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Buffalo District

ADDENDUM TO THE FEASIBILITY STUDY REPORT

FOR THE GROUNDWATER OPERABLE UNIT

LINDE SITE, TONAWANDA, NEW YORK

September 2005

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1. BACKGROUND AND PURPOSE

1.1 Background

Under its authority to conduct the Formerly Utilized Sites Remedial Action Program (FUSRAP), the United States Army Corps of Engineers (USACE) completed a report in October 2004 entitled, *Feasibility Study Report for the Groundwater Operable Unit, Linde Site, Tonawanda, New York* (USACE 2004). The feasibility study (FS) report was prepared to serve as a principal source for USACE Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) decision-making concerning the groundwater operable unit (OU) at the Linde FUSRAP Site in Tonawanda.

The FS report summarized historical activities undertaken at Linde under a Manhattan Engineer District (MED)/Atomic Energy Commission (AEC) contract that resulted in elevated radionuclide levels in portions of the Linde property. Elevated levels of radionuclides in Linde Site soils, buildings and structures resulting from MED/AEC activities have been or are being remediated by USACE in accordance with the *Record of Decision for the Linde Site, Tonawanda, New York* (USACE 2000) and the *Record of Decision for the Building 14 Operable Unit, Linde Site, Tonawanda, New York* (USACE 2003a).

The October 2004 FS report focuses on the MED/AEC discharges to groundwater that occurred at Linde and summarizes historical investigations of Linde groundwater and the more recent groundwater investigations by USACE. As required by CERCLA and CERCLA regulations, the National Contingency Plan (NCP), the FS report assessed Applicable or Relevant and Appropriate Requirements (ARARs) that may be pertinent to the consideration of groundwater quality at Linde and identified the groundwater standards of 40 CFR Part 192 as being relevant and appropriate to the assessment of groundwater conditions. The FS assesses the need for any groundwater remediation at Linde and concludes that remediation is not required, but envisions and evaluates, in addition to a no action alternative, a limited action alternative for groundwater involving land use controls to preclude potential uses of the groundwater.

1.2 Purpose

Following the issuance of the FS report in October 2004, USACE received a comment requesting that other non-drinkable uses of the groundwater such as irrigation for gardening, be evaluated. A further assessment of potential needs for remediation of Linde groundwater was conducted by USACE, including an evaluation of plausible exposure scenarios under which exposures to MED/AEC-related constituents in Linde groundwater might occur.

Based on the additional assessment, USACE has concluded that no completed pathways for current or future exposure to MED/AEC-related constituents in Linde groundwater exist and, therefore, the groundwater operable unit at the Linde Site poses no current or potential threat to human health or the environment. Since the groundwater operable unit poses no threat to human health or the environment both now or in the future, the consideration of ARARs or land use controls is not required and no action is warranted for Linde groundwater. This addendum to the FS report was prepared to document the findings of these additional assessments by USACE and amend the FS report to delete references to ARARs and related FS narrative that develops and assesses alternatives for Linde groundwater.

This addendum is organized as follows:

- Section 2. The additional assessments of plausible exposure scenarios and risks are documented,
- Section 3. An amended executive summary for the FS is provided,
- Section 4. FS report sections deleted or amended are identified,

2. EXPOSURE SCENARIOS

A complete exposure pathway consists of at least the following four elements: (1) a source and mechanism of contaminant release to the environment (a receiving medium); (2) an environmental transport medium for a released contaminant; (3) a point of contact with a contaminated medium (an exposure point); (4) a route of exposure (an exposure route). If any of these elements are missing, the pathway is incomplete and is not considered in an evaluation of potential threats to human health and the environment.

USACE reviewed the historical accounts of the discharge of MED/AEC-related constituents to the deep groundwater at Linde and determined that at that time (1940s) there was a release (by injection of liquid wastes) of MED/AEC contaminants to the subsurface (the groundwater) and a medium for contaminant transport (also the groundwater) existed and still exists. As described in detail in the FS report, however, physical and chemical conditions in the deep groundwater have precluded the transport of the MED/AEC-related constituents and groundwater sampling confirms that any elevated levels of MED/AEC-related contaminants are detected only in the immediate vicinity of the historical injection wells.

Based on this understanding of subsurface conditions, the potential for a human point of contact (with MED/AEC constituents in deep groundwater) and a human exposure route (to contaminants in deep groundwater) was assessed. Ingestion of drinking water and ingestion of produce irrigated with groundwater from the Site, were addressed.

2.1 Drinking Water

To use deep groundwater at Linde as a source of drinking water a deep well or wells would first be required along with appropriate pumps and ancillary equipment. Assuming that there is a sufficient yield capability in a supply well, groundwater could be available at the source of the Linde Site.

As described below, the groundwater made available would not, however, be suitable for drinking without costly treatment.

An evaluation of upgradient (background) wells at Linde indicates that without even considering wells potentially impacted by MED/AEC operations, groundwater at the Linde site is severely compromised. Results of the most recent sampling (June 2002) are provided in the table below.

Background Wells

	Chloride	Sulfate	TDS	Iron	Manganese	Aluminum	pH
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
Secondary MCL	250	250	500	0.3	.05	0.05 to 0.2	6.5-8.5
Well ID							
B29W01D	330	2400	4100	0.35	0.04	0.21	9.02
B29W07D	1700	3650	8050	1.65	0.33	1.55	8.99
B29W11D	540	2600	4700	0.43	0.07	.049	8.48

While the results above demonstrate exceedances of Secondary Maximum Contaminant Levels (SMCLs) (i.e., secondary drinking water standards)) rather than Primary MCLs, there are still very tangible impacts to using water that exceeds the secondary standards. Secondary standards were developed to address cosmetic and aesthetic effects in drinking water (such as taste, odor, tooth discoloration, staining, etc.). Waters with the concentrations demonstrated above can lead to laxative effects, scaling and/or corrosion in pipes, staining of household fixtures, and add a salty taste to water. In particular, the scaling and corrosion effects may have significant economic implications.

The sulfate concentration in seawater is about 2700 mg/L (USEPA 2003); seawater concentrations are present at the Linde site. Further, sulfate is known to cause a laxative effect in adults at concentrations above the secondary standard, particularly when combined with high total dissolved solids. Additional material is referenced below, taken from *Drinking Water Advisory: Consumer Acceptability Advice and Health Effects Analysis on Sulfate*, U.S. Environmental Protection Agency Office of Water (4304T), EPA 822-R-03-007, February 2003.

"The sulfate concentration in seawater is about 2,700 mg/L (Hitchcock 1975) and ranges from 3 to 30 mg/L in freshwater lakes (Katz 1977). Sulfate content in drinking water ranges from 0 to 1,000 mg/L in the United States (Trembaczowski 1991)."

"A health-based advisory for acute effects (absence of laxative effects) of 500 mg of sulfate/L is recommended. This value depends on the absence of other osmotically active materials in drinking water, which could lower the sulfate level associated with a laxative effect. Where the water contains high concentrations of total dissolved solids and/or other osmotically active ions, laxative-like effects may occur if the water is mixed with concentrated infant formula or a powdered nutritional supplement." The document goes on to state that adults may adapt to high sulfate concentrations within a period of two weeks, however, there is no evidence to show that infants have the same capability.

Thus, the naturally occurring concentrations of constituents in groundwater at Linde preclude its use without treatment. This is consistent with the findings of earlier reports for Linde and the Tonawanda area and the 1995 US Geological Survey (USGS) *Groundwater Atlas for the Lake Erie – Niagara River Basin* (USGS 1995).

The USEPA notes at its web site (http://www.epa.gov/safewater/consumer/2ndstandards.html) (USEPA 2005) that "Non-conventional treatments like *distillation, reverse osmosis* and *electrodialysis* are effective for removal of chloride, nitrates, total dissolved solids and other inorganic substances. However, these are fairly expensive technologies and may be impractical for smaller systems."

Removal of the background chemicals in the groundwater at the Linde Site using these methods would also remove any of the MED/AEC-related contaminants from the groundwater. Thus, the 4th element necessary for exposure (a route for human exposure) is missing because the MED/AEC contaminants would be removed in any case where drinking water was contemplated. As a practical matter, use of this water for drinking is not reasonable since treatment costs are high and a more than ample supply of fresh water exists in Tonawanda since the source of supply in this area is the Niagara River. Therefore, USACE concludes that there is no current or future completed drinking water exposure pathway for groundwater at Linde.

2.2 Irrigation Water

USACE also considered the possibility that groundwater at the Site would be used for irrigation of edible produce. As in the case of the consideration of drinking water, the potential that groundwater could be pumped to surface for irrigation exists. Because of the naturally occurring levels of salts in the groundwater, however, the continued use of this water without treatment is not reasonable. "The critical concentration [of dissolved salts] in the irrigation water depends on many factors; amounts in excess of 700 mg/liter are harmful to some plants, and more than 2000 mg/liter of dissolved salts is injurious to almost all crops." (Linsley and Franzini 1979). Continued use of saline waters for irrigation may also ultimately impact the viability of a soil to support crops and may also impact the infiltration rate of soils (Keonig and Isaman 1997).

The natural background concentrations of these constituents (salts) in groundwater at Linde would preclude continued use for irrigation without treatment. As a practical matter, use of this water for irrigation is not reasonable since treatment costs are high and a more than ample supply of fresh water exists in Tonawanda since the source of supply in this area is the Niagara River. Therefore, USACE concludes that there is no current or future completed irrigation water exposure pathway for groundwater at Linde.

3. REVISED EXECUTIVE SUMMARY

The Executive Summary in the October 2004 FS report for Linde groundwater is revised to read as follows:

EXECUTIVE SUMMARY

This executive summary provides an overview of the Feasibility Study (FS) report for the groundwater operable unit (OU) at the Linde Formerly Utilized Sites Remedial Action Program (FUSRAP) site in Tonawanda, New York. The FS report was prepared by the U.S. Army Corps of Engineers (USACE) to serve as a principal source of information for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) decision-making for the groundwater at the Linde Site. The FS report describes earlier Linde Site groundwater investigations by the U.S. Department of Energy (DOE) and groundwater investigations at Linde by USACE in 2001 and 2002. USACE has determined that there are no significant risks associated with Linde groundwater and that there is no need for groundwater remediation.

<u>BACKGROUND</u>

The Linde Site (now owned by Praxair) comprises about 135 acres located at East Park Drive and Woodward Avenue in the Town of Tonawanda. Uranium ore processing was conducted at Linde under a Manhattan Engineer District (MED)/Atomic Energy Commission (AEC) contract in the 1940's. During the uranium ore processing, portions of the property and buildings became contaminated with elevated levels of radionuclides (uranium, radium, and thorium).

Linde was designated as a FUSRAP Site in 1980, and DOE, under its FUSRAP authority at that time, initiated investigations at Linde and the other FUSRAP Sites in Tonawanda: Ashland 1, Ashland 2 and Seaway. A Remedial Investigation (RI) report, Baseline Risk Assessment (BRA), FS report and Proposed Plan (PP) were issued by DOE in 1993, addressing the Tonawanda FUSRAP sites. Following public review, DOE suspended decision-making on the Tonawanda Sites to re-evaluate potential remedial alternatives. In October 1997, responsibility for FUSRAP was transferred to USACE. In March 2000, a CERCLA Record of Decision (ROD) for the Linde Site was signed by USACE and remediation of Linde Site soils and buildings, excluding Building 14 and groundwater, was initiated in June 2000. A ROD for Linde Building 14 was issued by USACE in April 2003. As described above, the FS report for Linde groundwater will serve as a principal source of USACE decision-making on Linde groundwater.

LIQUID WASTE DISPOSAL AT LINDE

During the processing of uranium ore at Linde, liquid waste was produced. The liquids were discharged into storm sewers, sanitary sewers and into the on-site injection wells. From 1944 to 1946, approximately 55 million gallons of liquid wastes were injected under pressure into seven on-site injection wells. The injection wells ranged in depth from 90 to 150 feet and were drilled into bedrock. Approximately 12,000 pounds (lbs) of uranium oxide were discharged to the injection wells; equaling approximately 3 curies (Ci) of natural uranium. The average concentration of natural uranium in the discharge was approximately 14,400 picocuries per liter (pCi/L). An estimated 0.52 Ci of radium were also discharged with the liquid waste.

EARLIER GROUNDWATER INVESTIGATIONS AT LINDE

Groundwater sampling was conducted at Linde for DOE by Argonne National Laboratory (ANL), Oak Ridge Associated Universities (ORAU) and Ford Bacon and Davis Utah (FBDU) in 1981. In 1981, the Aerospace Corporation compiled the results of groundwater sampling at Linde and concluded that the very high natural mineral content of the groundwater at Linde makes it unacceptable as drinking water or for many other industrial or residential uses and that no significant pathway exists for groundwater exposure to the general public.

DOE also conducted additional groundwater investigations at Linde in the late 1980s – early 1990s as part of the RI of the Tonawanda Site (defined at that time to include the Ashland 1, Ashland 2, Seaway and Linde FUSRAP sites, all located in Tonawanda). In the RI report, BRA, and FS report for the Tonawanda Site, prepared in 1993, it was concluded that the high levels of naturally occurring constituents in Linde groundwater precluded its use for drinking without costly treatment and, in the BRA, it was concluded that there is no significant exposure pathway to Linde groundwater.

GROUNDWATER INVESTIGATIONS BY USACE IN 2001 and 2002

In the fall of 1997, the responsibility for FUSRAP was transferred to USACE. In March 2000, following review of prior investigations and conducting additional evaluations of site conditions, USACE issued a ROD for the Linde Site. USACE concluded that Linde groundwater presented no significant risks, but based on comments received concerning the adequacy of groundwater sampling, a decision on Linde groundwater was excluded from the ROD.

Following coordination with the U.S. Environmental Protection Agency (USEPA) and the New York State Department of Environmental Conservation (NYSDEC), USACE conducted additional groundwater investigations at Linde in 2001 and 2002.

Three deep and three shallow monitoring wells were installed as part of the 2001 field investigation and groundwater sampling of the new and existing wells was conducted in March and June 2001 and August 2002. Based on the March and June 2001 sampling results, a reduced subset of new and existing deep monitoring wells was selected for sampling in August 2002. Unfiltered samples and filtered samples were analyzed for the presence of radionuclides including radium isotopes, thorium isotopes, uranium isotopes, gross alpha radiation, gross beta radiation and total uranium. Unfiltered and filtered samples from the wells were also analyzed for the presence of target analyte list (TAL) metals. Unfiltered samples from the wells were also analyzed for general chemistry parameters. In March 2001 and August 2002, soil samples were collected for radionuclide analyses and leaching tests.

LINDE GROUNDWATER RESULTS AND CONTAMINANT FATE AND TRANSPORT

As detailed in the FS report, some elevated levels of MED/AEC- related constituents were detected in the vicinity of the former injection wells on the Site. The 1993 RI report concludes the liquid wastes containing radioactive constituents that were injected into the contact zone aquifer moved under pressure through fractures in the bedrock and into the more permeable contact zone overlying the bedrock. The RI report further concluded that because the waste was higher in temperature and had a higher pH than the natural groundwater, the radioactive constituents in the waste precipitated to form a relatively insoluble solid material within the bedrock fractures and contact zone formation. The RI report then describes the potential for transport of radioactive constituents within the bedrock fractures and contact zone as minimal due to the immobility of the constituents, the generally low permeability of the shale and the low hydraulic gradients in these formations. In summary, the RI report concludes that the radionuclides have precipitated in the groundwater and are now immobile in the vicinity of the locations where injection occurred.

The characterization data from the 1993 RI report and the results of the USACE investigations were used by USACE in geochemical modeling of soluble uranium in the deep groundwater at Linde. The modeling indicates that the soluble uranium present in injected waste could precipitate under the natural conditions in the contact zone aquifer and that the solubility of uranium under site conditions would be approximately 0.04 milligram per liter (mg/L) in the vicinity of the former injection wells or approximately 27 picocuries per liter (pCi/L). Estimates of the potential transport of uranium in the contact zone formation were also made by USACE. These estimates indicate that uranium should have been observed in groundwater at locations distant from the injection locations, since the injection occurred more than 55 years ago. Because the uranium has not been observed in groundwater samples from monitoring wells distant from the injection wells, it is concluded that the uranium has low solubility in the contact zone aquifer at Linde. This is consistent with the findings of the 1993 RI report and the premise that due to low ionic interaction with the subsurface material, the injected radionuclides have lower solubility. The results of the USACE investigation also confirm the earlier findings of the USGS (USGS 1995) and others that the groundwater at Linde is of poor quality with naturally occurring levels of dissolved solids and constituents such as sulfates and chlorides that preclude its use without costly treatment.

CONCLUSION

USACE conducted a further assessment of potential exposure scenarios and exposure pathways for Linde groundwater based on the non-MED/AEC-related constituents in the groundwater. USACE has concluded that no completed pathways exist for current or future exposure to MED/AEC-related constituents in Linde groundwater. The groundwater operable unit at the Linde Site poses no current or potential threat to human health or the environment. Therefore, no CERCLA action is warranted. (The basis for these conclusions is presented in Section 2 of this Addendum.)

William E. Ryan III
WILLIAM E. RYAN III
Colonel, Corps of Engineers
Acting Commander
Great Lakes and Ohio River Division

18 OCT 2005
Date

4. FS SECTIONS DELETED OR AMENDED

Sections 1 through 3 of the FS report remain unchanged. The following sections of the October 2004 FS report are hereby amended or deleted:

- The Executive Summary is deleted and replaced by the Executive Summary now included in Section 3 of this Addendum,
- Section 4.3 is revised to delete the last two (2) paragraphs and in the 1st paragraph the reference to tables in Appendix A is revised to read Tables 10 through 22.
- Sections 4.3.1, 4.3.2 (including the footnote referring to Table 1) and 4.3.3 are deleted,
- Section 4.3.4 is renumbered to be 4.3.1,
- Section 4.4.1, 2nd paragraph, the 2nd to last sentence is deleted,
- Section 4.4.2, the last two (2) paragraphs are deleted and replaced by the following:

The leaching test results suggest that there is potential for leaching of radionuclides (uranium) from Site soils. It is noted, however, that the actual shallow groundwater concentrations of uranium are not significantly elevated. As reported in the 1993 RI report, there were no elevated levels of radionuclides detected in the surface water samples collected from Twomile Creek. Given the extensive excavation and removal from the Site of soil containing elevated levels of uranium and other radionuclides, potential sources for leaching of radionuclides to shallow groundwater are now greatly reduced and any potential for impacts are not significant.

- Section 4.5.1, 4th paragraph, 1st sentence, the phrase "(Ra-226 + Ra-228 standard exceeded by less than 9%)" is deleted and the last paragraph of Section 4.5.1 is deleted,
- Section 4.5.2, the 2nd, 3rd, and 4th paragraphs are deleted and replaced by the following amended 2nd, 3rd and 4th paragraphs

The 2001 investigation at Linde included the installation of three shallow monitoring wells and two rounds of sampling. Water quality data is not available for one of the wells (LMW-02), due to the low recharge rate for this well. The results from the shallow wells, show no significant levels of radionuclides in the shallow groundwater.

Soil samples collected at Linde were subjected to leaching tests. The California WET and modified California WET were used. The results show that under the aggressive test conditions employed in the WET, radionuclides, especially uranium, may be leached from the soil. These conditions are considered to be more conservative than actual conditions at the site. It is noted that actual shallow groundwater concentrations of uranium are not elevated.

The March 2001 groundwater samples from the shallow wells were taken prior to remediation of the areas surrounding LMW-01 and LMW-03. The March 2001 soils samples had significantly elevated uranium concentrations. The CAL WET leaching analysis showed a high potential for leaching to groundwater, yet this was not supported by elevated concentrations in the groundwater.

- Section 5 is deleted and a revised Section 5 is added as follows

"5. CONCLUSIONS

> Based a further assessment of potential exposure scenarios and exposure pathways for Linde groundwater, USACE has concluded that no completed pathways for current or future exposure to MED/AEC-related constituents in Linde groundwater exist. Therefore, no CERCLA action is warranted. The basis for these conclusions is presented in Section 2 of this Addendum."

- Section 6 is deleted,
- Section 7 is deleted,
- Section 8 is deleted,
- The reference list in Section 9 of the FS report is revised to be Section 6 as shown in Attachment A to this Addendum, and
- Tables 1,2,3 and 4 are deleted from the main text.

The following revisions are made to Appendix A:

- Table 23, Table 24, Table 25, Table 26 and Table 27 are deleted,
- Table 28 is renumbered to become Table 23 and Table 29 is renumbered to become Table 24,
- In Tables 10 through 20, columns and rows and footnotes referring to standards are deleted. Any shading of cells in these tables is also deleted,
- Section 4.2, last paragraph, the reference to Table 29 is revised to Table 24,
- Section 4.3, 1st paragraph, last sentence is revised to read, "The results for the samples analyzed for general chemistry parameters are shown in Tables 21 and 22.",
- Section 4.3, the last paragraph is deleted,
- Section 4.4 is deleted and Section 4.4.1 is renumbered to 4.4, Section 4.4.1.1 is renumbered to Section 4.4.1 and Section 4.4.1.2 is renumbered to 4.4.2,
- Renumbered Section 4.4.1, 2nd sentence, reference to Table 28 is revised to reference Table 23. 3rd sentence, last phrase is revised to read: "but actual shallow groundwater concentrations of radionuclides are not elevated.",
- Renumbered Section 4.4.2, references in this Section to Table 28 are revised to reference Table 23 and the last paragraph of this Section, last sentence, last phrase is revised to: "that the actual shallow groundwater concentrations of uranium are not elevated.", and
- Section 5.3, 2nd paragraph, last sentence is deleted and the 5th paragraph is deleted.

Appendix C of the FS report is deleted in its entirety

ATTACHMENT A
REVISED REFERENCE LIST

6. REFERENCES

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