodegradable and mobile) in the shallow soil system is not expected to result from a release occurring in the 1942 to 1946 time period. The data indicate that the highest toluene concentration is typically in the first 0.6 m (2 ft) of the subsurface and that the concentrations decrease with depth (Table 4-7). If the toluene had been deposited 50 years ago and had not undergone biodegradation, the majority would have migrated deeper into the soils; therefore, the deeper samples would have higher toluene concentrations. The decrease in concentration with depth is a further indication that the toluene was deposited recently.

The chlorinated aliphatics are common industrial degreasers and appear to occur at Linde as either ethenes or ethenes mixed with ethanes. 1,1,2,2-~~tri~~tetrachloroethane was found only under Building 30 and was detected at the highest concentration of all the chlorinated compounds [190 µg/kg in B29R40 and 650 µg/kg in B29R38 at depths from 0 to 1.2 m (0 to 4 ft)]. The borehole log for B29R38 notes the presence of a black oily substance under the concrete floor in this interval. The chlorinated materials in these boreholes are mixed with MED-related radioactive waste. 1,1,2,2-tetrachloroethane is not a common degreaser; the compound is usually employed as a feedstock for production of other chlorinated compounds (Kirk-Othmer 1978). 1,1,2,2-tetrachloroethane could occur as a contaminant in trichloroethene or tetrachloroethene. However, 1,1,2,2-tetrachloroethane was the only chlorinated compound detected in the first interval sampled; although very mobile, it did not appear in the deeper sample where other chlorinated aliphatics and toluene were detected. Because 1,1,2,2-~~tri~~tetrachloroethane is similar to trichloroethene in mobility, the two would be expected to be present together if deposited at the same time.

Three other boreholes (B29R48, B29R51, and B29R82) contain ethanes, which were detected in the 0- to 0.6-m (0- to 2-ft) interval of B29R48 and B29R51 and in the 0.6- to 1.8-m (2- to 6-ft) interval of B29R82. Trichloroethene, tetrachloroethene, and/or methylene chloride were detected in 12 of the 18 samples analyzed for VOCs. Typically, the levels detected were low (less than 20 ppb), but unlike the pattern observed for toluene, the concentration gradient increased with depth. This is expected because these compounds are more mobile in clays than toluene. The highest concentration reported was for tetrachloroethene (42 ppb) in the 1.8- to 2.4-m (6- to 8-ft) interval in B29R23.

The exact origin of the chlorinated aliphatics cannot be accurately determined from the data. There does not appear to be any pattern to their distribution, although the shallow soil at the Linde facility has apparently become contaminated with relatively low levels (1 to 42 ppb) of these materials. However, because of natural degradation of chemical compounds over time, it is unlikely that degreasers that may have been used during MED operations would still be present in the shallow soil 50 years later. Therefore, for purposes of the RI/FS, these materials are considered non-MED related and a concern to the DOE remedial action program only for planning of remedial action and waste disposal when the materials are mixed with MED-contaminated material.

With the exception of B29R101, which is under 0.3 m (1 ft) of concrete, soil samples from all locations sampled for analysis of BNAEs contained a number of PAHs (see Table 4-7). The concentrations of PAHs found at Linde are above background and indicative of the surficial release of used crankcase oils from motor vehicles (especially diesel trucks). Most locations sampled were in areas currently used by vehicular traffic. The concentration gradient of the PAHs indicates that the less mobile compounds adsorbed in the first 0.6 m (2 ft) of soil and the more mobile compounds diminished to nondetectable concentrations at greater depths [i.e., in the 0.6- to 1.8-m (2- to 6-ft) interval] (see Table 4-7). The depths and concentrations of these constituents indicate a release time considerably shorter than the 50-yr period that has elapsed since MED operations ceased; their presence is more likely to be related to normal, ongoing industrial operations at Linde.

Metals. Linde is underlain by fill that is a complex mixture of fly ash, slag, gravel, and clays. Fly ash contains elevated levels of trace metals and radionuclides. Slag contains elevated levels of iron, magnesium, calcium, and trace metals, which may not be present at elevated levels in gravel and clays. Therefore, the analytical results for soil samples will depend upon the percentage of each of the above constituents in the samples.

Because of the potential difficulty in distinguishing MED-related metals from fly ash/slag-related metals, the data for each borehole must be examined separately, giving particular attention to its location at the property and the radionuclide mix.

Areas 1 and 2. Three soil samples (one each from B29R10, B29R16, and B29R68) were collected in the northwestern sector of the Linde facility and analyzed for metals. Analytical results are summarized in Table 4-8. The area is currently used for parking (Area 1) and the radioactive waste storage pile (Area 2). All three samples are described as consisting of clay and gravel fill with varying amounts of fly ash and slag. None of the sampling locations are near former injection wells, although MED wastes may have been placed in the area.

The sample from the 0- to 0.6-m (0- to 2-ft) interval of B29R10 exhibits a weak but nonetheless characteristic fingerprint of concentrations of vanadium lead, copper, and nickel that exceed background (Table 4-8). The sample is composed entirely of fill materials and has radium-226 and thorium-230 concentrations that exceed background but less than 1 pCi/g of thorium-232. This material should be considered MED related (i.e., Stage 2 filter cake). The sample from the 0.6- to 1.8-m (2- to 6-ft) interval did not contain high concentrations of trace metals but did contain levels of radium-226 and thorium-230 that exceed guidelines. This finding is probably related to the sampling interval collection method; the radiological sample was taken in the 0.6- to 1.2-m (2- to 4-ft) interval, which includes 0.3 m (1 ft) of fill, whereas the metals sample was composited with 0.9 m (3 ft) of clay. Therefore, the radionuclides probably originated from the fill material mixed with the sample; the metals sample is primarily composed of clean clay. The low levels of metals in the 0.6- to 1.8-m (2- to 6-ft) interval indicate that metals and radionuclides (which should behave similarly to several of the heavy metals) have not migrated downward from the fill into the natural clay.

B29R16 has 0.9 m (3 ft) of fill (clay and gravel with fly ash and slag) overlying a brown clay. Both of the radiological samples were taken in the fill material. The levels of radionuclides detected are close to background, with a slightly elevated thorium-230 concentration (3.4 pCi/g) in the first sampling interval. The material analyzed for metals in this interval may contain a small amount of Stage 1 filter cake (i.e., residue rich in calcium and manganese). However, it also contains elevated levels of arsenic (120 ppm) and magnesium. All of these metals could be non-MED-related because the slag would contain high levels of calcium and magnesium, and the fly ash could account for the manganese and arsenic levels that exceed background. Additionally, the Stage 1 filter cake should contain levels of copper that exceed background (Aerospace 1981) but does not. The evidence tends to support the conclusion that this material is not MED related. The second sample for metals from B29R16 was from natural clay at a depth of 0.6 to 1.8 m (2 to 6 ft). The results show some evidence of downward migration of arsenic, which is relatively mobile, but concentrations of other metals and radionuclides are close to background.

Subsurface conditions in B29R68 are similar to those in B29R016: 0.9 m (3 ft) of clay, gravel, and slag fill overlying a brown, moderately plastic clay. The radionuclide concentrations in the first sampling interval [0 to 0.6 m (0 to 2 ft)] are elevated (see Table 4-8). The metals composition (mean concentrations of calcium, manganese, and copper that exceed background) indicates that some Stage 1 filter cake is present. In the second sampling interval [0.6 to 1.8 m (2 to 6 ft)], calcium concentrations remain high, but copper and manganese (as well as the radionuclides) are at background levels; these results indicate minimal migration into the natural clays. Arsenic, which is not known to be a MED-related waste constituent (see Sections 1.3.2 "History" and 4.2.1 "Soil Characteristics at Linde"), exceeded background in the first interval (55.2 ppm); arsenic is mobile, and the concentration was slightly higher in the second sampling interval (87.5 ppm). However, given the uncertainty in the analytical method, these values are relative and may be much lower.

Areas 3 and 4. As in the northwestern sector of the facility, three boreholes were sampled for metals contamination in the northeastern sector (B29R82, B29R43, and B29R101). B29R82 is underlain by 0.6 m (2 ft) of sandy gravel and slag and 0.6 m (2 ft) of disturbed clay. Undisturbed material begins at a depth of 1.2 m (4 ft). Analytical results for these boreholes are summarized in Table 4-9.

The first sampling interval [0 to 0.6 m (0 to 2 ft)] contains thorium-232 above 1.0 pCi/g; no vanadium or copper; elevated levels of calcium and magnesium; and concentrations of manganese (3,070 ppm), arsenic (207 ppm), and beryllium (6.3 ppm) that exceed background. However, because of the presence of thorium-232, the absence of vanadium (Stage 2 filter cake), the absence of elevated copper concentrations (Stage 1 filter cake), and the presence of very high levels of magnesium and calcium (slag), this material is not considered MED related (Table 4-9). The second sampling interval [0.6 to 1.8 m (2 to 6 ft)] was not analyzed for radionuclides. The second interval has a different mineralogical composition (clay versus sandy gravel) than the first interval. However, as with the first sampling interval, there are no indicators of MED-related filter cake. Arsenic, magnesium, and calcium still exceed background, indicating that some downward migration may have occurred.

The soil profile in B29R43 is very similar to that in B29R82, with a sandy gravel and slag fill to 1.2 m (4 ft), underlain by undisturbed clay. As in B29R82, the first sampling interval [0 to 0.6 m (0 to 2 ft)] contains elevated levels of calcium and magnesium and background levels of lead, vanadium, and copper; thorium-232 at concentrations above 1 pCi/g; and levels of arsenic (166 ppm), beryllium (5.5 ppm), and manganese (2,050 ppm) that exceed background. The combinations and concentrations of constituents found in this interval indicate fill of unknown composition and slag (see Table 4-9). The materials in this borehole interval are not MED related. The 0.6- to 1.8-m (2- to 6-ft) interval represents, in general, a reflection of the first interval with lower concentrations of most constituents (including radionuclides). The exception is that chromium, iron, magnesium, nickel, sodium, and zinc concentrations were slightly higher than in the first interval, with only magnesium exceeding background levels. The second interval also does not show any evidence of MED-related materials.

The soil in B29R101 is covered by 0.3 m (1 ft) of concrete. The subsurface consists of a clay fill between 0.6 and 0.9 m (2 and 3 ft) with undisturbed clay beneath. The first sampling interval [0 to 0.3 m (0 to 2 ft)] contained above-background levels of vanadium, lead, and copper and above-guideline levels of uranium-238 (54.0 pCi/g), radium-226 (12.0 pCi/g), and thorium-230 (23.0 pCi/g). This sampling interval contained MED-related materials (see Table 4-9). In the second sampling interval [0.9 to 2.1 m (3 to 7 ft)], concentrations of all metals and radionuclides (except arsenic) decreased to levels at or near background. This indicates that there has been minimal leaching of heavy metals (vanadium remained slightly elevated at 38.6 ppm) and radionuclides into the subsurface soils. Therefore, the undisturbed clay in this area is considered free of MED-related materials.

Area 4. Nine boreholes were sampled for metals in and around Building 30. B29R38, B29R40, and B29R30 were drilled under Building 30; B29R48, B29R51, and B29R88 were drilled east of Building 30; and B29R23, B29W09D, and B29R34 were drilled north of the building. Analytical results are summarized in Tables 4-10 through 4-12.

B29R38 was advanced to 2.4 m (8 ft). The first 0.3 m (1 ft) consisted of a concrete floor. A sample taken in the 0.3- to 0.9-m (1- to 3-ft) interval was Stage 2 filter cake containing elevated levels of vanadium (437 ppm), lead (1,120 ppm), uranium-238 (930.0 pCi/g), radium-226 (150.0 pCi/g), and thorium-230 (820.0 pCi/g). The 1.2- to 2.4-m (4- to 8-ft) interval was also sampled for metals (Table 4-10). The reported sampling interval for the radionuclides was 1.5 to 2.1 m (5 to 7 ft). The metals data accompanying this sample indicate that the sample was taken closer to the fill/clay interface [the radiological sample contained elevated levels of uranium-238 (62.0 pCi/g), radium-226 (9.0 pCi/g), and thorium-230 (33.0 pCi/g), whereas the metals sample was a native uncontaminated clay]. Results for samples collected outside the building indicate that radionuclides and accompanying heavy metals are not migrating into the natural materials. Contamination in this borehole is related to MED activities and extends to a depth of just over 1.2 m (4 ft).

B29R40 is in the south-central portion of Building 30 and is covered by 0.6 m (2 ft) of concrete. The first sampling interval [0.6 to 1.2 m (2 to 4 ft)] is described as clayey fill. The metals and radiological data indicate that this layer contains American ore, based on levels of vanadium exceeding background (which are expected because the concentrate was sent from Colorado) and background levels of other heavy metals (see Table 4-10). In addition, the sample has elevated levels of uranium-238 (72.0 pCi/g) and low levels of radium-226 (1.6 pCi/g). The second sampling interval [1.2 to 2.2 m (4 to 7.5 ft)] does not contain elevated levels of trace metals; radionuclide concentrations are at background levels except for thorium-232 (3.0 pCi/g), indicating the presence of non-MED-related materials and the absence of uranium or vanadium migration.

B29R30, in the southwest corner of Building 30, is overlain by 0.3 m (1 ft) of concrete. Two sampling intervals were investigated for radionuclides and metals [0.3 to 0.9 m (1 to 3 ft) and 0.9 to 2.1 m (3 to 7 ft)]. The borehole log designates the sampling intervals as containing natural clays. However, the clays in the first interval are described as greenish gray, indicating a slightly different mineralogy than the normal brown clays found at the property. The analytical data indicate that copper, antimony, and iron concentrations exceed background (Table 4-10); however, none of the metals or radionuclides that are generally associated with MED-related materials were detected, and the elevated values are probably associated with the different clay mineralogy.

Analytical results for B29R48, B29R51, and B29R88 are summarized in Table 4-11. B29R48, located approximately 30 m (100 ft) southeast of Building 30, is near a railroad track and accessible to vehicular traffic. The organics detected indicate contamination by waste oils, which are also expected to contain more than trace levels of some heavy metals. Additionally, the borehole log describes the first 0.6-m (2-ft) interval as being composed of sandy silts with pieces of crushed slag and fly ash. The metals data might be interpreted as supporting the presence of Stage 1 filter cake because of the elevated levels of copper (109 ppm), manganese (1,400 ppm), and calcium (76,500 ppm). However, Stage 1 filter cake generally does not contain the high levels of lead observed in this sample (83.4 mg/kg), and Stage 2 filter cake would contain both lead and vanadium (Table 4-11). The high calcium level can be linked with the elevated magnesium concentration (13,500 mg/kg) and attributed to slag. Also, the radionuclides found in the first sampling interval include thorium-232 (4.0 pCi/g), which exceeds background. Because waste oils and fly ash can have elevated levels of lead, manganese, and copper, and MED ores were poor in thorium-232, it can be concluded that the metals and radionuclides found in this borehole interval originated from operations other than MED activities. The second sampling interval [0.6 to 1.8 m (2 to 6 ft)], described as a medium brown natural clay with greenish-gray mottling, shows slight elevation over background for many of the metals seen in the first sampling interval and declining radionuclide concentrations (see Table 4-11). The levels of metals that exceed background can be attributed either to the natural elevation of the mottled clay or to moderate leaching of the metals from the less permeable fill layer above. The metals and radionuclides at this sampling location are not MED related.

B29R51 is located in a setting similar to that of B29R48 and is about 60 m (200 ft) to the northeast. The sampling location is near a railroad track, is subject to vehicular traffic, and has a 0.1-m (0.3-ft) thick asphalt layer at the surface. Two intervals were sampled for radionuclides and metals [0 to 0.6 m (0 to 2 ft) and 0.6 to 1.8 m (2 to 6 ft)]. The first sampling interval is described in the borehole log as a gravel and sand fill with traces of slag and fly ash. As in B29R48, the first sampling interval in B29R51 shows waste oil contamination accompanied by levels of copper, lead, arsenic, beryllium, and manganese that exceed background (see Table 4-11). All radionuclide concentrations are at or near background. Results indicate that the heavy metals concentrations found in B29R51 are caused by materials found in the fill and recent waste oil spillage rather than by MED activities that ceased 50 years ago. All concentrations of heavy metals and radionuclides in the second sampling interval are within background ranges.

B29R88, located about 45 m (150 ft) northeast of the northeastern corner of Building 30, was sampled at the 5.1- to 6.3-m (17- to 21-ft) interval because it is overlain by 0.45 m (1.5 ft) of concrete and approximately 4.5 m (15.5 ft) of coarse limestone gravel fill. Analytical results (Table 4-11) indicate that concentrations of all constituents, with the exception of arsenic (79.3 ppm), are at or below background levels.

Analytical results for B29R23, B29W09D, and B29R34 are summarized in Table 4-12. B29R23, just to the northwest of Building 30, is located near a former injection well found just inside the building. Three intervals were sampled [0.3 to 0.6 m (1 to 2 ft), 0.6 to 1.8 m (2 to 6 ft), and 1.8 to 2.4 m

(6 to 8 ft)]. The area is overlain by 0.3 m (1 ft) of concrete. The borehole log describes the first 1.8 m (6 ft) as a gravelly clay fill with slag. The metals concentrations in the first sampling interval resemble those in clay with slag, with the exception of higher than normal sodium (2,360 ppm) accompanied by elevated radium-226 (6.0 pCi/g) (Table 4-12). A possible explanation of these values is that the processing effluents of African ores (which would contain relatively high levels of radium compared with the American ore effluents) were spilled onto the clay/slag fill near the injection well. The decrease in all concentrations at the depth of the natural clays in the third sampling interval indicates limited current migration. Nonetheless, the first 0.3-m (1-ft) interval of soil in this area contains low-level radionuclides (but not metals) that could be related to MED operations.

B29W09D is just northeast of B29R23. The borehole log describes the first 0.8 m (2.6 ft) as a silty sand with gravel fill that includes blebs of gray-black organic material and concrete rubble. Analytical results for organics suggest that these blebs are waste oils. The remainder of the soil is described as brown natural clays. Three sampling intervals were sampled for metals [0 to 0.6 m (0 to 2 ft), 0.6 to 1.2 m (2 to 4 ft), and 1.2 to 1.8 m (4 to 6 ft)]. The results for the first sampling interval suggest the remnants of a Stage 1 American ore filter cake mixed with waste oil metals (see Table 4-12). The reasoning for this conclusion is as follows: (1) The sample is enriched in radionuclides [uranium-238 (13.0 pCi/g), radium-226 (7.0 pCi/g), and thorium-230 (15.0 pCi/g)]; (2) the sample contains high levels of copper (932 ppm), calcium (110,000 ppm), and manganese (1,410 ppm) as is characteristic of the filter cake; and (3) the sample does not contain slag or fly ash but is rich in several metals found in waste oil [i.e., lead (193 ppm), nickel (34.4 ppm), and zinc (139 ppm)]. Results from the undisturbed clay layer [0.6 to 1.2 m (2 to 4 ft)] indicate that all constituents of interest are at or near background levels with the exception of calcium, manganese, and magnesium, which tend to be more mobile than the heavy metals.

In the third sampling interval, no metal constituents were detected at concentrations exceeding background.

B29R34 is located just north of an old injection well. The borehole log describes the first 1.2 m (4 ft) as a silty clay fill with slag and fly ash, and a moderate brown undisturbed clay from 1.2 to 1.8 m (4 to 6 ft). Two intervals were sampled in this borehole [0 to 0.6 m (0 to 2 ft) and 0.6 to 1.8 m (2-6 ft)]; both contained elevated levels of radionuclides (see Table 4-12). Neither sample exhibited a metals pattern characteristic of ore or filter cake, although the presence of slag was indicated by the high calcium and magnesium levels. Anion analyses were also performed on the soil samples; results indicated high levels of sulfate (980 ppm) relative to other Linde samples tested. Sulfate is expected to be a major constituent of the effluent waste stream. An elevated sulfate level is found in the second interval and probably reflects the influence of the clays in partially immobilizing some of the sulfate present in the effluent. As has been seen in the case of the filter cakes, radionuclides appear to sorb quite easily and do not appear to leach (hence, their higher levels in the shallower soil). The elevated radionuclides in this borehole are from MED-related materials.

Summary. Radionuclides were detected at levels exceeding guidelines in four general areas. For purposes of the RI, the areal extent and depths have been roughly delineated. Further delineation during cleanup will be necessary because the areas depicted in Figures 4-1 through 4-3 are conservative. Samples from selected boreholes were analyzed for metals to determine whether heavy metals associated with the extraction process had migrated from, or remained with, the radionuclides. Clear evidence demonstrates that the recoverable radionuclides and the heavy metals have remained immobilized in the near-surface fill material. Natural clays tested gave no indication of elevated radionuclides or heavy metals. Hence, constituents that may have migrated from the MED-related materials during the past 50 years have migrated at such a low rate that they cannot now be analytically differentiated from the near-surface natural clays.

VOCs and BNAE compounds were detected at a variety of locations across the facility. For the most part, the BNAEs were PAHs whose presence in soil can be linked with vehicular traffic and waste crankcase oils associated with heavy (diesel) truck traffic. Because of the distribution pattern (in open parking areas and driveways) and depths of these PAHs, it can be concluded that they were released less than 50 years ago and, hence, are not MED related. The VOCs fall into two broad classes (i.e., toluene and chlorinated aliphatics). Toluene was detected throughout the facility in the near-surface soils, with a migration pattern of high to low, indicating very recent deposition with limited depth penetration. Because biodegradation and volatilization would have removed near-surface toluene that was released 50 years ago, it is not considered to be an MED-related chemical. The chlorinated aliphatics, or degreasers, on the other hand, have a distribution pattern of low to high, indicating an older release and/or subsurface source. They are tied to general plant operations and, because they are not particularly biodegradable, can be long-lived. They could be linked with MED activities and/or normal Linde operations since 1946. Degreasers found in open areas subject to weathering were probably released more recently and are not MED related.

Subsurface Bedrock in the Vicinity of Old Injection Wells at Linde

Radionuclides. During the 1988-89 first-phase activities, elevated radioactivity was detected during a scan of a geological core sample taken near the southern set of old injection wells (monitoring well B29W10D). To confirm the existence of radionuclides in the deep subsurface [30 m (100 ft)], two additional boreholes were advanced near B29W10D and the three injection wells.

The first offset borehole (LIWRO#1), within 0.3 m (1 ft) of an injection well, was drilled to bedrock and cored to 36.3 m (119 ft) [approximately 9 m (30 ft) into bedrock]. During drilling, adjacent wells reacted to drilling water circulation. Fill material in the closest injection well subsided 2 m (6 ft) during drilling, and gas bubbled out of the water in the small injection well. The bubbles ceased when drilling stopped, which indicates that a hydraulic connection exists between the injection wells and LIWRO#1.

A subsurface gamma log (Table 4-13) and gamma scan (Table 4-14) of the core material from LIWRO#1 indicated elevated gamma radiation at a depth of approximately 30 m (100 ft); therefore, a core sample was collected at this depth and analyzed for radionuclides. Uranium-238 (176 pCi/g), radium-226 (1.3 pCi/g), and thorium-232 (0.4 pCi/g) were detected. The core had a visible layer of yellow material within a small fracture zone.

A second borehole (LIWRO#2), approximately 3.3 m (11 ft) from LIWRO#1, was drilled to bedrock and cored to 32 m (105 m). There was no evidence of hydraulic connection. A subsurface gamma log of this borehole did not indicate elevated radioactivity (Table 4-15). Scanning of core material from LIWRO#2 also indicated low values in comparison with core material from LIWRO#1 (Table 4-16); therefore, samples were not collected from LIWRO#2.

The radioactivity found in LIWRO#1 is most likely part of the precipitated materials that Linde reported as causing the wells to plug. The absence of this material 3 m (10 ft) from the injection well suggests a limited injection zone.

Surface Water and Sediments at and near Linde

Surface water and sediments were sampled for analysis of VOCs, metals, and radionuclides at a variety of locations at and near Linde (Figures 2-16 and 2-18). Sampling for nonradiological parameters was conducted in November 1988 and for radiological parameters in July 1988. For purposes of analysis, these sampling locations have been divided into two group: offsite (upstream and downstream on Twomile Creek) and onsite. This division also reflects the work done before the RI.

Offsite. Sampling location 4 is a control sampling point located just off the Linde property line, upstream of the creek's entrance to the property. Sampling locations 1, 2, and 3 are to the north of the property; location 1 is just off the Linde

ATTACHMENT 2

Uranium Content Estimates, Material Description,
Analytical Data for the Linde Site, and
Preliminary Material Characterization Report

4-7

Organics Detected in Soil at Linde

Page 1 of 5

Compound	B29W10D 0-2	B29W10D 2-4	B29W10D 4-6	B29W9D 0-2	B29W9D 2-4	B29W9D 4-6
	Sampling Location[a] and Depth (ft)					
	(Concentrations are reported in units of μg/kg)					
VOCs						
Methylene chloride	8	--[b]	--[b]	6.8	4	--[b]
Toluene	62	7.7	13	45	16	1.4
trans-1,2-Dichloroethene	--[b]	3	42	--[b]	--[b]	--[b]
BNAEs						
4-Methylphenol	--[b]	--[b]	--[b]	--[b]	120[b]	--[b]
2-Methylnaphthalene	190[c]	--[b]	--[b]	70[b]	--[b]	--[b]
Acenaphthene	540	--[b]	--[b]	120[b]	--[b]	--[b]
Anthracene	870	--[b]	--[b]	290[b]	--[b]	--[b]
Benzo(a)anthracene	2,700	140[c]	53[c]	1,200	98[c]	--[b]
Benzo(b)fluoranthene	1,500	110[c]	1,100	110[c]	--[b]	--[b]
Benzo(k)fluoranthene	2,000	81[c]	43[c]	670	120[c]	--[b]
Benzo(g,h,i)perylene	1,700	44[c]	1,400	91[c]	--[b]	--[b]
Benzo(a)pyrene	2,000	87[c]	1,200	98[c]	--[b]	--[b]
bis(2-Ethylhexyl)phthalate	190[d]	180[d]	250[d]	510[c]	170[d]	140[d]
Chrysene	2,800	170[c]	57[c]	1,700	170[c]	--[b]
Dibenz(a,h)anthracene	420	--[b]	--[b]	380[c]	--[b]	--[b]
Dibenzofuran	280[d]	--[b]	--[b]	56[c]	--[b]	--[b]
Di-n-butylphthalate	250[d]	240[d]	210[d]	280[d]	240[d]	230[d]
Fluoranthene	3,600	200[c]	90[c]	2,700	290[c]	--[b]
Fluorene	540	--[b]	--[b]	110[c]	--[b]	--[b]
Indeno(1,2,3-cd)pyrene	1,500	--[b]	--[b]	1,200	94[c]	--[b]
Naphthalene	160[c]	--[b]	--[b]	58[c]	--[b]	--[b]
Phenanthrene	3,200	140[c]	54[c]	1,600	140[c]	--[b]
Pyrene	3,100	200[c]	75[c]	2,200	200[c]	--[b]

Table 4-7

(continued)

Page 2 of 5

(Concentrations are reported in units of μg/kg)

Compound	Sampling Location[a] and Depth (ft)					
	B29R48		B29R10		B29R34	
	0-2	2-6	0-2	2-6	0-2	2-6
VOCs						
1,1,1-Trichloroethane	1.2	--[b]	--[b]	--[b]	--[b]	--[b]
1,1,2,2-Tetrachloroethane	1.2	--[b]	--[b]	--[b]	--[b]	--[b]
Methylene chloride	6.8	--[b]	--[b]	--[b]	--[b]	--[b]
Toluene	21	35	3.4	--[b]	75	16.3
Trichloroethene	--[b]	--[b]	--[b]	--[b]	2.2	--[b]
BNAEs						
2-Methylnaphthalene	210[c]	--[b]	60[c]	--[b]	--[b]	--[b]
Acenaphthylene	150[c]	--[b]	--[b]	--[b]	--[b]	--[b]
Anthracene	90[c]	--[b]	200[c]	--[b]	74[c]	--[b]
Benzo(a)anthracene	670	--[b]	570	--[b]	470	--[b]
Benzo(b)fluoranthene	860	--[b]	350[c]	--[b]	440	--[b]
Benzo(k)fluoranthene	860	--[b]	83[c]	--[b]	470	--[b]
Benzo(g,h,i)perylene	630	--[b]	--[b]	--[b]	330[c]	--[b]
Benzo(a)pyrene	640	--[b]	--[b]	--[b]	400[c]	--[b]
bis(2-Ethylhexyl)phthalate	590[c]	220[d]	260	160[c]	240[c]	--[b]
Chrysene	900	--[b]	530[c]	--[b]	490	--[b]
Dibenz(a,h)anthracene	170[c]	--[b]	--[b]	--[b]	--[b]	--[b]
Dibenzofuran	69[c]	--[b]	68[c]	--[b]	--[b]	--[b]
Di-n-butylphthalate	82[d]	72[d]	77[c]	44[c]	56[c]	45[c]
Fluoranthene	1,000[c]	--[b]	850	--[b]	750	--[b]
Fluorene	94[c]	--[b]	--[b]	--[b]	--[b]	--[b]
Indeno(1,2,3-cd)pyrene	220[c]	--[b]	--[b]	--[b]	430	--[b]
Naphthalene	140[c]	--[b]	81[c]	--[b]	--[b]	--[b]
Phenanthrene	420	--[b]	680	--[b]	--[b]	--[b]
Pyrene	1,100[c]	--[b]	790	--[b]	450	87[c]

T 4-7

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Page 3 of 5

Compound	Sampling Location[a] and Depth (ft)					
	B29R61		B29R68		B29R82	
	0-2	2-6	0-2	2-6	0-2	2-6
	(Concentrations are reported in units of µg/kg)					
VOCs						
1,2-Dichloroethane						36
Chloroform	1.7^f	--^{b}	--^{b}	--^{b}	--^{b}	--^{b}
Methylene chloride	49^f	--^{b}	--^{b}	--^{b}	--^{b}	--^{b}
Tetrachloroethene	3.8^f	--^{b}	--^{b}	--^{b}	--^{b}	--^{b}
Toluene	56^f	37	260	130	6	31
Trichloroethene	5.5^f	--^{b}	--^{b}	--^{b}	--^{b}	--^{b}
BNAEs						
2-Methylnaphthalene	830^c	--^{b}	--^{b}	--^{b}	--^{b}	--^{b}
Acenaphthene	820^c	--^{b}	--^{b}	--^{b}	--^{b}	--^{b}
Anthracene	710^c	--^{b}	--^{b}	--^{b}	74^c	--^{b}
Benzo(a)anthracene	3,100^c	--^{b}	250^c	120^c	89^e	--^{b}
Benzo(b)fluoranthene	3,200^c	--^{b}	230^c	190^c	--^{b}	--^{b}
Benzo(k)fluoranthene	3,100^c	--^{b}	200^c	--^{b}	110^c	--^{b}
Benzo(g,h,i)perylene	2,200^c	--^{b}	180^c	--^{b}	--^{b}	--^{b}
Benzo(a)pyrene	3,000^c	--^{b}	230^c	110^c	99^c	--^{b}
bis(2-Ethylhexyl)phthalate	530^e	130^e	750	--^{b}	--^{b}	--^{b}
Chrysene	3,900	--^{b}	310^c	--^{b}	180^c	--^{b}
Dibenz(a,h)anthracene	7,000	--^{b}	--^{b}	--^{b}	--^{b}	--^{b}
Dibenzofuran	640^c	47^c	--^{b}	--^{b}	--^{b}	--^{b}
Di-n-butylphthalate	--^{b}	--^{b}	54^c	--^{b}	--^{b}	--^{b}
Fluoranthene	--^{b}	--^{b}	610	260^c	460	--^{b}
Fluorene	660^c	--^{b}	--^{b}	--^{b}	--^{b}	--^{b}
Indeno(1,2,3-cd)pyrene	2,100^c	--^{b}	--^{b}	--^{b}	--^{b}	--^{b}
Naphthalene	960^c	--^{b}	--^{b}	--^{b}	--^{b}	--^{b}
Phenanthrene	4,700	--^{b}	290^c	140^c	350^c	--^{b}
Pyrene	6,200	--^{b}	340^c	200^c	320^c	--^{b}

Table 4-7

(continued)

Page 4 of 5

Compound	B29R43 1-2	B29R43 2-6	B29R16 0-2	B29R16 2-6	B29R23 0-2	B29R23 2-6	B29R23 6-8
	Sampling Location[a] and Depth (ft)						
	(Concentrations are reported in units of µg/kg)						
VOCs							
Chloroform	--[b]	--[b]	--[b]	2.2	--[b]	--[b]	--[b]
Tetrachloroethene	1.7	1.7	--[b]	6.7	1.2	--[b]	--[b]
Toluene	12	30	130	23	200	21	110
trans-1,2-Dichloroethene	--[b]	--[b]	--[b]	--[b]	9.3	4.1	2.6
Trichloroethene	--[b]	--[b]	--[b]	--[b]	6.2	17	42

Compound	B29R30 1-3	B29R30 3-7	B29R51 0-2	B29R51 2-6	B29R101 1-3	B29R101 3-7
	Sampling Location[a] and Depth (ft)					
VOCs						
1,1,1-Trichloroethane	--[b]	--[b]	2.3	--[b]	--[b]	--[b]
1,2-Dichloroethane	--[b]	--[b]	3.6	--[b]	--[b]	--[b]
Bromoform	--[b]	--[b]	5.2	--[b]	--[b]	--[b]
Methylene chloride	--[b]	--[b]	20	5.5	--[b]	--[b]
Toluene	17	49	160	26	9.8	10.5
trans-1,2-Dichloroethene	--[b]	--[b]	14	3.8	--[b]	--[b]
Trichloroethene	--[b]	--[b]	3.7	--[b]	--[b]	--[b]
BNAEs						
Benzo(a)anthracene	--[b]	--[b]	150[c]	--[b]	--[b]	--[b]
Benzo(b)fluoranthene	--[b]	--[b]	190[c]	--[b]	--[b]	--[b]
Benzo(k)fluoranthene	--[b]	--[b]	310[c]	--[b]	--[b]	--[b]
Benzo(g,h,i)perylene	--[b]	--[b]	85[c]	--[b]	--[b]	--[b]
Benzo(a)pyrene	--[b]	--[b]	120[c]	--[b]	--[b]	--[b]
bis(2-Ethylhexyl)phthalate	--[b]	--[b]	--[b]	--[b]	60[d]	--[b]
Chrysene	--[b]	--[b]	300[c]	--[b]	--[b]	--[b]
Di-n-butylphthalate	--[b]	--[b]	69[c]	--[b]	120[c]	120[c]
Fluoranthene	--[b]	--[b]	310[c]	--[b]	--[b]	--[b]
Indeno(1,2,3-cd)pyrene	--[b]	--[b]	93[c]	--[b]	--[b]	--[b]
Naphthalene	--[b]	--[b]	61[c]	--[b]	--[b]	--[b]
Phenanthrene	--[b]	--[b]	130[c]	--[b]	47[c]	--[b]
Pyrene	--[b]	--[b]	240[c]	--[b]	--[b]	--[b]

Table 4-7

(continued)

Page 5 of 5

Compound	B29R40 2-4	B29R40 4-7.5	B29R38 0-2	B29R38 4-8	B29R88 17-21	
	(Concentrations are reported in units of µg/kg)					
VOCs						
1,1,2,2-Tetrachloroethane	190	--[b]	650	--[b]	--[b]	--[b]
1,2-Dichloroethane	--[b]	1.4	--[b]	--[b]	--[b]	--[b]
Toluene	--[b]	27	--[b]	165	14	--[b]
trans-1,2-Dichloroethene	--[b]	8.4	--[b]	4.1	--[b]	--[b]
Trichloroethene	--[b]	16	--[b]	2.1	--[b]	--[b]

[a] Sampling locations are shown in Figure 2-2.

[b] Detected at or below the detection limit.

[c] Value estimated by laboratory.

[d] Value estimated by laboratory; analyte also found in laboratory blank.

[e] Also found in laboratory blank.

[f] Detected at a depth of 0 to 1 ft.

Table 4-8
Concentrations of Metals and Radionuclides in Soil in Areas 1 and 2 at Linde

	Sampling Location[a] and Depths (ft)					
Analyte	B29R10 0-2 (FILL: Clay and gravel, some slag and fly ash 0-3 ft)	B29R10 2-6 (Clay multicolor med. plast.)	B29R16 0-2 (FILL: Clay, gravel, slag, and fly ash to 2.7 ft; 0.3 ft asphalt)	B29R16 2-6 (Clay brown med. plast.)	B29R68 0-2 (FILL: Clay and gravel, slag to 3 ft)	B29R68 2-6 (Clay brown mod. plast.)
Aluminum	14,900	11,700	29,600	9,700	7,700	11,200
Antimony	15.3[b]	10.7[b]	10.5[b]	13.9[b]	12.2[b]	14.1[b]
Arsenic	65.4	34.7	120	70.8	55.2	87.5
Barium	243	109	372	204	103	104
Beryllium	1.3[b]	0.89[b]	4.9	1.2[b]	1[b]	1.2[b]
Boron	38	19.8	82.7	23.2[b]	37.7	29.5
Cadmium	1.3[b]	0.89[b]	0.87[b]	1.2[b]	1[b]	1.2[b]
Calcium	24,700	55,200	150,000	63,600	63,200	55,900
Chromium	45.3	17.4	12.1	16.8	27.6	29.8
Cobalt	12.8[b]	8.9[b]	8.7[b]	11.6[b]	10.2[b]	11.7[b]
Copper	1,080	22.8	13	20.4	121	25.9
Iron	27,200	19,400	16,900	16,900	22,100	20,300
Lead	163	24.9	35.9	23.2[b]	29.9	27.8
Magnesium	7,350	15,500	15,500	13,200	4,810	15,200
Manganese	570	484	2,130	461	927	566
Molybdenum	25.5[b]	17.9[b]	17.5[b]	23.2[b]	20.3[b]	23.4[b]
Nickel	185	21.6	7[b]	32.4	30	26.2
Potassium	1,710	1,710	1,510	1,160[b]	1,020[b]	1,290
Selenium	216	171	156	131	172	149
Silver	2.7	1.8[b]	4.1	3.8	5	5
Sodium	1,280[b]	893[b]	1,250	1,160[b]	1,020[b]	1,170[b]
Thallium	80.8	36.9	17.5[b]	23.2[b]	30.6	37.2
Vanadium	45.6	30	13.8	25.7	16.5	32.5
Zinc	634	59.5	22.7	79.6	129	142
Uranium-238	<9.0	<16.0	<4.0	<9.0	14.0 ± 6.0	NA[c]
Radium-226	5.0 ± 1.0	7.0 ± 2.0	1.2 ± 0.3	1.7 ± 0.9	3.1 ± 0.8	NA
Thorium-232	<1.0	<1.0	0.8 ± 0.4	<1.0	<1.0	NA
Thorium-230	5.9 ± 0.8	12 ± 2.0	3.4 ± 0.5	1.6 ± 0.4	6.3 ± 0.9	NA

[a] Metals are reported in mg/kg; radionuclides are in pCi/g. Sampling locations are shown in Figures 2-1 and 2-2.

[b] Sample detection limit.

[c] NA - not analyzed.

Table 4-9

Concentrations of Metals and Radionuclides in Soil in

Areas 3 and 4 at Linde

	Sampling Locations[a] and Depths (ft)					
	B29R43 0-2	B29R43 2-6	B29R82 0-2	B29R82 2-6	B29R101 1-3	B29R101 3-7
Analyte[a]	(FILL: Sandy gravel, red brick to 4 ft)	(Clay brown, light gray inclusions)	(FILL: Sandy gravel, 50% sand to 1.9 ft)	(FILL: Clay to 4 ft; undist. clay to 6 ft)	(FILL: Clay 0-1 ft; concrete)	(Clay brown, no plast., fissile)
Aluminum	23,900	13,700	30,800	15,000	19,100	13,300
Antimony	10.9[b]	12.6[b]	13.2	14[b]	14.3[b]	12.3[b]
Arsenic	166	89.9	207	110	150	99.9
Barium	275	129	276	152	205	89.2
Beryllium	5.5	2.2	6.3	1.2[b]	1.4	1[b]
Boron	61.4	43.3	94.1	35	30	33.8
Cadmium	1.2	1[b]	1[b]	1.2[b]	1.2[b]	1[b]
Calcium	168,000	89,300	183,000	43,600	16,500	50,900
Chromium	9.5	24.3	13	27	33.3	25
Cobalt	9.1[b]	10.5[b]	10.5[b]	11.6[b]	11.9[b]	10.2[b]
Copper	14.6	15.9	23.7	22	193	25.3
Iron	5,490	10,900	5,890	23,800	30,600	24,600
Lead	29.2	21[b]	31.8	26.3	42.9	25.3
Magnesium	11,400	20,500	36,300	12,700	7,400	13,600
Manganese	2,050	889	3,070	353	507	478
Molybdenum	18.2[b]	21[b]	20.9[b]	23.3[b]	23.8[b]	20.5[b]
Nickel	7.3[b]	24	12.7	26.3	39.7	25.3
Potassium	910[b]	1,160	1,310	1,960	2,040	1,960
Selenium	33.4	87.7	40.4	181	206	195
Silver	1.8[b]	3	2.1[b]	5.2	7.2	5.2
Sodium	949	1,110	1,470	1,160[b]	1,190[b]	1,020[b]
Thallium	18.2[b]	21[b]	20.9[b]	43.7	45.4	44
Vanadium	9.1[b]	16.1	10.5[b]	37.6	50	38.6
Zinc	29.5	83.5	39.5	76.9	213	83.6
Uranium-238	<1.0	<9.0	<10.0	NA[c]	54.0 ± 10.0	<8.0
Radium-226	4.0 ± 1.0	2.7 ± .9	2.0 ± 1.0	NA	12.0 ± 2.0	1.5 ± 0.7
Thorium-232	3.0 ± 1.0	<1.0	2.0 ± 1.0	NA	2.0 ± 1.0	1.3 ± 0.9
Thorium-230	2.9 ± 0.6	2.4 ± 1.1	3.1 ± 0.9	NA	23.0 ± 2.0	1.6 ± 0.6

[a] Metals are reported in mg/kg; radionuclides are in pCi/g. Sampling locations are shown in Figures 2-1 and 2-2.

[b] Sample detection limit.

[c] NA - Not analyzed.

Table 4-10
Concentrations of Metals and Radionuclides in Soil in Area 4
(Beneath Building 30) at Linde

	Sampling Locations[a] and Depths (ft)					
Analyte[a]	B29R38 0-2 (FILL: Gravelly clay with black oil to 4 ft; 0-1 ft concrete)	B29R38 4-8 (Clay dark brown, low plast.)	B29R40 2-4 (Fill: Clay high plast. to 3 ft; 0-2 concrete)	B29R40 4-7.5 (Clay - brown low plast.)	B29R30 1-3 (Clay-greenish gray med. plast.; 0-1 concrete)	B29R30 3-7 (Clay - dark yellowish brown, med. plast.)
Aluminum	14,200	9,510	17,000	11,400	11,200	12,400
Antimony	16.2^b	17.5	33.6	2.6	237	121
Arsenic	103	28.3	57.4	34.1	20^b	21.3^b
Barium	131	74.7	86.1	98	94.3	186
Beryllium	6.3	1.1^b	1.5	1.2^b	1^b	1.1^b
Boron	29.1	21.3^b	26.7^b	23.5^b	20^b	21.3^b
Cadmium	6	1.1^b	1.3^b	1.2	1^b	1.1^b
Calcium	82,100	52,600	18,200	50,700	2,850	5,220
Chromium	11.1	16.4	20.5	16.9	16	16.1
Cobalt	68.8	10.6^b	13.3^b	11.8^b	11.5	10.6^b
Copper	492	23.2	17.8	22.9	56.5	74.5
Iron	15,400	15,700	30,100	17,600	26,100	13,200
Lead	1,120	24.6	31.2	23.5^b	35.1	26.3
Magnesium	8,790	14,700	4,130	13,800	2,940	4,120
Manganese	1,370	388	397	483	251	172
Molybdenum	27^b	21.3^b	26.7^b	23.5^b	20^b	21.3^b
Nickel	265	16.7	14.1	19.2	22.8	23.9
Potassium	2,540	1,460	$1,330^b$	1,460	$1,000^b$	$1,060^b$
Selenium	74	133	212	132	20^b	21.3^b
Silver	2.7^b	2.1^b	2.7^b	2.4^b	2^b	2.1^b
Sodium	3,240	$1,060^b$	$1,330^b$	$1,180^b$	$1,000^b$	$1,060^b$
Thallium	28.8^b	30	52.3	36.9	39.7	21.3^b
Vanadium	437	28.2	40.8	29.4	31.6	22.5
Zinc	306	52.2	51.7	55.1	89.4	70.8
Uranium-238	930 ± 50	62 ± 12	72 ± 13	<8.0	<4.0	NA[c]
Radium-226	150 ± 10	9 ± 1.0	1.6 ± 0.9	2.2 ± 0.9	1.3 ± 0.7	NA
Thorium-232	<3.0	1.4 ± 0.9	<1.0	3.0 ± 1.0	1.2 ± 0.6	NA
Thorium-230	820 ± 20	33.0 ± 2.0	5.1 ± 0.6	1.0 ± 0.3	0.9 ± 0.5	NA

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[a] Metals are reported in mg/kg; radionuclides are in pCi/g. Sampling locations are shown in Figures 2-1 and 2-2.

[b] Sample detection limit.

[c] NA - not analyzed.

Table 4-11

Concentrations of Metals and Radionuclides in Soil in Area 4

(East of Building 30) at Linde

	Sampling Locations[a] and Depths (ft)				
	B29R48 0-2	B29R48 2-6	B29R51 0-2	B29R51 2-6	B29R88 17-21
Analyte	(FILL: Sandy silts, slag, fly ash)	(Clay brown med. plast.)	(FILL: Gravels-sand, fly ash, asphalt 0-.3 ft clay beneath)	(Clay multicolored mod. plast low plast.)	(Clay gray/brown high plast. 17 ft, limestone gravel fill above)
Aluminum	16,600	8,870	19,200	9,060	8,400
Antimony	91.5	39.3	10.9[b]	13.2[b]	24.7
Arsenic	20.6[b]	125	73.5	29	79.3
Barium	166	116	351	102	57
Beryllium	2.8	2.4	3	1.1[b]	0.95[b]
Boron	37	88	33	22.1[b]	18.9[b]
Cadmium	1[b]	1.1[b]	0.91[b]	1.1[b]	0.95[b]
Calcium	76,500	51,600	75,100	58,600	17,400
Chromium	20.3	26.3	18.7	12.8	10
Cobalt	10.3[b]	21.4	9.1[b]	11[b]	9.5[b]
Copper	109	27	42.8	21.4	20.1
Iron	9,820	14,700	11,200	16,600	16,500
Lead	83.4	39.8	61.4	22.1[b]	18.9[b]
Magnesium	13,500	15,800	8,730	15,600	6,480
Manganese	1,400	378	1,170	421	378
Molybdenum	20.6[b]	32.7	18.2[b]	22.1[b]	18.9[b]
Nickel	21.6	31.2	22.4	21.7	14.6
Potassium	1,030[b]	1,160	910[b]	1,100	1,240
Selenium	20.6[b]	292	104	168	112
Silver	2.1[b]	5.4	1.8[b]	2.2[b]	1.9[b]
Sodium	1,030[b]	1,140[b]	1,270	1,100[b]	97[b]
Thallium	20.6[b]	93.1	18.2[b]	30.5	27.3
Vanadium	18.9	39.4	20.1	22.3	23.9
Zinc	286	75.2	53.7	73.9	42.3
Uranium-238	<11.0	<8.0	<10.0	<8.0	<4.0
Radium-226	2.4 ± 1.0	2.5 ± 0.9	2.8 ± 1.0	1.5 ± 0.8	0.6 ± 0.4
Thorium-232	4.0 ± 1.0	1.0 ± 0.8	<1.0	<1.0	1.4 ± 0.8
Thorium-230	2.3 ± 0.6	1.4 ± 0.4	1.9 ± 0.4	1.2 ± 0.4	2.1 ± 0.5

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[a] Metals are reported in mg/kg; radionuclides are in pCi/g. Sampling locations are shown in Figures 2-1 and 2-2.

[b] Sample detection limit.

Table 4-12

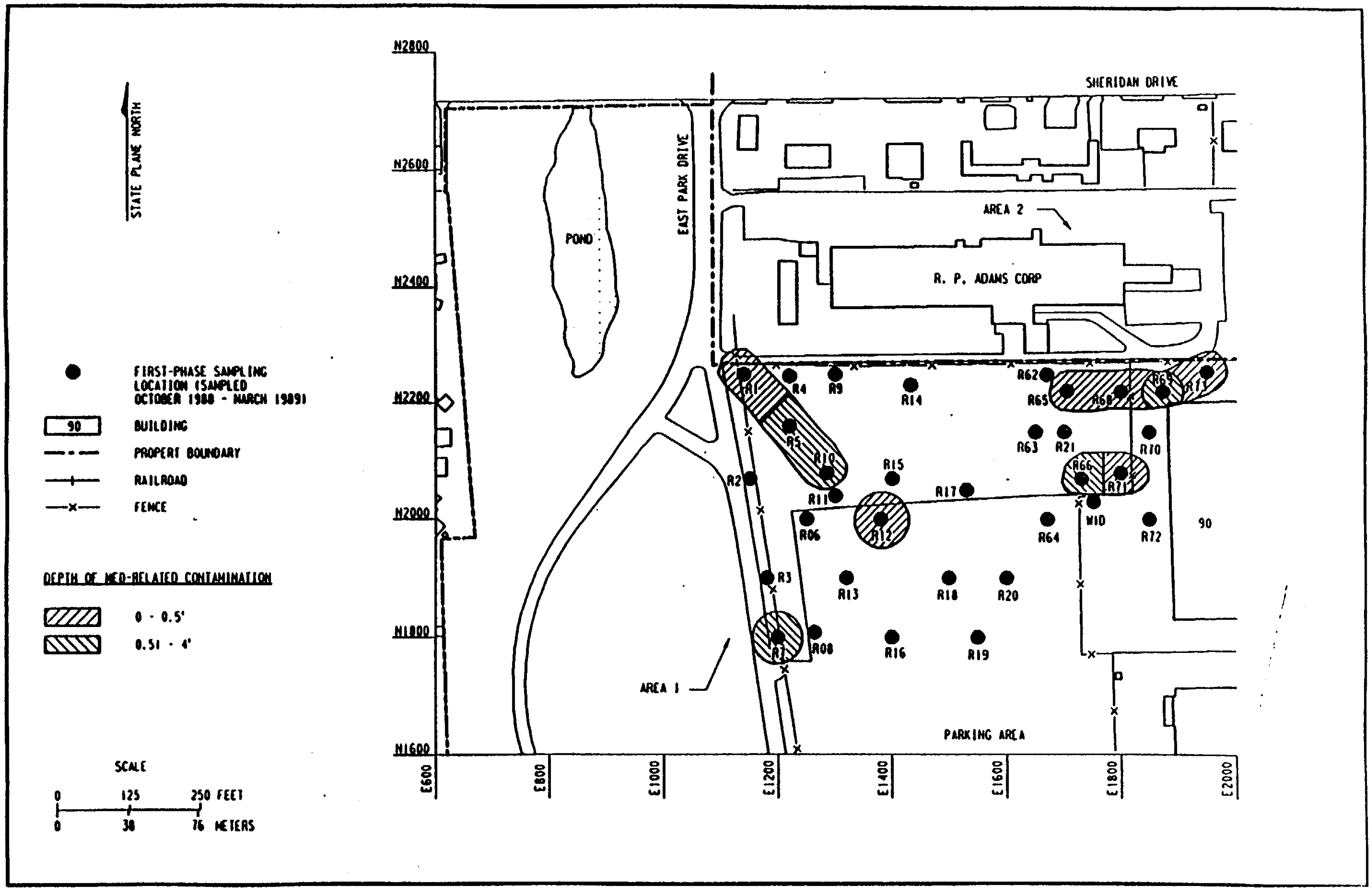
Concentrations of Metals and Radionuclides in Soil in Area 4 (North of Building 30) at Linde

	Sampling Locations[a] and Depths (ft)							
Analyte[a]	B29R23 0-2 (Fill: Gravelly clay with slag; concrete 0-1 ft)	B29R23 2-5 (Fill: Gravelly clay with slag; concrete 0-1 ft)	B29R23 6-8 (Clay-brown, low plast.)	B29W09D 0-2 (Fill: Silty sand with gravel/concrete)	B29W09D 2-4 (Clay-brown, low plast. from 2.6 ft)	B29W09D 4-6 (Clay-brown, low plast. from 2.6 ft)	B29R34 0-2 (Fill: Silty clay with flyash and slag to 4 ft)	B29R34 2-6 (Clay brown mod. plast. from 4 ft)
Aluminum	25,900	18,100	10,800	19,100	14,500	5,210	24,900	10,300
Antimony	14.2[b]	13[b]	13.1[b]	11.5[b]	14.7[b]	10.8[b]	13.6[b]	13[b]
Arsenic	181	132	84.8	64.6	24.5[b]	17.9[b]	88.2[b]	32
Barium	274	167	104	499	182	60.8	296	110
Beryllium	5.1	2.9	1.1[b]	3.4	1.2[b]	0.9[b]	4.3	1.1[b]
Boron	69.7	38.4	30.7	35.4	24.5[b]	17.9	66.5	21.6[b]
Cadmium	1.2[b]	1.1[b]	1.1[b]	1.5	1.2[b]	0.9[b]	1.1[b]	1.1[b]
Calcium	144,000	75,600	51,100	110,000	10,400	177,000	127,000	727,000
Chromium	16.6	17.5	22.3	12.7	19.8	8.9	11.6	14.9
Cobalt	11.9[b]	10.8[b]	10.9[b]	9.6[b]	12.2[b]	9.0[b]	11.4[b]	10.8[b]
Copper	19.5	16.9	20.4	932	33.2	21.8	26.2	30.1
Iron	19,300	14,700	19,100	7,780	17,700	12,300	9,010	17,000
Lead	31.1	27.5	22.4	193	34.1	19.9	56.7	21.6[b]
Magnesium	15,800	8,620	14,600	11,000	6,860	11,900	22,800	20,300
Manganese	1,960	1,070	452	1,410	297	1,470	2,420	430
Molybdenum	23.8[b]	21.6[b]	21.9[b]	19.1[b]	24.5[b]	17.9[b]	22.7[b]	12.6[b]
Nickel	15	22	21.5	34.4	64.4	11.2	34.7	23.7
Potassium	1,490	160	140	1,190	1,220[b]	897[b]	1,620	2,560
Selenium	161	113	153	63.4	154	131	86.6	167
Silver	4.3	3.6	4	1.9[b]	2.4[b]	1.8[b]	1.8[b]	2.2[b]
Sodium	2,360	1,480	1,090[b]	956[b]	1,220[b]	897[b]	1,330	1,080[b]
Thallium	23.8[b]	21.6[b]	28.9	19.1[b]	28.8	17.9[b]	22.7[b]	30.8
Vanadium	26.1	22.6	29.4	27.6	26.1	16.0	15.5	25.8
Zinc	32.9	50.1	67.5	139	50.4	8.6	65.1	76.9
Uranium-238	<13.0	17.0	NA[c]	13.0 ± 3.0	<2.0	NA	60.0 ± 18.0	20.0 ± 10.0
Radium-226	6.0 ± 1.0	2.0 ± 1.0	NA	7.0 ± 1.0	1.0 ± 0.4	NA	14.0 ± 2.0	7.0 ± 2.0
Thorium-232	<1.0	<2.0	NA	<1	<1	NA	<2.0	<1.0
Thorium-230	1.3 ± 0.5	1.6 ± 0.5	NA	15.0 ± 1.0	1.2 ± 0.4	NA	25.0 ± 3.0	10.0 ± 1.0

[a] Metals are reported in mg/kg; radionuclides are in pCi/g. Sampling locations are shown in Figures 2-1 and 2-2.

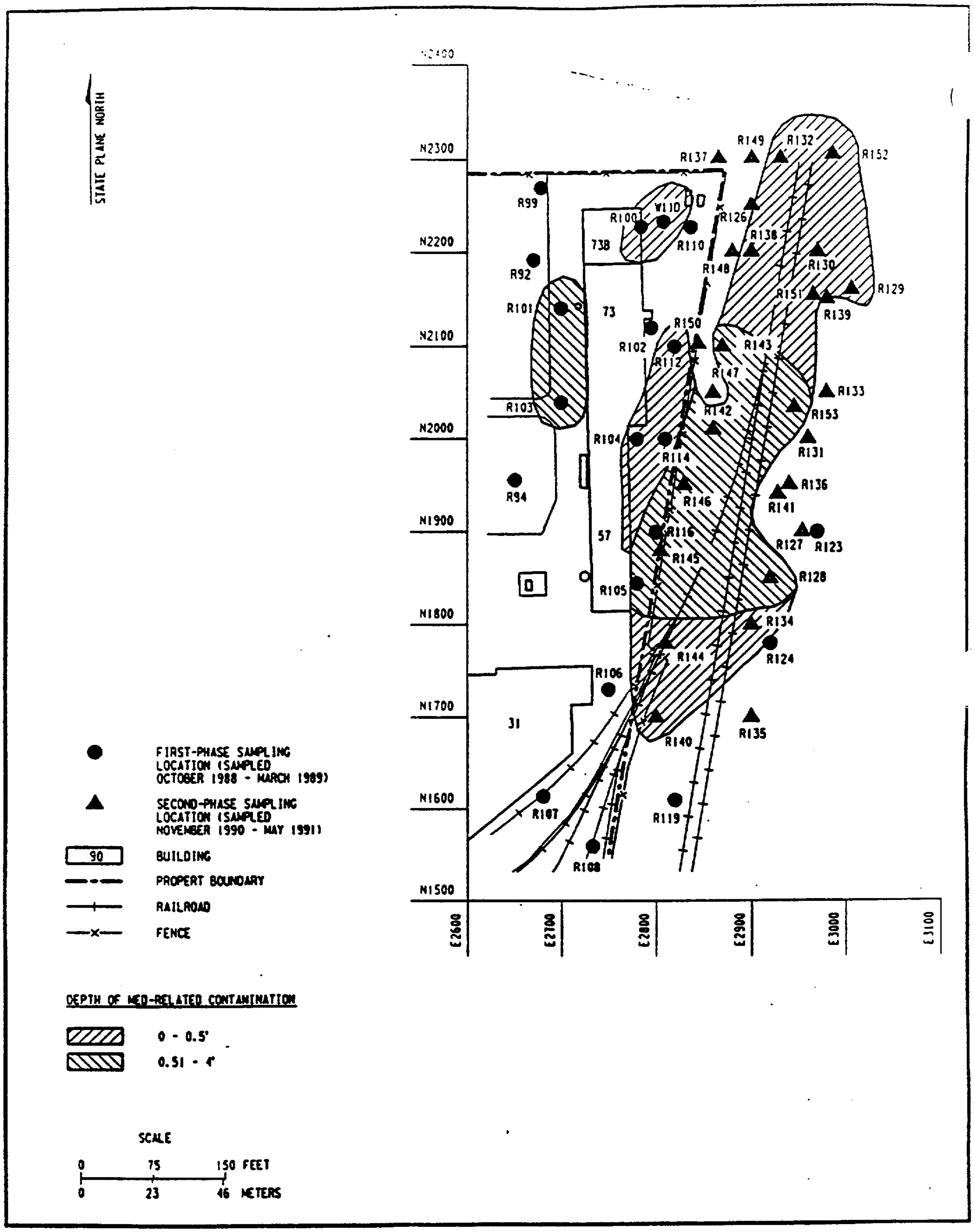
[b] Sample detection limit.

[c] NA - not analyzed.



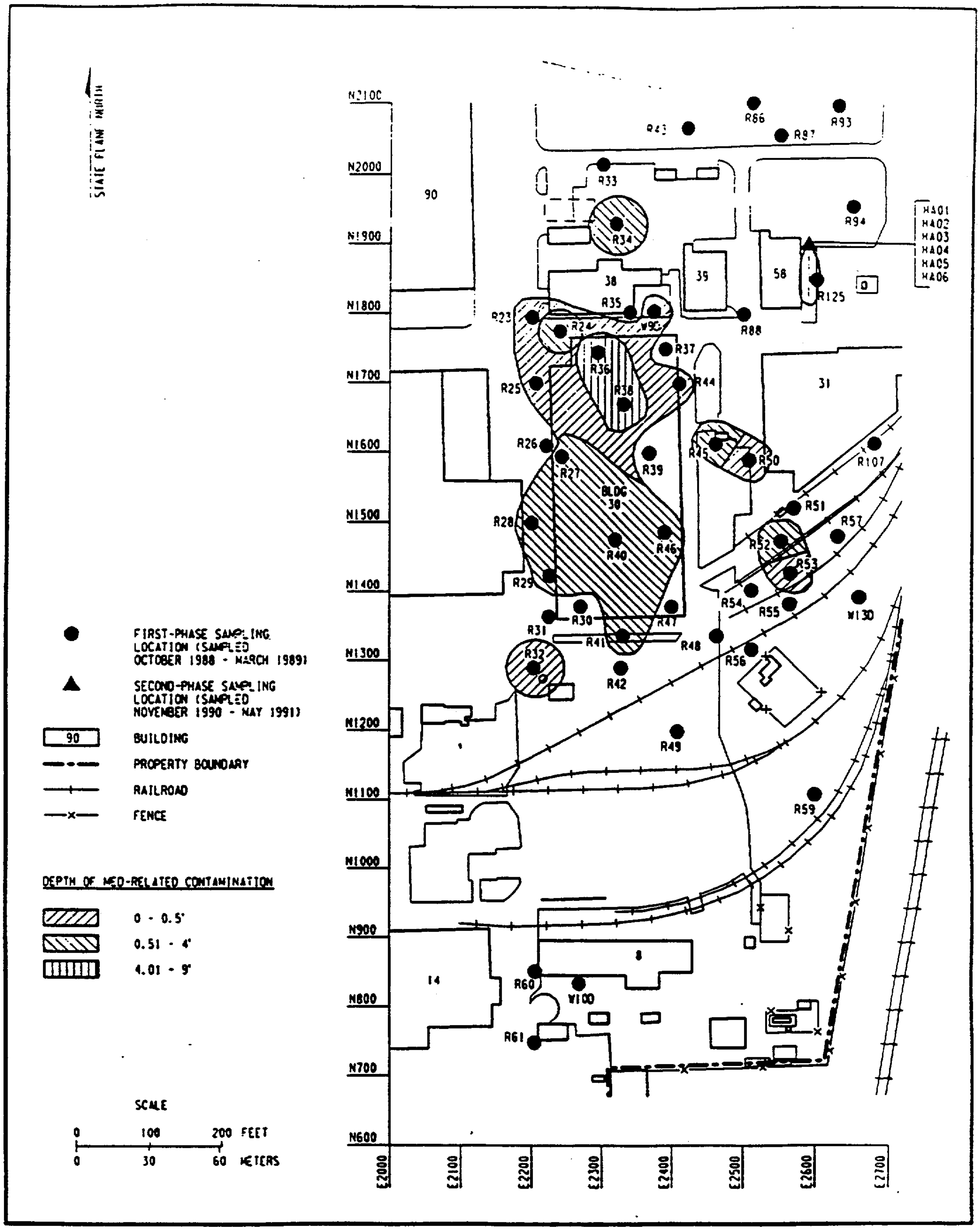
129 R15F032.DGN

Figure 4-1
Areas 1 and 2 of Radioactive Contamination in Soil at Linde



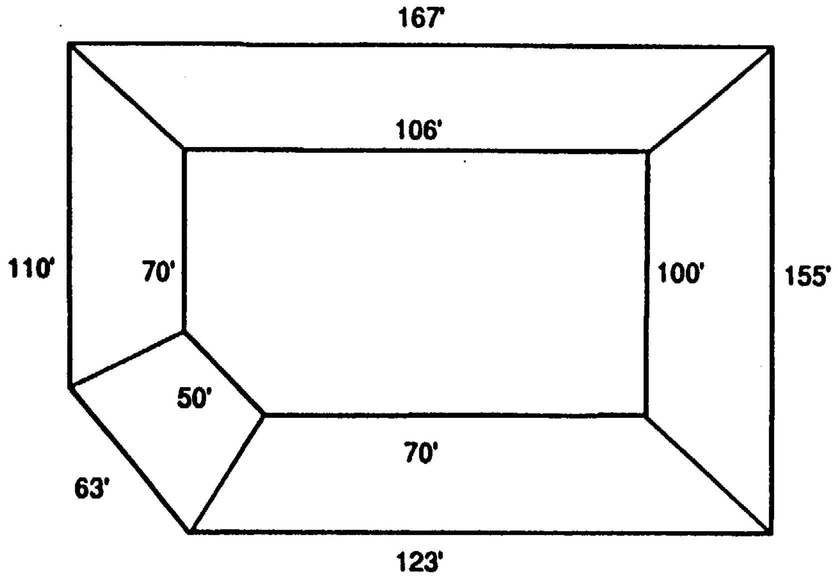
129 R15F034.DGN

Figure 4-2
Area 3 of Radioactive Contamination in Soil at Linde



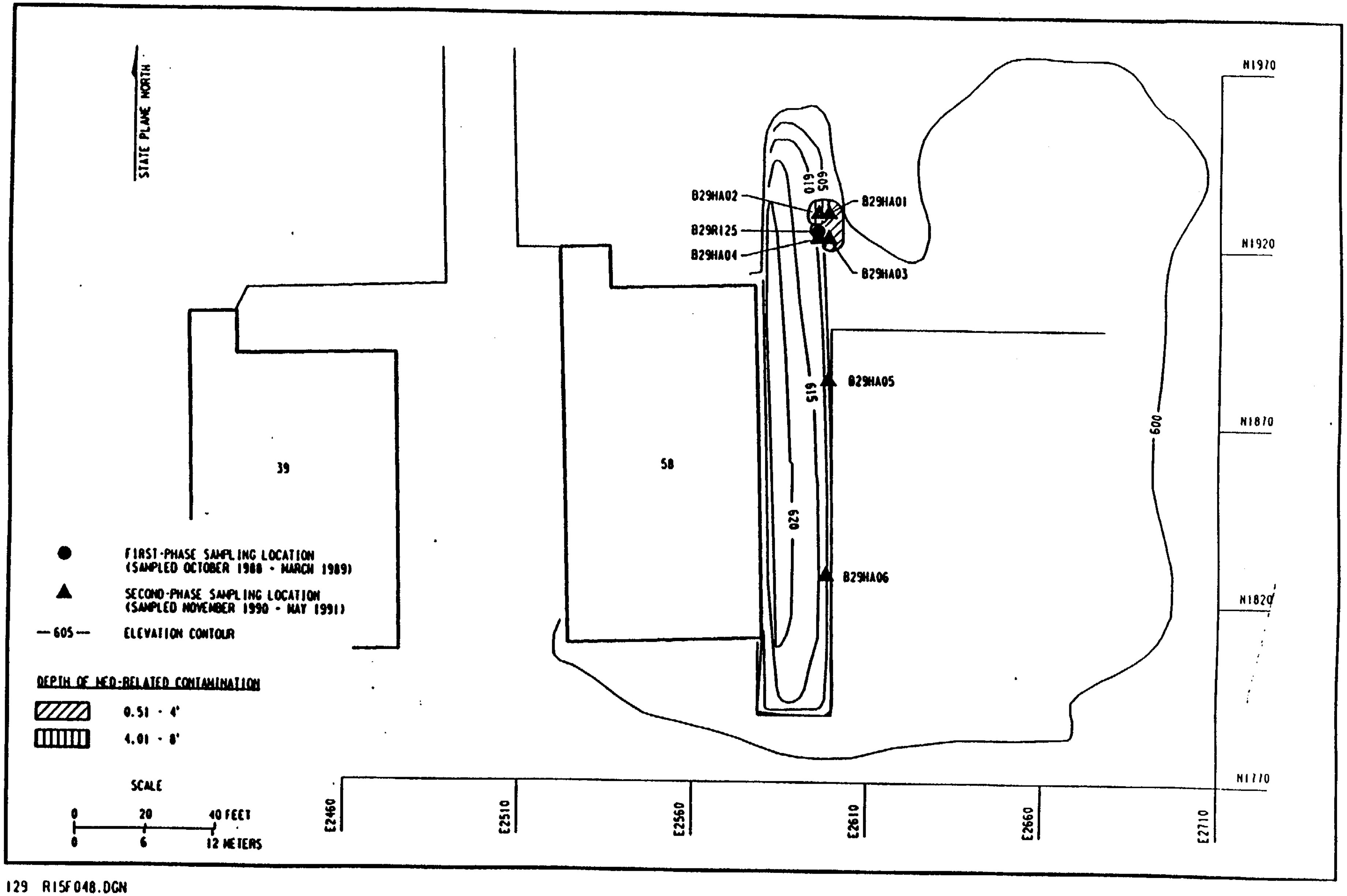
129 R15F033.DGN

Figure 4-3
Area 4 of Radioactive Contamination in Soil at Linde



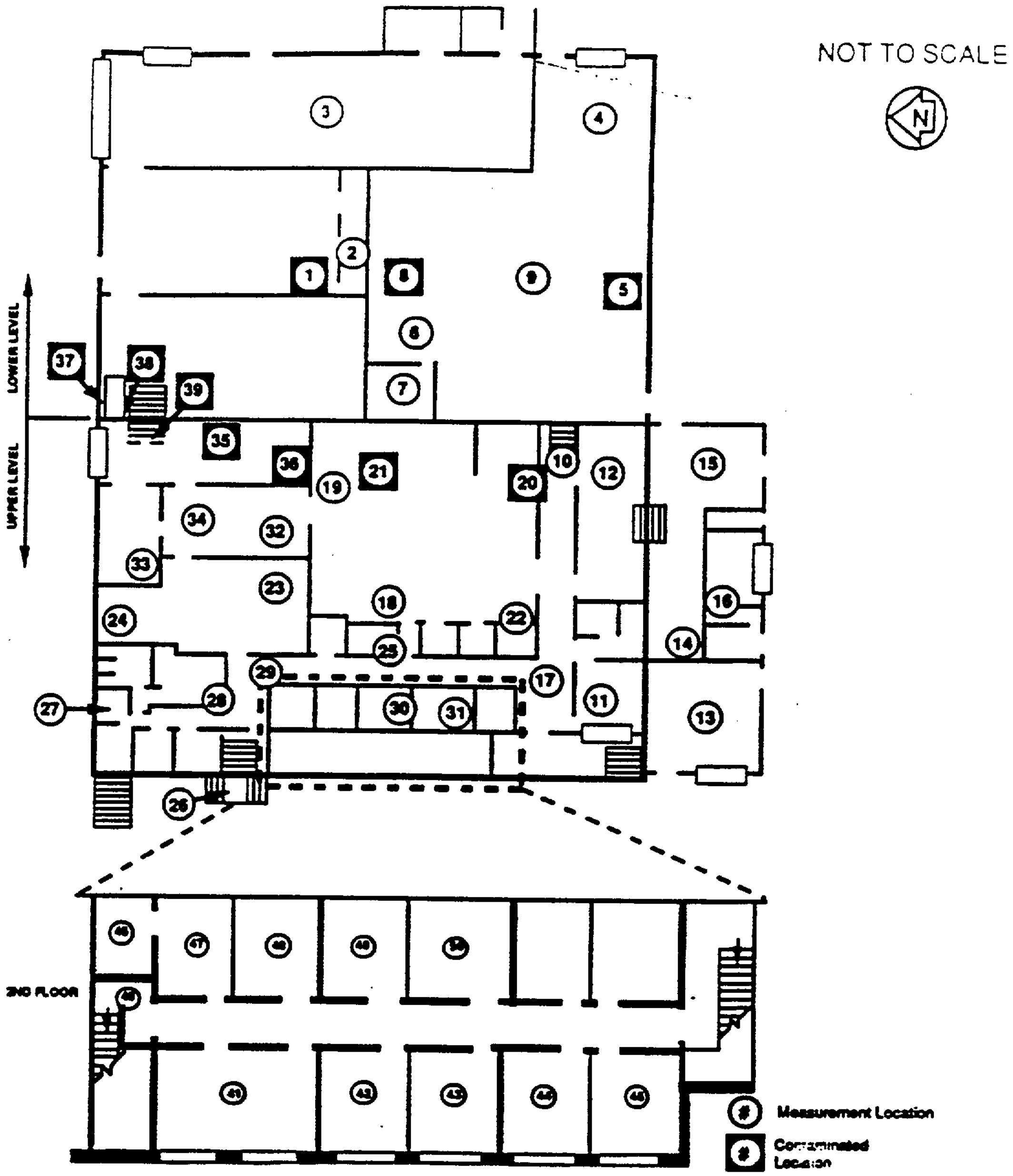
- Top of pile is approximately 15' above bottom of pile elevation.
- Measurements are approximate.
- There is approximately 2' of clean material covering the pile.

Figure 4-4
Approximate Dimensions of [illegible] Covered Waste Pile at Linde



129 R15F048.DGN

Figure 4-5
Areas of Radioactive Contamination in the Blast Wall
Adjacent to Building 58 at Linde



REMOVABLE	CONCENTRATIONS EXCEEDING BACKGROUND (dpm/100 cm²)	
	RANGE	AVG.
ALPHA:		
1st Floor	<3 — 102	11
2nd Floor	<3 — 8	6
BETA-GAMMA:		
1st Floor	<70 — 160	<70
2nd Floor	<70 — 110	76

FIXED	CONCENTRATIONS EXCEEDING BACKGROUND (dpm/100 cm²)	
	RANGE	AVG.
ALPHA:		
1st Floor	<40 — 1,310	120
2nd Floor	<40 — 90	55
BETA-GAMMA:		
1st Floor	<720 — 278,420	26,096
2nd Floor	<720 — 1,470	844

Figure 4-6
Areas of Radioactive Contamination in Building 14 at Linde

Table 4-5

Metals Concentrations in a Linde Borehole (B29R61) Contaminated with Fly Ash

Analyte[a]	B29R61[b] 0-2 ft (Fill: Gravel with clay, slag, and fly ash; grayish black)	B29R61[b] 2-6 ft (Clay; brown)
Aluminum	7,380	12,000
Antimony	11.7[c]	13.3[c]
Arsenic	62.6	99.9
Barium	96.2	141
Beryllium	1.3	1.1[c]
Boron	32.3	23.1
Cadmium	1.4	1.1[c]
Calcium	85,100	5,390
Chromium	35.1	24.1
Cobalt	9.8[c]	11.1[c]
Copper	151	26.4
Iron	14,600	22,000
Lead	121	27.2
Magnesium	8,840	6,400
Manganese	702	502
Molybdenum	19.5[c]	22.2[c]
Nickel	31.8	36.5
Potassium	976[c]	1,120
Selenium	107	168
Silver	3.7	5.4
Sodium	976[c]	1,110[c]
Thallium	19.5[c]	24.8
Vanadium	22.2	32.4
Zinc	146	118
% Solids	85.8	82.5
Chloride	23.3[c]	17.2
Nitrate	0.56	1.6
Sulfate	272	233
Uranium-238	<10.0	NA[d]
Radium-226	2.1 ± 0.6	NA
Thorium-232	1.4 ± 0.9	NA
Thorium-230	5.1 ± 0.6	NA

[a] Concentrations of metals and anions are given in mg/kg; radionuclide concentrations are in pCi/g.
[b] Sampling location is shown in Figures 2-2 and 4-3.
[c] Sample detection limit.
[d] NA - not analyzed.

Table 4-6
Radionuclide Concentrations in Soil in Areas of Radioactive Contamination at Linde

Page 1 of 3

Borehole[a]	Sampling Depth (ft)	Uranium-238 (pCi/g)	Radium-226 (pCi/g)	Thorium-232 (pCi/g)	Thorium-230 (pCi/g)
Background (mean)					
Area 1		3.1	1.1	1.2	1.4
B29R01	0 - 1[b]	16.0	4.0	2.0	1.5
	1 - 2	8.0	3.0	1.0	2.4
B29R05	0 - 1	8.0	4.0	1.4	4.4
	1 - 2[c]	14.0	8.0	1.0	23.0
	2 - 3	11.0	1.7	2.0	1.3
B29R07	0 - 1[c]	15.0	7.0	2.0	30.0
	2 - 3	9.0	1.0	1.0	1.1
B29R10	0 - 2[b]	9.0	5.0	1.0	5.9
	2 - 4[c]	16.0	7.0	1.0	12.0
B29R12	0 - 1[b]	11.0	4.0	3.0	2.7
	2 - 4	6.0	2.3	2.0	1.5
Minimum		6.0	1.0	1.0	1.1
Maximum		16.0	8.0	3.0	30
Mean		11.2	4.3	1.6	7.8
Standard Deviation		3.4	2.2	0.6	9.4
Area 2					
B29R65	0 - 1[b]	8.0	3.5	1.0	7.2
	1 - 2	9.0	2.5	1.9	2.8
B29R66	0 - 1	4.0	0.6	0.4	0.9
	2 - 4[b]	40.0	2.2	1.0	1.3
B29R68	0 - 2[c]	14.0	3.1	1.0	6.3
B29R69	0 - 2[c]	16.0	14.0	3.0	23.0
	2 - 4	4.0	1.2	1.2	2.8
B29R71	0 - 1[b]	15.0	3.2	0.9	5.0
	2 - 4	16.0	2.3	1.0	3.0
B29R73	0 - 1[b]	7.0	2.4	2.5	6.7
	1 - 2	7.0	2.5	1.0	3.6
Minimum		4.0	0.6	0.4	0.9
Maximum		40.0	14.0	3.0	23.0
Mean		12.7	3.4	1.4	5.7
Standard Deviation		9.7	3.4	0.7	5.8
Area 3					
B29R100	0 - 1[b]	7.0	2.2	2.5	6.0
	2 - 4	7.0	1.1	0.7	1.5
B29R101	1 - 3[c]	54.0	12.0	2.0	23.0
	3 - 5	8.0	1.5	1.3	1.6
B29R103	1 - 1.5[c]	7.0	8.0	2.2	16.0
	3 - 4	4.0	1.1	1.2	1.6
B29R104	0 - 1[b]	8.0	3.3	3.3	4.2
	1 - 2	4.0	2.1	0.9	8.7
B29R105	0 - 2[c]	9.0	1.9	0.6	2.0
	2 - 3[c]	31.0	5.0	1.2	8.2
B29R112	0 - 1[b]	15.0	4.0	1.0	5.7
	2 - 3	6.0	2.3	2.0	1.9
B29R114	0 - 2[b]	9.0	5.5	2.6	4.2
	2 - 3	7.0	2.3	1.2	1.3

Table 4-6

(continued)

Page 2 of 3

Borehole[a]	Sampling Depth (ft)	Uranium-238 (pCi/g)	Radium-226 (pCi/g)	Thorium-232 (pCi/g)	Thorium-230 (pCi/g)
Area 3 (cont'd)					
B29R116	0 - 1[c]	150.0	240.0	5.0	710.0
	2 - 3[c]	170.0	22.0	3.0	46.0
B29R128	0 - 0.5	5.4	1.3	0.9	0.5
	0 - 1[c]	4.0	4.9	0.9	21.0
	1 - 2	6.4	1.8	0.9	2.3
	2 - 3	5.9	1.4	1.0	2.6
B29R129	0 - 0.5[b]	16	9.1	0.9	6.3
B29R130	0 - 0.5[b]	6.9	4.0	1.4	12.0
B29R132	0 - 0.5[b]	16.0	9.1	0.9	6.3
B29R134	0 - 0.5[b]	4.7	1.6	1.1	6.5
B29R138	0 - 0.5[b]	9.6	3.6	0.8	5.5
B29R140	0 - 0.5[b]	10.0	5.2	0.7	8.2
B29R142	0 - 1[c]	14.0	6.7	1.0	15.0
	1 - 2	8.4	1.6	1.4	2.6
	2 - 3	5.2	1.6	1.0	1.5
B29R143	0 - 1	10.0	3.6	1.2	2.6
	1 - 2	4.9	1.1	1.4	1.1
	2 - 3[c]	8.0	1.1	1.8	17.0
B29R144	0 - 1[b]	5.5	3.7	1.4	10.0
	1 - 2	5.3	1.2	1.0	0.4
	2 - 3	5.6	1.2	1.5	0.6
B29R145	0 - 1[c]	100.0	43.0	1.9	110.0
	1 - 2[c]	21.0	17.0	2.2	40.0
	2 - 3[c]	8.3	12.0	1.0	29.0
B29R146	0 - 1[c]	37.0	14.0	1.2	65.0
	1 - 2	2.6	2.1	1.1	2.6
	2 - 3	5.1	1.6	1.1	2.3
B29R151	0 - 1[b]	2.6	2.3	1.3	7.5
	1 - 2	8.3	0.8	1.0	1.2
	2 - 3	6.8	0.7	0.8	1.2
B29R152	0 - 1[b]	2.6	2.3	1.3	7.5
	1 - 2	8.3	0.8	1.0	1.2
	2 - 3	6.8	0.7	0.8	1.2
B29R153	0 - 1	8.6	3.7	0.9	0.8
	1 - 2[c]	3.7	0.7	1.2	26.0
	2 - 3	2.8	0.9	1.3	1.2
B29W11D	0 - 1[b]	12.0	5.0	1.0	5.7
	4 - 5	6.0	1.6	1.1	1.0
Minimum		2.6	0.7	0.6	0.4
Maximum		170.0	240.0	5.0	710.0
Mean		17.1	9.4	1.4	24.4
Standard Deviation		32.9	33.3	0.8	97.1
Area 4					
B29R23	0 - 2[b]	13.0	6.0	1.0	1.3
	2 - 4	17.0	2.0	2.0	1.6
B29R24	0 - 1.5	4.0	0.8	1.0	0.7
	1 - 3[c]	8.0	5.5	1.2	14.0
B29R25	0 - 0.5[c]	24.0	3.8	1.0	18.0
	2 - 4	5.0	1.0	1.0	1.7
B29R27	2 - 4[c]	83.0	3.7	0.9	38.0
	4 - 5	7.0	1.7	1.0	2.3

Table 4-6

(continued)

Page 3 of 3

Borehole[a]	Sampling Depth (ft)	Uranium-238 (pCi/g)	Radium-226 (pCi/g)	Thorium-232 (pCi/g)	Thorium-230 (pCi/g)
Area 4 (cont'd)					
B29R28	1 - 2[c]	20.0	10.0	1.0	27.0
	2 - 4	5.0	5.0	1.0	7.4
B29R29	0 - 1[c]	88.0	42.0	1.0	88.0
	2 - 4[c]	32.0	14.0	1.0	19.0
B29R32	0 - 1[b]	7.0	4.0	1.6	6.3
	2 - 3	5.0	1.6	1.0	2.0
B29R34	0 - 2[c]	60.0	14.0	2.0	25.0
	2 - 4[c]	20.0	7.0	1.0	10.0
	4 - 6	14.0	1.7	3.0	1.7
B29R36	1.5 - 2.5[c]	21.0	3.1	1.2	5.4
	6.5 - 7.5[c]	30.0	1.1	1.4	1.6
B29R38	1 - 3[c]	930.0	150.0	3.0	820.0
	5 - 7[c]	62.0	9.0	1.4	33.0
B29R40	2 - 3[c]	72.0	1.6	1.0	5.1
	5 - 6	8.0	2.2	3.0	1.0
B29R41	1 - 2	2.0	1.6	1.0	2.1
	2 - 3[c]	15.0	13.0	1.0	16.0
B29R43	0 - 2[b]	10.0	4.0	3.0	2.9
	2 - 4	9.0	2.7	1.0	2.4
B29R44	0 - 1[b]	10.0	2.7	0.7	6.5
	2 - 3	9.0	2.2	1.4	1.5
B29R45	1 - 2[c]	43.0	11.0	2.0	19.0
	2 - 3	9.0	1.3	1.0	1.8
B29R46	0 - 1[c]	170.0	22.0	1.0	110.0
	2 - 3[c]	100.0	6.0	1.3	24.0
B29R48	0 - 2[b]	11.0	2.4	4.0	2.3
	2 - 6	8.0	2.5	1.0	1.4
B29R50	0 - 2[b]	6.0	2.6	1.0	6.1
	2 - 4	7.0	1.5	1.0	1.8
B29R52	0 - 1	7.0	1.8	1.0	4.1
	1 - 2[c]	12.0	6.0	1.0	14.0
B29R53	0 - 1[b]	11.0	6.0	1.0	4.5
	1 - 2	8.0	2.4	1.0	2.2
B29R125	0 - 1.5[c]	9.0	7.0	2.0	2.6
	1.5 - 3[c]	45.0	24.0	2.0	13.0
	3 - 6[c]	100.0	30.0	2.0	27.0
B29W9D	0 - 2[c]	13.0	7.0	1.0	15.0
	2 - 4	2.0	1.0	1.0	1.2
Minimum		2.0	0.8	0.7	0.7
Maximum		930.0	150.0	4.0	820.0
Mean		46.8	9.8	1.4	30.7
Standard Deviation		136.0	22.4	0.7	119.5

[a] Sampling locations are shown in Figure 2-1.

[b] Radioactively contaminated to 0.15 m (0.5 ft).

[c] Radioactively contaminated soil interval.

LINDE SITE PRELIMINARY MATERIAL CHARACTERIZATION REPORT

FUSRAP LINDE REMEDIAL ACTION
TONAWANDA, NEW YORK

FEBRUARY 2000
CONTRACT NO. DACA31-95-D-0083, TERC,
TASK ORDER NO. 32

IT CORPORATION
A Member of The IT Group

U.S. ARMY CORPS OF ENGINEERS

BUFFALO DISTRICT OFFICE

FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM

Table of Contents

List of Tables

List of Acronyms

µg/kg	micrograms per kilogram
µg/L	micrograms per liter
AA	atomic absorbtion
AEC	Atomic Energy Commission
ANL	Argonne National Laboratories
BDL	Below Detection Limit
BNAE	Base/Neutral and Acid Extractable
BNI	Bechtel National, Inc.
CFR	Code of Federal Regulations
cm	centimeters
DHF	Destination Handling Facility
DOE	United States Department of Energy
EP	Extraction Procedure
FUSRAP	Formerly Utilized Sites Remedial Action Program
IT	IT Corporation
m	meter
MED	Manhattan Engineering District
mg/kg	milligrams per kilogram
NRC	United States Nuclear Regulatory Commission
NYSDEC	New York State Department of Environmental Conservation
PAHs	Polyaromatic hydrocarbons
pCi/g	picocuries per gram
PPE	personal protective equipment
PMCR	Preliminary Material Characterization Report
Ra-226	Radium-226
RCRA	Resource Conservation Recovery Act
RFP	request for proposal
RI	Remedial Investigation
ROD	Record of Decision
SOR	Sum of Ratios
S.U.	Standard Units
SVOC	Semi-Volatile Organic Compounds
TAGM	Technical Administrative Guidance Document
Th-230	Thorium-230
Th-232	Thorium-232
U-238	Uranium 238
UrO_2	uranium oxide
USACE	U. S. Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds

Section 1.1 – Site History

The Manhattan Engineering District (MED) and its immediate successor, the Atomic Energy Commission (AEC), conducted numerous activities across the country during the 1940s and 1950s involving research, development, processing, and production of uranium and thorium, and storage of processing residues. Nearly all of this work involved some participation by private contractors and institutions. These sites, contaminated during the early period of the nuclear program, were decontaminated or stabilized in accordance with survey methods and guidelines then in existence. These sites were subsequently released for other uses. Since that time, however, guidelines have become more stringent and sites are being reevaluated and remediated under FUSRAP. The Linde, Ashland 1, Ashland 2, and Seaway Industrial Park sites are all located in Tonawanda, New York, and together constitute one of the FUSRAP projects.

From 1942 to 1946, several buildings at the Linde site (currently Praxair, Inc.) located in Tonawanda, New York, were used in activities for separation of seven different uranium ores under a MED contract. Four of the ores came from Africa and three came from the United States. The American ores were residuals left from the extraction of vanadium. The vanadium removal process also removed much of the naturally occurring radium from the ores. Thus, the American ore residues were low in radium compared to the levels of uranium and thorium. The African ores contained uranium in secular equilibrium with thorium and radium. Because of the relative abundance of radium in the residue from the processing of the African ores, these ore residues were kept separate from the domestic residues to preserve the potential for later extraction of radium. These African ore residues were shipped to the former Lake Ontario Ordnance Works where they were stored. At the Linde property, ownership of Buildings 30, 31, 37 and 38, which were built by MED on land owned by Union Carbide, was transferred to Linde when the MED contract was terminated (BNI, 1993).

The principal contaminants of concern at the Linde site were from the processing of wastes and residues generated from the separation of uranium from the ore (Phase 1) since residues generated by other phases of the operations (Phases 2 and 3) were reportedly to have been recycled. The processing activities resulted in radioactive contamination of portions of the property, the underlying aquifer and processing buildings. Historical surveys and Remedial Investigation (RI) results indicate that the Linde property has four sources of MED-related radioactive contamination: in surface and subsurface soils; residual radioactivity in the uranium processing buildings (Buildings 14, 31, 30, and 38, (Buildings 30 and 38 have already been demolished)); processing effluents that precipitated after being injected into fractured bedrock and the contact-zone aquifer; and in sediments found in building sumps and the storm and sanitary sewer systems.

The Linde property is approximately 135 acres in size and is heavily industrialized. Most of the area is impervious to infiltration of stormwater as about 68 acres of the property consists of buildings, sidewalks and pavement. The remaining area consists of compacted gravel surfaces that allow some infiltration. The average yearly percolation rate was calculated at approximately 3.7 inches and the annual volume of surface runoff is estimated to be 240 acre-foot (BNI, 1993).

Renovation of the Linde property over the ensuing years has prompted the consolidation of remaining contaminated materials. In 1977 soil was removed from the Building 90 construction area and placed in two windrows along the northern and eastern fences of the property and in the tailings pile on the northern portion of the site. Between 1979 and 1982 the windrows and pile of contaminated material were consolidated into one uncovered pile west of Building 90. The pile was covered in 1992.

Data presented in this Preliminary Material Characterization Report (PMCR) has been previously released in the RI (BNI, 1993) prepared for the United States Department of Energy (DOE). This report summarizes that data according to chemical and radiological characteristics for the purpose of selecting an appropriate Destination Handling Facility (DHF) for materials to be excavated at the Linde FUSRAP site.

The investigations focused on contaminated soils present outside and beneath buildings historically used for MED-related activities and other areas on the Linde site. This report summarizes the data generated by the RI in those specific areas on the Linde site slated for remedial action by the Record of Decision (ROD), specifically, Areas 8, 9, 9A, 10, and 11 (USACE, 1999).

The tables present the minimum and maximum chemical or radiologic concentrations reported in the RI. Note that "BDL" means "below detection limit".

Table 1
Volatile Organic Compounds (VOCs) Analytical Results

Chemical (VOCs)	Concentration Range (µg/kg*)
1,1,1-Trichloroethane	BDL – 2.3
1,1,2,2-Tetrachlorethane	BDL – 650
1,1,2-Trichloroethane	BDL
1,1-Dichloroethane	BDL
1,1-Dichloroethene	BDL
1,2-Dichloroethene (total)	BDL – 36
1,2-Dichloroethane	BDL – 36
1,2-Dichloropropane	BDL
2-Butanone	BDL
4-Hexanone	BDL
4-Methyl-2-pentanone	BDL
Acetone	BDL
Acrolein	BDL
Acrylonitrile	BDL
Benzene	BDL
Bromodichloromethane	BDL
Bromoethane	BDL
Bromoform	BDL – 5.2
Carbon disulfide	BDL
Carbon tetrachloride	BDL
Chlorobenzene	BDL

Table 1
Volatile Organic Compounds (VOCs) Analytical Results (continued)

Chemical (VOCs)	Concentration Range (µg/kg*)
Chloroethane	BDL
Chloroform	BDL – 2.2
Chloromethane	BDL
2-Chloroethylvinylether	BDL
cis-1,3-Dichloropropene	BDL
Dibromochloromethane	BDL
Ethylbenzene	BDL
Methylene chloride	BDL – 49
Styrene	BDL
Tetrachloroethene	BDL – 6.7
Toluene	BDL – 260
trans-1,3-Dichloropropene	BDL
trans-1,2-Dichlorethene	BDL – 42
Trichloroethene	BDL – 42
Trichlorofluoromethane	BDL
Vinyl acetate	BDL
Vinyl chloride	BDL
Xylenes (total)	BDL

* µg/kg: micrograms per kilogram (parts per billion)

Table 2
Base/Neutral and Acid Extractable (BNAE) Analytical Results

Compound (BNAEs)	Concentration (µg/kg)	Compound (BNAEs)	Concentration (µg/kg)
1,2,4-Trichlorobenzene	BDL	Benzo(b)fluoranthene	BDL – 3,200
1,2-Dichlorobenzene	BDL	Benzo(g,h,i)perylene	BDL – 2,200
1,3-Dichlorobenzene	BDL	Benzo(k)fluoranthene	BDL – 3,100
1,4-Dichlorobenzene	BDL	Benzoic acid	BDL
2,4,5-Trichlorophenol	BDL	bis(2-Chloroethoxy) methane	BDL
2,4,6-Trichlorophenol	BDL	bis(2-Chloroethyl)ether	BDL
2,4-Dichlorphenol	BDL	bis(2-Chloroisopropyl)ether	BDL
2,4-Dimethylphenol	BDL	bis(2-Ethylhexyl)phthalate	BDL – 750
2,4-Dinitrophenol	BDL	Butylbenzylphthalate	BDL
2,4-Dinitrotoluene	BDL	Chrysene	BDL – 3,900
2,6-Dinitrotoluene	BDL	Di-n-butylphthalate	BDL – 280
2-Chloronaphthalene	BDL	Di-n-octylphthalate	BDL
2-Chlorophenol	BDL	Dibenz(a,h)anthracene	BDL – 7,000
2-Methylnaphthalene	BDL – 830	Dibenzofuran	BDL – 640
2-Methylphenol	BDL	Diethylphthalate	BDL
2-Nitroaniline	BDL	Dimethylphthlate	BDL
3,3'-Dichlorobenzidine	BDL	Fluoranthene	BDL – 7000
3-Nitroaniline	BDL	Fluorene	BDL – 660

Table 2
Base/Neutral and Acid Extractable (BNAE) Analytical Results
(continued)

Compound (BNAEs)	Concentration (µg/kg)	Compound (BNAEs)	Concentration (µg/kg)
4,6-Dinitro-2-methylphenol	BDL	Hexachlorobenzene	BDL
4-Bromophenyl-phenylether	BDL	Hexachlorobutadiene	BDL
4-Chloro-3-methylphenol	BDL	Hexachlorocyclopentadiene	BDL
4-Chloroaniline	BDL	Hexachloroethane	BDL – 2,100
4-Chlorophenylether	BDL	Indeno(1,2,3-cd)pyrene	BDL – 2,100 *
4-Methylphenol	BDL – 120	Isophorone	BDL
4-Nitroaniline	BDL	N-nitroso-di-n-propylamine	BDL
4-Nitrophenol	BDL	N-nitrosodiphenylamine	BDL – 960
Acenaphthene	BDL – 820	Naphthalene	BDL – 960 *
Acenaphthylene	BDL – 150 *	Nitrobenzene	BDL
Anthracene	BDL – 870	Pentachlorophenol	BDL – 4,700
Benzo(a)anthracene	BDL – 3,100	Phenanthrene	BDL – 4,700
Benzo(a)pyrene	BDL – 3,000	Phenol	BDL
		Pyrene	BDL – 6,200

* Laboratory estimated value

Table 3
Target RCRA Characteristics

Reactivity	Maximum Concentration (µg/kg)
Cyanide (total)	BDL – 86.9*
Sulfide (total)	BDL – 0.5

* This is a total value and does not exhibit D003 reactivity

Corrosivity by pH (5-9 S.U.*)
* S.U. – Standard Units

Ignitability (not applicable)

Table 4
Toxicity by Extraction Procedure (EP)

EP Pesticides Leachate	Maximum Concentration (µg/L*)
Endrin	BDL
Gamma-BHC (lindane)	BDL
Methoxychlor	BDL
Toxaphene	BDL

* µg/L: micrograms per liter (parts per billion)

Table 5
EP Herbicides Analysis

EP Herbicides Leachate	Maximum Concentration (μg/L)
2,4-D	BDL
2,4,5-TP	BDL
2,4,5-T	BDL

Table 6
EP Metals Analysis

EP Metals Leachate	Maximum Concentration (μg/L)
Arsenic	BDL
Barium	BDL – 1,150
Cadmium	BDL
Chromium	BDL
Lead	BDL
Mercury	BDL
Selenium	BDL – 228
Silver	BDL

Table 7
Total Metals Analysis

Results	Concentration (mg/kg*)
Aluminum	3,130 – 30,800
Antimony	BDL – 237
Arsenic	BDL – 207
Barium	55 – 499
Beryllium	BDL – 6.3
Boron	BDL – 94.1
Cadmium	BDL – 6
Calcium	8,270 – 198,000
Chromium	7 – 35.1
Cobalt	BDL – 68.8
Copper	11 – 1,080
Iron	3,750 – 30,600
Lead	21 – 1,120
Magnesium	4,810 – 36,300
Manganese	341 – 3,070
Molybdenum	BDL – 32.7
Nickel	BDL – 265
Potassium	BDL – 2,560
Selenium	27 – 292
Silver	BDL – 7.2
Sodium	728 – 3,240
Thallium	BDL – 93.1
Vanadium	BDL – 437
Zinc	47 – 634

* mg/kg: milligrams per kilogram (parts per million)

All metals were analyzed by inductively coupled plasma (ICP) atomic emission spectrophotometry with the exception of arsenic, lead, selenium, and thallium, which were analyzed by atomic absorption (AA).

Table 8
Radiological Analysis (56 boreholes)

Radionuclide	Minimum (pCi/g*)	Maximum (pCi/g)
Uranium-238	2.0	4500.0
Radium-226	0.7	813.0
Thorium-232	0.6	5.0
Thorium-230	0.4	820.0

*pCi/g: picocuries per gram

Section 3 – Estimates of Excavated Soil Volume/Mass

Estimates on the amounts of soil to be excavated and shipped offsite are based on computer models prepared by Argonne National Laboratories (ANL, 1999) that take into account borehole sample results from the RI and cleanup criteria presented in the ROD that calculates the sum of ratios (SOR) for uranium, radium, and thorium averaged over 10 meter (m) by 10 m grid cells. Estimated volume/mass of soil and debris to be shipped offsite based on recent data and ROD cleanup requirements appears in the following table:

Table 9
Estimated Volume/Mass of Soil and Debris

Type of Material	Volume (cubic yards) Estimated	Mass (tons) Estimated	Expected nuclides Contamination Level (pCi/g)
Soils and Debris [1]	17,900	24,792[2]	see Table 8
Concrete slabs [3]	6,492	13,150	< 30
Asphalt [4]	4,000	6,500	< 100
Building Demolition Debris [1]	5,000	6,925	< 30
Personal Protective Equipment (tyveks, gloves, visqueen, disposable equipment) [5]	200	4	< 200

Note: It is anticipated that all materials will be transported and delivered in 25 CY intermodal containers. Disclose in bid package the distance that may be required to truck intermodal containers from nearest usable rail siding.

1 Debris may be sized and loaded to meet specific criteria as required by the bidder.
2 Conversion based on 1.385 tons/cubic yard excavated soils.
3 Concrete may be crushed to meet specific size criteria as required by the bidder. If concrete is crushed to gravel size consider radiological contamination to be uniformly distributed and near background levels.
4 Asphalt may be separated from soil shipments or properly sized and included as debris.
5 Specify if PPE may be included with bulk soil as debris at a maximum percentage per container or is to be shipped separately under separate approval.

Section 4 Summary

The major source of radionuclide contamination in Linde site soils is from processing of unlicensed pre-1978 uranium ores by the Manhattan Engineering District (MED) which contained only naturally occurring radioactivity. This information is furnished only to assist in characterization efforts and not as an assertion of regulatory status. Under the FUSRAP, chemical or nonradioactive contamination at the Linde site is the USACE's responsibility only if it is commingled with MED-related radioactive contamination or if it is related to MED operations at the Linde site.

Sources of non-MED chemical contamination that may be mixed with MED materials are: slag and fly ash used as fill at the Linde site, coal pile run-off, and solvents used in plant operations. Slag and fly ash are exempt from the RCRA (40 CFR 261.4(b)(4)(7)). Radioactive by-product material is exempt from solid-waste regulations (40 CFR 261.4 (a)(4)). Polyaromatic hydrocarbons (PAHs) resulting from prior coal storage at the Linde site (Table 2) are not regulated as hazardous wastes by the United States Environmental Protection Agency (USEPA). As identified in the RI, the only chemical contamination detected that is mixed with MED-related materials that could possibly be classified as RCRA hazardous waste status are some of the VOCs appearing in Table 1 and 2.

Contaminated media to be excavated and shipped offsite from the Linde site will probably not be characterized as USEPA hazardous waste. This determination is based on RI analytical data results, historical information, and planned execution of the "Contained In" Criteria for Environmental Media Technical Administrative Guidance Memorandum 3028 (TAGM 3028) provided by the State of New York State Department of Environmental Conservation (NYSDEC).

TAGM 3028 provides guidelines and action concentration levels for certain chemical contaminants that, if not exceeded, allow the environmental media in question to not be considered as "containing" a hazardous waste. This definition is based on the USEPA's "contained in" policy for environmental media. As directed by TAGM 3028, a "contained in" demonstration will be performed during remediation activities. This demonstration will require preparation and execution of a "work plan" approved by the NYSDEC which will involve sampling and analysis in order to validate a "contained out" determination. Results of this demonstration will be made available to the successful DHF bidder.

Concentrations of chemical contaminants present in Linde site soils and their corresponding "Contained-In" Action Levels are presented in the following table:

Table 10
"Contained-In" Action Levels for Chemicals of Concern

6

	Chemical (VOCs)	Concentration Range at Linde (µg/kg)	Soil/Sediment Action Level (µg/kg) As of 8/4/97
✓	1,1,1-Trichloroethane	BDL – 2.3	7,000,000
✓	1,1,2,2-Tetrachlorethane	BDL – 650	3,200
	1,2-Dichloroethene (total)	BDL – 36	cis- 780,000 trans- 1,600,000
✓	1,2-Dichloroethane	BDL – 36	7,000
✓	Bromoform	BDL – 5.2	81,000
✓	Chloroform	BDL – 2.2	100,000
	Hexachloroethane	BDL – 2,100	46,000
✓	Methylene chloride	BDL – 49	85,000
	Pentachlorophenol	BDL – 4,700	3,000
	Tetrachloroethene	BDL – 6.7	12,000
✓	Toluene	BDL – 260	16,000,000
✓	trans-1,2-Dichlorethene	BDL – 42	1,600,000
✓	Trichloroethene	BDL – 42	58,000

For purposes of determining the DHF, if there is reason to believe that the bidder's state environmental regulatory authority will not accept NYDEC's hazardous waste "contained in" determination, it is required by IT that this fact be disclosed in the bid response. If, through execution of the NYDEC approved work plan, radioactive contaminated media with hazardous waste components are identified they will be segregated and disposed under a separate material profile.

Argonne National Laboratories (ANL), 1999. Linde Site Soil Excavation Volume Estimates. 22 February 1999.

Bechtel National Inc. (BNI), 1993. Remedial Investigation Report for the Tonawanda Site. Prepared by Bechtel for the United States Department of Energy. February 1993.

NYSDEC, 1992. Technical Administrative Guidance Document (TAGM) 3028, "Contained - In" Criteria for Environmental Media. 30 November, 1992. Last update 4 August, 1997.

USACE, 1999. Proposed Plan for the Linde Site, Tonawanda, New York. March.

USACE, 1999. Record of Decision for the Linde Site, Tonawanda, New York. Draft.

US Army Corps of Engineers®
Buffalo District

RECORD OF DECISION

FOR THE LINDE SITE

TONAWANDA, NEW YORK

MARCH 2000

I.

DECLARATION FOR THE RECORD OF DECISION

DECLARATION FOR THE RECORD OF DECISION

SITE NAME AND LOCATION

Linde Site
Town of Tonawanda, New York

STATEMENT OF BASIS AND PURPOSE

This Record of Decision (ROD) presents the selected remedial action for the Linde Site in the Town of Tonawanda, New York. This remedial action was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act, 42 United States code 9601 et seq., as amended (CERCLA), and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) as directed by Congress in the Energy and Water Appropriation Act for Fiscal Year 1999, PL 105-245. The information supporting the United States Army Corps of Engineers (USACE) decision as the lead agency on the selected remedy is contained in the Administrative Record file located at the USACE Public Information Center, 1776 Niagara Street, Buffalo, NY 14207 and the Tonawanda Public Library, 333 Main Street, Tonawanda, NY 14150. Comments on the proposed plan provided by the New York State Department of Environmental Conservation (NYSDEC) during the public comment period were evaluated and considered in selecting the final remedy. USACE also considered comments from the U.S. Environmental Protection Agency. NYSDEC has expressed reservations especially regarding the cleanup level for uranium and the USACE application of 10 CFR Part 40, Appendix A, Criterion 6(6) which was used for the derivation of the uranium cleanup level. For this reason NYSDEC has reserved its support for the proposed plan pending review of the final status survey data once remediation is complete.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this ROD, may present an endangerment to public health, welfare, or the environment in the future.

DESCRIPTION OF THE SELECTED REMEDY

Background on Remedy Selection

During the early to mid-1940's, portions of the property formerly owned by Linde Air Products Corp., a subsidiary of Union Carbide Industrial Gas (Linde), now owned by Praxair, Inc., in the Town of Tonawanda, New York were used for the separation of uranium ores. The separation processing activities, conducted under a Manhattan Engineer District (MED) contract, resulted in elevated radionuclide levels in portions of the Linde property. Subsequent disposal and relocation of the processing wastes from the Linde property resulted in elevated levels of radionuclides at three nearby properties in the Town of Tonawanda: the Ashland 1 property; the Seaway property; and the Ashland 2 property. Together, these three (3) properties, with Linde, have been referred to as the Tonawanda Site.

Under its authority to conduct the Formerly Utilized Sites Remedial Action Program (FUSRAP), the U.S. Department of Energy (DOE) conducted a Remedial Investigation (RI), Baseline Risk Assessment (BRA), and Feasibility Study (FS) of the Tonawanda Site. In November 1993, DOE issued a Proposed Plan (PP) for public comment for the Tonawanda Site, describing the preferred remedial action alternative for disposal of remedial waste and cleanup plans for each of the Tonawanda Site properties. The 1993 PP recommended that remedial wastes from the Tonawanda Site properties be disposed in an engineered on-site disposal facility to be located at Ashland 1, Ashland 2, or Seaway.

Numerous concerns and comments were raised by the community and their representatives regarding the preferred alternative identified in DOE's 1993 PP and the proposed onsite disposal of remedial action waste. In 1994, DOE suspended the decision-making process on the 1993 PP and re-evaluated the alternatives that were proposed.

On October 13, 1997, the Energy and Water Development Appropriations Act, PL 105-62, was signed into law, transferring responsibility for the administration and execution of FUSRAP from DOE to USACE.

In April 1998, USACE issued a ROD for cleanup of Ashland 1, Ashland 2, and Area D of the Seaway Site properties. Remediation of those properties, was initiated by USACE in June 1998.

On March 26, 1999, after reviewing the history of the Linde Site and conducting an evaluation of Linde Site information not available in 1993 and potential remedial alternatives, USACE issued a revised PP for cleanup of the Linde Site. This ROD documents selection of a remedy which is significantly but not fundamentally different from the remedy proposed in the PP. The changes will not affect the degree of cleanup provided in the selected remedy and those portions of the site not included in this remedial action will be the subject of public comment in a later CERCLA action.

Remedies for Seaway Areas A, B and C are being addressed in a separate remedial action.

This remedial action does not address any contamination which may be present at the site due to activities at the site after the period of MED contract work.

Selected Remedy

The remedy selected for the Linde Site includes the residual radioactive material removal and building and slab removal actions of Alternative 2 as described in the PP issued on March 26, 1999 but does not include Building 14 nor the soils underneath Building 14. USACE has determined that the cleanup standards found in 40 CFR Part 192, the standards for cleanup of the uranium mill sites designated under the Uranium Mill Tailings Radiation Control Act (UMTRCA) and the Nuclear Regulatory Commission (NRC) standards for decommissioning of licensed uranium and thorium mills, found in 10 CFR Part 40, Appendix A, Criterion 6(6) are relevant and appropriate for cleanup of MED-related contamination at the Linde Site. The major elements of this remedy will involve excavation of the soils with contaminants of concern (COCs) (radium, thorium and uranium) above the soil cleanup levels and placement of clean materials to meet the other criteria of 40 CFR 192, and cleanup of contaminated surfaces in buildings with COCs above the surface cleaning levels.

Compliance with these standards will require USACE to: (1) Remove MED-related soil so that the concentrations of radium do not exceed background by more than 5 picocuries per gram (pCi/g) in the top 15 centimeters (cm) of soil or 15 pCi/g in any 15 cm layer below the top layer, averaged over an area of 100 square meters (m^2); (2) Remediate occupied or habitable buildings so that an annual average radon decay product concentration (including background) does not exceed 0.02 Working Level (WL) and the level of gamma radiation does not exceed the background level by more that 20 microroentgens per hour; (3) control the releases of radon into the atmosphere resulting from the management of uranium byproduct materials do not exceed an average release rate of 20 pCi/meter^2 second (m^2s); (4) removal of MED-related soils with residual radionuclide concentrations averaged over a 100 square meter area that exceeds unity for the sum of the ratios of these radionuclide concentrations to the associated concentration limits, above background, of 554 pCi/g for total uranium (U_{total}), 5 pCi/g for Radium-226 (Ra-226) and 14 pCi/g for Thorium-230 (Th-230) for surface cleanups and 3,021 pCi/g of U_{total}, 15 pCi/g of Ra-226 and 44 pCi/g of Th-230 for subsurface cleanups; (5) In addition, consistent with the proposed plan released for public comment in March 1999 prior to promulgation of the amendment to 10 CFR Part 40, Appendix A, Criterion 6(6) in June 1999, USACE will remediate the Linde Site to insure that no concentration of total uranium exceeding 600 pCi/g above background will remain in the site soils; and (6) removal of MED-related residual radioactive materials from surfaces necessary to meet the benchmark dose for surfaces of 8.8 mrem/y based on the specific location of the surfaces and exposure scenarios. Appropriate as low as reasonably achievable (ALARA) principles will be included in the detailed site remediation plan.

USACE had determined that, pursuant to 40 CFR 300.430(e)(2)(i)(A)(2), a site specific total uranium cleanup guideline was required to address isolated areas of elevated uranium contamination at the site because uranium is not specifically addressed in 40 CFR Part 192 or any other applicable or relevant and appropriate requirement (ARAR) available at the time the PP was released in March 1999. USACE had proposed to remove contaminated soils exceeding 600 pCi/g and committed to ensuring that the remaining soils will not exceed an average of 60 pCi/g of total uranium, as measured over a volume of soil 2,000 m^2 by 3 m thick. Subsequent to the public comment period, a new ARAR (amendment to 10 CFR Part 40, Appendix A, Criterion 6(6), as described above) was promulgated and became effective on June 11, 1999, making the use of the site specific uranium guideline unnecessary. USACE assessed the 10 CFR 40, Appendix A, Criterion 6(6) standards and the Linde radiological assessment (USACE 2000) and concluded that the criteria associated with this ARAR for the Linde Site soils would be to limit the residual radionuclide concentrations remaining in soils within a 100 square meter area to concentrations that results in unity or less for the sum of the ratios of these radionuclide concentrations to the associated concentration limits, above background, of 554 pCi/g for U_{total}, 5 pCi/g for Ra-226 and 14 pCi/g for Th-230 for surface cleanups and 3,021 pCi/g of U_{total}, 15 pCi/g of Ra-226 and 44 pCi/g of Th-230 for the subsurface. Remediation of the site in accordance with this ROD will result in a more stringent cleanup of U_{total} at the Linde Site than was originally proposed in the Proposed Plan and provides assurance that no concentration of total uranium exceeding 600 pCi/g above background will remain in soils at the Linde Site.

Verification of compliance with soil cleanup standards and criteria will be demonstrated using surveys developed in accordance with the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) and as may be required by the ARARs. Methodology to determine radon and gamma radiation levels will be developed in accordance with the ARARs and documented in the work plan for site remediation. The cleanup of contaminated building and structure surfaces will be conducted in accordance with the 10 CFR Part 40, Appendix A, Criterion 6(6) using building/structure-specific decontamination protocols to be detailed in the work plan for site remediation.

The selected remedy will involve the demolition of buildings necessary to remediate the site. These buildings include Buildings 57, 67, 73, 73B, 75 and 76 and will also include the building slabs and foundations. The slabs that are remaining after the demolition of Buildings 30 and 38 and the tank saddles north of Building 30 will also be removed. A wall in Building 31 will be removed to access sub-slab and sub-footing soils exceeding criteria. Soils and surfaces containing MED-related contamination will be remediated in order to meet the ARARs. The final remediation of Building 14 and soils under Building 14 has been excluded from this ROD, to be addressed separately in the future. The selected remedy will also include remediation of the adjacent Niagara Mohawk and CSX Corporation (formerly Conrail) properties, where radioactive contamination has already been identified or may be identified as the remediation work is implemented and will be limited to following releases that originated from the Linde Site resulting from MED-related operations. The plan also includes the removal of contaminated sediments from drainlines and sumps, the removal of contaminated soil from a blast wall structure located east of Building 58, and remediation of a subsurface vault structure located just west of Building 73. This ROD also does not address the groundwater at the Linde Site. A ROD will be issued in the future that evaluates the Site groundwater and selects any required remedial action. The selected remedy addresses the principal threat at the site by eliminating radioactive contamination in soils and on building structures that may pose a threat to the health of persons at the site. This remedy will not result in MED-related hazardous substances remaining at the site above the health-based levels after completion of the scope identified above. The Corps will perform all required 5-year reviews.

The estimated cost of the selected remedy is $27,700,000.

STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to hazardous substances which are the subject of this response action, and is cost-effective.

None of the remedial alternatives identified for the Linde Site provide onsite treatment for the materials to be removed. The selected remedy includes offsite disposal, involving containment at the final disposal location and any treatment, which may be required to meet the standards of the offsite facility. This alternative thus would achieve reduction in mobility, although no treatment is planned which will reduce the toxicity or volume of the disposed materials. The FS evaluated currently available treatment technologies for treatment during the removal and found none that would be economically and technologically feasible at this time. Thus, the selected alternative achieves the best possible result in terms of satisfying the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element.

MG Hans Van Winkle
Deputy Commanding General for Civil Works
20 Massachusetts Avenue, NW
Washington, DC 20314-1000

3 March 2000
Date

RECORD OF DECISION
FOR THE
LINDE SITE

TABLE OF CONTENTS

Table of Contents (continued)

Table of Contents (continued)

List of Figures

List of Attachments

List of Appendices

ACRONYMS AND ABBREVIATIONS

ALARA	As Low as Reasonably Achievable
ARAR	applicable or relevant and appropriate requirement
ave.	Average
BNI	Bechtel National, Inc.
BRA	Baseline Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Ci	Curie
CFR	Code of Federal Regulations
cm	centimeter
COC	contaminant of concern
Conrail	Consolidated Rail Corporation
cy	cubic yard(s)
DOE	Department of Energy
dpm	disintegrations per minute
ECIDA	Erie County Industrial Development Authority
EE/CA	Engineering Evaluation/Cost Analysis
FBDU	Ford Bacon Davis Utah, Inc.
ft	foot/feet
FS	Feasibility Study
FUSRAP	Formerly Utilized Sites Remedial Action Program
g	gram
gpm	gallons per minute
GPR	ground penetrating radar
HI	Hazard Index
HQ	Hazard Quotient
L	liter
lb	pound
m	meter
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MED	Manhattan Engineer District
mg	milligram
µR/hr	microroentgens per hour
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NRC	Nuclear Regulatory Commission
NWI	National Wetlands Inventory
NYSDEC	New York State Department of Environmental Conservation
O&M	Operations and Maintenance
ORNL	Oak Ridge National Laboratory
pCi	picocuries
PP	Proposed Plan
QA/QC	Quality Assurance/Quality Control
Ra	radium
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RME	reasonable maximum exposure
Rn	radon
ROD	Record of Decision
s	second

Acronym List (continued)

SAIC	Science Applications International Corporation
SFMP	Surplus Facilities Management Program
SHPO	State Historical Preservation Office
TEDE	Total Effective Dose Equivalent
Th	thorium
U	uranium
UMTRCA	Uranium Mill Tailings Radiation Control Act
U.S.	United States
U.S.C.	United States Code
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
WL	Working Level
yr	year(s)

II.

DECISION SUMMARY

1. SITE NAME, LOCATION, AND DESCRIPTION

Linde Site
Town of Tonawanda, New York

1.1 Site Overview

During the early to mid-1940's, portions of the property formerly owned by Linde Air Products Corp., a subsidiary of Union Carbide Industrial Gas (Linde), now owned by Praxair, Inc., in the Town of Tonawanda, New York, were used for the separation of uranium ores. These processing activities, conducted under a MED contract, resulted in radioactive contamination of portions of the property and buildings. Subsequent disposal and relocation of processing wastes from the Linde property resulted in radioactive contamination of three nearby properties in the Town of Tonawanda: the Ashland 1 property, the Seaway property, and the Ashland 2 property. Together these three properties, with Linde, have been referred to as the Tonawanda Site (Figures 1-1 and 1-2). This ROD addresses the Linde Site.

USACE is the lead agency for purposes of selecting and implementing the remedial action pursuant to authority established in CERCLA and Public Law 105-245. The Linde Site is not listed on the United States Environmental Protection Agency's (USEPA) National Priority List. For purposes of FUSRAP, the Linde Site remedial actions will address only hazardous substances that were released during the period of MED contract work and related to activities in support of MED and not any earlier or later releases of hazardous substances that may have occurred, except to the extent they may be commingled with the MED-related hazardous substances.

1.2 Site and Vicinity Land Use

1.2.1 Site Description

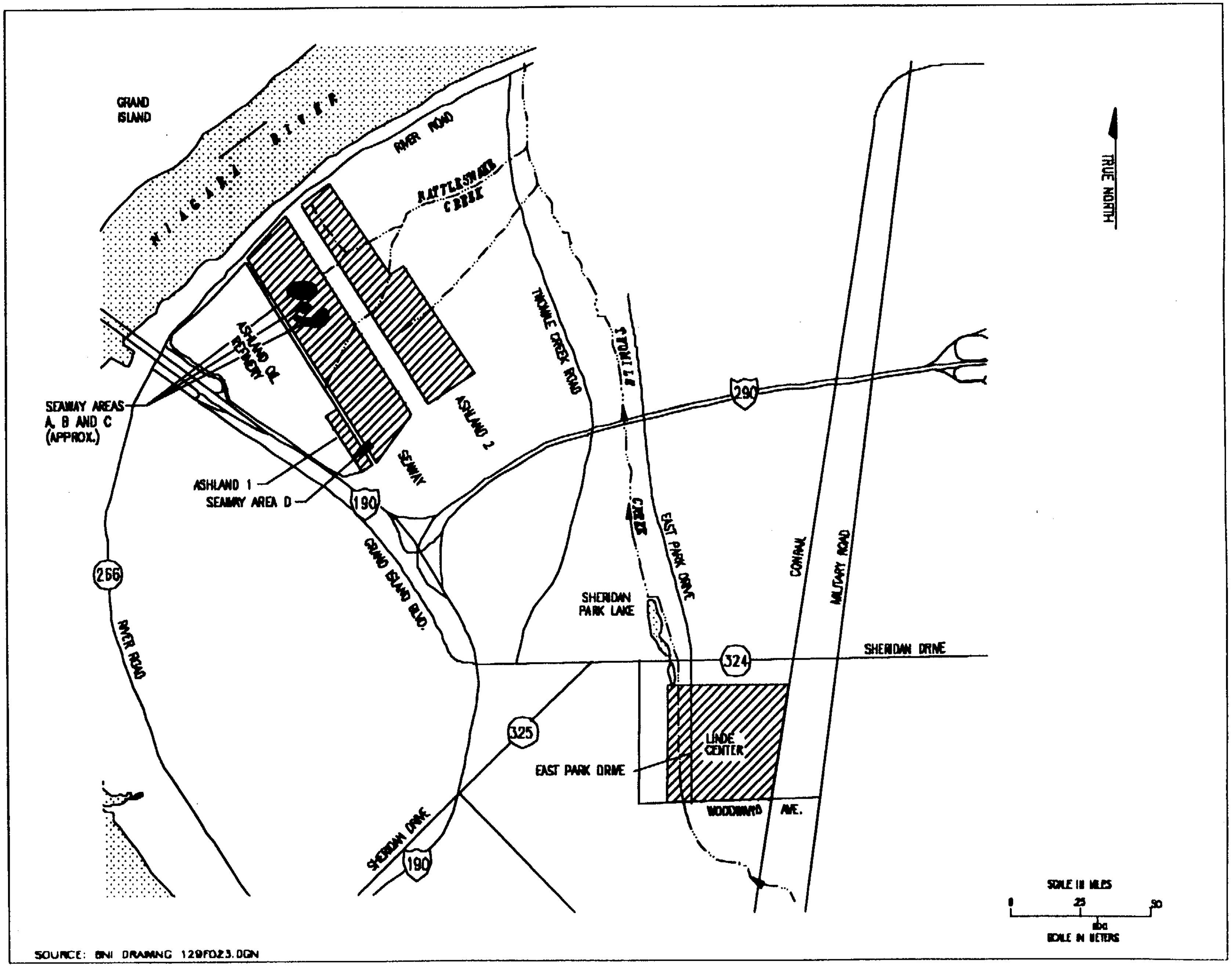
The Linde Site is now owned by Praxair and comprises about 135 acres located at East Park Drive and Woodward Avenue in the Town of Tonawanda. The site is bounded on the north and south by other industry and small businesses, on the east by the CSX Corporation (CSX) [formerly Consolidated Rail Corporation (Conrail)] railroad tracks and Niagara Mohawk property and easements, and on the west, by a park owned by Praxair which is open to the public. The regional and vicinity locations of the Linde Site are shown in Figures 1-1 and 1-2, respectively.

The property contains office buildings, fabrication facilities, warehouse storage areas, material laydown areas, and parking lots (Figure 1-3). Access to the property is controlled by Praxair. Approximately 1,400 employees work at the Praxair facilities.

The property is underlain by a series of utility tunnels that interconnect some of the main buildings and by an extensive network of storm and sanitary sewers. (Section 1.3.1 describes stormwater drainage at Linde.)

The Linde property is generally flat. In assessing stormwater runoff, the RI report (BNI 1993) estimates that approximately half of the Linde plant area is covered with impervious surfaces such as roofs, paved areas and sidewalks; and the other half is covered with a packed gravel surface that allows infiltration of precipitation. Several railroad spurs extend onto the property from the CSX property east of the site. A

[This should be Figure 1-1. It doesn't print or even appear on the screen. A message appears which says, "There was an error processing a page. Operation or data is too complex]



SOURCE: BNI DRAWING 129F023.DGN
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FIGURE 1–2
VICINITY LOCATIONS OF ASHLAND 1, ASHLAND 2,
SEAWAY AND LINDE SITES

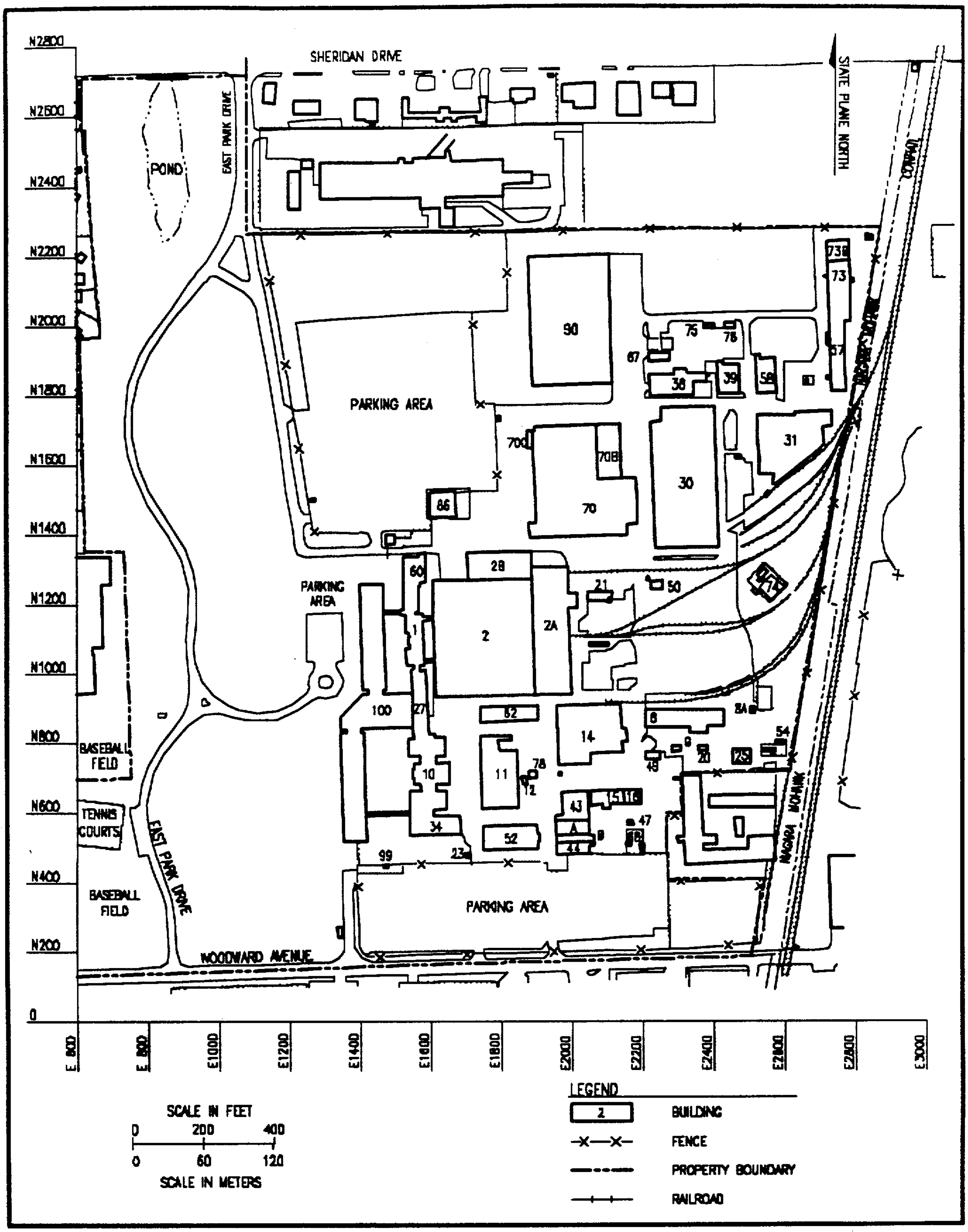

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FIGURE 1-3
LINDE SITE LOCATIONS

soil and timber blast wall is located east of Building 58. A subsurface storage vault, shown on a 1946 drawing of the Linde property, is believed to be located about 15 feet west of Building 73, based on a ground penetrating radar (GPR) investigation during the RI. Radioactive waste may be contained in this structure. Details of radioactive materials detected at Linde during the RI and subsequent investigations are described in Section 5 of this ROD.

1.2.2 Vicinity Description

Land uses in proximity to the Linde property include the CSX property, commercial and residential areas, and Kenmore Sisters of Mercy Hospital to the east, small businesses, light industries, and residential areas to the north, business and industrial areas to the south, and a low density residential area and Holmes Elementary School to the west. Sheridan Park, owned by the Town of Tonawanda's Parks and Recreation Department, is located one-fourth mile to the northwest of the Linde property. Two Mile Creek flows through this property. Recreational uses include an 18-hole public golf course, picnicking, and playgrounds. Sensitive uses within one mile of the Linde property include five schools, two community buildings, and a senior citizens' center. The Linde property is fenced and has a buffer zone of grass and trees around the main buildings (DOE 1993b).

1.2.3 Zoning and Future Land Uses

The Linde Site is currently used for commercial and industrial purposes, and industrial facilities have been present at the site for more than 60 years. As described above, the site is surrounded by industries and small business on three sides and by a park, which is owned by Praxair, on the side.

The Town of Tonawanda has adopted a zoning ordinance that regulates land uses. Zoning districts were established to permit varying degrees of land uses. There are three residential zoning districts, two commercial districts, and an industrial district. The Town of Tonawanda also has two other districts: performance standards and waterfront.

Most of the Linde property is owned by Praxair. A small parcel (4.7 acres), located within the Linde property, is owned by the Erie County Industrial Development Agency (ECIDA). The ECIDA purchased the property as an incentive for Linde to expand. The ECIDA is exempt from paying property taxes on the parcel and the parcel is used by Linde as a logistics center (DOE 1993b).

The Linde property is located in a Performance Standards Zoning District. The purpose of the Performance Standards District is to encourage and allow the most appropriate use of the land available now as well as approaching future commercial and industrial uses unhampered by restrictive categorizing, thus extending the desirability of flexible zoning, subject to change with changing conditions. Restrictions in this district permit an institution for human care or treatment or a dwelling unit only if the development abuts a residential zoning district. Other restricted uses include junkyards, waste transfer or disposal, land mining and stockyards. Any proposed uses must follow the acquisition of a Performance Standards use permit. Performance Standards uses are not permitted that exceed New York State regulations or other standards listed in the zoning codes book, such as standards for noise, odor emission, dust emission, and vibrations, as measured at the individual property line.

Zoning in the Linde property vicinity includes a business district to the north, a low-density residential area to the west, and the Performance Standard District to the south and east.

Current zoning for the site as a Performance Standard area is to encourage and allow the most appropriate use of the land available now as well as approaching future commercial and industrial uses unhampered by restrictive categorizing. Because the west boundary of the site abuts a residential zone, construction of an institution for human health care or treatment or a dwelling unit are not strictly prohibited under the Performance Standard zoning category. However, given the past and current use of the Linde Site for industrial and commercial uses t for more than 60 years, including the ownership of part of the property by ECIDA to promote industrial use, USACE has concluded that the reasonably anticipated future land use of the property will be for industrial/commercial purposes (USACE 1999b) (USACE 2000).

1.3 Physical and Environmental Site Characteristics

1.3.1 Topography and Surface Water Drainage

The Linde Site is relatively flat and is situated on a broad lowland east of Two Mile Creek, a tributary of the Niagara River. Two Mile Creek begins south of Linde in a natural channel. Near the southern boundary of the Linde Site flow in Two Mile Creek is directed into twin subsurface 9 feet (ft) x 7 ft box conduits which traverse the Linde Site, underground. Stormwater runoff from Linde is collected in the facility's stormwater sewer system and is discharged to the two conduits. The twin conduits carry Two Mile Creek flows northerly, ultimately discharging through two large flow control gates located on the downstream face of the concrete dam that impounds Sheridan Park Lake. The control gates are pressure operated, releasing storm flow from the conduits, when necessary. Downstream of the Sheridan Park Dam, the natural channel of the Two Mile creek conveys flow in a generally northerly direction to the Niagara River, approximately 2 ¼ miles north of the Linde Site (see Figure 1-2).

1.3.2 Geology

The Linde Site is located within the Erie-Ontario Lowland Physiographic Unit of New York (BNI 1993). The Erie-Ontario Lowland has significant relief characterized by two major escarpments—the Niagara and the Onondaga. The elevation of the ground surface is approximately 600 ft above mean sea level at the Linde Site (BNI 1993).

1.3.2.1 Regional Geology

Mapping of regional bedrock geology indicates that the site area is situated on clayey glacial till. Underlying this glacial till is the Camillus Shale of the Salina Group. This Upper Silurian formation is approximately 400 ft thick in the area and consists predominantly of gray, red, and green thin-bedded shale and massive mudstone. Interbedded with the shale and mudstone are relatively thin beds of gypsum, dolomite, and limestone. The Camillus Shale dips southward at approximately 0.8%. The formation contains broad, low folds with amplitudes of a few feet and frequencies of a few hundred feet. The fold axes are generally oriented from east to west.

1.3.2.2 Site Bedrock Geology

Boring logs for eight (8) monitoring wells constructed at Linde during the RI show bedrock encountered at depths ranging from approximately 82 to 96 ft (BNI 1993).

The bedrock encountered (shales of the Salina Group) is generally described as a gray shale and mudstone with abundant thin layers and irregularly shaped masses of gypsum. In some intervals, as thick as 10 ft., gypsum constitutes as much as half of the rock. The thickest individual gypsum layer found was 1 ft. Generally, gypsum is present in only small amounts, as joint and fracture fillings.

All boreholes with significant core recovery showed moderate to extensive fracturing in the upper 6 to 15 feet of bedrock. Cores were noted to be only slightly fractured in most places below this upper zone. Joints were primarily perpendicular to the core axes and parallel to bedding planes. Joint surfaces were mostly planar to gently undulated and slightly rough. Partial to full gypsum crystal development characterized many joints and a few joints were coated with mud. Jointing was found to be common at the contact between gypsum and shale. Core descriptions by field geologists indicate that solution features are relatively common in the bedrock, especially in the gypsum.

1.3.2.3 Site Soils

Based on numerous soil borings, the RI report indicates that the natural soils at Linde appear to be covered by a fill layer ranging in thickness from 0 to 17 ft. As noted in boring logs, the fill contains substantial quantities of slag and fly ash that was apparently brought on-site from local sources for grading purposes during the construction of the Linde facility (BNI 1993).

Undisturbed soils that underlie the site are composed primarily of clay and sandy clay. These soils have low permeabilities precluding significant infiltration of precipitation.

1.3.3 Groundwater

1.3.3.1 Regional Hydrogeology

Information on regional hydrogeology available in the RI report (BNI, 1993), indicates that the unconsolidated materials contain the most productive water-bearing zones in the Niagara Region. These materials have a wide range of hydrogeologic properties, caused by variations in thickness, distribution and lithology. In areas where relatively thick sequences of coarse-grained glaciofluvial deposits are present, well yields as much as 700 gallons per minute (gpm) are reported.

The soluble limestone and dolomites of the Salina Group and the overlying Onondaga Formation are considered to be a single aquifer. Groundwater within this aquifer is controlled by secondary porosity features (i.e., fractures, joints, and bedding plane openings). These discontinuities have been enlarged by the solutioning of gypsum by groundwater. Wells completed in this aquifer can yield as much as 300 gpm, but generally yield less then 100 gpm. Groundwater obtained from this aquifer is generally potable except where groundwater has been degraded by upward movement of mineralized water from the underlying shales of the Salina Group.

The Camillus Shale (shales of the Salina Group) is the most productive bedrock aquifer in the region. Water in this formation is obtained primarily from solution cavities that have formed as the gypsum contained in the rock dissolved. Yields from individual wells of greater than 1,000 gpm from the Camillus Shale are not unusual in the Buffalo-Tonawanda area.

Groundwater in the shales of the Salina Group generally exists under artesian conditions. Records of wells drilled at and near the Linde Site indicate that water rises to a depth approximately 40 ft below the surface of the land in wells completed in the shale. Average hydraulic conductivities measured at these wells are in excess of 1×10^{-3} ft/s (3×10^{-2} centimeters/second [cm/s]). These relatively high hydraulic conductivities can be attributed almost entirely to the gypsum solution cavities.

Although the shales of the Salina Group constitute the most productive bedrock aquifer in the region (well yields as much as 1,200 gpm), the shales also contain the poorest quality water. Groundwater from these shales have high concentrations of dissolved solids, calcium, magnesium, sulfate and chloride. In the vicinity of the Linde Site, waters drawn from wells completed in the shale typically have total dissolved solids contents ranging from 2,000 to 6,000 milligrams/liter (mg/L), sulfate contents of 1,000 to1,500 mg/L, and chloride contents of 1,500 to 2,000 mg/L. These high levels of total dissolved solids and salinity (derived from the evaporates) preclude use of this water for potable consumption without extensive, costly treatment. Its use is restricted to certain industries that can tolerate the high salinity and total dissolved solids.

Underlying the Salina Group are the dolomites of the Lockport Formation. Like the Salina Group, the dolomites have secondary porosity developed in open bedding, joints, fracture zones, and solution widened discontinuities. Reported well yields for the Lockport Formation (as much as 110 gpm) are lower than the Salina Group. Because the Lockport Formation contains a gypsiferous zone, the groundwater typically contains high concentrations of sulfate rendering it to be non-potable.

1.3.3.2 Site Hydrogeology

At the Linde Site, the most productive water-bearing zone is comprised of the coarse-grained basal zone of the unconsolidated deposits and the fractured and jointed upper part of the Salina Group bedrock. This zone is collectively referred to as the contact-zone aquifer. Because bedrock does not occur at uniform depths throughout the area and the favorable water-bearing characteristics of the bedrock portion may not always correspond to the areas of coarsest-grained overburden, differences in the water-bearing properties of the contact zone aquifer may occur within short distances.

Information on the contact-zone aquifer is based on data from a total of 19 deep boreholes/wells across the Tonawanda properties (i.e., 11 at Ashland 1 & 2 and 8 at Linde). Data from the 19 deep boreholes/wells indicate that groundwater in the contact-zone aquifer is under confined conditions. At location B32W02D water rose more than 55 ft above the top of the contact zone. At the Linde Site, groundwater rose 40-50 ft above the contact zone.

Recharge to the contact-zone aquifer probably occurs at several locations. For example, carbonate rocks that constitute an aquifer to the south are exposed (or are minimally covered by unconsolidated material) 3.5 to 4.5 miles southeast of Linde. Also, coarse-grained alluvial deposits along Ellicott Creek, approximately 6 miles east of Linde, may be hydraulically connected to the contact zone aquifer.

Piezometric surface maps for the contact-zone aquifer at the Tonawanda properties indicate fairly flat hydraulic gradients throughout the Tonawanda properties (i.e., gradients ranging from 0.0004 to 0.0005 ft/ft at Ashland 1 and the southeast portion of Ashland 2).

At Linde, the piezometric surface appears to slope gently to the southwest. Projections of piezometric contours suggest that the low heads probably existed in the industrial area along Sheridan Drive from the Niagara River to Kenmore Avenue. Several high capacity industrial wells are located in this area including wells owned by Goodyear Tire and Rubber (also referenced as Dunlop Tire and Rubber in the RI), E.I. DuPont de Nemours and Company (also referenced as E.I. DuPont and Co. in the RI), and Linde Air Products Corp.; a subsidiary of Union Carbide Industrial Gas (Linde), now owned by Praxair, Inc. It is reported that well yields for the industrial wells ranged from 90 to 3,000 gpm (or 0.1 to 4.3 million gallons per day).

Estimates of average linear groundwater velocity for the contact-zone aquifer provided in the RI report are based on piezometric data along with estimates of hydraulic conductivity. The estimated groundwater flow velocity was reported to range from 5.5 feet/year (ft/yr) to 82 ft/yr.

1.3.4 Ecological and Cultural Resources

1.3.4.1 Terrestrial Biota

The Linde property supports several nearby mature eastern cottonwood, American sycamore, white ash, northern red oak, and shagbark hickory trees that were planted during landscaping activities. Urban lawns with plantings of shrubs were also established and are given periodic maintenance. Original vegetation was destroyed and natural plant succession has been disrupted during the industrial development and use of the Linde facility and surrounding area. Years of continuous industrial activity have left only marginal areas for natural plant communities. The property provides minimal urban wildlife habitats, supporting only the cosmopolitan species of birds and small mammals (DOE 1993b).

1.3.4.2 Aquatic Biota

The pond, located in the northwest corner of the Linde property, is connected to Sheridan Park Lake by a culvert underneath Sheridan Drive. Sheridan Park Lake is stocked annually by the New York State Department of Environmental Conservation (NYSDEC) with about 2,000 adult calico bass (BNI 1993). An aquatic biota survey conducted of Sheridan Lake by NYSDEC in 1980 indicated the presence of warm water fish such as goldfish and perch.

Sections of Two Mile Creek's channel below Sheridan Park Lake are cleared of sediments annually by park staff. Increased water turbidity and disturbance of benthic and possibly of fish communities by physical removal are likely to result from this activity.

1.3.4.3 Floodplains and Wetlands

No portion of the Linde property is within the 100-year flood zone of Two Mile Creek since it is contained in twin box culvert conduits along the western boundary of the property (DOE 1993b).

A review of National Wetland Inventory (NWI) maps (Tonawanda West and Buffalo Northwest quadrangles) identified no floodplains or wetlands onsite at Linde. Surface runoff from the site drains into two offsite floodplain and wetland areas to the north and west. West of Linde, a marshy strip lying along the twin conduits situated in the stream bed that runs parallel to the western boundary and empties into Two Mile Creek is mapped as a palustrine emergent floodplain and wetland with persistent narrow-leafed vegetation and temporary water regime. On the northeast corner of Linde, a palustrine forested floodplain and wetland with broad-leaved deciduous vegetation and a temporary water regime was identified on NWI maps. Also, information in the *Soil Survey of Erie County, New York* indicates areas of Linde that meet the criteria for hydric soils (DOE 1993b).

1.3.4.4 Endangered and Threatened Species

Except for occasional transient individuals, no federally-listed or proposed endangered or threatened species under jurisdiction of the United States Fish and Wildlife Service (USFWS) have been sighted in the project impact area. The most likely listed species to appear on or near the sites are the osprey, bald eagle, and peregrine falcon. No listed or suspected critical habitats occur on the Linde Site (DOE 1993a).

1.3.4.5 Archaeological, Cultural, and Historical Resources

A review of New York State records on archaeological, cultural, and historical resources indicates that none of these resources is close to the project area. Specifically, State Historical Preservation Office (SHPO) records do not indicate any known archaeological sites within a mile of the project area. In addition, SHPO records indicate that there are no cultural or historic sites near the project area listed on or eligible for the National Register of Historic Places (DOE 1993b).

2. SITE HISTORY

2.1 Site History Overview

As described in the foregoing sections, during the early to mid-1940's, Linde Center was contracted by MED to separate uranium from pitchblende uranium ore and domestic ore concentrates. These processing activities resulted in elevated levels of radionuclides in portions of the property and buildings. Subsequent disposal and relocation of processing wastes from Linde resulted in elevated levels of radionuclides at three nearby properties in the Town of Tonawanda: the Ashland 1 property, the Seaway property, and the Ashland 2 property.

The history of the Linde Site is summarized below. (Refer to Figure 1-3 for locations.)

2.2 History of the Linde Property

2.2.1 Site Ownership

Tax mapping property information of the Town of Tonawanda indicates ownership of property at the Linde Site location by Union Carbide, Linde Division, in 1936. While portions of the land at the site were previously owned by the Town of Tonawanda, Excelsior Steel Ball Company, Metropolitan Commercial Corporation, and the Pullman Trolley Land Company, the land was not used by any of these owners (FBDU 1981). It is likely that at some time in the past, the land was farmed (FBDU 1981). Commercial industrial processes were being conducted at the Linde Site by the Linde Air Products Division of Union Carbide prior to MED operations in the 1940's. Union Carbide operations continued at the Linde Site after the MED-related activities ceased. In the 1990's Praxair acquired the property and continued to perform commercial industrial processes focusing primarily on research and development.

A radiological survey report prepared for the Linde Site by Oak Ridge National Laboratory (ORNL) in 1978 reports that the "site was used for the separation of uranium dioxide from uranium ores and for the conversion of uranium dioxide to uranium tetrafluoride during the period of 1940-1948" (ORNL 1978). The 1978 ORNL report also states that the Linde Air Products Division was under contract to MED to perform uranium separations from 1940 through approximately 1948 (ORNL 1978).

As described in the RI report, five (5) Linde buildings were involved in MED activities: Building 14 (built by Union Carbide in the mid-1930's) and Buildings 30, 31, 37, and 38 (built by MED on land owned by Union Carbide) (BNI 1993). Ownership of Buildings 30, 31, 37, and 38 was transferred to Linde when the MED contract was terminated (BNI 1993). As discussed in the RI report, there were three phases to the processing conducted at Linde – Phase 1: uranium separation from the ore; Phase 2: conversion of triuranium octoxide (U_3O_8) to uranium dioxide; and Phase 3: conversion of uranium dioxide to uranium tetrafluoride. The RI report states that the contaminants of concern at the Linde Site were primarily associated with the waste streams and residues of the Phase 1 operation and that any residues from the Phase 2 and 3 operations were reprocessed, which is discussed in more detail in Section 2.2.2. All phases of operation have been reported to have occurred during the 1942 to 1946 period. A review of historical and recent documents indicates that the operations may have extended to the year 1948, particularly the Phase 2 and 3 operations (DOE 1997). Regardless of the actual duration of operations, the primary activity over most, if not all of the period during which MED-related activities occurred at the Linde Site was the separation of uranium from the ore; and the principal contaminants of concern were from the processing of wastes and residues from that operation since the residues from the other two phases were reported to have been recycled (Aerospace 1981).

2.2.2 Uranium Processing at Linde

As described in the RI report, Linde was selected for a MED contract because of the company's experience in the ceramics business, which involved processing uranium to produce salts used to color ceramic glazes. Under the MED contract, uranium ores from seven different sources were processed in Linde: four African ores (three low-grade pitchblendes and torbernite) and three domestic ores (carnotite from Colorado) (BNI 1993).

The domestic ore tailings sent to Linde resulted from commercial processing, conducted primarily in the Western United States, to remove vanadium. The vanadium removal process resulted in disruption of the uranium decay chain and the removal of radium. For this reason, uranium supplied to Linde had low concentrations of radium compared with the natural uranium (U) and Thorium-230 (Th-230) concentrations.

The African ores shipped to Linde as unprocessed mining ores contained uranium in equilibrium with all of the daughter products in its decay chain (e.g., Th-230 and radium-226 [Ra-226]). The other constituents of the ores were similar to those of the domestic ores. Laboratory and pilot plant studies were conducted at Linde from 1942 to 1943 and uranium processing began at Linde in 1943 (BNI 1993). From mid-1943 to mid-1946, a total of about 28,000 tons of ore was processed at Linde (Aerospace 1981).

A three-phase process was used to separate uranium from the uranium ores and tailings. Phase 1 (conducted in Building 30) consisted of separating U_3O_8 from the feedstock materials by a series of process steps consisting of acid digestion, precipitation, and filtration. The filtrate (liquid remaining from the processing operations) from this step was discarded as liquid waste into the injection wells, storm sewers, or sanitary sewers, and the filter cake was discarded as solid waste and was ultimately taken to Ashland 1. The U_3O_8 from Phase 1 was processed into uranium dioxide (UO_2) in Phase 2 (Building 30). In Phase 3 (Buildings 31 and 38), the uranium dioxide was converted to uranium tetrafluoride (UF_4). Residues from Phases 2 and 3 were reprocessed (Aerospace 1981).

The principal solid waste resulting from Phase 1 was a solid, gelatinous filter cake consisting of impurities remaining after filtration of the uranium carbonate solutions. Phase 1 also produced insoluble precipitates of the dissolved constituents, which were combined with the tailings. The precipitated species included large quantities of silicon dioxide, iron hydroxide, calcium hydroxide, calcium carbonate, aluminum hydroxide, lead sulfate, lead vanadate, barium sulfate, barium carbonate, magnesium hydroxide, magnesium carbonate, and iron complexes of vanadium and phosphorus (Aerospace 1981).

Between 1943 and 1946, approximately 8,000 tons of filter cake from the Phase 1 processing of domestic ores were taken from the temporary tailings pile at Linde and transported to the former Haist property, now known as Ashland 1. These residues contained approximately 0.54 percent uranium oxide [86,100 pounds (lbs) of natural uranium], which corresponds to 26.5 curies (Ci) of natural uranium. Because the residues from the African ore were relatively high in radium content compared with processed domestic ore residues, the African ore supplier required that the African ore residues be stored separately so that the radium could be extracted. Between 1943 and 1946, approximately 18,600 metric tons (20,500 tons) of residues were shipped to the former Lake Ontario Ordnance Works in Lewiston, New York, where they could be isolated and stored in a secure area (Aerospace 1981). The production progress reports also showed that approximately 140 metric tons (154 tons) of African ore residues were shipped to Middlesex, New Jersey (Aerospace 1981).

2.2.3 Disposal of Liquid Effluent from Uranium Processing and Groundwater at the Linde Site

The 1993 RI report for the Tonawanda Site (BNI 1993) indicated that approximately 55 million gallons of waste effluent containing dissolved uranium oxide was injected into the subsurface at Linde through seven (7) wells over a period of three years beginning in 1944. The RI report further indicated that precipitates were formed in the bedrock formation where injection occurred. The RI report concluded that the subsurface radioactive contamination probably occurs in the subsurface at Linde as minor percentages of uranyl sulfates and carbonates precipitated in the shale under the Linde Site where they are presumed to be immobile (BNI 1993). This ROD does not address the groundwater at the Linde Site. A ROD will be issued in the future that evaluates the Site groundwater and selects any required remedial action.

2.3 Site Investigations and Studies

Extensive investigations and studies of the Linde Site and Linde Site conditions were conducted and were relied upon in the preparation of the RI report, BRA, and FS for the Linde Site, which were issued by DOE in 1993. USACE reviewed these DOE documents, conducted additional studies of the Linde Site, and issued the results of these studies in 1999. The following briefly identifies the key investigations and studies of the Linde Site that are available in the administrative record files.

The principal MED-related radiological COCs identified in the investigations conducted at the Linde Site are total uranium, radium and thorium. Additional details of site contamination are presented in Sections 5 and 6.

2.3.1 DOE Remedial Investigation

A two-phase remedial investigation of the Tonawanda Site, including Linde, was conducted by DOE from 1988 to 1992. The remedial investigation incorporated the findings of earlier site investigations including, but not limited to, a radiological survey of the site in 1976 by ORNL (ORNL 1978) and an evaluation of 1943 to 1946 liquid effluent discharge from the Linde plant (Aerospace 1981). The 1993 DOE RI report lists these and other references relied upon by DOE in preparing the report.

The 1993 DOE RI report (BNI 1993) describes the investigations conducted at the Linde Site and the findings of investigations and studies to characterize site conditions, determine the nature and extent of contamination, and characterize the fate and transport of contamination in site media.

2.3.2 DOE Baseline Risk Assessment

Using the results of the investigations and studies reported in the RI report, DOE conducted a baseline risk assessment and reported the findings in the BRA issued by DOE in 1993 (DOE 1993a). The BRA describes the potential risks to human health and the environment posed by the presence of MED-related contamination. No significant risks from chemical contamination were identified. The BRA found that radiological contamination could pose risks to human health if exposures to contamination in some Linde Site areas is not controlled or remediated.

2.3.3 DOE Feasibility Study

Based on the findings of the RI report and BRA, DOE conducted an FS to identify and evaluate remedial alternatives for the Tonawanda Site properties, including Linde. Cleanup objectives for the site were those that DOE uses under DOE Orders, which are not applicable to USACE. Included among the alternatives evaluated was an alternative envisioning the excavation of MED-contaminated soil from the Linde Site, and the other three Tonawanda Sites (Ashland 1, Ashland 2 and Seaway) and containment of all the Tonawanda Site contaminated soils in an engineered cell on Ashland 1, Ashland 2 or Seaway. Other alternatives included complete excavation with off-site disposal and partial excavation leaving inaccessible MED-contaminated soils in place. The details of the FS are available in the FS report (DOE 1993b) issued by DOE in 1993.

2.3.4 1993 DOE Proposed Plan

In November 1993, DOE issued its PP for the Linde Site (DOE 1993c). As described in Part I of this ROD, the remedial alternative recommended in the 1993 PP recommended containment of all MED-contaminated soils from the Tonawanda Site at an engineered cell to be constructed at Ashland 1, Ashland 2, or Seaway. Due to public concern over this proposed cell, DOE suspended further actions in order to re-evaluate remedial alternatives for the Tonawanda Sites, including Linde.

2.3.5 USACE Technical Memorandum: Linde Site Radiological Assessment

In early 1999, USACE, having no specific ARAR standards that addressed residual concentrations of uranium in soils, prepared a document entitled Technical Memorandum: Linde Site Radiological Assessment (USACE 2000). The USACE assessment (USACE 2000) considered the radiological risk associated with the presence of uranium in the Linde Site soils and also the risks associated with uranium due to its chemical toxicity. As described in the assessment report (USACE 2000), a uranium cleanup level for the Linde Site soils based on limiting radiological risks was determined to be more restrictive than the cleanup level based on the chemical toxicity of uranium. USACE found that the total residual uranium concentration could range from approximately 7 to 740 pCi/g for an intended future of industrial land use, which results in potential maximum radiological risks ranging from 10^{-6} to 10^{-4}, respectively. An evaluation of the radiological assessment report (USACE 2000) concludes that the risks associated with the residual radium and thorium concentrations after remediation to the 40 CFR Part 192 standards are approximately 10^{-5} for the assessment areas. Therefore, USACE chose a uranium cleanup guideline of 600 pCi/g for total uranium, which is based on limiting potential radiological risks due to uranium in the Linde Site soils to less than 10^{-4}. USACE evaluated using 600 pCi/g for total uranium as a cleanup guideline for these isolated spots throughout the site to estimate what the residual uranium concentrations would be after removing isolated spots exceeding this guideline. USACE found that the average residual uranium source term concentrations in the various assessment units (USACE 2000) would be below 60 pCi/g.

Since that evaluation, new regulations amending 10 CFR 40, Appendix A, Criterion 6(6) were promulgated by the NRC and became effective on June 11, 1999. These regulations were evaluated and determined to be relevant and appropriate for the Linde Site since they addressed residual uranium and other radionuclides present at uranium mill sites, similar to the Linde Site. USACE then used the information contained in this radiological assessment (USACE 2000) to determine what the surface and subsurface cleanup benchmark doses would be for the average member of the critical group (commercial/industrial worker scenario) and the associated concentration limits for each of the radionuclides to be used in computing the sum of the ratios for each radionuclide of concern present to the concentration limit which is limited to unity or less. The results of the evaluation found that the surface and subsurface cleanup benchmark doses for a commercial/industrial worker scenario were 8.8 mrem/y and 4.1 mrem/y, respectively. The various radionuclide concentration limits, above background, within a 100 square meter area for the surface cleanup benchmark dose were 554 pCi/g of U_{total}, 5 pCi/g of Ra-226 and 14 pCi/g of Th-230. The various radionuclide concentration limits, above background, within a 100 square meter area for the subsurface cleanup benchmark dose were 3,021 pCi/g of U_{total}, 15 pCi/g of Ra-226 and 44 pCi/g of Th-230.

2.3.6 USACE Addendum to the Feasibility Study for the Linde Site

In March 1999, USACE issued its Addendum to the Feasibility Study for the Linde Site (USACE 1999b). The Addendum to the FS focuses on the Linde Site and summarizes findings and assessments not available at the time the 1993 DOE FS (DOE 1993b) was prepared. Key findings of the 1993 DOE documents pertaining to the Linde Site and findings of the recent USACE Linde documents are included. The status of building demolition and decontamination at Linde is updated, and updated information on radiological contamination is summarized. The alternatives considered for the Linde Site are described and evaluated, including risks and costs.

2.3.7 Proposed Plan for the Linde Site

In March 1999, USACE also issued its Proposed Plan (PP) for the Linde Site (USACE 1999c). The PP summarizes findings of Linde Site investigations and studies, identifies the cleanup criteria for Linde Site remediation, describes the remedial action alternatives identified and evaluated by USACE, describes the findings of the evaluation, and proposes a plan for remediation, referred to as Alternative No. 4, which involves the excavation and off-site disposal of contaminated soils, decontamination of buildings, and the imposition of institutional controls in Building 14 of the Linde Site, where a minor amount of contamination would be left after remediation is completed. The details of the alternatives considered for Linde Site remediation are described in Section 7 of this ROD. An explanation of the significant differences between the PP and this ROD is provided in Section 11 of this ROD.

The remedy selected for the Linde Site includes the residual radioactive material removal and building and slab removal actions of Alternative 2 as described in the March 1999 PP but does not include Building 14 nor the soils beneath Building 14.

2.3.8 Recent Removal Actions Conducted at Linde

From 1995 to the present, several removal actions have been undertaken at the Linde Site. These actions are summarized in the following section.

2.3.8.1 Demolition of Building 38

In January 1996, DOE issued an Engineering Evaluation/Cost Analysis (EE/CA) for Praxair Interim Actions (DOE 1996a). This EE/CA addressed demolition of Building 38 and the cleanup of radioactively contaminated soil that was located next to Building 90 at Linde. Demolition of Building 38 and the off-site disposal of contaminated debris from Building 38 and the contaminated soil near Building 90 has been completed consistent with the preferred alternative described in the EE/CA.

2.3.8.2 Decontamination of Buildings 14 and 31

The January 1996 DOE EE/CA (DOE 1996a) also stated DOE's intent to decontaminate Buildings 14, 31, and 30 at the Linde Site. A categorical exclusion was prepared by DOE under the National Environmental Policy Act (NEPA) to address the decontamination at Buildings 14 and 31 (DOE 1996a). Decontamination work at Buildings 14 and 31 has been completed.

A report entitled *Post Remedial Action Report for Building 14 at the Linde Site, Tonawanda, New York* (USACE 1998c), provides details of efforts initiated under DOE to decontaminate Building 14 interior surfaces and subsurface soils beneath slabs inside the building where MED-related activities occurred. These decontamination efforts were completed by USACE in 1998. The decontamination criteria for the soils and surfaces used during this effort were established by DOE. The decontamination efforts were completed by USACE as part of the transfer of the FUSRAP from DOE to USACE and Congress' mandate for USACE to honor DOE's past commitments. A few currently inaccessible areas were identified where removal to the criteria established by DOE was not possible.
The report (USACE 1998c) indicates that risks from residual materials remaining in currently inaccessible areas would be acceptable under current circumstances and building uses and controls.

A document entitled *FUSRAP Technical Memorandum: Delineation and Remedial Action Performed in Building 31* at the Praxair Site (BNI 1997a) describes the decontamination performed in Building 31. The decontamination work was performed by DOE using criteria established by DOE. An ORNL report entitled *Results of the Independent Radiological Verification Survey of Remediation at Building 31, Former Linde Uranium Refinery* (ORNL 1998) indicates the decontamination in accordance with DOE criteria was successful. The report notes that there is still radioactive contamination under part of the Building 31 slab. Removal of the Building 31 slab and the contamination beneath the slab is included in the remedy selected for implementation at the Linde Site.

2.3.8.3 Demolition of Building 30

In November 1996, DOE issued an EE/CA addressing the demolition of Building 30 at Linde and the off-site disposal of the resulting contaminated building rubble (DOE 1996b). USACE issued a responsiveness summary and Action Memorandum selecting the preferred alternative as the appropriate course of action in February of 1998. The demolition of Building 30 was completed in accordance with the Action Memorandum in September 1998.

3. HIGHLIGHTS OF COMMUNITY PARTICIPATION

Public input was encouraged to ensure that the remedy selected for the Linde Site meets the needs of the local community in addition to being an effective solution to the problem. The administrative record file contains all of the documentation used to support the preferred alternative and is available at the following locations:

U.S. Army Corps of Engineers
Public Information Center
1776 Niagara Street
Buffalo, NY 14207-3199

Tonawanda Public Library
333 Main Street
Tonawanda, NY 14150

Letters announcing the release of the Proposed Plan were mailed on March 26 to 858 members of the community on the site mailing list. Advertisements announcing the release were placed in The Buffalo News on March 28, the Niagara Gazette on March 28, the Tonawanda News on March 31, The Record Advertiser on March 31, and The Ken-Ton Bee on March 31. A news release was also issued to the same newspapers.

USACE's PP for the Linde Site was issued on March 26, 1999 (USACE 1999c), the comment period started on March 28, 1999, and USACE granted extensions to the comment period through June 11, 1999.

Public meetings were held on April 27 and June 3, 1999 to provide information about the remedial alternatives and the opportunity to submit comments on the PP. Responses to public comments are presented in the Responsiveness Summary, which is provided as an appendix in this document. The Responsiveness Summary, combined with the FS and revised PP, will constitute the final FS and PP for the Linde Site.

Discussions regarding the significant changes between the PP and this ROD are presented in Section 11. As indicated in Section 11, a new public comment period is not required for the changes. The work excluded from this remedial action will be addressed in separate CERCLA documentation that will be presented to the public for comment at a later time. Also, the additional ARAR will not substantially affect the protectiveness of the remedy or subsequent uses of the site.

4. SCOPE OF REMEDIAL ACTION

The remedial action involves cleanup of MED-related radiological contaminated media and MED-related radiological contaminated structural surface areas in accordance with ARARs selected for the site.

4.1 Cleanup Criteria and Standards

The cleanup criteria and standards to be used in remediation of the Linde Site are described in the following sections.

4.1.1 ARARs

Agencies responsible for remedial actions under CERCLA must ensure that selected remedies meet ARARs. The following sections define ARARs and describe the ARAR adopted by USACE for cleanup of the Linde Site.

4.1.1.1 ARARs - Definitions

Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a CERCLA site. An applicable requirement directly and fully addresses an element of the remedial action.

Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria or limitations promulgated under federal environmental or state environmental or facility siting laws that while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is suited to the particular site.

Only those state standards that are promulgated, are identified by the state in a timely manner, and are more stringent than federal requirements may be applicable or relevant and appropriate. USACE has determined that the following are the cleanup ARARs for the remedial activities at the Linde Site.

4.2 ARARs for the Linde Site

The standards found in 40 CFR Part 192 are not considered applicable because the regulation is only applicable to specific sites designated under UMTRCA. However, USACE has determined that 40 CFR Part 192 is relevant and appropriate to the cleanup of the Linde Site. This determination was made based on the similarity of the ore processing activities to extract uranium and resulting radionuclides found in the waste after processing at uranium mill sites where the regulation is applicable.

Subpart B of 40 CFR Part 192 addresses cleanup of land and buildings contaminated with residual radioactive material from inactive uranium processing sites, and sets standards for residual concentrations of Ra-226 in soil. It requires that radium concentrations shall not exceed background by more than 5 pCi/g in the top 15 cm of soil or 15 pCi/g in any 15 cm layer below the top layer, averaged over an area of 100 m^2.

Subpart B also provides standards for any occupied or habitable building associated with the soils beneath or surrounding the building, not the equipment or surfaces within the building. These standards require that the remedial action shall be and reasonable effort shall be made to:

- achieve an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 Working Level (WL). In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL, and
- the level of gamma radiation shall not exceed the background level by more than 20 microroentgens per hour.

These 40 CFR Part 192, Subpart B requirements are considered relevant and appropriate to the cleanup of the Linde Site and buildings.

New regulations amending 10 CFR 40, Appendix a, Criterion 6(6) were promulgated and became effective on June 11, 1999. These regulations were evaluated and determined to not be applicable to the Linde Site. However, they were found to be relevant and appropriate for the Linde Site since they addressed residual uranium and other radionuclides present at uranium mill sites, similar to the Linde Site. 10 CFR 40, Appendix A, Criterion 6(6) requires that residual radioactive materials remaining after remediation will not result in a total effective dose equivalent (TEDE), considering all radionuclides present (e.g., radium, thorium, and uranium) to the average member of the critical group exceeding a benchmark dose established based on cleanup to the radium standards of 5 pCi/g in the top 15 centimeters and 15 pCi/g in subsequent 15 centimeter layers below the top layer and must be as low as reasonably achievable (ALARA). This benchmark dose is then used to establish allowable soil and surface concentration levels for the various radionuclides present other than radium.

Using the information contained in the radiological assessment (USACE 2000), USACE computed the benchmark doses for the cleanup of surfaces and subsurfaces. The results of the evaluation found that the surface and subsurface cleanup benchmark doses for a commercial/industrial worker scenario were 8.8 mrem/y and 4.1 mrem/y, respectively. The various radionuclide concentration limits, above background, within a 100 square meter area for the surface cleanup benchmark dose were 554 pCi/g of U_{total}, 5 pCi/g of Ra-226 and 14 pCi/g of Th-230. The various radionuclide concentration limits, above background, within a 100 square meter area for the subsurface cleanup benchmark dose were 3,021 pCi/g of U_{total}, 15 pCi/g of Ra-226 and 44 pCi/g of Th-230. These criteria would apply to the soils being remediated at Linde. The surface criteria will be developed for specific buildings or surfaces based on likely exposure scenarios and meeting the surface cleanup benchmark dose of 8.8 mrem/y. These specific surface criteria as well as appropriate ALARA principles will be included in their respective remediation work plans.

4.3 Summary of Remedial Action Objectives and Cleanup Standards and Guidelines for MED-Contaminated Media at the Linde Site

The general remedial action objectives for cleanup of the Linde Site are the CERCLA threshold criteria:

- the remedy must be protective of public health and the environment; and
- the remedy must attain ARARs.

In meeting these general remedial action objectives, USACE has determined that the standards of 40 CFR Part 192 and 10 CFR 40, Appendix A, Criterion 6(6) are relevant and appropriate for Linde Site cleanup. The cleanup criteria at the Linde Site will be the following: (1) the removal of soils exceeding the 40 CFR 192 standards for radium, which includes consideration of thorium, when averaged over 100 square meters; (2) removal of soils with residual radionuclide concentrations within a 100 square meter area that results in exceeding unity for the sum of the ratios of these radionuclide concentrations to the associated concentration limits, above background, of 554 pCi/g for U_{total}, 5 pCi/g for Ra-226 and 14 pCi/g for Th-230 for surface cleanups and 3,021 pCi/g of U_{total}, 15 pCi/g of Ra-226 and 44 pCi/g of Th-230 for subsurface cleanups, and (3) removal of residual radioactive materials from surfaces necessary to meet the benchmark dose for surfaces of 8.8 mrem/y based on the specific location of the surfaces and exposure scenarios. In addition to the above requirements of the ARAR, USACE will remediate the Linde site to insure that no concentration of total uranium exceeding 600 pCi/g above background will remain in the site soils. Application of the ARAR standards for MED-contaminated media at the Linde Site will be conducted as described, generally, below.

4.3.1 Soils Cleanup

Soils at the Linde Site exceeding the standards found in 40 CFR Part 192 will be excavated and disposed off-site as detailed in Section 7. In addition, in order to comply with 10 CFR Part 40, Appendix A, Criterion 6(6), soils within any 100 square meter area will be removed when necessary to reduce to less than unity the sum of the ratios of the residual radionuclide concentrations to the associated concentration limits, above background, of 554 pCi/g for U_{total}, 5 pCi/g for Ra-226 and 14 pCi/g for Th-230 for surface cleanups and 3,021 pCi/g of U_{total}, 15 pCi/g of Ra-226 and 44 pCi/g of Th-230 for subsurface cleanups to comply with 10 CFR 40, Appendix A, Criterion 6(6). In addition to the above requirements of the ARAR, USACE will remediate the Linde site to insure that no concentration of total uranium exceeding 600 pCi/g above background will remain in the site soils. In order to gain access to MED-contaminated soils located under buildings or buildings slabs, demolition of building slabs will be required. Appropriate ALARA principles will be included in the detailed site remediation plan. Soils beneath Building 14 will be addressed separately from this ROD. MED-contaminated sediments in drainlines at Linde, as detailed in the RI, will also be remediated to the standards of 40 CFR Part 192 as well as the new standards in 10 CFR Part 40, Appendix A, Criterion 6(6). Verification of compliance with soil cleanup standards and criteria will be demonstrated using surveys developed in accordance with the Multi-Agency Radiation Survey and site Investigation Manual (MARSSIM) and as may be required by the ARARs.

4.3.2 Building and Structures Cleanup

The cleanup of contaminated building and structure surface areas will be conducted in accordance with the 10 CFR Part 40, Appendix A, Criterion 6(6) using building/structure specific decontamination protocols to be detailed in the work plan for site remediation. Residual radioactive materials will be removed from surfaces necessary to meet the benchmark dose for surfaces of 8.8 mrem/y based on the specific location of the surfaces and exposure scenarios and appropriate ALARA principles. Building 14 MED-related radiological contamination will be addressed separately from this ROD.

4.3.3 Groundwater

This ROD does not address the groundwater at the Linde Site. A ROD will be issued in the future that evaluates the Site groundwater and selects any required remedial action.

5. SUMMARY OF SITE CHARACTERISTICS

5.1 Site contamination Overview

The 1993 DOE RI report (BNI 1993) describes elevated levels of radionuclides at the Linde Site resulting from the separation of uranium ores at the property during the mid-1940's under a MED contract. The MED-related contamination at Linde resulted, for the most part, from three activities associated with uranium processing: the handling of uranium ores, the temporary storage and handling of solid residues before they were shipped offsite for disposal, and the disposal of liquid waste from the uranium processing operations. The 1993 PP (DOE 1993c) identified three sources of radioactive contamination at Linde: the uranium processing buildings, surface and subsurface soils, and sediments in sumps and storm and sanitary sewers. The primary radioactive contaminants in the soils and sediments are U-238, Ra-226, Th-230, and their respective radioactive decay products (DOE 1993c).

The following sections provide additional details of the MED-related contamination as reported in the 1993 RI and FS reports. In the 1993 DOE reports, radiological contamination is defined in terms of DOE criteria. DOE's criteria are described in Section 2.6.1 of the Addendum to the Feasibility Study (USACE 1999b).

Since the RI report was prepared in 1993 Buildings 38 and 30 have been demolished and Buildings 14 and 31 have been decontaminated. The findings of pre-remediation investigations undertaken as part of these activities and an update of current contamination conditions following building demolition and decontamination at the Linde Site are included in the descriptions of current contamination at the Linde Site where appropriate.

5.2 Radioactive Contamination in Surface and Subsurface Soils

The RI (BNI 1993) indicates that U-238, Ra-226, and Th-230 are the primary MED-related radionuclides of concern in the surface and subsurface soils at Linde. The 1993 RI identified contamination in four (4) areas of the Site as follows:

Area 1 contains primarily superficial radioactive contamination located in the northwest corner of the main parking lot area at Linde. The RI report indicates the contamination does not extend deeper than 4 ft.

Area 2 contains primarily superficial contamination located along the northern boundary of Linde and the northeastern corner of the main parking area. A temporary storage pile for the consolidation of radioactively contaminated soils and windrow materials is located in this area. Contamination does not extend deeper than 1.2 m (4 ft). (This material has now been removed from the Linde Site.)

Area 3 is located along the fence line in the northeastern corner of the property. Evidence of radioactive contamination in this area extends off the property and encompasses a railroad spur formerly used to haul uranium ore into Linde. Sampling results show that the radioactive contamination is present to a depth of 4 ft in the area west of the railroad tracks and to a depth of 2.0 ft east of the tracks.

Area 4 includes the areas of Buildings 30, 31, 38, 58, and a blast wall outside Building 58. Sampling results show that the soil beneath Building 30 is radioactively contaminated to a depth of 2.4 m (8 ft).

As described in Section 2.3.9, several remedial actions have been conducted at Linde since the 1993 RI and FS reports were prepared. These remedial actions included the demolition of Buildings 38 and 30 and the decontamination of Buildings 31 and 14.

A subsurface investigation at Buildings 31 and 57 was conducted in 1996. Results of the investigation indicate the presence of radioactive contamination in soils at locations not reported in the 1993 DOE documents, including contamination under Building 57.

As described in Section 2.3.9.2, decontamination of Building 14 was completed in 1998, including removal of radioactively contaminated soils from beneath floor slabs (USACE 1998c). A small, inaccessible volume of radioactively contaminated soils were left under structural support members. As described in Section 4.3.1, Building 14 and the soils under the building will be addressed separately from the action under this ROD.

The information available in the 1993 DOE documents, along with the findings of subsequent surveys and investigations, were used by USACE to develop an updated database for MED-related radioactively contaminated soils at Linde. The updated database and the 5/15/600/60(ave.) criteria described in Section 4.3 were used to estimate the volume of MED-related radioactively contaminated soils as reported in the Addendum to the Feasibility Study for the Linde Site (USACE 1999b) and the PP (USACE 1999c).

As detailed in the *USACE Technical Memorandum: Linde Site Radiological Assessment* (USACE 2000), the 95 percent upper confidence limit (UL_{95}) values for radiological contamination in site soil used in the assessment of risks ranged from 0.88 pCi/g to 41.7 pCi/g for Ra-226, from 2.5 pCi/g to 82.4 pCi/g for Th-230, and from 30 pCi/g to 197 pCi/g for U-238. Results of analyses of individual soil samples ranged from background to in excess of 1,800 pCi/g for total uranium, from background to in excess of 200 pCi/g for Ra-226, and from background to in excess of 800 pCi/g for Th-230. Additional details of the location of and the assessment of radiological contamination in site soils is presented in Section 6.4

5.3 Chemical Contamination in Surface and Subsurface Soils

The non-radioactive MED-related contaminants in the surface and subsurface soils at Linde were determined to be metal precipitates expected to be found in MED filter cake. The 1993 RI evaluated the possible existence of Resource Conservation and Recovery Act (RCRA) hazardous waste and concluded that Linde soils would not contain hazardous waste. Additionally, the BRA concluded that chemical contaminants found on the Linde Site do not pose a health threat (DOE 1993a).

The remedial action to be conducted at Linde will not address any releases of hazardous substances that may have occurred due to operations conducted at Linde prior to or after MED operations, except to the extent that substances are commingled with the MED era radioactive contamination. Sampling will be conducted of all materials to be disposed during the remedial action to ensure proper disposal of the material (i.e., demonstrate compliance with disposal facility waste acceptance criteria). Should any hazardous materials be found that are not commingled with MED-related radiological materials, the site owner, Praxair, will be notified for them to take the appropriate actions for that material as well as any remaining similar materials at the site. Details of the sampling will be included in the work plans for the project.

5.4 Contamination in Surface Water

The RI report reported no surface water contamination from MED-related activities in surface waters onsite or directly downstream from the Linde property.

5.5 Contamination in Sediments

Results of RI sampling of sediments downstream of Linde indicated no radionuclide concentrations above background (DOE 1993b).

Radioactive contamination was detected in sediments found in sumps inside Building 30 as well as in the sanitary and storm sewers. The sediments in the Building 30 sumps were found to contain concentrations of U-238, Ra-226, and Th-230, above background levels. Samples taken in the sanitary and storm sewers at various locations indicated U-238, Ra-226, and Th-230 contamination. The contamination may have resulted from process liquid collection systems used during operations or during the construction of the concrete floor. Contamination detected in the sanitary and storm sewers resulted from the disposal of production effluents into these systems. Contaminated sediments were found in sumps and drains during the decontamination of Building 14 (USACE 1998c). The RI concludes that the exact extent of contamination in the drain system will need to be determined during the remedial action.

5.6 Contamination of Groundwater

As discussed in Section 2.2.3, USACE has decided to address the status of groundwater at the Linde Site under a separate CERCLA action as a separate operable unit.

5.7 MED-Related Radioactive Contamination in Buildings and Structures

The 1993 DOE RI report (BNI 1993) described the primary types of radioactive contamination in Linde buildings as fixed beta-gamma emitting radionuclides and dust contaminated with U-238, Th-230, and Ra-226. The RI report identified radioactive contamination exceeding DOE guidelines in parts of Building 14, 30, 31 and 38. The presence of a subsurface vault just west of Building 73 was also identified as a structure that may contain radioactive waste.

As described in Section 2.3.9, Buildings 38 and 30 have been demolished and Buildings 14 and 31 have been decontaminated.

5.8 Radiological Data Evaluation

The goal of the data evaluation was to identify a set of radiological contaminants of concern (COCs) that are likely site-related and then select those COCs that are valid to use in the quantitative risk characterization. Radiological sample analyses for the RI were performed in accordance with approved protocols. The detailed analytical results are contained in appendices to the RI report (BNI 1993). Data quality objectives and Quality Assurance/Quality Control (QA/QC) procedures are discussed in Appendix D to the RI (BNI 1993). Similar procedures were used in the evaluation of data developed subsequent to the RI.

5.8.1 Background Levels of Radioactivity in Linde Site Soils

The standards contained in the ARARs are typically stated in terms of concentrations or levels in excess of site background. The 1993 BRA (DOE 1993a) adopted background levels for radioactivity in soils for all of the Tonawanda Sites based on mean concentrations reported for soils in an undisturbed area of Ashland 2. Background levels of radionuclides in soils used by DOE and USACE, in subsequent assessments, are:

- Ra-226, 1.1 pCi/g
- Th-230, 1.4 pCi/g
- U-238, 3.1 pCi/g

Based on the relative abundance of the uranium isotopes, the background values for total uranium was calculated to be 6.1 pCi/g.

5.8.2 Summary of Radiological COCs

The final list of radiological COCs for soil includes Ra-226, Th-230, U-238 and their associated decay products (DOE 1993a). Although not considered MED-related, the Th-232 and U-235 series were included in the risk assessment conducted by DOE. No elevated levels of radionuclides were detected in surface waters or sediments downstream of the Linde Site (DOE 1993b). Th-230 and U-238 were identified as radiological COCs in sediments found on the Linde Site in sumps and sanitary and storm sewers (DOE 1993b).

5.9 Potential Chemical COCs

The chemical data evaluated are those reported in the RI report for the Tonawanda Site (BNI 1993). Chemicals in the RI database were evaluated in accordance with EPA data validation guidance in *Risk Assessment Guidance for Superfund, Volume I* (EPA 1989). Background samples for soil were used to identify naturally-occurring levels of chemicals and ambient concentrations.

As detailed in the BRA, risks resulting from nonradioactive chemical constituents were found to be within the USEPA acceptable risk range. Therefore, there are no chemical COCs for human health concerns.

6. SUMMARY OF SITE RISKS

The 1993 BRA (DOE 1993a) was prepared to evaluate the risk to human health and the environment from the radioactive and chemical constituents at the site. In accordance with EPA guidance, the primary health risks investigated were cancer and other chemical-related illnesses, as well as the ecological risks. This assessment evaluated the potential risks that could develop in the absence of cleanup and assumes that no controls (e.g., fencing, maintenance, protective clothing, etc.) are, or will be, in place. The purpose of the BRA was to determine the need for cleanup and provide a baseline against which the remedial action alternatives were compared. The complete report is in the administrative record file and a brief summary of the radiological and chemical health risks, as well as the ecological risks, is provided herein.

The BRA identified the means by which people and the environment may be exposed to constituents present at the Tonawanda Site. Mathematical models were used to predict the possible effects on human health and the environment from exposure to radionuclides and chemicals for both present and future uses at the site. Under Section 300.400(e)(2)(i)(A)(2) of the NCP, "acceptable exposure levels are generally concentration levels that represent an excess upper bound life-time cancer risk to an individual of between 10^{-4} and 10^{-6} using information on the relationship between dose and response." The 10^{-6} risk level shall be used as the point of departure for determining remediation goals for alternatives when ARARs are not available or not sufficiently protective because of the presence of multiple pathways of exposure."

The modeled risk estimates in the BRA were then compared to the NCP's risk criteria. The findings of these comparisons of USACE's updated risk characterization for the site are described below.

6.1 Radiological Health Risk

The 1993 BRA provides risk estimates for average (mean) exposure conditions under hypothetical scenarios for current and projected future land use. These estimated risks were calculated using the average radionuclide concentrations present at the properties. The results predicted that, for the current land uses, no one would be exposed to unacceptable risks. For assumed future land uses, the mean radiological risk, as was reported in the original 1993 PP, was predicted to be within the NCP's range of acceptability at Linde.

USEPA's guidance for risk characterization requires that modeling to estimate risks also include what is called a Reasonable Maximum Exposure (RME) scenario. RME calculations assume that a worker at the site for a longer period of time than the average worker (30 years for the RME worker and 22 years for the average worker), would be exposed to higher concentrations of dust than the average worker, would inhale more air than the average worker, would spend more time each day outside than the average worker, and would ingest more soil each day than the average worker. Using these higher RME exposure assumptions, the BRA reported that RME radiological risks to workers at some Linde Site areas slightly exceed the NCP's target risk range under current conditions. The BRA assumed that future use of the Linde Site will be commercial/industrial.

As briefly described in Section 1, USACE prepared a Technical Memorandum (USACE 2000) evaluating radiological risks at the Linde Site assuming no action is taken and also assessing risks after cleanup.

The USACE assessment of radiological risks at the Linde Site used updated information on the location of radiologically contaminated soils. The Linde Site currently is used for commercial and industrial purposes, and industrial facilities have been present at the site for more than 60 years. Given the past and current use of the Linde Site for industrial and commercial uses over more than 60 years, including the ownership of part of the property by ECIDA to promote industrial use and the zoning restrictions on the property, USACE has concluded that the reasonably anticipated future land use of the property will be for commercial/industrial purposes (USACE 1999b) (USACE 2000). The USACE assessment considered the most likely future land use of the Linde Site to be its current commercial/industrial use.

The results of the USACE assessment show current risks to commercial/industrial workers at the site to be higher than the NCP's target risk range for several areas of the Linde Site. Additional details of the USACE assessment are presented in Section 6.4.

6.2 Chemical Health Risk

The 1993 BRA also evaluated cancer and chemical toxicity risks. The risk of developing an incremental increase of cancer over a 70-year lifetime from chemical carcinogens at the site was evaluated for both average (mean) exposure and for RME. The evaluation showed no chemical risks at Linde exceeding the NCP's target risk range.

Potentials for chemical noncarcinogenic health effects were also evaluated in the BRA. These potential effects are expressed as chemical-specific hazard quotients (HQs). HQs were tabulated for chemicals of concern. HQs were summed for each pathway to provide a total hazard index (HI) for the pathway. The calculated HIs for all exposure pathways for all scenarios evaluated at the Tonawanda Site properties, including Linde, are much less than 1, thus indicating that no unacceptable effects would be expected.

6.3 Ecological Risk

The Ecological Risk Assessment included in the 1993 BRA follows USEPA's general procedures for ecological assessments in the Superfund program. The characterization of habitats and biota at risk are semiqualitative, and screening of contaminants and assessment of potential impacts to biota are based on measured environmental concentrations of the constituents and toxicological effects reported in the literature.

The Linde Site is located in a highly modified urban, industrial area and provides urban wildlife habitat supporting only cosmopolitan species of birds and small mammals. No critical habitats for threatened or endangered species are present on the Site. No threatened or endangered species exist on the Linde Site and ecological risks are minimal. USACE has concluded that no significant impact has occurred to ecological resources from previous releases of hazardous substances at the Linde Site.

6.4 USACE Radiological Assessment of the Linde Site

An assessment of the Linde Site was conducted by USACE to estimate potential exposures and associated risks from radionuclides at the Linde Site (USACE 2000). As described in Section 4.1.1, the assessment was initially conducted in early 1999 to develop a site-specific cleanup guideline for uranium since there was no uranium ARAR available at that time. Since then, new regulations amending 10 CFR 40, Appendix A, Criterion 6(6) were promulgated and became effective on June 11, 1999. These regulations were evaluated and determined to be relevant and appropriate for the Linde Site since they addressed residual uranium and other radionuclides present at uranium mill sites, similar to the Linde Site.

The Linde Site assessment assumed that the most likely future land use at Linde will be continued commercial/industrial. The basis for concluding that the most likely use of the site in the future is commercial/industrial is presented in Section 1.2.3 of this ROD. The assessment also assumed that construction or utility workers will be involved in on-site activities in the remediated area for limited periods of time. Radiation doses and associated risks were evaluated using radiological contamination data from the site and the RESRAD Code (Yu et al. 1993).

The assessment included an evaluation to determine current risks, assuming no radiological materials have been removed from the Building 14 area and future risks at the Linde Site, as discussed in Section 2.3.5.

For purposes of the assessment, the Linde Site was divided into twelve (12) assessment units. The location of the assessment units and sample locations for the radiological data used in the assessment are shown in Figure 6-1.

Figure 6-2 shows the locations of samples exceeding the site cleanup criteria. As shown in Figure 6-2, criteria are only exceeded in assessment units 7 through 11. As shown in the assessment report, the no action alternative presents risks outside of the acceptable CERCLA risk range of 10^{-4} to 10^{-6}. The risks associated with the residual uranium after cleanup to the standards of the ARARs are acceptable (USACE 2000).

7. DESCRIPTION OF REMEDIAL ALTERNATIVES

7.1 Remedial Action Alternatives Evaluated in the 1993 FS and PP and Updated Description of Linde Alternatives

Detailed descriptions of the remedial alternatives considered for the Tonawanda site in 1993, including the Linde Site, can be found in the FS (DOE 1993b), which is available in the administrative record. A total of 6 alternatives were considered in the FS. The following section describes the 1993 alternatives and updates the descriptions of alternatives considered by USACE in the 1999 PP for the Linde Site.

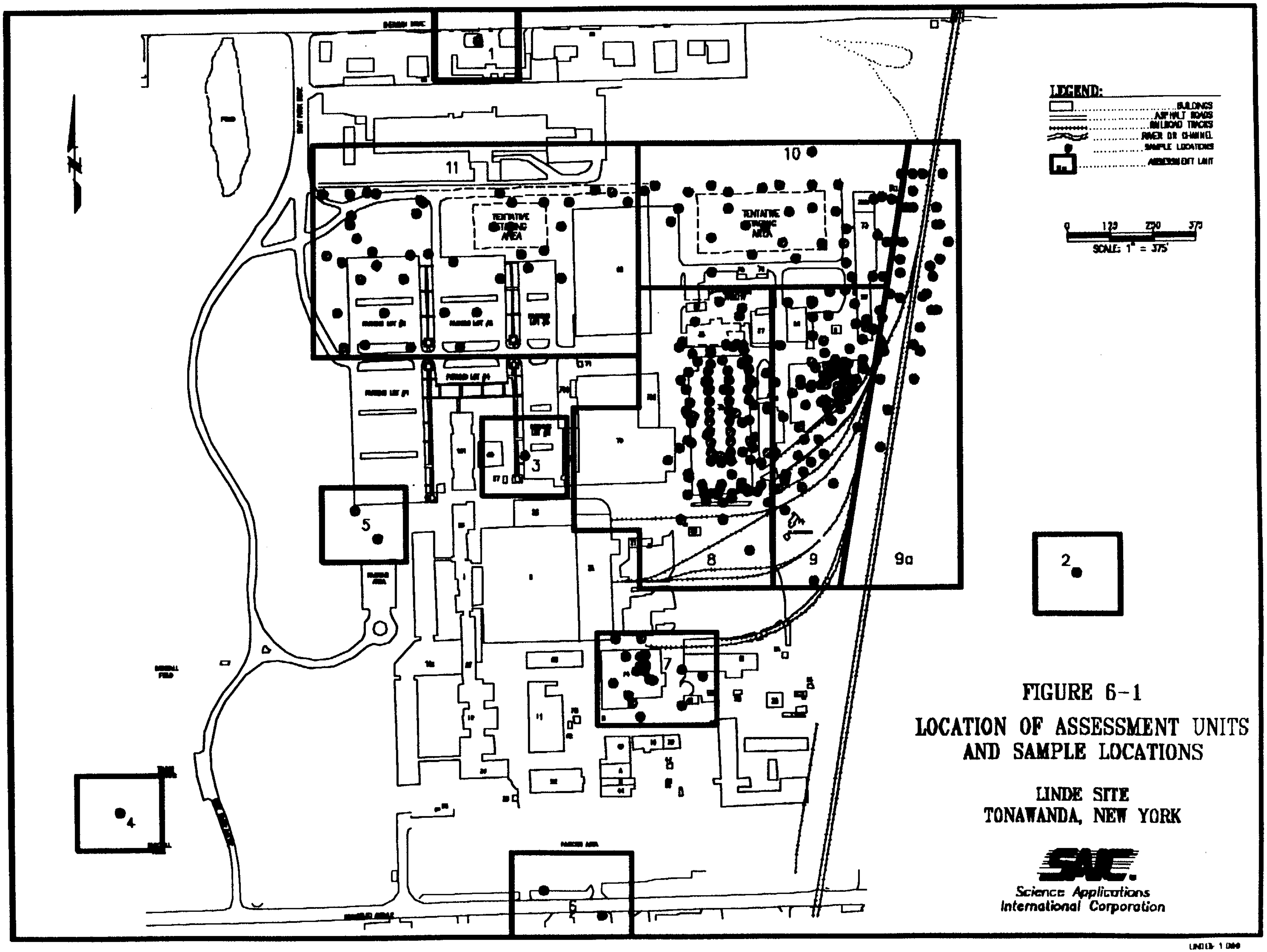

FIGURE 6-1

LOCATION OF ASSESSMENT UNITS AND SAMPLE LOCATIONS

LINDE SITE
TONAWANDA, NEW YORK

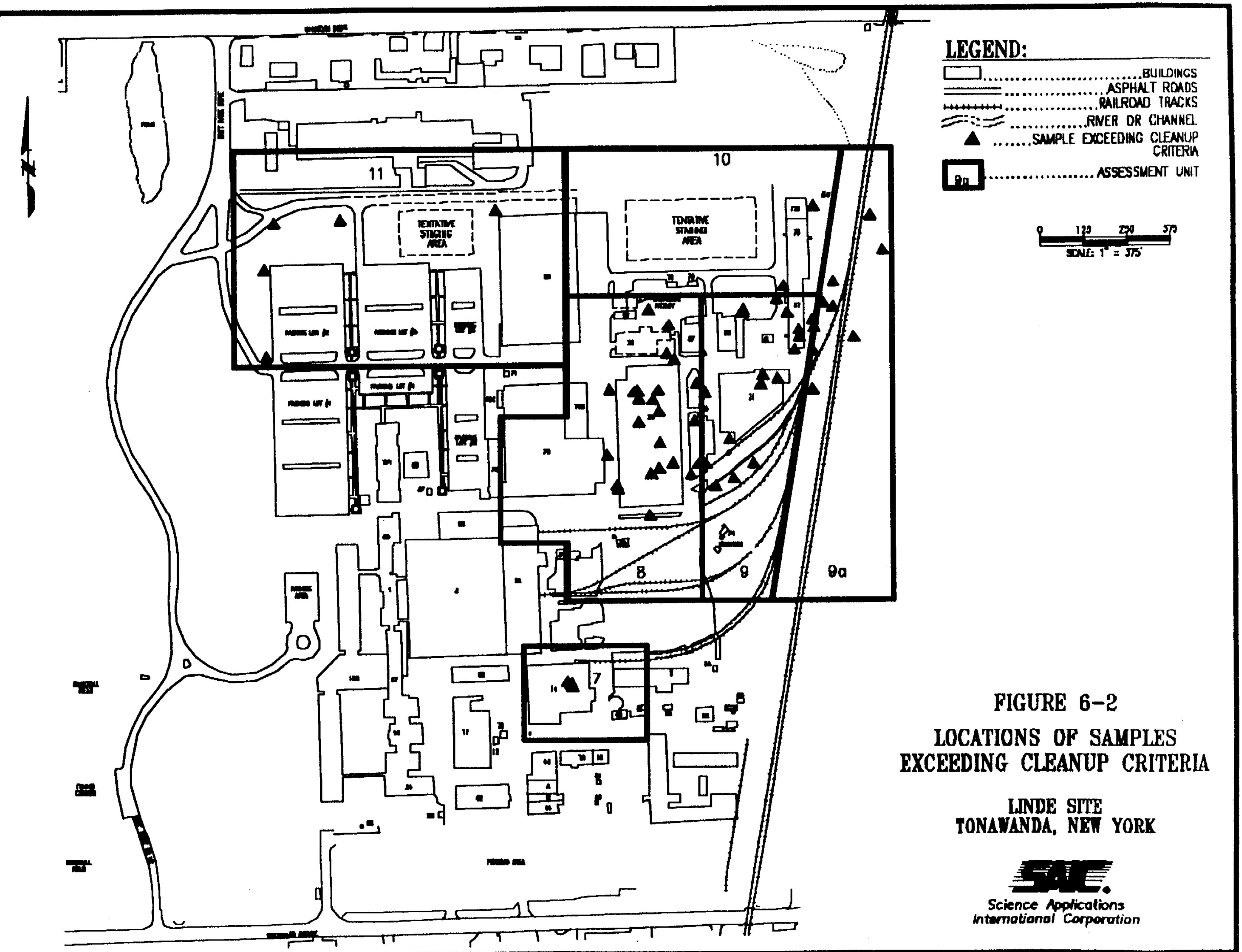

FIGURE 6-2

LOCATIONS OF SAMPLES EXCEEDING CLEANUP CRITERIA

LINDE SITE
TONAWANDA, NEW YORK

SAIC
Science Applications
International Corporation

7.1.1 Linde Site Alternatives

Alternative 1: No Action. The no-action alternative is required under CERCLA regulations to provide a baseline for comparison with other alternatives. Under this alternative, no action is taken to implement remedial activities. Periodic monitoring of the Site as appropriate would be continued. This alternative was evaluated in the 1993 FS and is the baseline for comparison with other alternatives for the Linde Site.

Alternative 2: Complete Excavation and Decontamination with Offsite Disposal. This alternative was evaluated in the 1993 FS. Complete excavation of MED-contaminated soils containing radionuclides above guidelines and offsite disposal and decontamination of the surfaces of structures exceeding guidelines would remove the source of elevated levels of radionuclides from the Linde Site. Section 4 addresses the cleanup standards and guidelines selected by USACE for Linde.

Alternative 3: Complete Excavation with Onsite Disposal. This alternative is similar to Alternative 2 regarding excavation of soils, however, all excavated soils would be placed in an on-site engineered disposal cell to be located on Ashland 1, Ashland 2 or Seaway. Institutional controls would be imposed to control access to the onsite engineered disposal cell and the cell would be designed to minimize future exposures or releases to the environment. After consideration of comments received from the public and State on the 1993 PP, USACE eliminated this alternative from further consideration.

Alternative 4: Partial Excavation with Offsite Disposal. In the 1993 FS, this alternative included the excavation of accessible contaminated soils, institutional controls and containment for "access-restricted" soils, demolition of Buildings 14, 31 and 38, decontamination of Building 30 and offsite disposal. Soils covered by buildings or structures were determined to be access-restricted. Under this alternative, the soils were to be left in place until the buildings or structures were abandoned and demolished.

Given the demolition of Buildings 38 and 30 and the decontamination of Building 14, including removal of all but a limited volume of contaminated soil beneath Building 14 that is considered inaccessible due to structural considerations, only a limited quantity of contaminated soil is currently considered inaccessible at the Linde Site. Accordingly, **Alternative 4** was redefined as **Excavation, Decontamination and Institutional Controls.** Under this alternative, surfaces and soil with contamination exceeding cleanup guidelines would either be decontaminated or removed from the site at all locations except the limited quantity that may exist at Building 14. Institutional Controls would be placed on the use of Building 14 to preclude future exposure to MED-related radionuclides that could exceed acceptable risk levels. The controls could include measures such as deed restrictions, prohibiting intrusion into building areas or subsurface areas without imposing restrictive conditions, restricting use of areas, employee training, posting warnings and similar measures.

Alternative 5: Partial Excavation With On-Site Disposal. Alternative 5 was the same as Alternative 4 in the 1993 FS and PP, except contaminated soils removed from Linde would be disposed in an on-site engineered disposal cell to be located at Ashland 1, Ashland 2, or Seaway. After consideration of comments received from the public and State on the 1993 PP, USACE eliminated this alternative from further consideration.

Alternative 6: Containment with Institutional Controls. Containment for the Linde Site would involve capping of areas exceeding guidelines for radiological contamination. After consideration of comments received from the public and State on the 1993 PP, USACE eliminated this alternative from further consideration.

7.1.2 Summary of Current Alternatives

As described above, the remedial alternatives considered by USACE in the 1999 PP for the Linde Site are:

- Alternative 1 - No Action.
- Alternative 2 - Complete Excavation and Decontamination with Off-Site Disposal.
- Alternative 4 - Excavation, Decontamination and Institutional Controls

However, since USACE has decided to exclude from the scope of this ROD the remedial actions associated with Building 14 and the groundwater system, Alternatives 2 and 4 are essentially the same with respect to the remedial actions to be taken for the soils and various contaminated surfaces. Therefore, there are only two alternatives for the scope addressed by this ROD: (1) No Action and (2) Complete Excavation and Decontamination with Off-Site Disposal. These two alternatives are analyzed in Section 8.

8. SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

The two alternatives that are appropriate for the scope of actions to be covered by this ROD are (1) No Action and (2) Complete Excavation and Decontamination with Off-Site Disposal as discussed in Section 7.1.2. These two alternatives were evaluated using the CERCLA criteria to determine the more favorable actions for the cleanup of the Linde Site. These criteria are described below. The criteria were established to ensure that the remedy is protective of human health and the environment, meets regulatory requirements, is cost effective, and utilizes permanent solutions and treatment to the maximum extent practicable. The results of the detailed evaluation of the two alternatives addressing the Linde Site soils and various contaminated surfaces, excluding Building 14 and groundwater system, are summarized in the following sections. The evaluation criteria are described in Section 8.1, followed by a summary of the comparative analysis in Section 8.2.

8.1 Evaluation Criteria

The following two criteria are threshold criteria and must be met.

- *Overall Protection of Human Health and the Environment* - addresses whether an alternative provides adequate protection and describes how risks are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

- *Compliance with Federal and State Environmental Regulations* - addresses if a remedy would meet all of the federal and state ARARs.

The following criteria are considered balancing criteria and are used to weigh major tradeoffs among alternatives being evaluated.

- *Long-Term Effectiveness and Permanence* - addresses the remaining risk and the ability of an alternative to protect human health and the environment over time, once cleanup goals have been met.

- *Short-Term Effectiveness and Environmental Impacts* - addresses the impacts to the community and site workers during cleanup including the amount of time it takes to complete the action.

- *Reduction in Toxicity, Mobility, or Volume Through Treatment* - addresses the anticipated performance of treatment that permanently and significantly reduces toxicity, mobility, or volume of waste.

- *Implementability* - addresses the technical and administrative feasibility of an alternative, including the availability of materials and services required for cleanup.

- *Cost* - compares the differences in cost, including capital, operation, and maintenance costs.

The following are considered modifying criteria and are generally taken into account after public comment is received on the PP.

- *State Acceptance* - evaluates whether the State agrees with, opposes, or has no comment on the preferred alternative.

- *Community Acceptance* - addresses the issues and concerns the public may have regarding each of the alternatives as expressed in comments.

8.2 Alternative Comparison

The purpose of the following analysis is to weigh the advantages and disadvantages of the alternatives, when compared with each other, based on the evaluation criteria. This information was used to select a preferred alternative.

The alternatives considered in the evaluation, Alternatives 1 and 2 would involve the following:

- **Alternative 1, No Action.** This alternative would involve no remediation of the Linde Site. Periodic monitoring would be required.

- **Alternative 2, Complete Excavation and Decontamination with Offsite Disposal.** This alternative would involve the demolition of buildings necessary to remediate the site. These buildings include Buildings 57, 67, 73, 73B, 75, and 76 and would also include the building slabs and foundations. The slabs that are now remaining after the demolition of Buildings 30 and 38 and the tank saddles north of Building 30 would also be removed. A wall in Building 31 would be removed to access sub-slab and sub-footing soil exceeding criteria. Contaminated sediments in drainlines and contaminated soils in the blast wall structure east of Building 58 would be removed. The subsurface vault west of Building 73 would be investigated and removed if found to be contaminated. MED-related soils would be removed in order to comply with the cleanup criteria. Surface cleanup criteria will be developed for specific buildings or surfaces based on likely exposure scenarios and meeting the surface cleanup benchmark dose of 8.8 mrem/y. These specific surface criteria will be included in their respective work plans.

The results of the evaluation are summarized in the following sections.

Overall Protection of Human Health and the Environment. Alternative 2, providing complete excavation of soils containing radionuclides and decontamination of surfaces to comply with the cleanup criteria, provides the greatest degree of protection to human health and the environment, because the materials containing radionuclides above the criteria are removed from the site and are permanently isolated in a disposal facility. A degree of risk to workers is involved with implementing this alternative, because the associated work involves intrusive activities for handling and moving materials containing radionuclides above guidelines. These risks can be minimized by using safety procedures and equipment. Alternative 1 provides no increased protection over the current site conditions and would not be protective of human health if current restrictions on exposure to areas containing contamination were to be discontinued.

Compliance with ARARs. Alternative 2 meets the ARARs because all soil containing MED-related radionuclides that does not meet the cleanup criteria would be excavated and permanently isolated in an off-site disposal cell or facility and all surface contamination would be remediated or eliminated by demolition and isolated in an off-site disposal cell or facility. Appropriate ALARA principles and practices to be used in the field for removal of soils and surfaces exceeding the criteria are included in the detailed remediation work plan, which is developed prior to any remediation efforts being initiated. One ALARA practice used by USACE is the actual over-excavation of materials as materials exceeding criteria are removed thus resulting in residual concentrations being much lower than the criteria. The remaining levels of residual radioactive materials after remediation to the cleanup standards will also result in compliance with the ARAR standards regarding radon and indoor gamma radiation levels above background. The estimated indoor radon concentrations were found to be below the standard of 0.2 WLs (USACE 2000). The maximum gamma radiation level inside building structures covered by the scope of this ROD was measured to be 15 μr/hr including background (ORNL 1978) before any soil remediation, which is already below the 20 μr/hr standard. Any soil remediation should reduce this maximum gamma radiation level even further. Alternative 1, however, is noncompliant with the ARARs because all of the waste on the Linde Site containing radionuclides above the cleanup criteria, remains on-site with no additional protection provided.

Long-term Effectiveness and Permanence. A primary measure of the long-term effectiveness of an alternative is the magnitude of residual risk to human health after remediation. The adequacy and reliability of engineering and/or institutional controls used to manage residual materials that remain onsite must also be considered.

Alternative 2 provides the highest degree of long-term effectiveness and permanence because all soils containing radionuclides above the cleanup criteria are excavated and removed from the site and all surface contamination would be remediated or eliminated by demolition and isolated in an off-site disposal cell or facility.

For Alternative 2, the risk calculated for an industrial/commercial worker at the Site, is within acceptable levels.

Alternative 1, no action, has low long-term effectiveness because the post-implementation remedial risks equal those now at the site.

Short-term Effectiveness and Environmental Impacts. Short-term effectiveness is measured with respect to protection of community and workers as well as short-term environmental impacts during remedial actions and time until remedial action objectives are achieved. An increase in the complexity of an alternative typically results in a decrease in short-term effectiveness because of increased handling and processing and, alternatives involving offsite disposal of wastes would result in a decrease in short-term effectiveness because of the increased time required and transportation-related risks.

Alternative 1, no action, is the most effective in protecting the community and workers and controlling impacts during implementation since no actions that could create impacts are undertaken. Alternative 1 requires the shortest time to implement. The short-term effectiveness of Alternative 2 ranks lower in terms of this criterion because it is more complex and will require a longer time to implement.

Reduction in Toxicity, Mobility, or Volume through Treatment. Neither of the alternatives provides treatment on site for the materials to be removed. Alternative 2, which provides for offsite disposal, will include containment at the final disposal location and any treatment which is required to meet the standards of the offsite facility. This alternative thus will achieve reduction in mobility, although no treatment is planned which will reduce the toxicity or volume of the disposed materials. The no action alternative, would provide no removal of materials. The 1993 Feasibility Study (DOE 1993b) evaluated currently available treatment technologies for treatment in the course of removal and found none are economically and technologically feasible at this time.

Implementability. In regard to implementability, the alternatives were evaluated with respect to the following:

- ability to construct and operate the technology,
- reliability of the technology,
- ease of undertaking additional remedial actions,
- ability to monitor effectiveness,
- ability to obtain approvals and coordinate with regulatory agencies,
- availability of offsite disposal services and capacity, and
- availability of necessary equipment and specialists.

The degree of difficulty in implementing an alternative increases with the complexity of the remediation activity. The design, engineering, and administrative requirements of Alternative 1, no action, are essentially negligible. Alternative 2 is more complex than Alternative 1 but is technically and administratively feasible. Materials and services for Alternative 2 are readily available.

Cost. The estimated costs for the Linde Site alternatives in 1999 dollars are:

- Alternative 1, No Action: $900,000
- Alternative 2, Complete Excavation and Decontamination and Off-Site Disposal: $27,700,000

Public Acceptance. At the public meeting conducted on June 3, 1999, support for the selected remedy was voiced by the public. The details of comments at the two public meetings conducted for the project, written comments and USACE's responses to comments, are included in Appendix A of this ROD.

State Acceptance. Correspondence from NYSDEC concerning this ROD received in 1999 is included in Appendix B, along with USACE responses and considerations of issues raised in these letters. Correspondence from NYSDEC received in February 2000 is included as Attachment 3 with a USACE response letter included as Attachment 4. Additionally, USEPA has provided comments on the preferred alternative (see Attachment 1). Attachment 2 is a response letter to USEPA.

9. THE SELECTED REMEDY

USACE has selected a remedy that includes the soils, buildings, and slabs removal actions described in the PP as Alternative 2 excluding Building 14 and soils beneath Building 14. The final remedy for Building 14 and any soils remaining under Building 14 that may exceed the removal criteria and groundwater will be addressed separately from this ROD. The selected remedy is believed to provide the best balance among the considered alternatives with respect to the evaluation criteria, will protect human health and the environment, will comply with ARARs, and is considered cost effective. This remedy requires the removal of MED-related residual radioactive materials so that the standards of the ARARs are met. That will involve the removal of residual radioactive materials so that; (1) the concentrations of radium in remaining soil do not exceed background by more than 5 pCi/g in the top 15 cm of soil or 15 pCi/g in any 15 cm layer below the top layer as averaged over $100m^2$; (2) the residual radionuclide concentrations remaining in soils within a 100 square meter area that results in unity or less for the sum of the ratios of these radionuclide concentrations to the associated concentration limits, above background, of 554 pCi/g for U_{total}, 5 pCi/g for Ra-226 and 14 pCi/g for Th-230 for surface cleanups and 3,021 pCi/g of U_{total}, 15 pCi/g of Ra-226 and 44 pCi/g of Th-230 for subsurface cleanups; and (3) the remaining residual radioactive materials on structure surfaces meet the benchmark dose for surfaces of 8.8 mrem/y based on the specific location of the surfaces and exposure scenarios. In addition, in order to meet the commitments made to the community at the public meetings, USACE will remediate the Linde site to insure that no concentration of total uranium exceeding 600 pCi/g above background will remain in the site soils.

The selected remedy will involve the demolition of buildings necessary to remediate the site. These buildings include Buildings 57, 67, 73, 73B, 75 and 76 and will also include the building slabs and foundations. The slabs that are remaining after the demolition of Buildings 30 and 38 and the tank saddles north of Building 30 will also be removed. A wall in Building 31 will be removed to access sub-slab and sub-footing soils exceeding criteria. The selected remedy will also include remediation of the adjacent Niagara Mohawk and CSX Corporation (formerly Conrail) properties, where radioactive contamination has already been identified or may be identified as the remediation work is implemented and will be limited to following releases that originated from the Linde Site resulting from MED-related operations. The plan also includes the removal of contaminated sediments from drainlines and sumps, the removal of contaminated soil from a blast wall structure located east of Building 58, and remediation of a subsurface vault structure located just west of Building 73.

It also provides the best balance among the considered alternatives with respect to the evaluation criteria. In addition, implementation of this remedy can be accomplished in compliance with all applicable laws relating to the protection of the public health and the environment. This remedy will not result in MED-related hazardous substances remaining at the site above the health-based levels after completion of the scope identified above. The Corps will perform all required 5-year reviews.

10. STATUTORY DETERMINATIONS

The selected remedy satisfies the statutory requirements of Section 121 of CERCLA as follows:

- the remedy must be protective of human health and the environment;
- the remedy must attain ARARs or define criteria for invoking a waiver;
- the remedy must be cost effective; and

- the remedy must use permanent solutions and alternative treatment technologies to the maximum extent practicable.

The manner in which the selected remedy satisfies each of these requirements is discussed in the following sections.

10.1 Protection of Human Health and Environment

Upon completion, the selected remedy for the Linde Site will be fully protective of human health and the environment and meet cleanup criteria based on ARARs. During remedial activities, engineering controls during construction will be put in place as required and environmental monitoring and surveillance activities will be maintained to ensure protectiveness, so that no member of the public will receive radiation doses above guidelines from exposure to residual radioactive contaminants.

There are no short-term threats associated with the selected remedy that cannot be readily controlled and mitigated. In addition, no adverse cross-media impacts are expected from the remedy.

10.2 Attainment of ARARs

USACE has determined that standards of 40 CFR Part 192 and the standards of 10 CFR Part 40, Appendix A, Criterion 6(6)are relevant and appropriate for Linde Site cleanup. USACE assessed the 10 CFR 40, Appendix A, Criterion 6(6) standards and the Linde radiological assessment (USACE 2000) and concluded that the criteria associated with this ARAR for the Linde Site would be to (1) limit the residual radionuclide concentrations remaining in soils averaged within a 100 square meter area to concentrations that results in unity or less for the sum of the ratios of these radionuclide concentrations to the associated concentration limits, above background, of 554 pCi/g for U_{total}, 5 pCi/g for Ra-226 and 14 pCi/g for Th-230 for surface cleanups and 3,021 pCi/g of U_{total}, 15 pCi/g of Ra-226 and 44 pCi/g of Th-230 for subsurface cleanups, and (2) limit remaining residual radioactive materials on structure surfaces to levels necessary to meet the benchmark dose for surfaces of 8.8 mrem/y based on the specific location of the surfaces and exposure scenarios.

This remedy requires the removal of MED-related residual radioactive materials so that the standards of the ARARs are met. That will involve the removal of residual radioactive materials so that; (1) the concentrations of radium in remaining soil do not exceed background by more than 5 pCi/g in the top 15 cm of soil or 15 pCi/g in any 15 cm layer below the top layer as averaged over $100m^2$, and (2) the residual radionuclide concentrations remaining in soils averaged within a 100 square meter area that results in unity or less for the sum of the ratios of these radionuclide concentrations to the associated concentration limits, above background, of 554 pCi/g for U_{total}, 5 pCi/g for Ra-226 and 14 pCi/g for Th-230 for surface cleanups and 3,021 pCi/g of U_{total}, 15 pCi/g of Ra-226 and 44 pCi/g of Th-230 for subsurface cleanups, and (5) the remaining residual radioactive materials on structure surfaces meet the benchmark dose for surfaces of 8.8 mrem/y based on the specific location of the surfaces and exposure scenarios. In addition to meeting this ARAR, USACE will remediate the Linde site to insure that no concentration of total uranium exceeding 600 pCi/g above background will remain in the site soils.

Verification of compliance with soil cleanup standards and criteria will be demonstrated using surveys developed in accordance with the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) and as may be required by the ARARs. Methodology to determine radon and gamma radiation levels will be developed in accordance with the ARARs and documented in the work plan for site remediation. The cleanup of contaminated building and structure surface areas will be conducted in accordance with the 10 CFR Part 40, Appendix A, Criterion 6(6), using building/structure-specific decontamination protocols to be detailed in the work plan for site remediation.

10.3 Cost Effectiveness

Cost is evaluated by comparing the costs between alternatives that meet the threshold criteria of protectiveness and compliance with ARARs, and then determining the alternative that provides the best balance of the five balancing criteria, including cost.

The selected remedy is effective because risks are reduced to acceptable levels. Increased short-term risks to workers, the public, and the environment may occur during implementation of the remedy, but these risks will be minimized by appropriate mitigative measures. Total cost in 1999 dollars for the selected remedy is estimated at $27,700,000. In consideration of these factors, the selected remedy provides the best overall effectiveness of all alternatives evaluated relative to its cost.

10.4 Utilization of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable

The selected remedy for the Linde Site provides a permanent solution to contamination that currently exists on this property.

None of the practicable alternatives identified for the Linde Site provides onsite treatment for the materials to be removed. Alternatives 2 and 4 provide for offsite disposal, which may include some treatment as possibly required of the disposal facilities. These alternatives, thus, would achieve reduction in mobility (through containment), although no treatment which will reduce the toxicity or volume of the disposed materials may be required. The FS evaluated available treatment technologies for treatment in the course of removal and found none were economically and technologically feasible. Thus, the selected alternative achieves the best possible result in terms of satisfying the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element.

11. EXPLANATION OF SIGNIFICANT CHANGES

The PP provided for involvement with the community through a document review process and a public comment period. Public meetings were advertised and held on April 22, 1999 and June 3, 1999. The public comment period was extended and comments that were received during the 71-day public comment period are addressed in Appendix A of this ROD.

After a review of the comments on the proposed plan, USACE determined that it was appropriate to make several changes to the preferred alternative before selecting a remedy. The changes involved the total uranium cleanup guideline and deferring a final decision on Building 14 and groundwater remediation. Each of these changes, which constitute a significant (pre-ROD) change from the preferred alternative presented in the PP, has been incorporated into this ROD and the selected remedy and are discussed below. The identification of 10 CFR Part 40, Appendix A, Criterion 6(6) as an ARAR for the Linde Site is also a pre-ROD change. None of these changes result in reducing the protectiveness of the remedy described in the Proposed Plan.

Based on the following evaluations, there were not significant changes justifying a new public comment period. The changes either had no significant effect on the remedy or they could have been reasonably anticipated. The new 10 CFR 40, Appendix A, Criterion 6(6) only provides a method of calculating the cleanup levels for a portion of the site contamination but will result in a cleanup level that is not significantly different from that included in the PP and will not change the expected land use assumed and discussed in the PP. In addition, the exclusion of the groundwater and Building 14 from this ROD will result in them being addressed in later CERCLA documentation that will be presented to the public for comment. As discussed in the following paragraphs, the NRC benchmark dose will result in a soil cleanup level for all radioactive contaminants that is as protective as that applicable to radium, which was included in the PP.

Total Uranium Cleanup Guideline

The comments received from the public indicated a concern for the application of the total uranium guideline for soils as it was originally expressed in the proposed plan. In order to address those concerns, USACE has further described and defined the guideline. Subsequent to the public input, new regulations amending 10 CFR 40, Appendix A, Criterion 6(6) were promulgated and became effective on June 11, 1999. These regulations were evaluated and determined to be relevant and appropriate for the Linde Site since they addressed residual uranium and other radionuclides present at uranium mill sites, similar to the Linde Site. USACE assessed the 10 CFR 40, Appendix A, Criterion 6(6) standards and the Linde radiological assessment (USACE 2000) and concluded that the criteria associated with this ARAR for the Linde Site soils would be to limit the residual radionuclide concentrations remaining in soils averaged within a 100 square meter area to concentrations that results in unity or less for the sum of the ratios of these radionuclide concentrations to the associated concentration limits, above background, of 554 pCi/g for U_{total}, 5 pCi/g for Ra-226 and 14 pCi/g for Th-230 for surface cleanups and 3,021 pCi/g of U_{total}, 15 pCi/g of Ra-226 and 44 pCi/g of Th-230 for subsurface. Compliance with this regulation will result in a more stringent cleanup of U_{total} at the Linde Site than was originally proposed in the Proposed Plan. In addition, in order to meet the commitments made to the community at the public meetings, USACE will remediate the Linde site to insure that no concentration of total uranium exceeding 600 pCi/g above background will remain in the site soils.

10 CFR 40, Appendix A, Criterion 6(6)

New regulations amending 10 CFR 40, Appendix A, Criterion 6(6) were promulgated and became effective on June 11, 1999. This new amendment addresses areas contaminated with other radionuclides in addition to radium, which is addressed by the 5 pCi/g and 15 pCi/g radium standards included in the first paragraph of Criterion 6(6) as well as 40 CFR 192, Subpart B. 10 CFR 40, Appendix A, Criterion 6(6) requires that radioactive contamination, considering all radionuclides including radium, remaining after remediation, will not result in a total effective dose equivalent (TEDE) to the average member of the critical group exceeding the benchmark dose after cleanup to the 40 CFR Part 192 standards of soils contaminated with radium only. The criterion also states if more than one residual radionuclide is present in the same 100-square-meter area, the sum of the ratios for each radionuclide of concentration present to the concentration limit will not exceed "1" (unity).

USACE evaluated the new standard, the draft NRC guidance included in the Federal Register (Vol. 64, N0. 69, dated April 12, 1999, pp. 17690–17695), and the Linde Radiological Assessment (USACE 2000). Based on the current understanding by USACE of the new standard and associated guidance, USACE was able to use the data and information contained in the Linde Radiological Assessment (USACE 2000) to establish the benchmark doses and associated radionuclide concentration limits for surface cleanups as well as subsurface cleanups. The results in the Linde Radiological Assessment were based on RESRAD runs modeling the conditions at the Linde Site. The document also included what the allowable concentrations would be for various radionuclides to meet dose objectives both with and without cover materials for the most likely scenario at the site, the industrial/commercial scenario. These results are contained in Table 3-3 of the Linde Radiological Assessment. Using those results, USACE was able to derive the benchmark dose for surface cleanup by dividing the 10 mrem/y (no cover) by the 5.7 pCi/g of Ra-226 associated with that dose and then multiplying the result by 5 pCi/g of Ra-226, which results in a benchmark dose of 8.8 mrem/y for surface cleanups. Table 3-3 data was then used to derive the allowable concentrations for the radionuclides, total uranium and Th-230. The same methodology was used in deriving the same information for subsurface cleanups. The data used were the results in Table 3-3 based on a cover depth of 6 inches. The resulting benchmark dose for subsurface cleanups was calculated to be 4.1 mrem/y. The following tabulates the results of the assessment and what the radionuclide limits are for surface and subsurface cleanups:

	Allowable Residual Concentration Limit for Indicated Benchmark Dose (pCi/g)	
Radionuclide	**Surface: 8.8 mrem/yr**	**Subsurface: 4.1 mrem/yr**
Ra-226	5.0	15
Th-230	14	44
U-total	554	3,021

During remediation, the actual radionuclide concentrations within a 100 square meter area will be divided by its corresponding concentration limit from the table above. These ratios are then added and must be equal to or less than "1" (unity). If the sum of these ratios exceeds unity, additional soil removal is necessary.

The allowable residual radionuclide concentrations on structure surfaces would be computed for specific structures and the associated exposure scenarios and would be based on meeting the benchmark dose of 8.8 mrem/y for surface cleanups.

Building 14

The two action alternatives presented in the PP for remediating the Linde Site (Alternatives 2 and 4) differed only in the way Building 14 (and soils remaining under the building slabs and footings that contain contaminants exceeding the cleanup guidelines) would be addressed during the remediation process. The preferred alternative presented in the PP, Alternative 4, proposed that the building would remain on the site and that institutional controls would be implemented to protect workers in the building, and future site users from inadvertent exposures to residual contaminants remaining within and under the building. Alternative 2 included the demolition and disposal of the building and residual contaminated soils currently remaining under the building.

Comments received during the public comment period, including the public meetings, indicated that the community is concerned about leaving residual contamination on the site, even if institutional controls would prevent exposure to the contaminants.

USACE has decided that additional assessment of the possible remedies for Building 14 (and residual soils under the building) is warranted. Therefore, the building and soils under the building are being excluded from this ROD and will be addressed separately in accordance with CERCLA, allowing for the initiation of remedial actions to proceed on the remainder of the site.

Groundwater

The original RI, FS and PP for the Linde (Tonawanda) site(s), proposed that no action was warranted to address on-site groundwater. USACE further investigated existing available information relating to the groundwater at the Linde Site and presented findings in a document entitled "Synopsis of Historical Information on Linde Effluent Injection Wells" (USACE 1999a). The result of that assessment was also a conclusion that no remediation of the groundwater is warranted. This conclusion was re-stated in the 1999 Linde PP (USACE 1999c).

Comments received during the comment period expressed concerns about the sufficiency of the samples relied upon in coming to the conclusion that no remediation of the groundwater is warranted. A ROD will be issued in the future that evaluates the Site groundwater and selects any required remedial action .

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ATTACHMENT 3

IUSA/UDEQ Hazardous Waste Protocol

State of Utah
DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF SOLID AND HAZARDOUS WASTE

Michael O. Leavitt
Governor
Dianne R. Nielson, Ph.D.
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Dennis R. Downs
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December 7, 1999

M. Lindsay Ford
Parsons, Behle and Latimer
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201 South Main Street
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Salt Lake City, Utah 84145-0898

RE: Protocol for Determining Whether Alternate Feed Materials are Listed Hazardous Wastes

Dear Mr. Ford:

On November 22, 1999, we received the final protocol to be used by International Uranium Corporation (IUSA) in determining whether alternate feed materials proposed for processing at the White Mesa Mill are listed hazardous wastes. We appreciate the effort that went into preparing this procedure and feel that it will be a useful guide for IUSA in its alternate feed determinations.

As was discussed, please be advised that it is IUSA's responsibility to ensure that the alternate feed materials used are not listed hazardous wastes and that the use of this protocol cannot be used as a defense if listed hazardous waste is somehow processed at the White Mesa Mill.

Thank you again for your corporation. If you have any questions, please contact Don Verbica at 538-6170.

Sincerely,

Dennis R. Downs, Executive Secretary
Utah Solid and Hazardous Waste Control Board

c: Bill Sinclair, Utah Division of Radiation Control

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November 22, 1999

Don Verbica
Utah Division of Solid & Hazardous Waste
288 North 1460 West
Salt Lake City, Utah

Re: Protocol for Determining Whether Alternate Feed Materials are Listed Hazardous Wastes

Dear Don:

I am pleased to present the final protocol to be used by International Uranium (USA) Corporation ("IUSA") in determining whether alternate feed materials proposed for processing at the White Mesa Mill are listed hazardous wastes. Also attached is a red-lined version of the protocol reflecting final changes made to the document based on our last discussion with you as well as some minor editorial changes from our final read-through of the document. We appreciate the thoughtful input of you and Scott Anderson in developing this protocol. We understand the Division concurs that materials determined not to be listed wastes pursuant to this protocol are not listed hazardous wastes.

We also recognize the protocol does not address the situation where, after a material has been determined not to be a listed hazardous waste under the protocol, new unrefutable information comes to light that indicates the material is a listed hazardous waste. Should such an eventuality arise, we understand an appropriate response, if any, would need to be worked out on a case-by-case basis.

Thank you again for your cooperation on this matter. Please call me if you have any questions.

Very truly yours,

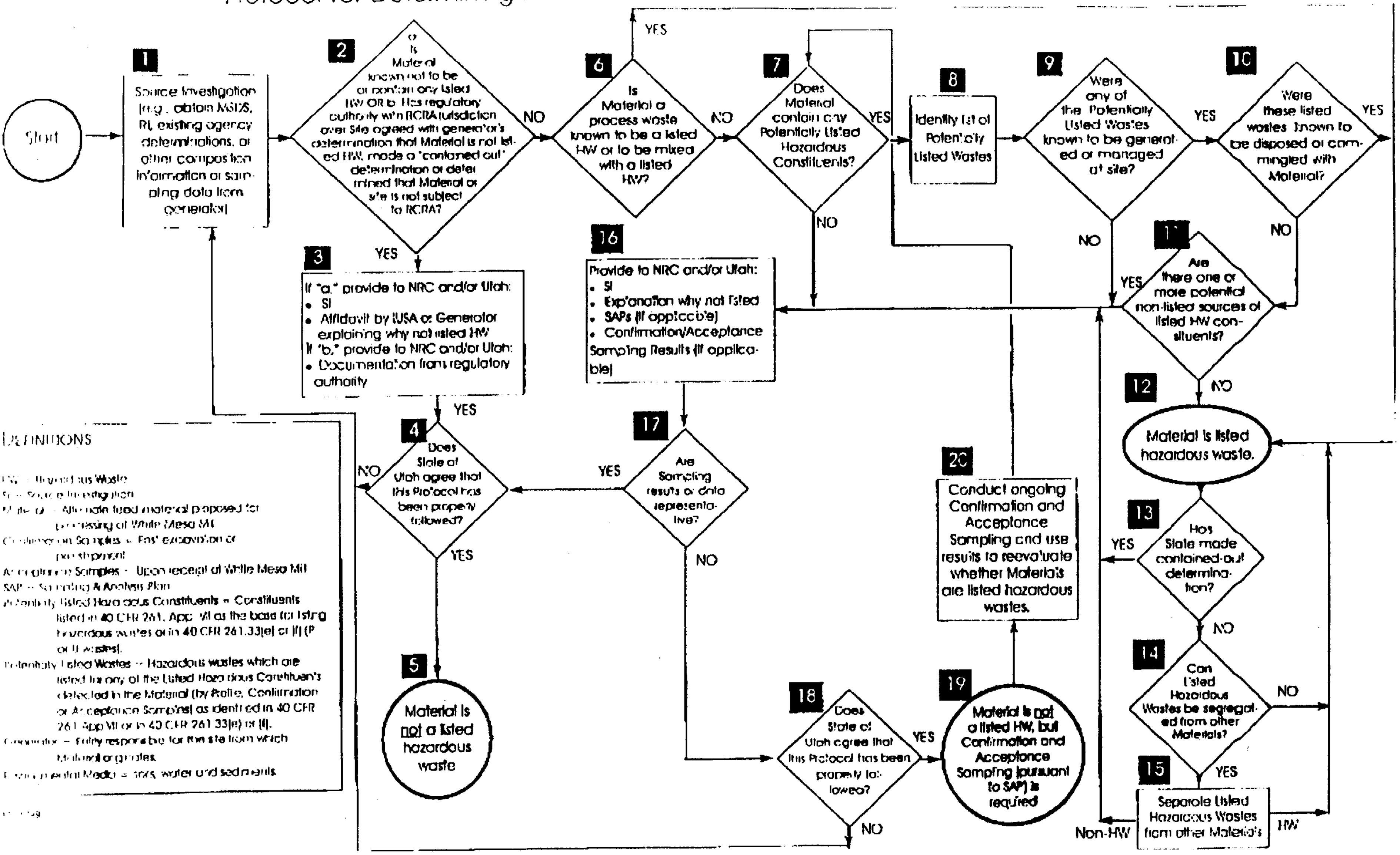
Parsons Behle & Latimer

Lindsay Ford

M. Lindsay Ford

cc: (with copy of final protocol only)
Dianne Nielson
Fred Nelson
Brent Bradford
Don Ostler
Loren Morton
Bill Sinclair
David Frydenlund
David Bird
Tony Thompson

Protocol for Determining if Alternate Feed Material Is a Listed Hazardous Waste



DEFINITIONS

HW = Hazardous Waste
SI = Source Investigation
Material = Alternate feed material proposed for processing at White Mesa Mill
Confirmation Samples = Post excavation or pre-shipment
Acceptance Samples = Upon receipt at White Mesa Mill
SAP = Sampling & Analysis Plan
Potentially Listed Hazardous Constituents = Constituents listed in 40 CFR 261, App. VII as the basis for listing hazardous wastes or in 40 CFR 261.33(e) or (f) (P or U wastes).
Potentially Listed Wastes = Hazardous wastes which are listed for any of the Listed Hazardous Constituents detected in the Material (by Profile, Confirmation or Acceptance Sampling) as identified in 40 CFR 261 App VII or in 40 CFR 261.33(e) or (f).
Generator = Entity responsible for the site from which Material originates.
Environmental Media = soils, water and sediments

PROTOCOL FOR DETERMINING WHETHER ALTERNATE FEED MATERIALS ARE LISTED HAZARDOUS WASTES[1]

NOVEMBER 16, 1999

1. SOURCE INVESTIGATION.

Perform a good faith investigation (a "Source Investigation" or "SI")[2] regarding whether any listed hazardous wastes[3] are located at the site from which alternate feed material[4] ("Material") originates (the "Site"). This investigation will be conducted in conformance with EPA guidance[5] and the extent of information required will vary with the circumstances of each case. Following are examples of investigations that would be considered satisfactory under EPA guidance and this Protocol for some selected situations:

- Where the Material is or has been generated from a known process under the control of the generator: (a) an affidavit, certificate, profile record or similar document from the Generator or Site Manager, to that effect, together with (b) a Material Safety Data Sheet ("MSDS") for the Material, limited profile sampling, or a material composition determined by the generator/operator based on a process material balance.

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[1] This Protocol reflects the procedures that will be followed by International Uranium (USA) Corporation ("IUSA") for determining whether alternate feed materials proposed for processing at the White Mesa Mill are (or contain) listed hazardous wastes. It is based on current Utah and EPA rules and EPA guidance under the Resource Conservation and Recovery Act ("RCRA"), 42 U.S.C. §§ 6901 et seq. This Protocol will be changed as necessary to reflect any pertinent changes to RCRA rules or EPA guidance.

[2] This investigation will be performed by IUSA, by the entity responsible for the site from which the Material originates (the "Generator"), or by a combination of the two.

[3] Attachment 1 to this Protocol provides a summary of the different classifications of RCRA listed hazardous wastes.

[4] Alternate feed materials that are primary or intermediate products of the generator of the material (*e.g.*, "green" or "black" salts) are not RCRA "secondary materials" or "solid wastes," as defined in 40 CFR 261, and are not covered by this Protocol.

[5] EPA guidance identifies the following sources of site- and waste-specific information that may, depending on the circumstances, be considered in such an investigation: hazardous waste manifests, vouchers, bills of lading, sales and inventory records, material safety data sheets, storage records, sampling and analysis reports, accident reports, site investigation reports, interviews with employees/former employees and former owners/operators, spill reports, inspection reports and logs, permits, and enforcement orders. *See e.g.*, 61 Fed. Reg. 18805 (April 29, 1996).

- Where specific information exists about the generation process and management of the Material: (a) an affidavit, certificate, profile record or similar document from the Generator or Site Manager, to that effect, together with (b) an MSDS for the Material, limited profile sampling data or a preexisting investigation performed at the Site pursuant to CERCLA, RCRA or other state or federal environmental laws or programs.
- Where potentially listed processes are known to have been conducted at a Site, an investigation considering the following sources of information: site investigation reports prepared under CERCLA, RCRA or other state or federal environmental laws or programs (*e.g.*, an RI/FS, ROD, RFI/CMS, hazardous waste inspection report); interviews with persons possessing knowledge about the Material and/or Site; and review of publicly available documents concerning process activities or the history of waste generation and management at the Site.
- If material from the same source is being or has been accepted for direct disposal as 11e.(2) byproduct material in an NRC-regulated facility in the State of Utah with the consent or acquiescence of the State of Utah, the Source Investigation performed by such facility.

Proceed to Step 2.

2. SPECIFIC INFORMATION OR AGREEMENT/DETERMINATION BY RCRA REGULATORY AUTHORITY THAT MATERIAL IS NOT A LISTED HAZARDOUS WASTE?

a. Determine whether specific information from the Source Investigation exists about the generation and management of the Material to support a conclusion that the Material is not (and does not contain) any listed hazardous waste. For example, if specific information exists that the Material was not generated by a listed waste source and that the Material has not been mixed with any listed wastes, the Material would not be a listed hazardous waste.

b. Alternatively, determine whether the appropriate state or federal authority with RCRA jurisdiction over the Site agrees in writing with the generator's determination that the Material is not a listed hazardous waste, has made a "contained-out" determination[6] with respect to the Material or has concluded the Material or Site is not subject to RCRA.

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[6] EPA explains the "contained-out" (also referred to as "contained-in") principle as follows:

> In practice, EPA has applied the contained-in principle to refer to a process where a site-specific determination is made that concentrations of hazardous constituents in any given

(footnote continued on next page)

If yes to either question, proceed to Step 3.

If no to both questions, proceed to Step 6.

3. PROVIDE INFORMATION TO NRC AND UTAH.

a. If specific information exists to support a conclusion that the Material is not, and does not contain, any listed hazardous waste, IUSA will provide a description of the Source Investigation to NRC and/or the State of Utah Department of Environmental Quality, Division of Solid and Hazardous Waste (the "State"), together with an affidavit explaining why the Material is not a listed hazardous waste.

b. Alternatively, if the appropriate regulatory authority with RCRA jurisdiction over the Site agrees in writing with the generator's determination that the Material is not a listed hazardous waste, makes a contained-out determination or determines the Material or Site is not subject to RCRA, IUSA will provide documentation of the regulatory authority's determination to NRC and the State. IUSA may rely on such determination provided that the State agrees the conclusions of the regulatory authority were reasonable and made in good faith.

Proceed to Step 4.

4. DOES STATE OF UTAH AGREE THAT ALL PREVIOUS STEPS HAVE BEEN PERFORMED IN ACCORDANCE WITH THIS PROTOCOL?

Determine whether the State agrees that this Protocol has been properly followed (including that proper decisions were made at each decision point). The State shall review the information provided by IUSA in Step 3 or 16 with reasonable speed and advise IUSA if it believes IUSA has not properly followed this Protocol in determining

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(footnote continued from previous page)

> volume of environmental media are low enough to determine that the media does not "contain" hazardous waste. Typically, these so-called "contained-in" [or "contained-out"] determinations do not mean that no hazardous constituents are present in environmental media but simply that the concentrations of hazardous constituents present do not warrant management of the media as hazardous waste. ...
>
> EPA has not, to date, issued definitive guidance to establish the concentrations at which contained-in determinations may be made. As noted above, decisions that media do not or no longer contain hazardous waste are typically made on a case-by-case basis considering the risks posed by the contaminated media.

63 Fed. Reg. 28619, 28621-22 (May 26, 1998) (Phase IV LDR preamble).

that the Material is not listed hazardous waste, specifying the particular areas of deficiency.

If this Protocol has not been properly followed by IUSA in making its determination that the Material is not a listed hazardous waste, then IUSA shall redo its analysis in accordance with this Protocol and, if justified, resubmit the information described in Step 3 or 16 explaining why the Material is not a listed hazardous waste. The State shall notify IUSA with reasonable speed if the State still believes this Protocol has not been followed.

If yes, proceed to Step 5.

If no, proceed to Step 1.

5. MATERIAL IS <u>NOT</u> A LISTED HAZARDOUS WASTE.

The Material is not a listed hazardous waste and no further sampling or evaluation is necessary in the following circumstances:

- **Where the Material is determined not to be a listed hazardous waste based on specific information about the generation/management of the Material <u>OR</u> the appropriate RCRA regulatory authority with jurisdiction over the Site agrees with the generator's determination that the Material is not a listed HW, makes a contained-out determination, or concludes the Material or Site is not subject to RCRA (and the State agrees the conclusions of the regulatory authority were reasonable and made in good faith) (Step 2); or**
- **Where the Material is determined not to be a listed hazardous waste (in Steps 6 through 11, 13 or 15) and Confirmation/Acceptance Sampling are determined not to be necessary (under Step 17).**

6. IS MATERIAL A PROCESS WASTE KNOWN TO BE A LISTED HAZARDOUS WASTE OR TO BE MIXED WITH A LISTED HAZARDOUS WASTE?

Based on the Source Investigation, determine whether the Material is a process waste known to be a listed hazardous waste or to be mixed with a listed hazardous waste. If the Material is a process waste and is from a listed hazardous waste source, it is a listed hazardous waste. Similarly, if the Material is a process waste and has been mixed with a listed hazardous waste, it is a listed hazardous waste under the RCRA "mixture rule." If the Material is an Environmental Medium,[7] it cannot be a listed hazardous waste by direct listing or under the RCRA "mixture rule."[8] If the Material is a process waste but is not known to be from a listed source or to be mixed with a listed waste, or if the Material is an Environmental Medium, proceed to Steps 7 through 11 to determine whether it is a listed hazardous waste.

If yes, proceed to Step 12.

If no, proceed to Step 7.

7. DOES MATERIAL CONTAIN ANY POTENTIALLY LISTED HAZARDOUS CONSTITUENTS?

Based on the Source Investigation (and, if applicable, Confirmation and Acceptance Sampling), determine whether the Material contains any hazardous constituents listed in the then most recent version of 40 CFR 261, Appendix VII (which identifies hazardous constituents for which F- and K-listed wastes were listed) or 40 CFR 261.33(e) or (f) (the P and U listed wastes) (collectively "Potentially Listed Hazardous Constituents"). If the Material contains such constituents, a source evaluation is necessary (pursuant to Steps 8 through 11). If the Material does not contain any Potentially Listed Hazardous Constituents, it is not a listed hazardous waste. The Material also is not a listed hazardous waste if, where applicable, Confirmation and Acceptance Sampling results do not reveal the presence of any "new" Potentially Listed Hazardous Constituents (*i.e.*, constituents other than those that have already been identified by the Source Investigation (or previous Confirmation/Acceptance Sampling) and determined not to originate from a listed source).

If yes, proceed to Step 8.

If no, proceed to Step 16.

8. IDENTIFY POTENTIALLY LISTED WASTES.

Identify potentially listed hazardous wastes ("Potentially Listed Wastes") based on Potentially Listed Hazardous Constituents detected in the Material, *i.e.*, wastes which are listed for any of the Potentially Listed Hazardous Constituents detected in the Material, as

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[7] The term "Environmental Media" means soils, ground or surface water and sediments.

[8] The "mixture rule" applies only to mixtures of listed hazardous wastes and other "solid wastes." *See* 40 CFR § 261.3(a)(2)(iv). The mixture rule does not apply to mixtures of listed wastes and Environmental Media, because Environmental Media are not "solid wastes" under RCRA. *See* 63 Fed. Reg. 28556, 28621 (May 26, 1998).

identified in the then most current version of 40 CFR 261 Appendix VII or 40 CFR 261.33(c) or (f).[9] With respect to Potentially Listed Hazardous Constituents identified through Confirmation and/or Acceptance Sampling, a source evaluation (pursuant to Steps 8 through 11) is necessary only for "new" Potentially Listed Hazardous Constituents (*i.e.*, constituents other than those that have already been identified by the Source Investigation (or previous Confirmation/Acceptance Sampling) and determined not to originate from a listed source).

Proceed to Step 9.

9. WERE ANY OF THE POTENTIALLY LISTED WASTES KNOWN TO BE GENERATED OR MANAGED AT SITE?

Based on information from the Source Investigation, determine whether any of the Potentially Listed Wastes identified in Step 8 are known to have been generated or managed at the Site. This determination involves identifying whether any of the specific or non-specific sources identified in the K- or F-lists has ever been conducted or located at the Site, whether any waste from such processes has been managed at the Site, and whether any of the P- or U-listed commercial chemical products has ever been used, spilled or managed there. In particular, this determination should be based on the following EPA criteria:

Solvent Listings (F001-F005)

> Under EPA guidance, "to determine if solvent constituents contaminating a waste are RCRA spent solvent F001-F005 wastes, the [site manager] must know if:
>
> - The solvents are *spent* and *cannot be reused without reclamation* or cleaning.
> - The solvents were *used exclusively for their solvent properties.*
> - The solvents are spent *mixtures and blends that contained, before use, a total of 10 percent or more (by volume) of the solvents* listed in F001, F002, F004, and F005.
>
> If the solvents contained in the [wastes] are RCRA listed wastes, the [wastes] are RCRA hazardous waste. When the [site manager] does not have guidance information on the use of the solvents and their characteristics before use, the [wastes] cannot be classified as containing a

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[9] For example, if the Material contains tetrachloroethylene, the following would be Potentially Listed Wastes: F001, F002, F024, K019, K020, K150, K151 or U210. *See* 40 CFR 261 App. VII.

listed spent solvent."[10] The person performing the Source Investigation will make a good faith effort to obtain information on any solvent use at the Site. If solvents were used at the Site, general industry standards for solvent use in effect at the time of use will be considered in determining whether those solvents contained 10 percent or more of the solvents listed in F001, F002, F004 or F005.

K-Listed Wastes and F-Listed Wastes Other Than F001-F005

Under EPA guidance, to determine whether K wastes and F wastes other than F001-F005 are RCRA listed wastes, the generator "must know the *generation process information* (about each waste contained in the RCRA waste) described in the listing. For example, for [wastes] to be identified as containing K001 wastes that are described as 'bottom sediment sludge from the treatment of wastewaters from wood preserving processes that use creosote and/or pentachlorophenol,' the [site manager] must know the manufacturing process that generated the wastes (treatment of wastewaters from wood preserving process), feedstocks used in the process (creosote and pentachlorophenol), and the process identification of the wastes (bottom sediment sludge)."[11]

P- and U-Listed Wastes

EPA guidance provides that "P and U wastes cover only unused and unmixed commercial chemical products, particularly spilled or off-spec products. Not every waste containing a P or U chemical is a hazardous waste. To determine whether a [waste] contains a P or U waste, the [site manager] must have direct evidence of product use. In particular, the [site manager] should ascertain, if possible, whether the chemicals are:

- Discarded (as described in 40 CFR 261.2(a)(2)).
- Either off-spec commercial products or a commercially sold grade.
- Not used (soil contaminated with spilled unused wastes is a P or U waste).

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[10] Management of Investigation-Derived Wastes During Site Inspections, EPA/540/G-91/009, May 1991 (emphasis added).

[11] Management of Investigation-Derived Wastes During Site Inspections, EPA/540/G-91/009, May 1991 (emphasis added).

- The sole active ingredient in a formulation."[12]

If Potentially Listed Wastes were known to be generated or managed at the Site, further evaluation is necessary to determine whether these wastes were disposed of or commingled with the Material (Steps 10 and possibly 11). If Potentially Listed Wastes were not known to be generated or managed at the Site, then information concerning the source of Potentially Listed Hazardous Constituents in the Material will be considered "unavailable or inconclusive" and, under EPA guidance,[13] the Material will be assumed not to be a listed hazardous waste.

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[12] Management of Investigation-Derived Wastes During Site Inspections, EPA/540/G-91/009, May 1991.

[13] EPA guidance consistently provides that, where information concerning the origin of a waste is unavailable or inconclusive, the waste may be assumed not to be a listed hazardous waste. *See e.g.*, Memorandum from Timothy Fields (Acting Assistant Administrator for Solid Waste & Emergency Response) to RCRA/CERCLA Senior Policy Managers regarding "Management of Remediation Waste Under RCRA," dated October 14, 1998 ("Where a facility owner/operator makes a good faith effort to determine if a material is a listed hazardous waste but cannot make such a determination because documentation regarding a source of contamination, contaminant, or waste is *unavailable or inconclusive*, EPA has stated that one may assume the source, contaminant, or waste is not listed hazardous waste"); NCP Preamble, 55 Fed. Reg. 8758 (March 8, 1990) (Noting that "it is often necessary to know the origin of the waste to determine whether it is a listed waste and that, *if such documentation is lacking, the lead agency may assume it is not a listed waste*); Preamble to proposed Hazardous Waste Identification Rule, 61 Fed. Reg. 18805 (April 29, 1996) ("Facility owner/operators should make a good faith effort to determine whether media were contaminated by hazardous wastes and ascertain the dates of placement. The Agency believes that by using available site- and waste-specific information ... facility owner/operators would typically be able to make these determinations. However, as discussed earlier in the preamble of today's proposal, *if information is not available or inconclusive, facility owner/operators may generally assume that the material contaminating the media were not hazardous wastes.*"); Preamble to LDR Phase IV Rule, 63 Fed. Reg. 28619 (May 26, 1998) ("As discussed in the April 29, 1996 proposal, the Agency continues to believe that, *if information is not available or inconclusive, it is generally reasonable to assume that contaminated soils do not contain untreated hazardous wastes ...*"); and Memorandum from John H. Skinner (Director, EPA Office of Solid Waste) to David Wagoner (Director, EPA Air and Waste Management Division, Region VII) regarding "Soils from Missouri Dioxin Sites," dated January 6, 1984 ("The analyses indicate the presence of a number of toxic compounds in many of the soil samples taken from various sites. However, the presence of these toxicants in the soil does not automatically make the soil a RCRA hazardous waste. The origin of the toxicants must be known in order to determine that they are derived from a listed hazardous waste(s). *If the exact origin of the toxicants is not known, the soils cannot be*

(footnote continued on next page)

If yes, proceed to Step 10.

If no, proceed to Step 16.

10. WERE LISTED WASTES KNOWN TO BE DISPOSED OF OR COMMINGLED WITH MATERIAL?

If listed wastes identified in Step 9 were known to be generated at the Site, determine whether they were known to be disposed of or commingled with the Material?

If yes, proceed to Step 12.

If no, proceed to Step 11.

11. ARE THERE ONE OR MORE POTENTIAL NON-LISTED SOURCES OF LISTED HAZARDOUS WASTE CONSTITUENTS?

In a situation where Potentially Listed Wastes were known to have been generated/managed at the Site, but the wastes were not known to have been disposed of or commingled with the Material, determine whether there are potential non-listed sources of Potentially Listed Hazardous Constituents in the Material. If not, unless the State agrees otherwise, the constituents will be assumed to be from listed sources (proceed to Step 12). If so, the Material will be assumed not to be a listed hazardous waste (proceed to Step 16). Notwithstanding the existence of potential non-listed sources at a Site, the Potentially Listed Hazardous Constituents in the Material will be considered to be from the listed source(s) if, based on the relative proximity of the Material to the listed and non-listed source(s) and/or information concerning waste management at the Site, the evidence is compelling that the listed source(s) is the source of Potentially Listed Hazardous Constituents in the Material.

If yes, proceed to Step 16.

If no, proceed to Step 12.

12. MATERIAL IS A LISTED HAZARDOUS WASTE.

The Material is a listed hazardous waste under the following circumstances:

(footnote continued from previous page)

considered RCRA hazardous wastes unless they exhibit one or more of the characteristics of hazardous waste ...").

- If the Material is a process waste and is known to be a listed hazardous waste or to be mixed with a listed hazardous waste (Step 6),
- If Potentially Listed Wastes were known to be generated/managed at the Site and to be disposed of/commingled with the Material (Step 10) (subject to a "contained-out" determination in Step 13), or
- If Potentially Listed Wastes were known to be generated/managed at the Site, were not known to be disposed of/commingled with the Material but there are not any potential non-listed sources of the Potentially Listed Hazardous Constituents detected in the Material (Step 11) (subject to a "contained-out" determination in Step 13).

Proceed to Step 13.

13. HAS STATE OF UTAH MADE A CONTAINED-OUT DETERMINATION.

If the Material is an Environmental Medium, and:

- the level of any listed waste constituents in the Material is "de minimis" ; or
- all of the listed waste constituents or classes thereof are already present in the White Mesa Mill's tailings ponds as a result of processing conventional ores or other alternate feed materials in concentrations at least as high as found in the Materials

the State of Utah will consider whether it is appropriate to make a contained-out determination with respect to the Material.

If the State makes a contained-out determination, proceed to Step 16.

If the State does not make a contained-out determination, proceed to Step 14.

14. IS IT POSSIBLE TO SEGREGATE LISTED HAZARDOUS WASTES FROM OTHER MATERIALS?

Determine whether there is a reasonable way to segregate material that is a listed hazardous waste from alternate feed materials that are not listed hazardous wastes that will be sent to IUSA's White Mesa Mill. For example, it may be possible to isolate material from a certain area of a remediation site and exclude that material from Materials that will be sent to the White Mesa Mill. Alternatively, it may be possible to increase

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sampling frequency and exclude materials with respect to which the increased sampling identifies constituents which have been attributed to listed hazardous waste.

If yes, proceed to Step 15.

If no, proceed to Step 12.

15. SEPARATE LISTED HAZARDOUS WASTES FROM MATERIALS.

Based on the method of segregation determined under Step 14, materials that are listed hazardous wastes are separated from Materials that will be sent to the White Mesa Mill.

For materials that are listed hazardous wastes, proceed to Step 12.

For Materials to be sent to the White Mesa Mill, proceed to Step 16.

16. PROVIDE INFORMATION TO NRC AND UTAH.

If the Material does not contain any Potentially Listed Hazardous Constituents (as determined in Step 7), where information concerning the source of Potentially Listed Hazardous Constituents in the Material is "unavailable or inconclusive" (as determined in Steps 8 through 11), or where the State of Utah has made a contained-out determination with respect to the Material (Step 13), the Material will be assumed not to be (or contain) a listed hazardous waste. In such circumstances, IUSA will submit the following documentation to NRC and the State:

- A description of the Source Investigation;
- An explanation of why the Material is not a listed hazardous waste.
- Where applicable, an explanation of why Confirmation/Acceptance Sampling has been determined not to be necessary in Step 17.
- If Confirmation/Acceptance Sampling has been determined necessary in Step 17 , a copy of IUSA's and the Generator's Sampling and Analysis Plans.
- A copy of Confirmation and Acceptance Sampling results, if applicable. IUSA will submit these results only if they identify the presence of "new" Potentially Listed Hazardous Constituents (as defined in Steps 7 and 8).

Proceed to Step 17.

17. ARE SAMPLING RESULTS OR DATA REPRESENTATIVE?

Determine whether the sampling results or data from the Source Investigation (or, where applicable, Confirmation/Acceptance Sampling results) are representative. The purpose of this step) is to determine whether Confirmation and Acceptance Sampling (or continued Confirmation and Acceptance Sampling) are necessary. If the sampling results or data are representative of all Material destined for the White Mesa Mill, based on the extent of sampling conducted, the nature of the Material and/or the nature of the Site (*e.g.*, whether chemical operations or waste disposal were known to be conducted at the Site), future Confirmation/Acceptance Sampling will not be necessary. If the sampling results are not representative of all Material destined for the White Mesa Mill, then additional Confirmation/Acceptance sampling may be appropriate. Confirmation and Acceptance Sampling will be required only where it is reasonable to expect that additional sampling will detect additional contaminants not already detected. For example:

- Where the Material is segregated from Environmental Media, *e.g.*, the Material is containerized, there is a high probability the sampling results or data from the Source Investigation are representative of the Material and Confirmation/Acceptance Sampling would not be required.
- Where IUSA will be accepting Material from a discrete portion of a Site, *e.g.*, a storage pile or other defined area, and adequate sampling characterized the area of concern for radioactive and chemical contaminants, the sampling for that area would be considered representative and Confirmation/Acceptance sampling would not be required.
- Where Material will be received from a wide area of a Site and the Site has been carefully characterized for radioactive contaminants, but not chemical contaminants, Confirmation/Acceptance sampling would be required.
- Where the Site was not used for industrial activity or disposal before or after uranium material disposal, and the Site has been adequately characterized for radioactive and chemical contaminants, the existing sampling would be considered sufficient and Confirmation/Acceptance sampling would not be required.
- Where listed wastes were known to be disposed of on the Site and the limits of the area where listed wastes were managed is not known, Confirmation/Acceptance sampling would be required to ensure that listed wastes are not shipped to IUSA (see Step 14).

If yes, proceed to Step 4.

If no, proceed to Step 18.

18. DOES STATE OF UTAH AGREE THAT ALL PREVIOUS STEPS HAVE BEEN PERFORMED IN ACCORDANCE WITH THIS PROTOCOL?

Determine whether the State agrees that this Protocol has been properly followed (including that proper decisions were made at each decision point). The State shall review the information provided by IUSA in Step 16 with reasonable speed and advise IUSA if it believes IUSA has not properly followed this Protocol in determining that the Material is not listed hazardous waste, specifying the particular areas of deficiency.

If this Protocol has not been properly followed by IUSA in making its determination that the Material is not a listed hazardous waste, then IUSA shall redo its analysis in accordance with this Protocol and, if justified, resubmit the information described in Step 16 explaining why the Material is not a listed hazardous waste. The State shall notify IUSA with reasonable speed if the State still believes this Protocol has not been followed.

If yes, proceed to Step 19.

If no, proceed to Step 1.

19. MATERIAL IS NOT A LISTED HAZARDOUS WASTE, BUT CONFIRMATION AND ACCEPTANCE SAMPLING ARE REQUIRED.

The Material is not a listed hazardous waste, but Confirmation and Acceptance Sampling are required, as determined necessary under Step 17.

Proceed to Step 20.

20. CONDUCT ONGOING CONFIRMATION AND ACCEPTANCE SAMPLING.

Confirmation and Acceptance Sampling will continue until determined no longer necessary under Step 17. Such sampling will be conducted pursuant to a Sampling and Analysis Plan ("SAP") that specifies the frequency and type of sampling required. If such sampling does not reveal any "new" Potentially Listed Hazardous Constituents (as defined in Steps 7 and 8), further evaluation is not necessary (as indicated in Step 7). If such sampling reveals the presence of "new" constituents, Potentially Listed Wastes must be identified (Step 8) and evaluated (Steps 9 through 11) to determine whether the new constituent is from a listed hazardous waste source. Generally, in each case, the SAP will specify sampling comparable to the level and frequency of sampling performed by other facilities in the State of Utah that dispose of 11e.(2) byproduct material, either directly or that results from processing alternate feed materials.

Proceed to Step 7.

Attachment 1

Summary of RCRA Listed Hazardous Wastes

There are three different categories of listed hazardous waste under RCRA:

- *F-listed wastes from non-specific sources (40 CFR § 261.31(a))*: These wastes include spent solvents (F001-F005), specified wastes from electroplating operations (F006-F009), specified wastes from metal heat treating operations (F010-F012), specified wastes from chemical conversion coating of aluminum (F019), wastes from the production/manufacturing of specified chlorophenols, chlorobenzenes, and chlorinated aliphatic hydrocarbons (F019-F028), specified wastes from wood preserving processes (F032-F035), specified wastes from petroleum refinery primary and secondary oil/water/solids separation sludge (F037-F038), and leachate resulting from the disposal of more than one listed hazardous waste (F039).
- *K-listed wastes from specific sources (40 CFR § 261.32)*: These include specified wastes from wood preservation, inorganic pigment production, organic chemical production, chlorine production, pesticide production, petroleum refining, iron and steel production, copper production, primary and secondary lead smelting, primary zinc production, primary aluminum reduction, ferroalloy production, veterinary pharmaceutical production, ink formulation and coking.
- *P- and U-listed commercial chemical products (40 CFR § 261.33)*: These include commercial chemical products, or manufacturing chemical intermediates having the generic name listed in the "P" or "U" list of wastes, container residues, and residues in soil or debris resulting from a spill of these materials.[1] "The phrase 'commercial chemical product or manufacturing chemical intermediate ...' refers to a chemical substance which is manufactured or formulated for commercial or manufacturing use which consists of the commercially pure grade of the chemical, any technical grades of the chemical that are produced or marketed, and all formulations in which the chemical is the sole active ingredient. It does not refer to a material, such as a manufacturing process waste, that contains any of the [P- or U-listed substances]."[2]

Appendix VII to 40 CFR part 261 identifies the hazardous constituents for which the F- and K-listed wastes were listed.

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[1] P-listed wastes are identified as "acutely hazardous wastes" and are subject to additional management controls under RCRA. 40 CFR § 261.33(e) (1997). U-listed wastes are identified as "toxic wastes." Id. § 261.33(f).

[2] 40 CFR § 261.33(d) note (1997).

ATTACHMENT 4

Review of Constituents in Linde Site Uranium Materials
to Determine Potential Presence of Listed Hazardous Waste

Review of Chemical Contaminants in Linde Materials to Determine the Potential Presence of Listed Hazardous Waste

1.0 Site History and Background

The Linde property is located in Tonawanda, New York, just north of the city of Buffalo. From 1942 to 1946, the former Linde Air Products Division of Union Carbide processed uranium ores at this site under contract to the Manhattan Engineering District ("MED"). The history of the Linde site can be summarized as follows:

Pre-1940's	Undeveloped farmland
1942	Union Carbide Linde Division, Uranium Colored Ceramics
1942 to early 1950's	Manhattan Engineering District, Uranium Ore Extraction
1950's to 1991	Union Carbide Linde Division, Gases and Air Products
1991 to 1998	Praxair, Gases and Air Products
1998 to present	Praxair Engineering Office

Union Carbide Corporation's former Linde Division constructed a ceramics plant at the location around 1942. One of the ceramics processes conducted by Union Carbide Linde Division at this location consisted of extraction of uranium from ores to produce uranium salts, for coloration of product glasses. Based on their experience, Union Carbide was placed under contract with the Manhattan Engineering District ("MED") from 1942 to 1946 to extract uranium from seven different ore sources: four African pitchblende ores and three domestic ores. Laboratory and pilot plant studies were conducted from 1942 to 1943. From 1943 to 1946, Linde conducted full scale processing of 28,300 tons of ore. The Linde division contract with the Manhattan Engineering District ended in the early 1950's.

The domestic ores processed at Linde resulted from commercial processing which removed vanadium, and consequently reduced the concentrations of radium relative to the uranium and thorium levels. The African ores contained uranium in equilibrium with all the daughter products in its decay chain.

MED utilized a three-phase process for extraction of uranium from both the domestic and foreign ores. Triuranium octoxide ("U_3O_8") was separated from the feedstock by acid digestion, precipitation, and filtration. The solid, gelatinous filter cake from this step was discarded as solid waste in a temporary tailings pile on the Linde site. Insoluble precipitates from the solution steps were combined with the filter cake for disposal on site. Approximately 8,000 tons of combined filter cake and precipitates were later relocated to Ashland 1. $U_3O_8$was converted to uranium dioxide and uranium tetrafluoride at the Linde site. Residuals from these two steps were reprocessed at the Linde site.

The Remedial Investigation ("RI") Report provides extensive detail on the chemicals utilized in full-scale ore extraction. Full-scale processing utilized sulfuric acid, pyrolucite, soda ash, sodium bicarbonate, ferrous and ferric sulfates, barium chloride, caustic soda, ammonium sulfate, and other materials.

Five buildings at the site were involved in MED activities. Building 14 had been constructed by Union Carbide in the mid-1930's. Buildings 30, 31, 37, and 38 were constructed at the location by MED, and their ownership was transferred to Linde when the MED contract ended.

Residues from uranium ore processing at the Linde facility were disposed of and/or stored at the Ashland 1, Ashland 2 and Seaway properties. Approximately 8,000 tons of Linde facility residues were disposed on the Ashland 1 property between 1944 and 1946. No material was transferred from Linde to Ashland 1 after this period. In 1974, the subsequent owner of the Ashland 1 property excavated a portion of the Linde residues and soils from the Ashland 1 site, and relocated them to the Ashland 2 property. NRC has already approved amendments to IUSA's license for processing of the portions of the Linde residues and soil moved to Ashland 1 and Ashland 2. As described below, after the transfer of residues to Ashland 1 was completed, Linde added manufacturing operations at the Linde facility that likely contributed additional contaminants to the materials remaining on the Linde site, but would not have affected materials already transferred to Ashland 1 and/or Ashland 2.

The Linde Division ceased ceramics operations and operated an inorganic gas equipment design and construction facility at the site from the 1950's through 1991. At that time, the Linde division was spun off from Union Carbide and changed its name to Praxair, Inc. Both Linde and Praxair designed and manufactured gas compressors, chillers, filters and gas purification equipment for installation and operation at customer sites. There is no record of any gas manufacture or chemical processing occurring at the site at any time, before or after the MED activities. Neither the ceramics operation, which was based on the conversion of mineral raw materials via inorganic processes, nor the equipment manufacturing operation, involved any synthetic organic chemical processing. Praxair continued to manufacture equipment at the site until 1991, when it closed all operations except the engineering center offices.

Renovation of the facility over the years has resulted in consolidation of the MED wastes and radioactively contaminated soils remaining at the property. In 1977, MED contaminated soil was removed from the construction area for the new building 90, and placed in two windrows along the northern property line. The windrows were consolidated into one pile between 1979 and 1982, and covered in 1992.

The Record of Decision ("ROD") for the Linde Property was not available at the time this evaluation was prepared. However, sufficient characterization information on the nature and extent of contamination is already available to assess the composition and sources of Uranium Material to be excavated.

2.0 Basis and Limitations of this Evaluation

The following contamination evaluation is based on:

1. Chemical Data presented in the Remedial Investigation ("RI") Report for Tonawanda Site (USDOE, December 1992).
2. Site information in the Proposed Plan for the Linde Site (USACE, 1999).
3. Various texts and published information on the history of chemical usage in uranium extraction research and processing.
4. IUSA "Protocol for Determining Whether Alternate Feeds Are Listed Hazardous Wastes" (IUSA, November, 1999).
5. The New York State Department of Environmental Conservation ("NYSDEC") Technical and Administrative Guidance Memorandum ("TAGM") on Hazardous Constituents from RCRA Listed Hazardous Waste Contained in Environmental Media. (NYSDEC, November 1992).
6. Site visit to the Praxair/Linde property on May 25, 1999.
7. Interviews with the USACE contractor at the Linde site.
8. The Linde Site Preliminary Material Characterization Report (USACE Buffalo District, February, 2000)

IUSA has developed a "Protocol for Determining Whether Alternate Feed Materials are Listed Hazardous Wastes" (November 22, 1999). This Protocol has been developed in conjunction with, and accepted by, the State of Utah Department of Environmental Quality ("UDEQ") (Letter of December 7, 1999). Copies of the Protocol and UDEQ letter are provided in Attachment 3 of this Request for Amendment. The evaluation and recommendations in this Attachment were developed in accordance with this Protocol.

3.0 Application of IUSA/UDEQ Hazardous Waste Protocol to Linde Materials

3.1 Source Investigation

Several of the information sources enumerated above were used to perform the Source Investigation indicated in Box 1 of the Protocol Diagram. The primary purpose of the field investigations at the Tonawanda Site properties was to determine the extent of radiological contamination, chemical characterization sampling was also conducted on each of the properties, including Linde. The USDOE RI characterization included analysis by EP Toxicity method for RCRA characteristic contaminants (metals and organics), corrosivity, ignitability, and reactivity, Total metals, EPA Method 8260 for Total VOCs, and EPA Method 8270 for Total SVOCs. None of the samples failed the

RCRA characteristic tests or exceeded regulatory criteria for EP toxicity. Although EPA has replaced the EP toxicity test with the TCLP test, both the EP toxicity results and totals results for all analytes were in the very low part per billion levels, and would not be expected to exceed the new TCLP criteria. Hence, the Uranium Material is not RCRA characteristic waste.

The following sections describe the status of the Linde materials relative to RCRA Listed Hazardous Waste regulations, and in accordance with the specific parameters identified in the IUSA/UDEQ hazardous Waste Protocol.

3.2 Contained-In/Contained-Out Considerations in the IUSA/UDEQ Protocol

The Protocol's Diagram states, in Decision Diamond 2, that if a "regulatory authority with RCRA jurisdiction over the site agreed with [the] generator's determination that Material is not listed hazardous waste, made a "contained-out" determination, or determined that material or site is not subject to RCRA" then IUSA and UDEQ will consider the material not to be listed hazardous waste.

As described above, NYSDEC has authorized USACE and its contractor, IT Corporation ("IT"), to use the TAGM contained-in/contained-out approach on the Linde material. This authorization satisfies the requirements agreed upon by IUSA and UDEQ as documented in the Protocol Diagram and supporting text. Hence, a contained-out determination made by the NYSDEC for specific contaminants would be sufficient basis for IUSA to consider Uranium Material not to be RCRA-listed hazardous waste with respect to those contaminants, and to accept such material at the White Mesa Mill.

The NYSDEC has published a Technical Administrative Guidance memorandum ("TAGM") addressing RCRA listed hazardous waste contaminants contained in environmental media (NYSDEC, November 1992). The TAGM defines NYSDEC's policy regarding contaminants (chemicals, compounds, and compound groups) associated with RCRA listed hazardous wastes detected in environmental media (soil, sediment, and water). The TAGM provides specific "contained-in" action levels (concentrations) for each contaminant. If all contaminants in a given media are present at levels lower than the specified "contained-in" action levels, then the media does not "contain" RCRA listed hazardous waste.

If any or all of the listed waste contaminants in the media are above the action levels, the material is a RCRA listed hazardous waste and, per the policy, may be managed in one of two ways:

1. The material may be shipped off site as RCRA listed hazardous waste, or
2. The material may be treated on site until all the listed waste contaminants are below the action levels, and then shipped off site, or managed on site, as non-listed waste.

NYSDEC's TAGM specifies that for the "contained-in/contained-out" determination to be applied to media from any site, the owner must prepare a Sampling Work Plan, to be approved by NYSDEC, specifying how the media will be sampled and analyzed to confirm that no contaminant exceeds any action level in the TAGM. NYSDEC has agreed with IT that the application of this approach is appropriate for thirteen of the constituents identified in the Linde RI, present at very low concentrations, as discussed in Sections 3.1.3 and 3.1.4, below. The USACE contractor, IT, is preparing a draft Sampling Work Plan to serve as the basis for this determination at the Linde site. This Plan will undergo NYSDEC review and approval prior to implementation.

3.3 Other Determination Methods in the IUSA/UDEQ Protocol

If such a direct confirmation is not available, the protocol describes additional steps IUSA will take to assess whether contaminants associated with any potential RCRA waste listings are present in the material, and the likelihood that they resulted form RCRA listed hazardous wastes or RCRA listed processes. These include tabulation of all potential listings associated with each known chemical contaminant at the site, and the review of chemical process and material/waste handling history at the site to assess whether the known chemical contaminants in the material resulted from listed or non-listed sources. This evaluation is described in Box 8 and Decision Diamonds 9 through 11 in the Protocol Diagram.

If the results of the above evaluation indicate that the contaminants are not listed waste, the protocol specifies an additional assessment of whether the data on which this determination was made is sufficiently representative, or whether an ongoing acceptance sampling program should be implemented, and a similar evaluation performed on any new constituents identified during acceptance sampling.

Both the evaluation methods described in Section 2.2 and 2.3 were used in the hazardous waste analysis below.

4.0 Chemical Contaminants at Linde

According to the USDOE RI, the Linde site appears to have been constructed atop a layer of fill ranging from zero to 17 feet thick, which was placed above natural soils for site grading and leveling. The borehole logs note that the fill is a mixture of flyash, slag, gravel and clays from local sources, and is present in different proportions at different locations throughout the site. According to the USACE contractor, the fill consists of coal-based ash and slag, from steel mill furnaces or other coal fired furnaces from local industrial plants. The USACE contractor also interviewed Linde personnel who were on site during the backfilling and MED construction, and examined photographs of the fill piles used for the backfilling operation. Both sources confirmed that the fill was coal-furnace ash and slag from a carbon steel mill in the area.

The chemical contamination reported in the RI was based primarily on samples from 17 locations throughout the site, collected within the fill layer. Background studies determined the composition of the fill by sampling areas that were known to contain fill, but which were outside the area of MED activities. Five samples were collected within the fill layer, but outside the area of MED activity, in an attempt to assess the contribution of fill to site metals and radionuclide levels. The background fill characterization indicated:

- A number of heavy metals above background levels originated in the fill, and are not associated with MED;
- Radionuclides such as thorium 232 originated with the fill and are not associated with MED;
- Other radionuclides and metals were possibly contributed by both the fill and the MED wastes.

Coal-based furnace slag and stack ash (fly ash), which are the known sources of Linde fill material, are specifically exempted from RCRA regulation[1]. As identified above, some inorganic contaminants at Linde may have derived either from the fill, the MED wastes, or both.

4.1 Organic Contaminants at Linde

Seventeen locations in shallow soils were sampled for VOCs. Of these, nine were also analyzed for SVOCs. Four classes of organic compounds have been detected at Linde: Polynuclear Aromatic Hydrocarbons (PAHs); phthalates; toluene; and halogenated volatile organic compounds (VOCs).

4.1.1 PAHs

A large number of PAH compounds and substituted ring compounds were detected at Linde, as follows: acenaphthene; anthracene; benzo (a) anthracene; benzo (a) fluoranthene; benzo (b) fluoranthene; benzo (k) fluoranthene; benzo (g,h,i) perylene; benzo (a) pyrene; chrysene; dibenz (a,h) anthracene; dibenzofuran; fluoranthene; fluorene; indeno (1,2,3 c,d) pyrene; phenanthrene; and pyrene.

The presence of this broad spectrum of PAHs is an indication of either:

a) plant surfaces currently or previously paved with road tar or asphalt;
b) disposal of used crankcase oil or other heavy machine oils;
c) both a) and b), including locations where spilled waste oil may have dissolved and mobilized asphalt components; or
d) presence of coal based ash or slag.

USDOE borings did locate media described as “blebs of gray-black organic material” which the RI determined to be “waste oil.” PAHs from paving materials, and from used oil, are not RCRA-listed wastes. As mentioned in section 3.0 above, the coal based slag and fly ash used as fill at Linde are exempt from RCRA.

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[1] 40CFR 261.4(b)(4)

Based on the above information, none of the PAHs is indicative of RCRA listed hazardous waste. The USACE Linde Site Preliminary Material Characterization Report has also determined that none of the PAHs at Linde are from RCRA listed waste sources.

4.1.2 Phthalates

The following substituted phthalates were detected at Linde: bis 2-ethyl hexyl phthalate; and di-n-butyl phthalate.

There is no history of industrial phthalate use or production on the Linde property. Both of the detected phthalates are natural degradation products of the oxidation of multi-ring aromatic compounds (PAHs), which, as described above, likely originated with paving sources, used oil sources, or fill sources. Phthalates derived from natural degradation of fill, paving material, and used oils are not RCRA-listed wastes. Phthalates are also common plasticizers and may contaminate samples due to their presence in vinyl, butyl and other plastic materials in sampling tools, packaging, and Personal Protective Equipment ("PPE").

Based on the above information, none of the phthalates is indicative of RCRA listed hazardous waste. The USACE Preliminary Material Characterization Report has also determined that none of the phthalates at Linde are from RCRA listed waste sources.

4.1.3 Toluene

Although the RI reported that toluene appeared in a number of borings, it was present at very low levels. All toluene detections reported were less than 300 parts per billion. The majority were less than 50 parts per billion. The RI also reports that toluene was detected at shallow depths, of 6 feet or less, and in general, its concentration decreased with depth, indicating a relatively recent source.

Had the toluene derived solely from MED sources 50 years ago, the majority of the toluene would have been volatilized or biodegraded with time, and would not likely be present at shallow depths during the 1990's field investigation. The RI considered it not to be related to MED operations.

There has been no toluene synthesis or use as a reagent on the site. Linde and Praxair both assembled, sand blasted, prepped, painted, and finished process hardware including tanks, pumps, compressors, etc. between the 1950's and the present. The toluene detected at Linde is most likely associated with the Linde/Praxair manufacturing activities, and may result from either potentially RCRA listed sources, such as solvent and paint and coating thinners, or from non-listed sources such as paint and coating components.

Additionally, since the Linde site is located in a highly industrialized area, it has not been determined conclusively whether nearby off site sources additionally contributed to the presence of toluene, and other mobile VOCs, at Linde. We are aware that this was the case at Ashland 1, for example, where a number of VOCs, including toluene, may have been introduced from refinery fuel terminal operations next door.

Overall, there is not enough information to make a definitive judgment regarding the source(s) of toluene. However, as described in this section, there are a number of plausible RCRA listed sources for toluene associated with the post 1950's Praxair/Linde gas equipment operation. These sources would appear to be the most likely sources of the toluene. Hence, this evaluation concludes that it is reasonable and appropriate to utilize the approach recommended by NYSDEC for this situation.

NYSDEC and the USACE contractor have concurred that at least some of the sources of toluene at Linde may be RCRA listed hazardous wastes. However, as stated above, the reported concentrations of toluene were extremely low. As a result, NYSDEC and USACE/IT have agreed on use of the TAGM approach, and have established that soil with concentrations of toluene lower than the TAGM contained-in action level of 16,000,000 ug/kg (parts per billion or "ppb") will not be RCRA listed hazardous waste. As described above, the highest toluene level detected to date was 300 ppb--more than 50,000 times lower than the contained-in action level. As a result, the USACE contractor expects that most or all of the Linde material will be determined to be non-listed waste with respect to toluene.

IT is currently preparing a pre-excavation characterization sampling plan for collection of fifteen in situ samples throughout the Linde site. The sample results will be used to confirm to NYSDEC, prior to excavation, that most or all of the toluene concentrations to be encountered during excavation can be expected to be below the TAGM action levels.

As described above, during excavation, IT will collect a large number of samples, for analysis in an on-site laboratory, to determine on a batch by batch bases, that all toluene levels are below the TAGM action level. Any sampled piles that contain toluene above the TAGM will be managed as hazardous waste and will not be shipped to IUSA, unless or until they meet all of the TAGM action levels.

4.1.4 Halogenated (Brominated and Chlorinated) VOCs

One brominated and eleven chlorinated VOCs were detected at very low levels, specifically: bromoform; chloroform; methylene chloride; 1,2 dichloroethane (1,2 DCA); cis- plus trans- isomers of 1,2 dichloroethane (1,2 DCE); trans 1,2 dichloroethene (trans 1,2 DCE); 1,1,1 trichloroethane (TCA); trichloroethene (TCE); 1,1,2,2 tetrachloroethane; tetrachloroethene (PCE); pentachlorophenol; and hexachloroethane. The majority of detections were at 50 parts per billion or less. Two detections of 1,1,2,2 tetrachloroethane and several detections of hexachloroethane and pentachlorophenol were at higher levels.

Trans 1,2 DCE was detected in five sample locations. Trans 1,2 DCE is not associated with any RCRA listings and is not a RCRA hazardous waste.

The RI concluded that the halogenated VOCs, which are long-lived in the environment, might have resulted from either MED activities or Linde operations since 1946. There is no history of chlorinated solvent production at the Linde Site. Neither Praxair nor Linde synthesized these compounds or used them as reagents. Ceramics operations are based on the conversion of inorganic mineral raw materials via inorganic and/or thermal processes, and do not utilize organic solvents. Hence, there is no likely source for these compounds prior to or during MED operations.

The Praxair/Linde gas equipment operation involved the preparation, cutting, welding, cleaning, and painting of sheet metal and other fabrication raw materials, and the assembly, testing, and servicing of heat exchangers, filters, tanks, and reciprocating and centrifugal machinery. Linde also operated and maintained cranes, hydraulic lifts, trolleys, and other heavy transfer devices necessary to move and assemble heavy machinery and equipment. These transfer devices, throughout many of the buildings on site, would have required use of degreasers and solvents for cleaning, maintenance, hydraulic flushing, etc. Hence, these compounds likely originated from use of commercially purchased solvents, degreasers, coolants, cutting fluids, or other uses in the Praxair/Linde gas equipment plants, from the 1950's to the 1990's.

Disposed off-spec, expired or spent product from solvent or degreasing use is consistent with the RCRA solvent listings. According to EPA guidance and internal memoranda[2], use, spill, or disposal of these compounds from coolant and cutting fluid use is not consistent with the solvent listings, that is, would not be a RCRA listed waste. Also, to the extent they resulted from MED activities, they may be 11e.(2) byproduct material, and not a RCRA listed hazardous waste. However, there is not enough historic information available to ascertain the exact use of any of these compounds or mixtures. Hence it is not possible to determine with certainty whether or not they are listed hazardous waste at Linde.

1,1,2,2 tetrachloroethane was detected beneath only one building and was mixed with MED waste. This compound is not used as a solvent or degreaser, but is a feedstock for other chlorinated compounds. It was likely an impurity of commercial grades of TCA, TCE or other chlorinated aliphatics used at the site. 1,2 DCA may have been an impurity in commercial grades of 1,1 DCA 1,1,1 TCA, or PCE used at the site.

Hexachloroethane, or perchloroethane, is used in production of nitrocellulose, pyrotechnics, explosives, and smoke devices; and as an inhibitor in fermentation processes. Neither MED nor Linde/Praxair conducted any of the above processes on site. Hexachloroethane is also used as a solvent and may also be present as an impurity in commercial grades of other chlorinated ethane and ethene solvents.

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[2] 50 FR 251 (December 31, 1985); RCRA/Superfund Hotline Report (March, 1989); RCRA/Superfund Hotline Report (June 28, 1989); RCRA/Superfund Hotline Report (June 1986); RCRA/Superfund Hotline Report (June 10, 1983)

Pentachlorophenol is a fungicide, bactericide, and algicide most commonly used as a wood preservative in telephone and electrical poles, railroad ties, and structural beams. No synthesis of pentachlorophenol or wood treatment processing was performed by either MED or Praxair/Linde. Pentachlorophenol may have been detected due to presence of treated wood chips and debris, or preservative compounds from the treated wood chips, in the rubble and soils on site. Pentachlorophenol identified in samples that include bits of treated wood scrap, or preservatives from treated wood scrap is not a RCRA listed hazardous waste.

Overall, there is not enough information to make a definitive judgment regarding the source(s) of halogenated VOCs at Linde. However, as described in this section, there are a number of plausible listed sources for these compounds associated with the post 1950's Praxair/Linde gas equipment operation. Hence, this evaluation concludes that it is reasonable and appropriate to utilize the NYSDEC TAGM approach for this situation.

NYSDEC and the USACE contractor have concurred that at least some of the sources of halogenated VOCs at Linde may be RCRA listed hazardous wastes. However, the reported concentrations of halogenated VOCs were extremely low or below detection limits ("BDL"). As a result, NYSDEC and USACE/IT have agreed on use of the TAGM approach, and have established that soil with concentrations of halogenated VOCs lower than the respective TAGM contained-in action levels for each contaminant will not be RCRA listed hazardous waste. Maximum concentrations of each halogenated contaminant at Linde and its respective TAGM action level is provided in Table 10 of the Linde Site Preliminary Material Characterization Report, and summarized below.

Halogenated VOC	**Concentration Range at Linde (ug/kg) Based on RI Data**	**TAGM Action Level (ug/kg)**
1,1,1-Trichloroethane (1,1,1 TCA)	BDL – 2.3	7,000,000
1,1,2,2-Tetrachloroethane	BDL – 650	3,200
1,2-Dichloroethene (total cis and trans isomers) (cis and trans 1,2 DCE)	BDL – 36	cis-780,000 trans-1,600,000
1,2 Dichloroethane (1,2 DCA)	BDL – 36	7,000
Bromoform	BDL – 5.2	81,000
Chloroform	BDL – 2.2	100,000
Hexachloroethane	BDL – 2,100	46,000
Methylene chloride	BDL – 49	85,000
Pentachlorophenol	BDL – 4,700	3,000
Tetrachloroethene (PCE)	BDL – 6.7	12,000
trans-1,2-Dichloroethene (trans 1,2 DCE)	BDL – 42	1,600,000
Trichlorethene (TCE)	BDL – 42	58,000

As indicated in the table above, every halogenated VOC, except pentachlorophenol, was reported to be present at levels from 5 times to as much as 3 million times lower than its respective TAGM action level. As a result, USACE/IT expect that most or all of the Linde material will not be RCRA hazardous waste.

Although one detection of pentachlorophenol exceeded the TAGM of 3,000 ug/kg, the majority of detections were below the TAGM. Per the USACE contractor, any excavated material that is determined to contain pentachlorophenol above the TAGM will be managed as hazardous waste and will not be shipped to IUSA, unless and until it meets the TAGM action levels.

4.2 Metals at Linde

According to the USDOE RI, twenty-four metals exceeded maximum expected background concentrations at Linde: aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, molybdenum, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc.

As described above, the Linde site was filled and graded with a combination of fly-ash, slag, gravel and clay fill. The fill has been determined to be a source of thorium-232 and arsenic, as well as a contributor to the elevated levels of cadmium, chromium, copper, lead and silver.

The RI attributes all the elevated metals at the site either to MED waste, fill, or combinations of the two. The RI does not attribute any of the metals to Linde site manufacturing activities or to any RCRA listed process sources.

Based on all of the above information, none of the metals are indicative of RCRA listed hazardous waste. The USACE Preliminary Material Characterization Report has also determined that none of the metals at Linde are from RCRA listed waste sources.

5.0 Conclusions

In summary, the following conclusions can be drawn from the Linde site information presented above:

1. None of the PAHs or phthalates in the Linde material came from RCRA listed hazardous waste sources. This determination is consistent with Box 8 and Decision Diamonds 9 through 11 in the IUSA/UDEQ Protocol Diagram.

2. None of the metals in the Linde material came from RCRA listed hazardous waste sources. This determination is consistent with Box 8 and Decision Diamonds 9 through 11 in the IUSA/UDEQ Protocol Diagram.

3. There is insufficient information to make a conclusive judgment regarding the sources of toluene and halogenated VOCs at Linde, and it is reasonable to expect that some of them may have originated from RCRA-listed sources. The lack of plausible non-listed sources, combined with the existence of plausible listed sources, leads to this conclusion. As a result, it is appropriate to assume that Linde material in which all VOC contaminants are lower than the NYSDEC action levels are not RCRA hazardous waste, and those which exceed them are RCRA listed hazardous waste, in accordance with NYSDEC policy. (The above determination differs from previous evaluations such as performed for Ashland 1 and 2 material, in which known non-listed sources could be identified for each potentially listed chemical contaminant; or for St. Louis material, for which both potential non-listed sources and unknown off-site or background sources could be identified that contributed to the presence of potentially listed chemical contaminants).

4. The documentation of the NYSDEC decision process is consistent with decision diamond number 2 in the IUSA/UDEQ Protocol Diagram. That is, material determined not to be RCRA hazardous waste with respect to VOCs by the NYSDEC TAGM should be acceptable for processing at the White Mesa Mill.

ATTACHMENT 5

New York State Technical Administrative Guidance Memorandum on "Contained-In" Criteria for Environmental Media

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF HAZARDOUS SUBSTANCES REGULATION
BUREAU OF TECHNICAL SUPPORT

Technical Administrative Guidance Memorandum

Technical Manual

Memorandum 3028 Page 1 of 21
Subject "Contained-In" Criteria for Environmental Media
Date: November 30, 1992

☒ New

☐ Obsolete

☐ Supercedes Memo No. ________

I. Policy

Environmental media containing hazardous constituents from listed hazardous waste identified in 6 NYCRR Part 371, must be managed as hazardous wastes unless or until the media contain hazardous constituent concentrations which are at or below action level concentrations.

II. Applicability

This "contained in" policy only applies to soil, sediment, and groundwater contaminated by listed hazardous waste and removed from their natural environment pursuant to a Department or EPA issued permit, order, approved closure plan, or approved corrective action plan (hereinafter referred to as permit/order/work plan). This policy does not apply to listed or characteristic hazardous wastes as initially generated or residuals derived from treating these listed hazardous wastes. Such residuals may include: fly and bottom ash from the incineration of listed hazardous waste; precipitation and biological sludge from the wastewater treatment of listed hazardous waste; spent activated carbon from the treatment of listed hazardous waste.

III. Intention and Purpose

The policy is primarily intended for situations where contaminated media, especially soil, is expected to contain low concentrations of listed hazardous waste for which treatment may not be practical or feasible. By far the most frequently occurring situation which this policy will address is the excavation of such

Technical
Administrative
Guidance
Memorandum

Technical Manual

Memorandum 3028	Page 2 of 21
Subject "Contained-In" Criteria for Environmental Media	
Date: November 30, 1992	
☒ New	
☐ Obsolete	
☐ Supercedes Memo No. ______	

contaminated soils for planned and emergency projects at RCRA facilities, including both RCRA Corrective Action and facility construction and reconstruction activities.

It is the purpose of this policy to set minimum criteria (i.e., action levels, cover requirements, and restricted access) for an environmental medium contaminated by listed hazardous waste which must be met in order to preclude its management as hazardous waste. Otherwise, management as hazardous waste could trigger one or more of the following stringent land disposal requirements:

- minimum technology standards;
- groundwater monitoring;
- land disposal restrictions; and
- closure/post-closure standards.

<u>There is no intention within this policy to put forth a methodology for developing cleanup levels for contaminated environmental media</u>. Nor does this policy preclude the Department from requiring the facility to implement a remedy that will achieve environmental media cleanup levels which could be more stringent than the action levels tabulated in Appendix I of the "Contained-In" Guidance presented as Attachment A to this policy document. Also, compliance with action levels discussed in Section VI of this policy does not necessarily mean that the media is entirely decontaminated and acceptable for unrestricted use.

TAGTR-2.FRM

Technical Administrative Guidance Memorandum

Technical Manual

Memorandum 3028	Page 3 of 21
Subject "Contained-In" Criteria for Environmental Media	
Date: November 30, 1992	
☒ New	
☐ Obsolete	
☐ Supercedes Memo No. ________	

IV. Regulatory Requirements

Certain situations may require contaminated media be subject to treatment before achieving this policy's action levels. That treatment system will be subject to RCRA permitting unless addressed in a Article 27, Title 13 Order on Consent, 71-2727(3) Corrective Action Order or if subject to a specific Part 373 exemption (e.g., wastewater treatment units with a surface water discharge). In most instances permitting may be accomplished by addressing the treatment system in the Corrective Measures Implementation section of the Corrective Action Module (i.e., Module III) of the Part 373 permit.

Environmental media, i.e., soil or sediment, contaminated by listed hazardous waste or commercial chemical products listed in 6 NYCRR Part 371, and subject to treatment before land disposal, must meet the land disposal requirements (LDRs) established pursuant to 6 NYCRR Part 376. That treated soil or sediment meeting LDRs, and then subsequently subject to land disposal, need not be managed as hazardous waste if it meets the "contained-in" criteria.

A successful "contained-in" demonstration, as discussed in Attachment A-"Contained-In" Guidance, may still require the environmental media be regulated and actively managed as a waste material. This "contained-in" policy does not exempt solid or semi-solid media relocated off the facility property from being subject to regulation as a solid waste, pursuant policy exempt aqueous waste from being subject to the discharges into the groundwater and surface waters of New York State.

Memorandum 3028 Page 4 of 21
Subject "Contained-In" Criteria for Environmental Media
Date: November 30, 1992
☒ New
☐ Obsolete
☐ Supercedes Memo No. ________

V. Implementation

This policy cannot be self-implemented by the facility, but will be put into effect by the Department on a case-by-case basis with a "contained-in" demonstration. That demonstration shall be made by the facility and evaluated by the Department as discussed in Attachment A - "Contained-In" Guidance. Before a "contained-in" demonstration is implemented at any facility, a work plan for the demonstration must be submitted to and approved by the Department. This work plan may be a separate document focusing on a specific area of contamination at the facility or it could be part of a closure plan for a hazardous waste TSD unit undergoing closure, or part of a facility-wide remedial investigation work plan. Work plans will address all hazardous constituents from listed hazardous waste contained in each environmental medium. In addition to these hazardous constituents derived from listed hazardous waste, hazardous constituents from all other known or suspected sources of contamination shall be addressed in the work plan.

Environmental media contaminated by hazardous constituents from listed hazardous waste at or below action levels as discussed in Section VI of this policy, either on initial removal or after treatment, shall be managed as follows:

A. If a solid or semi-solid (i.e., sediment), it may be:

(1) disposed on the facility property as a non-hazardous solid waste in accordance with acceptable management practices identified in permits/orders/work plans, or

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF HAZARDOUS SUBSTANCES REGULATION
BUREAU OF TECHNICAL SUPPORT

Technical
Administrative
Guidance
Memorandum

Technical Manual

Memorandum 3028 Page 5 of 21
Subject "Contained-In" Criteria for Environmental Media
Date November 30, 1992
☒ New
☐ Obsolete
☐ Supercedes Memo No. ______

(2) shipped off the facility property as a non-hazardous industrial solid waste to a permitted Part 360 land disposal facility, and

B. If aqueous, it may be:

(1) discharged on the facility property as a non-hazardous waste in accordance with a SPDES permit or Department Order, or

(2) shipped or discharged off the facility property as a non-hazardous industrial solid wastes to a POTW or industrial wastewater treatment facility.

VI. Action Level Concentrations

The action levels to be used in the "contained in" demonstration are listed in Appendix I - "Action Levels for Groundwater and Soil/Sediment" and only focus on the direct human ingestion exposure pathway. The levels were developed using promulgated USEPA and

State standards protective of human health with recourse to USEPA health risk assessment data or State guidance values in the absence of standards. Refer to Attachment A - "Contained-In" Guidance for further information on the development of action levels.

TAGTB-2.FRM

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF HAZARDOUS SUBSTANCES REGULATION
BUREAU OF TECHNICAL SUPPORT

Technical
Administrative
Guidance
Memorandum

Memorandum 3028 Page 6 of 21
Subject "Contained-In" Criteria for Environmental Media
Date: November 30, 1992

☒ New
☐ Obsolete
☐ Supersedes Memo No. ________

Technical Manual

The action levels tabulated in Appendix I that are not promulgated standards may change from time-to-time as new health risk assessment data becomes available. The Facility Compliance Region 2 Section, in the Bureau of Hazardous Waste Eastern Regions, has responsibility for updating the tabulation. These tables will be updated quarterly, if necessary.

Tables more than three (3) months old should not be used without first checking with the Section. That section should be contacted for information on action levels not found in Appendix I.

TAGTR-2.FRM

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF HAZARDOUS SUBSTANCES REGULATION
BUREAU OF TECHNICAL SUPPORT

Technical
Administrative
Guidance
Memorandum

Technical Manual

Memorandum 3028	Page 7 of 21
Subject "Contained-In" Criteria for Environmental Media	
Date: November 30, 1992	

☒ New

☐ Obsolete

☐ Supercedes Memo No. ____________

ATTACHMENT A

"Contained-In" Criteria Guidance

I. Basis for Action Levels

The "contained-in" criteria employs concentration levels for individual chemical constituents that are protective of public health through the direct ingestion pathway. The levels were developed from the following promulgated standards, USEPA health risk assessment data and New York State Department of Environmental Conservation (NYSDEC) guidance values.

A. Soil and Sediment Action Level Concentrations

The action levels to be used with the "contained-in" demonstration for soil and sediment are tabulated in Appendix I under the title "Soil/Sediment Action Levels." These levels are based on assuming human oral ingestion of soil or sediment. The soil/sediment tabulation lists action level concentrations calculated from USEPA, non-promulgated health risk assessment data (i.e., carcinogen slope factor (CSF) and the risk factor for carcinogens, and the chronic reference dose (RFD) for systemic toxicants) and oral intake assumptions (i.e., 0.1 g/day for a 70 kg. person/70 year exposure period for carcinogens, and 0.2g/day for a 16 kg. child/5 year exposure period for systemic toxicants). CSFs and RFDs are compiled from USEPA's Health Effects Assessment summary Tables (HEASTs) issued annually but updated periodically with supplements. The only soil/sediment action level representing a standard is the less than one (1) part per million (i.e., < 1.0 mg/kg) for polychlorinated biphenyls (PCBs). This standard was established under the TSCA PCB spill cleanup policy (i.e. 40 C.F.R. Part 761) for clean soil.

B. Groundwater Action Level Concentrations

Action levels to be used with the "contained in" demonstration for groundwater are tabulated in Appendix I under the title "Groundwater Action Levels." The tabulation lists for a particular constituent the most stringent level selected from promulgated New York State Part 703 Standards and USEPA MCLs. Recourse to non-promulgated USEPA health-based levels or more stringent New York State guidance values was considered appropriate only for constituents which do not have a State or USEPA Standard. The action level calculations based on USEPA health risk data included the same slope factor, risk factor, and reference dose used for soil/sediment action levels. The intake assumption of 2 l/day for a 70 kg. person/70 year exposure period was used for carcinogens and systemic toxicants. For a given chemical, non-promulgated health-based values or guidance values that are more stringent than promulgated standards were not selected as action levels.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF HAZARDOUS SUBSTANCES REGULATION
BUREAU OF TECHNICAL SUPPORT

Technical
Administrative
Guidance
Memorandum

Technical Manual

Memorandum 3028	Page 9 of 21
Subject "Contained-In" Criteria for Environmental Media	
Date: November 30, 1992	
☒ New	
☐ Obsolete	
☐ Supersedes Memo No. ______	

II. Action Levels Are Not Always Cleanup Levels

No attempt was made through the "contained in" criteria to develop cleanup levels for hazardous constituents in contaminated environmental media either left in place or subject to a removal action. The development of media specific cleanup levels is a complex undertaking that takes into consideration available and applicable remedial technologies, the degree of contamination in an environmental medium, and site-specific factors. These factors may include, but not be limited to, potential impacts on off-site public and/or environmental receptors, future land use (e.g., unrestricted vs. industrial), and intermedia contaminant transport (e.g., the influence of heavily contaminated groundwater on unsaturated soils lying over the groundwater). In the RCRA Corrective Action program, the Corrective Measures Study (CMS) is the appropriate means for the facility to address media cleanup levels in the context of the remedy selection process. The CMS should provide the necessary exposure and risk assessments coupled to an evaluation of remedial alternatives to focus the development of site-specific cleanup levels. However, in the RCRA program the Department will make the final determination on selecting cleanup levels. That determination could result in a cleanup level for a contaminant in a specific environmental medium being equated to the contaminant's action level for that medium.

Such a situation can occur in the RCRA corrective action program when hazardous constituents contaminate groundwater. Under this scenario the target cleanup levels for contaminants in groundwater equate to respective action levels tabulated in Appendix I, if protection of public health is the only concern (i.e., there is no environmental impact from the contaminated groundwater).

The action levels tabulated in Appendix I for soil and sediment only consider protection of public health through the direct ingestion pathway. These ingestion levels were selected as one of several criteria that must be met by soil and sediment contaminated by listed hazardous waste in order not to require their management as hazardous waste. However, these specific action levels may not equate to target cleanup levels. Target cleanup levels for sediments must address impacts on environmental receptors (i.e., aquatic life forms). Target cleanup levels for soils should be established considering potential impacts through their exposure pathways (e.g., inhalation, drinking water, etc) and not be limited to only the direct ingestion pathway. Therefore, target cleanup levels for soil and sediment will be less than the direct ingestion action levels tabulated in Appendix I for the majority of hazardous constituents identified to RCRA facilities.

A subsequent TAGM will provide more details on the subject of cleanup levels to RCRA facilities. That document discusses the use of action levels, target cleanup levels and cleanup standards (i.e., final cleanup levels) in the context of RCRA corrective action and RCRA "remove and decontaminate" closures.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF HAZARDOUS SUBSTANCES REGULATION
BUREAU OF TECHNICAL SUPPORT

Technical
Administrative
Guidance
Memorandum

Memorandum 3028 Page 11 of 21
Subject "Contained-In" Criteria for Environmental Media
Date: November 30, 1992
☒ New
☐ Obsolete
☐ Supersedes Memo No. ________

Technical Manual

III. "Contained In" Demonstration

In a "contained-in" demonstration, the facility will identify the source(s) of the environmental media contamination. If it can be conclusively established that the hazardous constituents in the media did not come from listed hazardous waste, or commercial chemical products, then the contaminated media need not be managed as hazardous waste, unless they exhibit one or more of the characteristics of a hazardous waste identified in 6 NYCRR Part 371, Section 3 or in the USEPA Toxicity Characteristic in 40 CFR 261.24.

Since a "contained-in" demonstration will be implemented through a work plan submitted by the facility, that plan should specify the source of the contamination including identification of the listed hazardous waste identified in 6 NYCRR Part 371 which contributed to the environmental contamination. For each listed waste identified the plan shall specify the hazardous constituents presented in 6 NYCRR Part 371, Appendix 22, which are the basis for listing the waste. Additionally, the plan will identify any hazardous constituent presented in 6 NYCRR 371, Appendix 23, and in 6 NYCRR 373, Appendix 33, which may be present in the contaminated media from sources other than listed hazardous waste.

A work plan for a "contained-in" demonstration applied to environmental media (i.e., soil or sediment) that will be subject to land disposal either before or after treatment, must address applicable land disposal restrictions (LDRs) established pursuant to 6 NYCRR Part 376. A facility may request a Treatability Variance from applicable LDRs through USEPA Region II and the NYSDEC for the

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF HAZARDOUS SUBSTANCES REGULATION
BUREAU OF TECHNICAL SUPPORT

Technical
Administrative
Guidance
Memorandum

Memorandum 3028 Page 12 of 21
Subject "Contained-In" Criteria for Environmental Media
Date: November 30, 1992

☒ New
☐ Obsolete
☐ Supersedes Memo No. ________

Technical Manual

environmental media. A "contained-in" demonstration work plan shall address the LDR variance obtained from USEPA/NYSDEC for the environmental media subject to the "contained-in" criteria. Treated or untreated environmental media meeting LDR requirements and subsequently subject to land disposal need not be managed as hazardous waste when the "contained-in" criteria are met. A "contained-in" demonstration requires that environmental media be sampled and analyzed in accordance with a work plan approved by the Department. Such plans must be developed in a manner that clearly sets forth the project objectives and the procedures that will be followed to meet those objectives. This entails specification in the work plan of a sufficient number of samples, sampling protocols, appropriate analytical methods, proper Quality Assurance/Quality Control (QA/QC) procedures, detection limits, and applicable action level concentrations. Analytical methods must be capable of achieving hazardous constituent detection levels less than their corresponding action levels. Refer to the most recent version, dated March 29, 1991, of the NYSDEC RCRA Quality Assurance Project Plan Guidance for information on work plan requirements and detection levels.

A crucial element of a "contained in" demonstration is the evaluation of analytical data generated after implementation of approved work plans. This evaluation will be made by the Department including review of laboratory QA/QC data and comparison of action levels with analytical data.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF HAZARDOUS SUBSTANCES REGULATION
BUREAU OF TECHNICAL SUPPORT

Technical Administrative Guidance Memorandum

Technical Manual

Memorandum 3028 Page 13 of 21
Subject "Contained-In" Criteria for Environmental Media
Date November 30, 1992

☒ New

☐ Obsolete

☐ Supercedes Memo No. ________

A. Soil and Sediment Evaluation

Solid or semi-solid environmental media (i.e., soil or sediment) shall be analyzed directly for total concentrations of each hazardous constituent expected to be contained in the medium. The resultant concentrations for each detected constituent will be compared against their corresponding "Soil/Sediment Action Level" in Appendix I.

Solid or semi-solid media must also have their respective leachate analyzed directly for each hazardous constituent expected to be contained in the contaminated environmental medium. The Synthetic Precipitation Leaching Procedure (SPLP) will be the preferred laboratory method employed to generate leachate for analysis when the excavated soil/sediment will remain on the facility property. Soil/sediment that will be excavated and relocated off the facility property will be subject to the Toxicity Characteristic Leaching Procedure (TCLP). The resultant concentrations for each detected constituent in leachate will be compared against their corresponding "Groundwater Action Level" in Appendix I.

The actual leaching test (i.e., SPLP or TCLP) may not have to be performed when the concentration of the hazardous constituent in the soil or sediment is accurately known, and when the following calculation shows that the constituent's concentration in the leachate to be equal to or less than its respective groundwater action level:

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF HAZARDOUS SUBSTANCES REGULATION
BUREAU OF TECHNICAL SUPPORT

Technical Administrative Guidance Memorandum

Technical Manual

Memorandum 3028 Page 14 of 21
Subject "Contained-In" Criteria for Environmental Media
Date: November 30, 1992
☒ New
☐ Obsolete
☐ Supersedes Memo No. ______

constituent concentration in soil or sediment (ug/kg or ppb)	÷ 20 =	maximum possible constituent concentration in the leachate test (ug/l or ppb)

This calculation presumes that the entire mass weight of the hazardous constituent present in the soil or sediment will leach out during the test.

When the resultant analyses demonstrate that all hazardous constituents detected in the soil or sediment and in their respective leachates are at or below corresponding action levels, the environmental medium does not have to be managed as hazardous waste However, if the medium is to be moved off the facility property it shall be managed in accordance with 6 NYCRR Part 360 and as directed by the Division of Solid Waste. If it is to be managed on the facility property, such management must be in accordance with an approved work plan.

Should the analyses for the soil or sediment and their respective leachates yield non-detectable measurements for hazardous constituents below approved detection limits, then unrestricted use of that medium will be approved. The constituents would be considered not present in the medium if not detected below approved analytical method detection limits (MDLs) for the matrix analyzed. The N.Y.S. RCRA QAPjP guidance addresses the issue of detection levels and their relationship to action levels. That guidance must be followed for the "contained-in" demonstration.

B. Groundwater Evaluation

This aqueous medium shall be analyzed directly for the total concentration (without filtering) of each hazardous constituent expected to be contained in the medium. The resultant concentrations for each detected constituent will be compared against the corresponding "Groundwater Action Level" in Appendix I. When the resultant analyses demonstrate that all hazardous constituents detected in groundwater are at or below their corresponding action levels, the environmental medium does not have to be managed as hazardous waste. However, groundwater discharges must still be managed in accordance with any prevailing and more stringent SPDES limitations (e.g., aquatic water quality standards or guidance values).

C. Evaluation for all Hazardous Constituents

The comparison of hazardous constituent analytical data with corresponding action levels will be carried out using all applicable action levels. For solid and semi-solid media subject to leaching evaluations, both soil/sediment and groundwater action levels will be examined. The evaluation will address all possible groups of hazardous constituents including the specific chemical compound and all inorganic elements and chemical species contributed by the compound for which action levels are listed in Appendix I.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF HAZARDOUS SUBSTANCES REGULATION
BUREAU OF TECHNICAL SUPPORT

Technical Administrative Guidance Memorandum

Technical Manual

Memorandum 3028 Page 16 of 21
Subject "Contained-In" Criteria for Environmental Media
Date: November 30, 1992
☒ New
☐ Obsolete
☐ Supercedes Memo No. ________

In Appendix I, action levels for several different groups of hazardous constituents have been identified.

Those groups include:

1. Total inorganic elements (e.g., total lead)
2. Total class of organic compounds (e.g., phenols)
3. Specific chemical species (e.g., total cyanide, hexavalent chromium); and
4. Specific chemical compounds (e.g., copper, cyanide, tetraethyl lead, phenol).

Several examples will serve to illustrate the use of Appendix I. Soil contaminated by the commercial chemical product tetraethyl lead would require soil and its leachate to be analyzed for the chemical compound itself and total lead. The compound can contribute lead to the contaminated media and Appendix I lists total lead with soil and groundwater action levels. A second example, soil contaminated by the commercial chemical product copper cyanide would require the soil to be analyzed for the chemical compound copper cyanide and total cyanide, a chemical species donated by the compound for which a soil action level exists. However, the soils' leachate would be analyzed for copper cyanide, total copper, and total cyanide because the latter two constituents donated by the compound have groundwater action levels. A third example illustrates the analysis required for a chemical compound which itself does not have a action level, but can transform to constituents with media specific action levels and which constituents have a total organic class medium action level. The chemical compound that best illustrates this example is the commercial chemical product creosote. This compound is a mixture of phenols, including the three isomers of cresol, if the creosote is derived from wood. The analysis of the contaminated environment medium may also indicate the presence of other phenolic compounds including phenol. Soil/sediment contaminated by creosote would require gas chromatographic (GC) analysis for phenolic compounds including phenol. However, analysis of the soils' leachate can be limited to total phenols since its groundwater action level is the most restrictive of all individual phenolic compounds including phenol.

The last example points to the only situation where the analysis would only be required for a constituent (i.e., total phenols), with the most restrictive action level. This approach which focuses the demonstration only on the constituent(s) with the most restrictive level is not always appropriate. The "contained in" criteria requires the contaminated media to be analyzed for residual concentrations of all hazardous constituents. Limiting the analysis only to a constituent with the most stringent action level would violate the criteria unless a petition, as discussed in Section III-D of this attachment, is submitted by the facility and approved by the NYSDEC. Also, certain technical issues preclude focusing the demonstration in this manner. For example, analyzing only for a constituent component of a chemical compound because its action level is more stringent than the compound's level could result in a false negative determination (i.e., the contaminated medium passes the "contained in" evaluation). Such false results may occur when small differences exist between the action level of the compound and the more stringent action level of a constituent contributed by the compound. There is a reason for such erroneous results; the weight of a chemical compound always exceeds the weight of any of its individual parts taken separately and, therefore, the compound always contributes more mass of contamination per unit weight or volume to the media. Many listed hazardous wastes are not listed for a specific chemical compound, but only for metallic elements or for certain chemical species. For example, F006 waste is listed for cadmium, nickel, cyanide, and hexavalent chromium. Therefore, environmental media contaminated by only F006 waste would require analysis for all four constituents, including total cadmium, total nickel, total cyanide, and hexavalent chromium.

D. Analytical Proposals and Petitions

When a standard laboratory analytical procedure is not available for a hazardous constituent the facility will propose one. The proposed analytical method will be included in the work plan submitted by the facility for NYSDEC approval, and it should be capable of detecting chemical compounds or chemical species below their respective action levels. The proposal will be examined and, if approved, it will become part of the work plan.

The facility may petition the NYSDEC through the work plan not to analyze for certain hazardous constituent chemical compounds that cannot be detected by practical analytical methods. Such a situation could arise when a chemical compound transforms into other constituents leaving only undetectable trace levels of the original compound in the sample matrix. The petition must include verified technical data, which can be taken from referenced literature, that clearly demonstrates the impact transformation processes have on the chemical compound in the environmental medium under evaluation. Such processes may include hydrolysis, photolysis, oxidation, dissociation, equilibria, and biotransformation. The petition will be examined and, if approved, it will become part of the work plan.

For chromium the most restrictive action level in soil is for the hexavalent species. When analyzing a solid or semi-solid matrix for chromium using SW-846 methodology the sample preparation step in the laboratory (i.e., digestion of the sample by acidification) converts by chemical reduction most, if not all, hexavalent chromium to the trivalent species which is

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF HAZARDOUS SUBSTANCES REGULATION
BUREAU OF TECHNICAL SUPPORT

Technical
Administrative
Guidance
Memorandum

Technical Manual

Memorandum 3028 Page 20 of 21
Subject "Contained-In" Criteria for Environmental Media
Date November 30, 1992
☒ New
☐ Obsolete
☐ Supersedes Memo No. ______

reported as total chromium. Therefore, unless the facility proposes an approvable analytical method for hexavalent chromium, the "contained in" demonstration will compare the hexavalent chromium action level in soil/sediment with the sample's total chromium concentration.

IV. Acceptable Management Practices

Under the "contained-in" criteria soil/sediment must meet oral human ingestion action levels, and not leach out contaminants above groundwater action levels. However, that requirement may not be sufficient to mitigate potential impacts via other exposure pathways (e.g., inhalation) or site-specific exposure conditions (e.g., the additive impact from mixtures of hazardous constituents) either of which may threaten public health. Also, potential impacts on environmental receptors (e.g., leachate discharging to surface water) are not considered under the "contained in" demonstration. Therefore, to be fully protective of public health and the environment, soil/sediment at or below the action levels in Appendix I and above approved detection limits must be managed in a manner that affords restricted access to the media by the public and that provides cover for the medium, if unrestricted access is not granted by NYS Department of Health. These requirements will be satisfied by managing the media off the facility property in accordance with 6 NYCRR Part 360 and as directed by the Division of Solid Waste. Management on the facility property should be in approved areas at locations where public access is restricted. Such areas must be tracked and noticed in a legal instrument that will be examined when the property is sold or transferred.

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF HAZARDOUS SUBSTANCES REGULATION
BUREAU OF TECHNICAL SUPPORT

Technical Administrative Guidance Memorandum

Memorandum 3028 Page 21 of 21
Subject "Contained-In" Criteria for Environmental Media
Date: November 30, 1992

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Technical Manual

To mitigate other potential public health and environmental impacts through the air and surface water exposure pathways the approved on-site areas will be covered. Cover designs will be submitted by the facility to the Department for review and approval. The cover design submittal should occur simultaneously with the submittal of the "contained-in" work plan. However, if site-specific circumstances preclude such a simultaneous submittal, no placement of soil/sediment media must occur until a cover design is approved by the Department. Cover designs should demonstrate how wind blown particulate matter will be eliminated at the approved area and account for long term inspection and maintenance of the cover. If necessary, the cover design will address mitigating impacts on the air exposure pathway from volatilizing hazardous constituent residuals that remain in the approved area. This release mechanism may be important for volatile constituents with high soil/sediment ingestion action levels which do not readily leach out from the medium. Such a situation could allow large residual volatile contaminant concentrations in the soil/sediment which may result in negative air impacts. Cover designs should also demonstrate protection of adjacent surface waters from runoff.

NYSDEC
Contained-In Action Levels

Soil/Sediment "Contained-In" Criteria: cannot exceed ingestion action levels in media and media's leachate cannot adversely impact groundwater, see TAGM p. 13.

SUBSTANCE	CASNUM	Groundwater Action Level (ug/L)	REF	Soil/ Sediment Action Level (mg/kg)	REF
ACENAPHTHENE	83-32-9	2.0E+01	d	4.7E+03	C
ACENAPHTHYLENE	208-96-8	5.0E+01	a		
ACEPHATE	30560-19-1	5.0E+01	a	7.4E+01	C
ACETONE (2-PROPANONE)	67-64-1	5.0E+01	d	7.8E+03	C
ACETONE CYANOHYDRIN (2-METHYLLACTONITRILE)	75-86-5	2.8E+01	e	6.3E+01	C
ACETONITRILE (METHYL CYANIDE)	75-05-8	5.0E+01	a	4.7E+02	C
ACETOPHENONE (1-PHENYL-ETHANONE)	98-86-2	5.0E+01	a	7.8E+03	C
2-ACETYLAMINOFLUORENE (2-AAF)	53-96-3	5.0E+01	a		
ACROLEIN (2-PROPENAL)	107-02-8	5.0E+00	a	1.8E+03	C
ACRYLAMIDE	79-06-1	5.0E+00	a	1.4E-01	C
ACRYLIC ACID	79-10-7	5.0E+01	d	3.9E+04	C
ALACHLOR	15972-60-8	3.5E+01	a	7.9E+00	C
ALDICARB	116-06-3	7.0E+00	a	7.8E+01	C
ALDICARB & METHOMYL	116-06-3;16752-77-5	3.5E-01	a		
ALDRIN	309-00-2	ND	a	3.8E-02	C
ALKYL DIMETHYL BENZYL AMMONIUM CHLORIDE	68391-01-5	5.0E+01	d		
ALLYL ALCOHOL	107-18-6	5.0E+01	a	3.9E-02	C
ALLYL CHLORIDE (3-CHLORO-1-PROPENE)	107-05-1	5.0E+00	a	1.8E+02	C
ALUMINUM PHOSPHIDE	20859-73-8	1.4E+01	e	3.1E-01	C
AMETRYN	834-12-8	5.0E+01	a	7.0E+02	C
AMIBEN	133-90-4	8.8E+01	a		
4-AMINOBIPHENYL	92-67-1	5.0E+00	a		
m-AMINOPHENOL	591-27-5	*3	a	5.5E+03	C
4-AMINOPYRIDINE	504-24-5	1.0E+00	g	1.6E+00	C
AMMONIA	7664-41-7	<2.0E+03	a		
ANILINE (BENZENAMINE)	62-53-3	5.0E+00	a	1.1E+02	C
ANTHRACENE	120-12-7	5.0E+01	d	2.3E+04	C
ANTIMONY, TOTAL	*1	3.0E+00	a	3.1E+01	C
ARAMITE	140-57-8	5.0E+01	d	2.5E-01	C
ARSENIC, TOTAL	*1	2.50E+01	a	4.0E-01	C
ATRAZINE	1912-24-9	7.50E+00	a	2.7E+03	C
AZINPHOSMETHYL	86-50-0	4.40E+00	a		
AZOBENZENE	103-33-3	5.0E+00	a	5.8E+00	C
BARIUM, TOTAL	*1	1.00E+03	a	5.5E+03	C
BARIUM CYANIDE	542-62-1	2.5E+03	e	5.5E+03	C
BENEFIN	1861-40-1	3.50E+01	a	2.3E+04	C
BENZALDEHYDE	100-52-7	5.0E+01	d	7.8E+03	C
BENZ(a)ANTHRACENE (BENZANTHRACENE)	56-55-3	2.0E-03	d	9.0E-01	C
BENZENE	71-43-2	7.0E-01	a	2.2E+01	C
BENZIDINE	92-87-5	5.0E+00	a	2.8E-03	C
BENZISOTHIAZOLE	271-61-4	5.0E+01	d		
BENZO(b)FLUORANTHENE	205-99-2	2.0E-03	d	9.0E-01	
BENZO(k)FLUORANTHENE	207-08-9	2.0E-03	d	9.0E+00	

8/4/97

NYSDEC
Contained-In Action Levels

Soil/Sediment "Contained-In" Criteria: cannot exceed ingestion action levels in media and media's leachate cannot adversely impact groundwater, see TAGM p. 13.

SUBSTANCE	CASNUM	Groundwater Action Level (ug/L)	REF	Soil/ Sediment Action Level (mg/kg)	REF
BENZOIC ACID	65-85-0	5.0E+01	a	3.2E+05	C
BENZO(g,h,i)PERYLENE	191-24-2	5.0E+01	a		
BENZO(a)PYRENE	50-32-8	ND	a	9.0E-02	C
BENZOTRICHLORIDE	98-07-7	5.0E+01	a	4.9E-02	C
BENZYL ALCOHOL (BENZENEMETHANOL)	100-51-6	5.0E+01	a	2.3E+04	C
BENZYL CHLORIDE	100-44-7	5.0E+01	a	3.8E+00	C
BERYLLIUM, TOTAL	*1	4.0E+00	d	1.6E-01	C
alpha-BHC	319-84-6	ND	a	1.0E-01	C
beta-BHC	319-85-7	ND	a	3.6E-01	C
delta-BHC	319-86-8	ND	a		
1,1-BIPHENYL	92-52-4	5.0E+00	a	3.9E-03	C
BIS(2-CHLOROETHOXY)METHANE	111-91-1	5.0E+00	a		
BIS(2-CHLOROETHYL)ETHER	111-44-4	1.0E+00	a	5.8E-01	C
BIS(CHLOROMETHYL)ETHER (BCME)	542-88-1	5.0E+00	a	2.9E-03	C
BIS(2-CHLORO-1-METHYLETHYL)ETHER	108-60-1	5.0E+00	a	9.1E+00	C
BIS(2-ETHYLHEXYL)PHTHALATE	117-81-7	5.0E+01	d	4.6E+01	C
BISPHENOL A	80-05-7	*3	a	3.9E+03	C
BIS(PENTABROMOPHENYL)ETHER	1163-19-5	5.0E+00	e	7.8E+02	C
BORIC ACID, BORATES & METABORATES	11113-50-1;10043-35-3;1303-96-4	1.3E+02	a	7.0E+03	C
BORON, TOTAL	*1	1.0E+03	e	7.0E+03	C
BROMACIL	314-40-9	4.4E+00	a		
BROMIDES	NA	2.0E+03	e		
BROMOBENZENE	108-86-1	5.0E+00	a		
BROMOCHLOROMETHANE	74-97-5	5.0E+00	a		
BROMODICHLOROMETHANE	75-27-4	5.0E+01	d	1.0E+01	C
BROMOFORM (TRIBROMOMETHANE)	75-25-2	5.0E+01	d	8.1E+01	C
BROMOMETHANE (METHYL BROMIDE)	74-83-9	5.0E+00	a	1.1E+02	C
4-BROMOPHENYL PHENYL ETHER (1-BROMO-4-PHENOXYBENZENE)	101-55-3	5.0E+00	a		
BROMOPHOS	2104-96-3	5.0E+00	a	3.9E+02	C
BROMOXYNIL	1689-84-5	5.0E+00	a	1.8E-03	C
1-BUTANOL (BUTYL ALCOHOL)	71-36-3	5.0E+01	a	7.8E+03	C
BUTACHLOR	23184-66-9	3.5E+00	a		
BUTOXYETHOXYETHANOL	112-34-5	5.0E+01	d		
BUTOXYPROPANOL	5131-66-8	5.0E+01	d		
BUTYLATE	2008-41-5	5.0E+01	a	3.9E+03	C
n-BUTYLBENZENE	104-51-8	5.0E+00	a		
sec-BUTYLBENZENE	135-98-8	5.0E+00	a		
tert-BUTYLBENZENE	98-06-6	5.0E+00	a		
BUTYL BENZYL PHTHALATE	85-68-7	5.0E+01	d	1.8E+04	C
BUTYL ISOPROPYL PHTHALATE	NA	5.0E+01	d		
CACODYLIC ACID (AGENT BLUE)	75-60-5	5.0E+01	e	2.3E+02	C
CADMIUM, TOTAL	*1	5.0E+00	b	7.8E-01	C
CALCIUM CYANIDE	592-01-8	1.4E+03	e	3.1E+03	C

8/4/97

NYSDEC
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SUBSTANCE	CASNUM	Groundwater Action Level (ug/L)	REF	Soil/ Sediment Action Level (mg/kg)	REF
CAPROLACTAM	105-60-2	5.0E+01	a	3.9E+04	C
CAPTAFOL	2425-06-1	5.0E+01	a	7.4E+01	C
CAPTAN	133-06-2	1.8E+01	a	1.8E+02	C
CARBARYL	63-25-2	2.9E+01	a	7.8E+03	C
CARBAZOLE	86-74-8	5.0E+00	a	3.2E+01	C
CARBOFURAN	1563-66-2	1.5E+01	a	3.9E+02	C
CARBON DISULFIDE	75-15-0	5.0E+00	a	7.8E+03	C
CARBON TETRACHLORIDE (TETRACHLOROMETHANE)	56-23-5	5.0E+00	a	4.9E+00	C
CHLORAL (TRICHLOROACETALDEHYDE)	75-87-6	5.0E+01	a	1.8E+02	C
CHLORANIL	118-75-2	5.0E+00	a	1.8E+00	C
CHLORDANE	57-74-9	1.0E-01	a	4.9E-01	C
CHLORIDES	NA	2.5E+05	a		
CHLORINE CYANIDE	506-77-4	1.8E+03	e	3.9E+03	C
CHLOROACETIC ACID	79-11-8	5.0E+01	a	1.6E+02	C
p-CHLOROANILINE (4-CHLOROANILINE)	106-47-8	5.0E+00	a	1.6E+01	C
CHLOROBENZENE	108-90-7	5.0E+00	a	1.6E+03	C
CHLOROBENZILATE	510-15-6	5.0E+01	a	1.6E+03	C
p-CHLOROBENZOIC ACID	74-11-3	5.0E+00	a	1.6E+04	C
4-CHLOROBENZOTRIFLUORIDE	98-56-6	5.0E+00	a	1.6E+03	C
1-CHLOROBUTANE	109-69-3	5.0E+00	e	3.1E+04	C
p-CHLORO-m-CRESOL (4-CHLORO-3-METHYLPHENOL)	59-50-7	*3	a		
1-CHLORO-2,3-EPOXYPROPANE (EPICHLOROHYDRIN)	106-89-8	5.0E+00	a	6.5E+01	C
CHLOROETHANE (ETHYL CHLORIDE)	75-00-3	5.0E+00	a	4.9E+01	C
CHLOROFORM (TRICHLOROMETHANE)	67-66-3	7.0E+00	a	1.0E+02	C
CHLOROMETHYL METHYL ETHER (CMME)	107-30-2	5.0E+00	a	2.9E-03	C
2-CHLORONAPHTHALENE	91-58-7	1.0E+01	d		
o-CHLORONITROBENZENE	88-73-3	5.0E+00	a	2.8E+01	C
p-CHLORONITROBENZENE	100-00-5	5.0E+00	a	3.6E+01	C
2-CHLOROPHENOL	95-57-8	*3	a	3.9E+02	C
4-CHLOROPHENYL PHENYL ETHER	7005-72-3	5.0E+01	a		
CHLOROPRENE (2-CHLORO-1,3-BUTADIENE)	126-99-8	5.0E+00	a	1.6E+03	C
CHLOROPROPHAM (CHLORPROPHAM)	101-21-3	5.0E+00	a	1.6E+04	C
CHLOROPYRIFOS (CHLORPYRIFOS)	2921-88-2	5.0E+01	a	2.3E+02	C
CHLOROTHALONIL (TETRACHLOROISOPHTHALONITRILE)	1897-45-6	5.0E+00	e	1.2E+03	C
CHLOROTHIOPHOS	21923-23-9	5.0E+01	a	6.4E+01	C
2-CHLOROTOLUENE (o-CHLOROTOLUENE)	95-49-8	5.0E+00	a	1.6E+03	C
4-CHLOROTOLUENE (p-CHLOROTOLUENE)	106-43-4	5.0E+00	a		
4-CHLORO-o-TOLUIDINE (4-CHLORO-2-METHYLANILINE)	95-69-2	5.0E+00	a	1.1E+00	C
4-CHLORO-o-TOLUIDINE HYDROCHLORIDE	3165-93-3	5.0E+00	a	1.4E+00	C
5-CHLORO-o-TOLUIDINE (3-CHLORO-6-METHYLANILINE)	95-79-4	5.0E+00	a		
CHROMIUM, TOTAL	*1	5.0E+01	e		
CHROMIUM, HEXAVALENT (CHROMIUM (VI))	18540-29-9	5.0E+01	a	3.9E+02	C
CHROMIUM, TRIVALENT (CHROMIUM (III))	16065-83-1	5.0E+01	a	7.8E+04	C

8/4/97

NYSDEC
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CHRYSENE	218-01-9	2.0E-01	b	8.8E+01	
COPPER, TOTAL	*1	<200	a		
COPPER CYANIDE	544-92-3	1.8E+02	e	3.9E+02	C
m-CRESOL (3-METHYL PHENOL)	108-39-4	*3	a	3.9E+03	C
o-CRESOL (2-METHYL PHENOL)	95-48-7	*3	a	3.9E+03	C
p-CRESOL (4-METHYL PHENOL)	106-44-5	*3	a	3.9E+03	C
CRESOLS	1319-77-3	*3	a	3.9E+03	C
CROTONALDEHYDE (2-BUTENAL)	123-73-9	5.0E+00	a	3.4E-01	C
CYANAZINE	21725-46-2	7.0E+01	e	1.6E+02	C
CYANIDE, TOTAL	*1	<100	a	1.6E+03	C
CYANOGEN	460-19-5	1.4E+03	e	3.1E+03	C
CYANOGEN BROMIDE	506-68-3	8.0E+00	a	7.0E+03	C
CYCLOHEXYLAMINE	108-91-8	5.0E+01	a	1.6E+04	C
DACTHAL (DCPA)	1861-32-1	5.0E+00	a	3.9E+04	C
DALAPON (SODIUM SALT)	127-20-8	5.0E+01	a	2.3E+03	C
2,4-DB	94-82-6	5.0E+00	a	6.3E+02	C
4,4'-DDD	72-54-8	ND	a	2.7E+00	C
4,4'-DDE	72-55-9	ND	a	1.9E+00	C
4,4'-DDT	50-29-3	ND	a	1.9E+00	C
DEMETON (DEMETON-O & DEMETON-S)	8065-48-3	1.4E+00	e	3.1E+00	C
DEMETON-O	298-03-3	5.0E+01	a		
DEMETON-S	126-75-0	5.0E+01	a		
DIALLATE	2303-16-4	5.0E+01	a	1.0E+01	C
DIAZINON	333-41-5	7.0E-01	a	7.0E+01	C
DIBENZ(a,h)ANTHRACENE	53-70-3	2.0E-01	b	9.0E-02	C
DIBENZOFURAN	132-64-9	5.0E+01	a		
1,4-DIBROMOBENZENE (p-DIBROMOBENZENE)	106-37-6	5.0E+00	a	7.8E+02	C
DIBROMOCHLOROMETHANE (CHLORODIBROMOMETHANE)	124-48-1	5.0E+01	d	7.6E+00	C
1,2-DIBROMO-3-CHLOROPROPANE (DBCP)	96-12-8	2.0E-01	b	2.9E-02	C
DIBROMODICHLOROMETHANE	594-18-3	5.0E+00	a	7.6E+00	C
1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	106-93-4	5.0E+00	e	7.5E-03	C
DIBROMOMETHANE (METHYLENE BROMIDE)	74-95-3	5.0E+00	a	7.8E+02	C
2,2-DIBROMO-3-NITRILOPROPIONAMIDE	10222-01-2	5.0E+01	a		
DI-n-BUTYL PHTHALATE	84-74-2	5.0E+01	a	7.8E+03	C
DICAMBA	1918-00-9	4.4E-01	a	2.3E+03	C
DICHLONE (2,3-DICHLORO-1,4-NAPHTHOQUINONE)	117-80-6	5.0E+00	a		
1,2-DICHLOROBENZENE (o-DICHLOROBENZENE)	95-50-1	4.7E+00	a	7.0E+03	C
1,3-DICHLOROBENZENE (m-DICHLOROBENZENE)	541-73-1	5.0E+00	a		
1,4-DICHLOROBENZENE (p-DICHLOROBENZENE)	106-46-7	4.7E+00	a	2.7E-01	C
3,3-DICHLOROBENZIDINE	91-94-1	5.0E+00	a	1.0E+00	C
1,4-DICHLORO-2-BUTENE	764-41-0	5.0E+00	a		
trans-1,4-DICHLORO-2-BUTENE	110-57-6	5.0E+00	a		
DICHLORODIFLUOROMETHANE (F-12)	75-71-8	5.0E+00	a	1.6E+04	C

8/4/97

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1,1-DICHLOROETHANE	75-34-3	5.0E+00	a	7.8E+03	c
1,2-DICHLOROETHANE (ETHYLENE DICHLORIDE)	107-06-2	5.0E+00	a,b	7.0E+00	c
1,1-DICHLOROETHYLENE	75-35-4	5.0E+00	a	1.1E+00	c
cis-1,2-DICHLOROETHYLENE	156-59-2	5.0E+00	a	7.8E+02	c
trans-1,2-DICHLOROETHYLENE	156-60-5	5.0E+00	a	1.6E+03	c
DICHLOROFLUOROMETHANE	75-43-4	5.0E+00	a		
2,4-DICHLOROPHENOL	120-83-2	*3	a	2.3E+02	c
2,6-DICHLOROPHENOL	87-65-0	*3	a		
2,4-DICHLOROPHENOXYACETIC ACID (2,4-D)	94-75-7	4.4E+00	a	7.8E-02	c
1,2-DICHLOROPROPANE	78-87-5	5.0E+00	a	9.4E+00	c
1,3-DICHLOROPROPANE	142-28-9	5.0E+00	a		
2,2-DICHLOROPROPANE	594-20-7	5.0E+00	a		
1,1-DICHLOROPROPENE	563-58-6	5.0E+00	a		
1,3-DICHLOROPROPENE	542-75-6	5.0E+00	a	3.6E+00	c
cis-1,3-DICHLOROPROPENE	10061-01-5	5.0E+00	a		
trans-1,3-DICHLOROPROPENE	10061-02-6	5.0E+00	a		
DICHLORVOS (DICHLOROVOS)	67-73-7	5.0E+00	a	2.2E+00	c
DICYCLOPENTADIENE	77-73-6	5.0E+01	a	2.3E+03	c
DIELDRIN	60-57-1	ND	a	4.0E-02	c
DIETHYLENE GLYCOL MONOETHYL ETHER	111-90-0	5.0E+01	a	1.6E+05	c
DIETHYLFORMAMIDE	617-84-4	5.0E+01	a	8.8E+03	c
DIETHYLPHTHALATE	84-66-2	5.0E+01	d	6.3E+04	c
o,o-DIETHYL o-2-PYRAZINYL PHOSPHOROTHIOATE	297-97-2	5.0E+01	a		
DIETHYLSTILBESTROL (DES)	56-53-1	5.0E+01	a	1.3E-03	c
DIMETHOATE	60-51-5	7.0E+00	e	1.6E+01	c
3,3'-DIMETHOXYBENZIDINE	119-90-4	5.0E+00	a	4.6E+01	c
p-(DIMETHYLAMINO)AZOBENZENE	60-11-7	5.0E+00	a		
2,4-DIMETHYLANALINE (2,4-XYLIDINE)	95-68-1	5.0E+00	a	8.5E-01	c
n,n-DIMETHYLANILINE	121-69-7	5.0E+00	a	1.6E+02	c
7,12-DIMETHYLBENZ(a)ANTHRACENE	57-97-6	5.0E+01	a		
3,3'-DIMETHYLBENZIDINE	119-93-7	5.0E+00	a	7.0E-02	c
DIMETHYLFORMAMIDE (n,n-DIMETHYLFORMAMIDE)	68-12-2	5.0E+01	d	7.8E+03	c
1,1-DIMETHYLHYDRAZINE	57-14-7	5.0E+01	a	7.4E-02	c
1,2-DIMETHYLHYDRAZINE	540-73-8	5.0E+01	a	4.8E-04	c
alpha, alpha-DIMETHYLPHENETHYLAMINE	122-09-8	5.0E+00	a		
2,4-DIMETHYLPHENOL	105-67-9	*3	a	1.6E+03	c
2,6-DIMETHYLPHENOL	576-26-1	*3	a	4.7E+01	c
3,4-DIMETHYLPHENOL	95-65-8	*3	a	7.8E-01	c
DIMETHYL PHTHALATE	131-11-3	5.0E+01	d	7.8E+04	c
DIMETHYL-p-PHTHALATE	120-61-6	5.0E+01	a	7.8E+03	c
1,3-DINITROBENZENE (m-DINITROBENZENE)	99-65-0	5.0E+00	a	7.8E+00	c
4,6-DINITRO-o-CRESOL (2-METHYL-4,6-DINITROPHENOL)	534-52-1	*3	a	7.8E+00	c
2,4-DINITROPHENOL	51-28-5	*3	a	1.6E+02	c

NYSDEC
Contained-In Action Levels

Soil/Sediment "Contained-In" Criteria: cannot exceed ingestion action levels in media and media's leachate cannot adversely impact groundwater; see TAGM p. 13.

SUBSTANCE	CASNUM	Groundwater Action Level (ug/L)	REF	Soil/ Sediment Action Level (mg/kg)	REF
2,4-DINITROTOLUENE	121-14-2	5.0E+00	a	9.4E-01	C
2,6-DINITROTOLUENE	606-20-2	5.0E+00	a	9.4E-01	C
DINOCAP	6119-92-2	5.0E+00	a		
DINOSEB (DNBP)	88-85-7	~3	a	7.8E+01	C
DI-n-OCTYL PHTHALATE	117-84-0	5.0E+01	d	1.6E+03	C
1,4-DIOXANE	123-91-1	5.0E+01	a	5.8E+01	C
DIPHENYLAMINE (N,N-DIPHENYLAMINE)	122-39-4	5.0E+00	a	2.0E+03	C
1,2-DIPHENYLHYDRAZINE	122-66-7	ND	a	8.0E-01	C
DISULFOTON	298-04-4	ND	a	3.1E+01	C
DITHANE D-14	142-59-6	1.8E+00	a		
DYPHYLLINE	479-18-5	5.0E+01	d		
ENDOSULFAN	115-29-7	5.0E+00	a	7.8E+00	C
ENDOSULFAN I	959-98-8	5.0E+00	a		
ENDOSULFAN II	33213-65-9	5.0E+00	a		
ENDOSULFAN SULFATE	1031-07-8	5.0E+00	a		
ENDOTHALL	145-73-3	5.0E+01	d	1.6E+03	C
ENDRIN	72-20-8	ND	a	2.3E+01	C
ENDRIN ALDEHYDE	7421-93-4	5.0E+00	a		
ETHION	563-12-2	5.0E+01	a	3.9E+01	C
2-ETHOXYETHANOL	110-80-5	5.0E+01	a	3.1E+04	C
2-ETHOXYETHANOL ACETATE	111-15-9	5.0E+01	a	2.3E+04	C
ETHYL ACETATE	141-78-6	5.0E+01	a	7.0E+04	C
ETHYL ACRYLATE	140-88-5	5.0E+01	a	1.3E+01	C
ETHYLBENZENE	100-41-4	5.0E+00	a	7.8E+03	C
ETHYL DI-n-PROPYLTHIOCARBOMATE (EPTC)	759-94-4	5.0E+01	a	2.0E+03	C
ETHYLENE CHLOROHYDRIN	107-07-3	5.0E+01	d		
ETHYLENE CYANOHYDRIN	109-78-4	5.0E+01	a	2.3E+04	C
ETHYLENEDIAMINE	107-15-3	5.0E+01	a	1.8E+03	C
ETHYLENE GLYCOL	107-21-1	5.0E-01	d	1.8E+05	C
ETHYLENE OXIDE	75-21-8	5.0E-02	d	1.8E+00	C
ETHYLENETHIOUREA	96-45-7	ND	a	1.8E+01	C
ETHYL ETHER	60-29-7	5.0E+01	a	3.9E+04	C
ETHYL METHACRYLATE	97-63-2	5.0E+01	a	7.0E+03	C
ETHYL METHANESULFONATE	62-50-0	5.0E-01	a		
FAMPHUR	52-85-7	5.0E+01	a		
FERBAM	14484-64-1	4.2E+00	a		
FLUORANTHENE	206-44-0	5.0E+01	d	3.1E+03	C
FLUORENE	86-73-7	5.0E+01	d	3.1E+03	C
FLUORIDES	NA	<1500	a	4.7E+03	C
FOLPET	133-07-3	5.00E+01	a	1.8E+02	C
FORMALDEHYDE (METHYL ALDEHYDE)	50-00-0	5.0E+00	a	2.1E+01	C
FORMIC ACID	64-18-6	5.0E+01	a	1.6E+05	C
FURAN	110-00-9	3.5E+01	e	7.8E+01	C

NYSDEC
Contained-In Action Levels

Soil/Sediment "Contained-In" Criteria: cannot exceed ingestion action levels in media and media's leachate cannot adversely impact groundwater; see TAGM p. 13.

SUBSTANCE	CASNUM	Groundwater Action Level (ug/L)	REF	Soil/ Sediment Action Level (mg/kg)	REF
FURAZOLIDONE	67-45-8	5.0E+01	a	1.7E-01	C
FURFURAL	98-01-1	5.0E+01	a	2.3E+02	C
FURIUM	531-82-8	7.0E-03	e	1.3E-02	C
GLYCIDALDEHYDE (2,3-EPOXYPROPANAL)	765-34-4	5.0E+01	a	3.1E+01	C
GROSS ALPHA RADIATION	NA	5Cpi/L	b		
GROSS BETA RADIATION	NA	1000pCi/L	d		
GUAIFENESIN	93-14-1	5.0E+01	d		
HEPTACHLOR	76-44-8	ND	a	1.4E-01	C
HEPTACHLOR EPOXIDE	1024-57-3	ND	a	7.0E-02	C
HEXABROMOBENZENE	87-82-1	5.0E+00	a	1.6E+02	C
HEXACHLOROBENZENE	118-74-1	3.5E-01	a	4.0E-01	C
HEXACHLORO-1,3-BUTADIENE	87-68-3	5.0E+00	e	8.2E+00	C
HEXACHLOROCYCLOPENTADIENE	77-47-4	5.0E+00	a	5.5E+02	
HEXACHLORODIBENZO-p-DIOXIN	19408-74-3	?	a	1.0E-03	C
HEXACHLOROETHANE	67-72-1	5.0E+00	a	4.6E+01	C
HEXACHLOROPHENE	70-30-4	7.0E+00	a	2.3E+01	C
HEXACHLOROPROPENE	1888-71-7	5.0E+00	a		
N-HEXANE	110-54-3	5.0E+01	a	4.7E+03	C
2-HEXANONE	591-78-6	5.0E+01	d		
HYDRAZINE	302-01-2	1.2E-02	e	2.1E-01	C
HYDRAZINE SULFATE	10034-93-2	1.2E-02	e	2.1E-01	C
HYDROGEN CYANIDE	74-90-8	7.0E+02	e	1.6E+03	C
HYDROGEN SULFIDE	7783-06-4	1.1E+02	e	2.3E+02	C
HYDROQUINONE (p-HYDROQUINONE)	123-31-9	5.0E+01	d	3.1E+03	C
1-HYDROXYETHYLIDENE-1,1-DIPHOSPHONIC ACID	2809-21-4	5.0E+01	d		
2-(2-HYDROXY-3,5-DI-TERTPENTYLPHENYL)-BENZOTRIAZOLE	25973-55-1	5.0E+01	d		
INDENO(1,2,3-cd)PYRENE	193-39-5	2.0E-03	d	9.0E-01	C
IRON, TOTAL	*1	3.0E+02	a, *2		
ISOBUTYL ALCOHOL (2-METHYL-1-PROPANOL)	78-83-1	5.0E+01	a	2.3E+04	C
ISODECYL DIPHENYL PHOSPHATE	29761-21-5	5.0E+01	a		
ISODRIN	465-73-6	5.0E+00	a		
ISOPHORONE	78-59-1	5.0E+01	d	6.7E+02	C
ISOPROPALIN	33820-53-0	5.0E+00	a	1.2E+03	C
ISOPROPYLBENZENE (CUMENE)	98-82-8	5.0E+00	a	3.1E+03	C
p-ISOPROPYLTOLUENE	99-87-6	5.0E+00	a		
ISOSAFROLE	120-58-1	5.0E+01	a		
KARBUTILATE	4849-32-5	5.0E+00	a		
KEPONE	143-50-0	ND	a		
LEAD, TOTAL	*1	1.5E+01	b	4.0E+02	h
LINDANE (gamma-BHC)	58-89-9	ND	a	4.9E-01	C
LINURON	330-55-2	5.0E+00	a	1.6E+02	C
MAGNESIUM, TOTAL	*1	3.5E+04	e		
MALATHION	121-75-5	7.0E+00	a	1.6E+03	C

8/4/97

NYSDEC
Contained-In Action Levels

Soil/Sediment "Contained-In" Criteria: cannot exceed ingestion action levels in media and media's leachate cannot adversely impact groundwater, see TAGM p. 13.

SUBSTANCE	CASNUM	Groundwater Action Level (ug/L)	REF	Soil/ Sediment Action Level (mg/kg)	REF
MALEIC ANHYDRIDE (2,5-FURANDIONE)	108-31-6	5.0E+01	a	7.8E+03	C
MALEIC HYDRAZIDE	122-33-1	5.0E+01	a	3.9E+04	C
MALONONITRILE	109-77-3	5.0E+01	a	1.6E+00	C
MANCOZEB (DITHANE M-45)	8018-01-7	5.0E+01	a	2.3E+03	C
MANEB	12427-38-2	1.8E+00	a	3.9E+02	C
MANGANESE, TOTAL	*1	3.0E+02	a, *2	1.1E+04	C
MCPA	94-74-6	4.4E-01	a	3.9E+01	C
MCPB	94-81-5	5.0E+00	a	8.6E+02	C
MCPP	93-65-2	5.0E+00	a	7.8E+01	C
MEPHOSFOLAN	950-10-7	5.0E+00	a	7.0E+00	C
MERCAPTOBENZOTHIAZOLE	149-30-4	5.0E+01	d		
MERCURY, TOTAL	*1	2.0E+00	a	2.3E+01	C
METHACRYLIC ACID	79-41-4	5.0E+01	d		
METHACRYLONITRILE (2-METHYL-2-PROPENENITRILE)	126-98-7	5.0E+00	a	7.8E-01	C
METHANOL	67-56-1	5.0E+01	a	3.9E+04	C
METHAPYRILENE	91-80-5	5.0E+01	d		
METHOMYL	16752-77-5	5.0E+01	a	2.0E+03	C
METHOXYCHLOR	72-43-5	3.5E+01	a	3.9E+02	C
2-METHOXYETHANOL	109-86-4	5.0E+01	a	7.8E+01	C
2-METHOXYETHANOL ACETATE	110-49-6	5.0E+01	a	1.6E+02	C
2-METHOXYETHYLBENZENE	3558-60-9	5.0E+01	d		
1-METHOXYETHYLBENZENE	4013-34-7	5.0E+01	d		
2-METHOXY-5-NITROANILINE	99-59-2	5.0E+00	a	1.4E+01	C
METHYL ACRYLATE	96-33-3	5.0E+01	a	2.3E+03	C
2-METHYLANILINE	100-61-8	5.0E+00	a	2.7E+00	C
2-METHYLANILINE HYDROCHLORIDE	636-21-5	5.0E+00	a	3.6E+00	C
METHYL CHLORIDE (CHLOROMETHANE)	74-87-3	5.0E+00	a	4.9E+01	C
3-METHYLCHOLANTHRENE	56-49-5	5.0E+01	a	6.8E-02	C
4,4-METHYLENE-BIS-(2-CHLOROANILINE)	101-14-4	5.0E+00	a	4.9E+00	C
4,4'-METHYLENEBIS(N,N'-DIMETHYL)ANALINE	1807-55-2	5.0E+00	a	1.4E+01	C
METHYLENE BISTHIOCYANATE	6317-18-6	5.0E+01	d		
METHYLENE CHLORIDE (DICHLOROMETHANE)	75-09-2	5.0E+00	a	8.5E+01	C
4-(1-METHYLETHOXY)-1-BUTANOL	31600-69-8	5.0E+01	d		
2-METHYLETHYL-1,3-DIOXOLANE	126-39-6	5.0E+01	a		
METHYL ETHYL KETONE (2-BUTANONE)	78-93-3	5.0E+01	d	4.7E+04	C
METHYL IODIDE (IODOMETHANE)	74-88-4	5.0E+00	a		
METHYL ISOBUTYL KETONE (4-METHYL-2-PENTANONE)	108-10-1	5.0E+01	d	6.3E+03	C
METHYL MERCURY	22967-92-6	5.0E+01	a	2.3E+01	C
METHYL METHACRYLATE	80-62-6	5.0E+01	a	6.3E+03	C
METHYL METHANESULFONATE	66-27-3	5.0E+01	a		
2-METHYLNAPHTHALENE	91-57-6	5.0E+01	a		
2-METHYL-5-NITROANILINE (5-NITRO-o-TOLUIDINE)	99-55-8	5.0E+00	a	1.9E+02	C
METHYL PARATHION	298-00-0	1.5E+00	a	2.0E+01	C

6/4/97

NYSDEC
Contained-In Action Levels

Soil/Sediment "Contained-In" Criteria: cannot exceed ingestion action levels in media <u>and</u> media's leachate cannot adversely impact groundwater; see TAGM p. 13.

SUBSTANCE	CASNUM	Groundwater Action Level (ug/L)	REF	Soil/ Sediment Action Level (mg/kg)	REF
METHYL STYRENE	25013-15-4	5.0E+00	a	4.7E-02	C
MEVINPHOS (PHOSDRIN)	7786-34-7	5.0E+00	e		
MIREX	2385-85-5	5.0E+00	a	3.6E-01	C
MOLINATE	2212-67-1	5.0E+01	a	1.6E+02	C
MOLYBDENUM, TOTAL	*1	1.8E+02	e	3.9E+02	C
NAPHTHALENE	91-20-3	1.0E+01	d	3.1E+02	C
1,4-NAPHTHOQUINONE	130-15-4	5.0E+01	a		
1-NAPHTHYLAMINE (1-NAPHITHALENAMINE)	134-32-7	5.0E+00	a		
2-NAPHTHYLAMINE (2-NAPHITHALENAMINE)	91-59-8	5.0E+00	a		
NIACINAMIDE	98-92-0	5.0E+01	a		
NICKEL, TOTAL	*1	1.0E+02	b	1.6E+03	C
NITRALIN	4726-14-1	3.5E+01	a		
NITRATES (as N)	NA	1.0E+04	b	1.3E+05	C
NITRIC OXIDE	10102-43-9	3.5E+03	e	7.8E+03	C
NITRITE	NA	1.0E+03	b	7.8E+03	C
NITRILOTRIACETIC ACID	139-13-9	3.0E+00	d		
m-NITROANILINE (3-NITROBENZENAMINE)	99-09-2	5.0E+00	a		
o-NITROANILINE (2-NITROBENZENAMINE)	88-74-4	5.0E+00	a		
p-NITROANILINE (4-NITROBENZENAMINE)	100-01-6	5.0E+00	a		
NITROBENZENE	98-95-3	5.0E+00	a	3.9E+01	C
NITROFURANTOIN	67-20-9	5.0E+01	a	5.5E-03	C
NITROFURAZONE	59-87-0	5.0E+01	a	4.3E-01	C
NITROGEN DIOXIDE	10102-44-0	3.5E+04	e	7.8E-04	C
o-NITROPHENOL (2-NITROPHENOL)	88-75-5	*3	a		
p-NITROPHENOL (4-NITROPHENOL)	100-02-7	*3	a		
2-NITROPROPANE	79-46-9	5.0E+01	a	6.7E-02	C
4-NITROQUINOLINE 1-OXIDE	56-57-5	5.0E+01	a		
n-NITROSODI-n-BUTYLAMINE	924-16-3	5.0E+01	a	1.2E-01	C
n-NITROSODI-ETHANOLAMINE	1116-54-7	5.0E+01	a	2.3E-01	C
n-NITROSODIETHYLAMINE	55-18-5	5.0E+01	a	4.3E-03	C
n-NITROSODIMETHYLAMINE	62-75-9	5.0E+01	a	1.3E-02	C
n-NITROSODIPHENYLAMINE	86-30-6	5.0E+01	d	1.3E+02	C
n-NITROSO-n-DIPROPYLAMINE (DI-n-PROPYLNITROSAMINE)	621-64-7	5.0E+01	a	9.1E-02	C
n-NITROSOMETHYLETHYLAMINE	10595-95-6	5.0E+01	a	2.9E-02	C
n-NITROSO-n-METHYL UREA	684-93-5	5.0E+01	a	2.1E-02	C
n-NITROSOMORPHOLINE	59-89-2	5.0E+01	a		
n-NITROSOPIPERIDINE	100-75-4	5.0E+01	a		
n-NITROSOPYRROLIDINE	930-55-2	5.0E+01	a	3.0E-01	C
NITROTOLUENES, TOTAL	NA	5.0E+00	a	7.8E+02	C
OCTAMETHYLPYROPHOSPHORAMIDE	152-16-9	5.0E+00	a	1.6E+02	C
PARAQUAT	4685-14-7	3.0E+00	a	3.5E-02	C
PARATHION	56-38-2	1.5E+00	a	4.7E+02	C
PEBULATE	1114-71-2	5.0E+01	a	3.9E-03	C

NYSDEC
Contained-in Action Levels

Soil/Sediment Contained-in Criteria: Meet both the ingestion action level in soil/sediment and meet groundwater action level in soil/sediment leachate.

SUBSTANCE	CASNUM	Groundwater Action Level (ug/L)	REF	Soil/ Sediment Action Level (mg/kg)	REF
PENDIMETHALIN	40487-42-1	5.0E+00	a	3.1E+03	c
PENTACHLOROBENZENE	608-93-5	5.0E+00	a	6.3E+01	c
PENTACHLOROETHANE	76-01-7	5.0E+00	a		
PENTACHLORONITROBENZENE	82-68-8	ND	a	2.5E+00	c
PENTACHLOROPHENOL	87-86-5	*3	a	3.0E+00	c
PHENACETIN	62-44-2	5.0E+00	a		
PHENANTHRENE	85-01-8	5.0E+01	d		
PHENOL	108-95-2	*3	a	4.7E+04	c
PHENOLS, TOTAL	NA	*3 1.0E+00	a		
o-PHENYLENEDIAMINE (1,2-BENZENEDIAMINE)	95-54-5	5.0E+00	a	1.4E+01	c
m-PHENYLENEDIAMINE (1,3-BENZENEDIAMINE)	108-45-2	5.0E+00	a	4.7E+02	c
p-PHENYLENEDIAMINE (1,4-BENZENEDIAMINE)	106-50-3	5.0E+00	a		
PHENYL ETHER	101-84-8	1.0E+01	d		
PHENYL MERCURIC ACETATE	62-38-4	5.0E+01	a	8.3E+00	c
2-PHENYL PHENOL	90-43-7	*3	a	3.4E+02	c
PHENYLPROPANOLAMINE	14838-15-4	5.0E+01	d		
PHORATE	298-02-2	ND	a		
PHOSPHINE	7803-51-2	1.1E+01	e	2.3E+01	c
PHTHALIC ANHYDRIDE	85-44-9	5.0E+01	e	1.6E+05	c
2-PICOLINE (2-METHYL PYRIDINE)	109-06-8	5.0E+01	a		
POLYBROMINATED BIPHENYLS (PBBs)	59536-65-1	5.0E+00	a	7.2E-02	c
POLYCHLORINATED BIPHENYLS (PCBs)	1336-36-3	NA	a	NA	i,j
POTASSIUM CYANIDE	151-50-8	1.8E+03	e	3.9E+03	c
POTASSIUM SILVER CYANIDE	506-61-6	7.0E+03	e	1.6E+04	c
PROFLURALIN	26399-36-0	5.0E+00	a	4.7E+02	c
PRONAMIDE	23950-58-5	5.0E+01	a	5.9E+03	c
PROPACHLOR	1918-16-7	3.5E+01	a	1.0E+03	c
PROPANIL	709-98-8	7.0E+00	a	3.9E+02	c
PROPAZINE	139-40-2	1.6E+01	a	1.5E+03	c
PROPIONITRILE (ETHYL CYANIDE)	107-12-0	5.0E+01	a		
PROPOXUR	114-26-1	5.0E+01	a	3.1E+02	c
n-PROPYLBENZENE	103-65-1	5.0E+00	a		
PROPYLENE GLYCOL (1,2-PROPANEDIOL)	57-55-6	5.0E+01	a	1.6E+06	c
PROPYLENE GLYCOL MONOETHYL ETHER	19089-47-5	5.0E+01	e	6.5E+04	c
PROPYLENE GLYCOL MONOMETHYL ETHER	1589-49-7	5.0E+01	a	5.5E+04	c
PROPYLENE OXIDE	75-56-9	5.0E+01	e	2.7E+00	c
PYRENE	129-00-0	2.0E-01	b	2.3E+03	c
PYRIDINE	110-86-1	5.0E+01	a	7.8E+01	c
QUINOLINE	91-22-5	5.0E+01	a	5.1E-02	c
RADIUM 226	NA	3 pCi/L	d		
RADIUM 226 PLUS RADIUM 228	NA	5 pCi/L	b		
RDX (CYCLONITE)	121-82-4	5.0E+01	a	5.8E+00	c
RESERPINE	50-55-5	5.0E+01	a	6.1E-02	c

8/4/97

NYSDEC
Contained-In Action Levels

Soil/Sediment "Contained-In" Criteria: cannot exceed ingestion action levels in media <u>and</u> media's leachate cannot adversely impact groundwater; see TAGM p. 13.

SUBSTANCE	CASNUM	Groundwater Action Level (ug/L)	REF	Soil/ Sediment Action Level (mg/kg)	REF
RONNEL	299-84-3	5.0E+00	a	3.9E+03	c
ROTENONE	83-79-4	5.0E+01	a	3.1E+02	c
SAFROLE	94-59-7	5.0E+01	a		
SELENIOUS ACID	7783-00-8	1.8E+02	e	3.9E-02	c
SELENIUM, TOTAL	*1	1.0E+01	a	3.9E+02	c
SELENOUREA	630-10-4	1.8E+02	e	3.9E-02	c
SILVER, TOTAL	*1	5.0E+01	a	3.9E+02	c
SILVER CYANIDE	506-64-9	3.5E+03	e	7.8E-03	c
SIMAZINE	122-34-9	4.00E+00	b	5.3E+00	c
SODIUM, TOTAL	*1	<20000	a		
SODIUM CYANIDE	143-33-9	1.4E+03	e	3.1E+03	c
SODIUM DIETHYLDITHIOCARBAMATE	148-18-5	5.0E+01	a	2.4E+00	c
SODIUM METAVANADATE	13718-26-8	3.5E+01	e	7.8E+01	c
STRONTIUM 90	NA	10pCi/L	d		
STRYCHNINE AND SALTS	57-24-9	5.0E+01	a	2.3E+01	c
STYRENE (ETHENYLBENZENE)	100-42-5	5.0E+00	a	2.1E-01	c
SULFATES	NA	2.5E+05	a		
SULFIDES (as H2S)	NA	5.0E+01	d		
TEMEPHOS	3383-96-8	5.0E+01	a	1.6E+03	c
TERBUFOS	13071-25-6	9.0E-02	d	7.9E+00	c
1,2,4,5-TETRACHLOROBENZENE	95-94-3	5.0E+00	a	2.3E+01	c
2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN (2,3,7,8-TCDD) *2	1746-01-6	3.50E-05	a	4.1E-06	c
1,1,1,2-TETRACHLOROETHANE	630-20-6	5.0E+00	a	2.5E+01	c
1,1,2,2-TETRACHLOROETHANE	79-34-5	5.0E+00	a	3.2E+00	c
TETRACHLOROETHYLENE (PERCHLOROETHYLENE)	127-18-4	5.0E+00	a	1.2E+01	c
2,3,4,6-TETRACHLOROPHENOL	58-90-2	*3	a	2.3E+03	c
p,alpha,alpha,alpha-TETRACHLOROTOLUENE	5216-25-1	5.0E+00	a	3.2E-02	c
TETRACHLORVINPHOS (STIROFOS)	961-11-5	5.0E+00	a	2.7E+01	c
TETRAETHYL DITHIOPYROPHOSPHATE (SULFOTEPP)	3689-24-5	5.0E+01	a	3.9E-01	c
TETRAETHYL LEAD	78-00-2	3.5E-03	e	7.8E-03	c
TETRAHYDROFURAN	109-99-9	5.0E+01	d		
THALLIC OXIDE	1314-32-5	3.5E+00	e	7.8E+00	c
THALLIUM, TOTAL	*1	2.0E+00	b	7.8E+00	c
THALLIUM ACETATE	563-68-8	3.2E+00	e	7.0E+00	c
THALLIUM CARBONATE	6533-73-9	2.8E+00	e	6.3E+00	c
THALLIUM CHLORIDE	7791-12-0	2.8E+00	e	6.3E+00	c
THALLIUM NITRATE	10102-45-1	3.2E+00	e	7.0E+00	c
THALLIUM SELENITE	12039-52-0	3.5E+00	e	7.8E+00	c
THALLIUM SULFATE	10031-59-1	3.5E+00	e	7.8E+00	c
THEOPHYLLINE	58-55-9	4.0E+01	d		
2-(THIOCYANOMETHYLTHIO)-BENZOTHIAZOLE (TCMTB)	21564-17-0	5.0E+01	a	2.3E+03	c
THIOFANOX	39196-18-4	6.0E+01	e	2.3E-01	c
THIOUREA	62-56-6	5.0E+01	a	3.3E-01	c

NYSDEC
Contained-in Action Levels

Soil/Sediment "Contained-in" Criteria: cannot exceed ingestion action levels in media and media's leachate cannot adversely impact groundwater; see TAGM p. 13.

SUBSTANCE	CASNUM	Groundwater Action Level (ug/L)	REF	Soil/ Sediment Action Level (mg/kg)	REF
THIRAM	137-26-8	1.8E+00	a	3.9E+02	C
TIN, TOTAL	7440-31-5	2.1E+04	e	1.8E+04	C
TOLUENE (METHYL BENZENE)	108-88-3	5.0E+00	a	1.6E+04	C
2,4-TOLUENEDIAMINE	95-80-7	5.0E+00	a	2.0E-01	C
2,5-TOLUENEDIAMINE	95-70-5	5.0E+00	a	4.7E+04	C
2,6-TOLUENEDIAMINE	823-40-5	5.0E+00	a	1.6E-04	C
TOLUENE DIISOCYANATE	584-84-9	5.0E+00	a		
o-TOLUIDINE (2-METHYL BENZENAMINE)	95-53-4	5.0E+00	a	2.7E+00	C
p-TOLUIDINE (4-METHYL BENZENAMINE)	106-49-0	5.0E+00	a	3.4E+00	C
TOLYLTRIAZOLE	29385-43-1	5.0E+01	d		
TOXAPHENE	8001-35-2	ND	a	5.8E-01	C
2,4,5-TP (SILVEX)	93-72-1	2.6E-01	a	6.3E+02	C
TRIALLATE	2303-17-5	4.6E+02	e	1.0E+03	C
1,2,4-TRIBROMOBENZENE	NA	5.0E+00	a	3.9E+02	C
TRIBUTYLTIN OXIDE	56-35-9	5.0E+01	d	2.3E+00	C
2,4,6-TRICHLOROANILINE	634-93-5	5.0E+00	a	1.9E+01	C
2,4,6-TRICHLOROANILINE HYDROCHLORIDE	NA	5.0E+00	a	2.2E+01	C
1,2,3-TRICHLOROBENZENE	87-61-6	5.0E+00	a		
1,2,4-TRICHLOROBENZENE	120-82-1	5.0E+00	a	7.8E+02	C
1,1,1-TRICHLOROETHANE (METHYL CHLOROFORM)	71-55-6	5.0E+00	a	7.0E+03	C
1,1,2-TRICHLOROETHANE	79-00-5	5.0E+00	a	1.1E+01	C
TRICHLOROETHYLENE (TRICHLOROETHENE)	79-01-6	5.0E+00	b	5.8E+01	C
TRICHLOROFLUOROMETHANE (F-11)	75-69-4	5.0E+00	a	2.3E+04	C
2,4,5-TRICHLOROPHENOL	95-95-4	*3	a	7.8E+03	C
2,4,6-TRICHLOROPHENOL	88-06-2	*3	a	5.8E+01	C
2,4,5-TRICHLOROPHENOXY ACETIC ACID (2,4,5-T)	93-76-5	1.0E+01	b	7.8E+02	C
1,1,2-TRICHLOROPROPANE	598-77-6	5.0E+00	a	3.9E+02	C
1,2,3-TRICHLOROPROPANE	96-18-4	5.0E+00	a	4.7E+02	C
1,2,3-TRICHLOROPROPENE	96-19-5	5.0E+00	a	3.9E+02	C
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	76-13-1	5.0E+00	a	2.3E+05	C
o,o,o-TRIETHYL PHOSPHOROTHIOATE	126-68-1	5.0E+01	a		
TRIFLURALIN	1582-09-8	3.5E+01	a	8.3E+01	C
1,2,4-TRIMETHTYLBENZENE	95-63-6	5.0E+00	a		
1,3,5-TRIMETHYLBENZENE	108-67-8	5.0E+00	a		
TRIMETHYL PHOSPHATE	512-56-1	5.0E+01	a	1.7E+01	C
2,4,6-TRIMETHYLPYRIDINE (2,4,6-COLLIDINE)	108-75-8	5.0E+01	d		
2,3,6-TRIMETHYLPYRIDINE	1462-84-6	5.0E+01	d		
sym-TRINITROBENZENE (1,3,5-TRINITROBENZENE)	99-35-4	5.0E+00	a	3.9E+00	C
2,4,6-TRINITROTOLUENE (TNT)	118-96-7	5.0E+00	a	3.9E+01	C
TRITHION (CARBOPHENOTHION)	786-19-6	5.0E+01	a		
TRIPHENYLPHOSPHATE	115-86-6	5.0E+01	d		
VANADIUM, TOTAL	*1	2.5E+02	e	5.5E+02	C
VANADIUM PENTOXIDE	1314-62-1	3.2E+02	e	7.0E+02	C

NYSDEC
Contained-In Action Levels

Soil/Sediment "Contained-In" Criteria: cannot exceed ingestion action levels in media and media's leachate cannot adversely impact groundwater, see TAGM p. 13.

SUBSTANCE	CASNUM	Groundwater Action Level (ug/L)	REF	Soil/ Sediment Action Level (mg/kg)	REF
VANADYL SULFATE	27774-13-6	7.0E+02	e	1.8E+03	c
VERNOLATE	1929-77-7	3.5E+01	e	7.8E+01	c
VINYL ACETATE	108-05-4	5.0E+01	a	7.8E+04	c
VINYL CHLORIDE (CHLOROETHENE)	75-01-4	2.0E+00	b	3.4E-01	c
WARFARIN	81-81-2	5.0E+01	a	2.3E+01	c
XYLENE, TOTAL (DIMETHYL BENZENE)	1330-20-7	5.0E+00	a	1.6E+08	c
m-XYLENE (3-DIMETHYL BENZENE)	108-38-3	5.0E+00	a	1.6E+05	c
o-XYLENE (2-DIMETHYL BENZENE)	95-47-6	5.0E+00	a	1.6E+05	c
p-XYLENE (4-DIMETHYL BENZENE)	106-42-3	5.0E+00	a		
ZINC, TOTAL	*1	5.0E+03	e	2.3E+04	c
ZINC CYANIDE	557-21-1	1.8E+03	e	3.9E+03	c
ZINC PHOSPHIDE	1314-84-7	1.1E+01	e	2.3E+00	c
ZINEB	12122-67-7	1.8E+00	a	3.9E+03	c
ZIRAM	137-30-4	4.2E+00	a		

8/4/97

Footnotes

*1 All species in the groundwater and/or soil that contain this element are included in the total.

*2 Total concentration of iron and manganese should not exceed 500 µg/l.

*3 All phenolic compounds (total phenols) shall not exceed 1 µg/L [NY TOGS (1.1.1)].

*4 Total concentration of these four trihalomethanes shall not exceed 100 µg/l.

NA Not Available

ND Not Detectable by tests or analytical determinations. The groundwater protection concentration should be written as non-detectable (ND) with a footnote specifying the method detection limit (MDL) for the most sensitive analytical technique (e.g., benzene ND by USEPA Method 602 or 8020 with an MDL = 0.2 ug/l).

References

a) Taken from 6 NYCRR Part 703.5(a)(3) Class GA groundwater quality standards (September 15, 1991).

b) Taken from USEPA MCLs (February 1996).

c) Based on USEPA Health Effects Assessment Summary (HEASTs) Data (May 1995) and oral ingestion equation.

d) 6NYCRR Part 703 GA Standard or USEPA MCL does not exist for this constituent, Guidance value from NYSDEC Division of Water Technical and Operational Guidance Series (TOGS) 1.1.1 was used since either no HEASTS data is available or if available, it was less conservative than TOGS guidance value.

e) 6NYCRR Part 703 GA Standard or USEPA MCL does not exist for this constituent, a Health based value from USEPA HEASTs data was used since it was more conservative than the guidance value in TOGS.

f) Guidance value taken from NYS TOGS 1.1.1 for total chlorinated dibenzo-p-dioxins and chlorinated dibenzofurans is 0.0000002 µg/L equivalents of 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD). The 2,3,7,8-TCDD equivalent for a congener is obtained by multiplying the concentration of that congener by its toxicity equivalence factor (TEF) from the table below. The guidance value for Class GA waters does not include the congener 2,3,7,8-TCDD.

A guidance value for an individual congener value can be calculated by dividing 0.0000002 µg/L by the TEF for that congener.

0.000035 µg/L applies only to 2,3,7,8-TCDD

Congener	TEF
2,3,7,8-TETRACHLORODIBENZO-p-DIOXIN	1
Other tetrachlorodibenzo-p-dioxins	0.01
2,3,7,8-PENTACHLORODIBENZO-p-DIOXIN	0.5
Other pentachlorodibenzo-p-dioxins	0.005
2,3,7,8-HEXACHLORODIBENZO-p-DIOXINS	0.05
Other hexachlorodibenzo-p-dioxins	0.0005
2,3,7,8-HEPTACHLORODIBENZO-p-DIOXIN	0.005
Other heptachlorodibenzo-p-dioxins	0.00005
OCTACHLORODIBENZO-p-DIOXIN	0.005
2,3,7,8-TETRACHLORODIBENZOFURAN	0.1
Other tetrachlorodibenzofurans	0.001
2,3,4,7,8-PENTACHLORODIBENZOFURAN	0.5
1,2,3,7,8-PENTACHLORODIBENZOFURAN	0.05
Other pentachlorodibenzofurans	0.005
2,3,7,8-HEXACHLORODIBENZOFURAN	0.1
Other hexachlorodibenzofurans	0.001
2,3,7,8-HEPTACHLORODIBENZOFURAN	0.005
Other heptachlorodibenzofurans	0.00005
OCTACHLORODIBENZOFURAN	0.005

g) Refer to footnotes in the NYSDEC Division of Water Technical and Operational Guidance Series (TOGS) 1.1.1.

h) This is USEPA's recommendation based on their Intergrated Exposure Uptake Biokinetic (IEUBK) Model in assessing total lead exposure children (U.S.EPA July 14,1994).

i) USEPA Guidance on Remdiation Action for Superfund Sites with PCB contamination (U.S.EPA, 1990).

j) Do not manage as hazardous waste if less than 50 ppm.

ATTACHMENT 6

International Uranium (USA) Corporation
White Mesa Mill
Equipment Release/Radiological Survey Procedure

2.6 Equipment Release Surveys

2.6.1 Policy

Materials leaving a restricted area going to unrestricted areas for usage must meet requirements of Annex C Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use (dated September, 1984).

All material originating within the restricted area will be considered contaminated until checked by the radiation protection department. All managers who desire to ship or release material from the facility will inform the Radiation Protection Officer of their desires. The Radiation Protection Officer has the authority to deny release of materials exceeding Annex C Guidelines. No equipment or materials will be released without documented release by the Radiation Protection Officer.

2.6.2 Limits

The release limits are:

Alpha emissions:

Average	5,000 dpm/100 cm^2
Maximum	15,000 dpm/100 cm^2
Removable	1,000 dpm/100 cm^2

Beta-gamma emissions (measured at a distance of one centimeter):

Average	0.2 mr/hr or 5,000 dpm/100 cm^2
Maximum	1.0 mr/hr or 15,000 dpm/100 cm^2

2.6.3 Equipment

Equipment used for equipment surveys includes as examples (or equivalent):

1. Eberline PRM-7 gamma scintillator, or equivalent
2. Ludlum Model 3 with 44-5 detector, or equivalent
3. Ludlum Model 3 with 43-5 detector, or equivalent
4. Ludlum Model 2200 with 43-17 detector, or equivalent
5. Glass fiber wipe filters

2.6.4 Procedures

Upon notification that materials are requested for release, the radiation protection department shall inspect and survey the material. Surveys include fixed and removable alpha surveys and beta-gamma surveys. A document inspection and release form is to be prepared and signed by the Radiation Protection Officer or his designee. Any material released from the mill will be accompanied with the appropriate release form. If contamination exceeds Annex C levels, then decontamination may proceed at the direction of the Radiation Protection Officer. If the material cannot be decontaminated, then it will not be released.

2.6.5 Records

Documented records for each released item are filed in the radiation protection department files.

2.6.6 Quality Assurance

The policy and documented release forms are periodically reviewed by the Radiation Protection Officer and the audit committee to ensure policy and regulatory compliance.

ATTACHMENT 7

USACE Value Engineering Proposal for
Ashland 1 and Ashland 2

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: C-11 PAGE NO [illegible] OF 4
DESCRIPTION: Recycle Uranium, Rare Earth Minerals, and Other Metals

ORIGINAL DESIGN:

Ship material offsite for disposal, or perform soil washing (offsite) to reduce volume; then, dispose of resultant waste streams by shipment to disposal facility(ies).

PROPOSED DESIGN:

Use recycling and mineral recovery technologies at a uranium mill to reduce radioactive material disposal costs. An operating conventional uranium mill, such as the one operated by International Uranium Corporation (IUC) in southeastern Utah, has the technology necessary to recycle materials for extraction of uranium, vanadium, rare earth minerals, and other metals, and to provide for disposal of treated waste in the facility's fully lined and NRC-compliant existing tailings impoundments. Based on a preliminary review of the materials stored and disposed of in pits or trenches at the Ashland sites, it appears that recoverable levels of uranium, vanadium and/or rare earth minerals may exist in the material to be excavated from these locations as well as other FUSRAP sites.

Since the characterization data is limited, it is difficult to quantify the uranium content and recycle value of this material. It appears, however, that significant portions of the material could be recycled so as to reduce the Corps' total remediation costs. Until treatability tests confirm the levels of recoverable material, which would reduce the processing cost, a not-to-exceed processing cost is assumed, based on a very low content of recycleable uranium and other minerals of value. This proposal should be revised to indicate larger savings if more favorable data becomes available.

ADVANTAGES:

1. Conforms to Congressional and regulatory mandates which encourage use of recycling.
2. Reduces radioactivity of the material to be disposed of.
3. Recycles uranium and other minerals.
4. Reduces cost of disposal of by-product from recycling operation.
5. Treatment and on-site disposal are performed at one location, with the by-product from recycling being disposed of in an NRC-compliant disposal system, meeting 10 CFR 40 design criteria.
6. 11e(2) by-product is disposed of in an existing tailings impoundment which is consistent with 10 CFR 40 Appendix B intent for nonproliferation of small sites.
7. Actual cost savings for treatment and disposal versus cost of direct disposal can only be greater than projected in this proposal, depending upon the actual content of recoverable uranium or other minerals found in the waste stream .

8. This technology has been demonstrated on multiple waste streams and has potential applicability to all other FUSRAP sites.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: C-11 PAGE NO: 2 OF 4

DISADVANTAGES:

1. Transportation by rail is possible to a railhead located within approximately 100 miles of the IUC Mill. However, rehandling of materials for truck transportation via dump bodies or intermodal containers is necessary to transfer materials from the railhead to the IUC Mill site.
2. The Mill has in place an NRC license to possess, store, and dispose of source material; however, an amendment, similar in content and format to previous routinely-granted amendments, may be necessary to accept this material under terms of NRC guidance.
3. Cost estimate for treatment and disposal cannot be refined until further characterization data which indicates the content of uranium, and other minerals of value, is available.
4. NPL status of Ashland 1 and 2 sites may present regulatory hurdles.

JUSTIFICATION:

This proposal will provide a cost effective remediation option. Recycling is a means of meeting Congressional directives to treat waste streams, when possible, and to potentially recycle uranium or other minerals (as mandated under RCRA), while meeting the Public's and State's preference that the material not be treated on site, and that is be disposed offsite. Although the cost savings in this proposal are conservatively based on an assumption that only lower levels of uranium or other metals can be recovered, greater cost savings could be projected if treatability tests demonstrate higher content and levels of recovery. Processing at the uranium mill operated by IUC in Utah is used as the basis of this proposal estimate because of its proximity to Envirocare, providing a fair comparison of costs based on locality handling issues and transportation costs.

Note that two cost estimates are provided for this proposal, Estimate A based on the current project estimate which use rates derived from the Bechtel estimates, and Estimate B based on the rates for the current Kansas City contract for RAD disposal. Proposal C-1 addresses this difference.

COST ESTIMATE WORKSHEET (ESTIMATE A)

PROPOSAL NO: C-11

DELETIONS

ITEM	U/M	QTY	UNIT COST	TOTAL
Disposal at Envirocare				
Ashland 2(FY98)	CY	19,500	*$215.00	$4,192,500
Ashland 1(FY99)	CY	21,750	215.00	4,676,250
Ashland 1(FY00)		CY21,750	215.00	4,676,250
Loading Facility	CY	1,500	335.00	502,500
TOTAL DELETIONS				$14,047,500

ADDITIONS

ITEM	U/M	QTY	UNIT COST	TOTAL
Process and Dispose at Mill	**CY**			
Ashland 2(FY98)	**CY**	**19,500**	****$110.00**	**$2,145,000**
Ashland 1(FY99)	**CY**	**21,750**	**110.00**	**2,392,500**
Ashland 1(FY00)	**CY**	**21,750**	**110.00**	**2,392,500**
Loading Facility	**CY**	**1,500**	**428.00**	**642,000**
Additional Transportation and Handling Cost				
Ashland 2(FY98)	**CY**	**19,500**	**$18.00**	**$351,000**
Ashland 1(FY99)	**CY**	**21,750**	**18.00**	**391,500**
Ashland 1(FY00)	**CY**	**21,750**	**18.00**	**391,500**
Loading Facility	**CY**	**1,500**	**18.00**	**27,000**
TOTAL ADDITIONS				**$8,733,000**

Net Savings (Deletes - Adds)	**$5,314,500**
*****Markups 25%**	**1,328,625**
TOTAL SAVINGS	**$6,643,125**

***Unit cost is from the current project estimate and is based on Bechtel's disposal rates.**

****Unit cost based on uranium content ≤0.5 percent, and no recovered minerals. A credit of as much as $10/ton could be given for each 0.1 percent incremental increase in uranium content above 0.5 percent. Given the variability of value of other minerals, rare earths, or metals, credits due to such elements would be a function of the market value and content of the particular element. Cost of treatment via processing could be refined and reduced based on the results of treatability tests or other relevant considerations. Addition of these variables all serve to increase cost savings**

***** Markups: Includes Contingency (25%)**

Note: Additional transportation and handling costs, compared to transportation to Envirocare, of $ 18/CY, include costs of off-loading from gondola cars at the railhead, loading into dumptrucks or container trucks, trucking to the site, and offloading/delivery

at the IUC site.

COST ESTIMATE WORKSHEET (ESTIMATED)

PROPOSAL NO: C-11 PAGE NO: 4 OF4

DELETIONS

ITEM	U/M	QTY	UNIT COST	TOTAL
Disposal at Envirocare				
Ashland 2(FY98)	CY	19,500	*$167.00	$3,256,500
Ashland 1(FY99)	CY	21,750	167.00	3,632,250
Ashland 1(FY00)		CY21,750	167.00	3,632,250
Loading Facility	CY	1500	428.00	642,000
TOTAL DELETIONS				$11,163,000

ADDITIONS

ITEM	U/M	QTY	UNIT COST	TOTAL
Process and Dispose at Mill	CY			
Ashland 2(FY98)	CY	19,500	**$110.00	$2,145,000
Ashland 1(FY99)	CY	21,750	110.00	2,392,500
Ashland 1(FY00)	CY	21,750	110.00	2,392,500
Loading facility	CY	1,500	110.00	165,000
Additional Transportation and Handling Cost				
Ashland 2(FY98)	CY	19,500	$18.00	$351,000
Ashland 1(FY99)	CY	21,750	18.00	391,500
Ashland 1(FY00)	CY	21,750	18.00	391,500
Loading facility	CY	1,500	18.00	27,000
TOTAL ADDITIONS				$8,256,000
Net Savings (Deletes - Adds)				$2,907,000
***Markups 25%				726,750
TOTAL SAVINGS				$3,633,750

* Unit cost based on the Kansas City RAD waste disposal Contract rates.

**Unit cost based on uranium content ≤0.5 percent, and no recovered minerals. A credit of as much as $10/ton could be given for each 0.1 percent incremental increase in uranium content above 0.5 percent. Given the variability of value of other minerals, rare earths, or metals, credits due to such elements would be a function of the market value and content of the particular element. Cost of treatment via processing could be refined and reduced based on the results of treatability tests or other relevant considerations. Addition of these variables all serve to increase cost savings

*** Markups: Includes Contingency (25%)

Note: Additional transportation and handling costs, compared to transportation to

Envirocare, of $ 18/CY, include costs of off-loading from gondola cars at the railhead loading into dumptrucks or container trucks, trucking to the site, and offloading/delivery at the IUC site.

ATTACHMENT 8

Classification of Uranium Material as 11e.(2) Byproduct Material

SHAW PITTMAN
POTTS & TROWBRIDGE
A PARTNERSHIP INCLUDING PROFESSIONAL CORPORATIONS

MEMORANDUM

TO: Stuart A. Treby
Maria E. Schwartz

FROM: Anthony J. Thompson
Warren U. Lehrenbaum

DATE: March 1, 1999

RE: Status of Materials at FUSRAP Sites

This memorandum is intended to follow up on our telephone conversation earlier this week, during which we discussed whether or not materials present at sites administered under the Department of Energy's ("DOE's") Formerly Utilized Sites Remedial Action Program ("FUSRAP") can constitute "byproduct material" as defined in Section 11e.(2) of the Atomic Energy Act, as amended (the "AEA").

I. ISSUE PRESENTED

It is our understanding that concerns have been raised recently within NRC's Office of General Counsel ("OGC") regarding DOE's characterization of certain FUSRAP materials as constituting 11e.(2) byproduct material.[1] In particular, we understand that OGC is concerned that FUSRAP materials that were created prior to the enactment of the Uranium Mill Tailings Radiation Control Act ("UMTRCA") and that were not created pursuant to an NRC-licensed activity cannot qualify as 11e.(2) byproduct material.

OGC's concerns regarding the status of FUSRAP materials as 11e.(2) byproduct material appear to relate to a letter that Robert L. Fonner, Special Counsel for Fuel Cycle and Safeguards Regulations (NRC) wrote to the U.S. Army Corps of Engineers ("USACE") about a year ago. In that letter, dated March 2, 1998, Mr. Fonner took the position that NRC does not have

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[1] FUSRAP sites generally contain a variety of radioactive materials; DOE has determined that a number of FUSRAP sites contain 11e.(2) byproduct material. *See* U.S. DOE *The Formerly Utilized Sites Remedial Action Program (FUSRAP): Building Stakeholder Partnerships to Achieve Effective Cleanup*, DOE/EM-0233 (April 1995), Appendix I.

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jurisdiction over materials present at various FUSRAP sites. Specifically, Mr. Fonner stated that:

> UMTRCA gave NRC statutory authority over tailings [from ore processed for source material content], but only over tailings from activities licensed by NRC as of the effective date of the Act (November 8, 1978), or thereafter. See Section 83 of the Atomic Energy Act of 1954 as amended.
>
> . . .
>
> Because the residuals at the listed [FUSRAP] sites were generated long before NRC had any jurisdiction over tailings, and were never produced from source material extraction under NRC license, NRC today has no basis to assert any regulatory authority over the handling of those residuals at the listed sites.

Letter from Robert L. Fonner, Special Counsel for Fuel Cycle and Safeguards Regulations (NRC) to Ann Wright, Counsel, HTRW Center of Expertise (USACE) dated March 2, 1998 (hereinafter the "Fonner Letter") at 1.

We believe that OGC's concerns regarding DOE's characterization of certain FUSRAP materials as being 11e.(2) byproduct material are unwarranted. Specifically, as we explain below, we believe FUSRAP materials can be characterized as 11e.(2) byproduct material (assuming such materials satisfy the definition of 11e.(2) byproduct material) consistent with the statutory scheme created by Congress, with NRC and DOE past practice, and with the ideas expressed in the Fonner Letter.

II. DISCUSSION

When considering the status under UMTRCA of FUSRAP materials derived from the processing of uranium ores, it is important to bear in mind that Congress, when it enacted UMTRCA, intended to create a comprehensive system for regulating the tailings and related wastes resulting from processing ore for its source material content. Congress itself expressed the twofold purpose of UMTRCA to be as follows: (i) to assess and remediate *inactive* mill tailings sites (i.e., sites contaminated with uranium mill tailings and related wastes that are not subject to an active NRC license), and (ii) to regulate the management and disposition of uranium mill tailings and related wastes at *active* mill tailings sites (i.e., sites subject to an active license). 42 U.S.C. § 7901. To accomplish these dual objectives, Congress created an integrated, two-part regulatory scheme, under which tailings at inactive sites are addressed primarily under Title I of UMTRCA and tailings present at active sites are addressed primarily under Title II.

The keystone of the Title II program was the creation of a new category of AEA-regulated material -- 11e.(2) byproduct material -- which Congress defined to mean:

> the tailings and wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content.

42 U.S.C. § 2014e.(2). Two things about this definition must be emphasized. First, Congress did not impose any temporal limitations on the types of materials that qualify as 11e.(2) byproduct material. In other words, Congress did not define 11e.(2) byproduct material to mean tailings and wastes produced . . . after the effective date of UMTRCA. Instead, Congress imposed temporal limitations only on the activities that may be subject to NRC's licensing jurisdiction. Thus, Section 83 of the AEA (referred to in the Fonner Letter) provides that:

> Any *license* issued or renewed after the effective date of this section . . . [for] any activity that results in the production of [11e.(2)] byproduct material . . . [shall contain specified terms and conditions]

42 U.S.C. § 2113(a). Indeed, Section 83 itself directs NRC to regulate as 11e.(2) byproduct material tailings present at licensed sites that were generated prior to the enactment of UMTRCA. For example, the statute provides that:

> Any license *which is in effect* on the effective date of this section and which is subsequently terminated without renewal shall comply with paragraphs (1) and (2) upon termination [specifying that ownership of any 11e.(2) byproduct material resulting from the licensed activity shall be transferred to the government]

Id. Clearly, then, Congress understood that materials generated prior to the effective date of UMTRCA could still qualify as 11e.(2) byproduct material. Section 83 speaks to NRC's *licensing authority* over materials generated both prior to and following the enactment of UMTRCA; it does *not* provide that a material must have been created after 1978 or pursuant to an NRC-issued license in order to qualify as 11e.(2) byproduct material.

The second important feature of the definition of 11e.(2) byproduct material that must be borne in mind is that Congress purposely defined 11e.(2) byproduct material broadly, to encompass *all* wastes – including both radioactive and non-radioactive wastes – resulting from uranium ore processing, in order to ensure that none of these wastes would go unregulated.[2] Similarly, Congress intentionally defined 11e.(2) byproduct material in a manner that was broad

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[2] Thus, as NRC has noted:

> The fact that the term "any ore" rather than "unrefined and unprocessed ore" is used in the definition of 11e.(2) byproduct material implies that a broader range of feed materials could be processed in a mill, with the wastes still being considered as 11e.(2) byproduct material.

57 Fed. Reg. at 20,532.

enough to ensure that wastes resulting from processing ores containing less than licensable levels (i.e., 0.05%) of uranium would still be encompassed within the class of 11e.(2) byproduct material.[3] Thus, as the D.C. Circuit concluded following a review of UMTRCA's legislative history:

> It is clear from this exchange [in the legislative history] that the definition of "byproduct material" proposed by [then NRC chairman] Dr. Hendrie and adopted by Congress was designed to extend the NRC's regulatory authority over *all* wastes resulting from the extraction or concentration of source materials in the course of the nuclear fuel cycle.

Kerr-McGee v. U.S. Nuclear Regulatory Com'n, 903 F.2d 1, 7 (D.C. Cir. 1990).

While Title II of UMTRCA was designed to achieve the comprehensive regulation of all wastes and tailings resulting from uranium processing activities at active mill sites, Title I was intended to perform a complementary role by providing for the remediation and regulation of tailings and wastes associated with uranium processing activities that had occurred at inactive and abandoned milling sites. Congress, in Title I, specified 22 inactive milling sites to be evaluated and remediated by DOE. In addition, Congress directed DOE to identify, evaluate and, if necessary, remediate any additional inactive milling sites designated by DOE, as well as sites in the vicinity of inactive milling sites that were contaminated with tailings and wastes from the milling activities (so-called "vicinity sites"). 42 U.S.C. §§ 7911(6); 7912.[4] Just as Congress

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[3] As the following testimony from the legislative history of UMTRCA reveals, Congress modified the definition of 11e.(2) byproduct material to apply to "*any* ore" processed primarily for its source material content in a licensed uranium mill for the specific purpose of ensuring that all wastes from processing such ores, including ores containing less than 0.05% uranium, would fall within the regulatory program established for 11e.(2) byproduct material.

> [Chairman Hendrie] The Commission is informed that there are a few mills currently using feedstock of less than 0.05-percent uranium. As high-grade ores become scarcer, there may be a greater incentive in the future to turn to such low grade materials.
>
> Since such operations should be covered by any regulatory regime over mill tailings, the Commission would suggest that the definition of byproduct material in H.R. 13382 be revised to include tailings produced by extraction of uranium or thorium from any ore processed primarily for its source material content.

Uranium Mill Tailings Radiation Control Act of 1978, Hearings on H.R. 11698, H.R. 12229, H.R. 12938, H.R. 12535, H.R. 13049 and H.R. 13650, Subcomm. On Energy and Power, House Comm. On Interstate and Foreign Commerce, 95th Cong. (hereinafter "*Uranium Mill Tailings Radiation Hearings*") at 343-44.

[4] It is worth noting that when it created the remediation program in Title I, Congress recognized that the government had a special responsibility for these sites because they had been used to process uranium for the Manhattan Engineering District and Atomic Energy Commission in support of the nation's early nuclear program. *See, e.g.*, *Uranium Mill Tailings Radiation Hearings* at 238 ("the sites [covered by Title I] are locations where uranium ore

Footnote continued on next page

defined 11e.(2) byproduct material as the cornerstone of the Title II program, it also defined a new class of material – "residual radioactive material" – as the cornerstone of the Title I program. Specifically, Congress defined "residual radioactive material" to mean:

> (A) waste (which the Secretary [of DOE] determines to be radioactive) in the form of tailings resulting from the processing of ores for the extraction of uranium and other valuable constituents of the ores; and
>
> (B) other waste (which the Secretary [of DOE] determines to be radioactive) at a processing site which relate to such processing, including any residual stock of unprocessed ores or low-grade materials

42 U.S.C. § 7911(7). Thus, the term "residual radioactive materials" used in Title I of UMTRCA *encompasses* materials that constitute 11e.(2) byproduct material. Congress simply defined residual radioactive material more broadly to sweep in a wider range of wastes that might be found at abandoned milling sites and vicinity properties. (Indeed, recent amendments to UMTRCA implicitly recognize that 11e.(2) byproduct material and residual radioactive material are essentially equivalent, by providing for the *direct disposal* of residual radioactive material from Title I sites at licensed Title II facilities. *See* 42 U.S.C. § 7918(a)(1)[5].)

Thus, Congress created in UMTRCA an integrated two-part scheme for comprehensively regulating uranium mill tailings and related wastes – both from past activities at inactive, abandoned sites and from ongoing activities at active sites. Under this statutory scheme DOE was given primary responsibility for administering Title I, while NRC was given primary responsibility for administering Title II. However, Congress' overriding aim in enacting UMTRCA was to ensure that tailings and wastes from the processing of ore for its source material content – whether already existing or yet to be generated -- would be adequately regulated by either NRC or DOE in a manner that would provide definitive protection of public

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has been processed to produce uranium to sell to the government for national defense"); *Id.* at 241-243 ("These tailings [at Title I sites] . . . were produced primarily as a result of the Federal Government's Manhattan Engineering District and Atomic Energy Commission programs from the early 1940's through the early 1970's. . . . Given these circumstances, the GAO believes that the Federal Government has a strong moral responsibility to at least assist in cleaning up the abandoned tailings. Further, it is probably the only organization with the ability to carry out such a cleanup on a comprehensive basis.")

[5] Similarly, the mill tailings and related wastes present at FUSRAP sites essentially identical to the residual radioactive materials found at Title I sites. However, a given site containing tailings and related wastes would have been addressed under the FUSRAP program rather than the Title I program typically either because there was a responsible party associated with the site (i.e., the site was not abandoned and therefore would not have been a likely candidate for inclusion within the Title I program) or because the site was owned or controlled by the government (since sites owned or controlled by the federal government are expressly excluded from the Title I program, *see* 42 U.S.C. § 7911(6)).

health and the environment. *See* 42 U.S.C. § 7901; *see also* H. Rep. No. 95-1480 at 13 (explaining that the Act was intended to address both unregulated and unremediated tailings as well as to clarify NRC's jurisdiction to regulate the management and disposal of mill tailings at active sites).

The position expressed in the Fonner Letter is consistent with Congress' intent to ensure that uranium mill tailings are adequately regulated by either DOE or NRC, at least with respect to the Fonner Letter's treatment of materials that are present *on-site* at FUSRAP sites. The Fonner letter states that such materials are not subject to NRC jurisdiction "*at the [FUSRAP] sites*" because the materials were not generated under NRC license and therefore NRC has no basis for asserting jurisdiction over them. This result makes sense and is consistent with Congress' intent as expressed in UMTRCA, because so long as the materials remain at a FUSRAP site, they are subject to DOE jurisdiction and control. However, the fact that material present at the FUSRAP site is not subject to NRC's licensing jurisdiction does not preclude that material from qualifying as 11e.(2) byproduct material, so long as the material fits within the definition of 11e.(2) byproduct material. During the time that such material is present on-site at a FUSRAP site it is 11e.(2) byproduct material that is subject to DOE title and jurisdiction. Once that material is *moved* from a FUSRAP site and enters an NRC-licensed uranium recovery facility, *NRC obtains jurisdiction over the material* and the material becomes 11e.(2) byproduct material *subject to NRC regulatory control.*

This approach comports with Congress' intent in UMTRCA by ensuring that either NRC or DOE retains regulatory jurisdiction over uranium mill tailings. In addition, this approach is consistent with the way in which the FUSRAP program has in fact been administered. For example, in a letter from USACE to NRC's Office of General Counsel dated June 16, 1998 (hereinafter the "USACE letter"), USACE concluded, based on historical and site characterization information, that material at a particular FUSRAP site meets the definition of 11e.2 byproduct material.[6] However, USACE recognized that since this material was not processed after passage of the UMTRCA and was not generated pursuant to an NRC license, the material *at the FUSRAP site* is not subject to licensing by the NRC. In addition, USACE went on to note that when the material is moved from the FUSRAP site, any facility receiving the material would have to possess all "legally applicable licenses, permits, or approvals from all regulators with jurisdiction over their operations, including the proposed handling of the materials." In other words, the material, once transferred to an NRC-licensed uranium recovery facility, would be 11e.(2) byproduct material subject to regulation by NRC.

Not only is the approach outlined above consistent with Congressional intent and with the manner in which the FUSRAP program has been administered; it is also consistent with the way in which NRC has implemented UMTRCA in other contexts. For example, NRC does not ordinarily exercise jurisdiction over mining activities, nor does the Commission ordinarily exercise jurisdiction over ore containing licensable quantities of source material produced as a

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[6] Letter from Lt. Colonel Michael J. Conrad, U.S. Army to Office of Counsel, U.S. NRC Waste Management Section (June 16, 1998).

result of such activities, either at the mine site or in transit to a uranium mill. However, NRC has taken the position that ore containing source material, that was not previously regulated by NRC, once it is transferred to a licensed uranium mill becomes subject to NRC regulation. The Commission explained this position in its Final Generic Environmental Impact Statement on Uranium Milling:

> Comment: The proposed [UMTRCA] regulations should not address ore pads because no uranium milling or ore processing to create source material takes place until ore enters the mill and is processed . . .
>
> Response: . . . Section 84 [of the AEA] states in part that "the Commission shall ensure that the management of any byproduct material , as defined in section 11e.(2) is carried out in such a manner as . . . the Commission deems appropriate to protect the public health and safety and the environment from radiological and nonradiological hazards associated with the processing and with the possession and transfer of such material . . .". The storage of ore on an ore pad prior to milling clearly constitutes an activity associated with processing. Under the language of new Section 84, therefore, it is within NRC's authority to regulate ore pad activities.

U.S. NRC Final Generic Environmental Impact Statement on Uranium Milling, NUREG-0706 (September 1980), vol. II at A-89.[7] Thus, as with the case of material at a FUSRAP site that qualifies as 11e.(2) byproduct material, once the ore containing source material is transferred to an NRC-licensed uranium mill it becomes subject to NRC jurisdiction; prior to being moved to a licensed facility it is not subject to the Commission's jurisdiction.

Finally, to the extent that DOE has determined that materials at FUSRAP sites fit within the definition of 11e.(2) byproduct material, that determination should be entitled to deference. UMTRCA grants DOE the authority to determine whether materials qualify as "residual radioactive materials" subject to regulation under Title I. As discussed above, the term "residual radioactive materials" encompasses materials that meet the definition of 11e.(2) byproduct material. Since DOE is granted the authority under UMTRCA to determine whether materials constitute "residual radioactive material," DOE's determination that a material qualifies as a particular subcategory of residual radioactive material (i.e., 11e.(2) byproduct material) should be entitled to deference.

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[7] Similarly, NRC does not have jurisdiction over materials present at Title I sites being administered by DOE; however, once remediation at a Title I site is completed, NRC assumes jurisdiction over the site, and the materials present on site become subject to NRC's licensing authority.

Moreover, as a practical and policy matter, there are sound reasons why NRC should defer to a DOE determination that material at a FUSRAP is 11e.(2) byproduct material. First, when DOE makes the determination that a FUSRAP material constitutes 11e.(2) byproduct material it is fully cognizant of the fact that, if that material is ultimately disposed of in an NRC-licensed 11e.(2) impoundment DOE will eventually have to take custody of the material (and the site used for its disposal). *See* 42 U.S.C. 2113. In other words, DOE makes such a characterization "with its eyes open" and as a co-equal regulatory authority under UMTRCA. One implication of this is that if a FUSRAP material designated as 11e.(2) byproduct material by DOE were to be processed as an alternate feed material in an NRC-licensed uranium mill, *NRC could be assured that processing the material and disposing of the resulting tailings and wastes in the mill's tailings impoundment would not jeopardize transfer of title and custody of the mill tailings impoundment to DOE following site closure* (a key concern underlying the Alternate Feed Policy[8]), since DOE will have already determined that the material qualifies as 11e.(2) byproduct material. Thus, there are sound practical reasons why the approach outlined above makes sense.

Conversely, the practical implications of NRC refusing to recognize that FUSRAP materials may constitute 11e.(2) byproduct material are severe. For example, there are a number of NRC-licensed 11e.(2) facilities that have accepted for disposal (and have disposed of) FUSRAP materials that were characterized by DOE as being 11e.(2) byproduct material. If NRC now takes the position that FUSRAP materials cannot be 11e.(2) byproduct material, the Commission will have violated its Non-11e.(2) Policy by allowing these materials to be disposed of in a licensed 11e.(2) facility without first ensuring that the nine criteria set out in the Non-11e.(2) Policy were satisfied.[9] Similarly, if NRC takes the position that these materials cannot be 11e.(2) byproduct material, some might attempt to argue that 11e.(2) licensees who have already accepted such materials for disposal (and disposed of the material) have violated the terms of their licenses. Finally, by refusing to recognize that FUSRAP materials may constitute 11e.(2) byproduct material NRC threatens to "orphan" a substantial amount of mill tailings and related wastes currently in DOE inventory that DOE has designated as 11e.(2) byproduct material. This

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[8] *See* 57 Fed. Reg. 20,525, 20,531 (May 13, 1992).

[9] Indeed, the inconsistency of NRC taking such a position (i.e., asserting that FUSRAP material cannot be 11e.(2) byproduct material) is evident from comments made by NRC when it was developing its Non-11e(2) and Alternate Feed Policies. Then, the Commission explicitly acknowledged that some materials at FUSRAP sites constitute 11e.(2) byproduct material. Thus, in the preamble to Federal Register notice publishing the proposed policies, NRC states with respect to FUSRAP sites that:

> Government contracts were issued for thorium source material used in the Manhattan Engineering District and early Atomic Energy Commission programs. Wastes resulting from that processing and disposal at these [FUSRAP] sites *would qualify as 11e.(2) byproduct material.*

57 Fed. Reg. at 20,527 (May 13, 1992). It would be a stunning reversal of position for NRC to now assert that FUSRAP materials cannot qualify as 11e.(2) byproduct material simply because the were not produced pursuant to an NRC-licensed activity or were produced prior to the enactment of UMTRCA.

is precisely what Congress intended *not* to happen when it enacted UMTRCA, as the *Kerr McGee* court pointedly noted.[10]

III. CONCLUSION

The position articulated in the Fonner Letter is a reasonable one – at least as it applies to materials present on-site at FUSRAP sites. NRC does not have jurisdiction over materials present at FUSRAP sites, even if those materials meet the definition of 11e.(2) byproduct material, since the materials were not generated as part of an NRC-licensed activity. While at a FUSRAP site, the materials are 11e.(2) byproduct material subject to DOE regulatory jurisdiction and control. However, when such 11e.(2) byproduct material is transferred to an NRC-licensed uranium mill, is becomes subject to NRC regulatory jurisdiction and control. This approach to jurisdiction comports with Congressional intent, is consistent with the manner in which the FUSRAP program and UMTRCA have been administered, and makes sense as a matter of policy and practicality.

We would welcome the opportunity to discuss this issue with you further, if you think that would be helpful. In any event, if you have any questions regarding this memorandum please feel free to call us at 202-663-9198.

cc: Mitzi A. Young

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[10] *See* 903 F.2d at 7 ("NRC's interpretation recreates the regulatory gap that the UMTRCA was designed to eliminate and excludes from regulation for the protection of the public health some of the radioactive mill tailings that Congress intended to bring within the Agency's authority.")

FEB 1 4 2000

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

'00 FEB 10 P3

COMMISSIONERS.

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Greta Joy Dicus
Nils J. Diaz
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Jeffrey S. Merrifield

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In the Matter of INTERNATIONAL URANIUM (USA) CORPORATION (Request for Materials License Amendment)	Docket No. 40-8681-MLA-4

CLI-00-01

MEMORANDUM AND ORDER

I. Introduction

In this decision we review a Presiding Officer's Initial Decision, LBP-99-5, 49 NRC 107 (1999), which upheld a license amendment issued to the International Uranium (USA) Corporation ("IUSA"). The license amendment authorized IUSA to receive, process, and dispose of particular alternate feed material from Tonawanda, New York. The state of Utah challenges the license amendment and now on appeal seeks reversal of the Presiding Officer's decision. Envirocare of Utah, Inc., has filed an amicus curiae brief supporting Utah's challenge of the Presiding Officer's decision. The NRC staff and IUSA support the Presiding Officer's decision. We affirm the decision for the reasons we give below.

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II. Background

IUSA owns and operates a uranium mill located at White Mesa, near Blanding, Utah. On May 8, 1998, IUSA submitted a request for a license amendment to allow it to receive and process approximately 25,000 dry tons of uranium-bearing material from the Ashland 2 Formerly Utilized Sites Remedial Action Program (FUSRAP) site, currently managed by the Army Corps of Engineers and located near Tonawanda, New York.[1] The NRC granted the IUSA license amendment on June 23, 1998. Utah timely petitioned for leave to intervene in the license amendment proceeding. On September 1, 1998, the Presiding Officer admitted Utah as a party to the proceeding. See International Uranium (USA) Corporation (Receipt of Material from Tonawanda, New York), LBP-98-21, 48 NRC 137 (1998).

At issue in this proceeding is the Atomic Energy Act's definition of 11e.(2) material, defined by the statute as "the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content." 42 U.S.C. § 2014e (emphasis added). Utah interprets this to mean that the primary purpose for acquiring the ore must be an interest in processing the material to recover the uranium. Emphasizing that IUSA is being paid over four million dollars to receive the Ashland 2 material from the FUSRAP site, Utah argues that IUSA's interest in obtaining the material is "primarily for payment of a disposal fee" and not for recovering any uranium the material might contain. Utah's Appeal Brief (May 24, 1999) at 11.

Utah explains that the fee IUSA will receive for this transaction far exceeds the monetary value of the uranium which might be extracted from the material. Utah accordingly suggests that

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[1] IUSA made a similar request to receive, process, and dispose of uranium-bearing material from the nearby Ashland 1 and Seaway Area D FUSRAP sites. That license amendment is the subject of a separate NRC adjudicatory proceeding (Docket No. 40-8681-MLA-5) currently held in abeyance pending the outcome of this appeal.

the "primary" reason IUSA is <u>processing</u> the material is so that it can be reci material and then disposed of at the IUSA mill site. <u>See id</u>. at 10

In short, Utah argues that the NRC staff improperly granted this licen because IUSA is not processing the Ashland 2 material "primarily" to recover minimal uranium content, but rather to obtain the generous handling and dis emphasizes that IUSA's license amendment application failed to adequately the material was to be "processed primarily" for its uranium content. Utah in objective documentation" to show that recovery of the uranium, not payment IUSA's primary interest behind the license amendment. <u>See</u> Utah's Reply t IUSA's Briefs (June 28, 1999)("Utah's Reply Brief") at 10. Given the "wide c the fee IUSA will receive for taking and processing the material and the prot of the uranium that can be recovered, Utah claims that the "only reasonable drawn is that the "primary purpose of applying for the license amendment w million dollar disposal fee." <u>Id.</u> at 9-11.

In interpreting what is meant by § 11e.(2)'s requirement that ore be for its source material content," Utah relies heavily upon language in the NF Guidance on the Use of Uranium Mill Feed Material Other Than Natural Ores, 49,296 (Sept. 22, 1995)("Alternate Feed Guidance"). The Alternate Feed Gui licensees to "certify" that the feed material will be "processed primarily for the uranium and for no other purpose." <u>Id.</u> at 49,297. The Guidance goes on t possible ways a licensee can "justify" this certification that feed material is t source material. The three possible factors a licensee can cite are "financi high uranium feed content of the feed material, or other grounds." <u>Id</u>. Thro proceeding, the parties sharply have disputed the meaning of these and other statements in the Alternate Feed Guidance.

Utah, for instance, argues that the Guidance included a "Certification and Justification" test expressly to prohibit licensees from "using a uranium mill to process material for the primary purpose of . [reclassifying] the material to allow it to be disposed of in the mill tailings impoundment." See Utah's Appeal Brief at 10,12. Utah claims that processing material merely for the sake of reclassifying it as 11e.(2) material is "sham processing," and that the wastes or mill tailings generated from such "sham processing" do not meet the definition of 11e.(2) byproduct material See id. at 10-11. Utah concludes that IUSA "failed to justify and document under the Alternate Feed Guidance any satisfactory or plausible grounds to show that [IUSA] was not engaged in sham processing." Id. at 11.

In LBP-99-5, the Presiding Officer rejected Utah's arguments. "[O]re is processed primarily for its source material content," stated the Presiding Officer, "when the extraction of source material is the principal reason for *processing* the ore," regardless of any other reason behind the licensee's interest in acquiring the material or seeking the overall transaction. See 49 NRC at 109.

On the other hand, the Presiding Officer went on to explain, "[i]f ... the material were processed primarily to remove some other substances (vanadium, titanium, coal, etc.) and the extraction of uranium was incidental, then the processing would not fall within the statutory test and it would not be byproduct material within the meaning of the Atomic Energy Act. That is, the adverb 'primarily,' applies to what is removed from the material by the process and not to the motivation for undertaking the process." Id. (emphasis added). In the Presiding Officer's view, "the only 'sham' that stops material from being byproduct material is if it is not actually milled. If it is milled, then it is not a sham." Id. at 111 n.6.

The Presiding Officer found this interpretation of § 11e (2) consistent with the language and legislative history of the Uranium Mill Tailings Radiation Control Act of 1978, as amended (UMTRCA). He went on to conclude that the staff appropriately granted the license amendment because IUSA "is milling ore" to extract uranium and therefore is "not involved in a sham." See id. at 113. The Presiding Officer also found that Utah had misunderstood the NRC Alternate Feed Guidance. He rejected Utah's claim that the Guidance was intended to prevent material from being categorized as 11e (2) byproduct material if the licensee's primary economic motive was to receive a fee for waste disposal instead of to recover the uranium. Id. at 112. "The Alternate Feed Guidance," the Presiding Officer stated, "is not supportive of the position, taken by the State of Utah, that material is to be considered byproduct only if the primary economic motivation is to remove uranium rather than to dispose of waste." Id. Under LBP-99-5, then, the licensee's underlying motive or purpose for acquiring the material in the first place is irrelevant. What matters is that the material actually is processed through the mill to recover source material.

Both the NRC staff and IUSA endorse the Presiding Officer's conclusions. The staff explains that "the Presiding Officer properly applied the [alternate feed] guidance by focusing on whether the processing was primarily to extract uranium," regardless of any economic motivations involved. See NRC Staff Opposition to Utah Appeal of LBP-99-5 ("Staff Brief")(June 14, 1999) at 13 (emphasis added). The staff also stresses that "[n]either a high uranium content nor economic profitability is 'required' under the guidance," which provides three separate and alternative reasons a licensee can describe to support a proposed license amendment, including any number of reasons which might fall within the category of "other grounds." See id. Indeed, the staff argues, the definition of § 11e (2) byproduct material should be broad enough to encompass those fuel cycle activities involving the processing of even low grade -- with relatively low concentration of uranium -- feedstock Id at 15. "Utah's attempt to require an economic motive test and to require detailed financial review should be rejected," the staff urges. Id

Focusing upon UMTRCA's legislative history, IUSA similarly concludes that at issue is simply whether the tailings and wastes were "produced as part of the nuclear fuel cycle." See IUSA's Reply to Utah's Appeal Brief and Envirocare's Amicus Curiae Brief ("IUSA Brief")(June 14, 1999) at 9-10 According to IUSA, those tailings and waste from feeds processed to recover uranium outside of the nuclear fuel cycle, as in a secondary or side-stream process at a phosphate recovery operation, would not be 11e (2) material because the actual processing was not [intended] primarily for the source material content. Id. But where there is a licensed uranium mill involved, "the *only* question to be answered," argues IUSA, "is whether it is reasonable to expect that the ore will, *in fact*, be processed for the extraction of uranium." Id at 15

While not adopting the Presiding Officer's reasoning in its entirety, the Commission affirms LBP-99-5, for the reasons given below

III. Analysis

To clear away a threshold matter, we must briefly consider the NRC staff's claim that the Ashland 2 material already was § 11e.(2) byproduct material, even before it was sent to IUSA and even before it was processed. See Staff Brief at 8 n.11; 14 n.18; 15 n.19. The staff's theory derives from the Department of Energy's certification that the Ashland 2 material was the residue of a Manhattan Project uranium extraction project, and therefore constituted "tailings or waste produced by the extraction ... of uranium ... from ... ore processed primarily for its source material content" within the meaning of section 11e.(2). We find it unnecessary to reach the staff argument. Historically, the NRC has maintained that it lacks regulatory authority over uranium-bearing material, like the Ashland 2 material, generated at facilities not licensed on or after 1978 (when UMTRCA was passed). See United States Army Corps of Engineers, DD-99-7, 49 NRC 299, 307-08 (1999). Nothing in this opinion addresses the pre-1978 question or should be understood to do so. Instead, our opinion rests solely on section 11e.(2)'s "processed primarily for its source material content" clause.

On appeal, Utah finds the Presiding Officer's "first error" to have been that of having "resort[ed] to interpretation of the AEA and the legislative history of UMTRCA in searching for the meaning of 'primarily processed for.'" See Utah Appeal Brief at 11-12. Instead, Utah argues the Presiding Officer should have focused only upon the NRC's Alternate Feed Guidance to discern how the § 11e.(2) definition is to be applied and met. Id. at 12. The Commission, however, agrees with the Presiding Officer that the § 11e.(2) definition, with its requirement that material be "primarily processed for its source material content," can only be properly understood within the context of UMTRCA and its legislative history.

Based on an in-depth review of UMTRCA and its legislative history, and of the Alternate Feed Guidance and its background documents, the Commission reaches several conclusions. To begin with, the Guidance does appear to contemplate an NRC staff inquiry into a licensee's motives for a license amendment, just as Utah suggests. The Guidance, for instance, expresses a "concern that wastes that would have to be disposed of as radioactive or mixed waste would be proposed for processing at a uranium mill primarily to be able to dispose of it in the tailings pile as 11e.(2) byproduct material." 60 Fed. Reg. 49,296, 49,297 (Sept. 22, 1995). The Guidance thus outlines possible "justifications" that a licensee may describe in support of the license application, and these are intended to assist the staff "[i]n determining whether the proposed processing is primarily for the source material content or for the disposal of waste." Id.

Indeed, the requirement of a licensee "justification" apparently stemmed from a 1993 Presiding Officer decision which questioned, in another proceeding, whether a simple licensee "certification, without more, would adequately protect against ulterior motives to dispose of waste." See UMETCO Minerals Corp., LBP-93-7, 37 NRC 267, 283 (1993)(emphasis added).

Such statements do not support the NRC staff's current view that under the Guidance all that matters is that processing for uranium was intended, regardless of underlying motive. On the contrary, the statements in both the proposed and final Guidance take as a given that processing for uranium content will take place, but also indicate that such processing should not be employed simply as a device to reclassify material to enable it to be disposed of -- as 11e.(2) byproduct material -- at a uranium mill site.[2] As Utah has maintained, therefore, the Alternate Feed Guidance certainly can be understood -- and is perhaps best understood -- as reflecting an intent to prevent material from being categorized as 11e.(2) byproduct material when the licensee's overriding economic motive is to receive a fee for waste disposal.

Yet, although the drafters of the Guidance apparently intended to distinguish between those license amendment requests where the licensee's overriding interest is obtaining uranium and those where payment for disposal is driving the transaction, the NRC staff apparently has not consistently utilized the Guidance in this way. While the language of the Guidance may suggest that a licensee's motivations are to be scrutinized, parsed, and weighed, the NRC staff

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[2] In fact, when the Guidance was first proposed, there was a description of how owners of low-level or mixed waste, facing the high costs of disposal, might find it "very attractive" to "pay a mill operator substantially less to process [the material] for its uranium content and dispose of the resulting 11e.(2) material," rather than to pay for disposal at a low-level or mixed waste facility. See "Uranium Mill Facilities, Request for Public Comments on Guidance on the Use of Uranium Mill Feed Materials Other Than Natural Ores," 57 Fed. Reg. 20,525, 20,533 (May 13, 1992)("Proposed Guidance"). The Proposed Guidance labeled such transactions "sham disposals," and implied they "would not meet the definition of 11e.(2) byproduct material." Id. at 20,533.

typically has not relied upon such probing reviews of licensee motives. It has not been the staff's practice, for example, to require licensees essentially to "prove" quantitatively or otherwise that the value of the uranium to be recovered from a particular licensing action will outweigh other economic reasons for the transaction. See, e.g., UMETCO, 37 NRC at 274, 281-82; Staff Brief at 15-16. Since the Guidance was first issued, it seems, there has been little connection between what the Guidance seemingly proposes and what the staff in reality has required.

This fact has prompted the Commission on this appeal to take an in-depth look at the Guidance and its policy ramifications. We find that the apparent intent in the Guidance to have the staff scrutinize the motives behind the license amendment transaction is neither compelled by the statutory language or history of UMTRCA nor reflects sound policy. Our review of UMTRCA and its legislative history confirms the Presiding Officer's conclusion that the requirement that material be "processed primarily for its source material content" most logically refers to the actual act of processing for uranium or thorium within the course of the nuclear fuel cycle, and does not bear upon any other underlying or "hidden" issues that might be driving the overall transaction.

As we describe in further detail below, the purposes behind the wording of § 11e.(2)'s definition served: (1) to expand the types of materials that properly could be classified as byproduct material; (2) to make clear that even feedstock containing less than 0.05% source material could qualify as byproduct material; and (3) to assure that the NRC's jurisdiction did not cross over into activities unrelated to the nuclear fuel cycle. The IUSA license amendment is consistent with these statutory intentions, regardless of whether IUSA's bigger interest was payment for taking the material or payment for the recovered uranium. Indeed, even accepting Utah's claim that the four million dollar payment IUSA contracted to receive for processing and disposing of the Ashland 2 FUSRAP site material was the primary motivator for this transaction, the tailings generated from the processing can still properly be classified as § 11e (2) byproduct material

UMTRCA's Purposes and History

It may be helpful to outline a little of UMTRCA's legislative history and, in particular, how the § 11e.(2) definition came about. UMTRCA had two general goals: (1) providing a remedial-action program to stabilize and control mill tailings at various identified inactive mill sites, and (2) assuring the adequate regulation of mill tailings at active mill sites, both during processing and after operations ceased. As then Chairman Hendrie of the NRC explained to Congress, the agency at the time did not have direct regulatory control over uranium mill tailings The tailings themselves were not source material and did not fall into any other category of NRC licensable material The NRC exercised some control over tailings, but only indirectly as part of the Commission's licensing of ongoing milling operations. Once operations ceased, however, the NRC had no further jurisdiction over tailings. This resulted in dozens of abandoned or "orphaned" mill tailings piles

To prevent future abandoned and unregulated tailings piles, Congress enacted the 11e.(2) definition, which expressly declared mill tailings to be a form of byproduct material. As Chairman Hendrie explained, tailings are "fairly regarded as waste materials from the milling operation," but the proposed definition would classify them as byproduct material and thus make them licensable under the AEA. Under the new § 11e.(2) definition, Chairman Hendrie emphasized, tailings generated during uranium milling operations would "formally be byproducts rather than waste." Uranium Mill Tailings Radiation Control Act of 1978, Hearings on H.R. 11698, H.R. 12229, H.R. 12938, H.R. 12535, H.R. 13049, and H.R. 13650, (hereinafter

"UMTRCA Hearings I") Subcomm. On Energy & Power, House Comm. On Interstate & Foreign Commerce, 95th Cong. 2nd Sess. at 400 (1978)(statement of Joseph M. Hendrie, Chairman, NRC).

At the time Congress drafted UMTRCA, the Environmental Protection Agency had some authority over uranium mill tailings under the Resource Conservation and Recovery Act of 1976 (RCRA), but EPA had no authority over the milling process which generated the tailings. By defining mill tailings as a byproduct material, the new 11e.(2) definition removed mill tailings from RCRA's coverage since RCRA excludes all source, byproduct, and special nuclear material. This exclusion from RCRA was intended to minimize any "dual regulation" of tailings by both EPA and the NRC. Chairman Hendrie suggested that since the NRC already regulated the site-specific details of uranium milling, it seemed logical for the NRC to regulate the treatment and disposal of tailings "which we permitted to be generated in the first place." Id. at 342-43.

From the legislative history, we can glean a few conclusions about the actual wording of the 11e.(2) definition. As originally proposed, the definition of 11e.(2) byproduct material was directly linked to the Commission's definition of source material. The original definition referred to "the naturally occurring daughters of uranium and thorium found in the tailings or wastes produced by the extraction or concentration of uranium or thorium from source material as defined in [then] Section 11z.(2)." But Chairman Hendrie was concerned that a definition of byproduct material that was linked to that of source material would exclude ores containing 0.05% or less of uranium or thorium.[3] He proposed that the language be revised to "from any

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[3] "Source material" has been defined by the Commission to exclude ores containing less than 0.05% of uranium or thorium. 10 C.F.R. § 40.4.

ore processed primarily for its source material content." His discussion with Congressman Dingell went as follows.

> Mr. Hendrie: The Commission is informed that there are a few mills currently using feedstock of less than 0.05 percent uranium. As high grade ores become scarcer, there may be a greater incentive in the future to turn to such low grade materials.
>
> Since such operations should be covered by any regulatory regime over mill tailings, the Commission would suggest that the definition of byproduct material in H.R. 13382 be revised to include tailings produced by extraction of uranium or thorium from any ore processed primarily for its source material content.
>
> Mr. Dingell. I am curious why you include in that the word "processed" primarily for source material content. There are other ores that are being processed that do contain thorium and uranium in amounts and I assume equal in value to those you are discussing here. Is there any reason why we ought not to give you the same authority with regard to those ores?
>
> Mr. Hendrie: The intent of the language is to keep NRC's regulatory authority primarily in the field of the nuclear fuel cycle. Not to extend this out into such things as phosphate mining and perhaps even limestone mining which are operations that do disturb the radium-bearing crust of the Earth and produce some exposures but those other activities are not connected with the nuclear fuel cycle.

UMTRCA Hearings I at 343-44.

There were, therefore, two principal intentions behind Chairman Hendrie's proposed language, which Congress accepted. First, the 11e.(2) definition was intended to reach even "low grade" feedstock with less than a 0.05% concentration of uranium. Second, the definition was intended to make sure that the NRC's jurisdiction did not expand into areas not traditionally part of the NRC's control over the "nuclear fuel cycle." The definition therefore "focuses upon uranium milling wastes" and not, for example, upon the wastes from phosphate ore processing which are also contaminated with small quantities of radioactive elements. Id. at 354 ("Section by Section Analysis of H.R. 13382 As Revised by NRC Recommended Language Changes").

Similarly, 11e (2) material was not to encompass uranium mining wastes because, as Chairman Hendrie explained, "[w]e don't regulate mines The mining is regulated by the Department of Labor under other regulations so our definition was drawn to maintain that and to keep us out of the mine-regulating business." Id. at 401.

We find, then, that the § 11e.(2) definition focused upon whether the process generating the wastes was uranium milling within the course of the nuclear fuel cycle. As Chairman Hendrie made clear, the concentration of the uranium or thorium in the feedstock was not a determinative factor in whether the resulting tailings should be considered 11e.(2) material. The focus was not on the value of the extracted uranium but on the activity involved.

In short, the § 11e.(2) definition focuses upon the process that generated the radioactive wastes -- the removal of uranium or thorium as part of the nuclear fuel cycle. See Kerr-McGee Chemical Corp. v. NRC, 903 F.2d 1, 7 (D.C. Cir. 1990). But UMTRCA does not require that the market value of the uranium recovered be the licensee's predominant interest, and thus UMTRCA does not require the NRC to assure that no other incentives lie behind the licensee's interest in processing material for uranium. There simply is no reason under UMTRCA why licensees cannot have several motives for a transaction.[4] That IUSA's primary goal here may

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[4] See also, e.g. Kerr-McGee, 903 F.2d at 7 (where the court suggested that the word "primarily" in the § 11e.(2) definition could be read to mean "substantially," and thus the tailings from the coproduction of source material and rare earths could still be deemed 11e.(2) byproduct material so long as one of the reasons for processing the ore was for extracting source material). The court's reasoning in Kerr-McGee is consistent with the UMTRCA history, which reflects that it has long been the case, for instance, that both vanadium and uranium might be extracted during a processing of material, and indeed that the amount of recoverable vanadium may very likely be much greater than that of the recoverable uranium. See, e.g., UMTRCA Hearings I at 155 (where private company reprocessing material was extracting 2 ½ pounds of vanadium for every ½ pound of uranium extracted); see also UMTRCA Hearings III at 136 ("We recover ... about 1,000 pounds a day of uranium, about 4,000 pounds of vanadium"). There was never any suggestion in the legislative history that if the amount or value of the vanadium proved higher than that of the uranium, the tailings could not be categorized as 11e.(2) byproduct material.

have been the four million dollar payment for disposal instead of potential profit from any recoverable uranium, does not in and of itself prevent the tailings generated from the milling process from falling within the § 11e (2) definition. Moreover, as we touch upon further below, making such purely economic considerations a determinative part of the staff's review would unnecessarily divert agency resources to issues unrelated to public health and safety.

The Need for Revising the Guidance

In this litigation, Utah and the other parties focused not upon UMTRCA and its legislative history, but upon the NRC's Alternative Feed Guidance. The Commission, however, is not bound by the Guidance. Like NRC NUREGS and Regulatory Guides, NRC Guidance documents are routine agency policy pronouncements that do not carry the binding effect of regulations. See, e.g., Curators of the University of Missouri, CLI-95-1, 41 NRC 71, 149 (1995), International Uranium (USA) Corp. (White Mesa Uranium Mill), LBP-97-12, 46 NRC 1, 2 (1997)(referring specifically to final Alternate Feed Guidance as "non-binding Staff guidance") Such guidance documents merely constitute NRC staff advice on one or more possible methods licensees may use to meet particular regulatory requirements. See, e.g., The Curators of the University of Missouri, CLI-95-1, 41 NRC 71, 150 & n.121 (1995); Petition for Emergency and Remedial Action, CLI-78-6, 7 NRC 400, 406-07 (1978); Consumers Power Co. (Big Rock Point Nuclear Plant), ALAB-725, 17 NRC 562, 568 n.10 (1983); Vermont Yankee Nuclear Power Corp. (Vermont Yankee Nuclear Power Station), CLI-74-40, 8 AEC 809, 811 (1974). These guides, however, do not themselves have the force of regulations for they do not impose any additional legal requirements upon licensees. Licensees remain free to use other means to accomplish the same regulatory objectives. See id. "[A]gency interpretations and policies are not 'carved in stone' but rather must be subject to re-evaluations of their wisdom on a continuing basis." Kansas Gas & Elec. Co. (Wolf Creek Generating Station, Unit 1), 49 NRC 441, 460 (1999)(referencing Chevron U.S.A., Inc. v. Natural Resources Defense Council, Inc., 467 U.S. 837, 863-64).

Accordingly, it has long been an established principle of administrative law that an agency is free to choose among permissible interpretations of its governing statute, and that at times new interpretations may represent a sharp shift from prior agency views or pronouncements. Chevron, 467 U.S. at 842-43, 862 (1984). This is permissible so long as the agency gives "adequate reasons for changing course." Envirocare of Utah v. NRC, __ F.3d __ No. 98-1426 (D.C. Cir. Oct. 22, 1999), slip op. at 6. Given that: (1) the disputed portions of the Alternate Feed Guidance are not derived directly from UMTRCA or its history; (2) the Guidance apparently has not been consistently applied in the manner proposed by the State of Utah; (3) the precise terms of the Guidance are not entirely clear (c.f., e.g., "other grounds"); and (4) the Commission believes that literal adherence to the apparent intent of the Guidance would lead to unsound policy results, the Commission declines to follow it here and will require the NRC staff to revise it as soon as practicable.[5]

Several policy reasons support departing from the Guidance. First, the NRC's statutory mission is public health and safety. Our regulations establish comprehensive criteria for the possession and disposal of 11e.(2) byproduct material under NRC or Agreement State jurisdiction. See 10 C.F.R. Part 40, Appendix A. The criteria were designed to assure the safe

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[5] The Commission has promulgated no regulation implementing the Guidance. Thus, the Commission's rejection of the Guidance does not present a situation where the Commission has altered "suddenly and sub silentio settled interpretations of its own regulations." Natural Resources Defense Council, Inc. v. NRC, 695 F.2d 623, 625 (D.C. Cir. 1982). See generally Syncor Int'l Corp. v. Shalala, 127 F.3d 90 (D.C. Cir. 1997); Paralyzed Veterans of America v. D.C. Arena L.P., 117 F.3d 579 (1997), cert. denied, 523 U.S. 1003 (1998); United Technologies Corp. v. EPA, 821 F.2d 714 (D.C. Cir. 1987).

disposal of bulk material whose primary radiological contamination is uranium, thorium, and radium in low concentrations. But whether the concentration of uranium in the feedstock material is 058% or 008% -- the initial high and low estimates, respectively, of the Ashland 2 material based upon samples taken -- has *no* impact upon the general applicability and adequacy of the agency's health and safety standards for disposal of § 11e.(2) material. Yet, in Utah's view, whether the actual uranium concentration proved to be 058% or 008% could well dictate whether the resulting tailings appropriately could be classified as § 11e.(2) material and regulated by the NRC.

Utah's interpretation thus divides byproduct material into two different regulatory camps based solely upon market-oriented factors, *i.e.*, the expected profit from selling recovered uranium versus any other economically advantageous aspects of the license amendment. Utah emphasizes, for example, that it "has not objected to several [IUSA] alternate feed license amendment requests where the waste material contained [greater amounts] of uranium." *See* Utah's Petition for Review of LBP-99-5 (Feb. 26, 1999) at 9 n.10. From a health and safety perspective, though, there is no reason to prohibit IUSA from disposing of tailings material in its disposal cells solely on account of the feedstock having a lower uranium concentration or lower market value. *Cf. Kerr-McGee*, 903 F.2 at 7-8.

Second, the Guidance, if applied as originally intended, would cast the NRC staff into an inappropriate role, conducting potentially multi-faceted inquiries into the financial attractiveness of transactions. The staff essentially would need to look behind and verify every assertion about the economic factors motivating a proposed processing of material -- an unnecessary and wasteful use of limited agency resources, at a time when the Commission increasingly has moved away from performing economics-oriented reviews that have no direct bearing on safety and are not specifically required by Congress.[6]

In addition, the NRC seeks to regulate efficiently, imposing the least amount of burdens necessary to carry out our public health and safety mission. Yet, as this proceeding itself demonstrates, the Alternate Feed Guidance's unwieldy "Certification and Justification" test lends itself easily to protracted disputes among the NRC staff, intervenors, and the licensee over such issues as how much the licensee will "really" profit from selling recovered uranium, what the licensee's "bigger" motives may be, etc. All this effort and attention imposes burdens on the parties while detracting from our central mission – radiological safety, i.e., assuring that there are no constituents in the alternate feed material that would prevent the mill from complying with all applicable NRC health and safety regulations.

Nor is it inconceivable that eventual potential changes in the marketplace could impact whether particular material might fall within the § 11e.(2) definition one year but not the next, merely on account of some new market factor. Purely economic factors, in short, should not determine how radioactive material is defined. Whether IUSA was paid a "substantial sum," as Utah emphasizes, a nominal sum, or had to pay a sum to acquire the Ashland 2 material has no bearing on health and safety issues. Therefore, this is not appropriately the Commission's concern and also should have no bearing on whether the resulting tailings meet the statutory definition of byproduct material under § 11e.(2).

While it may be true, as Utah states, that when Congress enacted UMTRCA there was no "thought of using offsite active uranium mills to process and dispose of industrial cleanup

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[6] See, e.g., Final Rule, Environmental Review for Renewal of Nuclear Power Plant Operating Licenses, 61 Fed Reg. 28,467, 28,484 (June 5, 1996); Kansas Gas & Elec. Co. (Wolf Creek Generating Station, Unit 1), CLI-99-19, 49 NRC 441 (1999).

waste from FUSRAP sites." Utah's Reply Brief at 5, several Congressmen did express an interest in having private corporations take and reprocess materials as a means to offset the federal government's ultimate disposal costs for cleaning up UMTRCA's designated Title I sites. See, e.g., UMTRCA Hearings on H.R. 13382, H.R. 12938, H.R. 12535, and H.R. 13049 ("UMTRCA Hearings II") Subcomm. On Energy & the Environment, House Comm. On Interior & Insular Affairs (1978) at 82 (statement of Rep. Weaver)(some "companies might be interested in sharing the cost of stabilization of tailings in return for access to minerals remaining in the piles").[7] Then Chairman Hendrie voiced no objection, stating that "[i]f they want to reprocess the piling to make a complete recovery of the resource there, I think that is fine from a conservation standpoint. It also puts them back in the active business of milling." See UMTRCA Hearings II at 82.

Here, the Ashland 2 material has been approved for processing and disposal, and the resulting byproduct material will be disposed of pursuant to the same health and safety standards that apply to any other 11e.(2) material in an NRC-licensed mill: 10 C.F.R. Part 40, Appendix A. Though Utah may be dissatisfied with those standards, an adjudicatory proceeding is not the appropriate forum to contest generic NRC requirements or regulations. See, e.g., Duke Energy Corporation (Oconee Nuclear Station, Units 1, 3, and 3), CLI-99-11, 49 NRC 328, 334 (1999).

We note, additionally, that early in the proceeding Utah expressed concern that the Ashland 2 material, contrary to the NRC staff's findings, possibly contained listed hazardous

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[7] See also, e.g., UMTRCA Hearings 1 at 89-90 (written statement of Rep. Johnson), Hearings On S.3008, S.3078, and S.3253 ("UMTRCA Hearings III") Subcomm. On Energy Prod & Supply, Senate Comm. On Energy & Natural Resources (1978) at 59 (statement of Sen. Haskell)(if private companies reprocessed some of the tailings, that would be regulated under the NRC's regulations).

waste. But while the accuracy of the license application can appropriately be the subject of an adjudication, notwithstanding staff findings, here subsequent events have rendered Utah's hazardous waste concern moot. Following negotiations with IUSA and, after analyzing investigations and data from the Ashland 2 site, Utah formally withdrew its allegation that the Ashland 2 material may contain listed hazardous waste. See Utah's Appeal Brief at 3 n.2. Instead, although Utah is upset that the staff's allegedly "scanty" review took only "about six weeks," its own review failed to uncover any errors in the staff's conclusion that the material contains no listed hazardous waste. Utah's remaining generalized complaint about how the staff reached its conclusion is not a litigable issue, given that Utah now concurs with the staff's conclusion and no longer alleges the presence of any listed hazardous waste.

Nevertheless, such disputes about the presence of hazardous waste are likely to recur, and the issue is a significant one, implicating three concerns: (1) possible health and safety issues, (2) the potential for an undesirable, complex NRC-EPA "dual regulation" of the same tailings impoundment, and (3) the potential for jeopardizing the ultimate transfer of the tailings pile to the U.S. government, for perpetual custody and maintenance. See generally UMTRCA, Title II, § 202 (Section 83 of the AEA). In view of our decision that the Alternate Feed Guidance requires revision to reflect our decision on the 11e.(2) definition, we will direct the staff to consider whether the Guidance also should be revised to include more definitive and objective requirements or tests to assure that listed hazardous or toxic waste is not present in the proposed feed material. We note, for example, that in a recent license amendment proceeding, the Presiding Officer declared it simply "impossible" for him to "ascertain the basis for the Staff determination that this material is not hazardous." International Uranium (USA) Corp. (White Mesa Uranium Mill), LBP-97-12, 46 NRC 1, 5 (1997). Similarly, in another earlier proceeding, the Presiding Officer found that the "Staff's new guidance for determining whether feed material is a mixed [or hazardous] waste appears confusing," and accordingly suggested there be more "specific protocols .. to determine if alternate feed materials contain hazardous components." UMETCO, 37 NRC at 280-81. The Commission concludes that this issue warrants further staff refinement and standardization.

In conclusion, applying the Commission's statutory interpretation of § 11e.(2) byproduct material, the Commission finds that the IUSA license amendment properly was issued and that the mill tailings at issue do constitute § 11e.(2) byproduct material. From the information in the record, we believe that it was reasonable for the NRC staff to have concluded that: (1) processing would take place, and (2) uranium would be recovered from the ore. Utah itself has acknowledged that "[i]n three different estimates, taken from DOE documents, the average uranium content of the material ranged from a high of 0.058% to a low of 0.008%." See Utah's Appeal Brief at 4; see also Utah's Brief in Opposition to IUSA's License Amendment (Dec. 7, 1998)("Utah's Brief in Opposition") at 8, and Attachment at 7-8. Utah's own expert estimated that up to $617,000 worth of uranium might be recovered from the Ashland 2 material. See Utah's Brief in Opposition at 8, and Attachment at 9. Utah's primary argument all along has been that the monetary value of the recovered uranium would be much lower than the 4 million dollar payment IUSA would receive, not that no source material would be recovered through processing. See, e.g., id., Attachment at 9 (where Utah's expert stressed that the value of the uranium-238 that could be extracted from the Ashland 2 material "represents a fraction (1.6 to 15 percent) of the $4,050,000 that [IUSA] will receive from Material Handling & Disposal Services fees"); Utah's Reply Brief at 11 (the "disposal fee received by [IUSA] ... is almost 60 times the value of the uranium recovery").

Not only was it reasonable to conclude that uranium could be recovered from the Ashland 2 material, but it was also reasonable to conclude that the processing would indeed take place. IUSA had a contractual commitment to do so; its contract with the Army Corps of Engineers required IUSA to process the material prior to disposal. See IUSA Brief at 18, 25 In addition, as the Presiding Officer noted, "IUSA has a history of successfully extracting uranium from alternate feed material and has developed credibility with the NRC ... for fulfilling its proposals to recover uranium from alternate feeds." 49 NRC at 112. This was not an instance, then, where there was no reasonable expectation that the mill operator would in fact process material through the mill to extract recoverable uranium. Moreover, it is also the Commission's understanding that the Ashland 2 material has in fact been processed in the IUSA mill and that approximately 8,000 pounds of uranium were extracted. While that quantity of uranium was on the low end of IUSA's estimates, it nevertheless represents more than a minute or negligible recovery of uranium.[8]

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[8] Moreover, even if we had adhered to and sought to apply the Guidance's tests for licensee "motives," the record does not show that IUSA processed the Ashland 2 material as a means to change non-11e.(2) material into § 11e.(2) material. IUSA was aware that the NRC staff had accepted a DOE certification declaring that the Ashland 2 FUSRAP material met the 11e (2) byproduct material definition. Based upon the DOE certification, the staff had concluded that "the material could be disposed of directly in the White Mesa tailings impoundments," without any need of processing at the mill. See Technical Evaluation Report at 6, attached to Amendment 6 to Source Material License Sua-1358 (June 23, 1998). The staff thus claims that "sham disposal" was not a concern "since it did not appear that the material was being processed to change its legal definition, and as such was truly being processed for its uranium content." See Staff Aff. of Joseph Holonich at 7. Whether the Ashland 2 material actually already was § 11e.(2) byproduct material under UMTRCA remains unclear. See supra at 6-7. Nevertheless, IUSA was aware that DOE, the Army Corps of Engineers, and the NRC staff all had categorized the material as such, and that the staff indeed had stated that this was material that could have been disposed of without any further processing. This suggests that IUSA had a genuine interest in processing the material for the uranium and not simply an interest in "reclassifying" the material by processing it. The subtle and complex nature of this inquiry, however, reinforces our view that discerning a licensee's motives for a license amendment transaction is a difficult, virtually impossible and, in any event, unnecessary exercise. Accordingly, our approach in this decision rejects ultimate business motivations as irrelevant to the § 11e.(2) definition.

The Commission concludes, therefore, that the Presiding Officer's interpretation of the § 11e (2) definition reflects a sensible reading of the UMTRCA statute and legislative history – one we hereby embrace – and that the record overall supports the issuance of the license amendment.

III. Conclusion

For the foregoing reasons, LBP-99-5 is affirmed.

IT IS SO ORDERED

UNITED STATES NUCLEAR REGULATORY COMMISSION

For the Commission

Annette L. Vietti-Cook
Secretary of the Commission

Dated at Rockville, Maryland,
this 10th day of February, 2000.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of)
)
INTERNATIONAL URANIUM (USA)) Docket No. 40-8681-MLA-4
CORPORATION (IUSA))
(Receipt of Material from)
Tonawanda, New York))

CERTIFICATE OF SERVICE

I hereby certify that copies of the foregoing COMMISSION MEMORANDUM AND ORDER (CLI-00-01) have been served upon the following persons by U.S. mail, first class, except as otherwise noted and in accordance with the requirements of 10 CFR Sec. 2.712.

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Docket No 40-8681-MLA-4
COMMISSION MEMORANDUM
AND ORDER (CLI-00-01)

Adria T. Byrdsong
Office of the Secretary of the Commission

Dated at Rockville, Maryland,
this 10th day of February 2000