Final
Feasibility Study Report for Soils and Groundwater
Liberty Industrial Finishing Site
Farmingdale, New York
Index No. II CERCLA 97-0203

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LIST OF ACRONYMS AND ABBREVIATIONS

ARARs	Applicable or Relevant and Appropriate Requirements
BERA	Baseline Ecological Risk Assessment
BHHRA	Baseline Human Health Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cis-1,2-DCE	*cis*-1,2-dichloroethene
Cd	Cadmium
Cr	Chromium
[Cr]	Surrogate chromium concentration: [Cr] / 12.4 = Cd concentration
CRI	Continued Remedial Investigation
DAF	Dilution Attenuation Factor
DCE	Dichloroethene
DDC	Density-Driven Convection
DOT	Department of Transportation
EPA	U.S. Environmental Protection Agency
FFS	Focused Feasibility Study
FS	Feasibility Study
GAC	Granular Activated Carbon
GCW	Groundwater Circulation Well
IDW	Investigation Derived Waste
LDR	Land Disposal Regulations
M	Magothy aquifer
MNA	Monitored Natural Attenuation
NCP	National Contingency Plan
NYSDEC	New York State Department of Environmental Protection
O&M	Operation and Maintenance
OSHA	Occupational Safety and Health Administration
PCE	Tetrachloroethene
PED	Preliminary Engineering Design
POTW	Publicly Owned Treatment Works
PRB	Permeable Reactive Barrier
PRG	Preliminary Remediation Goal
PWC	Present Worth Cost
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SEL	Severe Effects Level
SPLP	Synthetic Precipitation Leachate Procedure
TAGM	Technical and Administrative Guidance Memorandum
TBC	To Be Considered
TCE	Trichloroethene
TCLP	Toxicity Characteristic Leachate Procedure
TDCC	Total Direct Construction Costs
TOC	Total Organic Carbon
TSDF	Treatment Storage and Disposal Facility
UG	Upper Glacial aquifer
UVB	Unterdruck Verdampfer Brunnen
VOCs	Volatile Organic Compounds

1.0 INTRODUCTION

URS has prepared this Final Feasibility Study (FS) report for the Liberty Industrial Finishing Site (the Site) on behalf of the active Liberty Continued Remedial Investigation/Feasibility Study (CRI/FS) Group (the Group). This Final FS report is part of the ongoing CRI/FS conducted by the Group. This Final FS report evaluates potential remedial actions for soil and groundwater. The necessity for, and the degree to which the remedial actions presented in this FS report are implemented, will be based on the findings of the Final Baseline Human Health Risk Assessment (BHHRA [URS, July 2000]). The Group also submitted a Draft Baseline Ecological Risk Assessment (BERA; Dames & Moore, June 30, 1999) and a Draft Final BERA (URS, May 19, 2000) to the EPA. However, upon review of these documents, the EPA decided to task its own subcontractor, Roy F. Weston, Inc. (Weston), with the completion of the Final BERA. Accordingly, this Final FS does not evaluate potential remedial actions for sediments in Massapequa Creek and Preserve. Instead, the FS Addendum report for Massapequa Creek and Preserve remedial actions will be prepared by Weston, acting as EPA's subcontractor.

It should be noted that certain documents prepared and submitted (e.g., the CRI report, the BHHRA) or certain activities performed (e.g., the CRI activities) on behalf of the Group are referenced as having been prepared by either 'Dames & Moore' (through April 2000) or by 'URS' (formerly 'Dames & Moore', referred to as 'URS' starting in May 2000).

1.1 RI/FS BACKGROUND

In 1990 the United States Environmental Protection Agency (EPA) authorized Roy F. Weston, Inc. (Weston) to conduct a Remedial Investigation/Feasibility Study (RI/FS) of the Liberty Industrial Finishing Site (site) located in the Town of Oyster Bay, Nassau County, New York. The RI field investigation of the Site was completed in July 1992. The results of the RI were presented in the Final Remedial Investigation for the Liberty Industrial Site, Farmingdale, New York, (RI Report, Weston, 1994). A supplemental soil characterization was performed in January 1997 (Weston, 1997c), and an FS to address soils and debris in the western portion of the Site was completed in July 1997 (Weston, 1997b). On behalf of the Group, Dames & Moore conducted the CRI between April 1997 and January 1999 to address soils and groundwater in the eastern portion of the Site, to further investigate groundwater downgradient of the Site, and to evaluate ecological impacts to Massapequa Preserve (located downgradient and southwest of the Site). In addition, Dames & Moore conducted on behalf of the Group a comprehensive soil investigation between December 1998 and January 1999. The results of the CRI and the comprehensive soil investigation were presented in the Final Continued Remedial Investigation Report (Final CRI Report, URS, July 20, 2000).

1.2 FORMAT OF THE FEASIBILITY STUDY

The format of this Final FS report follows, in general, the guidelines outlined in Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (EPA, 1988). Accordingly, this FS is divided into the following three phases:

PHASE I - IDENTIFICATION AND SCREENING OF TECHNOLOGIES

- Identification of general remedial actions for each remedial action objective.
- Determination of feasible technologies associated with each general remedial action.
- Screening of each technology based on effectiveness, implementability, and relative cost.

In order to avoid duplication of the detailed FS for soils/sludges and debris (Weston, 1997b) and the focused feasibility studies (FFS) for on-site groundwater (Weston, 1997a; Dames & Moore, 1997), this Final FS report uses an abbreviated approach to the identification of technologies, so that marginal or non-applicable technologies are not evaluated in detail.

PHASE II - DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES

- Assembling the technologies evaluated in Phase I into remedial alternatives.
- Description of each remedial alternative and the basis for its development.
- Screening of alternatives based on short-term and long-term analyses of effectiveness, implementability, and cost.
- Selection of alternatives for detailed evaluation and analysis.

In order to avoid duplication of the detailed FS for soils/sludges and debris (Weston, 1997b) and the focused feasibility studies (FFS) for on-site groundwater (Weston, 1997a; Dames & Moore, 1997), this Final FS report uses an abbreviated approach to developing and screening remedial alternatives, so that marginal or non-applicable alternatives are not evaluated in detail.

PHASE III - DETAILED ANALYSES OF ALTERNATIVES

- Further discussion of each remedial alternative with respect to the volumes of impacted media to be addressed, the technologies to be used, and any performance requirements associated with those technologies
- Evaluation and comparison of alternatives with respect to the criteria of:
  - Overall protection of human health and the environment.
  - Compliance with Applicable or Relevant and Appropriate Requirements (ARARs).
  - Long-term effectiveness and permanence.
  - Reduction of toxicity, mobility, and volume through treatment.
    - Short-term effectiveness.
  - Implementability.
  - Cost.
    - State acceptance.
  - Community acceptance.

The evaluation of the soil and groundwater remedial alternatives presented in this Final FS report is intended to lead to the selection of sitewide remedies that will be protective of the environment and human health, and be in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Specifically, Section 121 of CERCLA requires that remedial actions achieve a level of cleanup that "(a) protects human health and the environment; and (b) meets all applicable standards promulgated for any hazardous substances. In addition, the remedial actions should be consistent with cleanup criteria and requirements that are relevant and appropriate under the circumstances of the release or threatened release of such hazardous substances or constituents."

This Final FS report is based on the data and interpretation of Site characteristics that are discussed in the Final CRI Report (URS, July 20, 2000). Additionally, this Final FS report assumes that the future land use of the Site itself will be commercial/industrial (non-residential) or industrial commercial and recreational (western parcel only, near the existing Ellsworth-Allen Park). However, the on-site soil cleanup criteria were specifically selected to be protective of groundwater in order to achieve a comprehensive sitewide remedial approach.

1.3 GENERAL REMEDIAL ACTION OBJECTIVES

Media-specific remedial action objectives (RAO) were established to facilitate the development of remedial alternatives protective of human health and the environment. The remedial alternatives developed will protect human health and the environment by reducing concentrations of the constituents of concern (and thereby reducing the overall mass of these constituents) and potential exposures, as well as, eliminating migration pathways.

1.3.1 On-site Soil

There are two remedial action objectives for on-site soils:

1. Protection of Groundwater
2. Protection of Human Health for a specified end use

The primary RAO for the on-site soils is to prevent migration (leaching) of metals (cadmium and chromium) and volatile organic compounds (VOCs) from the unsaturated soil column toward and into the groundwater. In addition, this RAO includes the prevention of mobilization of metals from the soil fringe (15 to 21 feet below grade) directly above the seasonally low groundwater table (21 feet below grade). There are no generic New York State Department of Environmental Conservation (NYSDEC) protection-of-groundwater soil criteria for the inorganic constituents. Therefore, site-specific soil criteria were developed in the Final CRI report (URS, July 20, 2000), using the agency-approved Synthetic Precipitation Leachate Procedure (SPLP). The secondary RAO is to prevent potential risks to human health due to exposure to on-site soils under current and expected future use scenarios. The site-specific criteria for the organic and inorganic constituents (which are protective of groundwater quality and of human health for current and foreseeable future site use scenarios) are discussed in Section 1.5.1 of this Final FS report.

1.3.2 Groundwater

The general RAO for groundwater is to prevent potential future impacts of site-related constituents on the public water supply and to restore, to the extent practicable, the impacted aquifers. The NYSDEC GA groundwater standards and guidance values provide the most stringent criteria for on-site and off-site groundwater. However, additional criteria are considered in this Final FS report that will achieve the general RAO, such as hydraulic containment and natural attenuation processes. These processes are important in addressing the most downgradient portions of the groundwater plume where site-related constituents may be detectable at or slightly above the corresponding NYSDEC GA groundwater standards, and aquifer restoration by treatment only might be ineffective.

The RAO for off-site groundwater will also be protective of off-site surface water, because shallow groundwater recharges the northern reaches of the East branch of Massapequa Creek during the spring and early summer months of the year. The fact that surface water flow in the northern reaches of Massapequa Creek is seasonal demonstrates that stream flow is entirely driven by groundwater recharge (except during storm events). Although off-site surface water north of Pond A was observed to be impacted by site-related constituents (cadmium) (Final CRI report, URS, July 20, 2000), treatment of shallow off-site groundwater is expected to represent effective source control for surface water. When the cleanup criteria for groundwater are equal to or less than the corresponding surface water criteria, surface water need not be considered further in this Final FS report. In cases where surface water criteria are more stringent than the cleanup criteria for groundwater (e.g., cadmium), the treatment of off-site groundwater may not result in the short-term restoration of surface water quality to the applicable criteria.

1.4 SITE BACKGROUND INFORMATION

1.4.1 Site Location

The Site is located approximately one mile south of Bethpage State Park in the Town of Oyster Bay, Nassau County, New York. The Site includes Lots 326 and 327 of Block 518, Section 48, as recorded in the Nassau County Clerk's office. The Site is bordered by the Long Island Railroad to the north, Motor Avenue to the south, Main Street to the east and Ellsworth Allen Park to the west. The surrounding area is primarily residential with several commercial establishments along the major roads. A Site location map and a map of current Site conditions are presented as Figures 1-1 and 1-2, respectively.

1.4.2 Site Description

The Site may be divided into a western portion (generally unpaved and inactive) and an eastern portion (paved and limited activity). Site operations in the western portion have ceased, and only the foundations of some of the former structures and industrial facilities remain visible. The western portion of the Site also includes three excavated former disposal basins that previously received metal finishing wastewaters. This portion of the Site is secured by fence lines along the northern, western and southern property boundary.

The eastern portion of the Site (i.e., approximately half of the total Site acreage) is developed and includes several large warehouses and the remains of past industrial operations, including foundations of former process buildings. Many of the previous process buildings are no longer standing, but the former building locations can generally be identified by the remains of concrete floor slabs. Other Site structures, such as former water supply well vaults, a fire-fighting water storage reservoir, leaching chambers, and miscellaneous process area sumps and drains were described in the RI Report (Weston, 1994) and in the Final CRI Report (URS, July 20, 2000).

1.4.3 Site History

The initial Site facilities were utilized starting in 1934 by Kirkham Engineering and Manufacturing Company, which manufactured various aircraft-related equipment. In the 1940s, the Defense Plant Corporation (DPC) established operations at the Site for the manufacture of aircraft parts by the lessee, Liberty Aircraft Products Corporation. Liberty Aircraft Products Corporation and its various successors operated the facility as a metal plating operation up to 1978. The RI Report (Weston 1994) documented the history of the Liberty Industrial Finishing Site in detail, based on files compiled by the EPA and the NYSDEC. A brief summary of the Site history was also presented in the Final CRI Report (URS, July 20, 2000).

1.4.4 Site Hydrogeology

The principal aquifers beneath the Site are the Upper Glacial aquifer and the Magothy aquifer. The Magothy aquifer is developed for public water supply. The groundwater in the Upper Glacial aquifer exists under unconfined conditions, whereas partially confined conditions may exist in the Magothy aquifer where clay deposits are present. Groundwater flow in both aquifers is toward the south-southwest (URS, July 20, 2000). Within each aquifer, groundwater flow is predominantly horizontal, however, vertical hydraulic gradients exist between the Upper Glacial and the Magothy aquifers. In general, the vertical gradient is downward (as to promote flow from the Upper Glacial to the Magothy aquifer), except in the spring months when upward gradients were observed in the southern portions of the off-site areas (URS, July 20, 2000). Note that actual flow between the aquifers is mainly dependent on the vertical hydraulic conductivity between the two formations. The hydraulic connection of the Upper Glacial to the Magothy aquifer is believed to be limited in the Site vicinity, because a low-permeability layer is present between the Upper Glacial and the Magothy aquifers throughout much of the on-site and off-site areas (URS, July 20, 2000).

1.4.4.1 Upper Glacial Aquifer.

In the Site vicinity, the Upper Glacial aquifer is between 60- and 90-feet thick and is comprised of fine to coarse sand and gravel of Pleistocene age. The lower portion of the Upper Glacial aquifer is characterized by finer-grained sands and silts, which may contain minor lignite and clay. This finer-grained unit was recognizable in natural gamma logs across the entire area studied during the CRI and may correlate with the "20-foot clay" described in the regional geologic literature. The deposits of the Upper Glacial aquifer are very permeable and contain large quantities of water. The RI Report (Weston, 1994) suggested that the average hydraulic conductivity for the Upper Glacial aquifer is approximately 270 feet/day in the horizontal direction and approximately 27 feet/day in the vertical direction. Slug tests conducted during the RI and CRI suggest a somewhat lesser hydraulic conductivity of about 180 feet/day. In the Final CRI Report (URS, July 20, 2000), the average groundwater flow velocity in the Upper Glacial aquifer was estimated to be approximately 1.6 feet/day.

1.4.4.2 Magothy Aquifer

The Magothy aquifer consists of interlayered sand, silt, and clay deposits of Cretaceous age. The sandy portions of the Magothy aquifer consist of gray or light tan, fine to medium sand and gravel. The silt and clay deposits in the vicinity of the Site were dark-gray to tan and contained locally abundant lignite. The permeable portion of the Magothy Formation is the main aquifer of use for public water supply in Nassau County. The RI Report (Weston, 1994) suggested that the average hydraulic conductivity for the Magothy aquifer is approximately 50 feet/day in the horizontal direction and approximately 1.4 feet/day in the vertical direction. The RI Report (Weston, 1994) estimated the average groundwater flow velocity in the Magothy aquifer to be approximately 0.22 feet/day. Hydraulic data presented in the Final CRI Report (URS, July 20, 2000) place the average flow velocity at approximately 0.17 feet/day, using an average hydraulic conductivity of 15 feet/day.

1.5 EXISTING CONDITIONS

The determination of various remedial alternatives for on-site soils and sitewide groundwater is based on the characterization of actual environmental conditions for these media. In addition, a determination of volumes of impacted soil and groundwater is necessary. This Section presents a summary of these parameters.

1.5.1 On-Site Soil

1.5.1.1 Site-Specific Cleanup Criteria

The Final CRI Report (URS, July 20, 2000) presented soil cleanup criteria for selected volatile organic compounds (VOCs) and metals (cadmium and chromium) that are protective of groundwater quality and are protective of human health under current and foreseeable future site use scenarios. The cleanup criteria for VOCs are based upon non-site specific NYSDEC TAGM (NYSDEC, April, 1995) concentrations. The cleanup criteria for Cd and Cr are primarily based upon the site-specific synthetic precipitation leachate procedure (SPLP) approach for groundwater protection.

Non-site Specific Soil Cleanup Criteria for VOCs

The Final CRI report (URS, July 20, 2000) proposed non-site specific soil cleanup criteria for the primary VOCs at the Site (tetrachloroethene [PCE], trichloroethene [TCE], and *cis*-1,2-dichloroethene [*cis*-1,2-DCE]), as shown in Table 1-1A These non-site specific guidelines for soil cleanup follow Appendix A (Table 1) of the NYSDEC TAGM (NYSDEC, April 1995), which presents, among other things, soil cleanup objectives to protect groundwater quality. These NYSDEC TAGM soil cleanup objectives are based on a default soil organic carbon content of 1%. Although there is ample evidence that organic carbon in on-site soil may be (on the average) greater than 1% in near-surface soils, and less than 1% in subsurface soils (URS, July 20, 2000), the default NYSDEC TAGM values were chosen:

TABLE 1-1A
Generic Soil Cleanup Criteria to Protect Groundwater Quality for VOCs

	PCE	TCE	cis-1,2-DCE
	mg/kg	mg/kg	mg/kg
Soil Cleanup Level to Protect Groundwater Quality	1.4	0.70	0.25

Site-specific Criteria for Chromium and Cadmium

In the Final CRI report (URS, July 20, 2000), site-specific soil cleanup criteria of 143 mg/kg Cr and 10 mg/kg Cd (the NYSDEC TAGM soil cleanup level) were proposed. The first step in deriving these criteria was to calculate SPLP-based criteria for Cr and Cd that are protective of groundwater quality. The objective of the data analysis presented in the Final CRI report (URS, July 20, 2000) was to statistically define a soil concentration that with 90 percent certainty will not produce an SPLP leachate that, once it reaches and mixes with groundwater, would exceed the NYSDEC GA standards of 0.05 mg/L for chromium and 0.005 mg/L for cadmium. The most conservative method of accomplishing this is to compare the observed SPLP leachate concentrations for Cd and Cr directly to the corresponding NYSDEC GA standards. Thus, SPLP-based criteria were conservatively calculated by not considering any dilution or attenuation processes (i.e., a dilution attenuation factor [DAF] of 1 was chosen). Note that alternative methods involving a 'Dilution Factor Model' are specifically discussed in EPA's Soil Screening Guidance (EPA, 1996). The purpose of the 'Dilution Factor Model' would be to account for one or more processes that potentially dilute soil leachate concentrations prior or upon mixing with ambient groundwater. However, in order to remove uncertainty from the choice of potentially applicable DAFs and to derive conservative (and therefore protective) soil criteria, the DAF was chosen to be 1 (i.e., dilution was not considered in the derivation of the site-specific soil criteria).

Section 3.5.1.3 of the Final CRI report (URS, July 20, 2000) presents a detailed discussion of the SPLP data set and the statistical procedure used for this evaluation. In general, soils with greater Cr and Cd concentrations are expected to yield SPLP leachates with greater Cr and Cd concentrations. The observed data were generally consistent with this premise. However, it was also apparent that a relatively narrow range of soil concentrations can result in a relatively larger range of SPLP leachate concentrations (i.e., certain soils, although they had similar concentrations of cadmium or chromium, were being leached to variable extent). Such 'non-systematic' behavior is related to effects such as grain-size, soil pH, organic carbon content, and mineralogical differences. In summary, the inverse regression analysis that was employed to evaluate the coexisting soil concentration data and SPLP leachate data considered the cumulative effect of these 'non-systematic' factors. The objective of the inverse regression analysis was to predict the minimum soil concentration of Cr and Cd that would produce a SPLP leachate concentration of less than 0.05 mg/L Cr and 0.005 mg/L Cd. For Cr, this minimum concentration was predicted to be 143 mg/kg. For Cd, this minimum concentration was predicted to be 0.077 mg/kg. (Note that a standard inverse regression analysis [i.e., not considering the 'non-systematic factors'] would yield, at a confidence of 90 percent, concentrations of 1,716 mg/kg and 1.32 mg/kg for Cr and Cd, respectively).

The second step was to compare these SPLP-based criteria (which are solely based on protecting groundwater quality and use conservative assumptions for the inverse regression analysis) to alternative procedures that are sometimes used to determine site-specific soil cleanup criteria. These include: (1) default soil screening levels (EPA, April 1996) and (2) NYSDEC TAGM soil cleanup objectives (NYSDEC, April 1995). The details of this comparison analysis are presented in the Final CRI report (URS, July 20, 2000):

- Comparison to the default soil screening level partitioning equation for migration to groundwater (Equation 10, EPA Soil Screening Guidance, April 1996). Using the recommended soil-water partition coefficients for Cd and Cr, a DAF of 1, a pH value of 6.0, and the default values for soil porosity and soil bulk density (as given in EPA, 1996), the generic screening level for Cd would be approximately 0.19 mg/kg, and the generic screening level for chromium would be approximately 10,000 mg/kg for trivalent Cr and 1.16 mg/kg for hexavalent Cr. Using a site-typical ratio of 75-percent trivalent Cr to 25-percent hexavalent Cr, the soil screening level for total Cr would be approximately 18.4 mg/kg. Appendix B gives additional details for the derivation of this default soil screening level for Cr.

- Comparison to the NYSDEC TAGM soil cleanup objectives. The unrestricted use TAGM (NYSDEC, April 1995) concentration for chromium is 50 mg/kg, and the unrestricted use TAGM concentration for cadmium is 10 mg/kg.

The purpose of this discussion is to derive conservative site-specific soil criteria that are protective of groundwater quality as derived by the SPLP results, protective of human health under current and foreseeable future site use scenarios, and using a weight-of-evidence approach in conjunction with alternate methods of deriving site-specific soil criteria. Such site-specific criteria are expected to be:

- Equal (for relatively soluble constituents) or greater (for relatively insoluble constituents) than the NYSDEC TAGM soil cleanup objectives (NYSDEC, April 1995). Cadmium would be considered a relatively soluble constituent and chromium would be considered a relatively insoluble constituent. According to the NYSDEC TAGM, the soil cleanup objectives "at a minimum, eliminate all significant threats to human health and the environment" and therefore qualify as 'unrestricted use' criteria, which would be inclusive of protecting groundwater quality;

- Equal or greater than the minimum Cr and Cd soil concentrations that are predicted to yield SPLP leachate concentrations of less than 0.05 mg/L Cr and 0.005 mg/L Cd (i.e., the NYSDEC GA standards), and consider the uncertainty in leachate concentrations due to intrinsic, 'non-systematic' factors;

- Less than the predicted Cr and Cd soil concentrations that were derived using a standard inverse regression analysis (i.e., not considering the uncertainty in leachate concentrations due to intrinsic, 'non-systematic' factors).

The following chart summarizes the results of this comparison.

	TAGM	Soil Screening	SPLP (low)	SPLP (high)
Trivalent Chromium	----	10,000	----	----
Hexavalent Chromium	----	1.19	----	----
Total Chromium	50	18.4	143	1,716
Cadmium	10	0.19	0.077	1.32

all concentrations are in mg/kg

For total chromium a conservative site-specific criterion of 143 mg/kg was proposed in the Final CRI report (URS, July 20, 2000). This concentration is expected to be protective of groundwater quality, as it is derived from site-specific SPLP results using the conservative inverse regression procedure discussed above and in Appendix B. The site-specific chromium criterion of 143 mg/kg is approximately eight-times greater than the generic soil screening level for total chromium (18.4 mg/kg), assuming a proportion of 25 percent hexavalent chromium. Since, on the average, only 25-percent of the chromium in on-site soils exists as relatively soluble Cr^{6+}, the fact that the site-specific chromium criterion is greater than the 'unrestricted use' TAGM concentration (50 mg/kg) does not in itself present a concern as to the protection of groundwater quality. Note that the intended and foreseeable future use of the site is commercial/industrial and (in the western parcel of the site) includes recreational activities. EPA (1997) has previously determined preliminary remediation goals (PRGs) for chromium that are protective of such current or future site uses of 4,300 mg/kg (commercial/industrial use) and

2,150 mg/kg (recreational use). Therefore, the proposed chromium criterion of 143 mg/kg is protective of groundwater quality and of human health under current and foreseeable future site use scenarios.

The soil criterion for cadmium is proposed to be10 mg/kg (the 'unrestricted use' TAGM concentration). Although the regression analysis used in deriving site-specific protection-of-groundwater criteria yielded lesser concentrations of 0.077 to 1.32 mg/kg, the choice of the TAGM concentration ('unrestricted use' as defined in the NYSDEC TAGM, April 1995) is fully protective of both the environment (i.e., groundwater quality) and human health. EPA (1997) has previously determined preliminary remediation goals for cadmium that are protective of current or future site uses of 230 mg/kg (commercial/industrial use) and 30 mg/kg (recreational use). Therefore, the proposed cadmium criterion of 10 mg/kg is protective of groundwater quality and human health under current and foreseeable future site use scenarios.

These proposed soil cleanup criteria of 143 mg/kg Cr and 10 mg/kg Cd are inclusive of the additional objective of removing soils from the site that are hazardous by TCLP characteristic. The Final CRI report presented a qualitative discussion regarding the Cr and Cd soil concentrations that would render on-site soils hazardous. It was concluded that, on the average, Cd concentrations on the order of 120 mg/kg and Cr concentrations on the order of 100,000 mg/kg may have the potential of producing TCLP leachate concentrations in excess of the regulatory limits of 1.0 mg/L Cd and 5.0 mg/L Cr. Since the proposed criteria of 143 mg/kg Cr and 10 mg/kg Cr are less than the TCLP threshold concentrations of 100,000 mg/kg Cr and 120 mg/kg Cd, the proposed criteria are inclusive of all the RAOs, and therefore ensure that all potentially hazardous soil will be addressed in this Final FS Report.

Extent of Potential Remedial Activities

The soil analytical data presented in the Final CRI Report (URS, July 20, 2000) are comprehensive in nature and were incorporated in a 3-dimensional grid model (the conceptual Site model). The conceptual Site model divides on-site soils into a grid of 10-ft by 10-ft cells having a thickness of 5 feet each (except the near-surface soils which are modeled as a 0 to 3-ft depth layer). Based on the RI and CRI soil sampling data (including data from the 1997 and 1999 supplemental soil activities), the model then calculates the predicted chromium concentrations in each cell, which in turn allowed estimating the mass distribution of Cr and Cd in the on-site soils.

As detailed in Appendix D of the Final CRI report (URS, July 20, 2000), the Cr concentrations in on-site soils can be delineated with much greater confidence than Cd concentrations. It was also shown that Cr and Cd correlate spatially and by concentration, on the average, in a ratio of 12.4 Cr to 1.0 Cd. This correlation allowed expressing the proposed cadmium soil cleanup level of 10 mg/kg as a 'surrogate' chromium concentration (abbreviated as [Cr] in the remainder of the Final FS report), such that:

[Cr] = 10 mg/kg Cd x (12.4 mg/kg Cr /1.0 mg/kg Cd)

[Cr] = 124 mg/kg

Note that [Cr] = 124 mg/kg does <u>not</u> represent the soil cleanup criterion for chromium (the actual soil cleanup criterion for Cr is 143 mg/kg), but rather represents a surrogate for the cadmium soil cleanup criterion of 10 mg/kg. This surrogate concentration [Cr] = 124 mg/kg was used throughout this Final FS report to calculate Cd-impacted soil volumes and/or the areal extent of Cd-impacted Site areas, using the conceptual site computer model. It is important to remember, however, that [Cr] = 124 mg/kg does not imply that all soils with Cr concentrations greater than 124 mg/kg require some type of remediation. Only soils with Cd concentrations greater than 10 mg/kg or Cr concentrations greater than 143 mg/kg (i.e., the actual cleanup criteria) require remediation. This is an important consideration for any post-remediation sampling activities. For example:

- Post-remediation samples that would be collected from a particular area and yield Cd concentrations of less than 10 mg/kg and Cr concentrations <u>greater</u> than 124 mg/kg (but less than 143 mg/kg) would indicate that no further remedial activities in this particular area are necessary. Conversely,

- Post-remediation samples collected from a particular area that yield Cd concentrations greater than 10 mg/kg (but Cr concentrations <u>less</u> than 124 mg/kg) would indicate that further remedial activities are warranted. Similarly, post-remediation samples that yield Cr concentrations greater than 143 mg/kg would indicate that further remedial activities are warranted.

TABLE 1-1B
Site-Specific Soil Cleanup Criteria for Cadmium and Chromium

	To Protect Groundwater Quality	TCLP Threshold Concentration [1]
Cadmium (mg/kg)	10	120
Chromium (mg/kg)	143	100,000

Concentrations are in mg/kg (milligram per kilogram)
[1] = estimated threshold concentrations (URS, July 20, 2000)

1.5.1.2 Nature and Extent of Constituents of Interest

Volatile Organic Compounds

None of the samples collected and analyzed during the CRI had PCE and *cis*-1,2-DCE concentrations greater than the soil cleanup criteria. However, five (5) soil samples had TCE concentrations greater than the corresponding soil cleanup level of 0.7 mg/kg. These samples were collected from locations D-27 (1.17 mg/kg, 0.5-1 ft bgs), D-32 (0.78 mg/kg, 0.5-1 ft bgs), E-17 (5.1 mg/kg, 0.5-1 ft bgs), E-27 (7.6 mg/kg, 19.5 to 20 ft bgs), and L-04 (6.1 mg/kg, 0.5-1.0 ft bgs). Two of these samples (5.1 mg/kg and 6.1 mg/kg TCE, respectively) were collected near the former Building B basement and one sample (7.6 mg/kg TCE) was collected near a former floor drain at Building G: Both of these locations were previously identified as impacted with respect to VOCs (Weston, 1994). These CRI sample locations (URS, July 20, 2000) and the RI sample locations (Weston, 1994) where VOC concentrations were greater than the generic soil cleanup levels were detected are shown in Figure 1-3.

Chromium and Cadmium

Although a limited number of soil samples collected during the RI and CRI activities exceeded some of the site-specific VOC criteria, the potential need for remedial action is largely driven by a much greater number of soil samples that exceeded the site-specific criteria for Cr and Cd. Figures 1-4 and 1-5 summarize the chromium and cadmium analytical data acquired during the RI (Weston, 1994) and CRI (URS, July 20, 2000).

Figure 1-4 shows chromium concentrations in intervals leading up to the surrogate concentration of 124 mg/kg [Cr] (equal to 10 mg/kg Cd) in gray and green symbols. [Cr] greater than 124 mg/kg are expressed as yellow symbols, and [Cr] greater than 1,500 mg/kg (which corresponds to the approximate TCLP limit of cadmium = 120 mg/kg [URS, July 20, 2000]) are expressed in red symbols.

Figure 1-5 shows cadmium concentrations in intervals leading up to the site-specific cleanup level of 10 mg/kg Cd in gray and green symbols. Cadmium concentrations greater than 10 mg/kg are expressed as yellow symbols, and cadmium concentrations greater than 120 mg/kg (the approximate TCLP limit of cadmium [URS, July 20, 2000]) are expressed in red symbols.

The Final CRI report presented a detailed conceptual model that evaluated quantitatively the volume of soils with Cd concentrations greater than 10 mg/kg (which were expressed as surrogate concentrations [Cr] greater than 124 mg/kg). Because of the preponderance of Cd concentrations that were less than the detection limit, a quantitative evaluation based on Cd concentrations alone was not possible. As shown in Figures 1-4 and 1-5, the main on-site areas that have cadmium concentrations greater than 10 mg/kg and chromium concentrations greater than 143 mg/kg include the vicinity of the Northwest Disposal Area, the former disposal basins, the former Building B basement area, and the area south of the former disposal basins. It is possible that the approach of using [Cr] concentrations to calculate the volume of impacted soils overestimated the extent of soil impacts, especially south of the Northwest Disposal area and south of the former disposal basins (where Cr greater than 124 mg/kg was detected [see Figure 1-4], but Cd was generally less than 10 mg/kg [see Figure 1-5]). Therefore, the calculations of impacted soil volumes in this Section are conservative.

In addition, it is apparent from comparing Figures 1-3 and 1-4 that areas that yielded soils with VOC concentrations in excess of the generic NYSDEC TAGM criteria are included within the large soil volume that has Cd concentrations greater than 10 mg/kg and Cr concentrations greater than 143 mg/kg. There are only two isolated areas where VOCs concentrations were elevated but metals concentrations were not greater than the soil cleanup criteria (the former Building G floor drain and an isolated location 300 feet east of the Northwest Disposal Area). Therefore, the target areas for remedial alternatives developed in this Final FS report to address Cd and Cr concentrations in on-site soils generally coincide with the target areas for VOC impacts in on-site soils.

Volume of Impacted Soils

Table 1-2 presents a summary of soil volumes that are predicted to exceed certain Cd concentrations (expressed as surrogate [Cr] concentrations). Since the site-specific cleanup criterion for chromium (143 mg/kg) is nearly identical to the surrogate concentration of 124 mg/kg [Cr], this Final FS report does not present separate volume estimates based on 143 mg/kg Cr. These volume estimates were previously submitted to the EPA (Dames & Moore, May 6, 1999). The soil volume estimates are calculated from the conceptual site model, which includes all RI and CRI soil data, including the 1997 and 1999 supplemental soil investigations (approximately 632 soil samples are included). The details of the conceptual site model were provided in Appendix D of the Final CRI report (URS, July 20, 2000). The graphical output of the conceptual site model is provided in Appendix B to this Final FS report.

TABLE 1-2
Estimated Volumes of Impacted Soils

Surrogate [Cr] Concentration	Corresponding Cd Concentration	Volume 1 (impacted)	Volume 2 (removal)
(mg/kg)	(mg/kg)	(cy)	(cy)
50	4.0	123,000	158,000
124	10	73,000	82,000
1,500	120	16,000	16,500
4,300	347	5,000	5,500

Note: 'Volume 1 (impacted)' adds up volumes of any model cells whose estimated concentrations exceed the surrogate [Cr] concentration. 'Volume 2 (removal)' also includes the volumes of any model cells that would require excavation to reach the actually impacted cells.

mg/kg = milligram per kilogram; cy = cubic yards

Summary of the Derivation of Site-specific Criteria for Cr and Cd

The proposed site-specific cleanup criteria for Cr (143 mg/kg) and Cd (10 mg/kg) were initially derived using an EPA-approved approach of utilizing co-located SPLP and total soil concentration data. This approach did not consider any attenuation or dilution processes of the soil leachate either prior to or upon mixing with groundwater. In reality, metals that are leached from the soil matrix and travel through the unsaturated zone toward the water table would be expected to undergo several physical and chemical processes (e.g., sorption on mineral surfaces, partitioning into organic carbon, dilution) that would diminish the mass flux of dissolved metals into groundwater. By not considering these attenuating processes, it is likely that the conservative SPLP-based approach overestimated the potential for transfer of metals from the soil matrix into groundwater. In addition, two alternate approaches (default soil screening levels and unrestricted use NYSDEC TAGM soil cleanup objectives) were considered and compared to the SPLP-derived criteria. Based on this comparative analysis, the soil cleanup criteria for Cr and Cd are considered protective of groundwater quality and protective of human health under the current and expected future site use scenarios.

1.5.2 Groundwater

Groundwater in the Site vicinity occurs in two aquifers, the Upper Glacial aquifer and the underlying Magothy aquifer. The underlying Magothy aquifer is the primary aquifer for public water supply in Nassau County. Nassau County Health Ordinance Articles IV and VI prohibit the installation and use of private groundwater withdrawal wells where public water supplies are available. The results of the RI and CRI indicate that the Upper Glacial and Magothy aquifers are hydraulically interconnected, although a fine-grained unit was observed to exist between the two aquifers (URS, July 20, 2000) that, when present, appears to attenuate and/or limit the downward migration of metal constituents (Cd and Cr).

1.5.2.1 Groundwater Standards

Volatile Organic Compounds

The following VOCs were detected in on-site and off-site groundwater at concentrations greater than the corresponding NYSDEC GA standards (NYSDEC, TOGS, June 1998). These concentrations were reported in the Final CRI report, URS, July 20, 2000:

TABLE 1-3A
Detected VOC Concentrations in Groundwater Compared to NYSDEC GA Standards

Constituent	Range of Concentrations (detected)	Detected at Concentrations Greater than Standard or Guidance Value?		NYSDEC GA Standard	
	µg/L	on-site (max. in µg/L)	off-site (max. in µg/L)	µg/L	
1,1,1-TCA	0.2 - 140	YES (140)	YES (10)	5.0	POC
1,1-DCA	0.1 - 16	YES (16)	YES (9.0)	0.6	S
1,1-DCE	0.1 - 6.0	NO	YES (6.0)	5.0	POC
1,2-DCB	0.1 - 7.0	NO	YES (7.0)	3.0	S
1,4-DCB	0.1 - 4.0	NO	YES (4.0)	3.0	S
Acetone	8.0 - 310	YES (310)	YES (170)	50	S
Chlorobenzene	0.1 - 16	NO	YES (16)	5.0	POC
cis-1,2-DCE	0.1 - 810	YES (810)	YES (980)	5.0	POC
trans-1,2-DCE	0.2 - 33	YES (7)	YES (33)	5.0	POC
PCE	0.1 - 1,100	YES (930)	YES (1,100)	5.0	POC
TCE	0.1 - 1,500	YES (1,500)	YES (840)	5.0	POC
Toluene	0.1 - 15	NO	YES (15)	5.0	POC
Vinyl chloride	0.4 - 4.0	NO	YES (4.0)	2.0	S

Notes: µg/L = microgram per Liter
S standard explicitly listed in NYSDEC TOGS (1998)
POC Principal Organic Contaminant Standard of 5 µg/L (NYSEDC TOGS, 1998)

Table 1-3B summarizes observed maximum concentrations of three principal chlorinated VOCs (PCE, TCE, and *cis*-1,2-DCE) by aquifer (Upper Glacial aquifer vs. Magothy aquifer), location (on-site vs. off-site) and provenance (Plume A vs. Plume B). Note that the most elevated concentrations for VOCs in Plume B were observed in a monitoring well that is located upgradient of the Site.

TABLE 1-3B
Selected Maximum VOC Concentrations in Groundwater by Location

	PCE (µg/L)		TCE (µg/L)		cis-1,2-DCE (µg/L)	
	Plume A	Plume B	Plume A	Plume B	Plume A	Plume B
On-site Maximum						
Upper Glacial	2	930	1,500	21	810	60
Magothy	ND	NA	1.0	NA	0.1	NA
Off-site Maximum						
Upper Glacial	7	1,100	160	840	48	980
Magothy	3	490	490	63	24	76

ND = not detected,
NA = no data available (I.e., there are no wells in the corresponding aquifer or plume)

Inorganic Constituents

Six inorganic constituents were detected in on-site and off-site groundwater at concentrations greater than the corresponding NYSDEC GA standards (NYSDEC, TOGS, June 1998). These concentrations (total) were reported in the Final CRI report:

TABLE 1-4A
Detected Inorganic Concentrations in Groundwater Compared to NYSDEC GA Standards

Constituent	Range of Concentrations	Detected at Concentrations Greater than Standard or Guidance Value?		NYSDEC GA Standard	
	µg/L	on-site (max. in µg/L)	off-site (max. in µg/L)	µg/L	
Cadmium	0.93 – 262	YES (262)	YES (135)	5.0	S
Chromium	1.1 – 553	YES (156)	YES (553)	50	S
Cyanide	50.4 – 294	YES (294)	NO	200	S
Iron	58.2 – 13,700	YES (1,070)	YES (13,700)	300	S
Manganese	1.8 – 8,560	YES (1,750)	YES (8,560)	300	S
Thallium	4.3 – 6.8	YES (4.5)	YES (6.8)	0.5	G

Notes: µg/L microgram per Liter
S standard explicitly listed in NYSDEC TOGS (1998)
G guidance value listed in NYSEDC TOGS (1998)

Table 1-4B summarizes the observed maximum concentrations of the principal inorganic constituents (cadmium, total chromium, hexavalent chromium) by aquifer (Upper Glacial aquifer vs. Magothy aquifer), location (on-site vs. off-site) and sample type (total vs. filtered concentrations).

TABLE 1-4B
Selected Maximum Inorganic Concentrations in Groundwater by Location

	Cd (µg/L)		Cr (µg/L)		Cr-VI (µg/L)
	total	filtered	total	filtered	
On-site Maximum					
Upper Glacial	262	259	156	122	103
Magothy	ND	ND	10.2	ND	ND
Off-site Maximum					
Upper Glacial	135	136	514	509	553
Magothy	0.97	0.90	63.5	62.4	55.8

NA = no data available (I.e., there are no wells in the corresponding aquifer or plume)
Cr-VI = hexavalent chromium

1.5.2.2 Nature and Extent of Constituents of Interest

On-site Concentrations

On-site concentrations of 1,1-TCA and TCE (and the related dechlorination products) and inorganic constituents occur in a relatively narrow band between the basement of former Building B and the area south of the former disposal basins. The on-site VOC concentrations are limited to the uppermost portion of the Upper Glacial aquifer, whereas concentrations of Cd and Cr were also observed in the lower portion of the Upper Glacial aquifer.

Off-site Concentrations

As shown in Figure 1-6, TCE concentrations (designated as Plume 'A') extend from the Site about 0.75 miles south-southwest toward and intersecting with Massapequa Creek. Chromium and cadmium concentrations (shown in Figure 1-7 through 1-8) occupy a similar footprint.

Another VOC plume (designated 'Plume B' in Figure 1-6) has primarily PCE concentrations and is related to an upgradient, off-site source occupying a footprint shifted slightly to the east from Plume 'A'. As shown in Figure 1-6, Plume 'B' intersects and commingles with Plume 'A' downgradient of the Site.

The nature and extent of Plumes 'A' and 'B' were documented in a previous letter report (Dames & Moore, August 23, 1999) and in the Final CRI Report (URS, July 20, 2000). Up to the point where the two plumes intersect, Plume 'A' and 'B' can be distinguished from one another by: (a) their main constituents; (b) their areal extent; and (c) their apparent source (Plume 'A' has an apparent on-site source, Plume 'B' has an apparent off-site, upgradient source).

Cross Sections

Figures 1-9, 1-10, and 1-11 show cross sections along the main axes of Plume 'A', and the Cr and Cd plumes. It is apparent that Cd and Cr concentrations are almost entirely restricted to the Upper Glacial aquifer (except near MW-29 where chromium was detected in the upper portion of the Magothy aquifer), whereas concentrations of TCE were also detected in the Magothy aquifer between the site and the headwaters of the east branch of Massapequa Creek. However, TCE or other VOCs were not detected in the Magothy aquifer south of well location MW-11.

As described in Section 4.3.9 of the Final CRI Report (URS, July 20, 2000), the mass of site-related TCE, Cr, and Cd in groundwater was estimated using a conceptual box model:

- The estimated total volume of dissolved TCE in Plume 'A' (which is thought to originate from the Site) is 33.9 gallons. The proportion of TCE in the Upper Glacial aquifer is approximately 33.5 percent, compared to about 66.5 percent of the TCE residing in the Magothy aquifer.
- The estimated mass of dissolved Cd is approximately 370 pounds. All of the dissolved Cd appears to be present in the Upper Glacial aquifer.
- The estimated mass of Cr is approximately 378 pounds, 90 percent of which is thought to exist as hexavalent Cr. The proportion of Cr in the Upper Glacial aquifer is approximately 94.5 percent, compared to about 5.5 percent of the Cr residing in the uppermost portion of the Magothy aquifer.

Table 1-5
Estimated Mass of Dissolved Site-Related Constituents

Constituent	On/Off-Site	Upper Glacial Aquifer	Magothy Aquifer	Total %
TCE	On-site	1.4 gallons (4.1%)	0 gallons (0%)	4.1%
	Off-site	9.9 gallons (29.2%)	22.6 gallons (66.7%)	95.9%
Chromium	On-site	32 pounds (8.5%)	0 pounds (0%)	8.5%
	Off-site	325 pounds (86.0%)	21 pounds (5.5%)	91.5%
Cadmium	On-site	62 pounds (16.8%)	0 pounds (0%)	16.8%
	Off-site	308 pounds (83.2%)	0 pounds (0%)	83.2%

Note: the percentages in parentheses express the fraction of sitewide dissolved volume or mass.

It is apparent from Table 1-5 that the bulk of the site-related constituents presently reside within the off-site groundwater plumes (e.g., approximately 96% of the dissolved TCE mass resides off-site, and approximately 83% of the dissolved cadmium mass resides off-site). Despite the fact that the great majority of the constituent mass dissolved in groundwater resides beneath off-site areas, the Group is presently implementing an on-site Interim Remedial Action ('Non-Time Critical Removal Action') at the Site property boundary with the objective to contain and treat on-site groundwater. The Non-Time Critical Removal Action will be considered a component of all groundwater remedial alternatives, as discussed in Sections 3.0 and 4.0 of this Final FS report.

1.5.3 Subsurface Features

1.5.3.1 Constituents of Interest

No site-specific cleanup criteria were developed for solid or aqueous material present in on-site subsurface features (e.g., sumps, drains, leaching chambers). The solid and aqueous materials present in the subsurface features are not considered to represent continuing on-site sources to groundwater impacts (Final CRI report, URS, July 20, 2000). However, the subsurface features (as described in the Final CRI report) may be of potential concern due to a cumulative risk of 1.0 x 10^{-3} excess cancer risk for future construction workers for the eastern portion of the Site (Final BHHRA, URS, July 2000). In addition, the non-cancer cumulative hazard index for the future construction worker was estimated at 34. These excess risk estimates were primarily due to the potential of exposure to aqueous materials in the subsurface features.

Specifically, the principal constituents of concern (PCOCs) that contributed to the excess cumulative cancer risk estimate were benzo(a)pyrene (excess cancer risk of 5.3×10^{-4}) and dibenz(a,h)anthracene (excess cancer risk of 2.4×10^{-4}) from exposure to aqueous material. The PCOPs that contributed to the cumulative non-cancer hazard index were arsenic (HI = 0.18) and copper (HI = 0.7) from incidental ingestion of solid material, and hexavalent Cr (HI = 1.5), PCBs (HI = 30), and 4,4'-DDT (HI = 0.59) from incidental ingestion of aqueous material.

Table 1-7 summarizes the range of the detected concentrations for these PCOCs in solid and aqueous material collected from subsurface features, respectively.

Table 1-6
Principal Constituents of Concern in Subsurface Features

Constituent	PCOP in		Solid Material (mg/kg)		Aqueous Material (mg/L)	
	solid	aqueous	minimum	maximum	minimum	maximum
Benzo(a) pyrene		X			0.0001	0.041
Dibenz(a,h)anthracene		X			0.0001	0.007
4,4'-DDT		X			0.00032	0.0085
Aroclor-1260		X			0.0015	0.033
Arsenic	X		0.54	22.5		
Chromium (hex)	X	X			0.0014	11.4
Copper	X		1.7	21,600		

Since these PCOCs were identified only in regard to future Site uses involving construction activities, and there are no other identifiable excess risks to human health or the environment, the solid and aqueous materials observed in the subsurface features were not included in the screening and detailed analyses of remedial alternatives in this Final FS report.

However, in the absence of formal remedial measures addressing the on-site subsurface features, it is proposed (in the case that future construction activities at the Site involve the uncovering or removal of these subsurface features) to limit and control the potential of human exposure to these materials by the appropriate health and safety measures. In addition, to the extent practicable, the aqueous and solid materials will be removed from the subsurface features prior to or during the implementation of final remedial measures for on-site soils. Such a remedial action would include readily available technologies (such as liquid and sludge removal by vacuum suction) and be implemented separately from the remedial measures contemplated in the Proposed Plan for the Site.

1.5.3.2 Extent of Constituents of Interest

Aqueous Material

Concentrations of SVOCs (primarily polynucleated aromatic hydrocarbons [PAHs], which are common constituents in diesel and other hydrocarbon, fuels) and pesticides were detected at several locations inside Building H. Several of these features are open to the surface (steel grates) and may have collected dripping or leaking vehicle fuels or motor oils, as Building H has been used for various warehousing and storage activities. Other detections of PAHs were noted inside or near Building F and in a drain box outside Building K. The former Site use (storage of automotive equipment in Building F) or the characteristic of these features (open drain boxes with steel grates) is consistent with the detected concentrations of fuel-related residues in the aqueous samples from the subsurface features.

Although SVOCs and pesticides (specifically the PCOCs benzo(a)pyrene, dibenz(a,h)anthracene, and 4,4'-DDT) were detected in several of the on-site subsurface features, these constituents are generally not mobile and are not transferred to groundwater. Note that the RI report (Weston, 1994) and the Final CRI report (URS, July 20, 2000) concluded that SVOCs and pesticides are not constituents of concern in either on-site or off-site groundwater.

Solid Material in Subsurface Features

Although various organic constituents (BTEX compounds, chlorinated VOCs, SVOCs, and pesticides and PCBs) were detected in many of the subsurface features described in the Final CRI report (URS, July 20, 2000), the Final BHHRA (URS, July 2000) concluded that the PCOCs for potential exposure to solid materials are limited to arsenic, copper, and chromium.

The maximum arsenic, chromium, and copper concentrations were detected at locations outside Building F and inside Building W. The presence of these constituents may be related to past waste management practices, but more likely is related to the presence of individual fill components (steel, nails, metal debris, treated wood) in the solid material. Regardless of the nature and extent of these concentrations in the subsurface features, the RI report (Weston, 1994) and the Final CRI report (URS, July 20, 2000) concluded that chromium in groundwater is only present downgradient of the former disposal basins. Chromium was not detected in groundwater beneath the central and eastern portion of the Site (where the majority of the subsurface features is located), and therefore the solid material observed in the subsurface features does not represent potential sources of groundwater impacts.

1.5.4 Other On-site Features

Several on-site features will be further investigation and/or remediated (if necessary) prior to or during the implementation of the on-site soil remedy. These features include several buried underground storage tanks (USTs) that, for various reasons, were not completely evaluated during the CRI activities. In addition, several subsurface features (drains, manholes, or shallow vaults) were not investigated or were not sampled during the CRI activities (as described in the Final CRI report, URS, July 20, 2000). Specifically, Appendix O of the Final CRI report provides descriptions of these work plan modifications during the implementation of the CRI activities. The extent to which the potential USTs and subsurface features require further investigation will be determined based on the discussion provided in the Final CRI report.

In general, the underground tanks were either not accessible during the CRI or could not be investigated without risking injury or damage to existing on-site structures. Two of the suspected tank features in question ('Site 4' north of Building C and 'Site 2' between Buildings H and U [as described in the Final CRI report, URS, July 20, 2000]) are located outside the area targeted for soil remediation. Absent additional evidence that these features represent significant sources to soil or groundwater impacts (such as evidence obtained during future investigations), no further action should be required for 'Site 4' and 'Site 2'. However, if all or portions of the Site that include 'Site 4' and 'Site 2' become subject to development and related construction activities (for a purpose consistent with the use restrictions placed on the Site), such activities would have to be consistent with the potential presence of buried features at 'Site 4' and 'Site 2'.

One suspected tank feature ('Site 12' east of the Building S foundation, as described in the Final CRI report, URS, July 20, 2000) could not be located during the CRI activities, using remote geophysical methods. Although 'Site 12' is located outside the areas targeted for soil remediation, it is sufficiently close to targeted excavation areas (former disposal basin #2) and capping areas as to interfere with these potential remedial activities. Therefore, prior to conducting an on-site soil remedy, the vicinity of 'Site 12' will be investigated fully. This may include further attempts at locating the suspected tank feature using remote methods and/or uncovering of the area to verify the presence/absence of the suspected tank feature. In the case that a tank feature is observed at or near 'Site 12', the content of the tank and the adjacent and subjacent soils will be sampled and the soil analytical results evaluated against the NYSDEC TAGM criteria for the protection of groundwater. If necessary, the tank and its content (if any) will be removed.

One buried tank feature is suspected to be present at the northwest corner of the former Building N foundation. This feature is located within the area south of the former disposal basins that is targeted for soil remedial activities (excavation or capping). Therefore, prior to conducting the on-site soil remedy, the northwest corner of the former Building N foundation will be investigated fully. This may include attempts at locating the suspected tank feature using remote methods and/or uncovering of the area to verify the presence/absence of the suspected tank feature. In the case that a tank feature is observed, the content of the tank and the adjacent and subjacent soils will be sampled and the soil analytical results evaluated against the NYSDEC TAGM criteria for the protection of groundwater. If necessary, the tank and its content (if any) will be removed.

1.5.5 Other Off-site Media (Soil in Ellsworth-Allen Park, Sediment and Surface Water in Massapequa Preserve, Fish from Massapequa Preserve)

The Final BHHRA (URS, July 2000) determined that there are no potential risks to adults and children related to recreational activities in Massapequa Preserve (wading, swimming). Similarly, there are no potential risks to children related to recreational activities in Ellsworth-Allen Park near the Site. The final BHHRA also evaluated the potential risks related to the ingestion of fish retrieved from Massapequa Preserve. The total hazard index (HI) for fish ingestion by adults was estimated to be 0.7 (cadmium HQ = 0.56, chromium HQ = 0.14), and by children was estimated to be 1.1 (cadmium HQ = 0.9, chromium HQ = 0.23). HIs greater than 1 indicate the potential of risk. These estimates of potential risk are based on observed maximum fish fillet concentrations of chromium and cadmium in carp (Final CRI report, URS, July 20, 2000) and a conservative scenario for consuming fish caught in Massapequa Preserve. For example, the consumption rates used in the Final BHHRA are equivalent to 51 half-pound fillet portions per year for adults and 35 quarter-pound fillet portions per year for children (note that these fish intakes assume that all fish is derived from Massapequa Preserve). Therefore, based on the risk evaluation presented in the Final BHHRA (URS, July 2000), adults are not at risk and children are slightly at risk from ingesting fish obtained from Massapequa Preserve.

2.0 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

2.1 GENERAL REMEDIAL ACTIONS

2.1.1 On-Site Soil

The general remedial actions are those actions that will satisfy the RAOs identified in Section 1.3.1. The following general actions are considered to be appropriate and applicable for the mitigation of Cd, Cr, and VOC concentrations in on-site soils. Note that some broad areas of possible remedies are not presented (e.g., thermal or biological treatment technologies) due to their not being applicable:

(a) No Action – Under this action, no remedial actions will be conducted relative to the soil impacts. Under the National Contingency Plan (NCP), it is required to consider this action to provide a baseline comparison to all other general actions.

(b) Institutional Controls – Under this action, institutional controls will be required for the Site to prevent Site activities that could increase impact or risk to human health or the environment. This action could be performed by itself or in conjunction with other actions at the site.

(c) Collection (Excavation) – Under this action, soils with concentrations greater than a desired limit would be excavated from the ground. Excavated soil would then be treated and disposed off-site, or placed beneath an on-site cover system.

(d) Cover Systems – Under this action, soil with concentrations greater than a desired limit would be capped with an engineered cover system to minimize percolation of surface water through the impacted soil. The covered soil would consist of undisturbed impacted soil and/or impacted soil that is consolidated and placed above or below the existing grade.

(e) Treatment – This action alters the constituents of concern in on-site soils to render the constituents less toxic, less mobile, or of reduced volume. Treatment actions may be performed in-situ, or, when coupled with collection actions, ex-situ. The treatment action encompasses physical or chemical treatment technologies.

(f) Placement – This action addresses the ultimate location of constituents, treated media, and treatment residuals. It generally encompasses on-site consolidation, off-property disposal, or a combination of these or related actions.

(g) Stormwater Controls – This action addresses site work that can be performed to control stormwater at the Site to minimize infiltration of surface water in areas with elevated concentrations.

2.1.2 Groundwater

The general remedial actions are those actions that will satisfy the RAOs identified in Section 1.3.2. The following general actions are considered to be appropriate and applicable for the mitigation of the groundwater plumes in the Upper Glacial and Magothy aquifers:

(a) No Action – Under this action, no remedial actions will be conducted relative to the groundwater impacts. Under the NCP, this action is required to be considered to provide a baseline comparison to all other general actions.

(b) Subsurface Barriers – Under this action, a subsurface barrier would be installed perpendicular to the natural groundwater flow. The barrier would consist of a material that would greatly reduce or eliminate the migration of constituents in the groundwater flow, by containing the groundwater.

(c) Groundwater Collection – A collection remedial action removes or collects the constituents from the environment without altering either the physical state or the chemistry of the constituents. In the case of groundwater plumes, the collection action is coupled with either treatment or disposal actions for the overall remedial alternative.

(d) Treatment – This action alters the constituents of concern in the groundwater plumes to render the constituents less toxic, less mobile, or of reduced volume. Treatment actions may be performed in-situ, or, when coupled with collection actions, ex-situ. The treatment action encompasses physical, chemical, biological, or thermal treatment technologies.

(e) Placement – This action addresses the ultimate location of constituents, treated media, and treatment residuals. It generally encompasses on-site recharge of treated groundwater, off-property discharge (either to groundwater, surface water, or publicly owned treatment works) of treated and/or pretreated groundwater, and off-site disposal of treatment residuals such as treatment plant sludges and exhausted treatment media (activated carbon, ion exchange resins, etc.).

(f) In-Situ Remediation – This action removes constituents from the environment without the need to extract groundwater from the aquifer. This approach minimizes the wastes generated and avoids groundwater withdrawal for nonproductive purposes. Generally, in-situ remediation relies on biological, physical, chemical, or physicochemical treatment, or a combination of these processes, to achieve the remedial action objectives.

2.2 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

The remedial technologies and technology process options applicable to each general remedial action are identified in this section. Table 2-1 presents a summary of the initial screening of the remedial technology types and process options.

During the initial screening step, process options and remedial technologies are removed from further consideration if they fail the screening for technical implementability. The remedial technology screening was performed using information gained during the RI and CRI and is based on screening within the previous feasibility studies performed for on-site groundwater and soils. Therefore, the screening (fail/pass) of the remedial technology process options shown in Table 2-1 is only briefly described.

2.2.1 On-Site Soil

2.2.1.1 No Action

Description: Under this action, no remedial actions will be conducted relative to the soil impacts. Under the NCP, this action is required to be considered to provide a baseline for all other general actions.

Initial Screening: No Action will be retained.

2.2.1.2 Institutional Controls

Description: Under this action, institutional controls such as deed restrictions will be required for the Site to protect human health by preventing any use of the Site other than commercial/industrial. This action could be performed by itself or in conjunction with other actions at the site.

Initial Screening: Institutional Controls will be retained.

2.2.1.3 Collection (Excavation)

Description: Under this action, soil would be excavated from the Site using earth-moving equipment. The excavation of soil would be extended to a depth sufficient to collect the soils with concentrations greater than the targeted concentration. Due to elevated concentrations being present at different horizontal layers, soils with concentrations less than the targeted concentration may be required to be excavated in order to collect targeted soil beneath it.

Initial Screening: Collection (Excavation) is a common and easy to implement collection strategy. This technology will be retained for further evaluation.

2.2.1.4 Cover System

(a) Single-Layer Cap

Description: Under this action, a single-layer cap (constructed of clay, asphalt, concrete, geosynthetics, etc.) will be installed over the impacted soils. This type of cap will redirect the majority of surface water away from the capped area and reduce the potential for generating leachate.

Initial Screening: Single-layer caps are effective at preventing the vast majority of surface water from infiltrating into the subsurface. They require maintenance, as they are susceptible to puncturing, cracking, and differential settlement. This technology will be retained for further evaluation.

(b) Dual-Layer Cap

Description: Under this action, an engineered cap will be constructed over the impacted soils. This type of cap consists of two layers, typically a geosynthetic liner under a concrete or asphalt cover or other engineered cover type. This type of cap can be less permeable than a single-layer cap, be more reliable against surface water infiltration, and will redirect the vast majority of surface water away from the capped area.

Initial Screening: Dual-type caps are effective at preventing the vast majority of surface water from infiltrating into the subsurface and minimizing leachate generation. This technology will be retained for further evaluation.

(c) Multi-Layer Cap

Description: Under this action, a multi-layer cap, such as a RCRA-engineered cap, would be constructed. The cap would be placed on a compacted and graded soil base. The cap would typically consist of a soil layer, compacted clay, soil layer, geosynthetic material, drainage layer, and vegetation. This type of cap is typically used for hazardous waste landfills and is designed to prevent any infiltration of surface water into the subsurface.

Initial Screening: Multi-layer caps are very effective and have long-life in the field. However, they are more costly than other types of caps. The level of protection afforded by multi-layer caps is not warranted at the site from a practical and regulatory basis. Therefore, this technology will not be retained for further evaluation.

2.2.1.5 Treatment

Various treatment technologies were reviewed for this FS, including chemical, physical, thermal, and biological options. Thermal and biological options were not pursued further, due to their inability to adequately address metals-impacted soils.

(a) Chemical Treatment

Soil Washing

Description: Under this ex-situ action, excavated soil is treated with washing solutions (e.g., surfactants, solvents) to extract the constituents from the soil. This action would require several steps to apply the washing fluid, extract the constituents, concentrate the constituents, and then recover/remove the washing fluid from the remaining soil.

Initial Screening: As noted in previous correspondence (comment letter from the Liberty Group, dated September 25, 1997), stand-alone soil washing was eliminated for various reasons. However, in conjunction with other technologies (e.g., soil separation) soil washing can be effective. Therefore, this technology will be retained for further evaluation.

Soil Flushing

Description: Under this action, constituents in the soil are flushed in-situ using a flushing agent (e.g., surfactants). The flushing fluid increases the mobility of the constituents, allowing the constituents to migrate where they can be recovered or treated.

Initial Screening: Due to the potential to impact groundwater, this technology will not be retained for further evaluation.

Stabilization

Description: Under this action, soil is mixed with the reagents or additives in either an in-situ or ex-situ manner to stabilize the soil. This process encapsulates and/or fixates the constituents in the soil matrix.

Initial Screening: Although this process would require bench-scale pilot tests to evaluate the effectiveness and susceptibility to leaching, this technology presents a viable alternative to off-site disposal or on-site capping of soils. Therefore, this technology will be retained for further evaluation.

(b) Physical Treatment

Vacuum Extraction

Description: Under this action, a vacuum is placed on a well screened in the vadose zone, which will draw air through the soil matrix. This movement of air will volatilize the organic compounds from the soil to the surface, where they can be treated prior to discharge to the atmosphere, if required. This technology may be suitable for the limited areas of known elevated VOC concentrations that are located outside the areas targeted for remediation of metals concentrations.

Initial Screening: Vacuum extraction does not address metals, however, it can address organic constituents in areas where metals are not an issue, or it can be used with other technologies. This technology will be retained for further evaluation.

Soil Separation

Description: Under this action, excavated soil is separated into finer fractions (less than 45 μm grain diameter, estimated to represent about 10 to 15 percent of Site soils by volume) and the corresponding coarser fraction (estimated to represent about 85 to 90 percent of Site soils by volume). It is expected that the bulk of the mass of metal constituents will reside in the finer fraction. The coarser fraction will contain lesser concentrations and is amenable for further treatment, if necessary (i.e., soil washing or stabilization), and subsequent use for backfill.

Initial Screening: Soil Separation is effective in reducing the contaminant volume and facilitates other treatment options. It can be used alone or with other technologies (e.g., subsequent soil washing or stabilization). This technology will be retained for further evaluation.

2.2.1.6 Placement

(a) On-Site Placement

Description: Under this action, excavated soil would be placed into on-site areas that have Cd concentrations greater than the targeted concentration limit of 10 mg/kg. Such on-site consolidation would reduce the areal extent of the impacted soil of interest. The consolidation area can then be capped with a cover system. Clean fill may be required for placement in the excavated areas to restore the site to the original grade.

Initial Screening: Consolidation could reduce the capping costs for the site. In addition, on-site consolidation presents an alternative to off-site disposal of excavated soils. This technology will be retained for further evaluation.

(b) Off-Site Disposal

Description: Under this action, excavated soil would be transported to an approved off-site disposal facility. Clean fill may be required for placement in the excavated areas to restore the site to the original grade.

Initial Screening: Off-site disposal is a viable alternative for the site. This technology will be retained for further evaluation.

2.2.1.7 Stormwater Control

(a) Grading

Description: Under this action, the topography at the site can be changed to direct the stormwater runoff and further reduce the impact of the residual constituents in the soil. For example, the site could be graded to direct surface runoff from a cover system to an area with minimal VOC or metals impacts and minimize ponding by the cover system.

Initial Screening: Grading can minimize the impact of residual soil concentrations. This technology will be retained for further evaluation.

(b) Stormwater Collection System

Description: Under this action, a stormwater collection system (e.g., catch basins, piping) is installed to collect and direct surface water to a stormwater detention basin. The basin would be constructed by excavating 'clean' soil (ideally for placement in other excavated areas to restore grade). The excavated 'clean' soil (e.g., concentrations less than the targeted Cr and Cd concentrations could be placed in the basin areas or in areas where soil has been excavated.

Initial Screening: This technology will be retained for further evaluation.

2.2.2 Groundwater

Portions of this groundwater feasibility evaluation were adapted from the 1997 Final Focused Feasibility Study (FFS) for On-Site Groundwater by Weston (1997a) and the 1997 FFS and Preliminary Engineering Design (PED) for In-Situ Groundwater Remediation (Dames & Moore, 1997).

2.2.2.1 No Action

Description: Under this action, no remedial actions will be conducted relative to the impact to groundwater (on- and off-site). Under the NCP, this action is required to be considered to provide a baseline for all other general actions.

Initial Screening: No Action will be retained.

2.2.2.2 Subsurface Barriers

Description: Slurry walls, sheet piling, grout curtains, and diaphragm walls are used for long-term waste containment, and groundwater diversion and control. These barriers are relatively impermeable and are used to prevent groundwater flow past the barrier. To prevent underflow of impacted groundwater, the barriers are typically keyed into underlying confining clay layers below an aquifer.

Initial Screening: These options were not retained for further consideration because of the absence of a competent and laterally continuous confining layer beneath the Upper Glacial aquifer at the Site.

2.2.2.3 Groundwater Collection

Groundwater collection techniques actively manipulate groundwater heads to contain or extract groundwater in the impacted portion of the aquifer, and to prevent the migration of impacted groundwater. Well types used in groundwater collection may include well points, ejector wells, and pumping wells, with the selection of the appropriate well type depending on the depth of groundwater impacts and the hydrogeologic characteristics of the aquifer.

(a) Well Point Dewatering Systems

Description: A well point dewatering system consists of an array of well points (constructed of steel pipes with perforated tips) that are driven into the aquifer and connected at the surface by a manifold hooked up to a vacuum system.

Initial Screening: Well point dewatering systems are best suited for shallow aquifers. At the site, groundwater impacts are also present at greater depths; therefore, well point dewatering systems were not retained for further evaluation.

(b) Ejector Wells

Description: Ejector well construction specifications are similar to those of well points. Pumping and extraction of groundwater are achieved by bubbling air upward through the well casing and allowing the air pressure to lift the groundwater to the surface. Ejector wells are generally applicable for high-lift, low-flow conditions.

Initial Screening: Ejector well specifications require high-lift, low-flow conditions. These conditions are not met at the site; therefore, ejector wells are not further evaluated.

(c) Pumping Wells

Description: Pumping wells are similar to traditional wells and are installed in a boring consisting of riser casing, well screen, and sand filter pack. The wells can be installed at appropriate intervals across a site to allow for the overlapping of capture zones, which will achieve the collection of impacted groundwater and therefore arrest the further downgradient migration of the constituents of interest.

Initial Screening: Pumping wells will be retained for further evaluation.

(d) Subsurface Drains

Description: Subsurface drains include any type of buried conduit used to convey and collect groundwater by gravity flow. Subsurface drains installed at regular intervals across a site are constructed by the excavation of trenches in the aquifer of concern, placement of a perforated drainage pipe in the base of the trench, and backfilling of the trench with aggregate. The individual drainage pipes subsequently drain into a collection sump, which can be emptied periodically.

Initial Screening: Subsurface drains are most effective for shallow depths of less than 20 feet and for low-flow, low-conductivity aquifers. At the site, groundwater impacts are present at depths greater than 20 feet; therefore, subsurface drains are not retained for further evaluation.

2.2.2.4 Treatment - Groundwater

(a) Physical

Coagulation, Flocculation, and Sedimentation

Description: Coagulation, flocculation, and sedimentation are the combination of three processes for the removal of solids in water. Sedimentation is the separation of suspended particles that are heavier than water by gravitational settling. Coagulation is a chemical technique directed towards the destabilization of colloidal particles in the water into larger particles that can settle out. Flocculation is a slow mixing technique that promotes the agglomeration of the destabilized particles to precipitate them out of the water.

Initial Screening: Coagulation, flocculation, and sedimentation can be an integral part of any aqueous treatment system, wherein the removal of suspended solids is required. Reduction of organics and dissolved inorganic constituents will also require treatment via other physical or chemical processes. This treatment technology will be retained for further evaluation.

Filtration

Description: Filtration is the separation and removal of suspended solids from a liquid by passing the liquid through a porous medium comprised of a fibrous fabric, a screen, or a bed of granular material.

Initial Screening: Filtration is used primarily to remove any residual suspended solids remaining in the water following coagulation/sedimentation. This treatment technology will be retained and considered.

Granular Activated Carbon

Description: Organic constituents of interest can be removed from water by the physical and chemical adsorption onto the surface of carbon particles. Water is pumped through a bed of granular activated carbon where close contact with carbon particles promotes adsorption of the constituents. Carbon adsorption removes a broad range of organic constituents. The exhausted carbon must be removed for disposal or regeneration.

Initial Screening: The technology is very effective for the removal of volatile organic constituents and generally achieves high removal efficiency. The process will be retained for further evaluation.

Ion Exchange

Description: Ion exchange is a process by which ions of a given species are displaced from an insoluble exchange material by ions of a different species in solution. Spent resin is usually regenerated by exposing it to a very concentrated solution of the original exchange ion, enabling a reverse exchange to take place, resulting in regenerated resin and a concentrated solution of the removed ion, which can then be processed for recovery or reuse.

Initial Screening: The process is used to remove cationic or anionic metal species from water. The limitations to the ion exchange process are compound selectivity or competition, pH dependency of the resin for optimal performance, and the presence of suspended solids. The ion exchange process will be retained for further evaluation.

Chelation

Description: Chelation is a chemical process in which ionic species (such as cationic metals) form coordination bonds with molecules called ligands. Ligands are usually attached to an inert matrix (such as silica gel) and have the effect of removing dissolved ionic species from solution and tying them to the solid matrix. Ligands are generally pH sensitive and selective for specific metal groups. When the loading capacity is reached, the chelating medium must be regenerated.

Initial Screening: The process is used to remove cationic or anionic metal species from water. The chelation process can be highly selective for the metal species of interest. The limitations to the chelation process are compound selectivity or competition, pH dependency of the ligands for optimal performance, and the presence of suspended solids. The chelation process will be retained for further evaluation.

Air Stripping

Description: Air stripping is a mass transfer process in which volatile constituents in water are transferred into the air. Air stripping is frequently accomplished in a packed tower equipped with an air blower. The factors important in the removal of organics from water include Henry's Law constant, temperature, pressure, air-to-water ratios, and the surface area available for mass transfer.

Initial Screening: Air stripping is most effective for the removal of volatile constituents as a pretreatment step prior to activated carbon. The process will be retained for further evaluation.

Steam Stripping

Description: Steam stripping uses steam to evaporate volatile constituents from water. Stream stripping is essentially a continuous fractional distillation process, which may be carried out in a packed or tray tower.

Initial Screening: Due to the relatively low concentrations of volatile constituents in the Upper Glacial aquifer, steam stripping is not considered further.

Reverse Osmosis

Description: Reverse osmosis uses a semi-permeable membrane that will allow the passage of only certain components of a solution, and a driving force to separate these components at a useful rate. The membrane is permeable to the solvent (groundwater), but impermeable to most dissolved organics and inorganic constituents.

Initial Screening: Reverse osmosis is a high-cost treatment alternative and is suitable only for low-volume applications. Because the anticipated groundwater volume that will require treatment is large, reverse osmosis will not be considered further.

Thickening/Dewatering

Description: Thickening/dewatering is a process used to increase the solids content of sludge by removing a portion of the liquid fraction by processes such as filtration or evaporation.

Initial Screening: The process is generally used for the treatment of wastewater sludges (such as those that may be generated from a pump-and-treat system) and will be retained for further evaluation.

(b) Chemical

Neutralization

Description: Neutralization is the interaction of an acidic solution with an alkaline solution to achieve the adjustment of pH in the resulting mixed solution.

Initial Screening: The process is generally used for the treatment of wastewater or any water that requires pH adjustment prior to another treatment process. Neutralization will be retained for further consideration.

Chemical Precipitation

Description: Chemical precipitation is widely used for the removal of dissolved heavy metals from groundwater. The solubility constant of an ionic metal species is lowered through the addition of an acidic (to precipitate anionic species) or alkaline (to precipitate cationic species) solution. The resulting precipitate (frequently in the form of insoluble hydroxides) separates from the solution either as colloidal or solid particulates.

Initial Screening: Chemical precipitation may be utilized as part of a pump-and-treat train for the treatment of metals. The process is generally limited in that not all metals have a common pH at which they precipitate. For example, the presence of cationic (such as Cd^{2+}) and anionic (such as Cr^{6+} in the form of CrO_4^{2-}) species generally requires two separate treatment steps. Chemical precipitation will be retained for further evaluation.

Ultraviolet/Oxidation

Description: Ultraviolet radiation causes the rearrangement of molecular structures, resulting in the formation of new chemical compounds. Conventional ultraviolet/oxidation techniques utilize a liquid-phase reaction wherein an oxidant (hydrogen peroxide or ozone) is bubbled through the water. The mixture is then exposed to ultraviolet radiation in a mixing tank, leading to the degradation of the constituents and the splitting of the peroxide into free oxygen, causing further oxidation of the constituents.

Initial Screening: Ultraviolet/oxidation is generally best suited for low flow situations. Due to the anticipated flow rates at the Site, this process will not be retained for further evaluation for the treatment of VOCs.

(c) Biological

Suspended Growth - Activated Sludge

Description: The activated sludge process only breaks down the organic constituents in the water through the activity of aerobic microorganisms that metabolize biodegradable organics.

Initial Screening: The process will not be further evaluated, due to the low content of organics in the groundwater and the presence of chlorinated organics and heavy metals.

Fixed Film Growth (e.g., Rotating Biological Contactor, Trickling Filters)

Description: Rotating biological contactors employ microorganisms attached to a fixed medium that is rotated through the water in a closed reactor. In a trickling filter, the influent wastewater is distributed over fixed media that serve as a substrate for the microbes. A fixed film growth system aerobically treats impacted groundwater containing alcohol, phenols, phthalates, cyanide, and ammonia.

Initial Screening: The process will not be further evaluated, due to the low content of organics in the groundwater and the presence of chlorinated organics and metals.

(d) Thermal

Liquid Injection Incineration

Description: Liquid injection incinerators are usually refractory secondary combustors for low-calorific material. A liquid waste would be introduced to the combustion chamber by means of specifically designed nozzles that mix with air and fuel as needed.

Initial Screening: Heavy metal constituents and waste streams with high inorganic contents are not suitable for treatment. The process will not be retained for further evaluation.

Pyrolysis

Description: Pyrolysis is the chemical decomposition of waste material accomplished in an oxygen-deficient atmosphere at elevated temperatures.

Initial Screening: Pyrolysis is only applicable to waste materials that contain pure organic constituents. The process will not be retained for further evaluation.

2.2.2.5 Placement - Disposal of Groundwater/Treatment Sludges

(a) Off-Site Disposal

Discharge to Local Publicly Owned Treatment Works

Description: In this option, groundwater would be routed to a nearby publicly owned treatment works (POTW) following pretreatment to comply with the facility's pretreatment standards.

Initial Screening: At present, this option is feasible, assuming that the POTW's flow and discharge requirements can be met. This option will be retained for further evaluation.

Disposal to Off-Site Treatment, Storage, and Disposal Facility (TSDF)

Description: This option entails off-site hauling of wastes treated to the levels necessary for acceptance at an approved off-site TSDF.

Initial Screening: This option is not applicable to groundwater at the site because of the large volume of groundwater that would have to be transported to the TSDF. However, this may be a viable alternative for treatment sludges, and will be retained for that application.

(b) On-Site Disposal

Discharge to Surface Water

Description: In this disposal option, treated groundwater would be directly discharged to the stormwater conveyance system at the site. The receptor of such discharge would be the eastern branch of Massapequa Creek.

Initial Screening: This disposal option is feasible assuming that direct discharge effluent quality requirements and flow volume requirements can be met. This option will be retained for further evaluation.

Reinjection

Description: Reinjection involves recharge of treated groundwater back into the aquifer.

Initial Screening: Reinjection of treated groundwater must occur outside the limits of groundwater impacts to be effective. This option will be retained for further evaluation.

2.2.2.6 In-Situ Remediation

(a) Biological

Bioremediation

Description: Various potential bioremediation methods have been investigated and/or developed for chlorinated VOCs (such as TCE or *cis*-1,2-DCE), which may include reductive dechlorination or methanogenic degradation. For the purposes of this alternative, anaerobic reductive dechlorination has been selected as the process option for analysis because of the nature of the groundwater impacts. It would be accomplished by injection of co-metabolic substrates into and upgradient of the impacted area, which would trigger a series of in-situ reactions causing the breakdown of TCE and *cis*-1,2-DCE to less chlorinated and generally less harmful compounds (e.g., ethene, CO_2, water) via anaerobic reductive dechlorination.

Although the primary focus of anaerobic bioremediation is typically chlorinated organic constituents, the low redox potentials that result from the biological consumption of dissolved oxygen may contribute to the reduction and precipitation of dissolved metals within the aquifer.

Initial Screening: The treatment technology was tested for inorganic and organic constituents at the site during the pilot test program for the Non-Time Critical Removal Action in the Upper Glacial aquifer (Dames & Moore, June 3, 1999). The results indicated that, within the allotted test period of nearly four months, a sufficiently large or sufficiently effective reactive zone was not established and no significant reduction of the constituents of interest was observed. The engineered process option will not be retained for further evaluation in the high-flow and oxygen-rich conditions in the Upper Glacial aquifer (note that the presence of *cis*-1,2-DCE in the Upper Glacial aquifer clearly indicates that dechlorination reactions are naturally occurring, albeit at a rate that is not sufficient to completely degrade the available TCE). However, the option (both engineered and natural attenuation via biologically mediated reactions) will be retained for the Magothy aquifer, where flow and redox conditions may be more amenable.

(b) Physical

Groundwater Circulation Wells (GCW)

Description: GCW technology involves the creation of a groundwater circulation pattern to contain and/or treat groundwater. Air-lift pumping (density driven convection [DDC type GCW]) or down-hole pumps (UVB-type GCW) are used to lift groundwater. Treatment in the DDC-type GCW (typically one lower influent and one upper effluent screen) occurs via transfer of the volatile constituents into the entrained air phase, air-water separation by decompression in the well casing, and subsequent removal of these constituents via an appropriate technology (such as vapor-phase GAC). The treatment of volatile constituents in the UVB-type GCW (one or more influent and effluent screens) is more flexible and may occur by a variety of processes, including 'open-loop' air stripping at the wellhead or an appropriate 'closed-loop' technology (e.g., liquid-phase GAC). The treated groundwater is then forced away from the GCW by recirculating groundwater through the effluent screen(s). A portion of the treated groundwater leaves the circulation cell, while another portion of the treated groundwater flows toward (i.e., recirculates) to the influent screen(s). Therefore at any given time, the influent groundwater consists of both recirculated treated groundwater and upgradient impacted groundwater. The ratio of recirculated treated groundwater and upgradient groundwater is dependent on the specific hydraulic conditions and the circulation well configuration. The flow rate, well spacing, and orientation of the circulation cell(s) may be varied to achieve the desired radius of influence and capture zone (at a given removal efficiency for the constituents of interest).

Initial Screening: The in-situ GCW technology was successfully tested for its hydraulic characteristics and removal of organic constituents at the site during the pilot test program for the Non-Time Critical Removal Action in the Upper Glacial aquifer (Dames & Moore, June 3, 1999). The results indicated that, within the allotted test period of three weeks each for the UVB-type and DDC-type, recirculation cell(s) were established, groundwater flow within the capture zone was redirected from the effluent toward the influent screen(s), and organic constituents near the GCW were removed. The testing period (less than the time required for one complete pore volume flushing due to the creation of circulation cells) was too short to quantify the extent of organic constituent removal. The process will be retained for further evaluation.

Air Sparging

Description: In-situ air sparging of the groundwater would be conducted by constructing sparge points (wells) to the appropriate depths into the impacted aquifer. Aeration would be provided at each sparge point by blowers/compressors and, as necessary, an aboveground header/distribution system. A soil vapor extraction system (SVE) (vents and vacuum blowers) with off-gas treatment could be used to capture VOC-laden air from the vadose zone above the sparge point system.

Initial Screening: Air sparging is effective in removing VOCs from the groundwater; however, it is less desirable due to costs and difficulty of implementation and operation. In addition, it does not address metals impacts to groundwater. The process will not be retained for further evaluation.

(c) Chemical

Permeable Reactive Barrier Treatment Walls

Description: Reactive treatment walls (e.g., reactive iron walls) involve the construction of permanent, semi-permanent, or replaceable units across the flow path of a groundwater plume. As the impacted groundwater moves passively through the treatment wall, the constituents are removed by physical, chemical, and/or biological processes, including precipitation, sorption, oxidation/reduction, fixation, or degradation.

Initial Screening: Treatment or reactive barrier walls can be designed for the abatement of both organic and inorganic constituents of interest. The process will be retained for further evaluation.

Funnel-and-Gate Treatment Walls

Description: The funnel-and-gate system for in-situ treatment of impacted plumes consists of low hydraulic conductivity (e.g., $1x10^{-6}$ cm/sec) cutoff walls with gaps that contain in-situ reaction zones. Cutoff walls (the funnel) modify flow patterns so that groundwater primarily flows through high-conductivity gaps (the gates). Typically, the wall needs to be keyed into a low permeability unit.

Initial Screening: Since an appropriate low-permeability unit (to key in the cutoff wall) is not consistently present at the site, the process will not be considered further.

(d) Physicochemical

In-Situ Direct Precipitation

Description: This group of approaches would involve the injection of reactive materials into the impacted aquifer zone to result in the precipitation of metals into or onto the solid aquifer matrix. The precipitated metals would be bound within the aquifer matrix with limited or significantly reduced mobility and/or potential for remobilization under future groundwater conditions. The addition of an organic substrate to the aquifer will stimulate microbial activity and, under suitable conditions (including the presence of sufficient sulfate species in the groundwater), the biological activity results in the lowering of the aquifer redox potential and formation of insoluble sulfide or hydroxide precipitates.

Initial Screening: The treatment technology was tested for inorganic and organic constituents at the Site during the pilot test program for the Non-Time Critical Removal Action in the Upper Glacial aquifer (Dames & Moore, June 3, 1999). The results indicated that, within the allotted test period of nearly four months, a sufficiently large or sufficiently effective reactive zone was not established and no significant reduction of the constituents of interest was observed. The process will not be retained for further evaluation.

Natural Attenuation

Description: Natural attenuation would involve the demonstration that natural processes are effective in arresting, slowing, or attenuating the migration of Site constituents. Natural attenuation differs from "No Action" in that it is implemented only if it can be demonstrated that natural attenuation will reduce the constituent levels to meet the Remedial Action Objectives (RAOs) and Applicable or Relevant and Appropriate Requirements (ARARs). Natural attenuation processes for metals include precipitation, sorption, and partitioning onto or into aquifer materials (e.g., mineral surfaces, mineral structures, and organic carbon), either as ionic species or as compound molecular or colloidal species. Natural attenuation for organic constituents may include retardation, sorption, and partitioning onto or into aquifer materials (e.g., mineral surfaces, mineral structures, and organic carbon) or biodegradation (such aerobic or anaerobic dechlorination). Other natural attenuation processes that are common to both groups of constituents include dispersion and dilution.

In accordance with EPA's OSWER Directive 9200.4-17P (effective date, April 21, 1999) a site-specific demonstration of the applicability of Natural Attenuation is generally needed. This demonstration would involve periodic sampling and analyses of a monitoring well network (existing and supplemented with additional wells) for constituents of concern, as well as, indicator parameters for natural attenuation. Further, appropriate fate and transport modeling would be conducted to predict the time scale of attenuation of constituents. Note that the effectiveness of natural attenuation is typically based on empirical monitoring data, which may be projected into the future by appropriately calibrated fate and transport models.

Initial Screening: At this time natural attenuation cannot be fully evaluated because the necessary physical, chemical, and microbiological data are not available to document its effectiveness. For example, the monitoring frequency of constituent concentrations in on-site and off-site groundwater is not sufficient at this time to document specific degradation or attenuation patterns. However, the Group is presently conducting a site-specific fate and transport modeling study to support a Monitored Natural Attenuation demonstration once the necessary monitoring data are available. Natural attenuation will be retained for further evaluation.

2.3 EVALUATION OF TECHNOLOGY PROCESS OPTIONS

In this section, the technology process options considered to be technically implementable are evaluated in greater detail. The objective of this screening step is to reduce the number of representative process options for each remedial technology type and to simplify the subsequent development and evaluation of alternatives without limiting flexibility during the remedial design.

The representative processes selected provide a basis for developing performance specifications during the preliminary design stage; however, the specific process or processes actually used in the implementation of the remedial action at the Site may or may not be selected until the remedial design phase.

The process options are evaluated using the criteria of effectiveness, implementability, and cost. An important distinction made at this point is that these criteria are applied only to the remedial technologies and the general remedial actions. They are intended to satisfy the media of concern, and not to the Site as a whole. In addition, the evaluation focuses on the effectiveness criteria, with lesser emphasis directed towards the implementability and cost criteria.

The technology process evaluation criteria are summarized as follows:

Effectiveness

Specific technology process options identified are evaluated relative to other processes within the same technology type. The evaluation focuses on:

1. The potential effectiveness of the process options in handling the impacted media and in meeting the goals identified in the remedial action objectives.
2. Potential impacts to human health and the environment during the construction and implementation stages.
3. Proven performance and reliability of the technology with respect to the constituents and conditions at the Site.

Implementability

Implementability encompasses both the technical and institutional feasibility of implementing the technology process options addressing the treatment of impacted media on- and off-site at the Site. Emphasis is placed on the institutional aspects of implementability, such as the ability to obtain necessary permits and/or meet the substantial requirements of permits for remedial actions, and also the availability of necessary equipment and services.

Cost

Cost plays a limited role in the screening of the process options. The cost estimates generated for each technology are based on engineering judgment and are used for comparing technologies that are able to achieve similar remediation objectives.

2.3.1 Evaluation of Technology Process Options for On-Site Soils

As mandated by NCP, the "No Action" option remains for baseline comparison. Institutional controls were retained, as was collection of soils by excavation. Of the various cover systems evaluated (single-, dual-, and multi-layer caps), the single and dual layer cover systems were retained for further evaluation. Several technologies have been retained to address the on-site organic and inorganic constituents. Therefore, the retained technologies or actions include:

- No Action
- Institutional Controls
- Collection (excavation)
- Cover Systems
  - Single-layer Cover System
  - Dual-layer Cover System
- Treatment
  - Vacuum Extraction for VOCs
  - Soil Separation
  - Soil Washing
  - Soil Stabilization

- Soil Placement
  - On-site Placement
  - Off-site Disposal
- Stormwater Management
  - Grading
  - Stormwater Collection Systems

Limitations

Of the various treatment options, soil vacuum extraction may be used at the Site only to remove VOCs from areas where VOCs are present above the site-specific criteria, but no metals remedial action is anticipated. For example, this technology may be used in the area of the former Building G sump, if no other removal action is recommended for this area. Because there are few (if any) other such areas with VOC concentrations greater than the generic criteria and metals concentrations that are less than the site-specific criteria, vacuum extraction will be included implicitly along with the principal alternatives for on-site soils. These principal alternatives were developed based on the objective to remediate the on-site areas that are impacted by metals.

Likewise, stormwater management is an integral component of several primary technology options (e.g., excavation, capping, and on-site consolidation) that were combined into the on-site soil alternatives presented in Section 3.0. Therefore, stormwater management will not be further discussed as a stand-alone technology, but is implicit within the discussion of the primary technology options (e.g., excavation, capping, and on-site placement).

Extent of Remediation

All options, except No Action and Institutional Controls, will involve some degree of on-site soil excavation and placement. The extent of excavation and on-site/off-site placement are governed by the choice and interpretation of the site-specific criteria for Cr and Cd. This Final FS report considers RAOs for Cr, Cd, and VOCs that are protective of human health (assuming a use restriction for the Site) and groundwater quality. The RAOs for Cr and Cd are 143 mg/kg and 10 mg/kg, respectively. The RAO for VOCs are the generic NYSDEC TAGM soil cleanup objectives for the protection of groundwater. This Final FS report views these RAOs as discrete soil cleanup standards for the protection of groundwater, although such an approach is conservative as it does not consider that infiltration and leaching are path-dependent processes and, as such, may be viewed more appropriately as occurring along the length of the infiltration pathway.

2.3.2 Evaluation of Technology Process Options for Groundwater

As mandated by the NCP, the "No Action" option remains for baseline comparison. None of the 'Containment' general remedial actions relating to subsurface barriers have been retained because of unfavorable hydrogeologic conditions. Pumping wells have been retained under the 'Groundwater Collection' general remedial actions. Several treatment technologies have been retained under the 'Treatment' general remedial action due to the complexity of the groundwater matrix, which will likely require more than one treatment technology to remove both organic and inorganic constituents. Under the 'Disposal' general remedial action, on-site reinjection and disposal of treated groundwater into Massapequa Creek via the stormwater conveyance systems have been retained. Off-site disposal via a TSDF has been retained only for the wastewater sludges, as the anticipated large volumes of pumped groundwater preclude the cost-effectiveness of this option. Under the 'In-Situ Remediation' general remedial action, Groundwater Circulation Wells, Permeable Reactive Treatment Wall, and Monitored Natural Attenuation have been retained. Therefore, the retained technologies or actions include:

- No Action
- Collection
  - Pumping Wells
- Treatment
  - Air Stripping
  - Ion Exchange
  - Thickening/Dewatering
  - Neutralization
  - Granular Activated Carbon
  - Coagulation, Flocculation, and Sedimentation
  - Filtration
  - Chemical Precipitation
  - Chelation

- Disposal

  On-site Reinjection

  Discharge to Surface Water

  Off-site Disposal of Treatment Sludges

- In-Situ Remediation

  Bioremediation (Magothy aquifer only; engineered or naturally occurring)

  Groundwater Circulation Wells (GCW)

  Permeable Reactive Treatment Wall

  Monitored Natural Attenuation

3.0 DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES

In this Chapter, remedial alternatives are developed by assembling combinations of technologies retained from Section 2.3, and the environmental media to which they would be applied. Each alternative is then evaluated with respect to its effectiveness, implementability, and cost.

3.1 EVALUATION CRITERIA AND APPROACH

3.1.1 Criteria

The three evaluation criteria (effectiveness, implementability, and cost) evaluated for each alternative are discussed in EPA's Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (EPA, 1988) and the Handbook for Remedial Action at Waste Disposal Sites (EPA, 1985). A description of each of these criteria follows.

3.1.1.1 Effectiveness

The effectiveness evaluation considers the capacity of each remedial alternative to protect human health and the environment during the construction and implementation phase (short term) and the period after remediation is complete (long term). Effectiveness in the short-term and long-term is related to the reduction in toxicity, mobility, and/or volume of constituents each alternative provides.

3.1.1.2 Implementability

The implementability evaluation is used to assess the technical and administrative feasibility of constructing, operating, and maintaining each remedial alternative. In addition, the availability of the technologies involved in a remedial alternative is considered.

3.1.1.3 Cost

The cost evaluation considers both capital costs and annual operation and maintenance (O&M) costs. These costs are presented on an estimated pre-design basis.

A description of each remedial alternative, including a summary of the effectiveness, implementability, and cost for each of the alternatives, is presented below.

3.2 DESCRIPTION AND EVALUATION OF REMEDIAL ALTERNATIVES

In this Section, the technologies/process options identified previously and retained are grouped into potential remedial alternatives for the on-site soils and sitewide groundwater. These remedial alternatives consist of one or more individual technologies/options retained during the screening process. The alternatives below do not present all combinations, but are limited to those alternatives that best satisfy the criteria of effectiveness, implementability, and costs.

3.2.1 On-Site Soil

Nine soil remediation alternatives were selected based on combinations of technology/process options that passed the screening evaluation and that were considered to be feasible remedial options for the site. With the exception of 'No Action' (SL-1) and 'Institutional Controls' (SL-2), the remedial alternatives (SL-3 through SL-9) presented in this Section are basically permutations of soil collection (i.e., partial or complete excavation of soils with concentrations greater than the cleanup criteria) with various placement and/or treatment options.

Table 3-1 clearly summarizes the various alternatives, their technology components, their extent, and their estimated costs (capital costs, annual operations and maintenance [O&M] costs, and total present worth costs). In addition, Figure 3-1 shows a schematic outline of technology components and criteria underlying the development of the soil remedial alternatives.

3.2.1.1 Alternative SL-1: No Action

(a) Effectiveness

The No Action alternative does not prevent the migration of inorganic and organic constituents from the unsaturated soil column into groundwater and, therefore, does not satisfy the RAO for on-site soils. This alternative provides no reduction in the toxicity, mobility, or volume for the constituents of concern and does not inhibit or control the migration of constituents.

(b) Implementability

This alternative is easily implementable.

(c) Cost

There are no capital and no operations and maintenance (O&M) costs for this alternative.

TABLE 3-1
REMEDIAL ALTERNATIVES FOR ON-SITE SOILS

		Technology Components					Details			Cost		
		Excavation	Capping	Off-site Disposal	Treatment	On-site Placement	Excavation Criterion for Cd, Cr (mg/kg)	Excavation Volume (cubic yard)	Capped Area (acres)	TDCC	Annual O&M	PWC
SL-1										$0	$0	$0
SL-2	X									$53,252	$20,000	$266,901
SL-3	X	X	X			X	120 [1] 10, 143 [2]	25,600	4.25 [3] 4.50 [4]	$3,533,352	$35,000	$5,283,582
SL-4	X	X	X	X			120 [1] 10, 143 [2]	25,600	8.75	$8,354,352	$35,000	$11,309,322
SL-5	X	X	X		X	X	120 [1] 10, 143 [2]	25,600	8.75	$4,461,952	$35,000	$6,610,266
SL-6	X	X	X	X	X	X	120 [1] 10, 143 [2]	25,600	8.75	$7,721,200	$35,000	$10,852,954
SL-7	X	X		X			10, 143	82,000	0	$14,682,582	$20,000	$19,095,178
SL-8	X	X			X	X	10, 143	82,000	0	$9,235,707	$20,000	$12,864,253
SL-9	X	X		X	X	X	10, 143	82,000	0	$12,529,354	$20,000	$16,877,308

Notes to Table 3-1:

SL-1 No Action

SL-2 Institutional Controls with Monitoring

SL-3 Excavation of all soils with Cd concentrations greater than the TCLP characteristic of 120 mg/kg. In addition, excavation of all soils within the 15-21 ft interval and overlying soils where Cd concentrations are greater than 10 mg/kg and/or Cr concentrations are greater than 143 mg/kg. Consolidation of the excavated material into the Northwest Disposal Area where it will be capped with a NYSDEC Section 360-type cover system. The remaining areas where Cd and/or Cr concentrations are greater than 10 and 143 mg/kg, respectively, would be capped with either an asphalt cover or an engineered structure, such as a building.

SL-4 Excavation and off-site disposal of all soils with Cd concentrations greater than the TCLP characteristic of 120 mg/kg. In addition, excavation and off-site disposal of all soils within the 15-21 ft interval (groundwater fluctuation zone) and overlying soils where Cd concentrations are greater than 10 mg/kg and/or Cr concentrations are greater 143 mg/kg. The remaining areas where Cd and/or Cr concentrations are greater than 10 and 143 mg/kg, respectively, would be capped with either an asphalt cover system or an engineered structure, such as a building.

SL-5 Excavation of all soils with Cd concentrations greater than the TCLP characteristic of 120 mg/kg. In addition, excavation of all soils within the 15-21 ft interval and any overlying soils that exceed 10 mg/kg Cd and/or 143 mg/kg Cr. On-site treatment (stabilization) of excavated soils and on-site placement of treated soils. Capping of remaining on-site area where soils exceed a Cd concentration of 10 mg/kg and/or Cr concentration of 143 mg/kg.

SL-6 Excavation of all soils with Cd concentrations greater than the TCLP characteristic of 120 mg/kg. In addition, excavation of all soils within the 15-21 ft interval and any overlying soils that exceed 10 mg/kg Cd and/or 143 mg/kg Cr. The excavated soils would be separated into two fractions: the coarse fraction would be treated by soil washing and consolidated on-site; the fine fraction would be disposed off-site. Capping of remaining on-site area where soils exceed a Cd concentration of 10 mg/kg and/or a Cr concentration of 143 mg/kg.

SL-7 Excavation and off-site disposal of all on-site soils where Cd and/or Cr concentrations are greater than 10 and 143 mg/kg, respectively.

SL-8 Excavation and on-site treatment (stabilization) of soils where Cd and/or Cr concentrations are greater than 10 and 143 mg/kg, respectively, followed by on-site placement of treated soils.

SL-9 Excavation of all soils where Cd and/or Cr concentrations are greater than 10 and 143 mg/kg., respectively. The excavated soils would be separated into two fractions: the coarse fraction would be treated by soil washing and consolidated on-site; the fine fraction would be disposed off-site. Capping of remaining on-site area where soils exceed Cd and/or Cr concentration of 10 and 143 mg/kg, respectively.

TDCC Total Direct Construction Cost (in US $)
Annual O&M Annual Operation and Maintenance (in US $)
PWC Present Worth Cost (in US $), inclusive of engineering, oversight, and contingency (20%), figured at 8% over 20 years.

(1) The criterion of Cd = 120 mg/kg refers to soils that are potentially failing the Cd TCLP test. The CRI data suggested that Cd = 120 mg/kg is the threshold concentration at which soils fail the TCLP test (note that the volume of soils > 120 mg/kg Cd was estimated using [Cr] > 1,500 mg/kg)

(2) The criteria of Cd= 10 and Cr = 143 mg/kg refer to soils that are situated within the groundwater fluctuation zone (15 to 21 feet below grade).

(3), (4) The cap areas are 4.25 acres for a NYSDEC Section 360-type cap and 4.5 acres for a low-permeability asphalt cap. The 8.75-acre cap is for a low-permeability asphalt cap only.

3.2.1.2 Alternative SL-2: Institutional Controls with Monitoring

The RAOs presented in Section 1.3.1 and the exposure analysis presented in the Final BHHRA (URS, July 2000) are consistent in assuming that the future land use of the Site will be commercial/industrial (i.e., non-residential) or recreational (western parcel only). Therefore, institutional controls are necessary to assure the continued restricted use of the Site. Specific controls include a use restriction on the property created by the property owner, as well as, a groundwater use restriction, which is presently enacted as Nassau County Public Health Ordinance Article IV (August 1, 1987) and Article VI (February 1, 1990). Because of the need to assure future restricted use of the Site, each of the subsequent alternatives will also contain institutional controls as a component of the remedy.

(a) Effectiveness

This alternative limits the long-term availability of constituents to potential human receptors. This alternative does not, however, prevent the migration of inorganic and organic constituents from the unsaturated soil column into groundwater and, therefore, does not satisfy the RAO for on-site soils. It provides no reduction in the toxicity, mobility, or volume for the constituents of concern.

(b) Implementability

This alternative is easily implementable.

(c) Cost

There are minimal TDCC ($53,525) and moderate annual O&M costs ($20,000) for this alternative.

3.2.1.3 Alternative SL-3

Excavation of all soils with Cd concentrations greater than the TCLP characteristic of 120 mg/kg. In addition, excavation of all soils within the 15-21 ft interval that exceed 10 mg/kg Cd and/or 143 mg/kg Cr, respectively, and any of the corresponding overlying soils that exceed these criteria. Consolidation of the excavated material into the Northwest Disposal Area where it will be capped with a NYSDEC Section 360-type cover system (approx. 4.25 acres). Such a cover system would consist (from bottom to top) of double-sided HDPE liner (e.g., 60-mil thick), double-sided geocomposite drainage layer (e.g., 200-mil thick), protective soil cover (e.g., 30-

inch thick), and vegetated top soil (e.g., 6-inch thick). The remaining Site areas where soils with Cd and/or Cr concentrations greater than 10 and 143 mg/kg, respectively, are still in place would be capped with a low-permeability asphalt cover system or an engineered structure (such as a building).

(a) Effectiveness

This alternative limits potential human exposure to hazardous soils (by TCLP characteristic) and limits the mobility of constituents via a dual-layer cover system. In addition, soils with Cd concentrations greater than the site-specific criterion are removed from contact with the seasonal water table. By consolidating and capping this material (along with the other on-site areas where Cd concentrations exceed the site-specific criterion), this alternative prevents the migration of the majority of the mass of inorganic and organic constituents from the unsaturated soil column into groundwater and, therefore, does satisfy the RAO for on-site soils. By limiting the exposure of the capped soils to infiltration water, this alternative provides a reduction in the mobility of the constituents of concern.

(b) Implementability

This alternative is easily implementable.

(c) Cost

There are significant TDCC ($3,532,352) and moderate annual O&M costs ($35,000) for this alternative.

3.2.1.4 Alternative SL-4:

Excavation and off-site disposal of all soils with Cd concentrations greater than the TCLP characteristic of 120 mg/kg. In addition, excavation and off-site disposal of all soils within the 15-21 ft interval (groundwater fluctuation zone) and overlying soils where Cd and/or Cr concentrations are greater than 10 and 143 mg/kg, respectively. The areas where Cd and/or Cr concentrations exceed 10 and 143 mg/kg, respectively, would then be capped with either an asphalt cover system or an engineered structure, such as a building.

(a) Effectiveness

This alternative removes all hazardous soil (by Cd characteristic) from the Site. In addition, soils with Cd concentrations greater than the site-specific criterion are removed from contact with the seasonal water table. By off-site disposal of this material and capping the remaining on-site areas where Cd concentrations exceed the site-specific criterion, this alternative prevents the migration of the majority of the mass of inorganic and organic constituents from the unsaturated soil column into groundwater and, therefore, does satisfy the RAO for on-site soils. By disposing the excavated soils at an off-site facility, this alternative provides a reduction in volume of the constituents of concern and thereby permanently reduces the on-site mass of constituents.

(b) Implementability

This alternative is easily implementable.

(c) Cost

There are significant TDCC ($8,354,352) and moderate annual O&M costs ($35,000) for this alternative.

3.2.1.5 Alternative SL-5

Excavation of all soils with Cd concentrations greater than the TCLP characteristic of 120 mg/kg. In addition, excavation of all soils within the 15-21 ft interval (groundwater fluctuation zone) that exceed Cd and/or Cr concentrations of 10 and 143 mg/kg, respectively, and any of the corresponding overlying soils that exceed these criteria. On-site treatment (e.g., ex-situ stabilization) of all excavated soils and on-site placement of the treated soils. Capping of remaining on-site area where soils exceed a Cd and/or Cr concentration of 10 and 143 mg/kg, respectively, with either an asphalt cover system or an engineered structure, such as a building.

(a) Effectiveness

This alternative prevents the migration of a majority of the mass of inorganic and organic constituents from the unsaturated soil column into groundwater and, therefore, does satisfy the RAO for on-site soils. By consolidating the treated soils, this alternative provides a reduction in volume of the constituents of concern, but does not permanently reduce the on-site mass of constituents.

(b) Implementability

This alternative is moderately implementable, as it requires field- and/or bench-scale testing, which would prolong the implementation period.

(c) Cost

There are significant TDCC ($4,461,952) and moderate annual O&M costs ($35,000) for this alternative.

3.2.1.6 Alternative SL-6

Excavation of all soils with Cd concentrations greater than the TCLP characteristic of 120 mg/kg. In addition, excavation of all soils within the 15-21 ft interval (groundwater fluctuation zone) that exceed Cd and/or Cr concentrations of 10 and 143 mg/kg, respectively, and any of the corresponding overlying soils that exceed these criteria. The entirety of the excavated soils would be separated into two fractions: the coarse fraction (greater than 45 μm) would be treated by soil washing and placed on-site (e.g., as backfill material); the fine fraction (less than 45 μm) would be disposed off-site. Capping of remaining on-site area where soils exceed a Cd and/or Cr concentration of 10 and 143 mg/kg, respectively, with either an asphalt cover system or an engineered structure, such as a building.

(a) Effectiveness

This alternative prevents the migration of a majority of the mass of inorganic and organic constituents from the unsaturated soil column into groundwater and, therefore, does satisfy the RAO for on-site soils. By off-site disposal of the fine fractions and on-site treatment of the coarse fractions (e.g., soil washing) followed by on-site placement, this alternative permanently reduces the on-site mass of constituents.

(b) Implementability

This alternative is moderately implementable, as it would require bench- and/or field-scale testing, which would prolong the construction period.

(c) Cost

There are significant TDCC ($7,721,200) and moderate annual O&M costs ($35,000) for this alternative.

3.2.1.7 Alternative SL-7

Excavation and off-site disposal of the entire soil volume with Cd and/or Cr concentrations greater than 10 and 124 mg/kg, respectively. Since all soil with cadmium and chromium concentrations in excess of the site-specific criteria would be removed from the Site, there would be no remaining areas that require capping.

(a) Effectiveness

This alternative prevents the migration of a majority of the mass of inorganic and organic constituents from the unsaturated soil column into groundwater and, therefore, does satisfy the RAO for on-site soils. By disposing all soils with Cd concentrations greater than 10 mg/kg and/or Cr concentrations greater than 143 mg/kg at an off-site facility, this alternative provides a reduction in volume of the constituents of concern and thereby permanently reduce the on-site mass of constituents.

(b) Implementability

This alternative is moderately implementable, as it would require a prolonged construction period and present an inconvenience for the public and the Site owner due to increased site traffic.

(c) Cost

There are significant TDCC ($14,682,582) and moderate annual O&M costs ($20,000) for this alternative.

3.2.1.8 Alternative SL-8

Excavation of the entire soil volume with Cd and/or Cr concentrations greater than 10 and 143 mg/kg, respectively, followed by on-site treatment (e.g., by ex-situ stabilization) and on-site placement (e.g., as backfill) of the treated soils. Since all soil with cadmium and chromium concentrations in excess of the site-specific criteria would be treated, there would be no remaining areas that require capping.

(a) Effectiveness

This alternative prevents the migration of a majority of the mass of inorganic and organic constituents from the unsaturated soil column into groundwater and, therefore, does satisfy the RAO for on-site soils. By treating these soils on-site, this alternative provides a reduction in volume of the constituents of concern. However, it does not reduce the on-site mass of constituents.

(b) Implementability

This alternative is moderately implementable, as it would require a prolonged construction due to field- and/or bench scale testing. In addition, the large on-site volume of stabilized soil may restrict the potential end use of the Site.

(c) Cost

There are significant TDCC ($9,235,707) and moderate annual O&M costs ($20,000) for this alternative.

3.2.1.9 Alternative SL-9

Excavation of the entire soil volume with Cd and/or Cr concentrations greater than 10 and 143 mg/kg, respectively, followed by soil separation into fine (less than 45 μm) and coarse (greater than 45 μm) fractions. If necessary, the coarse fractions would be treated by soil washing and backfilled into the excavation. The fine fraction would be disposed off-site. Since all soil with cadmium and chromium concentrations in excess of the site-specific criteria would be removed from the Site or treated, there would be no remaining areas that require capping.

(a) Effectiveness

This alternative prevents the migration of a majority of the mass of inorganic and organic constituents from the unsaturated soil column into groundwater and, therefore, does satisfy the RAO for on-site soils. By treating and backfilling the coarse fraction of the excavated soils on-site, and by disposing the fine-fraction of the excavated soils off-site, this alternative provides a reduction in volume of the constituents of concern. Because the coarse soil fraction is treated prior to backfilling, this alternative permanently reduces the on-site mass of constituents.

(b) Implementability

This alternative is moderately implementable, as it would require field- and/or bench-scale testing, and a prolonged construction period.

(c) Cost

There are significant TDCC ($12,529,354) and moderate annual O&M costs ($20,000) for this alternative.

3.2.2 Groundwater

Five groundwater remedial alternatives (GW-1 through GW-5) were developed based on combinations of technology process options that passed the screening evaluation and that were considered feasible remedial options for the site. The continuation of the on-site 'Non-Time Critical Removal Action' (NTCRA) with groundwater monitoring is a component common to all remedial alternatives (except the No Action alternative GW-1). Groundwater monitoring would be in the form of 'monitored natural attenuation' (MNA) to document and monitor the off-site groundwater plume, including its leading edge where concentrations are near non-detect or drinking water standards. Therefore, the groundwater remedial alternatives discussed in this Section are various combinations of the on-site remedy (NTCRA with MNA, which is being implemented during the Spring and Summer 2000) with off-site remedial options. For costing purposes, it was assumed that all capital expenditures for the construction of the NTCRA will have been expended prior to the selection of a comprehensive Site remedy, and only the operations and maintenance (O&M) costs for the NTCRA system were considered. Table 3-2 clearly summarizes these groundwater remediation alternatives. Figure 3-2 shows a conceptual outline of the technology components contained in the groundwater alternatives.

The groundwater flow model (which was detailed in the Final CRI report [July 20, 2000]) was used to conceptualize the groundwater extraction/groundwater circulation rates and the well spacing necessary to achieve overlapping capture zones that extend across the observed width of the groundwater plume between the impacted off-site areas and the Site property boundary. Appendix E summarizes the capture zone analysis. Previous feasibility analysis for the on-site NTCRA (Weston, 1997a; Dames & Moore, June 3, 1999) had shown that capture zone modeling of groundwater extraction is adequate for the feasibility analysis of groundwater circulation technology as well. Therefore, the capture zone analysis summarized in Appendix E was also used for estimating the necessary circulation rate of the groundwater treatment systems utilizing GCW technology. However, to be conservative, a 50-percent increase in the total GCW flow rate was assumed.

3.2.2.1 Alternative GW-1: No Action

(a) Effectiveness

The No Action alternative does not prevent potential future impacts of site-related constituents on the public water supply and, therefore, does not satisfy the RAO for groundwater. The No Action alternative provides no reduction in the toxicity, mobility, or volume for the constituents of interest and does not inhibit or control the migration of constituents. However, it should be noted that currently none of the supply wells in the vicinity of the Site [Massapequa Water District, South Farmingdale Water District] has any reported concentrations of site-related constituents greater than NYSDEC GA standards. Further, given the historic range of pumping rates of these well fields, it is not anticipated that site-related constituents present in the uppermost portion of the Magothy aquifer will migrate toward the public supply wells (Final CRI report, July 20, 2000). In addition, under current [Nassau County Health Ordinance Articles IV and VI] and foreseeable future conditions, the Upper Glacial aquifer is not considered a supply aquifer for drinking or use water.

(b) Implementability

This alternative is easily implementable.

(c) Cost

There are no capital and no O&M costs for this alternative.

TABLE 3-2
REMEDIAL ALTERNATIVES FOR GROUNDWATER

Alternative	Technologies								Cost		
	Use Restriction	NTCRA	Flow Rate	GCW	GW Extraction	GW Injection	Treatment	MNA	TDCC	Annual O&M	PWC
GW-1	X								$0	$0	$0
GW-2	X	X						X	$121,500	$505,000	$5,116,040
GW-3	X	X	375	X			X	X	$3,115,395	$838,000	$12,433,267
GW-4	X	X	250		X	X	X	X	$3,375,135	$1,024,000	$14,610,064
GW-5	X	X	150	X			X	X	$4,559,760	$689,000	$12,692,290

GW-1 No Action
GW-2 Continuation of NTCRA (on-site) with MNA in the off-site areas
GW-3 Continuation of NTCRA (on-site) with UVB-type or DDC-type Groundwater Circulation and Treatment (off-site) and MNA
GW-4 Continuation of NTCRA (on-site) with Groundwater Extraction and Reinjection with Treatment (off-site) and MNA
GW-5 Continuation of NTCRA (on-site) with off-site Permeable Reactive Wall (Upper Glacial aquifer) and DDC-type Groundwater Circulation (Magothy aquifer) and MNA

NTCRA On-site Non-Time Critical Removal Action (capital cost is already expended)
GW Circulation Groundwater circulation technology as described in Section 2.2.2.6 (b)
GW Extraction Groundwater extraction technology as described in Section 2.2.2.3
GW Injection Groundwater injection technology as described in Section 2.2.2.5
Treatment Groundwater treatment technologies as described in Section 2.2.2.4
MNA Monitored Natural Attenuation, as described in Section 2.2.2.6 (d)

TDCC Total Direct Construction Cost (in US $)
Annual O&M Annual Operation and Maintenance (in US $)
PWC Present Worth Cost (in US $), inclusive of engineering, oversight, and contingency (20%), figured at 8% over 20 years.

Flow Rate in gallons per minute (gpm); Use Restriction are as codified in Nassau County Health Ordinance Articles IV and VI.

3.2.2.2 Alternative GW-2

The on-site NTCRA is continued, coupled with a comprehensive off-site monitoring program to evaluate the long-term aquifer conditions and changes in constituent concentrations. In addition, a fate and transport model would be used to support the off-site monitoring program by projecting the future plume configuration, based on historic and current monitoring data.

(a) Effectiveness

This alternative is not expected to satisfy the RAO for groundwater in the short-term (with the same exceptions as those noted in Section 3.2.2.1). However, if it can be shown that source control (i.e., the on-site NTCRA) in conjunction with natural attenuation processes are effective in reducing the toxicity (i.e., transformation of organic constituents to less toxic compounds such as ethene, water, and carbon dioxide), mobility (i.e., retardation and sorption to the aquifer matrix), or volume (i.e., dilution and dispersion processes, transformation of organic constituents to less toxic compounds) for the constituents of interest, then this alternative can be effective in the long-term or can complement an engineered remedial action that is more effective in the short-term.

(b) Implementability

This alternative is easily implementable. This alternative would be supported with a site-specific groundwater fate and transport model, and detailed groundwater monitoring.

(c) Cost

There are moderate TDCC ($121,500) and significant annual O&M costs ($505,000) for this alternative.

3.2.2.3 Alternative GW-3

The on-site NTCRA and off-site MNA would be continued, in conjunction with off-site UVB-type or DDC-type GCW technology and treatment. The UVB-type GCW technology was field tested successfully in the Upper Glacial aquifer (Dames & Moore, June 3, 1999). Similarly, DDC-type GCW technology was successfully field-tested. Approximately three (3) UVB-type GCWs (each circulating 75 gpm) would be installed approximately 60-feet deep in the Upper Glacial aquifer. The GCWs would be located near well cluster MW-9, and the wells would be spaced approximately 125 feet from one another. Approximately three (3) DDC-type GCWs (each circulating 50 gpm) would be installed approximately 180-feet deep in the Magothy aquifer. The GCWs would be located near well cluster MW-11, and the wells would be spaced approximately 150 feet from one another. Thus, the total recirculation rate of these six (6) GCWs would be approximately 375 gallons per minute (225 gpm in the Upper Glacial aquifer and 150 gpm in the Magothy aquifer). The GCWs in the Upper Glacial aquifer would likely be of the UVB-type, and groundwater would be treated for VOCs and metals. The GCWs in the Magothy aquifer would likely be of the DDC-type (or similar) and groundwater would require treatment for VOCs only. Note that the off-site aquifer thickness and hydraulic conditions differ from those observed during the on-site GCW pilot tests; therefore, the assumptions inherent to this alternative would require field- or pilot testing verification. Also note that the GCWs installed in the Magothy aquifer near MW-11 are likely to affect the western portion of Plume B, because the eastern edge of Plume A and the western edge of Plume B intersect in that area (see Figure 1-6).

(a) Effectiveness

This alternative does satisfy the RAO for groundwater. The on-site NTCRA would be continued as a 'source control' component to halt off-site migration of site-related constituents. Active remediation in the most-impacted off-site areas would provide a reduction in the volume for the constituents of interest by treatment (flexible treatment of organic constituents either by open-loop air-stripping or closed-loop GAC, and chelation treatment for metals). This alternative is also effective in limiting the further migration of constituents, as it provides hydraulic containment along a series of circulation wells with overlapping capture zones. Finally, natural attenuation processes would be evaluated to monitor concentrations of constituents downgradient of the on-site and off treatment systems.

(b) Implementability

This alternative is moderately implementable, and would require additional pilot testing for applications in the Magothy aquifer. The space requirements for a treatment structure (above- or below ground) are considerable. The placement of the proposed GCW system is likely to meet substantial resistance, because the optimal location is in the immediate vicinity of residential and public school properties.

(c) Cost

There are significant TDCC ($3,115,395) and significant annual O&M costs ($838,000) for this alternative.

3.2.2.4 Alternative GW-4

The on-site NTCRA and off-site MNA would be continued, in conjunction with pump-and-treat technology prior to discharge to surface water or reinjection outside the capture zone of the system. A variety of applicable treatment options for metals (ion exchange, chemical reduction and oxidation, precipitation, flocculation, and filtering) were laboratory tested using Site groundwater extracted from the Upper Glacial aquifer (Dames & Moore, June 3, 1999). The most effective location for off-site groundwater treatment is between Woodward Parkway and the headwaters of Massapequa Creek (i.e., east of Woodward Parkway School near the greatest VOC concentrations). Using a model-derived well spacing of approximately 250 feet, the proposed pump-and-treat system would consist of a series of approximately two (2) extraction wells pumping 75 gpm each within the Upper Glacial aquifer and two (2) extraction wells pumping 50 gpm each within the Magothy aquifer. Thus, the total recovery rate would be on the order of 250 gpm, with a resulting capture zone width of approximately 900 feet at the Site boundary (see Appendix E for modeling results). Approximately eight (8) reinjection wells would be necessary if the treated groundwater could not be discharged to surface water. It is likely that groundwater extracted from the Upper Glacial and Magothy aquifers would require different treatment trains, due to distinct aquifer conditions and constituents between the two aquifers. The assumptions inherent to this alternative would require extensive field- or pilot testing verification (such as aquifer pumping tests and treatability studies for groundwater extracted from the Magothy aquifer). Also note that the extraction wells installed in the Magothy aquifer are likely to affect the western portion of Plume B, because the eastern edge of Plume A and the western edge of Plume B intersect downgradient of the Site (see Figure 1-6).

(a) Effectiveness

This alternative (with various discharge options) does satisfy the RAO for groundwater. This alternative provides a reduction in the volume for the constituents of interest by active ex-situ treatment. This alternative is also effective in limiting the migration of constituents from the site, as it provides hydraulic containment along a series of pumping or extraction wells with overlapping capture zones. Finally, natural attenuation processes would be evaluated to monitor concentrations of constituents downgradient of the on-site and off treatment systems.

(b) Implementability

This alternative is moderately implementable. The space required for an aboveground treatment plant is significant, along with the possible difficulty associated with reinjecting large volumes of water. The permitting requirements associated with discharging treated groundwater to surface water are likely to be substantial. In addition, the optimal location of the proposed pump-and-treat system is in the immediate vicinity of private and public school properties, raising the potential for resistance from public or private property owners.

(c) Cost

There are significant TDCC ($3,375,135) and significant annual O&M costs ($1,024,000) for this alternative.

3.2.2.5 Alternative GW-5:

The on-site NTCRA and off-site MNA would be continued, in conjunction with the installation (by hydraulic fracturing) of an iron permeable reactive barrier (PRB) in the Upper Glacial aquifer for in-situ removal of VOCs by reductive dechlorination, reduction of hexavalent chromium, and co-precipitation of cadmium into the permeable reactive barrier. The optimal location for the PRB would be near well cluster MW-9 where the greatest metals concentrations were observed. The total length of the reactive wall would be on the order of 400 feet, and the estimated depth of the treatment wall would be on the order of 60 feet. Therefore, the cross section area of the reactive wall would be on the order 2,400 square feet.

The presence of VOCs in the Magothy aquifer would be addressed by a separate in-situ alternative (DDC-type GCW). The in-situ treatment alternative would operate independently of the reactive barrier wall, and would be located in the vicinity of well cluster MW-11, where the greatest VOC concentrations were observed. Similar to Alternative GW-3, approximately three (3) GCWs would be necessary within the Magothy aquifer, with an approximate total flow rate of 150 gallons per minute. Note that the GCWs installed in the Magothy aquifer near MW-11 are likely to affect the western portion of Plume B, because the eastern edge of Plume A and the western edge of Plume B intersect in that area (see Figure 1-6).

(a) Effectiveness

This alternative does satisfy the RAO for groundwater. This alternative provides a reduction in the volume for the constituents of concern by active in-situ treatment of organic and inorganic constituents by reactive iron. The PRB aspect (Upper Glacial aquifer) of this alternative does not (and need not) provide hydraulic containment, since the treatment wall is permeable. However, the GCW circulation aspect (Magothy aquifer) would provide hydraulic containment. Finally, natural attenuation processes would be evaluated to monitor concentrations of constituents downgradient of the on-site and off treatment systems.

(b) Implementability

The PRB aspect of the alternative is readily implementable in the Upper Glacial aquifer. The GCW aspect of the alternative is readily implementable in the Magothy aquifer. Both components of Alternative GW-5 would require bench- and field-scale pilot studies, especially concerning the feasibility of emplacing the PRB and its effectiveness for treating the constituents of interest.

(c) Cost

There are significant TDCC ($4,559,760) and significant annual O&M costs ($689,000) for this alternative.

3.3 SELECTION OF REMEDIAL ALTERNATIVES FOR DETAILED ANALYSIS

In this section, the soil and groundwater remedial alternatives presented in Sections 3.2.1 and 3.2.2, respectively, are screened against the evaluation criteria of effectiveness, implementability, and cost, and preferred alternatives are selected for further evaluation.

3.3.1 On-Site Soil

Based on the evaluation criteria of effectiveness, implementability, and cost, the following soil remediation alternatives were screened out and eliminated from further consideration in this FS:

SL-2 (Institutional Controls): This alternative was eliminated due to its inability to meet the RAO for on-site soils. However, institutional controls (i.e., use restrictions on the property created by the property owner) are implied as a necessary component of the remaining soil remedial alternatives to ensure that the RAOs are met.

SL-3 (Partial Excavation and Lateral On-site Consolidation): This alternative was eliminated because the on-site placement of untreated soils appears to contravene one of the ARARs (Long Island Landfill Law, NYSECL 27-0704) for the Site.

SL-6 (Partial Excavation and Soil Washing): This alternative, involving partial excavation to the extent and criteria discussed in Table 3-1 and on-site treatment using soil separation and soil washing was eliminated due to the unfavorable comments received during the public comment period of the previous Proposed Plan for the Site (EPA, 1997)

SL-9 (Complete Excavation and Soil Washing): This alternative, involving complete excavation to the extent and criteria detailed in Table 3-1 and on-site treatment using soil separation and soil washing was eliminated due to the unfavorable comments received during the public comment period of the previous Proposed Plan for the Site (EPA, 1997).

Therefore, the following soil remediation alternatives passed the screening analysis, and will be further evaluated in detail in Section 4.3.1:

SL-1 (No Action): The Superfund program requires that the 'No Action' alternative be considered as baseline for comparison to the other alternatives. Therefore this alternative will be further discussed in Section 4.0 of this Final FS report.

SL-4 (Partial Excavation, Off-Site Disposal of Hazardous Soil and other Excavated Soils, and Cover System): This alternative, involving partial excavation, off-site disposal of excavated soil, and capping to the criteria and extent detailed in Table 3-1 was retained.

SL-5 (Partial Excavation, Ex-situ Stabilization, On-site Placement of Stabilized Soils, and Cover System): This alternative, involving partial excavation, on-site treatment by stabilization, on-site placement of the stabilized soils as backfill, and capping to the criteria and extent detailed in Table 3-1 was retained.

SL-7 (Complete Excavation and Off-site Disposal): This alternative, involving the complete excavation and off-site disposal of all excavated soils to the criteria and extent detailed in Table 3-1 was retained.

SL-8 (Complete Excavation, Ex-situ Stabilization, and On-site Placement of Stabilized Soils): This alternative, involving complete excavation, on-site treatment by stabilization, and on-site placement of the stabilized soils as backfill to the criteria and extent detailed in Table 3-1 was retained.

3.3.2 Groundwater

Based on the evaluation criteria of effectiveness, implementability, and cost, none of the groundwater remediation alternatives discussed in Section 3.2.2 were screened out or eliminated from further consideration in this FS.

GW-1 (No Action): The Superfund program requires that the 'No Action' alternative be considered as baseline for comparison to the other alternatives. Therefore this alternative will be further discussed in Section 4.0 of this Final FS report.

GW-2 (Continued NTCRA with MNA): This alternative, involving the continued operation of the on-site NTCRA with an evaluation of natural attenuation will be retained for further evaluation.

GW-3 (Continued NTCRA with MNA and Off-site In-situ Treatment): This alternative, involving continued operation of the on-site NTCRA, evaluation of natural attenuation, and the implementation of an off-site groundwater treatment system using circulation well technology) will be retained for further evaluation.

GW-4 (Continued NTCRA with MNA and Off-site Groundwater Extraction and Ex-Situ Treatment): This alternative, involving continued operation of the on-site NTCRA, evaluation of natural attenuation, and the implementation of an off-site groundwater treatment system using extraction wells and above-ground treatments will be retained for further evaluation.

GW-5 (Continued NTCRA with MNA and Off-site Permeable Reactive Barrier and In-situ Treatment): This alternative, involving continued operation of the on-site NTCRA, evaluation of natural attenuation, and the installation of an off-site iron reactive PRB in the Upper Glacial aquifer in conjunction with an in-situ treatment technology in the Magothy aquifer will be retained for further evaluation.

4.0 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

4.1 INTRODUCTION

This section provides a description and comparative analysis of each remedial alternative that passed the screening evaluation in Section 3.0. The alternatives are assessed against nine evaluation criteria based on the CERCLA requirements:

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

An overview of each of the nine criteria is presented in the following sections.

4.2 OVERVIEW OF EVALUATION CRITERIA

4.2.1 Overall Protection of Human Health and the Environment

This criterion provides a final check to assess whether the alternatives are protective of human health and the environment. The overall assessment of protectiveness is based on a composite of factors assessed under the evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

4.2.2 Compliance with ARARs

This criterion assesses the ability of each alternative to comply with ARARs. In general, because the remedial alternatives described in this Final FS report are intended to: (a) minimize the migration of specific constituents of interest from soil to groundwater; (b) prevent impacted groundwater from affecting the current or future public water supply; and (c) restore the impacted aquifers, only the compliance with alternative-relevant ARARs will be considered. The ARARs applicable to the Site are listed in Appendix A. This appendix also contains information on chemical-specific ARARs and other federal and state criteria, advisories, guidance, and proposed standards and local ordinances that are not legally binding, but may provide useful information or recommended procedures, referred to as "To Be Considered" (TBC) criteria.

4.2.3 Long-Term Effectiveness and Permanence

This criterion assesses the long-term effectiveness of alternatives for protecting human health and the environment after the remedial objectives have been met. The primary focus of this evaluation is the extent and effectiveness of the controls that may be required to manage the potential risks posed by treatment residuals and/or any untreated media remaining in the environment.

4.2.4 Reduction of Toxicity, Mobility, and Volume through Treatment

This criterion assesses the anticipated performance of specific treatment technologies. This evaluation addresses the statutory preference for selecting remedial alternatives that employ treatment technologies to permanently and significantly reduce toxicity, mobility, or volume of the specific media.

4.2.5 Short-Term Effectiveness

This criterion examines the effectiveness of alternatives for protecting human health and the environment during the construction and implementation period until the remedial objectives have been met.

4.2.6 Implementability

The implementability criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during implementation.

4.2.7 Cost

The cost evaluation of each alternative includes consideration of capital costs and annual O&M costs based on existing vendor information and previous site remediation experience. The accuracy provided by these cost estimates is reflected by using a contingency of 20%. A present worth analysis is also conducted (8% compounded annually over 20 years), which allows all remedial alternatives to be compared on the basis of a single cost.

4.2.8 State Acceptance

This criterion assesses the technical and administrative issues and concerns that the State (or other support agencies) may have regarding each of the alternatives. The State will be provided with a formal opportunity to evaluate the detailed analysis of the remedial alternatives by reviewing this Final FS Report. Therefore, no formal comments from the State are currently available for evaluation against this criterion. The State comments will be incorporated in the Responsiveness Summary section of the EPA Record of Decision (ROD) document.

4.2.9 Community Acceptance

This criterion assesses the public comments regarding the evaluation of the remedial alternatives. The public will not be provided with a formal opportunity to review this analysis of the remedial alternatives until after the Final FS Report is made available by the EPA. Therefore, no formal comments from the public are currently available for the evaluation of this criterion. It is anticipated that the formal comments from the public will be provided during the public comment period on the Proposed Plan. These comments will then be addressed in the Responsiveness Summary section of the EPA ROD document.

4.3 DESCRIPTIONS AND DETAILED ANALYSIS OF ALTERNATIVES

4.3.1 Soil Alternatives

To improve the clarity of discussion, Table 4-1 presents some basic statistics related to on-site area, total on-site soil volume, total on-site Cr mass in the area of interest. These statistics are based on the site conceptual model that was developed during the CRI and Supplemental Soil Sampling activities, and was presented in detail in Appendix D of the Final CRI Report (URS, July 20, 2000).

TABLE 4-1

Conceptual Site Model General Statistics

Item	Value	Unit[1]
Total Site Area (as evaluated during CRI and Supplemental Soil Investigation)	753,200	sf
Total Site Area	17.3	acres
Total Site Volume (soils to a depth of 23 feet)	549,856	cy
Total Site Soil Mass	824,784	tons
Total Mass of Chromium in Total Site Volume	169	tons
Average Site Chromium Concentration	205	mg/kg
NYSDEC TAGM (1995) Background for Chromium	50	mg/kg
Percentage of Total Chromium Mass that is not attributable to background	75.6	%
Total Area of Disposal Basin Excavation	23,760	sf
Volume of Total Disposal Basin Excavation (incl. sloped buffer zone)	11,400	cy

[1] sf = square feet; 1 acre = 43,500 sf;
cy = cubic yards;
1 cy = 1.5 tons;
mg/kg = milligram per kilogram

4.3.1.1 Alternative SL-1 (No Action).

(a) Overall Protection of Human Health and the Environment – Alternative SL-1 does not protect human health and the environment beyond the protection that is currently afforded by the existing Site conditions (i.e., fencing, paving of the eastern Site parcel, current Site use). The Final BHHRA (URS, July 2000) evaluated, among other things, the potential risks associated with on-site reasonable maximum exposure to constituents in soils. Current risks to trespassers and future risks to commercial/industrial workers, construction workers, and recreational users (western parcel only) were quantitatively evaluated. Based on reasonable maximum exposure (RME) to soils, the excess cancer risks greater than 1×10^{-6} were determined to be potentially present for the current trespasser (western parcel, total excess risk of 2.1×10^{-6} mainly due to arsenic), the future commercial/industrial worker (western parcel, total excess risk of 6.1×10^{-6} mainly due to PCBs and arsenic; eastern parcel, total excess risk of 3.7×10^{-6} mainly due to PAHs), and the future recreational user (western parcel, total excess risk of 1.6×10^{-6} mainly due to arsenic and PCBs). These potential excess risks are slightly greater than the minimum excess risk of 1×10^{-6} that is acceptable (the range of acceptable excess risks is between 1×10^{-6} and 1×10^{-4}). With regard to non-carcinogenic risks, none of the total hazard indices was greater than 1.0, indicating that there is no potential for risk due to exposure to on-site soils. Note that the current concentrations of site-related constituents (Cd, Cr, VOCs) in on-site soils do not contribute significantly to the potential risks by human exposure (the excess risks discussed above are mainly due to arsenic, PCBs, and PAHs). Therefore, the No Action alternative is likely to be protective of human health under the foreseeable future use scenarios. However, the No Action alternative is likely not protective of the environment (i.e., protection of groundwater), as the current site conditions appear to promote continuing leaching of site-related constituents into groundwater.

(b) Compliance with ARARs –.Since there are no promulgated soil quality standards and Alternative SL-1 does not include any remedial actions, there are no applicable ARARs for this Alternative.

(c) Long-Term Effectiveness and Permanence – Alternative SL-1 does not provide any better long-term effectiveness and permanence than that afforded by the current Site conditions.

(d) Reduction of Toxicity, Mobility, or Volume – Alternative SL-1 does not result in the reduction of toxicity, mobility, or volume of constituents in the on-site soils.

(e) Short-Term Effectiveness – Alternative SL-1 does not provide any better short-term effectiveness than that afforded by the current Site conditions. As this alternative does not include any remedial actions, there are no short-term risks to workers or the surrounding community other than those currently present at the Site.

(f) Implementability – Alternative SL-1 is easy to implement

(g) Cost – There are no costs associated with Alternative SL-1, as no remedial activities would be implemented. Table C-1 (Appendix C, Table C-1) presents the estimated costs for Alternative SL-1.

(h) State Acceptance – No formal comments from the State are currently available for evaluation against this criterion. The State comments will be incorporated in the Responsiveness Summary section of the EPA ROD document.

(i) Community Acceptance – No formal comments from the public are currently available for the evaluation of this criterion. It is anticipated that the formal comments from the public will be provided during the public comment period and that these comments will be addressed in the Responsiveness Summary section of the EPA ROD document.

4.3.1.2 Alternative SL-4 (Partial Excavation, Off-Site Disposal of Hazardous Soil and other Excavated Soils, and Cover System) – Figure C-4, Cost Table C-4

This alternative incorporates the excavation and off-site disposal of soils that have Cd concentrations greater than the TCLP-limit of 120 mg/kg (estimated value from RI and CRI data). In addition, soils within the 15-21 ft interval below grade (the groundwater fluctuation zone) and corresponding overlying soils that exceed 10 mg/kg Cd and/or 143 mg/kg Cr would be excavated and disposed off-site. Clean fill would be placed in the excavated areas to restore the Site to the original grade. The remaining Site areas where Cd and/or Cr concentrations exceed 10 and 143 mg/kg, respectively, will be capped with an asphalt cover system or engineered structure, such as a building. If asphalt is used, it will be designed and constructed to include a 5-inch thick bituminous stabilized base course overlain by a petromat geotextile fabric and a 2-inch bituminous concrete wearing course (BLWC). The BLWC will have a permeability on the order of 5×10^{-8} cm/sec. The petromat fabric will prevent surface cracks from spreading, reduce the potential for infiltration through cracks that may occur between maintenance activities, and further reduce the overall permeability of the asphalt cover system.

The excavated soil to be disposed off-site would undergo a soil profile analysis (including total waste and toxicity characteristic leaching procedure [TCLP] analysis). Depending on these results, the excavated soil would be transported to an off-site RCRA Subtitle D landfill for disposal as a non-hazardous waste, or to a RCRA Subtitle C landfill for disposal as a hazardous waste. The effectiveness of the excavation would be evaluated via a suitable post-excavation sampling program, and the results compared to the site-specific cleanup criteria of 10 mg/kg Cd, 143 mg/kg Cr, and the generic VOC cleanup criteria presented in Table 1-1A.

Cost Table C-2 presents conservative assumptions on the proportions of hazardous and non-hazardous soils, which are based on the site conceptual model developed for the Final CRI report. The total volume of soil that will require excavation was calculated as follows:

Description	Value	Unit	Note
Soil > 124 mg/kg in 15 to 21 ft below grade interval	6,800	cy	(1)
Soil that requires displacement to get to the 15-21 ft interval	8,500	cy	(2)
Soil volume > TCLP concentration across entire Site	16,000	cy	(3)
Overlap between (3) and (2)+(1)	-5,700	cy	(4)
Total Excavation Volume for Alternative SL-4	25,600	cy	

(1) calculated as: 0.5-times total disposal basin excavation volume = 0.5 x 11,400 cy = 5,700 cy plus 1,100 cy from a small area (radius of 40-ft between 15 and 21 ft depth) northeast of the NW Disposal Area = 6,800 cy.

(2) calculated as: 0.5-times total disposal basin excavation volume = 0.5 x 11,400 cy = 5,700 cy plus 2,800 cy overlying the small area (radius of 40-ft between 0 and 15 ft) to the northeast of the NW Disposal Area = 8,500 cy .

(3) estimated as: modeled Cr mass distribution curve (see Appendix B)

(4) calculated as: 0.5-times the volume of former disposal basins (i.e., western basin only) in the 8 to 21 ft interval (the surface of the disposal basins is considered to be 8 ft below the grade)

Therefore, the total targeted soil excavation volume is approximately 25,600 cy. The remaining area where Cd and Cr exceed maximum concentrations of 10 mg/kg and 124 mg/kg, respectively, may be calculated as follows:

Description	Value	Unit
Total Site Area with Soils > 124 mg/kg	8.23	acres
Area of soils > TCLP in the Northwest Disposal Area	-0.50	acres
Area of soils excavated from the basin area	-0.57	acres
Small area northeast of the NW Disposal Area	-0.12	acres
Total Capping Area	7.0	acres

The actual area that requires capping under Alternative SL-4 may be greater than 7.0 acres by a factor of about 1.25 due to the odd shape of the target area and the need to implement a feasible cap design. Therefore, it is estimated that the asphalt cover system for Alternative SL-4 will cover an area of 1.25 x 7.0 acres = 8.75 acres.

(a) Overall Protection of Human Health and the Environment - Alternative SL-4 would provide high overall protection of human health through elimination of direct human exposure to soils with Cd and/or Cr concentrations greater than 10 and 143 mg/kg, respectively. The removal and off-site disposal of all hazardous waste (estimated to correspond to Cd concentrations greater than 120 mg/kg) and of the soils from the 15-21 ft below grade interval with concentrations greater 10 mg/kg Cd and/or 143 mg/kg Cr will result in the protection of groundwater quality. The installation of a low-permeability cover system over the remaining areas with Cd and/or Cr concentrations greater 10 and 143 mg/kg, respectively, further reduces the potential for leachate production and any groundwater impacts, and also eliminates the potential human exposure.

(b) Compliance with ARARs – Alternative SL-4 would comply with all ARARs, including Federal and NYSDEC air quality standards during excavation and other construction activities, RCRA landfill closure and post-closure requirements (codified at 40 Code of Federal regulations [CFR] §265.310), and RCRA long-term groundwater monitoring requirements (codified at 40 CFR §265.90-265.93). In addition, any hazardous waste that is taken off-site would be treated, if necessary, to achieve compliance with LDRs, and disposed of at a permitted hazardous waste disposal facility in accordance with RCRA requirements. All hazardous waste would be transported in accordance with U.S. Department of Transportation (DOT) regulations and with provisions specified in 6 NYCRR 373. A low-permeability asphalt cover system would be constructed in accordance with local codes and best engineering practices.

(c) Long-Term Effectiveness and Permanence – Alternative SL-4 would provide high long-term effectiveness and permanence. Direct human exposure to impacted soils above the target concentration would be eliminated by permanent removal and off-site disposal of impacted soils with concentrations greater than 120 mg/kg Cd. Moreover, soils above the target concentrations of 10 mg/kg Cd and/or 143 mg/kg Cr would also be removed from the groundwater fluctuation zone between 15-21 ft below grade. The low-permeability asphalt cover system would preclude future exposure through dermal contact with, incidental ingestion of, and inhalation of soil constituents above the site-specific criteria. The proposed cover system would also reduce the contact of surface run-off with the underlying soils, which would prevent the potential transport of these constituents to off-property locations. In addition, the low-permeability cover system would protect groundwater quality by significantly reducing infiltration and leachate production. Because any cover system is susceptible to weathering and cracking, a maintenance and inspection program will be required to ensure the long-term integrity of the cover system. Whereas future environmental and public health risks on-site would be greatly reduced by removing the impacted soils above the target concentrations from their existing locations and placing them in an appropriately designed and more secure location, some degree of long-term liability would be associated with placement of the excavated soils in an off-site disposal facility.

(d) Reduction of Toxicity, Mobility, or Volume – The removal and off-site disposal of the excavated soils would substantially reduce the toxicity, mobility, and volume of the targeted constituents at the Site. Any RCRA hazardous waste that is sent off-site for disposal may require treatment to meet LDRs. Off-site treatment to achieve LDRs would result in a reduction of the toxicity, mobility, and/or volume of the landfilled waste. Placement of either treated or untreated soil in RCRA Subtitle C or Subtitle D landfills would also result in a reduction of mobility of the constituents present in the soil. Further, by limiting the exposure of the capped soils to infiltration water, this alternative provides a reduction in the mobility of the constituents of concern.

(e) Short-Term Effectiveness – Short-term risks to on-site workers, the surrounding communities, and the environment are expected to be moderate. Site remediation activities would need to be conducted in accordance with OSHA and other applicable health and safety controls to ensure adequate protection of human health and the environment, and to reduce fugitive dust emissions during Site remediation activities. Fugitive dust controls and air monitoring may also be necessary to ensure compliance with the Clean Air Act and NYSDEC Air Quality Standards during excavation activities. The potential for adverse short-term impacts on-site could be easily mitigated by utilizing appropriate conventional controls such as dust suppression techniques and personal protective equipment to reduce the risk to on-site workers through dermal contact with impacted soils and inhalation of fugitive dust. Surrounding communities could also be exposed to the impacted soil during off-site transportation activities. These potential impacts would be mitigated by transporting the impacted soils in accordance with DOT and New York Site regulations.

(f) Implementability – Excavation of the targeted soils at the Site can be accomplished using technologies proven to be reliable and readily implementable. Equipment, services, and materials for this work are readily available. However, soil excavation within the seasonally fluctuating water table at the Site (15-21 feet below grade) will require extensive groundwater control measures or should be limited to periods of low water table conditions. The Site is accessible from major highways and has sufficient space for on-site transfer, loading, and truck turnaround activities. In addition, both RCRA Subtitle C and Subtitle D landfills that could accept the excavated soils are available.

(g) Cost – Table C-4 presents the estimated costs for Alternative SL-4. The TDCC is estimated to be $8,354,352. The total installed capital cost (TICC) is estimated to be $10,965,692. The annual O&M cost is estimated to be $35,000. The total present worth cost is estimated to be $11,309,322, based on a discount rate of 8 percent for a period of 20 years.

(h) State Acceptance – No formal comments from the State are currently available for evaluation against this criterion. The State comments will be incorporated in the Responsiveness Summary section of the EPA ROD document.

(i) Community Acceptance – No formal comments from the public are currently available for the evaluation of this criterion. It is anticipated that the formal comments from the public will be provided during the public comment period and that these comments will then be addressed in the Responsiveness Summary section of the EPA ROD document.

4.3.1.3 Alternative SL-5 (Partial Excavation, On-site Treatment and On-site Placement, and Cover System) – Figure C-5, Cost Table C-5

This alternative incorporates the excavation of soils that exceed the TCLP characteristic of soils (estimated to correspond to 120 mg/kg Cd), combined with the excavation of soils within the zone of the groundwater table fluctuation (15-21 ft interval below grade) that exceed 10 mg/kg Cd and/or 143 mg/kg Cr. The excavated soils that have concentrations greater than 10 mg/kg Cd and/or 143 mg/kg Cr would undergo on-site treatment (in the form of ex-situ stabilization, using cement additive and polymer to achieve the desired inertia to leaching). The treated soils would be placed in the excavated areas to restore the Site to the original grade. The remaining Site areas where Cd and/or Cr concentrations exceed 10 and 143 mg/kg, respectively, would be capped with an asphalt cover system or engineered structure, such as a building. If asphalt is used, it will be designed and constructed to include a 5-inch thick bituminous stabilized base course overlain by a petromat geotextile fabric and a 2-inch bituminous concrete wearing course (BLWC). The BLWC will have permeability on the order of 5×10^{-8} cm/sec. The petromat fabric will prevent surface cracks from spreading, reduce the potential for infiltration through cracks that may occur between maintenance activities, and further reduce the overall permeability of the asphalt cover system

The excavated soil volume will be 25,600 cy (equivalent to that of Alternative SL-4), which will increase to approximately 30,400 cy following stabilization. Not all of the excavated material may be suitable for backfill and, therefore, a certain proportion of the excavated material may require off-site disposal (see Cost Table C-5). The area that will require capping will be approximately 8.75 acres (equivalent to that of Alternative SL-4).

The effectiveness of the excavation would be evaluated via a suitable post-excavation sampling program, and the results compared to the site-specific cleanup criteria of 10 mg/kg Cd, 143 mg/kg Cr, and the VOC cleanup criteria presented in Table 1-1A.

(a) Overall Protection of Human Health and the Environment - Alternative SL-5 would provide high overall protection of human health and the environment. On-site treatment (ex-situ stabilization) and backfilling will elimination direct human exposures to the impacted soils and render the constituents immobile in the soil-to-groundwater pathway. The removal and on-site treatment of soils from the 15-21 ft below grade interval with concentrations greater 10 mg/kg Cd and/or 143 mg/kg Cr will result in the protection of groundwater quality. Capping of the remaining Site areas where soils have Cd and/or Cr concentrations greater 10 and 143 mg/kg, respectively, further reduces the potential for leachate production and any groundwater impacts, and eliminates the potential for human exposure.

(b) Compliance with ARARs – Alternative SL-5 would comply with all ARARs, with the potential exception of the New York State Environmental Conservation Law (NYSECL) 27-0704 that prohibits the siting of new landfills on Long Island. According to the definition of a "landfill" in 6 NYCRR Section 360-1.2 (b) (95) (General Provisions, Definitions), which would presumably also include the placement of treated waste. The ARARs that are being met include Federal and NYSDEC air quality standards during excavation and other construction activities, RCRA landfill closure and post-closure requirements (codified at 40 Code of Federal regulations [CFR] §265.310), and RCRA long-term groundwater monitoring requirements (codified at 40 CFR §265.90-265.93). A low-permeability asphalt cover system would be constructed in accordance with local codes and best engineering practices.

(c) Long-Term Effectiveness and Permanence – Alternative SL-5 would provide moderate long-term effectiveness and permanence. Direct human exposure to impacted soils above the target concentrations would be eliminated by excavation and ex-situ treatment. Moreover, soils above the target concentrations of 10 mg/kg Cd and/or 143 mg/kg Cr would also be removed from the soil fringe above the seasonally low water table between 15-21 ft below grade and treated. The low-permeability cover system would preclude future exposure through dermal contact with, incidental ingestion of, and inhalation of soil constituents above the site-specific criteria. The proposed cover system would also reduce the contact of surface run-off with soils under the cap, which would prevent the potential transport of these constituents to off-property locations. In addition, the cap would protect groundwater by reducing infiltration and limiting leachate production. Because a cover system is susceptible to weathering and cracking, a maintenance and inspection program would be required to ensure the long-term integrity of the cover system. While future environmental and public health risks on-site would be reduced by ex-situ treatment and on-site placement of the treated soils above the target concentrations, some degree of long-term liability would be associated with the on-site placement of the treated soils.

(d) Reduction of Toxicity, Mobility, or Volume – Excavation, ex-situ treatment, and on-site placement of the treated soils would limit the mobility and the toxicity of the soil constituents. Further, the construction of a low-permeability cover system covering in the remaining Site areas where Cd and/or Cr concentrations are greater than 10 and 143 mg/kg, respectively, would limit the mobility of soil constituents along the soil-to-groundwater pathway. Therefore, Alternative SL-5 provides a reduction in the mobility and toxicity of the constituents of concern. However, there would be no reduction in the volume of constituents present at the Site.

(e) Short-Term Effectiveness – Short-term risks to on-site workers, the surrounding communities, and the environment are expected to be moderate. Site remediation activities would need to be conducted in accordance with OSHA and other applicable health and safety controls to ensure adequate protection of human health and the environment, and to reduce fugitive dust emissions during Site remediation activities. Fugitive dust controls and air monitoring may also be necessary to ensure compliance with the Clean Air Act and NYSDEC Air Quality Standards during excavation activities. The potential for adverse short-term impacts on-site could be easily mitigated by utilizing appropriate conventional controls such as dust suppression techniques and personal protective equipment to reduce the risk to on-site workers through dermal contact with impacted soils and inhalation of fugitive dust. Surrounding communities could also be exposed to the impacted material during off-site transportation activities. These potential impacts would be mitigated by transporting the excavated soils in accordance with DOT and New York Site regulations.

(f) Implementability – Excavation, ex-situ treatment, and placement of the targeted soils at the Site can be accomplished using technologies proven to be reliable and readily implementable. Equipment, services, and materials for this work are readily available, although bench-scale testing is typically required to achieve the desired chemical stability of the treated materials. Soil excavation within the seasonally fluctuating water table at the Site (15-21 feet below grade) will require extensive groundwater control measures. Alternatively, the excavation should be conducted during periods of low water table conditions. The increase in soil volume during ex-situ stabilization may affect the consolidation and/or placement options of the treated soils.

(g) Cost – Table C-5 presents the estimated costs for Alternative SL-5. The TDCC is estimated to be $4,461,952. The TICC is estimated to be $6,266,636. The annual O&M cost is estimated to be $35,000. The total present worth cost is estimated to be $6,610,266, based on a discount rate of 8 percent for a period of 20 years.

(h) State Acceptance – No formal comments from the State are currently available for evaluation against this criterion. The State comments will be incorporated in the Responsiveness Summary section of the EPA ROD document.

(i) Community Acceptance – No formal comments from the public are currently available for the evaluation of this criterion. It is anticipated that the formal comments from the public will be provided during the public comment period and that these comments will then be addressed in the Responsiveness Summary section of the EPA ROD document.

4.3.1.4 Alternative SL-7 (Complete Excavation to the Site-specific Criteria and Off-site Disposal): Cost Table C-7, Figure C-7

This alternative incorporates the excavation and off-site disposal of the entire on-site soil volume with Cd and/or Cr concentrations greater than 10 and 143 mg/kg, respectively. By definition, this volume includes soils that are hazardous by characteristic (estimated to be greater 120 mg/kg Cd) and also includes all soils within the 15 to 21 ft bgs interval (groundwater fluctuation zone) that have Cd and/or Cr concentrations greater than 10 and 143 mg/kg, respectively. Clean backfill (from an off-site source) would be placed into the excavation to return the Site to grade. Since all soils with Cd and Cr concentrations in excess of the site-specific criteria would be excavated and removed from the Site, there are no remaining areas that would require capping to meet the RAOs.

The excavated soil to be disposed off-site would undergo a soil profile analysis (including total waste and toxicity characteristic leaching procedure [TCLP] analysis). Depending on these results, the excavated soil would be transported to an off-site RCRA Subtitle D landfill for disposal as a non-hazardous waste, or to a RCRA Subtitle C landfill for disposal as a hazardous waste. The effectiveness of the excavation would be evaluated via a suitable post-excavation sampling program, and the results compared to the site-specific cleanup criteria of 10 mg/kg Cd, 143 mg/kg Cr, and the VOC cleanup criteria presented in Table 1-1A.

According to the conceptual site model presented in Appendix B, the soil volume that has Cd concentrations greater than 10 mg/kg is approximately 73,000 cy (note that this calculation was performed using the surrogate criterion of [Cr] greater than 124 mg/kg). However, approximately 83,000 cy of soil need to be excavated (note the distinction of 'actual' volume and 'removal' volume, as defined in Table 1-2). The proportion of hazardous (16,000 cy, which is equivalent to 24,000 tons at 1.5 tons per cy [see notes to Appendix C tables]) vs. non-hazardous soils (57,000 cy, which is equivalent to 85,500 tons) was also estimated by the conceptual model. However, the actual volume of soils that needs to be transported to a RCRA Subtitle C landfill for disposal as hazardous waste is likely to be less.

(a) Overall Protection of Human Health and the Environment - Alternative SL-7 would provide high overall protection of human health and the environment. The excavation and off-site disposal of all on-site soils with concentrations greater than the site-specific criteria would eliminate direct human exposures to the soil constituents. As this alternative is inclusive of the removal of soils with Cd and/or Cr concentrations greater than 10 and 143 mg/kg, respectively, from the 15-21 ft below grade interval (groundwater fluctuation zone), it is protective of groundwater quality. Further, by removing all on-site soils with concentrations greater than the site-specific criteria, the potential for leachate production and any groundwater impacts is minimized.

(b) Compliance with ARARs – Alternative SL-7 would comply with all ARARs. The ARARs that are being met include Federal and NYSDEC air quality standards during excavation and other construction activities, RCRA landfill closure and post-closure requirements (codified at 40 Code of Federal regulations [CFR] §265.310), and RCRA long-term groundwater monitoring requirements (codified at 40 CFR §265.90-265.93). In addition, any hazardous waste that is taken off-site would be treated, if necessary, to achieve compliance with LDRs, and disposed of at a permitted hazardous waste disposal facility in accordance with RCRA requirements. All hazardous waste would be transported in accordance with U.S. Department of Transportation (DOT) regulations and with provisions specified in 6 NYCRR 373.

(c) Long-Term Effectiveness and Permanence – Alternative SL-7 would provide high long-term effectiveness and permanence. Direct human exposure to impacted soils above the target concentrations would be eliminated by excavation and off-site disposal. Moreover, soils above the target concentrations of 10 mg/kg Cd and/or 143 mg/kg Cr would also be removed from the groundwater fluctuation zone between 15-21 ft below grade and disposed off-site. While future environmental and public health risks on-site would be eliminated by excavation and off-site disposal of soils above the target concentrations, some degree of long-term liability would be associated with the off-site placement of these soils.

(d) Reduction of Toxicity, Mobility, or Volume – The removal and off-site disposal of the excavated soils would substantially reduce the toxicity, mobility, and volume of the targeted constituents at the Site. Any RCRA hazardous waste that is sent off-site for disposal may require treatment to meet LDRs. Off-site treatment to achieve LDRs would result in a reduction of the toxicity, mobility, and/or volume of the landfilled waste. Placement of either treated or untreated soil in RCRA Subtitle C or Subtitle D landfills would also result in a reduction of mobility of the constituents present in the soil.

(e) Short-Term Effectiveness – Short-term risks to on-site workers, the surrounding communities, and the environment are expected to be moderate. Site remediation activities would need to be conducted in accordance with OSHA and other applicable health and safety controls to ensure adequate protection of human health and the environment, and to reduce fugitive dust emissions during Site remediation activities. Fugitive dust controls and air monitoring may also be necessary to ensure compliance with the Clean Air Act and NYSDEC Air Quality Standards during excavation activities. The potential for adverse short-term impacts on-site could be easily mitigated by utilizing appropriate conventional controls such as dust suppression techniques and personal protective equipment to reduce the risk to on-site workers through dermal contact with impacted soils and inhalation of fugitive dust. Surrounding communities could also be exposed to the impacted soil during off-site transportation activities. These potential impacts would be mitigated by transporting the excavated soils in accordance with DOT and New York Site regulations.

(f) Implementability – Excavation of the targeted soils at the Site can be accomplished using technologies proven to be reliable and readily implementable. Equipment, services and materials for this work are readily available. However, soil excavation within the seasonally fluctuating water table at the Site (15-21 feet below grade) will require extensive groundwater control measures. Preferably, the excavation should be limited to periods of low water table conditions. The Site is accessible from major highways and has sufficient space for on-site transfer, loading, and truck turnaround activities. In addition, both RCRA Subtitle C and Subtitle D landfills that could accept the excavated soils are available.

(g) Cost – Table C-7 presents the estimated costs for Alternative SL-7. The TDCC is estimated to be $14,682,582. The TICC is estimated to be $18,898,818. The annual O&M cost is estimated to be $20,000. The total present worth cost is estimated to be $19,095,178, based on a discount rate of 8 percent for a period of 20 years.

(h) State Acceptance – No formal comments from the State are currently available for evaluation against this criterion. The State comments will be incorporated in the Responsiveness Summary section of the EPA ROD document.

(i) Community Acceptance – No formal comments from the public are currently available for the evaluation of this criterion. It is anticipated that the formal comments from the public will be provided during the public comment period and that these comments will then be addressed in the Responsiveness Summary section of the EPA ROD document.

4.3.1.5 Alternative SL-8 (Complete Excavation to the Site-specific Criteria, On-site Treatment, and On-Site Placement of Treated Soils: Cost Table C-8, Figure C-8

This alternative incorporates the excavation of the entire on-site soil volume with Cd and/or Cr concentrations greater than 10 and 143 mg/kg, respectively. By definition, this volume includes soils that are hazardous by characteristic (estimated to be greater than 120 mg/kg Cd) and also includes all soils within the 15 to 21 ft bgs interval (groundwater fluctuation zone) that have Cd and/or Cr concentrations greater than 10 and 143 mg/kg, respectively. The excavated soils would undergo on-site treatment (in the form of ex-situ stabilization, using cement additive and polymer to achieve the desired chemical stability of the treated material). The treated soils would be placed in the excavated areas to restore the Site to the original grade. Since all soils with concentrations in excess of the site-specific criteria would be excavated and treated to meet the RAOs, there are no remaining on-site areas that would require capping.

The excavated soil volume will be 82,000 cy (equivalent to that of Alternatives SL-7), of which only 73,000 cy will require treatment. Not all of the excavated material may be suitable for backfill and, therefore, a certain proportion of the excavated material may require off-site disposal (see Cost Table C-8). Following stabilization and off-site disposal of unsuitable material, the backfill volume will be approximately 95,125 cy.

The effectiveness of the excavation would be evaluated via a suitable post-excavation sampling program, and the results compared to the site-specific cleanup criteria of 10 mg/kg Cd, 143 mg/kg Cr, and the VOC cleanup criteria presented in Table 1-1A.

(a) Overall Protection of Human Health and the Environment - Alternative SL-8 would provide high overall protection of human health and the environment. On-site treatment (ex-situ stabilization) and backfilling will elimination direct human exposures to the impacted soils and render the constituents immobile in the soil-to-groundwater pathway. The removal and on-site treatment of soils from the 15-21 ft below grade interval with concentrations greater 10 mg/kg Cd and/or 143 mg/kg Cr will result in the protection of groundwater quality.

(b) Compliance with ARARs – Alternative SL-8 would comply with all ARARs, with the potential exception of the New York State Environmental Conservation Law (NYSECL) 27-0704 that prohibits the siting of new landfills on Long Island. According to the definition of a "landfill" in 6 NYCRR Section 360-1.2 (b) (95) (General Provisions, Definitions), this would presumably also include the placement of treated solid waste. The ARARs that are being met include Federal and NYSDEC air quality standards during excavation and other construction activities, RCRA landfill closure and post-closure requirements (codified at 40 Code of Federal regulations [CFR] §265.310), and RCRA long-term groundwater monitoring requirements (codified at 40 CFR §265.90-265.93).

(c) Long-Term Effectiveness and Permanence – Alternative SL-8 would provide moderate long-term effectiveness and permanence. Direct human exposure to impacted soils above the target concentrations would be eliminated by excavation and ex-situ treatment. Moreover, soils above the target concentrations of 10 mg/kg Cd and/or 143 mg/kg Cr would also be removed from the soil fringe above the seasonally low water table between 15-21 ft below grade and treated. While future environmental and public health risks on-site would be reduced by ex-situ treatment and on-site placement of the treated soils, some degree of long-term liability would be associated with the on-site placement of the treated soils.

(d) Reduction of Toxicity, Mobility, or Volume – Excavation and ex-situ treatment of the impacted soils would limit the mobility and the toxicity of the soil constituents. Therefore, Alternative SL-8 provides a reduction in the mobility and toxicity of the constituents of concern. However, there would be no reduction in the volume of constituents present at the Site.

(e) Short-Term Effectiveness – Short-term risks to on-site workers, the surrounding communities, and the environment are expected to be moderate. Site remediation activities would need to be conducted in accordance with OSHA and other applicable health and safety controls to ensure adequate protection of human health and the environment, and to reduce fugitive dust emissions during Site remediation activities. Fugitive dust controls and air monitoring may also be necessary to ensure compliance with the Clean Air Act and NYSDEC Air Quality Standards during excavation activities. The potential for adverse short-term impacts on-site could be easily mitigated by utilizing appropriate conventional controls such as dust suppression techniques and personal protective equipment to reduce the risk to on-site workers through dermal contact with impacted soils and inhalation of fugitive dust. Surrounding communities could also be exposed to the impacted material during off-site transportation activities. These potential impacts would be mitigated by transporting the excavated soils in accordance with DOT and New York Site regulations.

(f) Implementability – Excavation, ex-situ treatment, and placement of the targeted soils at the Site can be accomplished using technologies proven to be reliable and readily implementable. Equipment, services, and materials for this work are readily available. However, soil excavation within the seasonally fluctuating water table at the Site (15-21 feet below grade) will require extensive groundwater control measures. Alternatively, the excavation should be conducted during periods of low water table conditions. The increase in soil volume during ex-situ stabilization may affect the consolidation and/or placement options of the treated soils.

(g) Cost – Table C-8 presents the estimated costs for Alternative SL-8. The TDCC is estimated to be $9,235,707. The TICC is estimated to be $12,667,893. The annual O&M cost is estimated to be $20,000. The total present worth cost is estimated to be $12,864,253, based on a discount rate of 8 percent for a period of 20 years.

(h) State Acceptance – No formal comments from the State are currently available for evaluation against this criterion. The State comments will be incorporated in the Responsiveness Summary section of the EPA ROD document.

(i) Community Acceptance – No formal comments from the public are currently available for the evaluation of this criterion. It is anticipated that the formal comments from the public will be provided during the public comment period and that these comments will then be addressed in the Responsiveness Summary section of the EPA ROD document.

4.3.2 Groundwater Alternatives

An interim groundwater treatment system has been selected previously to remediate impacted groundwater on-site (Non-Time Critical Removal Action [NTCRA]). The Group is currently implementing the NTCRA and therefore, the NTCRA is considered a component of the sitewide groundwater remedy. The objective of the NTCRA is to minimize the off-site migration of constituents of interest via groundwater transport. Thus, the overall effect of the NTCRA is to provide on-site source control.

Since the NTCRA was discussed elsewhere (Dames & Moore, June 3, 1999) and is in the process of implementation at the Site, the discussion of the groundwater remedial alternatives in this Section is limited to the off-site components of the groundwater remedy. However, the O&M cost of the on-site component of the groundwater remedy (i.e., the NTCRA) is included in the cost tables D-1 through D-5 (Appendix D). Each of the groundwater remedial alternatives evaluated in the following sections would recover or intercept and treat the groundwater in the vicinity of the observed 'hot spots' in the off-site groundwater plume. These 'hot spots' are in the vicinity of well clusters MW–9 (metals) and MW-11 (VOCs). In conjunction with on-site source control accomplished by the NTCRA, focusing the off-site component of the groundwater remedy on these 'hot spots' near the headwaters of Massapequa Creek will effectively treat and/or contain the further downgradient migration of the impacted groundwater. Note that groundwater treatment in the Magothy aquifer near MW-11 (as described in Alternatives GW-3 through GW-5) is likely to also affect the western portion of Plume B, because the eastern edge of Plume A and the western edge of Plume B commingle downgradient of the site (see Figure 1-6). The intersecting geometries of Plume A (site-related) and Plume B (not site-related) imply that any treatment system that is designed to fully address the width of Plume A will also likely address the western portion of Plume B. Thus, at least a portion of the off-site extent of Plume B is likely to be addressed during the off-site component of the groundwater remedy, although the off-site groundwater remedy is not specifically designed to address Plume B.

Finally, since the NTCRA will provide on-site source control of Plume A (the site-related plume), the effects of the NTCRA will be monitored in the off-site, downgradient areas. Thus, the sitewide groundwater remedy includes also an evaluation of monitored natural attenuation (MNA), which would be conducted in conjunction with other off-site remedial activities (GW-3 through GW-5), or exclusive of other off-site remedial activities (GW-2). The evaluation of MNA will be supported by a site-specific groundwater flow and transport model. The transient groundwater flow model was presented in the Final CRI report (July 20, 2000), and the transport model is currently being developed. The principle and the potential scope of MNA at the Site were also presented in the Final CRI report (URS, July 20, 2000).

4.3.2.1 Alternative GW-1 (No Action): Table D-1 (Appendix D)

The No Action alternative is required by the NCP to provide a baseline to which all other alternatives may be compared. Under the 'No Action' alternative, no additional remedial actions would be initiated, and the currently implemented on-site NTCRA would be discontinued. However, the 'No Action' alternative would include the continuation of presently existing institutional controls or use restrictions at the Site. The principal use restriction is codified in Nassau County Health Ordinance Articles IV and VI that prohibit the installation of private water supply wells in areas of Nassau County where public water supply is available, as is the case at the Site.

(a) Overall Protection of Human Health and the Environment – Alternative GW-1 does not protect human health and the environment as it does not arrest the off-site migration of constituents from the Site. Beyond the effect of naturally occurring processes that may decrease constituent concentrations in the long-term, this alternative does not provide effective means to protect human health via potential exposure pathways (e.g., inhalation and ingestion), as discussed in the Final BHHRA (URS, July 2000). The Final BHHRA evaluated, among other things, the potential risks associated with on-site and off-site reasonable maximum exposure to constituents in groundwater. Current risks to on-site trespassers and future risks to on-site commercial/industrial workers, construction workers, and recreational users (western parcel only) were quantitatively evaluated. In addition, current risks to off-site residents, school children, and school employees were evaluated. Absent any remedial activities, excess on-site cancer risks greater 1×10^{-6} were determined to be potentially present only for the future on-site commercial/industrial worker (total excess risk of 7.3×10^{-5} mainly due to exposure to TCE and arsenic via groundwater ingestion). The combined hazard index for the same pathway was determined to be 12, mainly due to exposure to Cr and Cd by groundwater ingestion. Note that the existing use restriction for groundwater as codified in Nassau County Health Ordinance Article IV and VI makes it improbable that this critical exposure pathway (i.e., groundwater ingestion by the commercial/industrial on-site worker) would ever be complete. For off-site exposures, excess cancer risks greater than 1×10^{-6} were determined to be potentially present for the off-site resident (total excess risk of 2.5×10^{-3} for Upper Glacial aquifer mainly due to exposure to vinyl chloride and 1,1-DCE via groundwater ingestion and vapor inhalation; total excess risk of 4.9×10^{-4} for Magothy aquifer mainly due to exposure to arsenic, 1,1-DCE, and TCE via groundwater ingestion and vapor inhalation), the Woodward Parkway School child (total excess risk of 5.1×10^{-6} mainly due to vinyl chloride via vapor inhalation), and for the Woodward Parkway School employee (total excess risk of 2.0×10^{-5}, mainly due to vinyl chloride and 1,1-DCE via vapor inhalation). The combined hazard index for these pathways was determined to be 27 for adults and 98 for children (off-site resident, Upper Glacial aquifer mainly due to Cd, hexavalent Cr, and manganese via groundwater ingestion), 2.2 for adults and 9.7 for children (off-site resident, Magothy aquifer mainly due to Cd, hexavalent Cr, and manganese via groundwater ingestion), 0.0004 for the school child, and 0.0014 for the school employee. Therefore, the No Action alternative is not protective of human health for certain exposure pathways to both on-site groundwater and off-site groundwater.

(b) Compliance with ARARs – Alternative GW-1 would leave impacted groundwater in the aquifers and would not achieve ARARs for groundwater (i.e., the Class GA groundwater standards, as per NYCRR Part 703).

(c) Long-Term Effectiveness and Permanence – Alternative GW-1 does not provide any better long-term effectiveness and permanence than that afforded by the current Site conditions. Whereas natural processes (e.g., dispersion, dilution, or biodegradation) may effect long-term decreases in the extent of impacted groundwater, the 'No Action' alternative does not actively remediate groundwater, and constituent concentrations may remain at levels greater than applicable groundwater protection standards.

(d) Reduction of Toxicity, Mobility, or Volume – Alternative GW-1 does not result in the immediate or short-term reduction of toxicity, mobility, or volume of constituents in on-site or off-site groundwater.

(e) Short-Term Effectiveness – Alternative GW-1 would not arrest the off-site migration of impacted groundwater. As no remedial action is employed in this alternative, there is no short-term effectiveness of the 'No Action' alternative. This alternative does not pose short-term risk to workers or the surrounding community.

(f) Implementability – Alternative GW-1 is easy to implement, as the applicable Institutional Controls are already in place and will not be discontinued in the foreseeable future.

(g) Cost – There are no costs associated with Alternative GW-1, as no remedial activities would be implemented.

(h) State Acceptance – No formal comments from the State are currently available for evaluation against this criterion. The State comments will be incorporated in the Responsiveness Summary section of the EPA ROD document.

(i) Community Acceptance – No formal comments from the public are currently available for the evaluation of this criterion. It is anticipated that the formal comments from the public will be provided during the public comment period and that these comments will be addressed in the Responsiveness Summary section of the EPA ROD document.

4.3.2.2 Alternative GW-2 (Continuation of NTCRA and Evaluation of MNA): Table D-2 and Figure D-2 (Appendix D)

This alternative incorporates the continued operation of the on-site NTCRA, coupled with a comprehensive off-site monitoring program to evaluate the long-term aquifer conditions and changes in constituent concentrations. The NTCRA consists of a series of groundwater circulation wells at the downgradient Site boundary, intercepting groundwater and treating VOCs and metals prior to off-site migration. Thus, this alternative evaluates the long-term effects of on-site hydraulic containment and on-site groundwater remediation on downgradient groundwater quality. A fate and transport model would be used to support the off-site monitoring program by evaluating potential future plume configurations as a result of continued implementation of this alternative. The predicted future plume configurations would be evaluated based on the calibrated transient groundwater flow model (presented in the July 20, 2000 Final CRI report), constituent transport considerations (e.g., dispersivity, locations and strength of sources as a function of time), as well as, historic and current monitoring data.

(a) Overall Protection of Human Health and the Environment – Alternative GW-2 does protect human health and the environment in the immediate vicinity of the Site due to on-site hydraulic containment and groundwater treatment for VOCs and metals. The monitoring program (supported by fate and transport modeling) provides a long-term tool to evaluate the effects of on-site groundwater treatment and hydraulic control on the off-site constituent concentrations. Alternative GW-2 is not immediately effective in protecting human health and the environment downgradient of the Site, as no off-site remedial action (such treatment) would be employed (other than those naturally occurring processes that may decrease constituent concentrations in the long-term). Thus, the off-site, long-term risks to human health from inhalation or ingestion of impacted groundwater would continue to exist.

(b) Compliance with ARARs – In the short-term, Alternative GW-2 would leave impacted groundwater in the off-site aquifers and would not achieve ARARs for groundwater (i.e., the Class GA groundwater standards, as per NYCRR Part 703). The continued operation of the on-site NTCRA is expected to meet groundwater ARARs. The groundwater would be monitored in accordance with RCRA long-term groundwater monitoring requirements. As the NTCRA qualifies as an in-situ groundwater remedy, the recharge of treated groundwater back into the on-site aquifer is not required to meet NYSDEC Class GA groundwater standards. However, the treatment efficiency is adequate to provide a long-term goal of meeting NYSDEC Class GA groundwater standards within the aquifer. Hazardous waste that is taken off-site would be treated, if necessary, to achieve compliance with LDRs, and disposed of at a permitted hazardous waste disposal facility in accordance with RCRA requirements. The groundwater treatment wastes would probably be classified as RCRA hazardous waste. The hazardous waste would be transported in accordance with U.S. Department of Transportation (DOT) regulations and with provisions specified in 6 NYCRR373.

(c) Long-Term Effectiveness and Permanence – Alternative GW-2 provide long-term effectiveness and permanence in the vicinity of the Site, as groundwater migration is contained and groundwater is treated for VOCs and metals. Alternative GW-2 also provides long-term effectiveness and permanence for off-site areas, as the continued operation of the on-site NTCRA represents effective source control, which is expected to manifest itself in long-term decreases of the off-site plume extent and constituent concentrations. However, the effects of the on-site source control will manifest themselves on a scale that is proportional to the natural groundwater flow and natural attenuation regime downgradient of the Site, and therefore it is not expected that Alternative GW-2 would result in the immediate reduction of constituent concentrations in the far off-site areas.

(d) Reduction of Toxicity, Mobility, or Volume – Alternative GW-2 results in the reduction of toxicity, mobility, or volume of constituents in on-site groundwater due to hydraulic control and treatment of VOCs and metals. Any RCRA hazardous wastes that are sent off-site for disposal may require treatment to meet LDRs. Off-site treatment to achieve LDRs would result in a reduction of the toxicity, mobility, and/or volume of constituents in these wastes. This alternative is also effective in limiting the off-site migration of constituents, as it provides hydraulic containment along a series of circulation wells with overlapping capture zones. The toxicity and mobility of constituents in off-site groundwater is indirectly reduced, as Alternative GW-2 represents on-site source control and allows natural processes (e.g., dispersion, dilution, adsorption, degradation) to act more effectively in restoring off-site groundwater quality.

(e) Short-Term Effectiveness – Alternative GW-2 would result in the short-term restoration of on-site and near off-site groundwater quality due to hydraulic control and treatment of VOCs and metals. The short-term risk to on-site workers, the surrounding communities, and the environment are expected to be low. A short-term risk to workers exists from exposure to groundwater constituents during construction of the off-site extraction wells and operation of the groundwater treatment system. The groundwater remediation activities would be conducted in accordance with OSHA and other applicable health and safety controls to ensure adequate protection of human health and the environment. While surrounding communities could be exposed to the hazardous waste residuals during off-site transportation activities, the volume of these wastes would be small. This potential impact would be mitigated by transporting the wastes in accordance with DOT and New York State regulations.

(f) Implementability – Alternative GW-1 is easy to implement, as the on-site NTCRA is already being implemented on-site. The corresponding groundwater-monitoring program would be implemented in conjunction with a groundwater fate and transport model to evaluate the long-term effects of the on-site NTCRA (i.e., source control) on the nature and extent of the off-site groundwater plume. As with any other model-driven approach that is based on empirical data, the success of employing monitored natural attenuation to evaluate the long-term groundwater conditions downgradient of the Site hinges on the goodness of fit (i.e., calibration) relating modeled conditions with observed conditions.

(g) Cost – Table D-2 presents the estimated costs for Alternative GW-2. The TDCC is estimated to be $121,500. The TICC is estimated to be $157,950. The annual O&M cost is estimated to be $505,000. The total present worth cost is estimated to be $5,116,040, based on a discount rate of 8 percent for a period of 20 years.

(h) State Acceptance – No formal comments from the State are currently available for evaluation against this criterion. The State comments will be incorporated in the Responsiveness Summary section of the EPA ROD document.

(i) Community Acceptance – No formal comments from the public are currently available for the evaluation of this criterion. It is anticipated that the formal comments from the public will be provided during the public comment period and that these comments will be addressed in the Responsiveness Summary section of the EPA ROD document.

4.3.2.2 Alternative GW-3 (Continuation of NTCRA, MNA Evaluation, and Off-site Groundwater Circulation and In-situ Treatment): Table D-3, Figure D-3 (Appendix D)

This alternative is comprised of two components: (1) the on-site component of the groundwater remedy which incorporates the continued operation of the NTCRA; and (2) the off-site component of the groundwater remedy which incorporates groundwater circulation well (GCW) technology to transfer groundwater for the removal of VOCs by air-stripping or GAC technology and subsequent removal of heavy metal cations (if necessary) by chelating technology. The effectiveness of both components of the groundwater remedy would be evaluated using a groundwater-monitoring program in conjunction with a MNA evaluation. Below, only the off-site component of the groundwater remedy is described in further detail:

Both Density-Driven-Convection (DDC) GCW technology (VOCs only) and Unterdruck-Verdampfer-Brunnen (UVB) GCW technology (VOCs and metals) would be utilized, depending on the mix of constituents present. Only VOCs are present in the Magothy aquifer, which suggest the use of DDC-type GCW technology. Both VOCs and metals are present in the Upper Glacial aquifer, which suggest the use of UVB-type GCW technology. Both versions of GCW technology were previously tested for the on-site NTCRA. The flow rate, well spacing, and orientation of groundwater circulation cells created by the GCW technology would be designed to achieve the desired radius of influence and capture zone (at a specified removal efficiency for the constituents of interest). The details of GCW technology, GAC or air-stripping technology, and chelation technology were described in Section 2.2.2 of this Final FS.

The circulated groundwater would first be treated by either in-situ air stripping or closed–loop liquid-phase GAC for removal of VOCs. In the case of air stripping, the VOC vapors would be removed from the well casing by the vacuum blower for aboveground treatment with vapor-phase GAC units. Dissolved metals (cadmium and chromium) would be removed from groundwater via a chelation process. When the loading capacity of the chelating medium is reached, it would be regenerated in place by passing a dilute acidic and a dilute basic solution through the chelating material. The waste liquid or sludge from regeneration would be containerized and shipped to an off-site facility for disposal.

The most appropriate location for constructing the off-site component of the groundwater remedy is near the 'hot-spots' of the off-site groundwater plume, which are near well cluster MW-11 (VOCs) and MW-9 (metals). The off-site groundwater plume is somewhat atypical as the greatest concentrations of constituents were observed at some distance from the on-site source of the plume. Therefore, locating the circulation wells near these 'hot-spots' would recover and treat the greatest mass of constituents and provide maximum hydraulic control for the downgradient fringe of the groundwater plume (i.e., south of well clusters MW-11 and MW-9) where constituent were detected at significantly lesser concentrations. Previous feasibility analysis for the on-site NTCRA (Weston, 1997; Dames & Moore, June 3, 1999) has shown that capture zone modeling of groundwater extraction is adequate for the feasibility analysis of groundwater circulation technology. Therefore, the capture zone analysis summarized in

Appendix E (which was conducted for fully penetrating groundwater extraction wells) was used for estimating the size of the groundwater treatment system utilizing GCW technology. However, to be conservative, a 50-percent increase in the total GCW flow rate was assumed.

Approximately three (3) UVB-type GCWs (each circulating 75 gpm) would be installed approximately 60-feet deep in the Upper Glacial aquifer. The GCWs would be located near well cluster MW-9, and the wells would be spaced approximately 125 feet from one another. Approximately three (3) DDC-type GCWs (each circulating 50 gpm) would be installed to approximately 180-feet depth into the Magothy aquifer. The GCWs would be located near well cluster MW-11, and the wells would be spaced approximately 125 feet from one another. Thus, the total recirculation rate of these six (6) GCWs would be approximately 375 gallons per minute (225 gpm in the Upper Glacial aquifer and 150 gpm in the Magothy aquifer).

Two separate operation and treatment systems would be necessary to address metals and minor VOCs concentrations near well cluster MW-9, and VOCs concentrations near well cluster MW-11. The layout and design of the treatment would be specific to the respective GCW technologies employed. The DDC-type GCWs near well cluster MW-11 would only require treatment of VOCs via vapor-phase GAC. The UVB-type GCWs near well cluster MW-9 would require treatment of metals and minor VOC concentrations either at a centralized location or at each wellhead.

(a) Overall Protection of Human Health and the Environment – Alternative GW-3 would provide high overall protection of human health and the environment through the permanent removal of VOCs and metals from the Upper Glacial aquifer, and VOCs from the Magothy aquifer. Both the on-site component (on-site NTCRA) and the off-site component (GCW and treatment) would be located so that both mass removal of constituents and hydraulic containment are rendered most effective over short-term and long-term. Both components of the groundwater remedy limit the further downgradient migration of constituents, because the GCWs would be designed to create overlapping capture zones in order to provide effective hydraulic containment of the groundwater plume. A corresponding groundwater-monitoring program will monitor the effectives of Alternative GW-3.

(b) Compliance with ARARs – Alternative GW-3 would comply with all ARARs. Construction of a centralized treatment building and installation of the GCWs would have to comply with Federal and NYSDEC regulations related to wetlands evaluation and protection and flood plain evaluation and control. VOC emissions would comply with NYSDEC air quality regulations. The groundwater would be treated and monitored in accordance with NYSDEC Class GA groundwater standards and RCRA long-term groundwater monitoring requirements (however, because UVB-type and DDC-type GCW technology qualify as in-situ treatment technologies, treated groundwater need not to conform to NYSDEC Class GA groundwater standards upon recharge). In addition, any hazardous waste that is taken off-site would be treated, if necessary, to achieve compliance with LDRs, and disposed of at a permitted hazardous waste disposal facility in accordance with RCRA requirements. The wastes from regeneration of the chelation treatment system are expected to be classified as RCRA hazardous waste. The hazardous waste would be transported in accordance with U.S. Department of Transportation (DOT) regulations and with provisions specified in 6 NYCRR373.

(c) Long-Term Effectiveness and Permanence – Alternative GW-3 would provide high long-term effectiveness and permanence. It is expected that constituent concentrations in both the Upper Glacial and Magothy aquifers would eventually be significantly reduced. The GCW, chelation, and air stripping technologies are proven and reliable. The groundwater treatment residuals, which include spent GAC material and the waste from regenerating the chelation medium, would not pose a long-term risk, because they would be shipped off-site for treatment and disposal. In addition, most of the components of this remedial alternative are relatively compact which will result in reduced visibility of the system.

(d) Reduction of Toxicity, Mobility, or Volume – Alternative GW-3 would be effective in significantly reducing the volume and toxicity of constituents in groundwater in the off-site area. Any RCRA hazardous wastes that are sent off-site for disposal may require treatment to meet LDRs. Off-site treatment to achieve LDRs would result in a reduction of the toxicity, mobility, and/or volume of constituents in these wastes. This alternative is also effective in limiting the migration of constituents, as it provides hydraulic containment along a series of circulation wells with overlapping capture zones. This is important, because Alternative GW-3 would be constructed near the downgradient extent of the groundwater plume and therefore would address the great majority of the mass of constituents that reside upgradient of the treatment system. In conjunction with the continued operation of the on-site NTCRA, the on-site and the off-site component of the groundwater remedy would contain and treat groundwater

(e) Short-Term Effectiveness – Short-term risks to on-site workers, the surrounding communities, and the environment are expected to be low. The groundwater remediation activities would be conducted in accordance with OSHA and other applicable health and safety controls to ensure adequate protection of human health and the environment. While surrounding communities could be exposed to the waste residuals during off-site transportation activities, the volume of these wastes would be small. This potential impact would be mitigated by transporting the waste residuals in accordance with DOT and New York State regulations.

(f) Implementability – Alternative GW-3 uses innovative groundwater remediation technologies that have been proven under similar conditions: The GCWs and air stripping and chelation treatment systems have been tested at numerous sites, and have been proven effective in removing VOCs and metals under aquifer conditions similar to those present at the site. In addition, the on-site NTCRA employs a GCW system, which was previously field-tested successfully in the Upper Glacial aquifer (Dames & Moore, June 3, 1999). Chelation technology was tested successfully at the bench-scale, meeting the necessary requirements for removal efficiencies and selectivity for heavy metals (Dames & Moore, June 3, 1999). The current on-site NTCRA will yield full-scale information as to the operational parameters of the chelating treatment technology. The equipment, services, and materials needed to implement this alternative are readily available. While this alternative is easily implementable, additional pilot testing for application in the Magothy aquifer may be required. Further, approvals by public agencies or private parties might be required (or desired) for construction and operation of the treatment system, which would be located on or near public or private property. While an air discharge permit would not be required, it is anticipated that an application would be submitted to NYSDEC for approval of the VOC control system.

(g) Cost – Table D-3 presents the estimated costs for Alternative GW-3. The TDCC is estimated to be $3,115,395. The TICC is estimated to be $4,205,783. The annual O&M costs associated with Alternative GW-3 are estimated to be $838,000. The total present worth cost is estimated to be $12,433,267, based on a discount rate of 8 percent for a period of 20 years.

(h) State Acceptance – No formal comments from the State are currently available for evaluation against this criterion. The State comments will be incorporated in the Responsiveness Summary section of the EPA ROD document.

(i) Community Acceptance – No formal comments from the public are currently available for the evaluation of this criterion. It is anticipated that the formal comments from the public will be provided during the public comment period and that these comments will then be addressed in the Responsiveness Summary section of the EPA ROD document.

4.3.2.3 Alternative GW-4 (On-site NTCRA, Groundwater Extraction and Aboveground Treatment, Groundwater Discharge to Aquifer of Surface Water, MNA Evaluation): Table D-4, Figure D-4 (Appendix D)

This alternative is comprised of two components: (1) the on-site component of the groundwater remedy which incorporates the continued operation of the NTCRA; and (2) the off-site component of the groundwater remedy, which incorporates groundwater extraction and subsequent aboveground treatment of constituents (pump-and treat). The effectiveness of both components of the groundwater remedy would be evaluated using a groundwater-monitoring program in conjunction with a MNA evaluation. Below, only the off-site component of the groundwater remedy is described in further detail:

Groundwater would be extracted from the aquifers by a series of pumping wells screened in the Upper Glacial aquifer and the Magothy aquifer, respectively. Appendix E presents a summary of capture zone analysis for fully penetrating pumping wells. Using a model-derived well spacing of 250 feet, the proposed groundwater extraction system would consist of approximately two (2) extraction wells pumping 75 gpm each within the Upper Glacial aquifer and two (2) extraction wells pumping 50 gpm each within the Magothy aquifer. Thus, the total recovery rate would be on the order of 250 gpm, resulting in a capture zone width of approximately 900 feet at the Site boundary. As with Alternative GW-3, the most effective location for the pumping wells screened in the Upper Glacial will be near well cluster MW-9. The most effective location for the pumping wells screened in the Magothy aquifer will be near well cluster MW-11. The separation of the groundwater extraction wells will likely necessitate the construction of two separate operations and treatment systems (or alternatively will require a substantial connecting piping and distribution system).

A variety of applicable treatment options for metals (ion exchange, chemical reduction and oxidation, precipitation, flocculation, and filtering) were laboratory tested using Site groundwater extracted from the Upper Glacial aquifer (Dames & Moore, June 3, 1999). The treatment system may be similar to that presented in a previous feasibility analysis for the treatment of on-site groundwater (Weston, 1997a). Effective treatment for VOCs would likely be conducted by conventional air stripping. Treatment of the vapors would be via vapor-phase GAC, whereas the effluent from the air-stripping unit would be further treated by liquid-phase GAC to remove SVOCs (if any) and to remove any remaining VOCs. Filter cakes and other waste residues from the groundwater treatment processes would be transported off-site, where, based on the results of waste profile analyses, they would be disposed off at a RCRA Subtitle D landfill (non-hazardous waste), or at a RCRA Subtitle C landfill (hazardous waste). Wastes sent to a RCRA Subtitle C landfill may require pretreatment prior to disposal to comply with applicable land disposal restrictions (LDRs).

The treated groundwater would be either discharged to surface water (i.e., Massapequa Creek) or re-injected into the aquifer via injection wells located outside the capture zone of the system. It is estimated that approximately eight (8) reinjection wells would be necessary to discharge treated groundwater to the aquifers, in the case that discharge to surface water is infeasible.

The assumptions inherent to Alternative GW-4 would require field- or pilot testing verification (such as aquifer pumping tests and treatability studies for groundwater extracted from the Magothy aquifer). Based on such field- or pilot tests, the extraction rate and well spacing would be designed to achieve the desired width of the capture zone (not less than the width of the observed plume downgradient of the Site)

(a) <u>Overall Protection of Human Health and the Environment</u> – Alternative GW-4 would provide high overall protection of human health and the environment through the permanent removal of VOCs and metals from the Upper Glacial aquifer, and VOCs from the Magothy aquifer. Both the on-site component (on-site NTCRA) and the off-site component (Pump-and-Treat) would be located so that both mass removal of constituents and hydraulic containment are rendered most effective over the short-term and long-term. Both components of the groundwater remedy limit the further downgradient migration of constituents, as the circulation and recovery systems, respectively, would be designed to create overlapping capture zones in order to provide effective hydraulic containment of the groundwater plume. A corresponding groundwater-monitoring program will monitor the effectives of Alternative GW-4.

The discharge options for the off-site component of Alternative GW-4 may result in undesired adverse conditions: (a) recharge of treated groundwater to the aquifer could have adverse impacts on the water balance and hydraulic gradients, which could result in unwanted constituent migration; (b) discharge to surface water (Massapequa Creek) could potentially have adverse impacts on the ecosystem of Massapequa Creek, particularly during long-term maintenance shutdowns and subsequent start-ups of the groundwater pumping and treatment system. In addition, some depletion of groundwater resources in the off-site area would occur.

(b) Compliance with ARARs – Alternative GW-4 is expected to comply with all ARARs. The groundwater would be monitored in accordance with RCRA long-term groundwater monitoring requirements. The recharge of treated groundwater back into the aquifers would have to meet NYSDEC SPDES requirements and NYSDEC Class GA groundwater standards. The discharge of treated groundwater to Massapequa Creek would have to meet NYSDEC SPDES requirements and surface water quality standards. Construction of the groundwater treatment building and installation of the extraction and reinjection wells would have to comply with Federal and NYSDEC regulations related to wetlands evaluation and protection and flood plain evaluation and control. VOC emissions would comply with NYSDEC air quality regulations. These regulations are identified in Table A-2 (see Appendix A). In addition, any hazardous waste that is taken off-site would be treated, if necessary, to achieve compliance with LDRs, and disposed of at a permitted hazardous waste disposal facility in accordance with RCRA requirements. The groundwater treatment wastes would probably be classified as RCRA hazardous waste. The hazardous waste would be transported in accordance with U.S. Department of Transportation (DOT) regulations and with provisions specified in 6 NYCRR373.

(c) Long-Term Effectiveness and Permanence – Alternative GW-4 would provide high long-term effectiveness and permanence, as long as adequate monitoring and maintenance are continued. Constituent concentrations in both the Upper Glacial and Magothy aquifers are expected to be significantly reduced. The groundwater recovery and treatment technologies are proven and readily available, although the track record of large-scale pump-and-treat systems at meeting low target concentrations such as

NYSDEC Class GA groundwater standards is not always very good. Residuals of groundwater treatment would not pose a long-term risk, because they would be shipped off-site for treatment and disposal.

(d) Reduction of Toxicity, Mobility, or Volume – Alternative GW-4 would be effective in reducing the volume and toxicity of constituents in both on-site and off-site groundwater. As the constituents are removed from groundwater via treatment, the volume of groundwater with constituent concentrations remaining above ARARs will also decrease. Groundwater treatment wastes that would be sent off-site for disposal may require treatment to meet LDRs. Off-site treatment to achieve LDRs would result in a reduction of the toxicity, mobility, and/or volume of constituents in these wastes. This alternative is also effective in limiting the migration of constituents, as it provides hydraulic containment by the alignment of groundwater extraction wells with overlapping capture zones.

(e) Short-Term Effectiveness – Both components of Alternative GW-4 have immediate short-term benefits. The on-site component will arrest the off-site migration of impacted groundwater (i.e., the on-site NTCRA provides source control). The off-site component of Alternative GW-4 also provides hydraulic containment and therefore protects the most downgradient fringes of the groundwater plume. Short-term risks to on-site workers, the surrounding communities, and the environment are expected to be low. A short-term risk to workers exists from exposure to groundwater constituents during construction of the off-site extraction wells and operation of the groundwater treatment system. The groundwater remediation activities would be conducted in accordance with OSHA and other applicable health and safety controls to ensure adequate protection of human health and the environment. While surrounding communities could be exposed to the hazardous waste residuals during off-site transportation activities, the volume of these wastes would be small. This potential impact would be mitigated by transporting the wastes in accordance with DOT and New York State regulations.

(f) Implementability – Overall, Alternative GW-4 is readily implementable. The off-site component of Alternative GW-4 uses proven and reliable groundwater remediation technologies. Pump-and-treat systems have been used at numerous sites, and have been proven to be moderately effective in removing VOCs and metals under aquifer conditions similar to those present at the site. The equipment, services, and materials needed for the installation and operation of the extraction wells, the treatment system, and the reinjection wells/discharge conveyances are readily available. In addition, sufficient numbers and capacities of off-site commercial facilities exist for the treatment and/or disposal of the groundwater treatment residues. Reinjection of the treated groundwater back into the aquifer is expected to be technically feasible. The on-site component of Alternative GW-4 is currently being implemented.

However, whereas Alternative GW-4 appears to be easy to implement technically, there are several administrative and technical issues that could make implementation more complex. Approvals by public agencies or private parties might be required (or desired) for construction and operation of the treatment building, which would be relatively large and would be located on public or private property. This alternative also has significant permitting and regulatory approval issues associated with reinjecting/discharging the treated groundwater back into the aquifers or Massapequa Creek. While a SPDES permit would not be required, an application for approval of the groundwater remediation and reinjection systems would be submitted to NYSDEC. The NYSDEC approval, if obtained, is expected to include limitations on effluent flow rates and constituent concentrations to ensure that groundwater quality and supply are protected. In addition, while an air emissions permit would not be required, it is anticipated that an application would be submitted to NYSDEC for approval of the VOC control system.

(g) Cost – Table D-4 presents the estimated costs for Alternative GW-4. The TDCC is estimated to be \$3,375,135. The TICC is estimated to be \$4,556,432. The annual O&M costs associated with Alternative GW-4 are estimated to be \$1,024,000. The total present worth cost is estimated to be \$14,610,064, based on a discount rate of 8 percent for a period of 20 years.

(h) State Acceptance – No formal comments from the State are currently available for evaluation against this criterion. The State comments will be incorporated in the Responsiveness Summary section of the EPA ROD document.

(i) Community Acceptance – No formal comments from the public are currently available for the evaluation of this criterion. It is anticipated that the formal comments from the public will be provided during the public comment period and that these comments will then be addressed in the Responsiveness Summary section of the EPA ROD document.

4.3.2.5 Alternative GW-5 (On-site NTCRA, Off-site Permeable Reactive Barrier Wall, Off-site DDC-type GCW and In-situ Treatment, MNA): Table D-5, Figure D-5 (Appendix D)

This alternative is comprised of two components: (1) the on-site component of the groundwater remedy, which incorporates the continued operation of the NTCRA; and (2) the off-site component of the groundwater remedy, which incorporates: (i) a reactive-iron permeable reactive barrier (PRB) for addressing metals and minor VOC impacts in the Upper Glacial aquifer; and (ii) a DDC-type GCW system for addressing VOC impacts in the Magothy aquifer. The effectiveness of both components of the groundwater remedy would be evaluated using a groundwater-monitoring program in conjunction with a MNA evaluation. Below, only the off-site component of the groundwater remedy is described in further detail.

The reactive iron PRB would be installed in the Upper Glacial aquifer for in-situ removal of VOCs by reductive dechlorination, reduction of hexavalent chromium, and co-precipitation of cadmium into the PRB. The reactive medium in the PRB would consist of zero valence iron injected into the aquifer by an azimuth-controlled hydraulic fracturing technology. The iron would be injected through a series of wells installed along the barrier alignment across the width of the groundwater plume. Iron filings contained in a highly viscous gel would be injected through these wells to form an overlapping, continuous barrier. Geophysical tools would be used to monitor and control the PRB installation to ensure that the wall has the desired dimensions and characteristics. The optimal location for the PRB would be in the area of the greatest metals concentrations, near well cluster MW-9. The total length of the PRB would be on the order of 400 feet, and the estimated depth of the treatment wall would be on the order of 60 feet. Therefore, the cross section area of the reactive wall would be on the order 2,400 square feet.

Experience in installing and operating PRBs is generally limited to depths of approximately 100 feet. Therefore, this alternative alone would not be sufficient for remediation of the Magothy aquifer, which would require that the PRB be installed to a depth of approximately 180 feet. Therefore, the presence of VOCs in the Magothy aquifer would be addressed by DDC-type GCW, as discussed in Section 4.3.2.3. The discussion of evaluation criteria for Alternative GW-5 focuses on the PRB; however, the projected cost of Alternative GW-5 is discussed in terms of the complete remedial alternative (which would include the on-site NTCRA and the off-site DDC-type GCW).

(a) Overall Protection of Human Health and the Environment – Alternative GW-5 is expected to provide high overall protection of human health and the environment through the permanent removal of VOCs and metals from the Upper Glacial aquifer. While PRBs have been used at other sites with good results, a bench-scale (and possibly field-scale) demonstration would be needed to confirm how and if the required constituent removal efficiencies can be achieved for both the VOCs and metals under site-specific conditions. For example, the operation of the PRB would have to be monitored closely to avoid potential issues, such as incomplete dehalogenization of VOCs. In addition, if permeability decreases over time (e.g., iron fouling), constituents might be diverted below the PRB into the Magothy aquifer.

(b) Compliance with ARARs – The groundwater would be treated and monitored in accordance with NYSDEC Class GA groundwater standards and RCRA long-term groundwater monitoring requirements. Alternative GW-5 is expected to comply with all ARARs, assuming that the NYSDEC Class GA groundwater standards can, in fact, be achieved and maintained over the long-term. Because this alternative is a complete in-situ process, there are no ARARs associated with air emissions, liquid effluents, or other wastes.

(c) Long-Term Effectiveness and Permanence – Alternative GW-5 is expected to provide moderate to high long-term effectiveness and permanence. All of the components of this remedial alternative would be constructed below ground, resulting in greatly reduced visibility of the system. Overall, long-term effectiveness of this alternative is expected to be acceptable as long as adequate monitoring and maintenance are in effect. The effective life of the PRB medium is still subject to discussion in the regulated community, but may be on the order of 10 years. Anticipating that the full-scale, on-site source control will remain operational, and assuming constituent transport rates in the Upper Glacial aquifer of 0.5 to 1.0 ft/day (resulting in transfer of constituents at a rate of 200 to 400 feet per year), a 10-year life span of the PRB may be sufficient to remediate the majority of the mass of constituents in the Upper Glacial aquifer.

(d) Reduction of Toxicity, Mobility, or Volume – Alternative GW-5 would reduce the volume and toxicity of constituents in off-site groundwater by in-situ treatment of both VOCs and metals via the PRB. The mobility of the metals constituents is achieved by in-situ precipitation into the reactive iron barrier. The mobility of VOC constituents is not reduced, as the PRB does not provide hydraulic containment of the groundwater plume, and therefore, continued monitoring of the effectiveness of the PRB technology is of paramount importance.

(e) Short-Term Effectiveness – Short-term risks to on-site workers, the surrounding communities, and the environment are expected to be low. The PRB installation and other groundwater remediation activities would be conducted in accordance with OSHA and other applicable health and safety controls to ensure adequate protection of human health and the environment. With the exception of the on-site NTCRA component, there are no risks in regard to the transport or disposal of waste residues, as all processes would be operating in-situ within the impacted aquifers.

(f) Implementability – Alternative GW-5 would be readily implementable. The installation of the PRB requires only conventional well installation and injection technologies, although the number of contractors experienced in the construction and operation of PRBs is limited. PRBs have been installed and operated with good results at several sites, although the reliability of this alternative is subject to discussion due to limited long-term operating experience (the first PRB constructed by the hydraulic fracturing technology, which is the basis for Alternative GW-5, was installed around 1997). In contrast, PRBs constructed by conventional trenching technologies have been used since 1991. Monitoring of the constituent concentrations (including potential degradation products [i.e., dechlorination products of TCE]) and the permeability of the PRB would be needed to assess the performance and reliability of the PRB. Regulatory approval of this alternative should be relatively easy to obtain, as long as it can be demonstrated (via bench-scale demonstrations or similar site experience) that concentrations can be significantly reduced or that the NYSDEC Class GA groundwater standards can be met, since no effluents or wastes requiring disposal would be generated. This alternative may also generate the least resistance from public or private parties, due to its very limited visibility.

(g) Cost – Table D-5 presents the estimated costs for Alternative GW-5. The TDCC is estimated to be $4,559,760. The TICC is estimated to be $5,927,688. The annual O&M costs associated with Alternative GW-5 are $689,000 per year. The total present worth cost is estimated to be $12,692,290, based on a discount rate of 8 percent for a period of 20 years.

(h) State Acceptance – No formal comments from the State are currently available for evaluation against this criterion. The State comments will be incorporated in the Responsiveness Summary section of the EPA ROD document.

(i) Community Acceptance – No formal comments from the public are currently available for the evaluation of this criterion. It is anticipated that the formal comments from the public will be provided during the public comment period and that these comments will then be addressed in the Responsiveness Summary section of the EPA ROD document.

4.4 COMPARATIVE ANALYSES OF REMEDIAL ALTERNATIVES

The remedial alternatives evaluated in Section 4.3 are compared in terms of the nine evaluation criteria in Sections 4.4.1 and 4.4.2 for soil and groundwater, respectively.

4.4.1 Soil Alternatives

This section compares soil remedial alternatives SL-1, SL-4, SL-5, SL-7, and SL-8. Table 3-1 and Figure 3-1 will be useful to follow the comparative analysis of the soil remedial alternatives.

4.4.1.1 Overall Protection of Human Health and the Environment

With the exception of Alternative SL-1 (No Action), the soil remedial alternatives discussed in Section 4.3.1 of this Final FS report would provide for the overall protection of human health and the environment. In all cases, the vast majority of the mass of on-site Cr and Cd would be removed from the soil-to-groundwater pathway and from potential human exposure. Alternative SL-1, which offers no remedial actions, is the least protective alternative.

As a matter of degree, Alternatives SL-4 and SL-7 may provide slightly better overall protection, because a certain volume of soil would be removed from the Site and transported to an off-site disposal facility. In contrast, Alternatives SL-5 and SL-8 may provide slightly lesser protection by placing excavated and treated soils on-site as backfill (in the case of SL-5 beneath a low-permeability cover system). Alternative SL-4 and SL-5 also provide protection by capping certain on-site areas with a low-permeability cover system or an engineered structure (such as a building). Alternatives SL-7 and SL-8 do not incorporate cover systems because all on-site soils with concentrations greater than the site-specific criteria would be removed from the Site (SL-7) or treated and backfilled on-site (SL-8).

4.4.1.2 Compliance with ARARs.

The soil alternatives evaluated in Section 4.3.1 comply with the soil ARARs. Although Alternatives SL-5, and SL-8 include the on-site backfilling of treated soils above the groundwater fluctuation zone, it is anticipated that the NYSDEC will issue a waiver for the applicability of the Long Island Landfill Law (NYSECL 27-0704) for these alternatives. Therefore, all soil alternatives are expected to comply with the soil ARARs.

4.4.1.3 Long-Term Effectiveness and Permanence.

With the exception of Alternative SL-1 (No Action), the soil alternatives discussed in Section 4.3.1 of this Final FS report provide high degrees of long-term effectiveness and permanence. This is accomplished by either permanently removing a certain portion of soils from the site (SL-4 and SL-7), or by ex-situ treatment and on-site placement (SL-5 and SL-8). The alternatives that leave a portion of soils with concentrations greater than the site-specific criteria in place (SL-4 and SL-5) also include a low-permeability cover system that limits infiltration of rain water and subsequent leaching, as well as, prevent potential human exposure to Site constituents. Because any cover system is susceptible to weathering and cracking, a maintenance and inspection program would be required for Alternatives SL-4 and SL-5 to ensure the long-term integrity of the cover system. Alternative SL-1 provides no soil removal, treatment, or cover system and is not considered effective.

4.4.1.4 Reduction of Toxicity, Mobility, or Volume

Alternatives that remove or treat the greatest soil volume (with concentrations greater than the site-specific criteria) provide (by definition) the highest degree of reduction of volume. The soil alternatives with the greatest reduction in constituent volume, therefore, include SL-7 and SL-8. However, with the exception of SL-1, all alternatives discussed in Section 4.3.1 provide similar reductions in toxicity and mobility of constituents, either by on-site treatment (SL-5 and SL-8), excavation and removal of soils (SL-4 and SL-7), or installation of a low-permeability cover system (SL-4 and SL-5). The alternatives that include on-site treatment and placement of soils (SL-5 and SL-8) reduce the toxicity and mobility of the constituents by treatment, but leave their on-site volume unchanged. The alternatives that include capping (SL-4 and SL-5) reduce the mobility of constituents by preventing surface water infiltration and leaching. These alternatives also reduce the toxicity of constituents by limiting the potential for direct human exposure to the constituents. Finally, the alternatives discussed in Section 4.3.1 of this Final FS report eliminate the mobility of constituents in the groundwater fluctuation zone (15-21 ft below grade), by excavating soils with concentrations greater than the site-specific criteria from this zone. Alternative SL-1 offers no treatment or soil removal/disposal or capping, and therefore does not reduce the toxicity, mobility, or volume of soil constituents.

4.4.1.5 Short-Term Effectiveness.

With the exception of Alternative SL-1, the soil alternatives discussed in Section 4.3.1 of this Final FS report would incorporate varying amounts of excavating and handling impacted soils, and would therefore pose some short-term risks to on-site workers, the surrounding communities, and the environment. However, the potential for adverse short-term impacts could be easily mitigated by utilizing appropriate conventional controls such as dust suppression techniques and personal protective equipment. The short-term risks of Alternatives SL-7, and SL-8 would be slightly greater than those of the other alternatives due to potential impacts associated with the increased soil excavation volumes. In addition, Alternative SL-7 is likely to create the greatest short-term risks with regard to prolonged and increased Site traffic relating to the off-site transport and off-site disposal of approximately 110,000 tons of soils and placement of approximately 140,000 tons of backfill (which is equivalent to more than 10,000 trucking roundtrips over the construction period for this Alternative).

4.4.1.6 Implementability.

The soil alternatives discussed in Section 4.3.1 of this Final FS could be easily implemented, because they employ proven and reliable technologies. The equipment, services, and materials required for the excavation, capping, and off-site transport and disposal activities are readily available. The potential need for bench-scale and field-scale pilot testing in Alternatives SL-5 and SL-8 (ex-situ treatment by soil stabilization) renders the implementation schedule of these alternatives slightly less favorable.

4.4.1.7 Costs

For comparison, the estimated total capital costs, annual O&M costs, and the present worth costs (20 years at 8 percent compounding) of the soil remedial alternatives evaluated in Section 4.3.1 are as follows:

Alternative	Total Installed Capital Cost	Annual O&M Cost	Present Worth Cost
SL-1	$0	$0	$0
SL-4	$10,965,692	$35,000	$11,309,322
SL-5	$6,266,636	$35,000	$6,610,266
SL-7	$18,898,818	$20,000	$19,095,178
SL-8	$12,667,893	$20,000	$12,864,253

SL-1 No Action
SL-4 Partial Excavation, Off-site Disposal, Capping
SL-5 Partial Excavation, On-Site Treatment, On-site Placement, Capping
SL-7 Full Excavation, Off-site Disposal
SL-8 Full Excavation, On-site Treatment, On-site Placement

The lowest cost alternative (SL-1 [No Action]) is moderately effective in protecting human health, ineffective in protecting the environment (i.e., groundwater), and fails to meet the RAOs. The remaining alternatives (SL-4, SL-5, SL-7, and SL-8) provide similar degrees of protection (as discussed in Sections 4.4.1.1 through 4.4.1.4) at total present worth costs that range from $6,610,266 to $19,095,178. Alternatives SL-7 and SL-8 have the highest capital costs (due to complete excavation and disposal/treatment) and relatively low O&M costs (due to the absence of a cover system that would require a maintenance and inspection program). Alternatives SL-4 and SL-5 have lesser capital costs and somewhat greater annual O&M costs than both Alternatives SL-7 and SL-8. Overall, Alternative SL-7 (full excavation and off-site disposal) has the greatest total present worth costs ($19,095,178), whereas Alternative SL-5 has the least total present worth costs ($6,610,266).

4.4.1.8 <u>State and Community Acceptance</u>

Issues pertaining to state and community acceptance will be addressed once comments have been received.

4.4.2 Groundwater Alternatives

This section compares remedial alternatives GW-1, GW-2, GW-3, GW-4, and GW-5. Table 3-2 and Figure 3-2 will be useful to follow the comparative analysis of the groundwater remedial alternatives.

4.4.2.1 Overall Protection of Human Health and the Environment

Alternatives GW-3, GW-4, and GW-5, would each provide high overall protection of human health and the environment through the permanent removal of VOCs and metals from the Upper Glacial aquifer, and VOCs from the Magothy aquifer. In addition, these alternatives would limit the migration of constituents further off-site, because the groundwater circulation wells (GW-3 and GW-5) or extraction wells (GW-4) would be designed to have overlapping capture zones and would provide effective hydraulic containment of the groundwater plume. Alternative GW-5 is liable to provide slightly less overall protection of the Upper Glacial aquifer than Alternatives GW-3 and GW-4 due to the potential of incomplete VOC degradation and the possible diversion of groundwater beneath the PRB. However, these liabilities could be addressed by conducting bench- and/or field-scale pilot studies to evaluate the effectiveness of the PRB design.

The effectiveness of Alternative GW-2 and the degree of protection it affords for human health and the environment is limited in the short-term. Although Alternative GW-2 incorporates the continued operation of the on-site NTCRA and therefore provides source control, the constituent concentrations in the downgradient off-site areas (e.g., near well clusters MW-11 and MW-9) will not decrease in the short-term. However, with source control in place, it is expected that aquifer restoration will occur over the long-term. The time-scales over which natural processes can restore groundwater quality would be evaluated using a MNA approach, as suggested in EPA (1998). Alternative GW-1 (No Action) provides no treatment and is not considered to be effective.

4.4.2.2 Compliance with ARARs

Alternatives GW-3 through GW-5 are expected to comply with the groundwater ARARs in the short-term, whereas Alternative GW-2 is expected to meet the ARARs in the long-term. Specifically, Alternative GW-4 would have to comply with NYSDEC SPDES requirements, groundwater standards for the reinjection of the treated groundwater, and surface water quality standards for discharging the treated groundwater to Massapequa Creek (if necessary). Alternatives GW-3 and GW-5 incorporate in-situ treatment technologies and therefore need only to comply with NYSDEC Class GA groundwater standards as remediation goals. Alternatives GW-3 through GW-5 include an off-site groundwater remedy, the construction of which –may have to comply with wetlands and flood plain regulations (especially near well cluster MW-9 that is located along Massapequa Creek).

4.4.2.3 Long-Term Effectiveness and Permanence

Alternatives GW-3, GW-4, and GW-5 would each provide high long-term effectiveness and permanence by significantly reducing constituent concentrations in both the Upper Glacial and Magothy aquifers. The GCW, chelation, and VOC treatment technologies in Alternative GW-3 and the groundwater extraction and treatment technologies in Alternative GW-4 are reliable and proven technologies (GCW and Chelation are also considered innovative technologies). The long-term effectiveness of Alternative GW-5 may be considered less than that of the other alternatives, because the effective life of the reactive iron treatment medium is uncertain. However, experience from other sites where PRBs are employed and targeted bench- and/or field scale pilot studies could evaluate the effective life span of the PRB treatment medium. The long-term effectiveness and permanence of Alternative GW-2 would require a MNA Evaluation according to the guidelines provided in EPA (1998). Alternative GW-1 provides no treatment and no source control and is not considered effective.

4.4.2.4 Reduction of Toxicity, Mobility, or Volume

Alternatives GW-3 through GW-5 would reduce the volume and toxicity of constituents by treating the impacted on-site and off-site groundwater. Alternatives GW-3 and GW-4 would also reduce the mobility and migration of constituents by providing hydraulic containment of the groundwater plume. In the short-term, Alternative GW-2 provides only on-site reduction of toxicity, mobility, or volume of groundwater. The long-term effects of Alternative GW-2 regarding the toxicity (i.e., constituent concentrations), mobility (i.e., transport rate of constituents), and volume (i.e., extent of the groundwater plume) need to be demonstrated utilizing a MNA Evaluation according to guidelines provided in EPA (1998). Alternative GW-1 does not provide a reduction of toxicity, mobility, or volume of the groundwater constituents.

4.4.2.5 Short-Term Effectiveness

The short-term risks to on-site workers, the surrounding communities, and the environment would be low for all groundwater remedial alternatives discussed herein. The short-term risks of the ex-situ alternative GW-4 are slightly higher than those of the in-situ alternatives GW-2, GW-3 and GW-5 due to potential exposure to impacted groundwater. However, the potential for these short-term impacts could be easily mitigated by utilizing appropriate conventional and engineering controls. In addition, all construction and operational activities would be performed under a health and safety plan, utilizing the appropriate personnel protective equipment to minimize potential risks. Potential routes of exposure that may need to be addressed include volatilization of the organic constituents, transport activities related to the disposal of treatment residues, and handling of chemicals necessary to implement the respective treatment technologies.

4.4.2.6 Implementability

Alternatives GW-2, GW-3, and GW-4 can be readily implemented from a technical perspective, as they use reliable technologies that have been successfully field tested and/or employed at sites with similar conditions. The PRB technology component in Alternative GW-5 has the least extensive track record of implementation. With the exception of Alternative GW-2, all alternatives require various bench- and/or field-scale pilot studies to procure the design parameter necessary to install an effective sitewide groundwater remedy that can meet the RAOs. Whereas Alternative GW-4 (pump-and-treat) has the most conventional technology components, there are several administrative issues that could make its implementation difficult. Approvals by public agencies or private parties might be required for construction and operation of the aboveground treatment system, which would be relatively large would probably be located on public or private property. While an SPDES permit would not be required for Alternative GW-4, an application for approval of the groundwater remediation and effluent discharge systems would be submitted to NYSDEC. The NYSDEC approval, if obtained, is expected to include limitations on the treatment plant's effluent flow rates and constituent concentrations.

4.4.2.7 Costs

For comparison, the estimated total capital costs, annual O&M costs, and the present worth costs (20 years at 8 percent compounding) of the groundwater remedial alternatives evaluated in Section 4.3.2 are as follows:

Alternative	Total Installed Capital Cost	Annual O&M Cost	Present Worth Cost
GW-1	$0	$0	$0
GW-2	$157,950	$505,000	$5,116,040
GW-3	$4,205,783	$838,000	$12,433,267
GW-4	$4,556,432	$1,024,000	$14,610,064
GW-5	$5,927,688	$689,000	$12,692,290

GW-1 No Action
GW-2 On-site Continued NTCRA, MNA Evaluation
GW-3 On-site Continued NTCRA, Off-site GCW, MNA Evaluation
GW-4 On-site Continued NTCRA, Off-site Groundwater Extraction and Treatment, MNA Evaluation
GW-5 On-site Continued NTCRA, Off-site PRB, Off-site GCW, MNA Evaluation

The lowest cost alternative (GW-1 [No Action]) is not effective in protecting human health and the environment and fails to meet the RAOs. Similarly, Alternative GW-2 may not be effective in the short-term to protect human health and the environment and to meet the ARARs. The remaining alternatives (GW-3 through GW-5) provide similar degrees of protection (as discussed in Sections 4.4.2.1 through 4.4.2.4) at total present worth costs that range from $12,433,267 to $14,610,064. Alternative GW-4 has intermediate capital costs and the greatest annual O&M costs. Alternative GW-3 has lesser capital costs than both Alternatives GW-4 and GW-5. The increased capital costs for GW-5 are offset by its lesser annual O&M costs. Overall, Alternative GW-4 (continuation of on-site NTCRA and off-site pump-and-treat system) has the greatest present worth costs ($14,610,064), whereas Alternatives GW-3 (continuation of NTCRA and off-site GCW) and Alternative GW-5 (continuation of on-site NTCRA, off-site PRB, and off-site GCW treatment system) have lesser present worth costs of $12,433,267 and $12,692,290, respectively.

4.4.2.8 State and Community Acceptance

Issues pertaining to state and community acceptance will be addressed once comments have been received.

5.0 REFERENCES

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Table 2-1
Summary of Screening of Remedial Technologies
Liberty Industrial Finishing Site - Farmingdale, New York

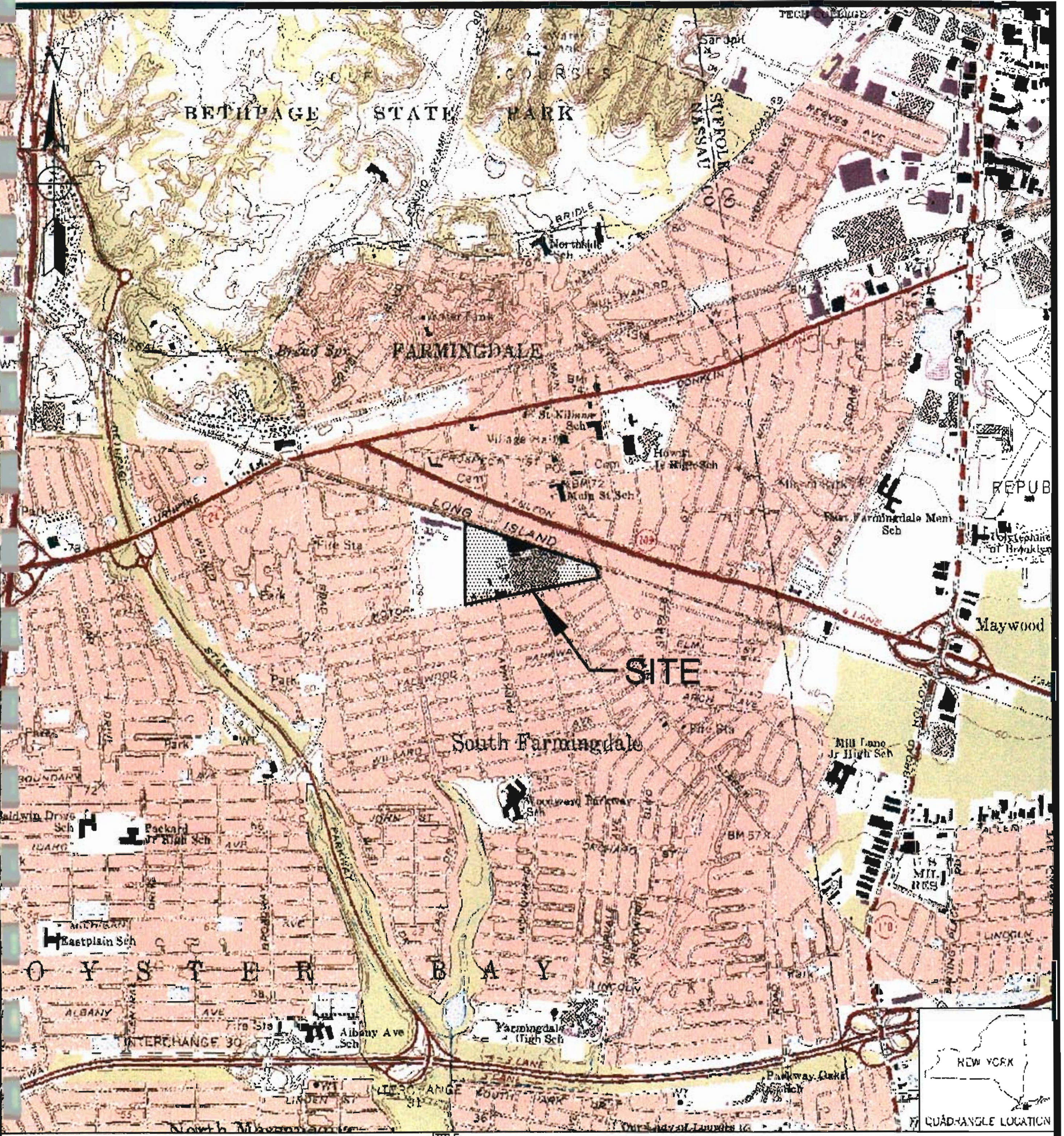
Description of Screened Technologies	Pass	Fail
Soils		
No Action	☑	
Institutional Controls	☑	
Collection	☑	
Cover System		
Single Layer Cap	☑	
Dual Layer Cap	☑	
Multi layer Cap		☑
Treatment		
Chemical Treatment		
Soil Washing	☑	
Soil Flushing		☑
Stabilization	☑	
Physical Treatment		
Vacuum Extraction	☑	
Soil Separation	☑	
Placement		
On-Site Placement	☑	
Off-Site Disposal	☑	
Stormwater Control		
Grading	☑	
Stormwater Collection System	☑	

Table 2-1
Summary of Screening of Remedial Technologies
Liberty Industrial Finishing Site - Farmingdale, New York

Description of Screened Technologies	Pass	Fail
Groundwater		
No Action	☑	
Subsurface Barrier		☑
Collection		
Well Point Dewatering System		☑
Ejector Wells		☑
Pumping Wells	☑	
Subsurface Drain		☑
Treatment		
Physical		
Coagulation, Flocculation, Sedimentation	☑	
Filtration	☑	
Granular Activated Carbon	☑	
Ion Exchange	☑	
Chelation	☑	
Air Stripping	☑	
Steam Stripping		☑
Reverse Osmosis		☑
Thickening/Dewatering	☑	
Chemical		
Neutralization	☑	
Chemical Precipitation	☑	
UV/Oxidation		☑
Biological		
Suspended Growth, Activated Sludge		☑
Fixed Film Growth		☑
Thermal		
Liquid Injection Incineration		☑
Pyrolysis		☑

Table 2-1
Summary of Screening of Remedial Technologies
Liberty Industrial Finishing Site - Farmingdale, New York

Description of Screened Technologies	Pass	Fail
Groundwater (cont.)		
Placement		
Off-Site Disposal		
Discharge to POTW	☑	
Disposal to TSDF	☑	☑
On-Site Disposal		
Discharge to Surface Water	☑	
Reinjection	☑	
In-Situ Remediation		
Biological		
Bioremediation (pass = Magothy aquifer, (fail = Upper Glacial aquifer)	☑	☑
Physical		
Groundwater Circulation Wells	☑	
Air Sparging		☑
Chemical		
Permeable Reactive Barrier Treatment Wall	☑	
Funnel and Gate Treatment Wall		☑
Physicochemical		
In-Situ Direct Precipitation		☑
Natural Attenuation	☑	



0 1000 2000 3000 FEET

GRAPHIC SCALE

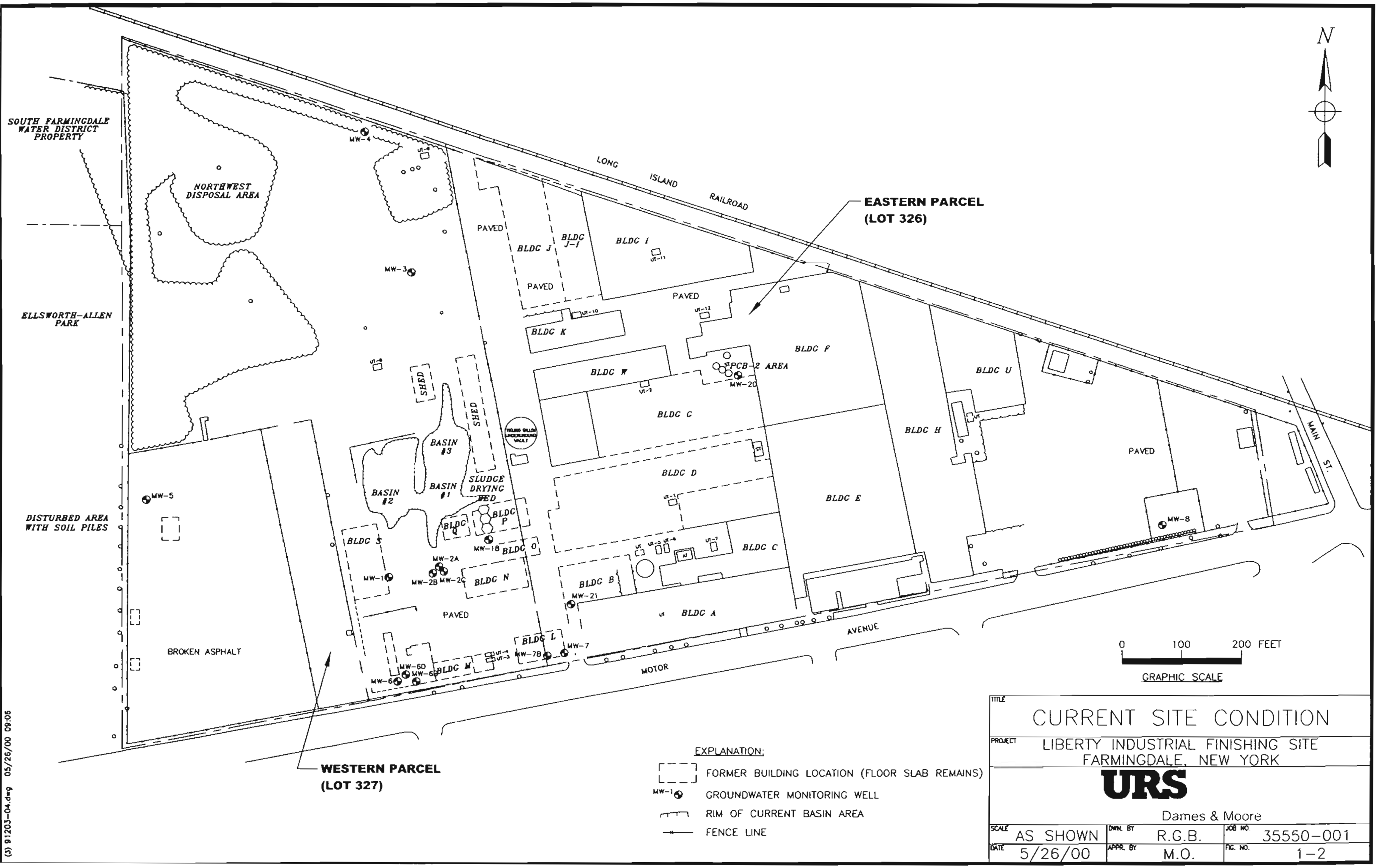
CONTOUR INTERVAL = 5 FEET

REFERENCE:
A PORTION OF USGS 7.5 MINUTE TOPOGRAPHIC MAP; AMITYVILLE QUADRANGLE, NEW JERSEY; 1969, PHOTOREVISED 1979.

TITLE	SITE VICINITY MAP
PROJECT	LIBERTY INDUSTRIAL FINISHING SITE FARMINGDALE, NEW YORK

URS
Dames & Moore

SCALE	AS SHOWN	DWN. BY	R.G.B.	JOB NO.	35550-001
DATE	7/15/99	APPR. BY	M.O.	FIG. NO.	1-1



TITLE	CURRENT SITE CONDITION
PROJECT	LIBERTY INDUSTRIAL FINISHING SITE FARMINGDALE, NEW YORK

URS

Dames & Moore

SCALE	AS SHOWN	DWN. BY	R.G.B.	JOB NO.	35550-001
DATE	5/26/00	APPR. BY	M.O.	FIG. NO.	1-2

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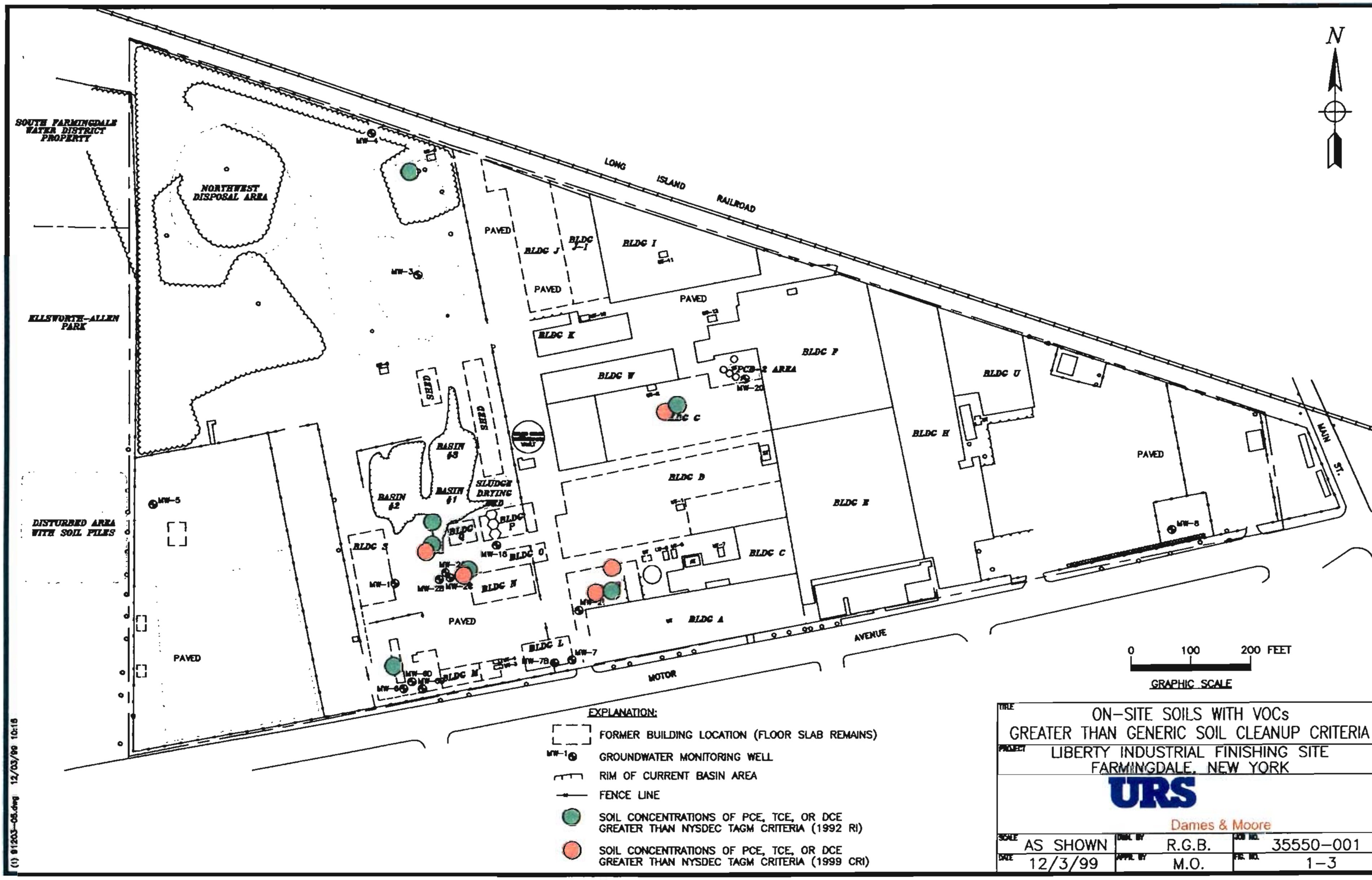
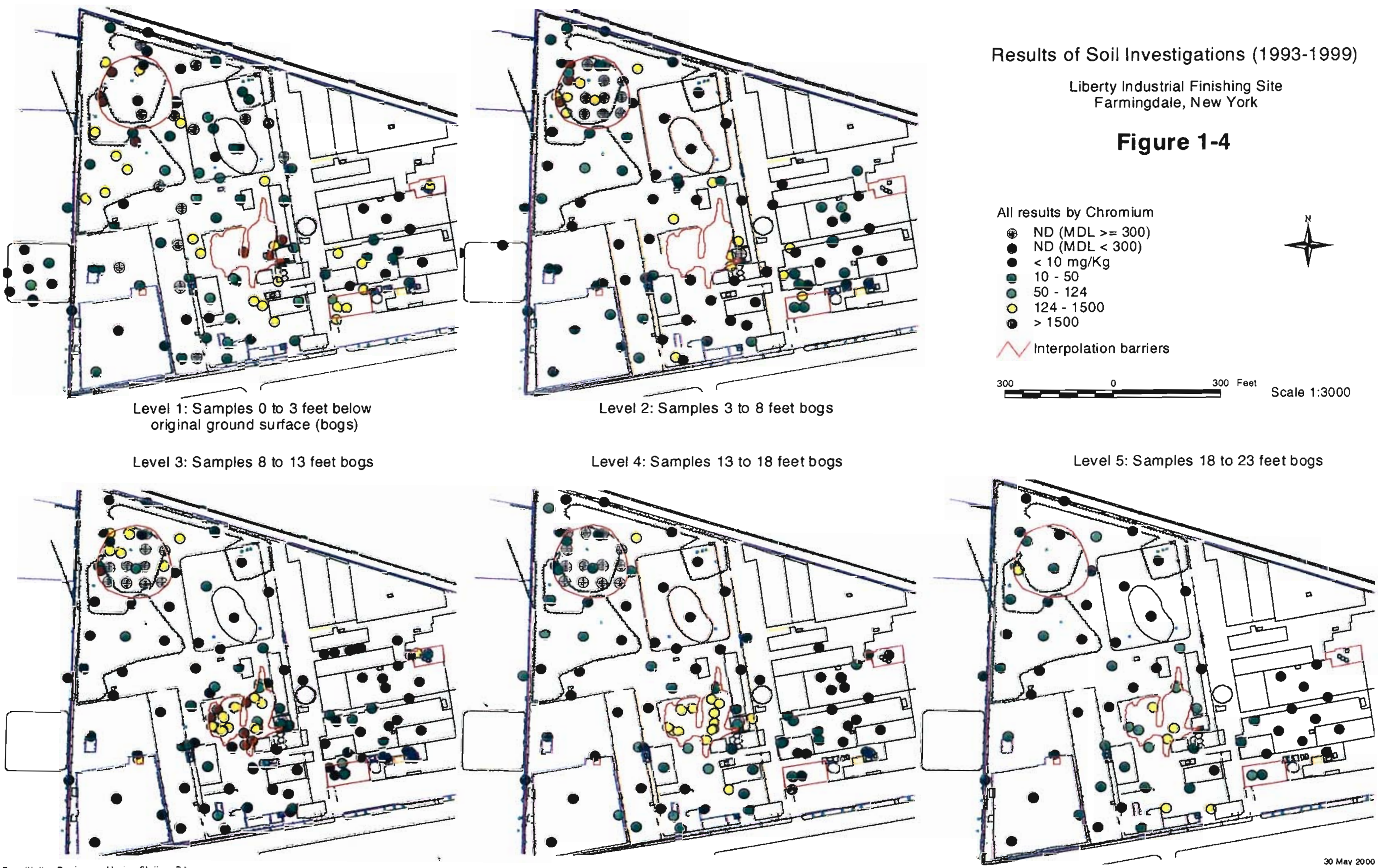


TITLE: ON-SITE SOILS WITH VOCs GREATER THAN GENERIC SOIL CLEANUP CRITERIA

PROJECT: LIBERTY INDUSTRIAL FINISHING SITE FARMINGDALE, NEW YORK

URS Dames & Moore

SCALE	DWN. BY	JOB NO.
AS SHOWN	R.G.B.	35550-001
DATE	APPR. BY	FIG. NO.
12/3/99	M.O.	1-3

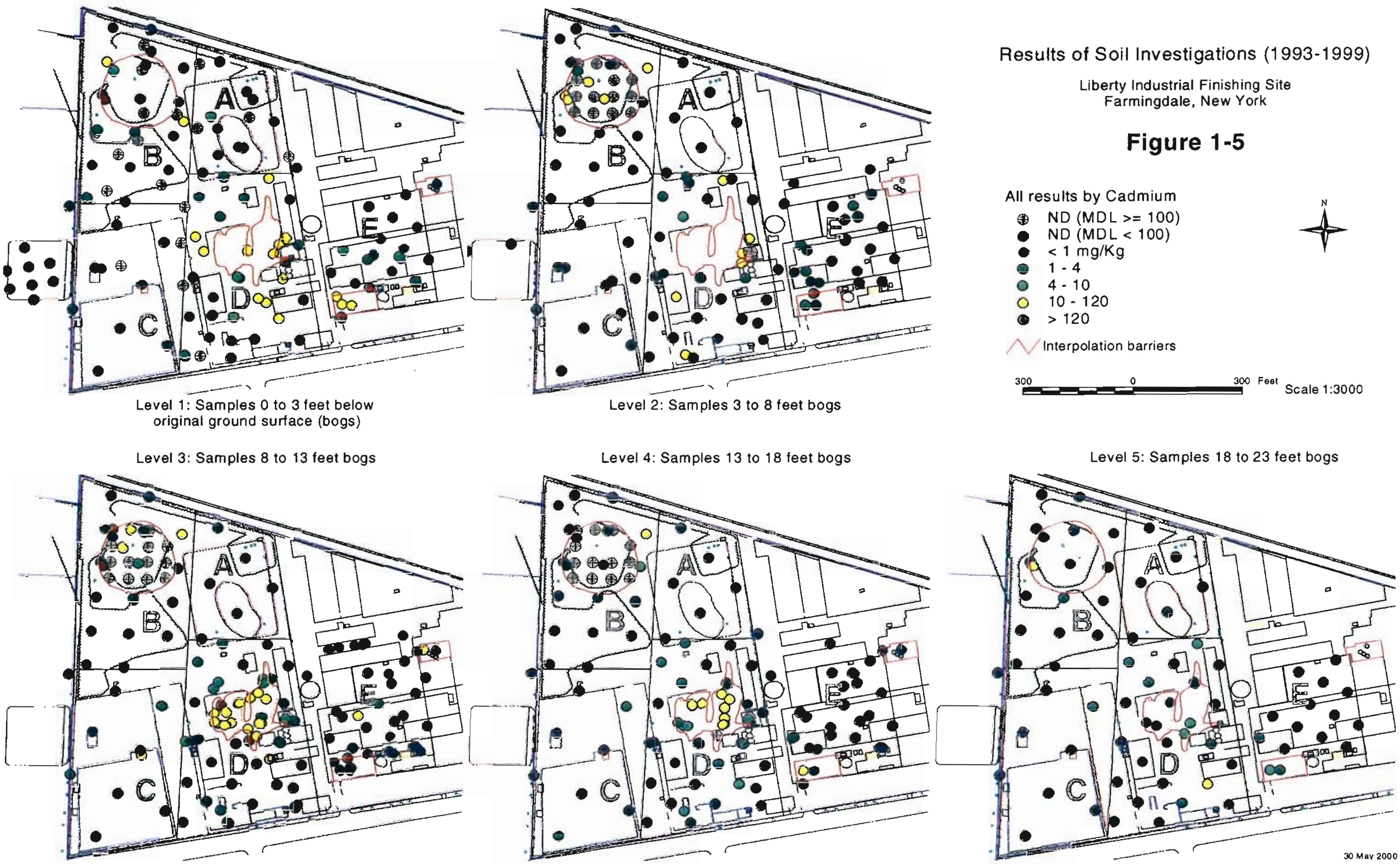


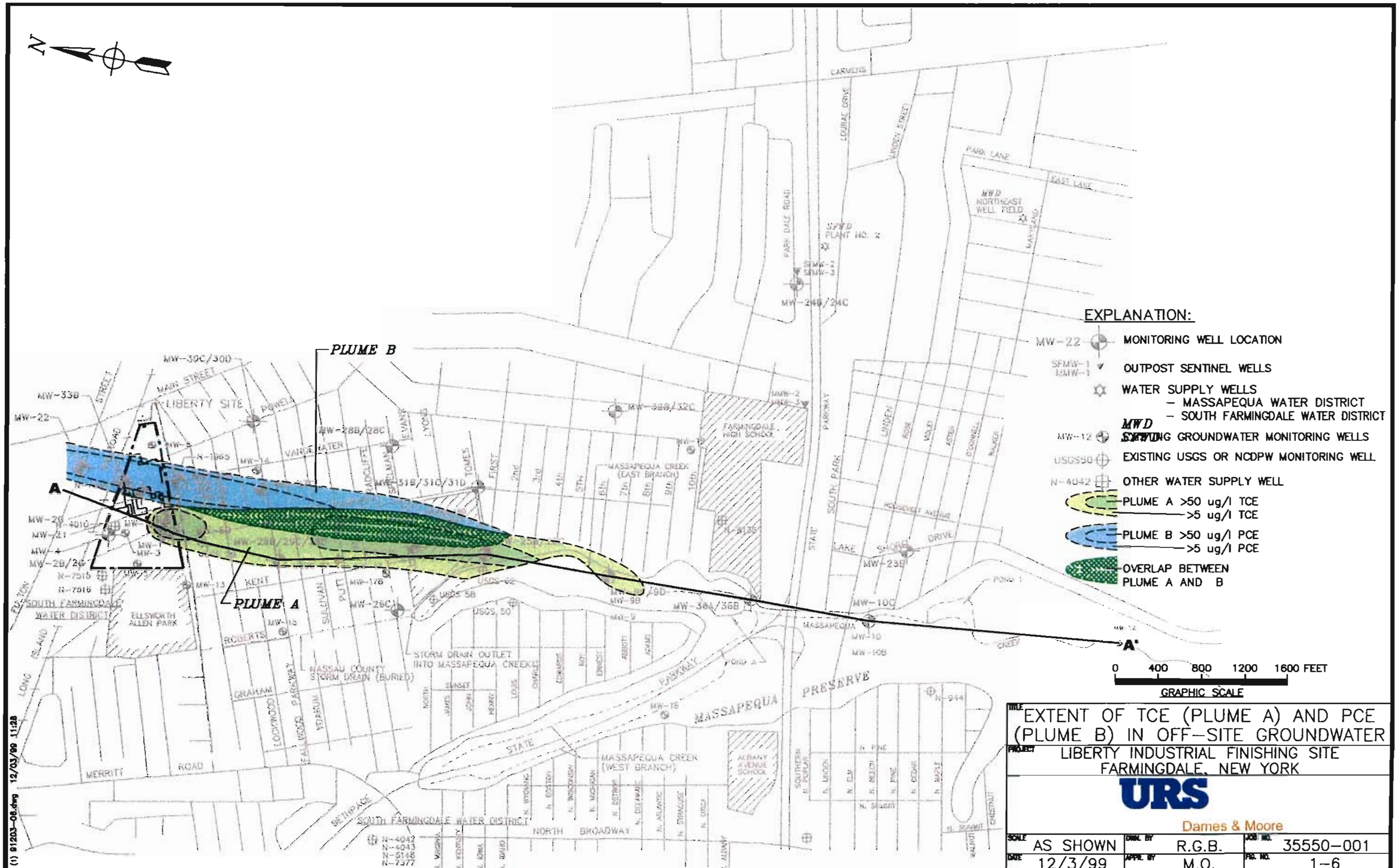
Results of Soil Investigations (1993-1999)
Liberty Industrial Finishing Site
Farmingdale, New York
Figure 1-4
All results by Chromium
ND (MDL >= 300)
ND (MDL < 300)
< 10 mg/Kg
10 - 50
50 - 124
124 - 1500
> 1500
Interpolation barriers
300
0
300 Feet
Scale 1:3000
Level 1: Samples 0 to 3 feet below original ground surface (bogs)
Level 2: Samples 3 to 8 feet bogs
Level 3: Samples 8 to 13 feet bogs
Level 4: Samples 13 to 18 feet bogs
Level 5: Samples 18 to 23 feet bogs
30 May 2000

Results of Soil Investigations (1993-1999)

Liberty Industrial Finishing Site
Farmingdale, New York

Figure 1-5




PLUME B
PLUME A
LIBERTY SITE
EXPLANATION:
MW-22 MONITORING WELL LOCATION
SFMW-1 MMW-1 OUTPOST SENTINEL WELLS
WATER SUPPLY WELLS
– MASSAPEQUA WATER DISTRICT
– SOUTH FARMINGDALE WATER DISTRICT
MW-12 EXISTING GROUNDWATER MONITORING WELLS
USGS90 EXISTING USGS OR NCDPW MONITORING WELL
N-4042 OTHER WATER SUPPLY WELL
PLUME A >50 ug/l TCE
>5 ug/l TCE
PLUME B >50 ug/l PCE
>5 ug/l PCE
OVERLAP BETWEEN PLUME A AND B
0 400 800 1200 1600 FEET
GRAPHIC SCALE
TITLE EXTENT OF TCE (PLUME A) AND PCE (PLUME B) IN OFF-SITE GROUNDWATER
PROJECT LIBERTY INDUSTRIAL FINISHING SITE FARMINGDALE, NEW YORK
URS
Dames & Moore
SCALE AS SHOWN
DATE 12/3/99
DWN. BY R.G.B.
APPR. BY M.O.
JOB NO. 35550-001
FIG. NO. 1-6
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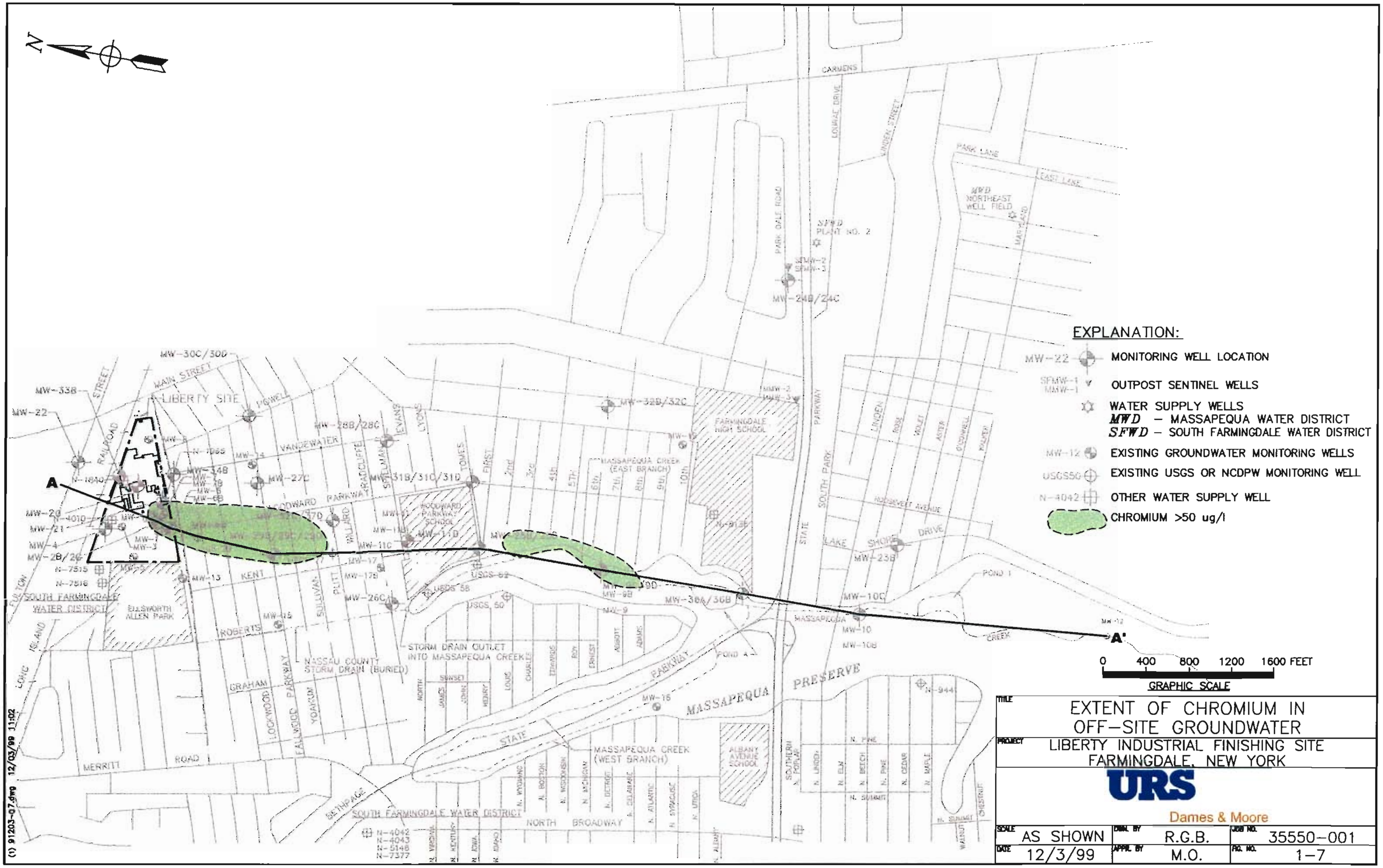
EXPLANATION:
MW-22 MONITORING WELL LOCATION
SFMW-1 MMW-1 OUTPOST SENTINEL WELLS
WATER SUPPLY WELLS
MWD – MASSAPEQUA WATER DISTRICT
SFWD – SOUTH FARMINGDALE WATER DISTRICT
MW-12 EXISTING GROUNDWATER MONITORING WELLS
USGS50 EXISTING USGS OR NCDPW MONITORING WELL
N-4042 OTHER WATER SUPPLY WELL
CHROMIUM >50 ug/l
0 400 800 1200 1600 FEET
GRAPHIC SCALE
LIBERTY SITE
A
A'
TITLE EXTENT OF CHROMIUM IN OFF-SITE GROUNDWATER
PROJECT LIBERTY INDUSTRIAL FINISHING SITE FARMINGDALE, NEW YORK
URS
Dames & Moore
SCALE AS SHOWN
DRWN BY R.G.B.
JOB NO. 35550-001
DATE 12/3/99
APPR. BY M.O.
FIG. NO. 1-7
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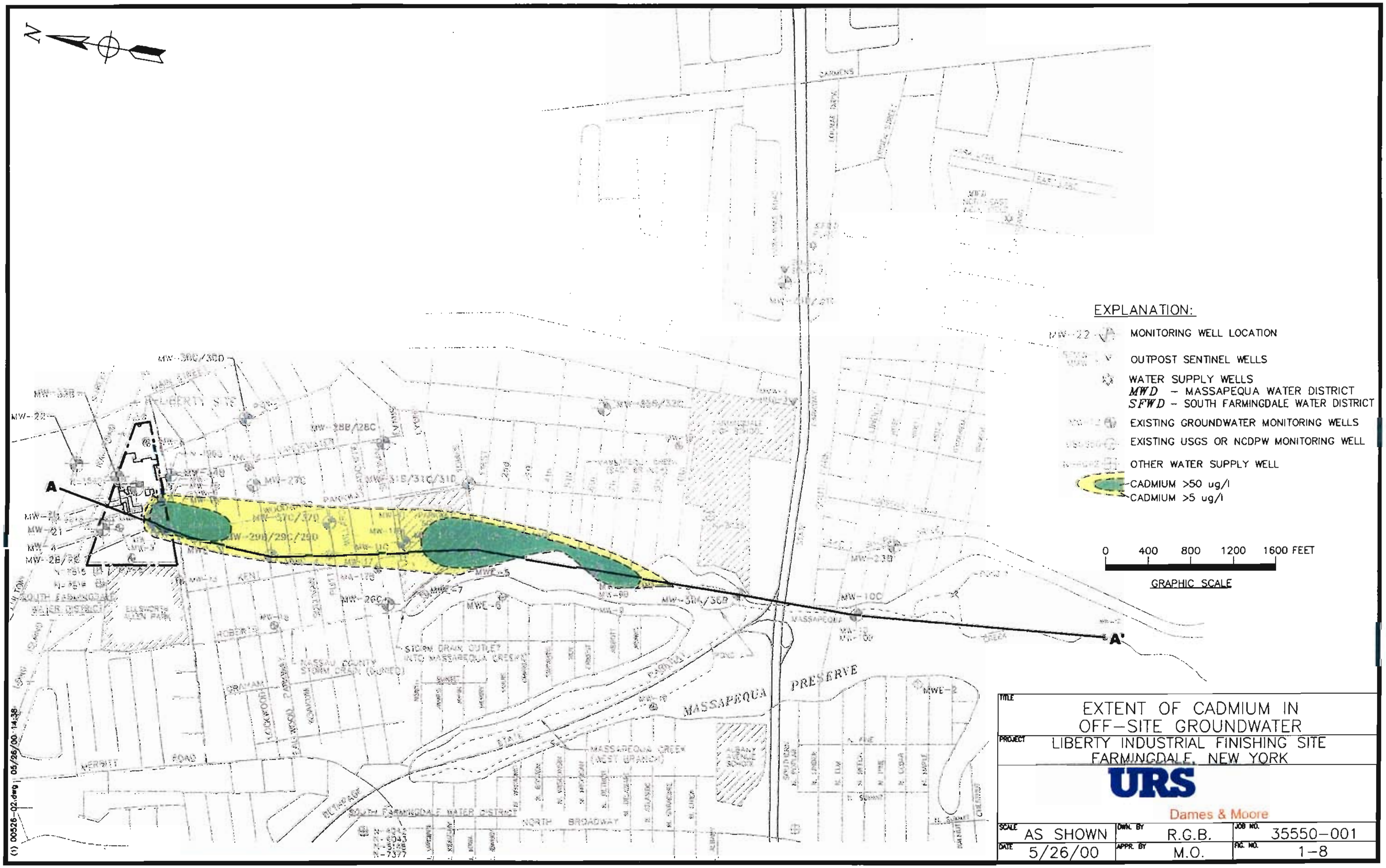
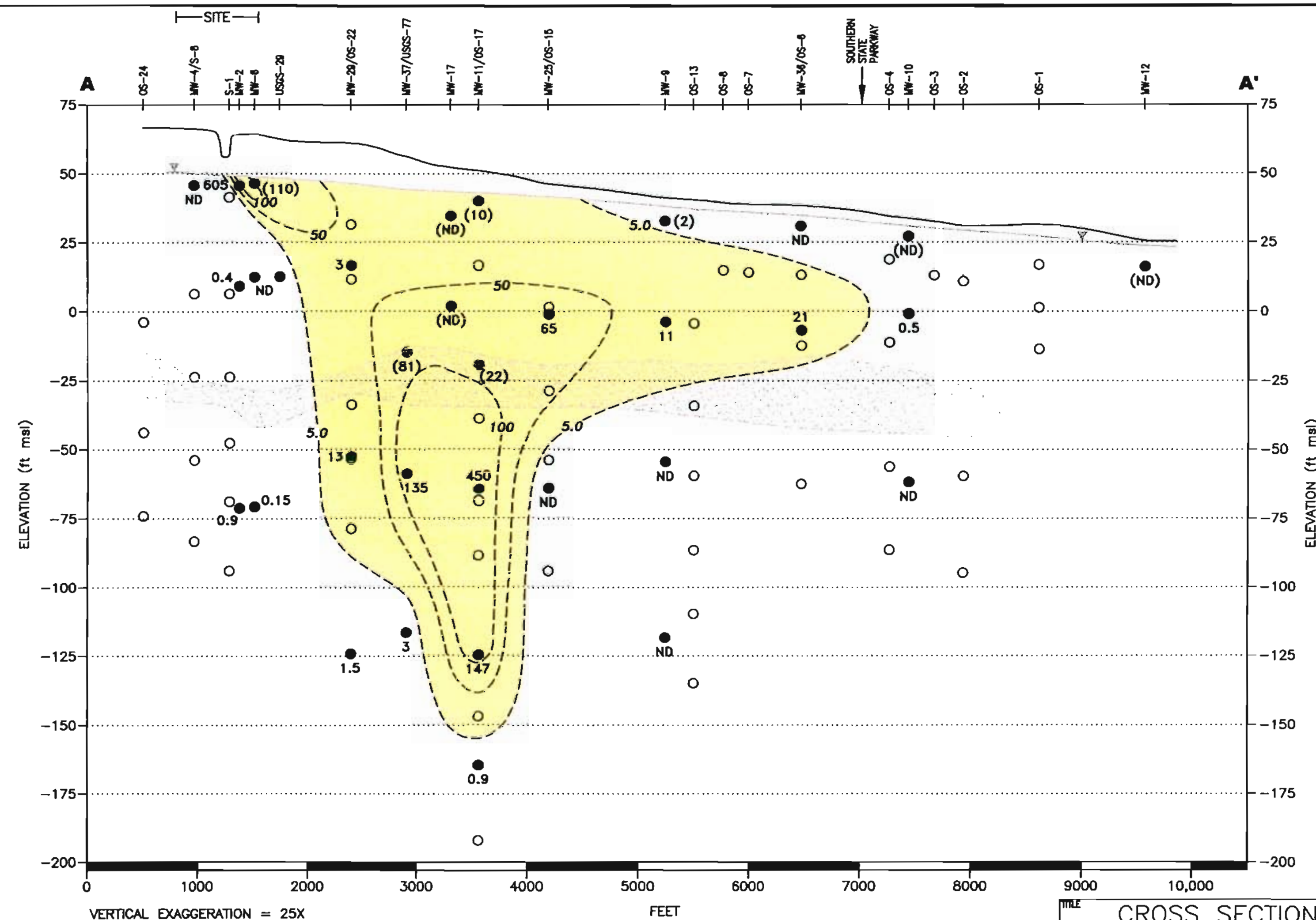

EXPLANATION:
MONITORING WELL LOCATION
OUTPOST SENTINEL WELLS
WATER SUPPLY WELLS
MWD - MASSAPEQUA WATER DISTRICT
SFWD - SOUTH FARMINGDALE WATER DISTRICT
EXISTING GROUNDWATER MONITORING WELLS
EXISTING USGS OR NCDPW MONITORING WELL
OTHER WATER SUPPLY WELL
CADMIUM >50 ug/l
CADMIUM >5 ug/l
0 400 800 1200 1600 FEET
GRAPHIC SCALE
A
A'
N
MW-30C/30D
MW-33B
MW-22
MW-21
MW-28B/28C
MW-27C
MW-31B/31C/31D
MW-29B/29C/29D
MW-26C
MW-35B/32C
MW-31A/36B
MW-23B
MW-10C
MWE-5
MWE-6
MWE-7
MWE-2
MASSAPEQUA PRESERVE
STORM DRAIN OUTLET INTO MASSAPEQUA CREEK
NASSAU COUNTY STORM DRAIN (BURIED)
MASSAPEQUA CREEK (WEST BRANCH)
SOUTH FARMINGDALE WATER DISTRICT
NORTH BROADWAY
MERRITT
ROAD
KENT
HOBERT
GRAHAM
LOCKWOOD
STATE
PARKWAY
CARMENS
(I) 00526-02.dwg 05/26/00 14:38
TITLE
EXTENT OF CADMIUM IN
OFF-SITE GROUNDWATER
PROJECT
LIBERTY INDUSTRIAL FINISHING SITE
FARMINGDALE, NEW YORK
URS
Dames & Moore
SCALE AS SHOWN
DWN. BY R.G.B.
JOB NO. 35550-001
DATE 5/26/00
APPR. BY M.O.
FIG. NO. 1-8



EXPLANATION:

EXTENT OF TRANSITIONAL UNIT BETWEEN UPPER GLACIAL AND MAGOTHY AQUIFER (BASED ON NATURAL GAMMA LOGS)

GROUNDWATER TABLE (AUGUST 17, 1998)

● MONITORING WELLS (CENTER OF SCREEN)

○ SCREENING SAMPLE

TCE TRICHLOROETHENE

ND NOT DETECTED

13 TCE CONCENTRATION IN ug/l

--5.0-- ISOCONCENTRATION LINE (ug/l)

EXTENT OF TCE CONCENTRATIONS ABOVE THE MCL OF 5 ug/l

( ) CONCENTRATIONS PRIOR TO 1998

NOTE:
THE TCE CONCENTRATIONS ARE AVERAGES OF THE CRI WELL SAMPLING RESULTS, OR THE MOST RECENT HISTORIC RESULT.

TITLE	CROSS SECTION OF OFF-SITE TCE GROUNDWATER PLUME
PROJECT	LIBERTY INDUSTRIAL FINISHING SITE FARMINGDALE, NEW YORK
	URS Dames & Moore
SCALE	AS SHOWN
DATE	12/3/99
DWN. BY	R.G.B.
APPR. BY	M.O.
JOB NO.	35550-001
FIG. NO.	1-9

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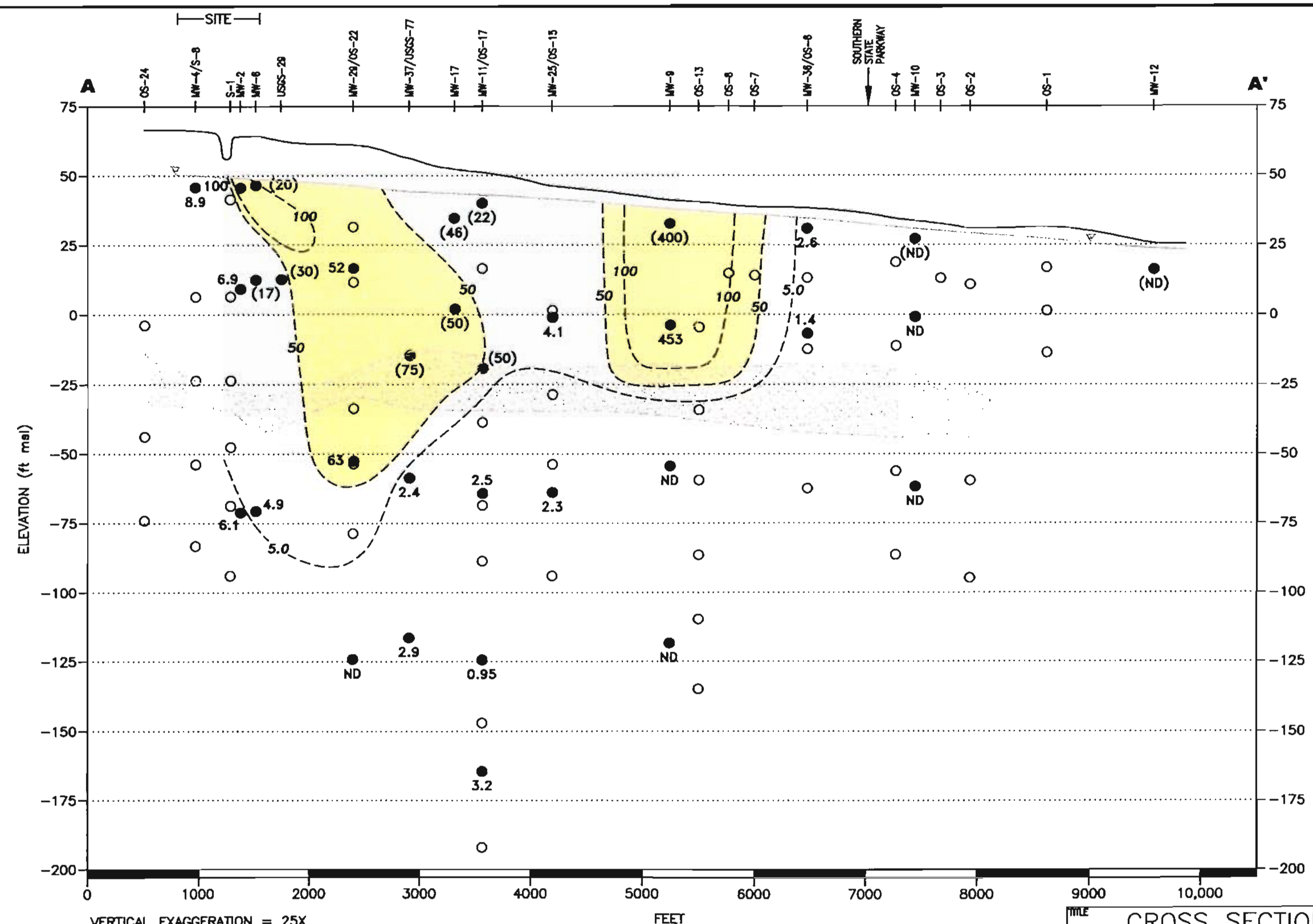

EXPLANATION:

EXTENT OF TRANSITIONAL UNIT BETWEEN UPPER GLACIAL AND MAGOTHY AQUIFER (BASED ON NATURAL GAMMA LOGS)

GROUNDWATER TABLE (AUGUST 17, 1998)

● MONITORING WELLS (CENTER OF SCREEN)

○ SCREENING SAMPLE

ND NOT DETECTED

13 CHROMIUM CONCENTRATION IN ug/l

5.0 ISOCONCENTRATION LINE (ug/l)

EXTENT OF CHROMIUM CONCENTRATIONS ABOVE THE MCL OF 50 ug/l

( ) CONCENTRATIONS PRIOR TO 1998

NOTE:
THE CHROMIUM CONCENTRATIONS ARE AVERAGES OF THE CRI WELL SAMPLING RESULTS, OR THE MOST RECENT HISTORIC RESULT.

TITLE	CROSS SECTION OF OFF-SITE CHROMIUM GROUNDWATER PLUME		
PROJECT	LIBERTY INDUSTRIAL FINISHING SITE FARMINGDALE, NEW YORK		
URS Dames & Moore			
SCALE AS SHOWN	DWN. BY R.G.B.	JOB NO. 35550-001	
DATE 12/3/99	APPR. BY M.O.	FIG. NO. 1-10	

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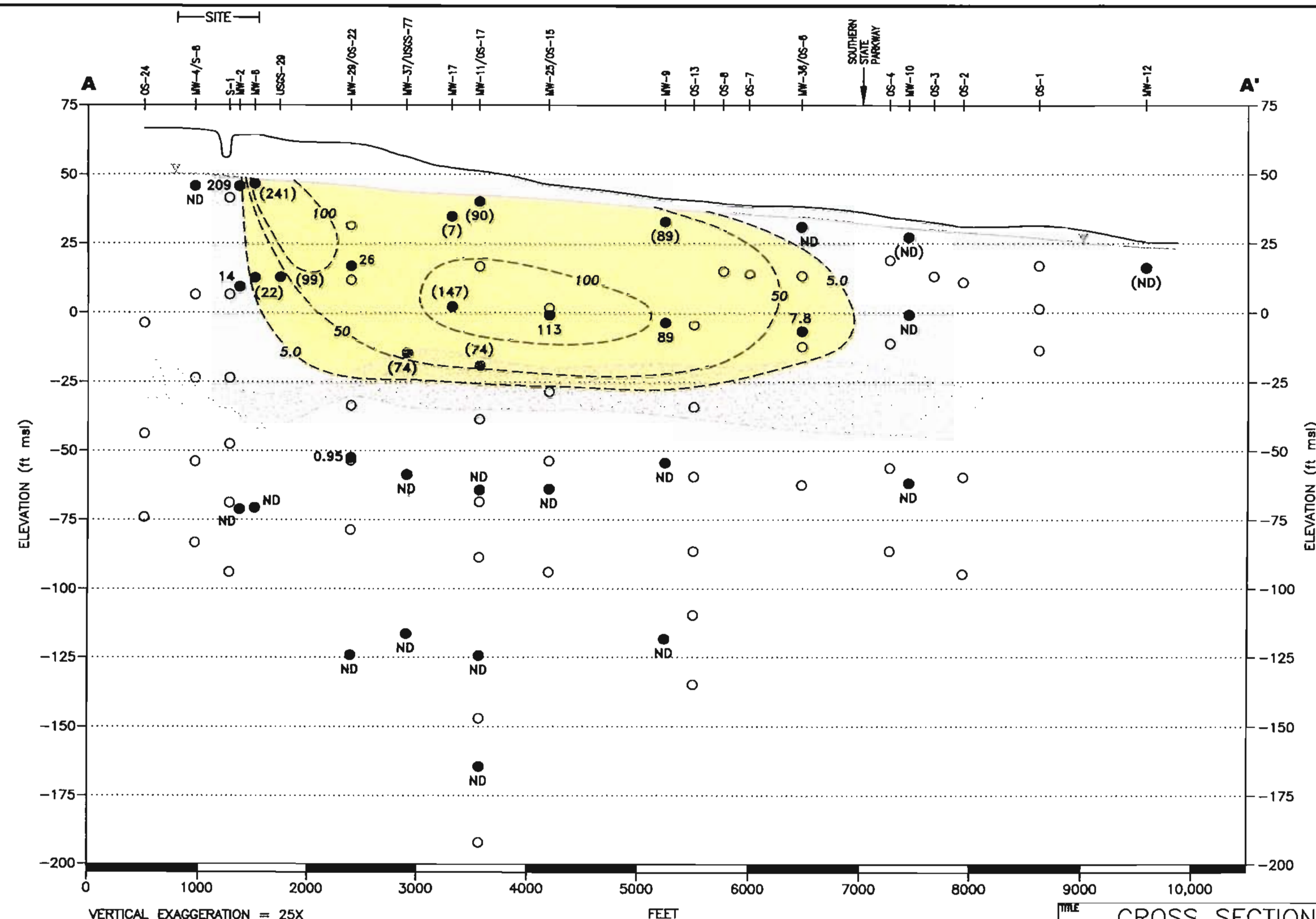

EXPLANATION:

EXTENT OF TRANSITIONAL UNIT BETWEEN UPPER GLACIAL AND MAGOTHY AQUIFER (BASED ON NATURAL GAMMA LOGS)

GROUNDWATER TABLE (AUGUST 17, 1998)

● MONITORING WELLS (CENTER OF SCREEN)

○ SCREENING SAMPLE

ND NOT DETECTED

13 CADMIUM CONCENTRATION IN ug/l

--5.0-- ISOCONCENTRATION LINE (ug/l)

EXTENT OF CADMIUM CONCENTRATIONS ABOVE THE MCL OF 5 ug/l

( ) CONCENTRATIONS PRIOR TO 1998

NOTE:
THE CADMIUM CONCENTRATIONS ARE AVERAGES OF THE CRI WELL SAMPLING RESULTS, OR THE MOST RECENT HISTORIC RESULT.

TITLE	CROSS SECTION OF OFF-SITE CADMIUM GROUNDWATER PLUME
PROJECT	LIBERTY INDUSTRIAL FINISHING SITE FARMINGDALE, NEW YORK
	URS Dames & Moore
SCALE	AS SHOWN
DATE	12/3/99
DWN. BY	R.G.B.
APPR. BY	M.O.
JOB NO.	35550-001
FIG. NO.	1-11

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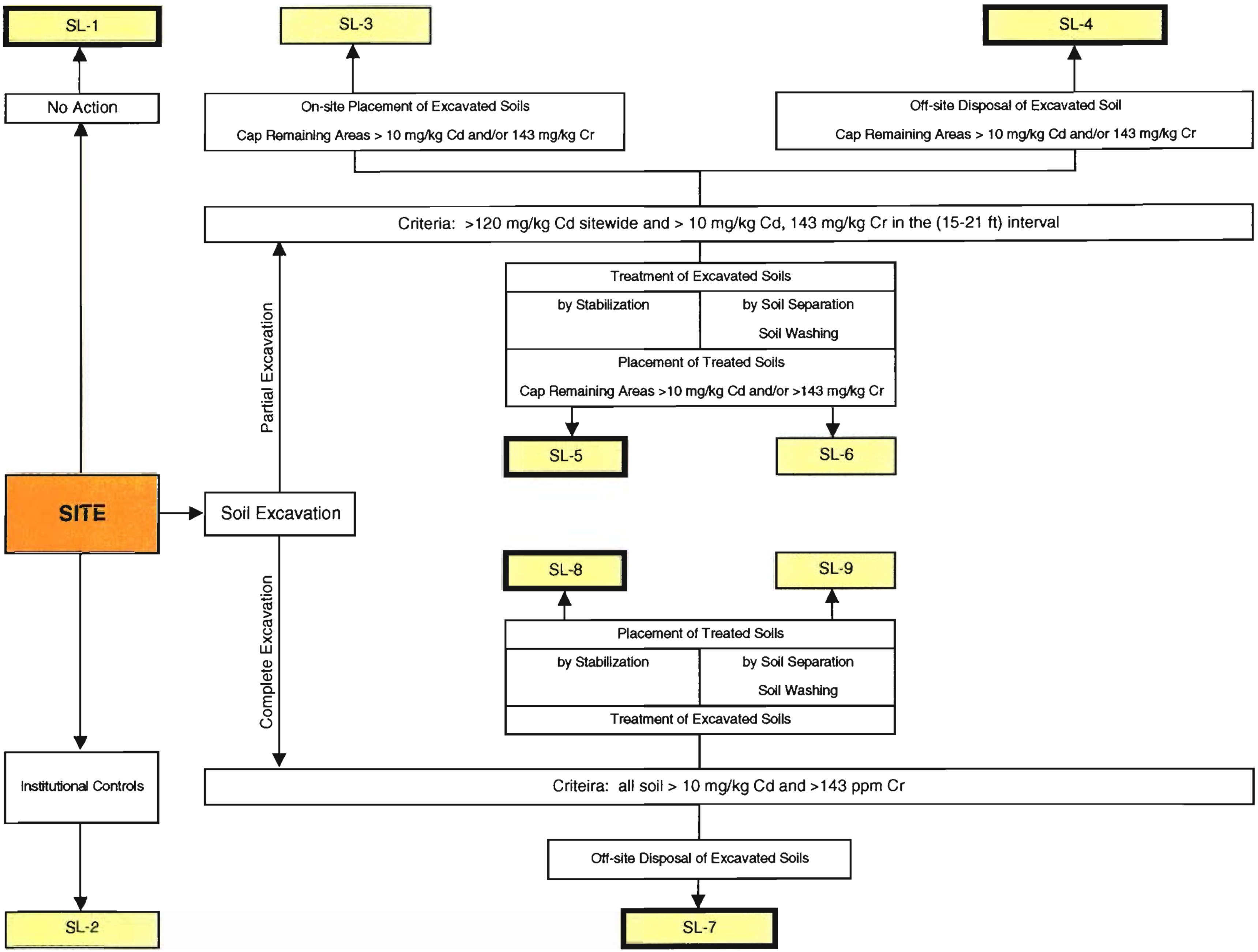
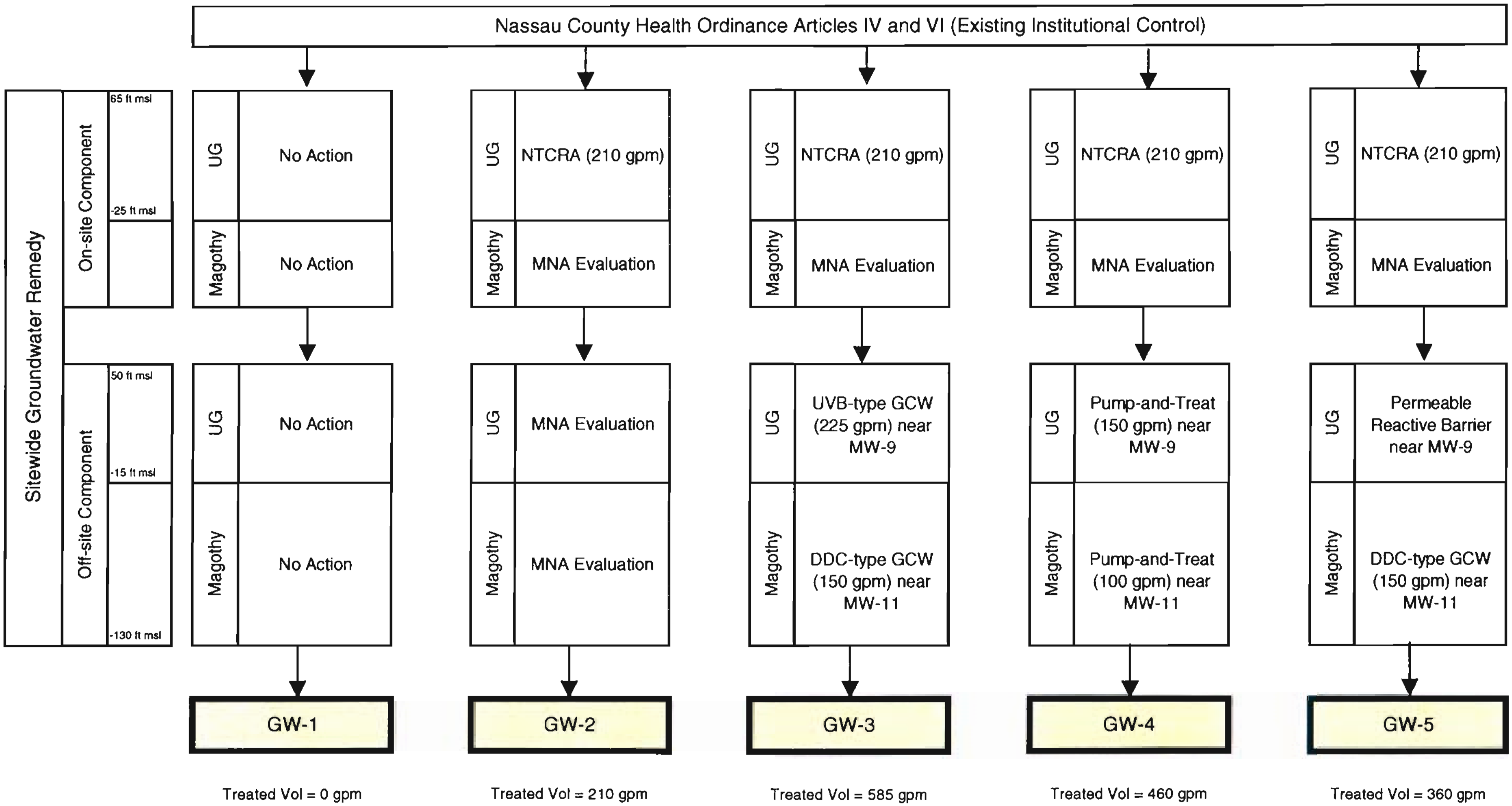


Figures Section 3.xls 07/25/2000

Figure 3-1
Conceptual Overview of Soil Alternatives



Figures Section 3.xls 07/25/2000

Figure 3-2
Conceptual Overview of Groundwater Alternatives

APPENDIX A

IDENTIFICATION OF ARARs

IDENTIFICATION OF POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

U.S. Environmental Protection Agency (EPA) policy, as reflected in the Superfund Amendments and Reauthorization Act of 1986 (SARA) and in the National Contingency Plan (NCP), provides that the development and evaluation of remedial actions under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA or Superfund) must include alternative site responses able to meet potential applicable or relevant and appropriate federal and state environmental and public health requirements (ARARs).

Potential ARARs are defined as follows:

- Applicable Requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, promulgated under federal or state law, that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.
- Relevant and Appropriate Requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements promulgated under federal or state law 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 a CERCLA site.

In addition to ARARs, or if no ARARs are identified for a site, "to be considered (TBC)" criteria may also be identified. Non-promulgated regulations, advisories, criteria, or guidance issued by Federal or State agencies are considered potential TBCs. TBCs are not legally binding, and their use is discretionary. TBCs may be useful in implementing ARARs and in determining preliminary remediation goals (PRGs) in the absence of promulgated standards.

Identification of potential ARARs is performed on a site-specific basis. Neither CERCLA, SARA, nor the NCP provide across-the-board standards for determining whether a particular remedy will produce an adequate cleanup at a particular site. Rather, the process recognizes that each site will have unique characteristics that must be evaluated and compared to those requirements that apply under the given circumstances. Under SARA, permits for compliance with the Resource Conservation and Recovery Act (RCRA), National Pollutant Discharge Elimination System (NPDES), and Clean Air Act (CAA) regulations for on-site remedial actions are not required. CERCLA and SARA, however, do require that the selected remedial alternative meet applicable or relevant and appropriate regulations where possible. The remedial action selected must meet all enforceable and applicable requirements unless a waiver from specific requirements has been granted.

Summaries of potential ARARs for the soils and groundwater at the Liberty Industrial Finishing Site (Liberty Site) are included in Tables A.1 and A.2, respectively.

Potential ARARs can be classified according to the following three categories:

- Chemical-specific requirements are health- or risk-based concentration limits or ranges in various environmental media for specific hazardous substances, pollutants, or contaminants. These limits may take the form of cleanup levels or discharge levels.
- Location-specific requirements are restrictions on activities that are based on the characteristics of a site or its immediate environment (e.g., regulations pertaining to development in a wetlands or flood plain).
- Action-specific ARARs are generally technology- or activity-based requirements or limitations on actions taken with respect to hazardous substances. These requirements are triggered by the particular activities that are selected to accomplish a remedy. An example of an action-specific ARAR is the VOC emissions rule, which requires generators and facilities managing hazardous wastes to limit VOC emissions from hazardous waste treatment.

LIBERTY INDUSTRIAL FINISHING SITE

TABLE A-1

Review of Potential ARARs For On-Site Soils Remediation

Environmental Laws and Regulations	Remedial Alternative*					Considerations as an ARAR
	SL-1	SL-4	SL-5	SL-7	SL-8	
I. SOLID AND HAZARDOUS WASTE						
A. Federal Regulations – Resource Conservation and Recovery Act (RCRA) (40 CFR 260-280)						
1. Proposed Media ID rule (61 FR 18780), April 26, 1996		X	X	X	X	Any media for removal need to be identified according to the hazardous waste rules, and classified under proposed hazardous waste rules for media. Rule contains different categorization for media containing contaminants at different risk levels. Could render contaminated soils and surface/groundwater as nonhazardous or hazardous, depending on the level of contamination.
2. Hazardous Waste Identification and Listing; Proposed Rule 40 CFR parts 260, 261, 266 and 268 (60 FR 66344, December 21, 1995)		X	X	X	X	Media containing hazardous constituents below threshold "exit level" may be managed as nonhazardous wastes, but still subject to (less restrictive) management standards described in site-specific waste management plan required by rule.
3. EPA Guidance for Management of Investigation-Derived Wastes; #9345.3FS, January 1992		X	X	X	X	Any wastes generated from ongoing monitoring or closure and post-closure activities could be subject to this guidance.
4. EPA Draft Soil Screening Guidance.		X	X	X	X	This guidance is applicable for remediation of contaminated soils.
B. New York Hazardous Waste Management Regulations (NYRCC)						
1. General Requirements, Identification and Listing of Hazardous Wastes (6 NYRCC, Part 261);		X	X	X	X	Contaminants in media should be evaluated to determine whether the media could qualify as hazardous under the state hazardous waste rules to determine subsequent management.
2. Hazardous Waste Manifest System and Related Standard for Generators, Transporters and Facilities (6 NYRCC Part 372); Department of Transportation regulations in (49 CFR 170-179), Waste Transport Permits (6 NYRCC Part 364)		X	X	X	X	Contaminated media must be managed according to the hazardous waste standards if found to contain hazardous wastes. Standards include proper containment, labeling, reporting, manifesting and other pre-transport requirements for off-site disposal. Hazardous waste should be transported in accordance with hazardous waste transporter regulations set by EPA, State of New York and the Department of Transportation.

TABLE A-1 (cont'd)

Environmental Laws and Regulations	Remedial Alternative*					Considerations as an ARAR
	SL-1	SL-4	SL-5	SL-7	SL-8	
3. Hazardous Waste Management Facilities (6 NYRCC Subpart 373) • Treatment, Storage and Disposal Facility Permitting Requirements (6 NYRCC Subpart 373-1) • Final Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities (6 NYRCC Subpart 373-2) • Interim status standards for Owners and Operators of Hazardous Waste Facilities (6 NYRCC Subpart 373-3)		X	X	X	X	Areas of contaminated media to be excavated for remediation on-site must be managed in accordance with regulations for owners and operators of hazardous waste treatment, storage and disposal facilities. These regulations include emergency response and planning requirements, manifest, reporting and recordkeeping requirements, ground-water monitoring, container, tank and waste pile requirements, and land treatment requirements. Furthermore, contaminated media to be excavated for remediation on-site must be managed in accordance with CAMU standards.
4. Inactive Hazardous Waste Disposal Sites (6 NYRCC Part 375)		X	X	X	X	Inactive hazardous waste disposal sites must be remediated in accordance with these rules.
5. Land Disposal Restrictions (6 NYRCC Part 376)		X	X	X	X	Hazardous waste must meet treatment standards prior to land disposal.
6. Solid Waste Management Facilities (6 NYRCC Part 360); New York State's Solid Waste Management Policy Guidance (SW-89-5001)		X	X	X	X	Wastes generated from excavation and/or treatment would be subject to LDR requirements to ensure that any wastes subsequently disposed of on land meet LDR requirements, and to ensure compliance with notification procedures for off-site disposal.
7. Solid Waste Management Facilities (6 NYRCC Part 360-1); also NYSECL 27-0704			X		X	NYSECL 27-0704 prohibits the siting of new or expanding existing landfills in Nassau and Suffolk County; definition of "landfill" in NYRCC Part 360-1.2 Definitions (b) 95 : "...land or a disposal facility or part of one where solid waste or its residue after treatment is intentionally placed....."
8. Hazardous Waste Reduction Plans (Section 27-0908, Environmental Conservation Law)		X	X	X	X	A hazardous waste reduction plan may be required depending on the amount of waste generated. The plan must identify activities planned to reduce the amount of waste generated.
9. Division Technical and Administrative Guidance Memorandum (TGAM); Habitat Based Assessment, Guidance Document for Conducting Environmental Risk Assessments at Hazardous Waste Sites (12/28/90)	X	X	X	X	X	This guidance would apply to conducting an environmental risk assessment at the site.

TABLE A-1 (cont'd)

Environmental Laws and Regulations	Remedial Alternative*					Considerations as an ARAR
	SL-1	SL-4	SL-5	SL-7	SL-8	
10. Releases of Hazardous Substances, Reporting, Response and Corrective Action (6 NYRCC Parts 595)		X	X	X	X	This rule may apply depending on the amount of contaminated waste generated at the site.
11. Handling and Storage of Hazardous Substances (6 NYRCC 598)		X	X	X	X	This rule may apply to waste generated at the site from remedial activities.
II. WATER						
A. Surface Water						
1. Surface Water Quality Standards (6 NYRCC Part 701 and 703)	X	X	X	X	X	This regulation presents classification for surface water bodies and standards to maintain best usage based upon human health, protection of aquatic life, aesthetics, chemical correlation, bioaccumulations, etc.
2. SPDES Permit, Monitoring, Reporting and Recordkeeping (6 NYRCC Parts 750 - 756); Proposed SPDES regulations, 4/7/99		X	X	X	X	Discharges to surface water will have to meet the intent of SPDES permit requirements.
3. Derivation and Use of Standards and Guidance on Values (6 NYRCC Part 702)		X	X	X	X	Allows the NYSDEC to require evaluation of short-term and long-term effects of discharge.
4. Classes and Standards of Quality and Priority Assigned to Fresh Surface and Tidal Salt Waters - Nassau County Waters						NYSDEC has classified Massapegua Creek north of Merrick Road as Class C-T, Fresh Surface Waters. This classification states that the best usage of such water is fishing.
5. Technical & Operations Guidance Series (TOGS)						
a. 1.1.1 Ambient Water Quality Standards and Guidance Values	X	X	X	X	X	This guidance identifies ambient water quality standards to be complied with.
b. 1.1.5 Procedures for Deriving Ambient Water Quality Standards and Guidance Values for the Protection of Wildlife.		X	X	X	X	This guidance should be consulted because ambient water quality standards must be met and wildlife protected during remediation.
c. 1.3.2 Toxicity Testing in the SPDES Permit Program		X	X	X	X	This document describes procedures to be followed when the decision has been made to include toxicity testing in a SPDES permit; this could become applicable in the future with regard to the site.
d. 1.3.4 BPJ Methodologies		X	X	X	X	This document outlines procedures to determine effluent limits to satisfy technical requirements of the Clean Water Act.

TABLE A-1 (cont'd)

Environmental Laws and Regulations	Remedial Alternative*					Considerations as an ARAR
	SL-1	SL-4	SL-5	SL-7	SL-8	
B. Groundwater						
1. Surface and Groundwater Quality Standards and Groundwater Effluent Standards (6 NYRCC Part 703)		X	X	X	X	This regulation presents classifications, quality standards, and effluent standards or limitations to prevent pollution of groundwater and to protect groundwater for use as potable water. Effluents generated by site remedial activity may require pretreatment.
2. Source of Water Supply (10 NYRCC Part 170)		X	X	X	X	Applies to any groundwater, surface water body that water is regularly taken for drink…or which has been classified for present or future public beneficial use or source for domestic purposes.
III. AIR QUALITY						
A. Air Cleanup Criteria (Division of Air Resources, 5/31/90)		X	X	X	X	This document concerns evaluation of air impact from contaminated sites. It describes the requirements and procedures for addressing emissions and impacts associated with pre-remediation, remediation and post-remediation activities.
B. NYSDEC Air Guide 1 - Guidelines for the Control of Toxic Ambient Air Contaminants		X	X	X	X	This document presents a screening mechanism to assist NYSDEC in determining whether and under what conditions a permit should be issued for emission sources.
C. General Provisions (6 NYRCC Part 200); Permits and Registration (6 NYRCC Part 201)		X	X	X	X	Excavation and treatment activities could release air emission from equipment and operations and, therefore, require a permit.
E. General Prohibitions (6 NYRCC Part 211)		X	X	X	X	This rule prohibits the release of air contaminants that would threaten human health and the environment. This prohibition applies to but is not limited to any particulate, fume, gas, mist, odor, smoke, vapor, pollen, toxic either alone or in combination with others. Excavation and treatment activities may generate particulates and smoke.
F. General Process Emission Sources (6 NYRCC Part 212)		X	X	X	X	Excavation and treatment activities could release air emission from equipment and from operations.
G. Air Quality Standards (6 NYRCC Part 257)		X	X	X	X	Emission from remedial activities must meet air quality standards for emission of SO_2, particulates, CO, photochemical oxidants, hydrocarbons (nonmethane), nitrogen dioxide (NO_2), fluorides, beryllium and hydrogen sulfide (H_2S)
H. Air Quality Classification - Nassau County (6 NYRCC Part 287)		X	X	X	X	The site is located in an air classification Level III area. Ambient air quality standards for particulate and nonmethane hydrocarbons may be applicable.
IV. OTHER APPLICABLE REGULATORY PROGRAMS						
A. Occupational Safety and Health Administration (OSHA)						
1. Requirement for workers at remedial action sites (29 CFR Part 1910)		X	X	X	X	Any remedial action onsite must be performed in accordance with applicable OSHA standards.

TABLE A-1 (cont'd)

Environmental Laws and Regulations	Remedial Alternative*					Considerations as an ARAR
	SL-1	SL-4	SL-5	SL-7	SL-8	
B. Cultural Resources; Preservation of Scientific, Historic, or Archaeological Data (National Historic Preservation Act, 16 U.S.C. 470, 40 CFR 6.301(b), 36 CFR 800; Archaeological and Historic Preservation Act of 1974, 16 U.S.C. 469, 40 CFR 6.301 (c); Historic Sites, Buildings, and Antiquities Act, 15 U.S.C. 461-467; 40 CFR 6.301(a))						No archeological or historic sites are known to be present at the Liberty Site.
C. Protection of Wetlands Order (E.O. 11990)						NYSDEC performed a wetlands evaluation and identified no wetlands at the site.
D. Floodplain Management (E.O. 11988)						The site is not in a floodplain and therefore is not applicable.
E. Fish and Wildlife Impact Analysis for Inactive Hazardous Waste Sites (October 1994) (NY Division of Fish and Wildlife)		X	X	X	X	This guidance should be consulted to determine effects of remedial activities on fish and wildlife.
F. Endangered and Threatened Species of Fish and Wildlife (6 NYRCC Part 182)						NYSDEC performed an endangered species evaluation at the site. No endangered species were identified at the site.
G. State Environmental Quality Review and Implementation of State Environmental Quality Review (6 NYRCC Parts 617 and 618)		X	X	X	X	These rules relate to permit application procedures.
H. Uniform Procedures and Permit Hearing Procedures (6 NYRCC Part 621 and 624)		X	X	X	X	These rules relate to the applicability of permits and permit procedures. Applicable to permit applications for SPDES, wetlands activity, air emission permits, waste transport etc.)

*The following codes represent the various remedial alternatives for on-site soils.
SL-1: No Action
SL-4: Partial Excavation, Off-site Disposal, and Capping
SL-5 Partial Excavation, On-site Treatment, Placement, and Capping
SL-7: Full Excavation and Off-site Disposal
SL-8: Full Excavation, On-site Treatment, and Placement

LIBERTY INDUSTRIAL FINISHING SITE

TABLE A-2

Review of Potential ARARs For Groundwater Remediation

Environmental Laws and Regulations	Remedial Alternative*					Considerations as an ARAR
	GW-1	GW-2	GW-3	GW-4	GW-5	
I. SOLID AND HAZARDOUS WASTE						
A. Federal Regulations – Resource Conservation and Recovery Act (RCRA) (40 CFR 260-280)						
1. Proposed Media ID rule (61 FR 18780), April 26, 1996		X	X	X	X	Any media or waste for removal need to be identified according to the hazardous waste rules, and classified under proposed hazardous waste rules for media. Rule contains different categorization for media containing contaminants at different risk levels. Could render contaminated soils and surface/ groundwater as non-hazardous or hazardous, depending on the level of contamination.
2. Hazardous Waste Identification and Listing; Proposed Rule 40 CFR parts 260, 261, 266 and 268 (60 FR 66344, December 21, 1995)		X	X	X	X	Media containing hazardous constituents below threshold "exit level" may be managed as non-hazardous wastes, but still subject to (less restrictive) management standards described in site-specific waste management plan required by rule.
3. EPA Guidance for Management of Investigation-Derived Wastes; #9345.3FS, January 1992		X	X	X	X	Any wastes generated from ongoing monitoring or closure and post-closure activities could be subject to this guidance.
B. New York Hazardous Waste Management Regulations (NYRCC)						
1. General Requirements, Identification and Listing of Hazardous Wastes (6 NYRCC, Part 261);		X	X	X	X	Contaminants in wastes should be evaluated to determine whether the media could qualify as hazardous under the state hazardous waste rules to determine subsequent management.
2. Hazardous Waste Manifest System and Related Standard for Generators, Transporters and Facilities (6 NYRCC Part 372); Department of Transportation regulations in (49 CFR 170-179); Waste Transport Permits (6 NYRCC Part 364)		X	X	X	X	Contaminated wastes must be managed according to the hazardous waste standards if found to contain hazardous wastes. Standards include proper containment, labeling, reporting, manifesting and other pre-transport requirements for off-site disposal. Hazardous waste should be transported in accordance with hazardous waste transporter regulations set by EPA, State of New York and the Department of Transportation.

TABLE A-2 (cont'd)

Environmental Laws and Regulations	Remedial Alternative*					Considerations as an ARAR
	GW-1	GW-2	GW-3	GW-4	GW-5	
3. Hazardous Waste Management Facilities (6 NYRCC Part 373) • Treatment, Storage and Disposal Facility Permitting Requirements (6 NYRCC Subpart 373-1 • Final Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities (6 NYRCC Subpart 373) • Interim status standards for Owners and Operators of Hazardous Waste Facilities (6 NYRCC Subpart 373-3)		X	X	X	X	Contaminated wastes generated or remediated on-site must be managed in accordance with regulations for owners and operators of hazardous waste treatment, storage and disposal facilities. These regulations include emergency response and planning requirements, manifest, reporting and record-keeping requirements, ground-water monitoring, container, tank and waste pile requirements, and land treatment requirements.
4. Inactive Hazardous Waste Disposal Sites (6 NYRCC Part 375)	X	X	X	X	X	Inactive hazardous waste disposal sites must be remediated in accordance with these rule.
5. Land Disposal Restrictions (6 NYRCC Part 376)		X	X	X	X	Waste deemed hazardous must comply with land disposal restrictions. Wastes that do not meet treatment standards are prohibited from land disposal.
6. Solid Waste Management Facilities (6 NYRCC Part 360); New York State's Solid Waste Management Policy Guidance (SW-89-5001)		X	X	X	X	Wastes generated from excavation and/or treatment would be subject to LDR requirements to ensure that any wastes subsequently disposed of on land meet LDR requirements, and to ensure compliance with notification procedures for off-site disposal.
7. Hazardous Waste Reduction Plans (Section 27-0908, Environmental Conservation Law)		X	X	X	X	A hazardous waste reduction plan may be required depending on the amount of waste generated. The plan must identify activities planned to reduce the amount of waste generated.
C. Underground Injection Control Program (40 CFR Part 144, 146, 147 and 148) State Underground Injection Rules (6 NYRCC 37303.18)				X		These rules are applicable for remedial activities involving reinjection of water.

TABLE A-2 (cont'd)

Environmental Laws and Regulations	Remedial Alternative*					Considerations as an ARAR
	GW-1	GW-2	GW-3	GW-4	GW-5	
II. WATER						
A. Surface Water						
1. Surface Water Quality Standards (6 NYRCC Part 701 and 703)				X		This regulation presents classification for surface water bodies and standards to maintain best usage based upon human health, protection of aquatic life, aesthetics, chemical correlation , bioaccumulations, etc.
2. SPDES Permit, Monitoring, Reporting and Recordkeeping (6 NYRCC Parts 750 - 756); Proposed SPDES regulations, 4/7/99				X		Discharges to surface water will have to meet the intent of SPDES permit requirements.
3. Derivation and Use of Standards and Guidance on Values (6 NYRCC Part 702)				X		Allows the NYSDEC to require evaluation of short-term and long-term effects of discharge.
4. Classes and Standards of Quality and Priority Assigned to Fresh Surface and Tidal Salt Waters - Nassau County Waters						NYSDEC has classified Massapequa Creek north of Merrick Road as Class C-T, Fresh Surface Waters. This classification states that the best usage of such water is fishing.
5. Use and Protection of Water (6 NYRCC Part 182)				X		A permit is required for various activities relating to impoundments, structure and dredge and fill.
6. Technical & Operations Guidance Series (TOGS)						
a. 1.1.1 Ambient Water Quality Standards and Guidance Values	X	X	X	X	X	This guidance identifies ambient water quality standards to be complied with.
b. 1.1.5 Procedures for Deriving Ambient Water Quality Standards and Guidance Values,Protection of Wildlife.				X		This guidance should be consulted because ambient water quality standards must be met and wildlife protected during remediation.
c. 1.3.2Toxicity Testing in the SPDES Permit Program				X		This document describes procedures to be followed when the decision has been made to include toxicity testing in a SPDES permit; this could become applicable in the future with regard to the site.
d. 1.3.4BPJ Methodologies				X		This document outlines procedures to determine effluent limits to satisfy technical requirements of the Clean Water Act.

TABLE A-2 (cont'd)

Environmental Laws and Regulations	Remedial Alternative*					Considerations as an ARAR
	GW-1	GW-2	GW-3	GW-4	GW-5	
B. Groundwater						
1. Surface and Groundwater Quality Standards and Groundwater Effluent Standards (6 NYRCC Part 703)		X	X	X	X	This regulation presents classifications, quality standards, and effluent standards or limitations to prevent pollution of groundwater and to protect groundwater for use as potable water. Effluents generated by site remedial activity may require pretreatment. Any effluent discharge to publicly owner treatment works (POTW) must meet pretreatment standards.
2. Source of Water Supply (10 NYRCC Part 170)		X	X	X	X	Applies to any groundwater, surface water body that water is regularly taken for drink...or which has been classified for present or future public beneficial use or source for domestic purposes.
C. Present/Future Drinking Water Supply						
1. State Sanitary Code, Part 5 - Drinking Water Supplies, Subpart 5.1 Public Water Systems, Subpart 5.2 - Water Well Construction			X	X	X	The regulation was promulgated to protect present or future source of water supply. It applies to all existing and proposed sources and addresses planning, siting, treatment and approval as well as MCLs, monitoring and quality control.
2. Applications for Long Island Wells (6 NYRCC Part 602)				X		Applicable for wells capable of withdrawing 45 gallons per minute or greater.
D. Wetlands						
1 Protection of Wetlands, Executive Order 11990		X	X	X	X	A wetlands evaluation should be performed to determine if the site contains wetlands as defined by federal law and New York regulations.
2. New York Freshwater Wetlands Act, NYSECL Article 24, (6 NYRCC Part 661, 663, 664 and 665)						Dredging activities would need to comply with these regulations.
3. Floodplain Management, Executive Order 11988		X	X	X	X	An evaluation to determine whether area is located within a floodplain should be conducted.
4. Floodplain Management Regulation (6 NYRCC Part 500)			X	X	X	Controls construction and other developing activities in areas subject to flooding and fringe areas.
E. Flora/Fauna						
1. Division Technical and Administrative Guidance Memorandum (TGAM); Habitat Based Assessment, Guidance Document for Conducting Environmental Risk Assessments at Hazardous Waste Sites (12/28/90)		X	X	X	X	Guidance would apply to conducting an environmental risk assessment at the site.

TABLE A-2 (cont'd)

Environmental Laws and Regulations	Remedial Alternative*					Considerations as an ARAR
	GW-1	GW-2	GW-3	GW-4	GW-5	
III. AIR QUALITY						
A. Air Cleanup Criteria (Division of Air Resources, 5/31/90)			X	X	X	This document concerns evaluation of air impacts from contaminated sites. It describes the requirements and procedures for addressing emissions and impacts associated with pre-remediation, remediation and post-remediation activities.
B. NYSDEC Air Guide 1 - Guidelines for the Control of Toxic Ambient Air Contaminants			X	X	X	This document presents a screening mechanism to assist NYSDEC in determining whether and under what conditions a permit should be issued for emission sources.
C. General Provisions (6 NYRCC Part 200), Permits and Registration (6 NYRCC Part 201)			X	X	X	Excavation and treatment activities could release air emission from equipment and operations and, therefore, require a permit.
D. General Prohibitions (6 NYRCC Part 211)			X	X	X	This rule prohibits the release of air contaminants that would threaten human health and the environment. This prohibition applies to but is not limited to any particulate, fume, gas, mist, odor, smoke, vapor, pollen, toxic either alone or in combination with others. Excavation and treatment activities may generate particulates and smoke.
E. General Process Emission Sources (6 NYRCC Part 212)			X	X	X	Excavation and treatment activities could release air emission from equipment and from operations.
F. Air Quality Standards (6 NYRCC Part 257)			X	X	X	Emission from remedial activities must meet air quality standards for emission of SO_2, particulates, CO, photochemical oxidants, hydrocarbons (non-methane), nitrogen dioxide (NO_2), fluorides, beryllium and hydrogen sulfide (H_2S)
G. Air Quality Classification - Nassau County (6 NYRCC Part 287)			X	X	X	The site is located in an air classification Level III area. Ambient air quality standards for particulate and non-methane hydrocarbons may be applicable.
IV. OTHER APPLICABLE REGULATORY PROGRAMS						
A. Occupational Safety and Health Administration (OSHA						
1. Requirement for workers at remedial action sites (29 CFR Part 1910)		X	X	X	X	Any remedial action onsite must be performed in accordance with applicable OSHA standards.

TABLE A-2 (cont'd)

Environmental Laws and Regulations	Remedial Alternative*					Considerations as an ARAR
	GW-1	GW-2	GW-3	GW-4	GW-5	
B. Cultural Resources; Preservation of Scientific, Historic, or Archaeological Data (National Historic Preservation Act, 16 U.S.C. 470, 40 CFR 6.301(b), 36 CFR 800; Archaeological and Historic Preservation Act of 1974, 16 U.S.C. 469, 40 CFR 6.301 (c); Historic Sites, Buildings, and Antiquities Act, 15 U.S.C. 461-467; 40 CFR 6.301(a))						No archeological or historic sites are know to be present at the Liberty Site.
C. Fish and Wildlife Impact Analysis for Inactive Hazardous Waste Sites (October 1994) (NY Division of Fish and Wildlife)		X	X	X	X	This guidance should be consulted to determine effects of remedial activities on fish and wildlife.
D. Endangered and Threatened Species of Fish and Wildlife (6 NYRCC Part 182)						NYSDEC performed an endangered species evaluation at the site and no endangered species were identified at the site.
E. State Environmental Quality Review and Implementation of State Environmental Quality Review (6 NYRCC Parts 617 and 618)		X	X	X	X	These rules relate to permit application procedures.
F. Uniform Procedures and Permit Hearing Procedures (6 NYRCC Part 621 and 624)			X	X	X	These rules relate to the applicability of permits and permit procedures. Applicable to permit applications for SPDES, wetlands activity, air emission permits, waste transport etc.)

*The following codes represent the various remedial alternatives for on-site groundwater.

GW-1: No Action
GW-2: Monitored Natural Attenuation
GW-3: Groundwater Circulation Well Technology with VOC and Metals Treatment
GW-4: Groundwater Extraction and VOC and Metals Treatment, Discharge to Aquifer/Surface Water
GW-5: Permeable Reactive Barrier in Conjunction with Groundwater Circulation and VOC and Metals Treatment

APPENDIX B

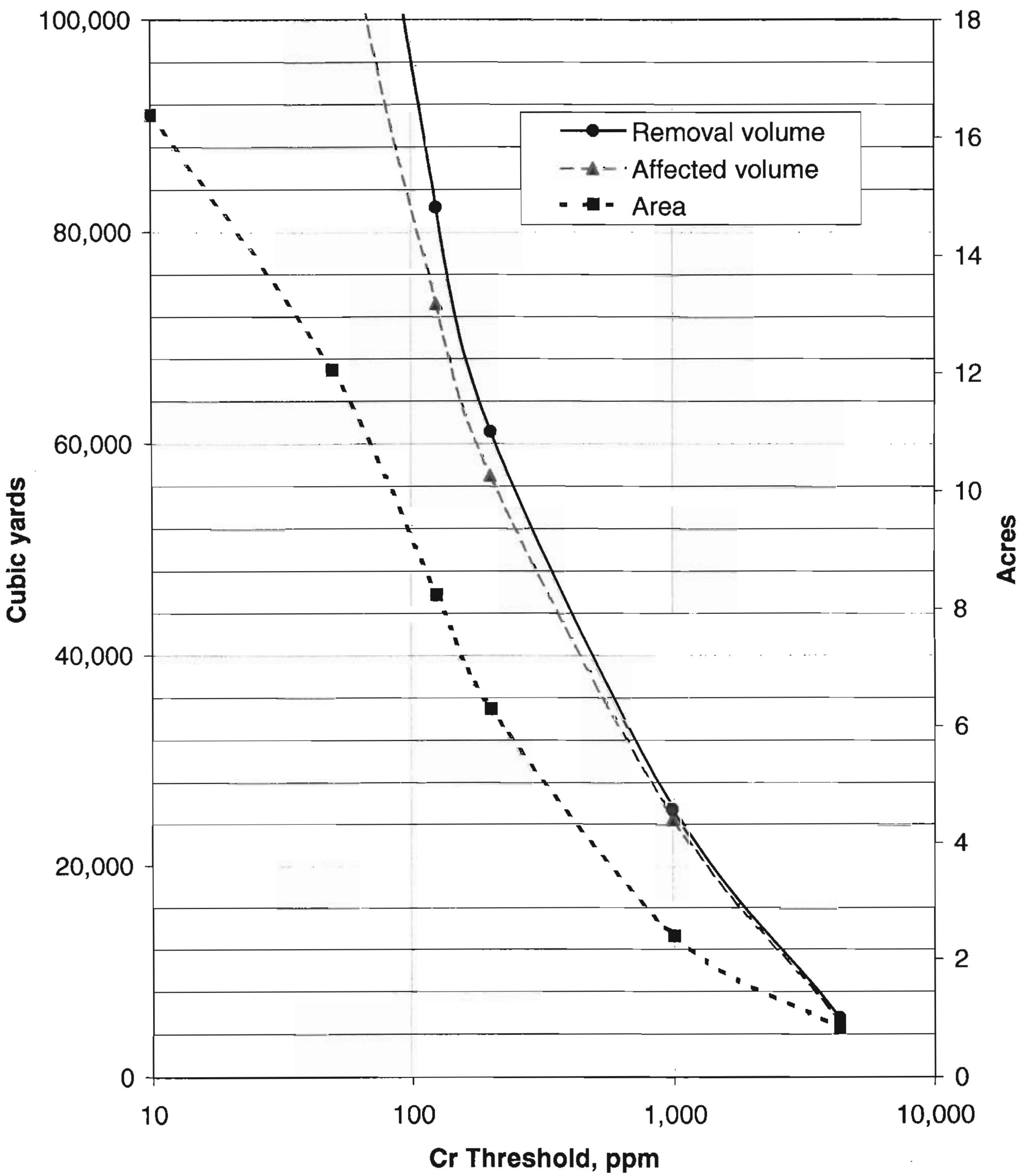
SITE CONCEPTUAL MODEL

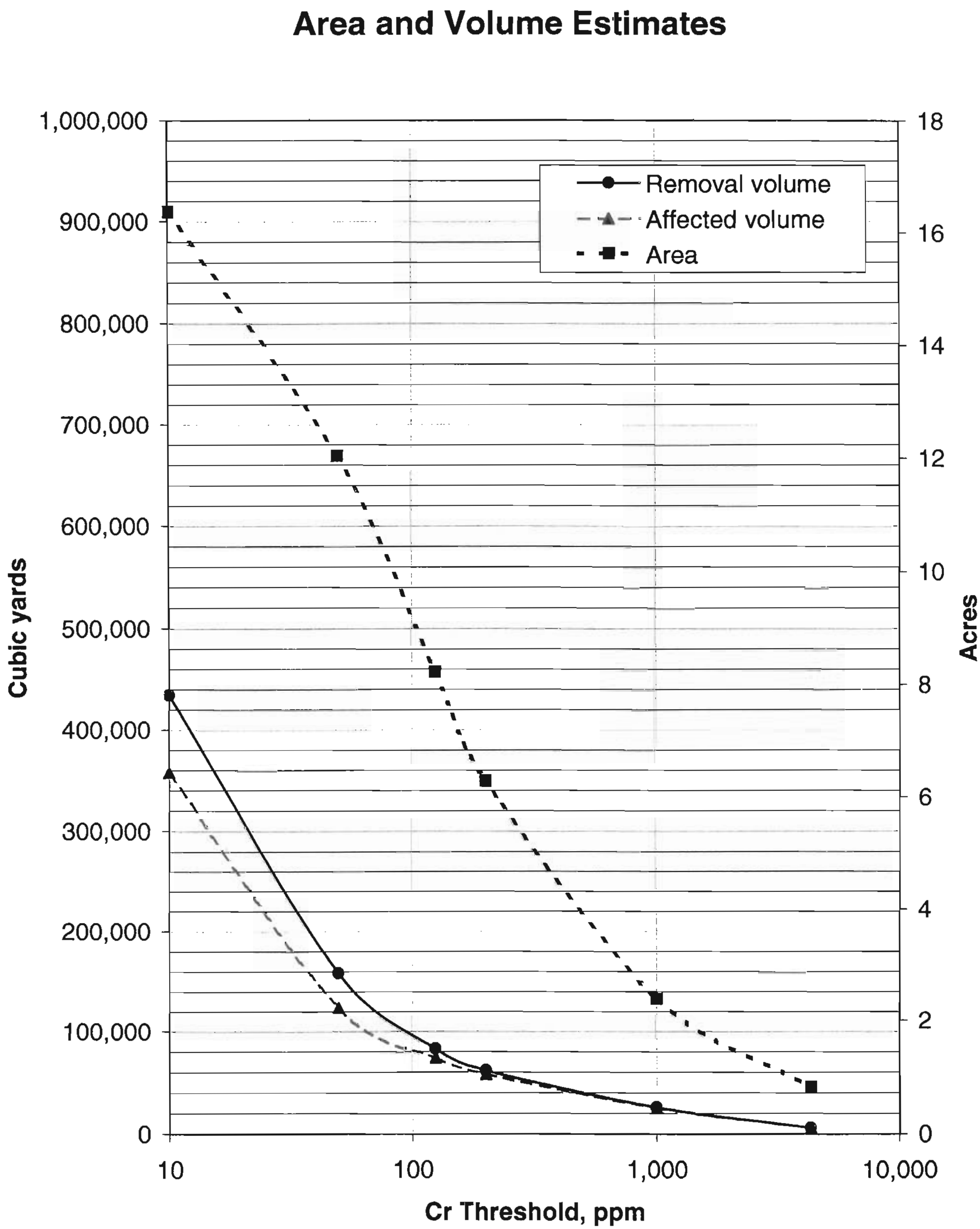
(a) Estimates of Area and Volume of Soils, as a function of [Cr] Concentration (based on gridded site conceptual model)

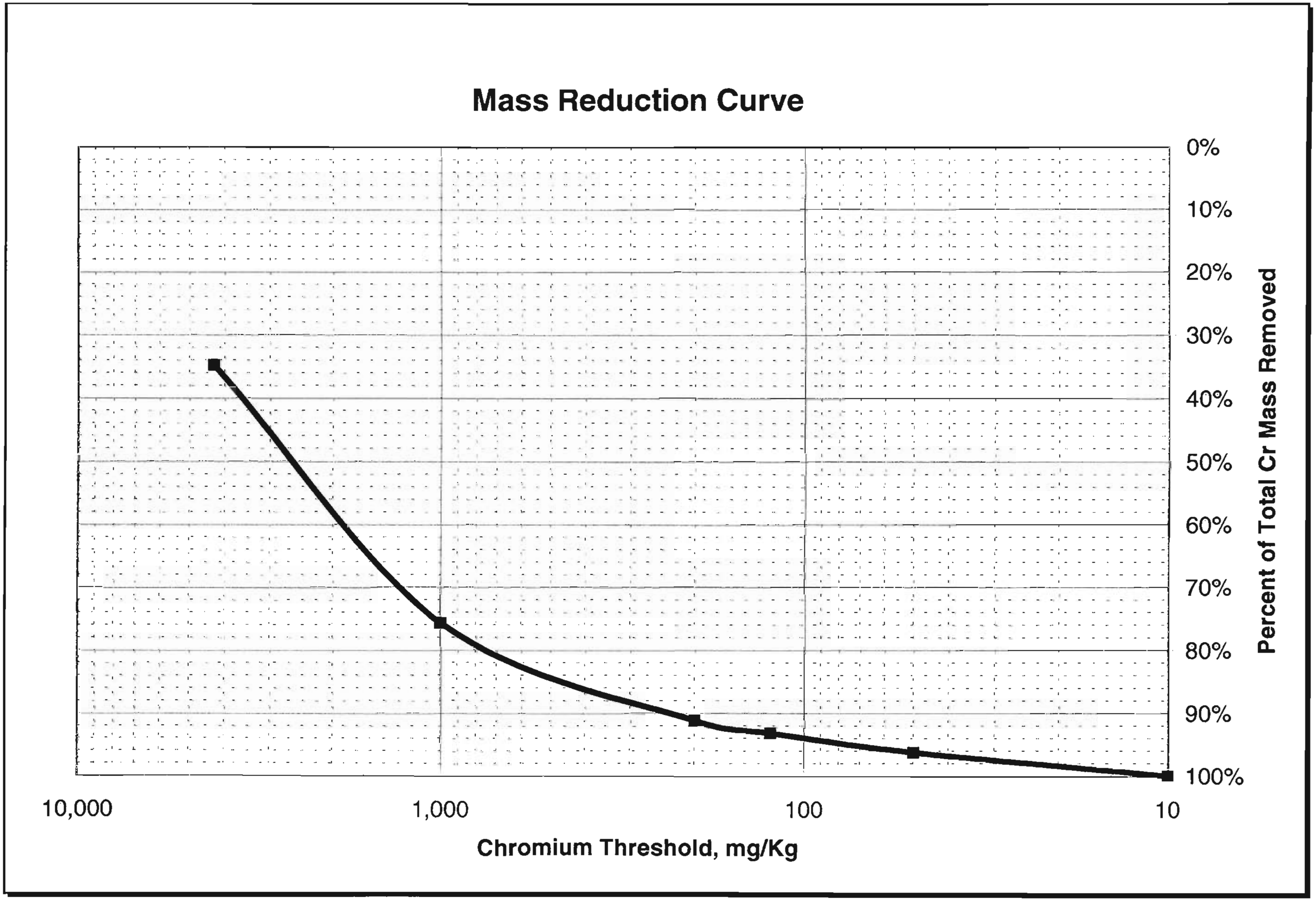
- Cadmium concentration may be calculated as: Cd = [Cr] / 12.4

(b) Derivation of Default Soil Screening Criteria (EPA, 1996) for Total Chromium

Area and Volume Estimates




Area and Volume Estimates
Removal volume
Affected volume
Area
Cubic yards
Acres
Cr Threshold, ppm
1,000,000
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
18
16
14
12
10
8
6
4
2
0
10
100
1,000
10,000


Mass Reduction Curve
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of Total Cr Mass Removed
10,000
1,000
100
10
Chromium Threshold, mg/Kg

Derivation of Default Soil Screening Levels for Total Chromium

Using EPA guidance contained in the *Soil Screening Guidance – A User's Guide* (EPA, 1996), total chromium soil screening levels for the protection of groundwater were derived, utilizing the following physical and chemical conditions:

- The soil pH ranges from 5.0 to 7.0. This soil pH range determines the range of selected soil-water partition coefficients for chromium (EPA, 1996);
- The fraction of hexavalent chromium (Cr^{6+}) ranges from 0 (0%) to 1 (100%);
- For a site-specific soil pH of 6.0 (estimate) and Cr^{6+} fraction of 0.25 (average measured fraction), the soil screening levels was calculated to be 18.4 mg/kg.

The following pages present the underlying equations and assumptions.

Equation 10 of the *Soil Screening Guidance – A User's Guide* (EPA, 1996) relates constituent concentrations adsorbed to soil organic carbon to soil leachate concentrations. It calculates soil screening levels corresponding to target soil leachate concentrations C(w). The full equation is stated as:

$$SSL = C(w) \times \left(Kd + \frac{\theta w + \theta a \times H}{\theta b} \right)$$

where:	SSL	soil screening level (mg/kg)
	C(w)	target leachate concentration (mg/L): 0.05 mg Cr/L and 0.005 mg Cd/L
	Kd	soil-water partition coefficient (L/kg)
	θw	water-filled soil porosity (0.3)
	θa	air-filled soil porosity (n - θw)
	ρb	dry soil bulk density (1.5)
	n	soil porosity (1 – ρb/ ρs)
	ρs	soil particle density (2.65 kg/L)
	H	dimensionless Henry's law constant (zero for metals)

Therefore, using the default parameters suggested in the Soil Screening Guidance (EPA, 1996), and using H = 0 (as appropriate for chromium), Equation 10 simplifies to:

$$SSL = C(w) \times \left(Kd + \frac{\theta w}{\rho b} \right)$$
$$SSL = C(w) \times (Kd + 0.2)$$

The values for Kd are listed in Table C-4 of Appendix C (EPA, 1996) as a function of pH value. Since the Kd's for chromium and cadmium are much greater than 1, the equation for deriving the soil screening level may be simplified further to:

$$SSL = C(w) \times Kd$$

Estimating a typical soil pH value of 6.0, the *Soil Screening Guidance* (EPA, 1996) lists Kd's for cadmium, trivalent chromium, and hexavalent chromium are as follows:

Cd	37 L/kg
Cr^{3+}	200,000 L/kg
Cr^{6+}	23 L/kg

As quoted in EPA (1996), the Kd for trivalent chromium exhibits a strong dependency on the pH conditions. For example for a pH range of 5.0 to 7.0, the Kd varies between 1,900 L/kg and 2,500,000 L/kg. However, as shown below, the sensitivity of the combined trivalent-hexavalent chromium soil screening level is not sensitive to pH variations, as long as the percentage of hexavalent chromium is greater than 10 percent of total chromium (as is the case at the Site).

The soil screening levels for cadmium, trivalent chromium and hexavalent chromium are therefore:

Cd	= 0.005 mg/L x 37 L/kg = 0.19 mg/kg
Cr^{3+}	= 0.05 mg/L x 200,000 L/kg = 10,000 mg/kg
Cr^{6+}	= 0.05 mg/L x 23 L/kg = 1.15 mg/kg

In order to calculate the soil screening level for <u>total chromium</u>, the following assumption was made:

- If the fraction of hexavalent chromium in soil chromium is n (where $0 \leq n \leq 1$), and the fraction of trivalent chromium in soil chromium is (1-n), then the fraction of hexavalent chromium and trivalent chromium in the leachate is also n and (1-n), respectively.

Therefore, using the simplified Equation 10 of the Soil Screening Guidance (EPA, 1996), the chromium soil concentration X that will produce a soil leachate of 0.05 mg total Cr/L (the maximum permissible leachate concentration), may be calculated using the following relations:

$$X(Cr^{3+}) = 0.05 \times Kd(Cr^{3+})$$
$$X(Cr^{6+}) = 0.05 \times Kd(Cr^{6+})$$

where X is a function of the fraction n [X(n)]
Kd is a function of the pH conditions [Kd(pH)]

For example, if the total chromium soil concentration X is 50 mg/kg, and the fraction of Cr^{6+} is 20 percent (i.e., n = 0.2), then resulting leachate concentration (at a pH of 6.0) would be:

$$C(w) = n \times \frac{n \times X}{Kd(Cr^{6+})} + (1-n) \times \frac{(1-n) \times X}{Kd(Cr^{3+})}$$

$$C(w) = \frac{0.2^2 \times 50}{23} + \frac{0.8^2 \times 50}{200{,}000}$$

$$C(w) = 0.08716\_mg/L$$

Thus, a total soil chromium concentrations of 50 mg/kg, and assuming that the chromium leachate is composed of n-times the Cr^{6+} leachate and (1-n)-times the Cr^{3+} leachate, would result in a chromium leachate concentration of 0.08716 mg Cr/L, which would be greater than the permissible limit of 0.05 mg Cr/L.

This equation can be written in general terms, using C(w) = 0.05 mg/L as the maximum permissible leachate concentration as follows:

$$0.05 = \frac{n^2 \times X}{Kd(Cr^{6+})} + \frac{(1-n)^2 \times X}{Kd(Cr^{3+})}$$

and solved for X:

$$X = \frac{0.05}{\frac{n^2}{Kd(Cr^{6+})} + \frac{(1-n)^2}{Kd(Cr^{6+})}}$$

This equation can be solved for any combination of the parameters n (fraction of hexavalent chromium) and Kd (a function of pH). The chart below shows five type-curves that were calculated for a range of pH conditions (pH = 5.0 to pH = 7.0). The x-axis (horizontal axis) shows the fraction of hexavalent chromium (n), and the y-axis (vertical axis) shows the corresponding total chromium soil concentration X that would result in a leachate concentration of 0.05 mg total Cr/L.

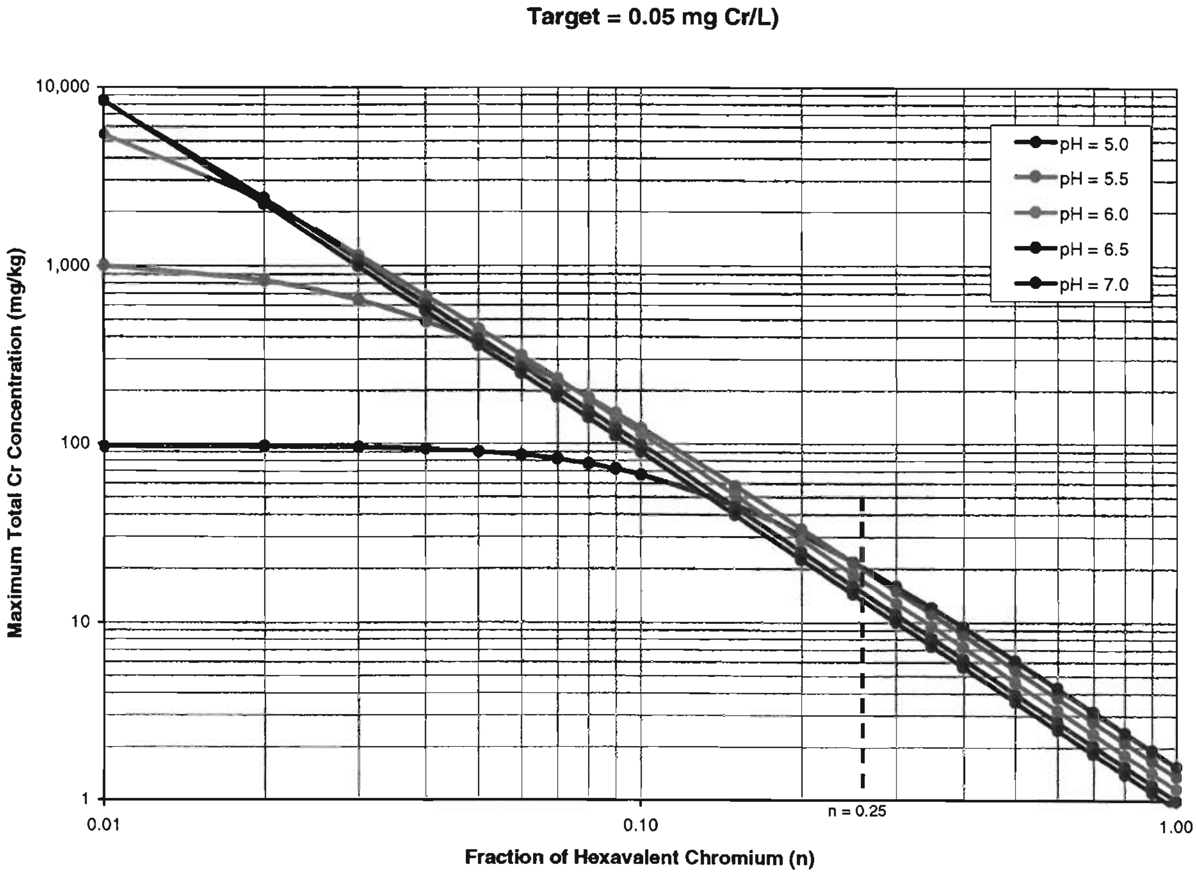
For example, using a pH value of 6.0 and a fraction of 25-percent hexavalent chromium (n = 0.25), a total chromium soil concentration of 18.4 mg/kg would result in a leachate concentration of 0.05 mg total Cr/L. Therefore, the calculated soil screening level is 18.4 mg Cr/kg.

Note that with increasing fraction (n), the total chromium soil concentration X that is expected to result in a leachate concentration of 0.05 mg Cr/L is no longer sensitive to pH conditions (this is because the Kd for Cr^{6+} is relatively insensitive to pH and is significantly lower than the Kd for Cr^{3+}). However, as the fraction (n) decreases, the total chromium concentration X that is required to produce a leachate concentration of 0.05 mg/L is very sensitive to pH conditions (this is because the Kd for Cr^{3+} is sensitive to pH, as discussed before).

It should be emphasized that this derivation of total chromium soil screening levels is dependent on two assumptions:

(a) The Kds listed in Appendix C, Table C-4 (EPA 1996) are appropriate Kds for the site-specific conditions encountered at the Site.

(b) The simplifying assumption of assigning the fractions of (n) and (1-n) to hexavalent and trivalent chromium, respectively, in the leachate is appropriate.


Target = 0.05 mg Cr/L)
10,000
1,000
100
10
1
Maximum Total Cr Concentration (mg/kg)
0.01
0.10
n = 0.25
1.00
Fraction of Hexavalent Chromium (n)
pH = 5.0
pH = 5.5
pH = 6.0
pH = 6.5
pH = 7.0

APPENDIX C

Soil Remedial Alternatives (Cost Tables and Conceptual Figures)

Tables C-1 through C-9

Figures C-2 through C-9

TABLE C-1

Estimated Cost Soil Alternative SL-1

Liberty Industrial Finishing Site, Farmingdale, New York

Item	Description	Quantity	Unit	Cost		Subtotal
1	Monitoring Well Installation					$0
	shallow wells (< 65 feet)		ea	$3,500	$0	
	deep wells (>65 feet)		ea	$5,000	$0	
2	Access Negotiation		ls		$0	$0
3	Legal Fees		ls		$0	$0
4	Bench- or Field Scale Testing		ls		$0	$0
5	Mobilization/Demobilization		ls		$0	$0
6	Site Preparation and Monitoring					$0
	Erosion Control		ac	$1,500	$0	
	Site Surveying		ls	$25,000	$0	
	Fencing (incl. 2 gates)		ft	$20	$0	
	Office and Construction Trailers		mo	$800	$0	
	Health and Safety Supplies		mo	$3,500	$0	
	Health and Safety Monitoring		mo	$2,500	$0	
	Utilities		mo	$1,000	$0	
	Supplies		mo	$1,000	$0	
7	Excavation		cy	$7	$0	$0
8	Soil Separation and Washing		cy	$100- $175	$0	$0
9	Backfill and Placement		cy	$25	$0	$0
10	On-Site Placement		cy	$5	$0	$0
11	Transport and Disposal (C code)		ton	$200	$0	$0
12	Transport and Disposal (D code)		ton	$75	$0	$0
13	Cover System					$0
	Section 360-type Cap		sf	$8	$0	
	Low-Permeability Asphalt		sf	$3	$0	
14	Vacuum Extraction					$0
	Mobilization		ls	$10,000	$0	
	Treatment		cy	$100	$0	
15	Soil Stabilization (incl. placement)		cy	$90	$0	$0
16	Confirmatory Sampling		ea	$275	$0	$0
17	Waste Profile Sampling		ea	$750	$0	$0
	TOTAL DIRECT CONSTRUCTION COSTS					$0
18	Engineering (10% except excavation and disposal at 5%)					$0
19	Oversight					$0
	Excavation		man/day		$0	
	Capping		man/day		$0	
	Treatment		man/day		$0	
	Disposal		man/day		$0	
20	Contingency (20 percent)					$0
	TOTAL INSTALLED CAPITAL COSTS					$0
	Annual O&M Costs	1	yr			
	Total O&M Costs (20 years at 8 percent)					$0
	ESTIMATED PRESENT WORTH COST (20 years at 8 percent)					$0

SL-1 No Action Alternative

TABLE C-2
Estimated Cost Soil Alternative SL-2
Liberty Industrial Finishing Site, Farmingdale, New York

Item	Description	Quantity	Unit	Cost		Subtotal
1	Monitoring Well Installation					$24,000
	shallow wells (< 65 feet)	4	ea	$3,500	$14,000	
	deep wells (>65 feet)	2	ea	$5,000	$10,000	
2	Access Negotiation		ls		$0	$0
3	Legal Fees	1	ls	$25,000	$25,000	$25,000
4	Bench- or Field Scale Testing		ls		$0	$0
5	Mobilization/Demobilization		ls		$0	$0
6	Site Preparation and Monitoring					$2,650
	Erosion Control		ac	$1,500	$0	
	Site Surveying		ls	$25,000	$0	
	Fencing (incl. 2 gates)		ft	$20	$0	
	Office and Construction Trailers	0.5	mo	$800	$400	
	Health and Safety Supplies		mo	$3,500	$0	
	Health and Safety Monitoring	0.5	mo	$2,500	$1,250	
	Utilities	0.5	mo	$1,000	$500	
	Supplies	0.5	mo	$1,000	$500	
7	Excavation		cy	$7	$0	$0
8	Soil Separation and Washing		cy		$0	$0
9	Backfill and Placement		cy	$25	$0	$0
10	On-Site Placement		cy	$5	$0	$0
11	Transport and Disposal (C code)		ton	$200	$0	$0
12	Transport and Disposal (D code)	25	ton	$75	$1,875	$1,875
13	Cover System					$0
	Section 360-type Cap		sf	$8	$0	
	Low-Permeability Asphalt		sf	$3	$0	
14	Vacuum Extraction					$0
	Mobilization		ls	$10,000	$0	
	Treatment		cy	$100	$0	
15	Soil Stabilization (incl. placement)		cy	$90	$0	$0
16	Confirmatory Sampling		ea	$275	$0	$0
17	Waste Profile Sampling	1	ea	$750	$750	$750
	TOTAL DIRECT CONSTRUCTION COSTS					$53,525
18	Engineering (10% except excavation and disposal at 5%)					$5,259
19	Oversight					$0
	Excavation		man/day		$0	
	Capping		man/day		$0	
	Treatment		man/day		$0	
	Disposal		man/day		$0	
20	Contingency (20 percent)					$11,757
	TOTAL INSTALLED CAPITAL COSTS					$70,541
	Annual O&M Costs	1	yr	$20,000		
	Total O&M Costs (20 years at 8 percent)					$196,360
	ESTIMATED PRESENT WORTH COST (20 years at 8 percent)					$266,901

SL-2 Institutional Controls

TABLE C-3
Estimated Cost Soil Alternative SL-3
Liberty Industrial Finishing Site, Farmingdale, New York

Item	Description	Quantity	Unit	Cost		Subtotal
1	Monitoring Well Installation					$24,000
	shallow wells (< 65 feet)	4	ea	$3,500	$14,000	
	deep wells (>65 feet)	2	ea	$5,000	$10,000	
2	Access Negotiation	1	ls	$10,000	$10,000	$10,000
3	Legal Fees	1	ls	$25,000	$25,000	$25,000
4	Bench-or Field Scale Testing		ls		$0	$0
5	Mobilization/Demobilization	1	ls	$50,000	$50,000	$50,000
6	Site Preparation and Monitoring					$205,600
	Erosion Control	10	ac	$1,500	$15,000	
	Site Surveying	1	ls	$25,000	$25,000	
	Fencing (incl. 2 gates)	3,000	ft	$20.00	$60,000	
	Office and Construction Trailers	12	mo	$800	$9,600	
	Health and Safety Supplies	12	mo	$3,500	$42,000	
	Health and Safety Monitoring	12	mo	$2,500	$30,000	
	Utilities	12	mo	$1,000	$12,000	
	Supplies	12	mo	$1,000	$12,000	
7	Excavation	25,600	cy	$7	$179,200	$179,200
8	Soil Separation and Washing		cy	$100-175	$0	$0
9	Backfill and Placement	30,720	cy	$25	$768,000	$768,000
10	On-Site Placement	25,600	cy	$5	$128,000	$128,000
11	Transport and Disposal (C code)	0	ton	$200	$0	$0
12	Transport and Disposal (D code)	0	ton	$75	$0	$0
13	Cover System					$2,071,875
	Section 360-type Cap	186,000	sf	$8	$1,488,000	
	Low-Permeability Asphalt	194,625	sf	$3	$583,875	
14	Vacuum Extraction					$60,000
	Mobilization	1	ls	$10,000	$10,000	
	Treatment	500	cy	$100	$50,000	
15	Soil Stabilization		cy	$90	$0	$0
16	Confirmatory Sampling	39	ea	$275	$10,677	$10,677
17	Waste Profile Sampling	0	ea	$750	$0	$0
	TOTAL DIRECT CONSTRUCTION COSTS					$3,532,352
18	Engineering (10% except excavation and disposal at 5%)					$344,275
19	Oversight					$240,000
	Excavation	60	man/day	$750	$45,000	
	Capping	260	man/day	$750	$195,000	
	Treatment	0	man/day	$750	$0	
	Disposal	0	man/day	$750	$0	
20	Contingency (20 percent)					$823,325
	TOTAL INSTALLED CAPITAL COSTS					$4,939,952
	Annual O&M Costs	1	yr	$35,000		
	Total O&M Costs (20 years at 8 percent)					$343,630
	ESTIMATED PRESENT WORTH COST (20 years at 8 percent)					$5,283,582

SL-3 Partial Excavation, On-site Placement, Capping (NYSDEC Section 360-type and low-permeability asphalt)

TABLE C-4
Estimated Cost Soil Alternative SL-4
Liberty Industrial Finishing Site, Farmingdale, New York

Item	Description	Quantity	Unit	Cost		Subtotal
1	Monitoring Well Installation					$24,000
	shallow wells (< 65 feet)	4	ea	$3,500	$14,000	
	deep wells (>65 feet)	2	ea	$5,000	$10,000	
2	Access Negotiation	1	ls	$10,000	$10,000	$10,000
3	Legal Fees	1	ls	$25,000	$25,000	$25,000
4	Bench-or Field Scale Testing		ls		$0	$0
5	Mobilization/Demobilization	1	ls	$50,000	$50,000	$50,000
6	Site Preparation and Monitoring					$205,600
	Erosion Control	10	ac	$1,500	$15,000	
	Site Surveying	1	ls	$25,000	$25,000	
	Fencing (incl. 2 gates)	3,000	ft	$20.00	$60,000	
	Office and Construction Trailers	12	mo	$800	$9,600	
	Health and Safety Supplies	12	mo	$3,500	$42,000	
	Health and Safety Monitoring	12	mo	$2,500	$30,000	
	Utilities	12	mo	$1,000	$12,000	
	Supplies	12	mo	$1,000	$12,000	
7	Excavation	25,600	cy	$7	$179,200	$179,200
8	Soil Separation and Washing		cy	$100-175	$0	$0
9	Backfill and Placement	30,720	cy	$25	$768,000	$768,000
10	On-Site Placement		cy	$5	$0	$0
11	Transport and Disposal (C code)	24,000	ton	$200	$4,800,000	$4,800,000
12	Transport and Disposal (D code)	14,400	ton	$75	$1,080,000	$1,080,000
13	Cover System					$1,141,875
	Section 360-type Cap		sf	$8	$0	
	Low-Permeability Asphalt	380,625	sf	$3	$1,141,875	
14	Vacuum Extraction					$60,000
	Mobilization	1	ls	$10,000	$10,000	
	Treatment	500	cy	$100	$50,000	
15	Soil Stabilization		cy	$90	$0	$0
16	Confirmatory Sampling	39	ea	$275	$10,677	$10,677
17	Waste Profile Sampling	38	ea	$750	$28,800	$28,800
	TOTAL DIRECT CONSTRUCTION COSTS					$8,354,352
18	Engineering (10% except excavation and disposal at 5%)					$532,475
19	Oversight					$251,250
	Excavation	60	man/day	$750	$45,000	
	Capping	260	man/day	$750	$195,000	
	Treatment	0	man/day	$750	$0	
	Disposal	15	man/day	$750	$11,250	
20	Contingency (20 percent)					$1,827,615
	TOTAL INSTALLED CAPITAL COSTS					$10,965,692
	Annual O&M Costs	1	yr	$35,000		
	Total O&M Costs (20 years at 8 percent)					$343,630
	ESTIMATED PRESENT WORTH COST (20 years at 8 percent)					$11,309,322

SL-4 Partial Excavation, Off-site Disposal, Capping (low-permeability asphalt)

TABLE C-5
Estimated Cost Soil Alternative SL-5
Liberty Industrial Finishing Site, Farmingdale, New York

Item	Description	Quantity	Unit	Cost		Subtotal
1	Monitoring Well Installation					$24,000
	shallow wells (< 65 feet)	4	ea	$3,500	$14,000	
	deep wells (>65 feet)	2	ea	$5,000	$10,000	
2	Access Negotiation	1	ls	$10,000	$10,000	$10,000
3	Legal Fees	1	ls	$25,000	$25,000	$25,000
4	Bench and Field Scale Testing	1	ls	$50,000	$50,000	$50,000
5	Mobilization/Demobilization	1	ls	$50,000	$50,000	$50,000
6	Site Preparation and Monitoring					$205,600
	Erosion Control	10	ac	$1,500	$15,000	
	Site Surveying	1	ls	$25,000	$25,000	
	Fencing (incl. 2 gates)	3,000	ft	$20.00	$60,000	
	Office and Construction Trailers	12	mo	$800	$9,600	
	Health and Safety Supplies	12	mo	$3,500	$42,000	
	Health and Safety Monitoring	12	mo	$2,500	$30,000	
	Utilities	12	mo	$1,000	$12,000	
	Supplies	12	mo	$1,000	$12,000	
7	Excavation	25,600	cy	$7	$179,200	$179,200
8	Soil Separation and Washing		cy	$100-175	$0	$0
9	Backfill and Placement		cy	$25	$0	$0
10	On-Site Placement	30,400	cy	$5	$152,000	$152,000
11	Transport and Disposal (C code)	1,824	ton	$200	$364,800	$364,800
12	Transport and Disposal (D code)		ton	$75	$0	$0
13	Cover System					$1,141,875
	Section 360-type Cap		sf	$8	$0	
	Low-Permeability Asphalt	380,625	sf	$3	$1,141,875	
14	Vacuum Extraction					$60,000
	Mobilization	1	ls	$10,000	$10,000	
	Treatment	500	cy	$100	$50,000	
15	Soil Stabilization	24,320	cy	$90	$2,188,800	$2,188,800
16	Confirmatory Sampling	39	ea	$275	$10,677	$10,677
17	Waste Profile Sampling	2	ea	$750	$1,368	$1,368
	TOTAL DIRECT CONSTRUCTION COSTS					$4,461,952
18	Engineering (10% except excavation and disposal at 5%)					$418,995
19	Oversight					$341,250
	Excavation	60	man/day	$750	$45,000	
	Capping	260	man/day	$750	$195,000	
	Treatment	120	man/day	$750	$90,000	
	Disposal	15	man/day	$750	$11,250	
20	Contingency (20 percent)					$1,044,439
	TOTAL INSTALLED CAPITAL COSTS					$6,266,636
	Annual O&M Costs	1	yr	$35,000		
	Total O&M Costs (20 years at 8 percent)					$343,630
	ESTIMATED PRESENT WORTH COST (20 years at 8 percent)					$6,610,266

SL-5 Partial Excavation, On-site Treatment, On-site Placement, Capping (low-permeability asphalt)

TABLE C-6
Estimated Cost Soil Alternative SL-6
Liberty Industrial Finishing Site, Farmingdale, New York

Item	Description	Quantity	Unit	Cost		Subtotal
1	Monitoring Well Installation					$24,000
	shallow wells (< 65 feet)	4	ea	$3,500	$14,000	
	deep wells (>65 feet)	2	ea	$5,000	$10,000	
2	Access Negotiation	1	ls	$10,000	$10,000	$10,000
3	Legal Fees	1	ls	$25,000	$25,000	$25,000
4	Bench and Field Scale Testing	1	ls	$50,000	$50,000	$50,000
5	Mobilization/Demobilization	1	ls	$50,000	$50,000	$50,000
6	Site Preparation and Monitoring					$205,600
	Erosion Control	10	ac	$1,500	$15,000	
	Site Surveying	1	ls	$25,000	$25,000	
	Fencing (incl. 2 gates)	3,000	ft	$20.00	$60,000	
	Office and Construction Trailers	12	mo	$800	$9,600	
	Health and Safety Supplies	12	mo	$3,500	$42,000	
	Health and Safety Monitoring	12	mo	$2,500	$30,000	
	Utilities	12	mo	$1,000	$12,000	
	Supplies	12	mo	$1,000	$12,000	
7	Excavation		cy	$7	$0	$0
8	Soil Separation and Washing	25,600	cy	$175	$4,480,000	$4,480,000
9	Backfill and Placement	5,120	cy	$25	$128,000	$128,000
10	On-Site Placement		cy	$5	$0	$0
11	Transport and Disposal (C code)	7,680	ton	$200	$1,536,000	$1,536,000
12	Transport and Disposal (D code)		ton	$75	$0	$0
13	Cover System					$1,141,875
	Section 360-type Cap		sf	$8	$0	
	Low-Permeability Asphalt	380,625	sf	$3	$1,141,875	
14	Vacuum Extraction					$60,000
	Mobilization	1	ls	$10,000	$10,000	
	Treatment	500	cy	$100	$50,000	
15	Soil Stabilization		cy	$90	$0	$0
16	Confirmatory Sampling	39	ea	$275	$10,725	$10,725
17	Waste Profile Sampling	8	ea	$750	$5,760	$5,760
	TOTAL DIRECT CONSTRUCTION COSTS					$7,721,200
18	Engineering (10% except excavation and disposal at 5%)					$695,320
19	Oversight					$341,250
	Excavation	60	man/day	$750	$45,000	
	Capping	260	man/day	$750	$195,000	
	Treatment	120	man/day	$750	$90,000	
	Disposal	15	man/day	$750	$11,250	
20	Contingency (20 percent)					$1,751,554
	TOTAL INSTALLED CAPITAL COSTS					$10,509,324
	Annual O&M Costs	1	yr	$35,000		
	Total O&M Costs (20 years at 8 percent)					$343,630
	ESTIMATED PRESENT WORTH COST (20 years at 8 percent)					$10,852,954

SL-6 Partial Excavation, Soil Separation, Soil Washing, Off-site Disposal, On-site Placement, Capping (low-perm asphalt).

TABLE C-7
Estimated Cost Soil Alternative SL-7
Liberty Industrial Finishing Site, Farmingdale, New York

Item	Description	Quantity	Unit	Cost		Subtotal
1	Monitoring Well Installation					$24,000
	shallow wells (< 65 feet)	4	ea	$3,500	$14,000	
	deep wells (>65 feet)	2	ea	$5,000	$10,000	
2	Access Negotiation	1	ls	$10,000	$10,000	$10,000
3	Legal Fees	1	ls	$25,000	$25,000	$25,000
4	Bench-or Field Scale Testing		ls		$0	$0
5	Mobilization/Demobilization	1	ls	$50,000	$50,000	$50,000
6	Site Preparation and Monitoring					$268,900
	Erosion Control	17	ac	$1,500	$25,500	
	Site Surveying	1	ls	$25,000	$25,000	
	Fencing (incl. 2 gates)	3,000	ft	$20.00	$60,000	
	Office and Construction Trailers	18	mo	$800	$14,400	
	Health and Safety Supplies	18	mo	$3,500	$63,000	
	Health and Safety Monitoring	18	mo	$2,500	$45,000	
	Utilities	18	mo	$1,000	$18,000	
	Supplies	18	mo	$1,000	$18,000	
7	Excavation	82,000	cy	$7	$574,000	$574,000
8	Soil Separation and Washing		cy	$100-175	$0	$0
9	Backfill and Placement	98,400	cy	$25	$2,460,000	$2,460,000
10	On-Site Placement		cy	$5	$0	$0
11	Transport and Disposal (C code)	24,000	ton	$200	$4,800,000	$4,800,000
12	Transport and Disposal (D code)	85,500	ton	$75	$6,412,500	$6,412,500
13	Cover System					$0
	Section 360-type Cap		sf	$8	$0	
	Low-Permeability Asphalt		sf	$3	$0	
14	Vacuum Extraction					$35,000
	Mobilization	1	ls	$10,000	$10,000	
	Treatment	250	cy	$100	$25,000	
15	Soil Stabilization		cy	$90	$0	$0
16	Confirmatory Sampling	84	ea	$275	$23,182	$23,182
17	Waste Profile Sampling	110	ea	$750	$82,125	$82,125
	TOTAL DIRECT CONSTRUCTION COSTS					$14,682,582
18	Engineering (10% except excavation and disposal at 5%)					$878,933
19	Oversight					$187,500
	Excavation	200	man/day	$750	$150,000	
	Capping		man/day	$750	$0	
	Treatment		man/day	$750	$0	
	Disposal	50	man/day	$750	$37,500	
20	Contingency (20 percent)					$3,149,803
	TOTAL INSTALLED CAPITAL COSTS					$18,898,818
	Annual O&M Costs	1	yr	$20,000		
	Total O&M Costs (20 years at 8 percent)					$196,360
	ESTIMATED PRESENT WORTH COST (20 years at 8 percent)					$19,095,178

SL-7 Complete Excavation, Off-site Disposal

TABLE C-8

Estimated Cost Soil Alternative SL-8

Liberty Industrial Finishing Site, Farmingdale, New York

Item	Description	Quantity	Unit	Cost		Subtotal
1	Monitoring Well Installation					$24,000
	shallow wells (< 65 feet)	4	ea	$3,500	$14,000	
	deep wells (>65 feet)	2	ea	$5,000	$10,000	
2	Access Negotiation	1	ls	$10,000	$10,000	$10,000
3	Legal Fees	1	ls	$25,000	$25,000	$25,000
4	Bench and Field Scale Testing		ls	$50,000	$0	$0
5	Mobilization/Demobilization		ls	$50,000	$0	$0
6	Site Preparation and Monitoring					$268,900
	Erosion Control	17	ac	$1,500	$25,500	
	Site Surveying	1	ls	$25,000	$25,000	
	Fencing (incl. 2 gates)	3,000	ft	$20.00	$60,000	
	Office and Construction Trailers	18	mo	$800	$14,400	
	Health and Safety Supplies	18	mo	$3,500	$63,000	
	Health and Safety Monitoring	18	mo	$2,500	$45,000	
	Utilities	18	mo	$1,000	$18,000	
	Supplies	18	mo	$1,000	$18,000	
7	Excavation	82,000	cy	$7	$574,000	$574,000
8	Soil Separation and Washing		cy	$100-175	$0	$0
9	Backfill and Placement		cy	$25	$0	$0
10	On-Site Placement	95,125	cy	$5	$475,625	$475,625
11	Transport and Disposal (C code)	6,150	ton	$200	$1,230,000	$1,230,000
12	Transport and Disposal (D code)		ton	$75	$0	$0
13	Cover System					$0
	Section 360-type Cap		sf	$8	$0	
	Low-Permeability Asphalt		sf	$3	$0	
14	Vacuum Extraction					$35,000
	Mobilization	1	ls	$10,000	$10,000	
	Treatment	250	cy	$100	$25,000	
15	Soil Stabilization	73,000	cy	$90	$6,570,000	$6,570,000
16	Confirmatory Sampling	84	ea	$275	$23,182	$23,182
17	Waste Profile Sampling	6	ea	$750	$4,613	$4,613
	TOTAL DIRECT CONSTRUCTION COSTS					$9,235,707
18	Engineering (10% except excavation and disposal at 5%)					$833,371
19	Oversight					$487,500
	Excavation	200	man/day	$750	$150,000	
	Capping		man/day	$750	$0	
	Treatment	400	man/day	$750	$300,000	
	Disposal	50	man/day	$750	$37,500	
20	Contingency (20 percent)					$2,111,315
	TOTAL INSTALLED CAPITAL COSTS					$12,667,893
	Annual O&M Costs	1	yr	$20,000		
	Total O&M Costs (20 years at 8 percent)					$196,360
	ESTIMATED PRESENT WORTH COST (20 years at 8 percent)					$12,864,253

SL-8 Complete Excavation, On-site Treatment, On-site Placement

TABLE C-9
Estimated Cost Soil Alternative SL-9
Liberty Industrial Finishing Site, Farmingdale, New York

Item	Description	Quantity	Unit	Cost		Subtotal
1	Monitoring Well Installation					$24,000
	shallow wells (< 65 feet)	4	ea	$3,500	$14,000	
	deep wells (>65 feet)	2	ea	$5,000	$10,000	
2	Access Negotiation	1	ls	$10,000	$10,000	$10,000
3	Legal Fees	1	ls	$25,000	$25,000	$25,000
4	Bench and Field Scale Testing	1	ls	$50,000	$50,000	$50,000
5	Mobilization/Demobilization	1	ls	$50,000	$50,000	$50,000
6	Site Preparation and Monitoring					$268,900
	Erosion Control	17	ac	$1,500	$25,500	
	Site Surveying	1	ls	$25,000	$25,000	
	Fencing (incl. 2 gates)	3,000	ft	$20.00	$60,000	
	Office and Construction Trailers	18	mo	$800	$14,400	
	Health and Safety Supplies	18	mo	$3,500	$63,000	
	Health and Safety Monitoring	18	mo	$2,500	$45,000	
	Utilities	18	mo	$1,000	$18,000	
	Supplies	18	mo	$1,000	$18,000	
7	Excavation		cy	$7	$0	$0
8	Soil Separation and Washing	73,000	cy	$100	$7,300,000	$7,300,000
9	Backfill and Placement	14,600	cy	$25	$365,000	$365,000
10	On-Site Placement		cy	$5	$0	$0
11	Transport and Disposal (C code)	21,900	ton	$200	$4,380,000	$4,380,000
12	Transport and Disposal (D code)		ton	$75	$0	$0
13	Cover System					$0
	Section 360-type Cap		sf	$8	$0	
	Low-Permeability Asphalt		sf	$3	$0	
14	Vacuum Extraction					$35,000
	Mobilization	1	ls	$10,000	$10,000	
	Treatment	250	cy	$100	$25,000	
15	Soil Stabilization		cy	$90	$0	$0
16	Confirmatory Sampling	78	ea	$275	$21,454	$21,454
17	Waste Profile Sampling	22	ea	$750	$16,425	$16,425
	TOTAL DIRECT CONSTRUCTION COSTS					$12,529,354
18	Engineering (10% except excavation and disposal at 5%)					$1,033,935
19	Oversight					$337,500
	Excavation		man/day	$750	$0	
	Capping		man/day	$750	$0	
	Treatment	400	man/day	$750	$300,000	
	Disposal	50	man/day	$750	$37,500	
20	Contingency (20 percent)					$2,780,158
	TOTAL INSTALLED CAPITAL COSTS					$16,680,948
	Annual O&M Costs	1	yr	$20,000		
	Total O&M Costs (20 years at 8 percent)					$196,360
	ESTIMATED PRESENT WORTH COST (20 years at 8 percent)					$16,877,308

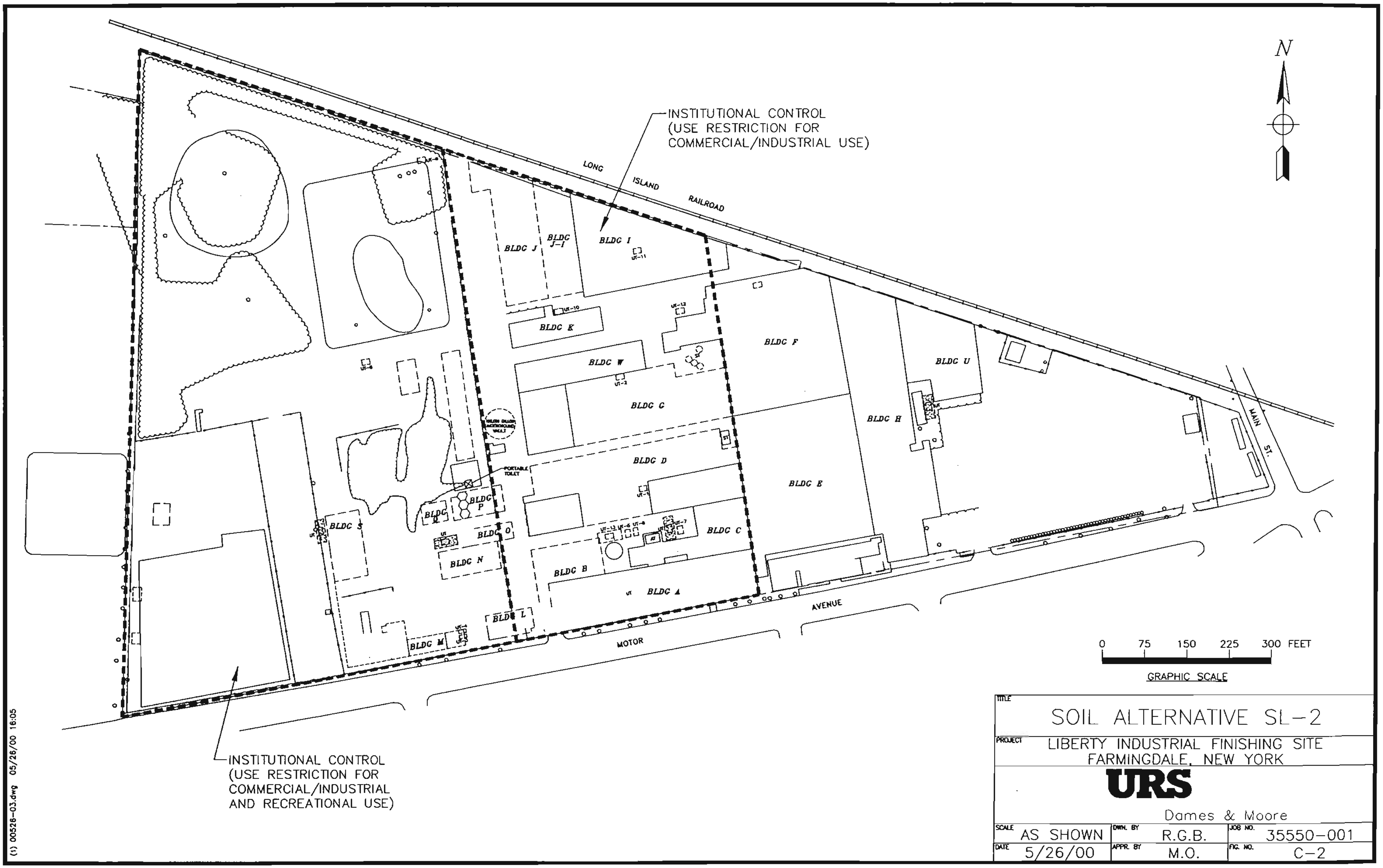
SL-9 Complete Excavation, Soil Separation, Soil Washing, Off-site Disposal, On-Site Placement

Notes to Tables C-1 through C-9

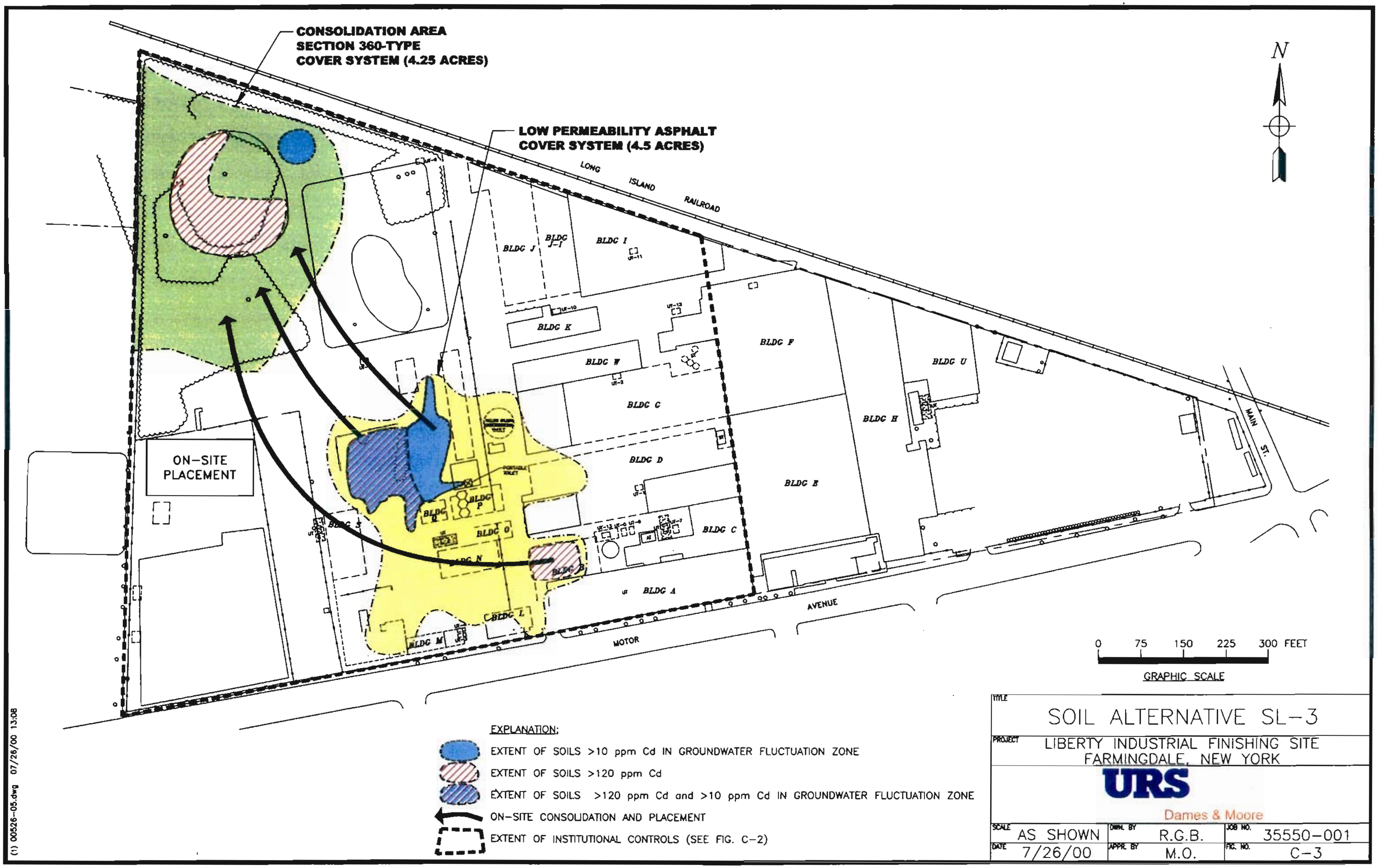
1	Monitoring Well Installation	Costs include drilling, installation, and oversight; assume four additional shallow wells along site property boundary, and two deep wells to monitor effectiveness of site remedy.
2	Access Negotiation	Costs include negotiations for access with the property owner, owners of adjoining properties, and the various public agencies (e.g., POTW for disposal of decontamination fluids.
3	Legal Fees	Covers costs for set-up of deed restriction (use restriction for commercial/industrilal or recreational use [western parcel only])
4	Bench- or Field Scale Testing	Bench-scale testing will be necessary to evaluate the effectiveness of soil stabilization (cement with polymer, pug mill) and soil separation and washing technologies.
5	Mobilization/Demobilization	Includes costs for subcontractor procurement, equipment transportation and set-up, insurance costs, set-up of decontamination facility, site preparation other than shown in (6)
6	Site Preparation and Monitoring	
	Erosion Control	Assumes a unit cost of $1,500 per acre (standard silt fence and hay bales)
	Site Surveying	Costs associated with property survey (if necessary), layout of excavation and sampling grid, and building surveys (if necessary)
	Fencing (incl. 2 gates)	Assumes industrial chain-link, 6-feet high with 3 strands of razor wire. Existing fencing is likely not adequate for site safety.
	Office and Construction Trailers	Assumes two 32' x 8' mobile offices at a long-term rental cost of $400/month for each unit.
	Health and Safety Supplies	Assumes 2 changes of personal protective equipment and clothing per day; other miscellaneous items for a crew of 12-16 persons.
	Health and Safety Monitoring	Assumes one full-time health and safety officer on-site and miscelleaneous equipment rentals and purchases
	Utilities	Electrical and sanitary facilities; includes set-up of adequate lighting and electrical service
	Supplies	Miscellaneous supplies
7	Excavation	Unit rate of $7 per cy is inclusive of labor and equipment; excavation volumes are based on conceptual site model estimates and are not inclusive of necessary sloping requirements; the time estimate for excavation assumes significant down-time during times of high water table (February through June), as dewatering in the groundwater fluctutaion zone is impractical. Note that for Alternatives SL-7, SL-8, and SL-9 the excavation volume is 82,000 cy (as per Table 1-2), but the treatment/disposal volume is based on 73,000 cy of impacted soil.
8	Soil Separation and Washing	The unit cost ($175 per cy for small-scale; $100 per cy for large scale) includes excavation, separation, washing, and placement of treated material, and is based on a vendor quote. Assumes off-site disposal of fine materials (assume 15-percent of total) plus five percent unsuitable material. Backfill is required for this material disposed off-site.
9	Backfill and Placement	Backfill volumes were estimated to equal the excavation volume minus the volume of unsuitable material that was disposed off-site. The cost $25/cy assume a fill source on Long Island. If no suitable source for backfill can be identified on Long Island, the cost would escalate significantly. For the ex-situ treatment alternatives (SL-5, SL-6, SL-8, SL-9) it was assumed that 5% of the excavation volume would be unsuitable for backfill and require off-site disposal as C-code hazardous waste.
10	On-Site Placement	The unit cost of $5/cy is inclusive of on-site transport and placement (incl. compaction etc.). For the on-site stabilization alternatives SL-5 and SL-8, it was assumed that the treated soil volume would be 25-percent greater than the pre-treatment volume.
11	Transport and Disposal (C code)	If TCLP characteristic soil is to be excavated and disposed off-site, the cost model always assumes 16,000 cy (based on conceptual site model); if TCLP characteristic soil is not to be disposed off-site (i.e., the on-site treatment alternatives SL-5, SL-6, SL-8, SL-9), the cost model assumes 5% of the excavation as unsuitable material; Transport and Disposal Cost are estimated at $200 per ton (1.5 tons per cy, using a wet weight of 113 pcf)
12	Transport and Disposal (D code)	Transport and Disposal Cost are estimated at $75 per ton (1.5 tons per cy, using a wet weight of 113 pcf)
13	Cover System	
	Dual-Layer	Assumes compacted graded soil base, followed by geosynthetic liner, drainage layer, and soil cover; the cap-design would be consistent with NYSDEC Section 360-type cover systems.
	Low-Permeability Asphalt	Assume 5-inch stabilized bituminous base course, followed by binder course with geotextile fabric and 2-inch bituminous concrete wearing course
14	Vacuum Extraction	
	Mobilization and Treatment	Assumes a default volume of 500 cy (SL-3 through SL-6) or 250 cy (SL-7 through SL-9) of material that requires treatment. If necesasary, these costs would also cover disposal of VOC-impacted materials that are not addressed by the excavation targeting metals impacts.

Notes to Tables C-1 through C-9

15	Soil Stabilization (incl. placement)	Assumes cement additive and additional polymer to achieve desired effectiveness for resistance to chemical and physical leaching; unit cost of $90/cy are engineering estimates without the benefit of bench-scale testing.
16	Confirmatory Sampling	The excavation volume (V) is conceptualized as a cube with an edge length of $V^{0.33}$. Thus each face of the cube has an area of $(V^{0.33})^2$. Suppose that sidewall and footwall sampling will be required: thus, five of the six cube faces need to be sampled. Suppose that confirmatory sampling is needed at a frequency of 1 sample for every 1000 sf of sidewall or footwall. Therefore, if the excavation volume (V) is given in cy, the number (N) of required confirmatory samples is: N = (1 sample/1000 sf) x (9 sf/sy) x (5 faces) x $(V^{0.33})^2$. The unit cost of $225 per sample is inclusive of labor and laboratory fees (cadmium, chromium, moisture, VOCs).
17	Waste Profile Sampling	It is assumed that one waste profile sample will be collected for every 1,000 cy of material shipped off-site and disposed. The unit cost of $750 per sample is inclusive of labor and laboratory fees (TCLP metals and TCLP VOCs).
18	Engineering	Engineering and design are estimated at 10-percent of the total direct construction cost (5-percent for transport and disposal).
19	Oversight	
	Excavation	Excavation oversight is estimated to require one person per day. Pending access restrictions, it is estimated that approximately 30 trucks (at 15 cy each) can be loaded each day. Therefore, the excavation schedule and oversight schedule may be calculated by dividing the excavation volume by 450 cy/day. Actual schedule will be determined by other factors (weather, site conditions, groundwater elevation).
	Capping	Capping oversight is estimated to require three persons per day. It is estimated that approximately 0.5 acres of cover system can be constructed per 5-day week (both Section 360-type cap and low-permeability asphalt cover).
	Treatment	Treatment oversight is estimated to require one person per day. Treatment volume is estimated to be approximately 225 cy per day.
	Disposal	Disposal oversight is estimated to require 25-percent of the effort for excavation oversight.
20	Contingency (20 percent)	A contingency rate of 20-percent was applied to the sum of Total Direct Construction Costs, Engineering and Design, and Oversight.
	Annual O&M Costs	Annual O&M cost for Alternatives SL-2, SL-7, SL-8, and SL-9 (i.e., the alternatives not including a cover system) assume quarterly site inspections ($5,000/yr) and semi-annual groundwater sampling ($15,000/year); the annual O&M costs for Alternatives SL-3, SL-4, SL-5, and SL-6 (i.e., alternatives that include a cover system) assume quarterly site inspections ($5,000/yr), semi-annual groundwater sampling ($15,000/yr), and periodic cover system repair and maintenance ($15,000/yr). Note that replacement cover systems are not included in these estimates.



TITLE	SOIL ALTERNATIVE SL-2		
PROJECT	LIBERTY INDUSTRIAL FINISHING SITE FARMINGDALE, NEW YORK		
	URS Dames & Moore		
SCALE AS SHOWN	DWN. BY R.G.B.	JOB NO. 35550-001	
DATE 5/26/00	APPR. BY M.O.	FIG. NO. C-2	



CONSOLIDATION AREA
SECTION 360-TYPE
COVER SYSTEM (4.25 ACRES)
LOW PERMEABILITY ASPHALT
COVER SYSTEM (4.5 ACRES)
LONG ISLAND RAILROAD
MAIN ST.
MOTOR AVENUE
ON-SITE PLACEMENT
BLDG J
BLDG J-1
BLDG I
BLDG K
BLDG W
BLDG C
BLDG D
BLDG F
BLDG U
BLDG H
BLDG B
BLDG C
BLDG A
BLDG P
BLDG O
BLDG N
BLDG L
BLDG M
BLDG S
PORTABLE TOILET
N
0 75 150 225 300 FEET
GRAPHIC SCALE
EXPLANATION:
EXTENT OF SOILS >10 ppm Cd IN GROUNDWATER FLUCTUATION ZONE
EXTENT OF SOILS >120 ppm Cd
EXTENT OF SOILS >120 ppm Cd and >10 ppm Cd IN GROUNDWATER FLUCTUATION ZONE
ON-SITE CONSOLIDATION AND PLACEMENT
EXTENT OF INSTITUTIONAL CONTROLS (SEE FIG. C-2)
TITLE
SOIL ALTERNATIVE SL-3
PROJECT
LIBERTY INDUSTRIAL FINISHING SITE
FARMINGDALE, NEW YORK
URS
Dames & Moore
SCALE AS SHOWN
DWN. BY R.G.B.
JOB NO. 35550-001
DATE 7/26/00
APPR. BY M.O.
FIG. NO. C-3
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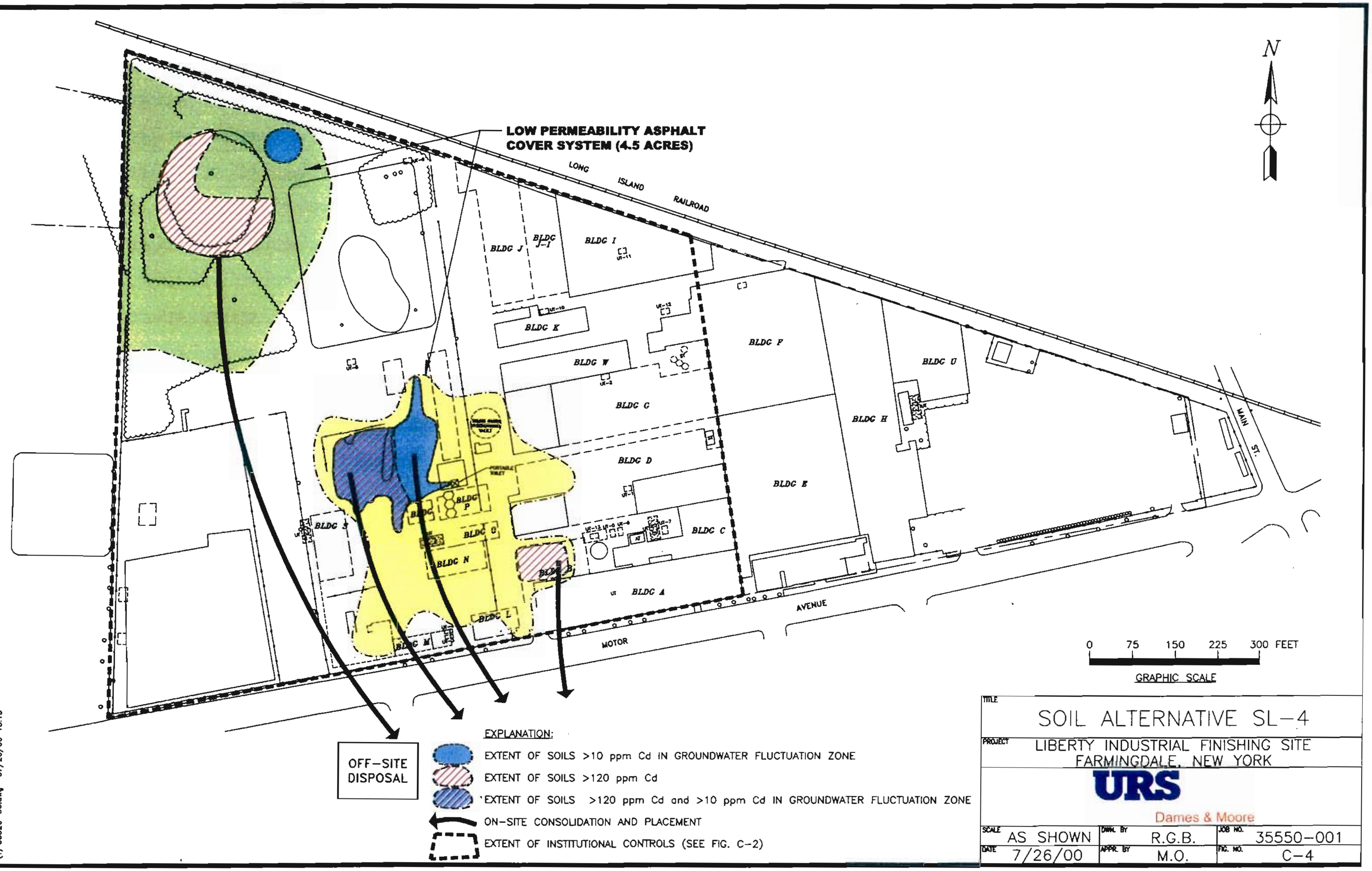
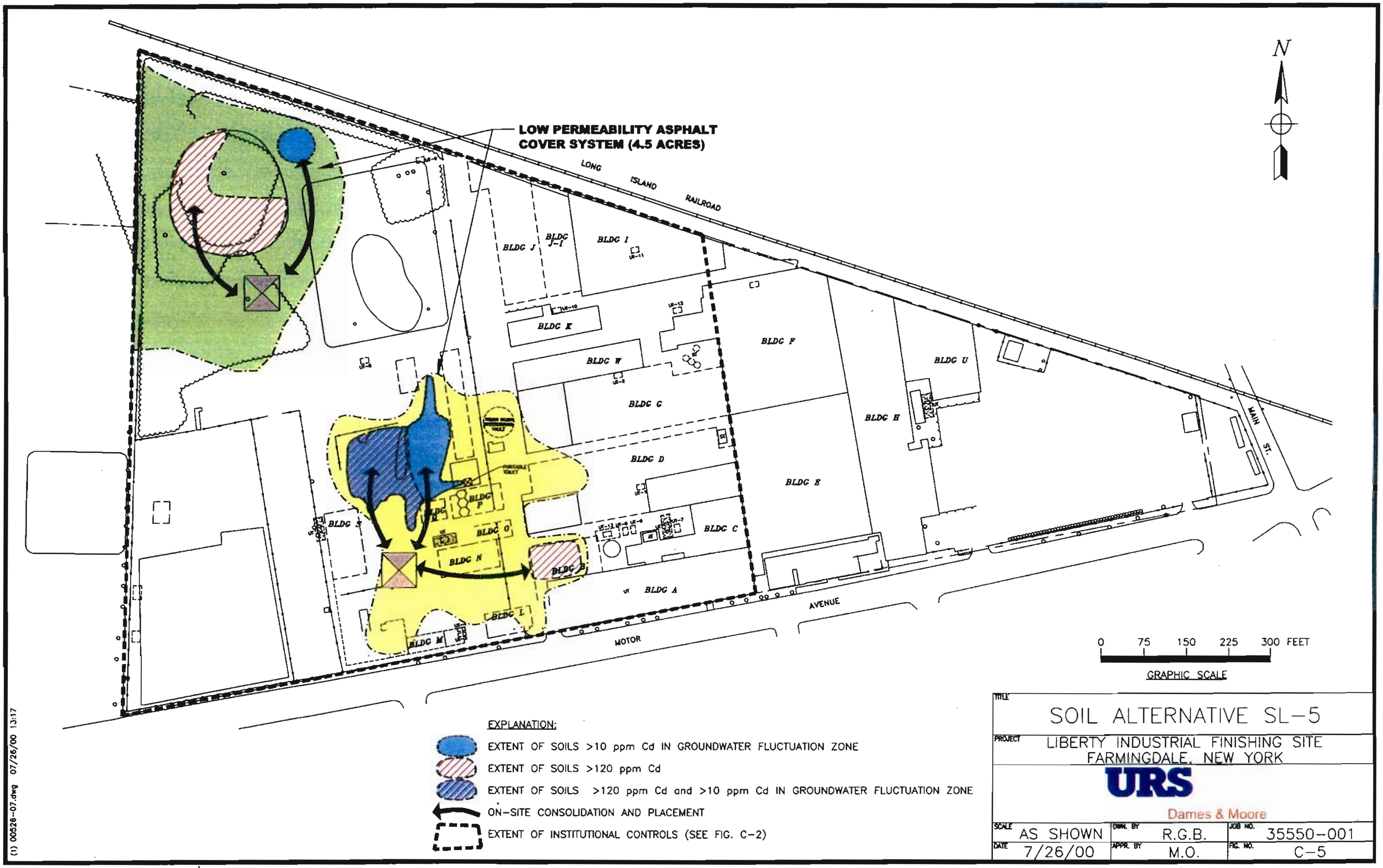

N
LOW PERMEABILITY ASPHALT COVER SYSTEM (4.5 ACRES)
LONG ISLAND RAILROAD
MAIN ST.
MOTOR AVENUE
BLDG J
BLDG J-1
BLDG I
BLDG K
BLDG W
BLDG G
BLDG D
BLDG F
BLDG E
BLDG U
BLDG H
BLDG C
BLDG A
BLDG N
BLDG O
BLDG P
BLDG L
BLDG M
BLDG S
0 75 150 225 300 FEET
GRAPHIC SCALE
OFF-SITE DISPOSAL
EXPLANATION:
EXTENT OF SOILS >10 ppm Cd IN GROUNDWATER FLUCTUATION ZONE
EXTENT OF SOILS >120 ppm Cd
EXTENT OF SOILS >120 ppm Cd and >10 ppm Cd IN GROUNDWATER FLUCTUATION ZONE
ON-SITE CONSOLIDATION AND PLACEMENT
EXTENT OF INSTITUTIONAL CONTROLS (SEE FIG. C-2)
TITLE
SOIL ALTERNATIVE SL-4
PROJECT
LIBERTY INDUSTRIAL FINISHING SITE
FARMINGDALE, NEW YORK
URS
Dames & Moore
SCALE AS SHOWN
DRN. BY R.G.B.
JOB NO. 35550-001
DATE 7/26/00
APPR. BY M.O.
FIG. NO. C-4



N
LOW PERMEABILITY ASPHALT COVER SYSTEM (4.5 ACRES)
LONG ISLAND RAILROAD
MAIN ST.
MOTOR AVENUE
BLDG J
BLDG J-I
BLDG I
BLDG K
BLDG W
BLDG G
BLDG D
BLDG F
BLDG E
BLDG H
BLDG U
BLDG C
BLDG A
BLDG B
BLDG N
BLDG O
BLDG P
BLDG L
BLDG M
BLDG S
0 75 150 225 300 FEET
GRAPHIC SCALE
EXPLANATION:
EXTENT OF SOILS >10 ppm Cd IN GROUNDWATER FLUCTUATION ZONE
EXTENT OF SOILS >120 ppm Cd
EXTENT OF SOILS >120 ppm Cd and >10 ppm Cd IN GROUNDWATER FLUCTUATION ZONE
ON-SITE CONSOLIDATION AND PLACEMENT
EXTENT OF INSTITUTIONAL CONTROLS (SEE FIG. C-2)
TITLE SOIL ALTERNATIVE SL-5
PROJECT LIBERTY INDUSTRIAL FINISHING SITE FARMINGDALE, NEW YORK
URS
Dames & Moore
SCALE AS SHOWN
DWN. BY R.G.B.
JOB NO. 35550-001
DATE 7/26/00
APPR. BY M.O.
FIG. NO. C-5
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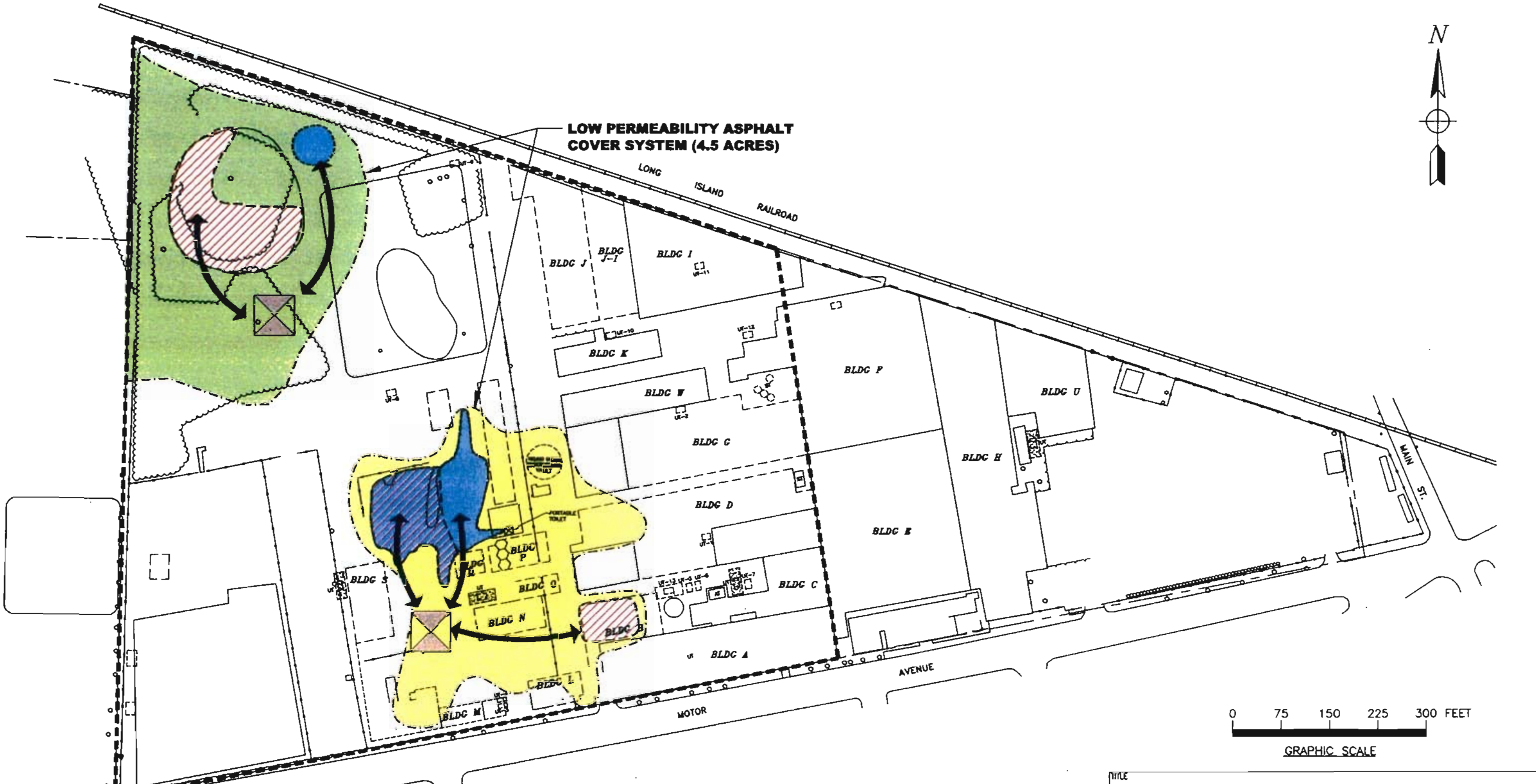

EXPLANATION:

- EXTENT OF SOILS >10 ppm Cd IN GROUNDWATER FLUCTUATION ZONE
- EXTENT OF SOILS >120 ppm Cd
- EXTENT OF SOILS >120 ppm Cd and >10 ppm Cd IN GROUNDWATER FLUCTUATION ZONE
- ON-SITE CONSOLIDATION AND PLACEMENT
- EXTENT OF INSTITUTIONAL CONTROLS (SEE FIG. C-2)

TITLE	SOIL ALTERNATIVE SL-6
PROJECT	LIBERTY INDUSTRIAL FINISHING SITE FARMINGDALE, NEW YORK
	URS Dames & Moore
SCALE	AS SHOWN
DATE	7/26/00
DWN. BY	R.G.B.
APPR. BY	M.O.
JOB NO.	35550-001
FIG. NO.	C-6

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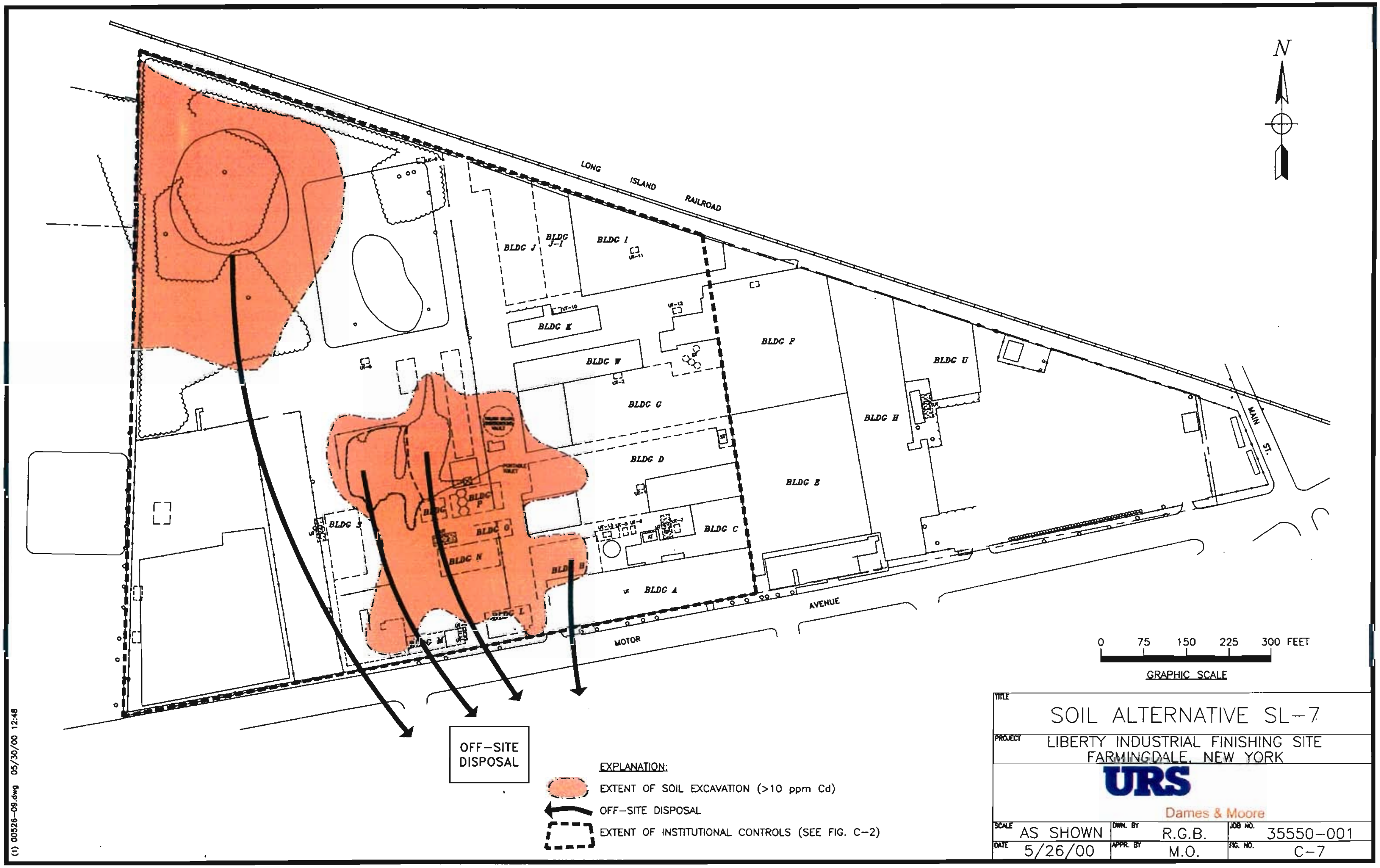
LONG ISLAND RAILROAD
MAIN ST.
MOTOR AVENUE
N
BLDG J
BLDG J-1
BLDG I
BLDG K
BLDG W
BLDG G
BLDG D
BLDG F
BLDG U
BLDG H
BLDG E
BLDG C
BLDG A
BLDG S
BLDG N
BLDG O
BLDG P
BLDG L
BLDG M
0 75 150 225 300 FEET
GRAPHIC SCALE
OFF-SITE DISPOSAL
EXPLANATION:
EXTENT OF SOIL EXCAVATION (>10 ppm Cd)
OFF-SITE DISPOSAL
EXTENT OF INSTITUTIONAL CONTROLS (SEE FIG. C-2)
TITLE
SOIL ALTERNATIVE SL-7
PROJECT
LIBERTY INDUSTRIAL FINISHING SITE
FARMINGDALE, NEW YORK
URS
Dames & Moore
SCALE AS SHOWN
DWN. BY R.G.B.
JOB NO. 35550-001
DATE 5/26/00
APPR. BY M.O.
FIG. NO. C-7
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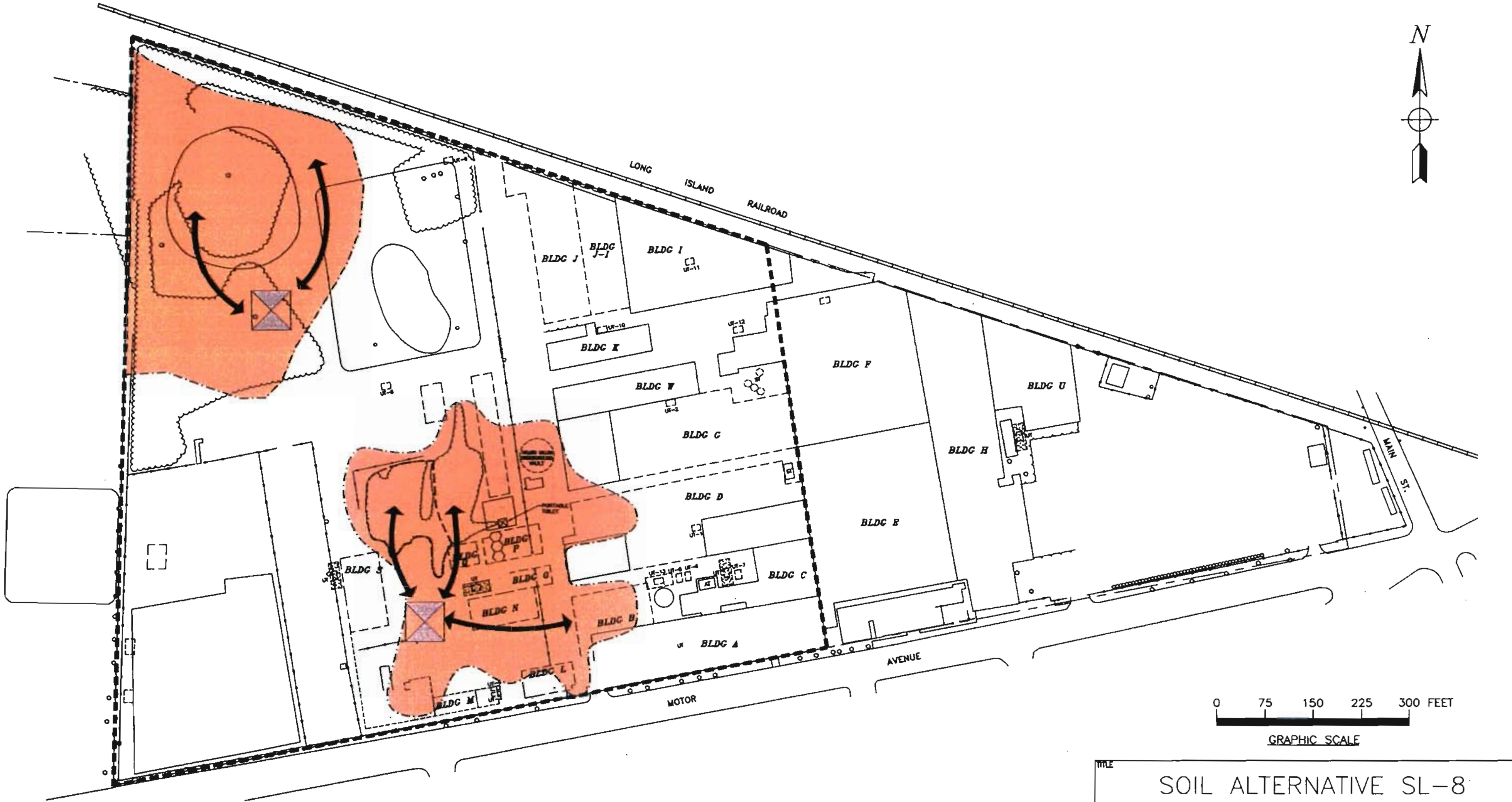

EXPLANATION:

EXTENT OF SOIL EXCAVATION (>10 ppm Cd)

ON-SITE TREATMENT AND ON-SITE PLACEMENT

EXTENT OF INSTITUTIONAL CONTROLS (SEE FIG. C-2)

TITLE	SOIL ALTERNATIVE SL-8		
PROJECT	LIBERTY INDUSTRIAL FINISHING SITE FARMINGDALE, NEW YORK		
	URS Dames & Moore		
SCALE AS SHOWN	DWN. BY R.G.B.	JOB NO. 35550-001	
DATE 5/26/00	APPR. BY M.O.	FIG. NO. C-8	

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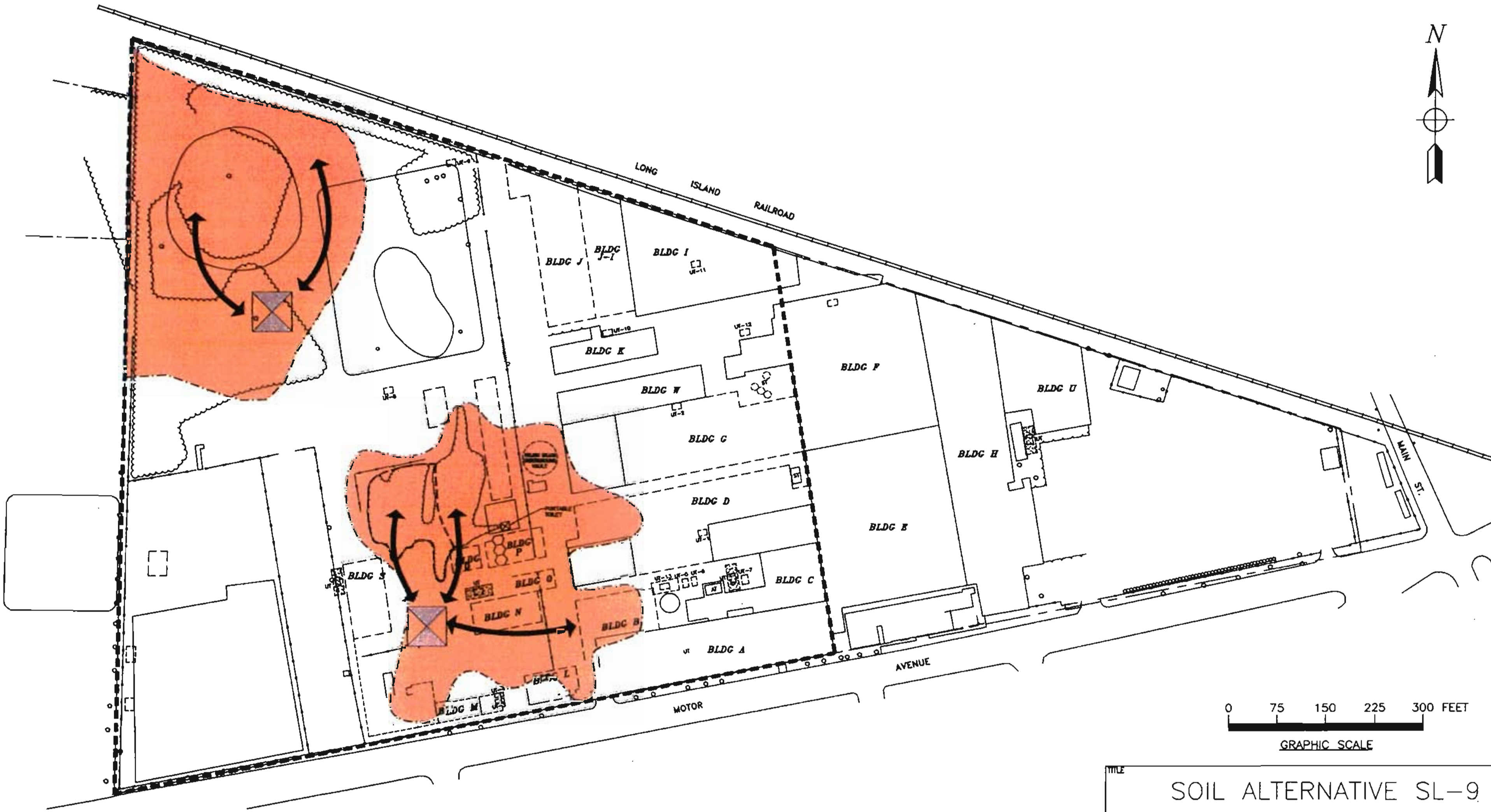

EXPLANATION:

EXTENT OF SOIL EXCAVATION (>10 ppm Cd)

ON-SITE TREATMENT AND ON-SITE PLACEMENT

EXTENT OF INSTITUTIONAL CONTROLS (SEE FIG. C-2)

TITLE	SOIL ALTERNATIVE SL-9				
PROJECT	LIBERTY INDUSTRIAL FINISHING SITE FARMINGDALE, NEW YORK				
URS Dames & Moore					
SCALE	AS SHOWN	DWN. BY	R.G.B.	JOB NO.	35550-001
DATE	5/26/00	APPR. BY	M.O.	FIG. NO.	C-9

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APPENDIX D

Groundwater Remedial Alternatives (Cost Tables and Conceptual Figures)

Tables D-1 through D-5

Figures D-2 through D-5

TABLE D-1

Estimated Cost Groundwater Alternative GW-1
Feasibility Study
Liberty Industrial Finishing Site, Farmingdale, New York

Item	Description	Quantity	Unit	Cost		Subtotal
1	Access Negotiation		ls		$0	$0
2	Legal Fees		ls		$0	$0
3	Bench-or Field Scale Testing		ls		$0	$0
4	Site Preparation					$0
	Mobilization, Decon Pad, Erosion Control, Fencing		ls		$0	
	Office and Construction Trailers		mo		$0	
	Utilities		mo		$0	
	Supplies		mo		$0	
5	Well Installations (incl. oversight)					$0
	Circulation Wells (60 ft)		well		$0	
	Circulation Wells (180 ft)		well		$0	
	Extraction Wells (60 ft)		well		$0	
	Extraction Wells (180 ft)		well		$0	
	Injection Wells		well		$0	
	Shallow monitoring wells		well		$0	
	Deep monitoring wells		well		$0	
	Traffic-rated manhole		ea		$0	
6	Permeable Reactive Wall		sf		$0	$0
7	Equipment					$0
	VOC treatment		ls		$0	
	Metals treatment		ls		$0	
8	Structural (treatment building)		sf		$0	$0
9	Transport and Disposal (D Code)		cy		$0	$0
	SUBTOTAL					$0
10	Mechanical Installation (0% of subtotal)				$0	$0
11	Electrical Installation (0 % of subtotal)				$0	$0
12	Civil Site Work (0% of subtotal)				$0	$0
13	Instrumentation (0% of subtotal)				$0	$0
	TOTAL DIRECT CONSTRUCTION COSTS					$0
14	Engineering and Oversight (10% of subtotal)				$0	$0
15	Contingency (20 percent)				$0	$0
	INSTALLED CAPITAL COSTS					$0
OPERATIONS AND MAINTENANCE						
16	On-site On-site NTCRA		ls		$0	$0
17	MNA Groundwater Sampling		qtr		$0	$0
	Modeling Support		qtr		$0	
	Reporting		qtr		$0	
18	Off-site Utilities		yr		$0	$0
	Maintenance		day		$0	
	Operations		day		$0	
	Engineering and Regulatory Support		yr		$0	
	Replacement Materials		yr		$0	
	Disposal		yr		$0	
	ESTIMATED ANNUAL O&M COST					$0
	ESTIMATED TOTAL O&M COST (20 years at 8 percent)					$0
	ESTIMATED TOTAL PRESENT WORTH COST					$0

GW-1 No Action Alternative

TABLE D-2

Estimated Cost Groundwater Alternative GW-2
Feasibility Study
Liberty Industrial Finishing Site, Farmingdale, New York

Item	Description	Quantity	Unit	Cost		Subtotal
1	Access Negotiation	1	l.s.	$10,000	$10,000	$10,000
2	Legal Fees	1	ls	$25,000	$25,000	$25,000
3	Bench-or Field Scale Testing		l.s.		$0	$0
4	Site Preparation					$4,500
	Mobilization, Decon Pad, Erosion Control, Fencing		ls		$0	
	Office and Construction Trailers	3	mo	$500	$1,500	
	Utilities	3	mo	$500	$1,500	
	Supplies	3	mo	$500	$1,500	
5	Well Installations (incl. oversight)					$108,000
	Circulation Wells (60 ft)		well		$0	
	Circulation Wells (180 ft)		well		$0	
	Extraction Wells (60 ft)		well		$0	
	Extraction Wells (180 ft)		well		$0	
	Injection Wells		well		$0	
	Shallow monitoring wells	6	well	$6,000	$36,000	
	Deep monitoring wells	6	well	$12,000	$72,000	
	Traffic-rated manhole		ea		$0	
6	Permeable Reactive Wall		sf		$0	$0
7	Equipment					$0
	VOC treatment		ls		$0	
	Metals treatment		ls		$0	
8	Structural (treatment building)		sf		$0	$0
9	Transport and Disposal (D Code)	120	ton	$75	$9,000	$9,000
	SUBTOTAL					$121,500
10	Mechanical Installation (0% of subtotal)				$0	$0
11	Electrical Installation (0 % of subtotal)				$0	$0
12	Civil Site Work (0% of subtotal)				$0	$0
13	Instrumentation (0% of subtotal)				$0	$0
	TOTAL DIRECT CONSTRUCTION COSTS					$121,500
14	Engineering and Oversight (10% of subtotal)				$12,150	$12,150
15	Contingency (20 percent)				$24,300	$24,300
	INSTALLED CAPITAL COSTS					$157,950
OPERATIONS AND MAINTENANCE						
16	On-site On-site NTCRA	1	yr	$325,000	$325,000	$325,000
17	MNA Groundwater Sampling	4	qtr	$32,500	$130,000	$180,000
	Modeling Support	4	qtr	$7,500	$30,000	
	Reporting	4	qtr	$5,000	$20,000	
18	Off-site Utilities		yr		$0	$0
	Maintenance		day		$0	
	Operations		day		$0	
	Engineering and Regulatory Support		yr		$0	
	Replacement Materials		yr		$0	
	Disposal		yr		$0	
	ESTIMATED ANNUAL O&M COST					$505,000
	ESTIMATED TOTAL O&M COST (20 years at 8 percent)					$4,958,090
	ESTIMATED TOTAL PRESENT WORTH COST					$5,116,040

GW-2 Continued NTCRA and Monitored Natural Attenuation Evaluation

TABLE D-3

Estimated Cost Groundwater Alternative GW-3
Feasibility Study
Liberty Industrial Finishing Site, Farmingdale, New York

Item	Description	Quantity	Unit	Cost		Subtotal
1	Access Negotiation	1	l.s.	$10,000	$10,000	$10,000
2	Legal Fees	1	ls	$25,000	$25,000	$25,000
3	Bench-and Field Scale Testing	1	l.s.	$150,000	$150,000	$150,000
4	Site Preparation					$75,200
	Mobilization, Decon Pad, Erosion Control, Fencing	1	ls	$50,000	$50,000	
	Office and Construction Trailers	9	mo	$800	$7,200	
	Utilities	9	mo	$1,000	$9,000	
	Supplies	9	mo	$1,000	$9,000	
5	Well Installations (incl. oversight)					$420,000
	Circulation Wells (60 ft)	3	well	$20,000	$60,000	
	Circulation Wells (180 ft)	3	well	$40,000	$120,000	
	Extraction Wells (60 ft)		well		$0	
	Extraction Wells (180 ft)		well		$0	
	Injection Wells		well		$0	
	Shallow monitoring wells	12	well	$6,000	$72,000	
	Deep monitoring wells	12	well	$12,000	$144,000	
	Traffic-rated manhole	6	ea	$4,000	$24,000	
6	Permeable Reactive Wall		sf		$0	$0
7	Equipment					$1,050,000
	VOC treatment	1	ls	$150,000	$150,000	
	Metals treatment	1	ls	$900,000	$900,000	
8	Structural (treatment building)	4,000	sf	$125	$500,000	$500,000
9	Transport and Disposal (D Code)	1,500	ton	$75	$112,500	$112,500
	SUBTOTAL					$2,307,700
10	Mechanical Installation (10% of subtotal)				$230,770	$230,770
11	Electrical Installation (10 % of subtotal)				$230,770	$230,770
12	Civil Site Work (10% of subtotal)				$230,770	$230,770
13	Instrumentation (5% of subtotal)				$115,385	$115,385
	TOTAL DIRECT CONSTRUCTION COSTS					$3,115,395
14	Engineering and Oversight (15% of subtotal)				$467,309	$467,309
15	Contingency (20 percent)				$623,079	$623,079
	INSTALLED CAPITAL COSTS					$4,205,783
OPERATIONS AND MAINTENANCE						
16	On-site On-site NTCRA	1	yr	$325,000	$325,000	$325,000
17	MNA Groundwater Sampling	4	qtr	$32,500	$130,000	$180,000
	Modeling Support	4	qtr	$7,500	$30,000	
	Reporting	4	qtr	$5,000	$20,000	
18	Off-site Utilities	1	yr	$90,000	$90,000	$333,000
	Maintenance	52	day	$750	$39,000	
	Operations	52	day	$750	$39,000	
	Engineering and Regulatory Support	1	yr	$25,000	$25,000	
	Replacement Materials	1	yr	$100,000	$100,000	
	Disposal	1	yr	$40,000	$40,000	
	ESTIMATED ANNUAL O&M COST					$838,000
	ESTIMATED TOTAL O&M COST (20 years at 8 percent)					$8,227,484
	ESTIMATED TOTAL PRESENT WORTH COST					$12,433,267

GW-3 Continued NTCRA, Off-site GCW and In-situ Treatment, Monitored Natural Attenuation Evaluation

TABLE D-4

Estimated Cost Groundwater Alternative GW-4
Feasibility Study
Liberty Industrial Finishing Site, Farmingdale, New York

Item	Description	Quantity	Unit	Cost		Subtotal
1	Access Negotiation	1	l.s.	$10,000	$10,000	$10,000
2	Legal Fees	1	ls	$25,000	$25,000	$25,000
3	Bench-and Field Scale Testing	1	l.s.	$150,000	$150,000	$150,000
4	Site Preparation					$83,600
	Mobilization, Decon Pad, Erosion Control, Fencing	1	ls	$50,000	$50,000	
	Office and Construction Trailers	12	mo	$800	$9,600	
	Utilities	12	mo	$1,000	$12,000	
	Supplies	12	mo	$1,000	$12,000	
5	Well Installations (incl. oversight)					$454,000
	Circulation Wells (60 ft)		well	$20,000	$0	
	Circulation Wells (180 ft)		well	$40,000	$0	
	Extraction Wells (60 ft)	2	well	$15,000	$30,000	
	Extraction Wells (180 ft)	2	well	$30,000	$60,000	
	Injection Wells	8	well	$12,500	$100,000	
	Shallow monitoring wells	12	well	$6,000	$72,000	
	Deep monitoring wells	12	well	$12,000	$144,000	
	Traffic-rated manhole	12	ea	$4,000	$48,000	
6	Permeable Reactive Wall		sf		$0	$0
7	Equipment					$1,500,000
	VOC treatment	1	ls	$300,000	$300,000	
	Metals treatment	1	ls	$1,200,000	$1,200,000	
8	Structural (treatment building)	4,000	sf	$50	$200,000	$200,000
9	Transport and Disposal (C Code)	1,500	ton	$75	$112,500	$112,500
	SUBTOTAL					$2,500,100
10	Mechanical Installation (10% of subtotal)				$250,010	$250,010
11	Electrical Installation (10 % of subtotal)				$250,010	$250,010
12	Civil Site Work (10% of subtotal)				$250,010	$250,010
13	Instrumentation (5% of subtotal)				$125,005	$125,005
	TOTAL DIRECT CONSTRUCTION COSTS					$3,375,135
14	Engineering and Oversight (15% of subtotal)				$506,270	$506,270
15	Contingency (20 percent)				$675,027	$675,027
	INSTALLED CAPITAL COSTS					$4,556,432
OPERATIONS AND MAINTENANCE						
16	On-site On-site NTCRA	1	yr	$325,000	$325,000	$325,000
17	MNA Groundwater Sampling	4	qtr	$32,500	$130,000	$180,000
	Modeling Support	4	qtr	$7,500	$30,000	
	Reporting	4	qtr	$5,000	$20,000	
18	Off-site Utilities	1	yr	$150,000	$150,000	$519,000
	Maintenance	52	day	$750	$39,000	
	Operations	250	day	$500	$125,000	
	Engineering and Regulatory Support	1	yr	$25,000	$25,000	
	Replacement Materials	1	yr	$100,000	$100,000	
	Disposal	1	yr	$80,000	$80,000	
	ESTIMATED ANNUAL O&M COST					$1,024,000
	ESTIMATED TOTAL O&M COST (20 years at 8 percent)					$10,053,632
	ESTIMATED TOTAL PRESENT WORTH COST					$14,610,064

GW-4 Continued NTCRA, Off-site Groundwater Extraction and Aboveground Treatment, MNA Evaluation

TABLE D-5

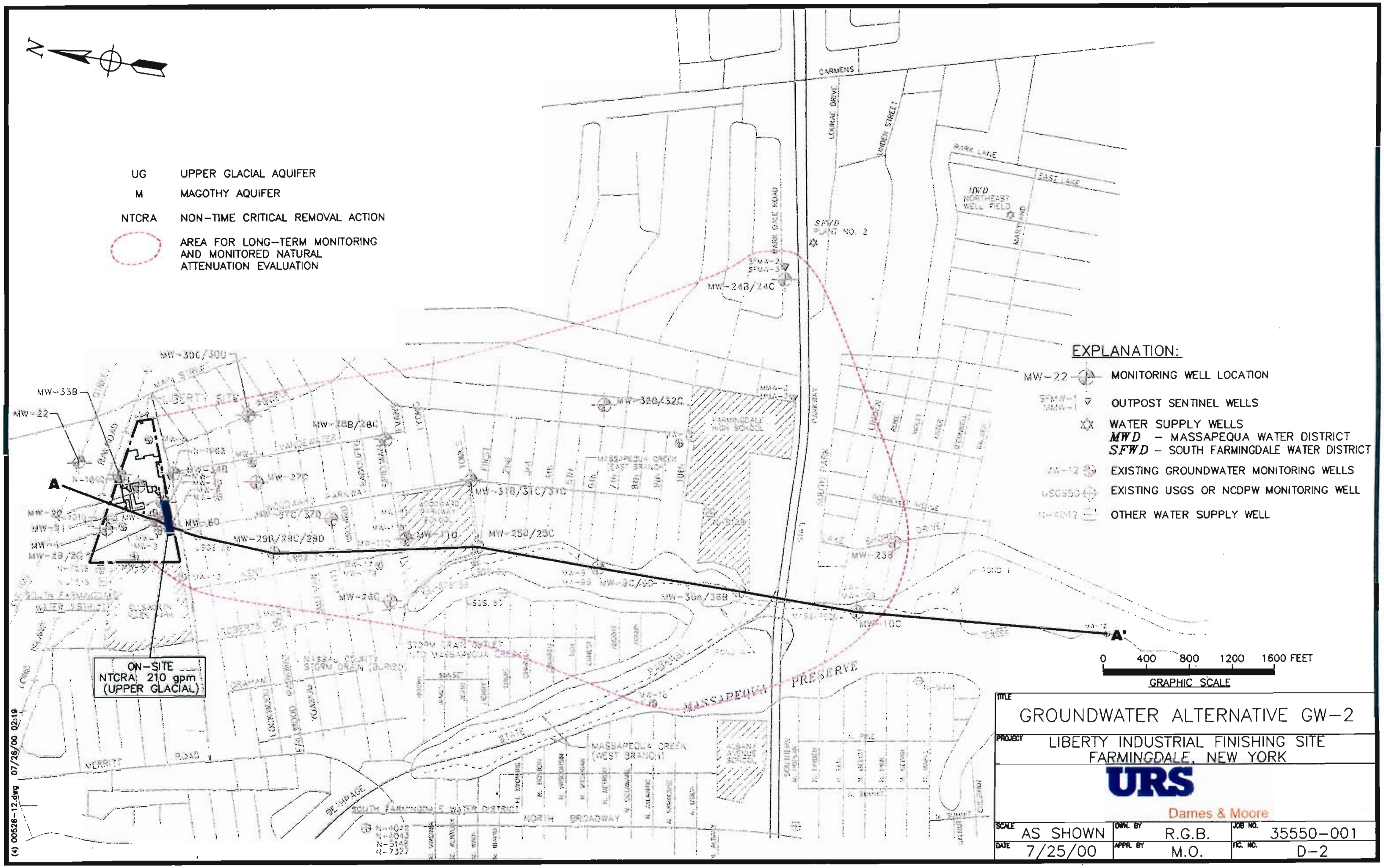
Estimated Cost Groundwater Alternative GW-5
Feasibility Study
Liberty Industrial Finishing Site, Farmingdale, New York

Item	Description	Quantity	Unit	Cost		Subtotal
1	Access Negotiation	1	l.s.	$10,000	$10,000	$10,000
2	Legal Fees	1	ls	$25,000	$25,000	$25,000
3	Bench- and Field Scale Testing	1	l.s.	$150,000	$150,000	$150,000
4	Site Preparation					$66,800
	Mobilization, Decon Pad, Erosion Control, Fencing	1	ls	$50,000	$50,000	
	Office and Construction Trailers	6	mo	$800	$4,800	
	Utilities	6	mo	$1,000	$6,000	
	Supplies	6	mo	$1,000	$6,000	
5	Well Installations (incl. oversight)					$348,000
	Circulation Wells (60 ft)		well		$0	
	Circulation Wells (180 ft)	3	well	$40,000	$120,000	
	Extraction Wells (60 ft)		well		$0	
	Extraction Wells (180 ft)		well		$0	
	Injection Wells		well		$0	
	Shallow monitoring wells	12	well	$6,000	$72,000	
	Deep monitoring wells	12	well	$12,000	$144,000	
	Traffic-rated manhole	3	ea	$4,000	$12,000	
6	Permeable Reactive Wall	2,400	sf	$1,150	$2,760,000	$2,760,000
7	Equipment					$150,000
	VOC treatment	1	ls	$150,000	$150,000	
	Metals treatment		ls			
8	Structural (treatment building)	2,000	sf	$125	$250,000	$250,000
9	Transport and Disposal (C Code)	1,000	ton	$75	$75,000	$75,000
	SUBTOTAL					$3,799,800
10	Mechanical Installation (5% of subtotal)				$189,990	$189,990
11	Electrical Installation (5 % of subtotal)				$189,990	$189,990
12	Civil Site Work (5% of subtotal)				$189,990	$189,990
13	Instrumentation (5% of subtotal)				$189,990	$189,990
	TOTAL DIRECT CONSTRUCTION COSTS					$4,559,760
14	Engineering and Oversight (10% of subtotal)				$455,976	$455,976
15	Contingency (20 percent)				$911,952	$911,952
	INSTALLED CAPITAL COSTS					$5,927,688
Operations and Maintenance						
16	On-site On-site NTCRA	1	yr	$325,000	$325,000	$325,000
17	MNA Groundwater Sampling	4	qtr	$32,500	$130,000	$180,000
	Modeling Support	4	qtr	$7,500	$30,000	
	Reporting	4	qtr	$5,000	$20,000	
18	Off-site Utilities	1	yr	$50,000	$50,000	$184,000
	Maintenance	52	day	$500	$26,000	
	Operations	26	day	$500	$13,000	
	Engineering and Regulatory Support	1	yr	$25,000	$25,000	
	Replacement Materials	1	yr	$50,000	$50,000	
	Disposal	1	yr	$20,000	$20,000	
	ESTIMATED ANNUAL O&M COST					$689,000
	ESTIMATED TOTAL O&M COST (20 years at 8 percent)					$6,764,602
	ESTIMATED TOTAL PRESENT WORTH COST					$12,692,290

GW-5 Continued NTCRA, Off-site Permeable Reactive Barrier and GCW with In-situ Treatment, MNA Evaluation

Notes to Tables D-1 through D-5

1	Access Negotiations	Primary contacts will be the Town of Oyster bay Highway Department, the South Farmingdale Public School District, and private property owners in the vicinity of the Woodward Parkway Elementary School.
2	Legal Fees	Covers costs for the setup and negotiations of use or deed restrictions.
3	Bench- Field-Scale Testing	Alternatives GW-3 through GW-5 require field-scale testing of groundwater circulation efficiency in the Magothy aquifer, groundwater extrcation efiiciency in the Upper Glacial and Magothy aquifers, and testing of the effectiveness of a Permeable Reactive Wall.
4	Site Preparation	Mobilization, construction of decontamination facility, fencing (at $20/ft), and erosion control measures (at $1,500/acre) was estimated to amount to $50,000.
		The estimated costs for site utilities (construction period only), on-site facilities, and miscellaneous supplies were estimated from the projected schedule for GW-2 (3 months for various well installations), GW-3 (9 months), GW-4 (12 months), and GW-5 (6 months)
5	Drilling	Well installation costs assume stainless steel screen and riser, development, and oversight (1 person per well at $70/hr). Disposal costs are included under item 9.
		Circulation wells, extraction wells, and injection wells were assumed to require traffic-rated manholes. Monitoring wells were assumed to require standard 2' x 2' road boxes.
6	Permeable Reactive Wall	Unit price per square foot ($1,150) was derived from an estimate received from Golder Sierra Assoc., Inc., and includes all costs related to installation, mobilization, bench-scale testing, engineering and design, and royalties.
7	Equipment	VOC treatment: estimated from cost for air-stripping (GW-4 only) and vapor-phase/liquid-phase GAC (GW-3 through GW-5).
		Metals treatment: estimated from sequenced treatment (ion exchange, hydroxide precipitation, filtration) for GW-4 and estimated from experience with on-site NTCRA for GW-3 and GW-5.
8	Structural	The unit cost of the treatment building was estimated based on experience and construction complexity. For example, the building for GW-3 may require a sizeable basement similar to that used for the on-site NTCRA.
9	Transport and Disposal	All construction or drilling-derived wastes were assumed to be non-hazardous. The volume of the waste is dependent on the size of the excavations and the number of wells drilled.
10 through 15		The proportional costs for mechanical, electrical, civil site work, and instrumentation are based on straight percentages as shown. Engineering and oversight are estimated at 15% for Alternatives GW-3 and GW-4, and at 10 percent for Alternatives GW-2 and GW-5 (the unit price for the PRB already contains the cost for engineering and oversight). Contingency was always 20%.
16	O&M for NTCRA	The annual O&M cost for the on-site NTCRA is inclusive of Plume 'A' and Plume 'B', and corresponds to recent (April 2000) estimates.
17	MNA Evaluation	The estimated cost for Monitored Natural Attenuation evaluation assumes quarterly sampling of approximately 40 wells for VOCs and metals, using low-flow purge and sampling methods. Quarterly updates to the groundwater transport model are assumed.
18	Off-site O&M Costs	These costs are based on engineering estimates considering these treatment volumes: GW-3: Upper Glacial aquifer at 225 gpm (Cr = 0.5 ppm, Cd = 0.1 ppm, Fe = 0.05 ppm, total VOCs = 0.05 ppm) and Magothy aquifer at 125 gpm (Cr = 0.005 ppm, Cd = 0.005 ppm, Fe = 2.0 ppm, and total VOCs = 1.0 ppm) GW-4: Upper Glacial aquifer at 225 gpm (Cr = 0.5 ppm, Cd = 0.1 ppm, Fe = 0.05 ppm, total VOCs = 0.05 ppm) and Magothy aquifer at 125 gpm (Cr = 0.005 ppm, Cd = 0.005 ppm, Fe = 2.0 ppm, and total VOCs = 1.0 ppm) GW-5: Magothy aquifer at 125 gpm (Cr = 0.005 ppm, Cd = 0.005 ppm, Fe = 2.0 ppm, and total VOCs = 1.0 ppm)



TITLE	GROUNDWATER ALTERNATIVE GW-2				
PROJECT	LIBERTY INDUSTRIAL FINISHING SITE FARMINGDALE, NEW YORK				
	URS Dames & Moore				
SCALE	AS SHOWN	DWN. BY	R.G.B.	JOB NO.	35550-001
DATE	7/25/00	APPR. BY	M.O.	FIG. NO.	D-2

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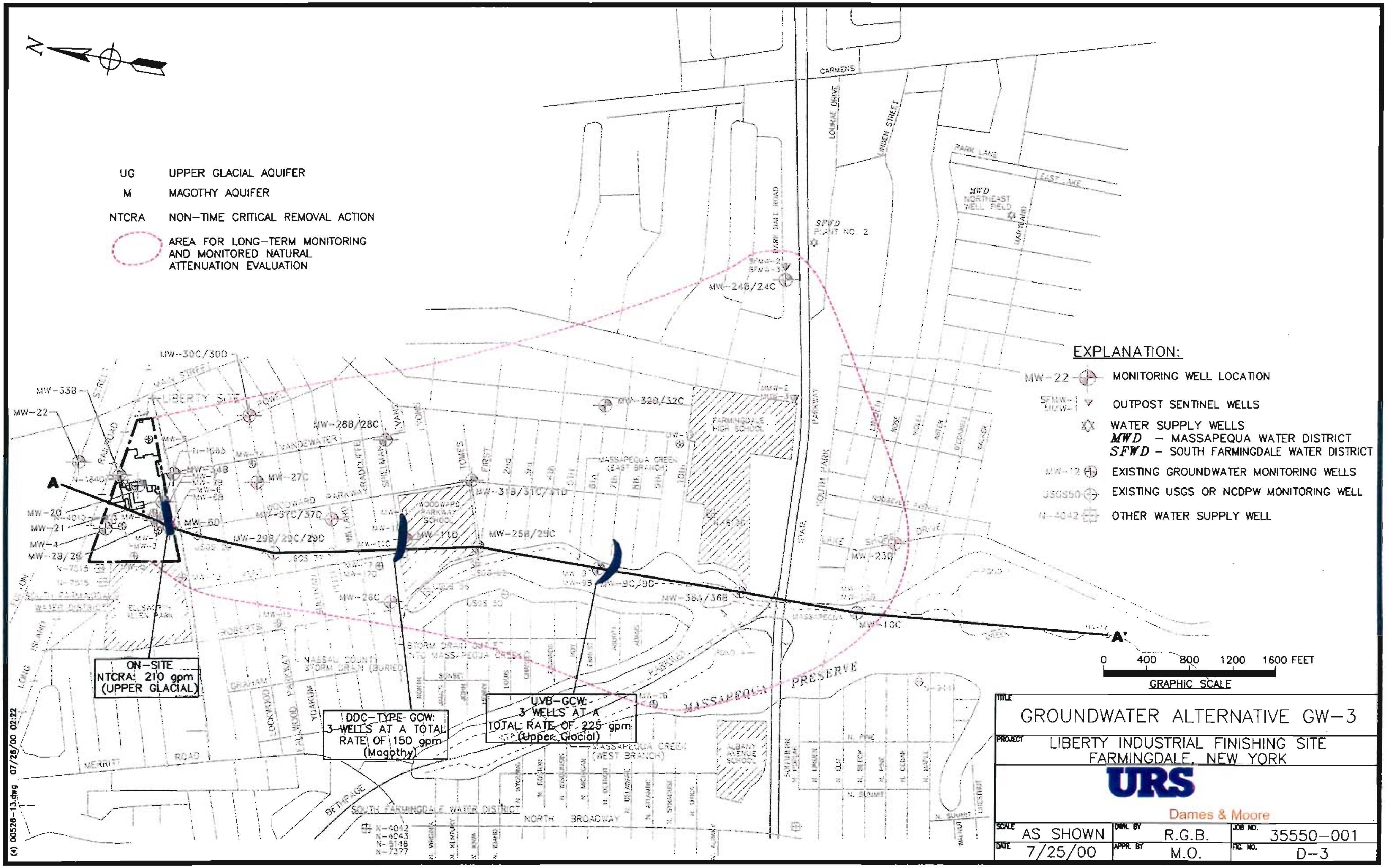
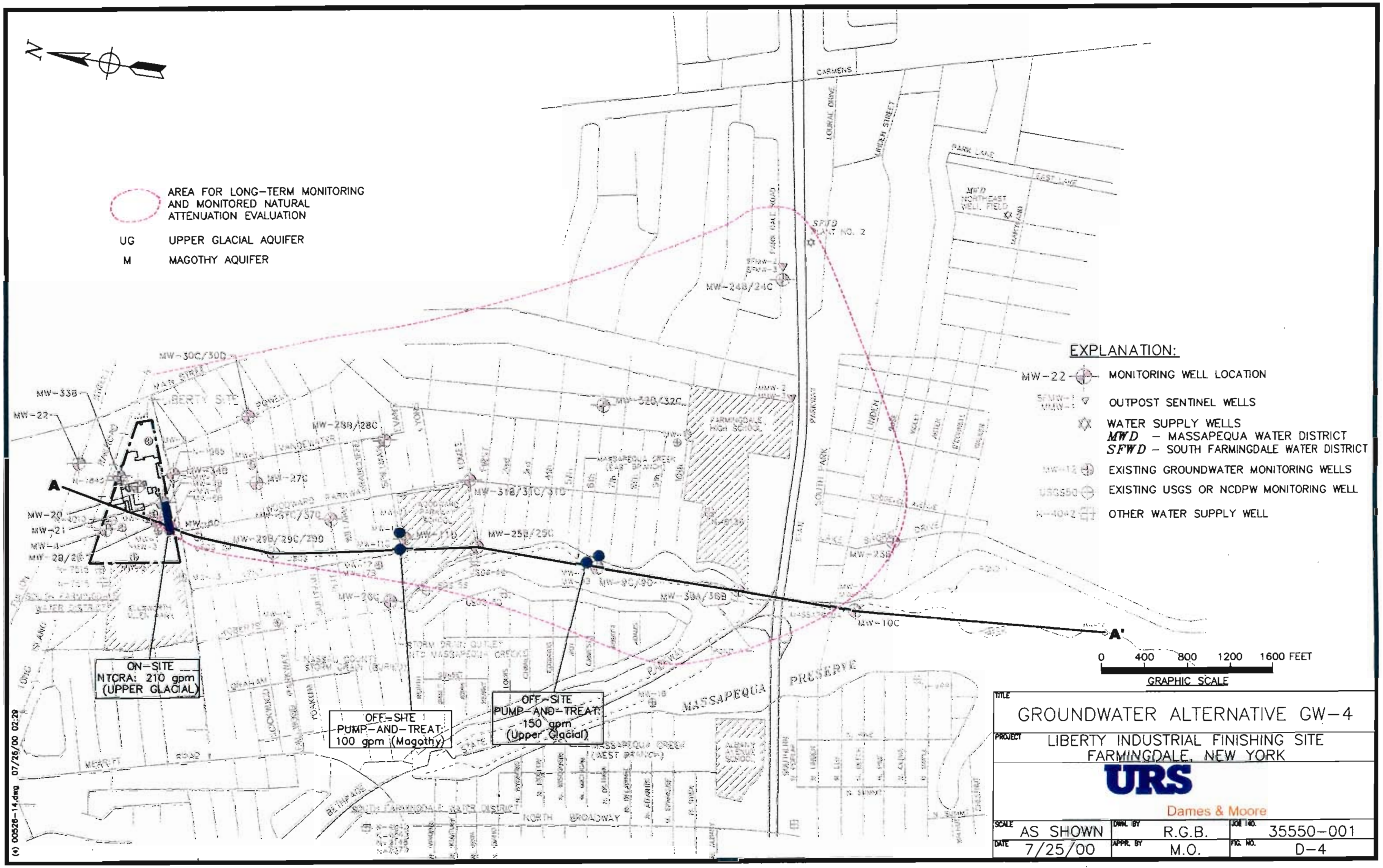
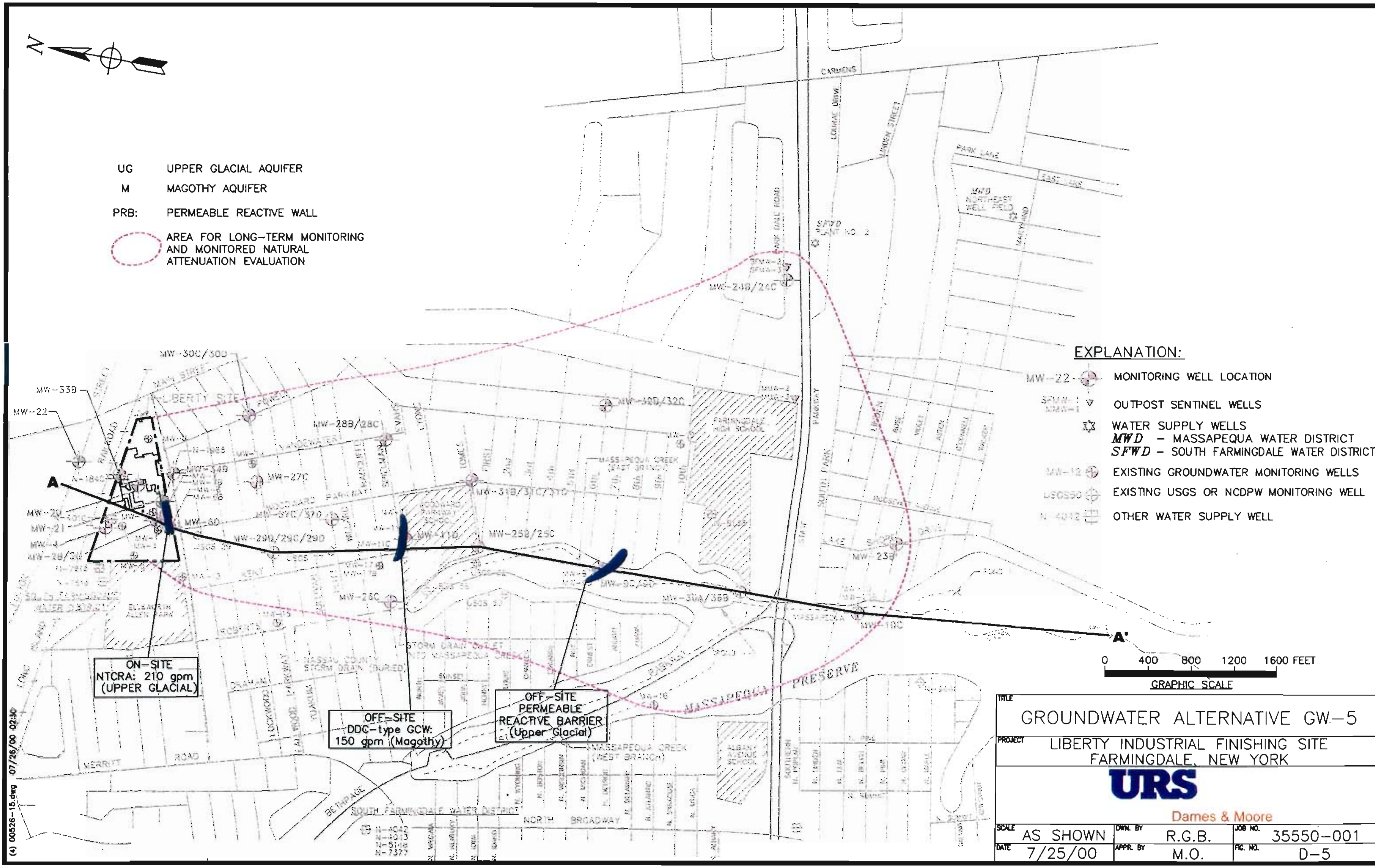


TITLE	GROUNDWATER ALTERNATIVE GW-3				
PROJECT	LIBERTY INDUSTRIAL FINISHING SITE FARMINGDALE, NEW YORK				
	URS Dames & Moore				
SCALE	AS SHOWN	DWN. BY	R.G.B.	JOB NO.	35550-001
DATE	7/25/00	APPR. BY	M.O.	FIG. NO.	D-3



N
AREA FOR LONG-TERM MONITORING AND MONITORED NATURAL ATTENUATION EVALUATION
UG UPPER GLACIAL AQUIFER
M MAGOTHY AQUIFER
EXPLANATION:
MW-22 MONITORING WELL LOCATION
OUTPOST SENTINEL WELLS
WATER SUPPLY WELLS
MWD – MASSAPEQUA WATER DISTRICT
SFWD – SOUTH FARMINGDALE WATER DISTRICT
EXISTING GROUNDWATER MONITORING WELLS
EXISTING USGS OR NCDPW MONITORING WELL
OTHER WATER SUPPLY WELL
ON-SITE
NTCRA: 210 gpm
(UPPER GLACIAL)
OFF-SITE
PUMP-AND-TREAT:
100 gpm (Magothy)
OFF-SITE
PUMP-AND-TREAT:
150 gpm
(Upper Glacial)
A
A'
MW-33B
MW-22
MW-20
MW-21
MW-30C/30D
MW-28B/28C
MW-27C
MW-29B/29C/29D
MW-31B/31C/31D
MW-25B/25C
MW-32B/32C
MW-24B/24C
MW-9C/9D
MW-36A/36B
MW-10C
MW-26C
LIBERTY SITE
CARMENS
LOURAE DRIVE
LINDEN STREET
PARK LANE
EAST LANE
MWD NORTHEAST WELL FIELD
SFWD PLANT NO. 2
FARMINGDALE HIGH SCHOOL
MASSAPEQUA CREEK (EAST BRANCH)
MASSAPEQUA CREEK (WEST BRANCH)
MASSAPEQUA PRESERVE
SOUTH PARK
STORM DRAIN OUTLET TO MASSAPEQUA CREEK
NASSAU COUNTY STORM DRAIN (BURIED)
NORTH BROADWAY
BETHPAGE
SOUTH FARMINGDALE WATER DISTRICT
0 400 800 1200 1600 FEET
GRAPHIC SCALE
TITLE
GROUNDWATER ALTERNATIVE GW-4
PROJECT
LIBERTY INDUSTRIAL FINISHING SITE
FARMINGDALE, NEW YORK
URS
Dames & Moore
SCALE AS SHOWN
DWN. BY R.G.B.
JOB NO. 35550-001
DATE 7/25/00
APPR. BY M.O.
FIG. NO. D-4
(4) 00526-14.dwg 07/26/00 02:29



TITLE GROUNDWATER ALTERNATIVE GW-5

PROJECT LIBERTY INDUSTRIAL FINISHING SITE
FARMINGDALE, NEW YORK

URS
Dames & Moore

SCALE AS SHOWN	DWN. BY R.G.B.	JOB NO. 35550-001
DATE 7/25/00	APPR. BY M.O.	FIG. NO. D-5

APPENDIX E

Capture Zone Simulations for Off-site Component of Groundwater Remedy

Figures E-1 through E-5

The groundwater flow model presented in Appendix J and Section 4.3.9 of the Final CRI report (URS, July 20, 2000) was utilized to evaluate pumping rates and well spacing in the Upper Glacial aquifer and Magothy aquifer to achieve a desired capture zone width for groundwater remediation in the off-site portion of the groundwater plume.

Three scenarios were evaluated (all wells were modeled as fully penetrating the Upper Glacial aquifer and penetrating the Magothy aquifer to an elevation of –160 ft msl (equivalent to 200 feet below grade at location MW-11):

Scenario I: Simultaneous groundwater extraction from two (2) wells in the Upper Glacial aquifer at 100 gpm each and from two (2) wells in the Magothy aquifer at 100 gpm each. The two extraction well clusters (one Upper Glacial aquifer and one Magothy aquifer well each) are located near well cluster MW-11 and extend perpendicular to groundwater flow. The total groundwater extraction rate would be 400 gpm, and the well clusters would be spaced approximately 250 feet. The resulting capture zone is shown in Figure E-1. The capture zone is approximately 1,500 feet wide along the Site property boundary, whereas the off-site groundwater plume ('Plume A') is only approximately 600 feet wide. Therefore, Scenario I results in an oversized capture zone.

Scenario II: Simultaneous groundwater extraction from two (2) wells in the Upper Glacial aquifer at 75 gpm each and from two (2) wells in the Magothy aquifer at 50 gpm each. The two extraction well clusters (one Upper Glacial aquifer and one Magothy aquifer well each) are located near well cluster MW-11 and extend perpendicular to groundwater flow. The total groundwater extraction rate would be 250 gpm and the well clusters would be spaced approximately 250 feet. The resulting capture zones for the Upper Glacial and Magothy aquifers, respectively, are shown in Figure E-2 and E-3. The capture zone is approximately 1,000 feet wide along the Site property boundary, which is adequate to capture the off-site groundwater plume ('Plume A').

Scenario III: Simultaneous groundwater extraction from two (2) wells in the Upper Glacial aquifer at 75 gpm each and from two (2) wells in the Magothy aquifer at 50 gpm each. One extraction well cluster (one Upper Glacial aquifer and one Magothy aquifer well each) is located near well cluster MW-11 and the other well cluster is located approximately half-way between MW-11 and MW-29. Thus, the extraction wells clusters extend parallel to groundwater flow. The total groundwater extraction rate would be 250 gpm and the well clusters would be spaced approximately 800 feet from one another. The resulting capture zones for the Upper Glacial and Magothy aquifers, respectively, are shown in Figure E-4 and E-5. Similar to Scenario II, the capture zone is approximately 1,000 feet wide along the Site property boundary, which is adequate to capture the off-site groundwater plume ('Plume A').

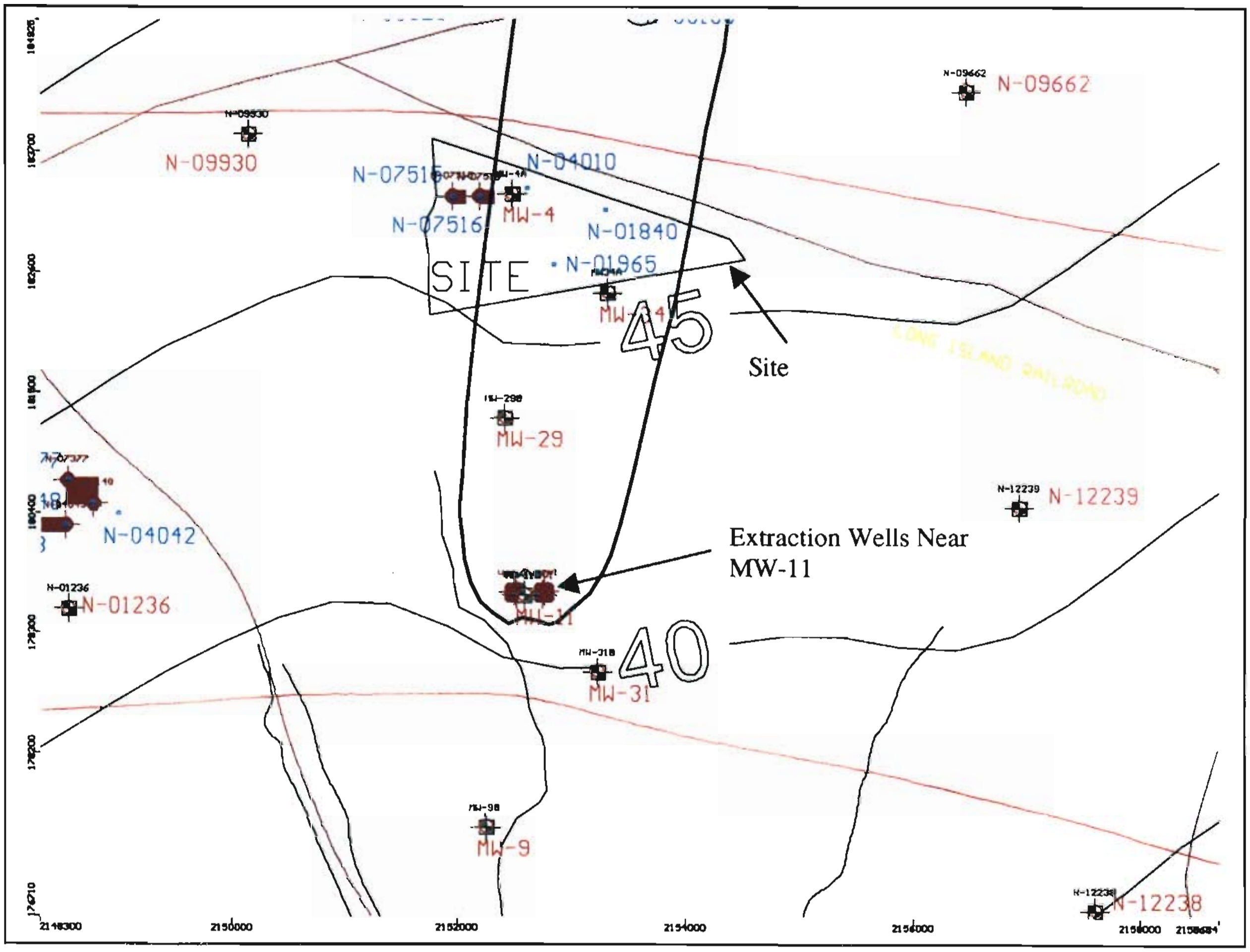


Figure E-1

Extraction Scenario I
Two (2) Extraction Wells in Upper Glacial aquifer at 100 gpm each
Two (2) Extraction Wells in Magothy aquifer at 100 gpm each

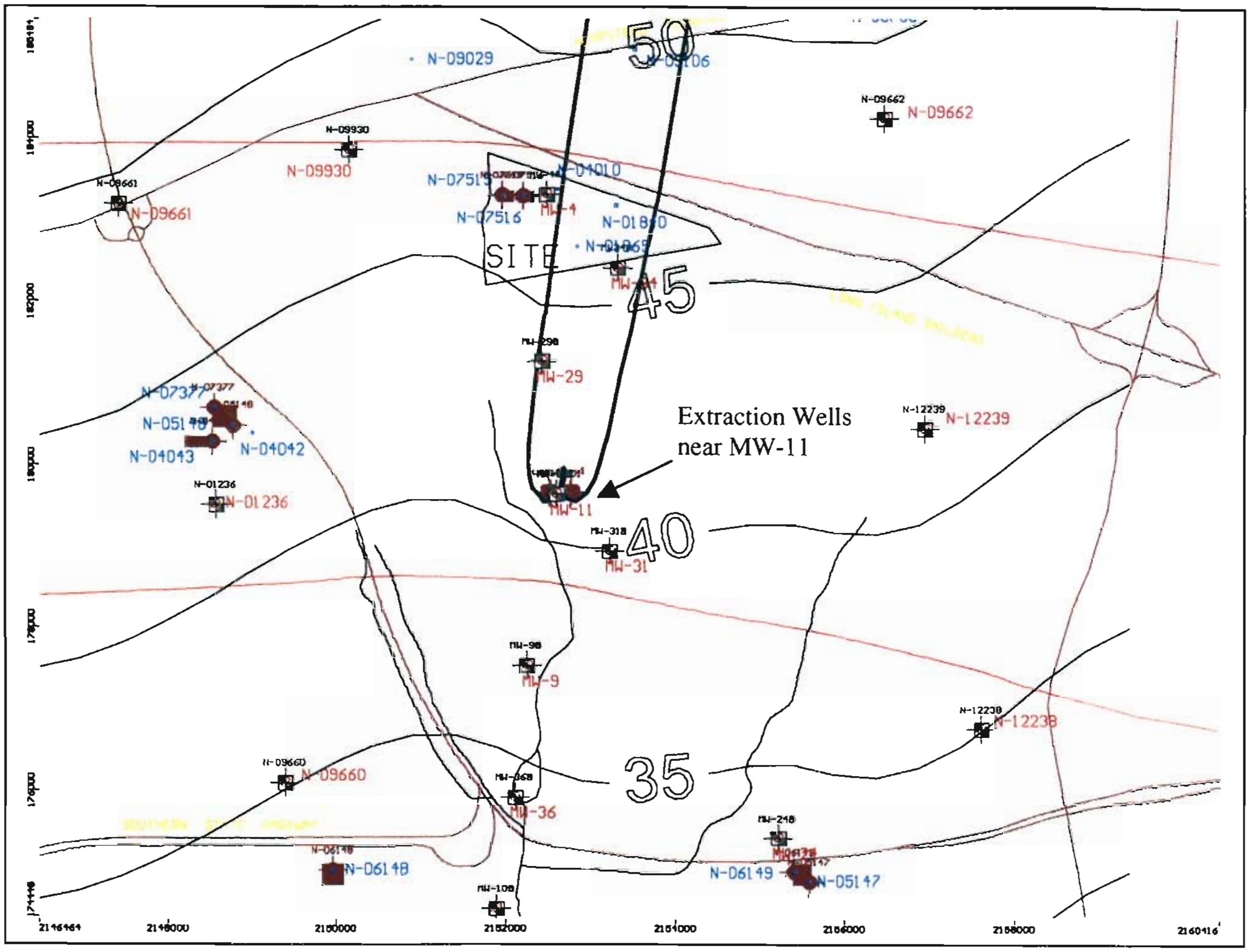
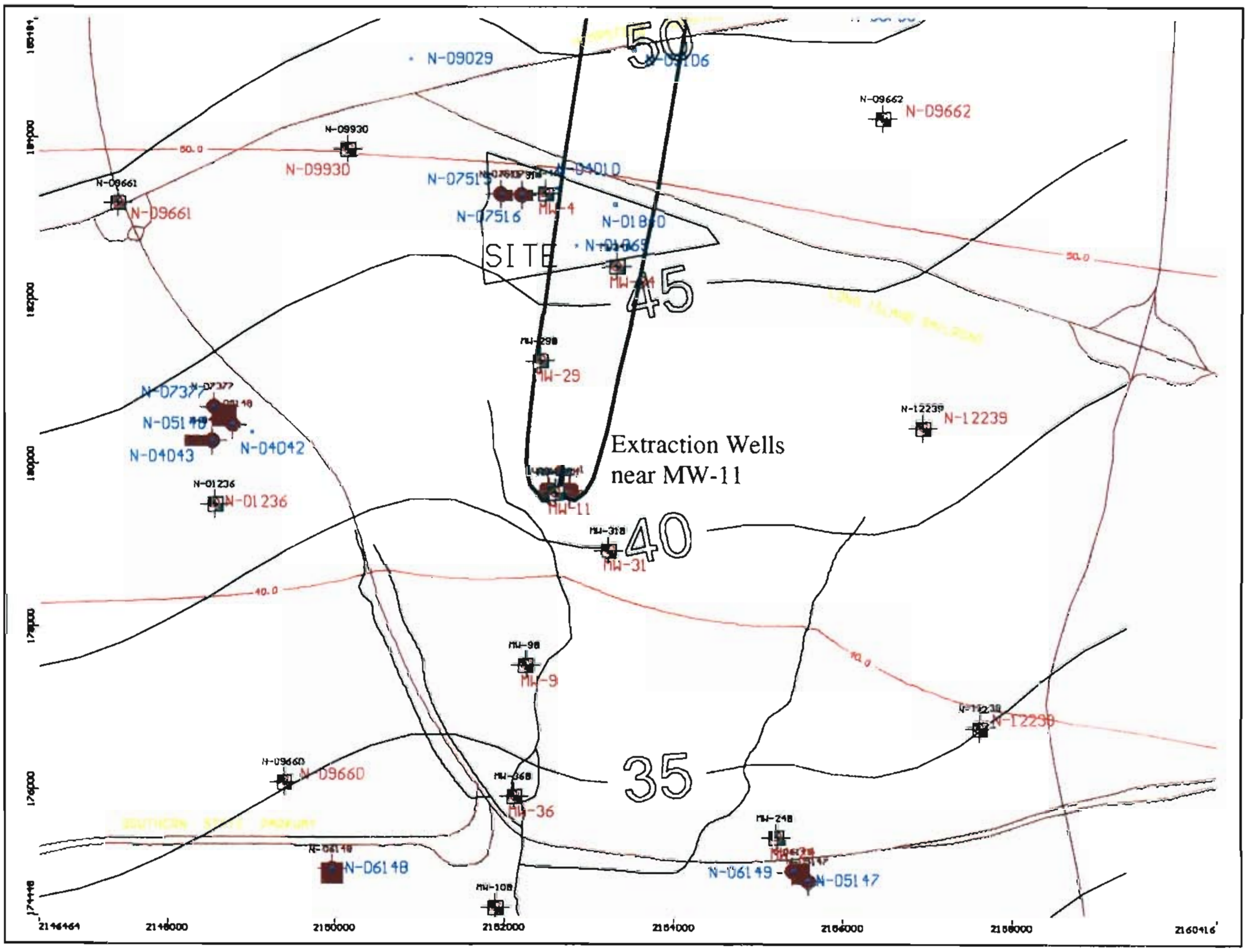


Figure E-2

Extraction Scenario II(UG)
Two (2) Extraction Wells in Upper Glacial aquifer at 75 gpm each



<u>Figure E-3</u>

Extraction Scenario II(M)
Two (2) Extraction Wells in Magothy aquifer at 50 gpm each

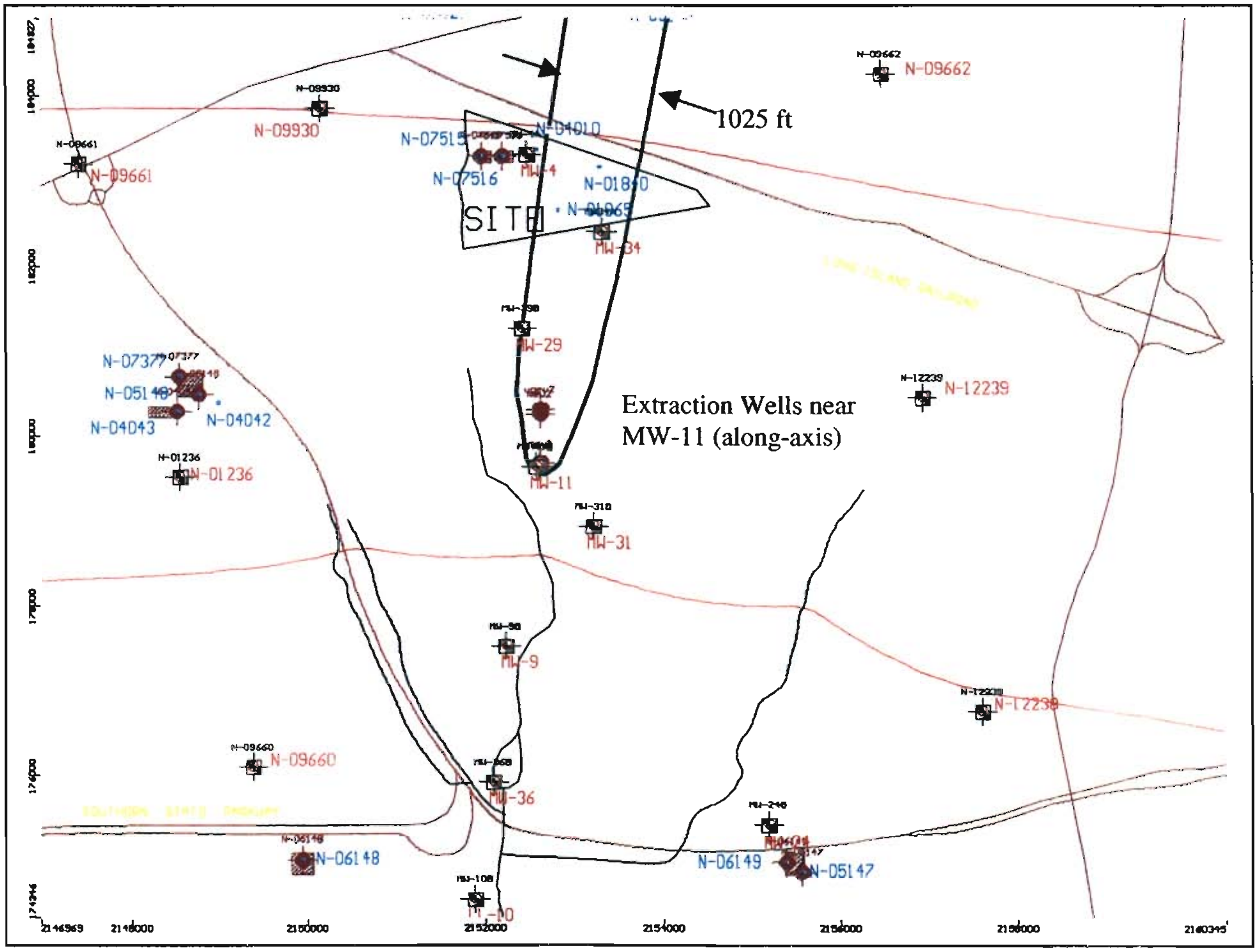


Figure E-4

Extraction Scenario III(UG)
Two (2) Extraction Wells in Upper Glacial aquifer at 75 gpm each. The wells are located along the main axis of the plume, as shown.

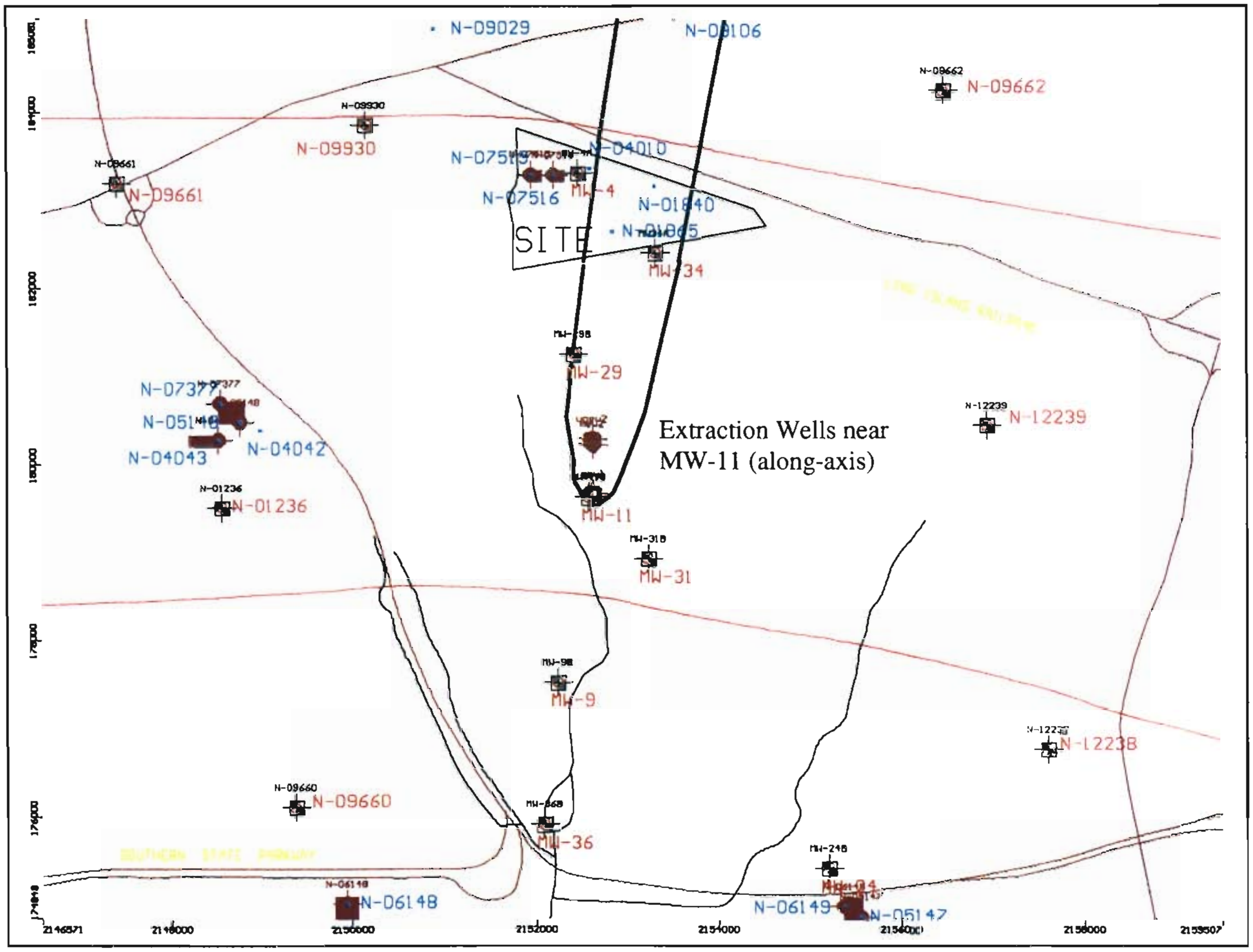


Figure E-5

Extraction Scenario III(M)
Two (2) Extraction Wells in Magothy aquifer at 50 gpm each. The extraction wells are location along the main axis of the plume as shown.