Final Remedial Alternatives Report

The DeLaval Property
Rinaldi Boulevard
City of Poughkeepsie, New York

CHA Project Number: 11205.1012.1102

Prepared for:

City of Poughkeepsie
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January 2005

CERTIFICATION

I, the undersigned, certify under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly prepared this remedial alternatives report for the DeLaval Property located in the City of Poughkeepsie, New York, in accordance with Section 5.4 of the May 2002 Municipal Assistance Environmental Restoration Projects "Brownfields Program" Procedures Handbook, the Division of Environmental Remediation (DER) Draft DER-10 Technical Guidance for Site Investigation and Remediation (December 2002), and in general compliance with the July 2004 Municipal Assistance for environmental Restoration Projects Procedures Handbook. Based upon my personal activities and my direct supervision of the persons directly responsible for preparing the remedial alternatives report, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

For Clough, Harbour & Associates LLP:

(Professional Seal)

Keith J. Ziobron
Printed Name of Certifying Engineer

[signature]
Signature of Certifying Engineer

January 31, 2005
Date of Certification

072760-1
Registration Number

New York
Registration State

Clough, Harbour & Associates LLP
Company

Associate
TITLE

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LIST OF ACRONYMS & ABBREVIATIONS

AMSL	Above Mean Sea Level
AOC	Area of Concern
ARAR	Applicable or Relevant and Appropriate Requirements
BCP	Brownfield Cleanup Program
BGS	Below the Ground Service
CAMU	Corrective Action Management Unit
CHA	Clough, Harbour & Associates LLP
COC	Contaminant of Concern
CVOC	Chlorinated Volatile Organic Compound
DER	Division of Environmental Remediation
ESA	Environmental Site Assessment
GAC	Granular Activated Carbon
HASP	Health & Safety Plan
IC	Institutional Control
IDA	Industrial Development Agency
IRM	Interim Remedial Measure
LDR	Land Disposal Restrictions
LNAPL	Less-Dense Non-Aqueous Phase Liquid
LTTD	Low Temperature Thermal Desorption
MDL	Method Detection Limit
MOSF	Major Oil Storage Facility
MRC	Metal Remediation Compound
MSW	Municipal Solid Waste
MW	Monitoring Well
NCP	National Contingency Plan
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
O&M	Operation and Maintenance
OM&M	Operation, Maintenance and Monitoring
ORC®	Oxygen-Releasing Compound
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl's
PID	Photoionization Detector
PILOT	Payment In Lieu of Taxes
PPM	Parts Per Million
PRAP	Proposed Remedial Action Plan
PRB	Passive Reactive Barrier
RAO	Remedial Alternative Objective
RAR	Remedial Alternatives Report
RCRA	Resource Conservation and Recovery Act
REC	Recognized Environmental Condition
ROD	Record of Decision
SCG	Standard, Criteria, and Guidance
SCS	Soil Conservation Survey

LIST OF ACRONYMS & ABBREVIATIONS
(Continued)

SI	Site Investigation
SPDES	State Pollutant Discharge Elimination System
STP	Sewage Treatment Plant
SVE	Soil Vapor Extraction
SVOC	Semi- Volatile Organic Compound
TAGM	Technical & Administrative Guidance Memorandum
TCC	The Chazen Companies
TCLP	Toxicity Characteristic Leaching Procedure
TMP	Tax Map Parcel
TOGS	Technical & Operational Guidance Series
TP	Test Pit
US	United States
USGS	United States Geologic Survey
UST	Underground Storage Tank
UV	Ultraviolet
VOC	Volatile Organic Compound
WWTP	Wastewater Treatment Plant

1.0 INTRODUCTION

The City of Poughkeepsie Common Council and the City of Poughkeepsie Urban Renewal Agency will be undertaking the sale and/or lease of approximately twenty-four acres of land on three parcels to the City of Poughkeepsie Industrial Development Agency (IDA), which will, in turn, sell or lease most of the property to a private developer, Poughkeepsie Waterfront Development, LLC. The parcels include the DeLaval property, the subject of this report, the City's former sewer treatment plant, and the PURA-14 property, an urban renewal property. The City will retain approximately two acres of land along the Hudson River.

Following transfer of control of the property, Poughkeepsie Waterfront Development, LLC would undertake a development that would consist of 40,600 square feet of restaurant space; a 43,200 square foot catering facility; 30,000 square feet of retail space; a 72-room hotel; and 92,800 square feet of office space. Public improvements to the waterfront would also include a public non-motorized boat launch, deep water pier, historical interpretive area, two public restroom facilities, roadways and parking areas, fishing stations, and finally a 50-slip marina.

The City of Poughkeepsie intends to stabilize the shoreline with rip-rap and bulk heading, and to construct a promenade along the shoreline with lighting and benches. The total cost of developer's improvements is estimated at $40 million. The cost of the shoreline stabilization and promenade are estimated at $3.7 million.

When all phases of the project are complete, the project will create up to 350 full time equivalent jobs in the City of Poughkeepsie, generate approximately $1.35 million in sales tax, and generate approximately $400,000 per year in property taxes for the City. As part of the City's compensation, Poughkeepsie Landing LLC would pay rent, make PILOT (payment in lieu of taxes) payments, and provide a percentage of gross sales from operations and a percentage of rent.

Given the historic industrial nature of the Poughkeepsie waterfront, it is not surprising that areas of environmental concern are associated with each of the three properties which make up the Poughkeepsie Southern waterfront project. The City will remediate the DeLaval Site and the PURA-

14 property, while the developer, Poughkeepsie Landing LLC, will remediate the third parcel which was once home to the City's wastewater treatment plant (WWTP). A site location map which identifies the approximate limits of the DeLaval site has been included as Figure 1, and Figure 2 illustrates the locations of the PURA-14 and former waste water treatment plant sites relative to the DeLaval Property.

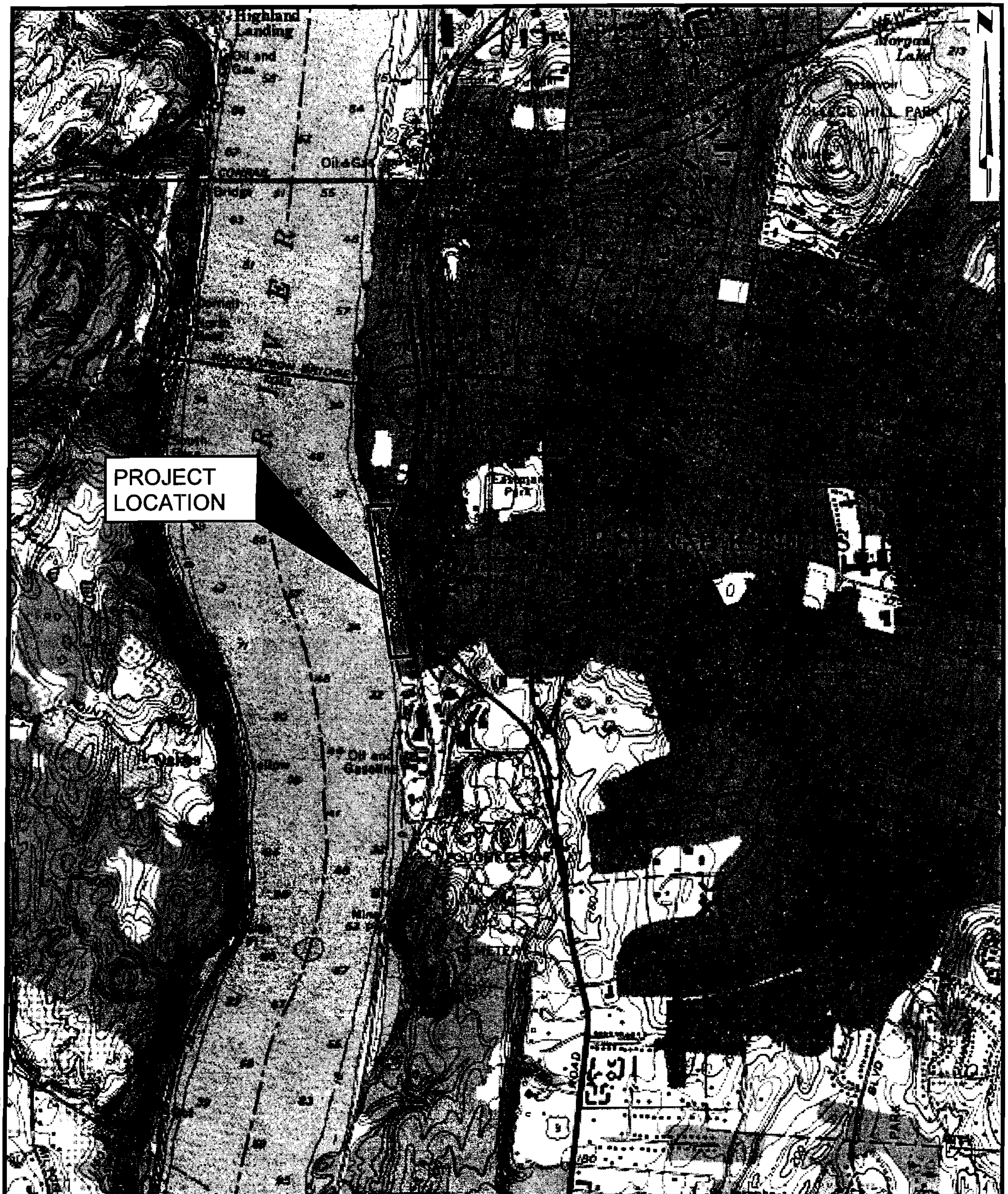
This Final Remedial Alternatives Report (RAR) was prepared to properly evaluate the means and methods of addressing the documented contamination associated with the DeLaval site and to ultimately identify the most effective and efficient means of addressing the documented environmental concerns. The Final RAR has been updated to reflect the data collected during the Supplemental Investigation performed following the initial submission of the RAR in July of 2004. The environmental concern associated with the PURA-14 property will be addressed at a later date.

Since the remediation of the DeLaval Property is to be funded in-part by the New York State Department of Environmental Conservation's (NYSDEC's) Environmental Restoration Program, this RAR has been prepared in accordance with Section 5.4 of the May 2002 Municipal Assistance Environmental Restoration Projects "Brownfields Program" Procedures Handbook, the Division of Environmental Remediation (DER) Draft DER-10 Technical Guidance for Site Investigation and Remediation (December 2002), and in general compliance with the July 2004 Municipal Assistance for environmental Restoration Projects Procedures Handbook.

The City has selected the DeLaval property as an integral part of the City's waterfront revitalization program. Nearly all of the planned public amenities associated with the project will be constructed on the DeLaval property. The City is currently planning to begin redevelopment of the property in 2005. However, this schedule is contingent upon NYSDEC approval of this RAR, and the agencies ability to issue a Record of Decision (ROD) for the site based on this RAR.

1.1 PURPOSE OF THE REPORT

As stated, the purpose of this Final RAR is to identify the remedial alternative, or alternatives, which will best address the site-specific environmental conditions associated with the DeLaval site. The



SOURCE: USGS QUADRANGLES – POUGHKEEPSIE, NEW YORK. (1957, PHOTOINSPECTED 1982).

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SCALE: 1"=2000'±

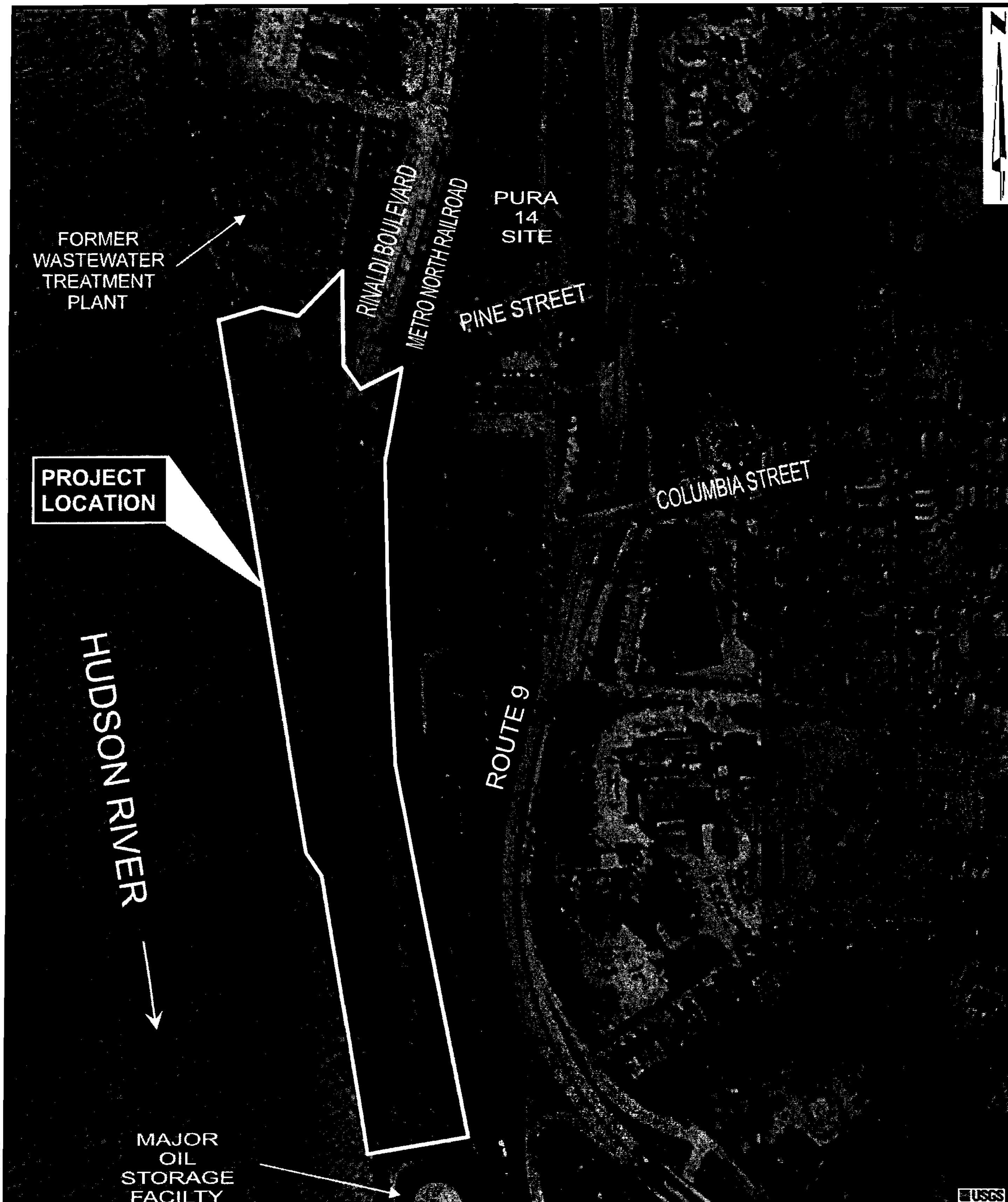
DATE: JANUARY 2005

FIGURE 1

SITE LOCATION MAP

DELAVAL PROPERTY
CITY OF POUGHKEEPSIE
COUNTY OF DUTCHESS, STATE OF NEW YORK

M:\11205\Rpt\RAR-Final\Figure 1 - Site Location.doc



SOURCE: MICROSOFT TERRASERVER-USGS AERIAL PHOTOGRAPH, POUGHKEEPSIE, NY. MARCH 27, 1995.

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FIGURE 2
1995 AERIAL PHOTOGRAPH
DELAVAL PROPERTY
CITY OF POUGHKEEPSIE
COUNTY OF DUTCHESS, STATE OF NEW YORK

SCALE: NONE | DATE: JANUARY 2005

M:\11205\Rpt\RAR-Final\Figure 2 - Aerial.doc evaluation of remedial alternatives for this site was conducted in keeping with the provisions of the previously cited guidance documents.

1.2 ORGANIZATION OF REPORT

The City of Poughkeepsie retained Clough, Harbour & Associates LLP (CHA) to prepare this RAR for the DeLaval property. The RAR is divided in to five major sections. Section 1 identifies the DeLaval project and describes the purpose and organization of the report. Section 2 provides a description of the site, the history of the site, the nature and extent of contamination on the site, and a brief description of the suspected fate and transport mechanisms of the identified contaminants at the site. This section also incorporates the results of the Supplemental Investigation completed in July and August of 2004. Section 3 of the report identifies the remedial action objectives for the project, discusses in general how each objective will be achieved, and briefly describes that rationale for each remedial alternative that will be discussed in the report. Section 4 provides a detailed analysis of each remedial alternative selected in Section 3. Each alternative has been assessed individually and compared to other alternatives based upon the following criteria:

1. Overall protection of human health and the environment
2. Compliance with Standards, Criteria, and Guidance (SCG)
3. Long-term effectiveness and permanence
4. Reduction in toxicity, mobility, and volume
5. Short-term effectiveness
6. Implementability
7. Cost
8. Community Acceptance

The community acceptance criterion will be evaluated by the NYSDEC after the public comment period is complete. More specifically, concerns of the community regarding the SI/RAR reports and the Proposed Remedial Action Plan (PRAP) will be evaluated. A responsiveness summary will be prepared that describes public comments received and the manner in which the NYSDEC will address the concerns raised. If the selected remedy differs significantly from the proposed remedy, notices to the public will be issued describing the differences and reasons for the changes.

Section 5 of the report identifies the remedial alternative that CHA recommends as the most appropriate for the site and the rationale behind the alternative selection. Other recommendations regarding the planned remediation and development of the DeLaval site are also presented in Section 5. Finally, a schedule for the remediation and redevelopment of the DeLaval site is presented in Section 6.

It is important to note that the success of this project is contingent upon the phasing of the remediation and development work. The schedule included in Section 6 provides a framework for the coordination effort, and while the specific dates or time frames may be shifted slightly due to administrative or construction delays, it is important that certain site remediation and development actions follow one another in rapid succession.

2.0 SITE DESCRIPTION & BACKGROUND INFORMATION

2.1 SITE DESCRIPTION

The DeLaval site consists of a single parcel located to the southwest of the intersection of Rinaldi Boulevard and Pine Street, and is approximately 13.2-acres in size. The site is identified as Tax Map Parcel (TMP) No. 31-6061-43-752749 by the City of Poughkeepsie and is currently vacant. The site is mainly unpaved and almost entirely covered by grass, scrub brush, small trees, and other vegetation. A degraded asphalt/gravel drive traverses the site from north to south, but the pathway transitions to a dirt path along the southern two-thirds of the parcel. The site is accessed through a gate at the north end of the property, located off the southwest corner of the intersection between Rinaldi Boulevard and Pine Street.

2.1.1 Neighboring Properties

The DeLaval property is bordered to the north by the former City of Poughkeepsie Sewage Treatment Plant. The treatment plant is higher in elevation and a stone retaining wall and wrought iron fence provide security along the north side of the Property. This site has been cleared and is being remediated/addressed by the developer under NYSDEC Brownfield Cleanup Program (BCP). In addition, previously existing site structures have been demolished.

The site is bordered to the east by a set of railroad tracks, used by Conrail Corporation, Metro North, and Amtrak. The tracks run in a north-south direction, parallel to the site and the Hudson River. The railroad tracks are also elevated above the site and a concrete retaining wall along the tracks limit access to the property from the east.

Several large above-ground petroleum storage tanks are located along the south side of the property, on a parcel that was allegedly owned and operated by Effron Oils as a major oil storage facility (MOSF). A chain link fence runs along the southern property line of the DeLaval property and separates access to and from the property used for petroleum storage. There are several small trees and brush along both sides of the fence line.

The site is bordered to the west by the Hudson River. A concrete bulkhead runs along the western property line, but is in a state of disrepair or is completely missing in several locations along the edge of the river.

2.1.2 Site Topography

According to the United States Geological Survey (USGS) Poughkeepsie, New York Quadrangle, the DeLaval site has an approximate elevation of four (4) feet above mean seal level (AMSL), sloping gently westward towards the Hudson River. Storm water runoff occurring on the Property generally drains westward towards the Hudson River, although there are scattered shallow depressions across the majority of the site where water collects after periods of precipitation.

2.1.3 Site Geology

In the *Phase I Environmental Site Assessment (ESA) Report for the Procida Waterfront Property*, dated December 28, 1999 and prepared by The Chazen Companies (TCC), they reported that according to the *Dutchess County, New York Soil Conservation Survey (SCS)*, the soils occurring on the DeLaval site consist of Udorthents. These soils are described as very deep, somewhat excessively drained to moderately well drained soils that have been altered by cutting and filling.

CHA's review of the *Surficial Geologic Map of New York, Lower-Hudson Sheet* (1989), indicated that the overburden on-site consists of recent alluvial deposits. These soils generally consist of oxidized, non-calcareous, fine sand to gravel and are often overlain by silt in larger valleys. These soils vary in thickness from one to ten meters and are subject to frequent flooding. However, the surficial soils encountered in the test pits excavated by TCC during their 2001 Phase II Subsurface Investigation supported the presumption that the site is generally underlain by fill. Construction debris including concrete, asphalt, bricks, metal piping, garbage, and debris were encountered in a majority of the test pits.

Similarly, CHA encountered fill materials during the 2004 supplemental investigation program. CHA noted that the fill contained silt, sands, cobbles, brick, concrete, scrap metal, metal lathe millings, glass, plastic, ceramic tile, wood, asphalt roofing material, slag, tires, etc. While the thickness of the fill materials varies across the site, the depth of fill reportedly ranges between two and fifteen feet below the ground surface (bgs).

According to the *Geologic Map of New York, Lower-Hudson Sheet* (1970), the bedrock beneath the site is mapped as the Trenton Group and Metamorphic equivalents. These rocks are described as the Taconic Melange, which is a chaotic mixture of Early Cambrian through Middle Ordovician pebble to block-size clasts in a pelitic matrix of Middle Ordovician (Barneveld) age. The borings and test pits installed as part of TCC's Phase II Subsurface Investigation were limited to a depth of seventeen feet below the ground surface. Bedrock was not encountered in the majority of the test pits or in any of the test borings. However, it should be noted that weathered shale was observed by TCC along the east side of the DeLaval site, just south of the Rinaldi Boulevard entrance to the site at depths ranging between 4.5 to 9.5 feet below the ground surface. During a supplemental investigation, CHA encountered bedrock at the south end of the DeLaval Property at depths ranging from the surface to fifteen feet below the ground surface, suggesting that there may be a bedrock ledge near the south end of the site.

2.1.4 Site Hydrogeology

TCC reported that groundwater movement is often related to topography, lithology, elevation of the recharge and discharge areas, and man-made influences. Referenced groundwater elevations were determined for the site by measuring the elevation of the top of casing for each monitoring well relative to mean sea level, measuring the depth to water in the monitoring wells from the referenced top of casing elevation, and computing the elevation of groundwater at the time of the measurement.

TCC also reported that the average static depth to groundwater at the DeLaval property ranged from five (5) to seven (7) feet bgs; however, TCC indicated that groundwater elevations fluctuations at the site are likely a function of tidal changes associated with the Hudson River. TCC noted that a realistic evaluation of groundwater flow and movement was not performed as part of their Phase II investigation due to the extreme variations in water levels observed over short periods of time. The fluctuations in the water levels were, however, directly correlated to changes in the river elevation (tidally influenced). TCC stated additional long-term water level assessment would be required to evaluate net flow conditions beneath the site and to understand the tidal influence between the Hudson River and the groundwater beneath the site.

During a supplemental investigation, CHA observed a number of concrete barriers or walls running parallel to the Hudson River near the down-gradient side of areas of concern (AOCs) AOC-2/AOC-3. The condition of these barriers varies, but recent well gauging events at the site indicated that the barriers are not significantly impeding groundwater flow towards the Hudson River.

2.2 SITE HISTORY

The site history for the DeLaval property was summarized from the *Phase I Environmental Site Assessment for the Procida Waterfront Property*, prepared by TCC and dated December 28, 1999. TCC's research of the DeLaval property development revealed that two dwellings, a tannery, a carpenter shop, and two coal sheds were located on the DeLaval site as early as 1887. A 1945 Sanborn Fire Insurance Map revealed that a rubber manufacturing plant owned by the DeLaval Separator Company was present on the site. The DeLaval Separator Company also manufactured cream separators, milk machines, centrifuges to separate milk and oil, and other stainless steel farming equipment.

TCC's review of the available Sanborn maps for the DeLaval property indicated that sometime between 1922 and 1945, the Spoor Lasher Company, a supplier of construction materials (concrete, stone, asphalt), occupied a storehouse on the property. A 1952 Sanborn map indicated that two underground fuel oil storage tanks were located midway down the main plant building along the east side of the structure. While a 1962 aerial photograph of the site indicated that a large rectangular, one-story building occupied majority of the parcel, a 1967 aerial photograph revealed that the DeLaval site was vacant and largely unvegetated. Some vegetation was visible on the site by the 1980 aerial photograph. According to the title search performed by TCC at the Dutchess County Real Property Tax Office, the City of Poughkeepsie purchased the DeLaval property from the DeLaval Separator Company in 1968.

The 1990 Sanborn map and 1995 aerial photograph indicate that the site has remained vacant since the City obtained ownership of the site. A copy of the 1995 aerial photograph has been included as Figure 2. Based upon the documents reviewed, it appears that there has been no development or significant activity on the DeLaval property since at least 1967.

2.3 PREVIOUS REPORTS & INVESTIGATIONS

The investigation of the DeLaval site began with TCC preparing a *Phase I Environmental Site Assessment Report for the Procida Waterfront Property*, dated December 28, 1999. In addition to the DeLaval site, the Phase I report also incorporated three other parcels, including the Sewage Treatment Plant (STP) parcel north of the DeLaval site and the two parcels associated with the Pura-14 area located northeast of the DeLaval Site. The Phase I report identified a number of potential environmental concerns associated with the DeLaval property, including the following:

- A 1952 Sanborn Fire Insurance map of the DeLaval property showed that two underground fuel oil storage tanks were located midway down the former main plant building on the site, along the east side of the structure.
- Ten test borings installed on the DeLaval site in 1968 by Empire Soils Investigation, Inc. revealed that the site is covered with six to twenty feet of fill material. However, the soil and groundwater quality in the vicinity of the fill areas was unknown.
- Minor convenience dumping was observed at various locations on the property during TCC's site inspection. An area of construction debris and two rusted 55-gallon drums was observed near the southern border of the DeLaval site. TCC suspected that the construction debris was a remnant of a former small building located at the south end of the site, but the contents of the drums were not determined.
- The presence (or former presence) of petroleum and chemical storage tanks was identified on the STP property, adjacent to the north side of the DeLaval property. In addition, five spill reports were reported for the treatment plant facility.

Based upon the recognized environmental conditions (RECs) identified in the Phase I, the City of Poughkeepsie retained TCC to characterize the soil and groundwater quality beneath the DeLaval site to define the potential environmental liability associated with the property. In May of 2001, TCC submitted a *Phase II Subsurface Investigation Report of the DeLaval Property* to the City that identified four areas with potential environmental issues, based upon their subsurface investigation.

The four areas TCC identified with potential environmental issues are defined in Section 2.4 of this report.

After reviewing the Phase I and II reports prepared by TCC, CHA developed a work plan for preparing a RAR in August 2003. The purpose of the work plan was to formalize the measures which were to be taken to complete an evaluation of potential remedial alternatives for addressing the environmental conditions associated with the site. As this project is funded in part by the NYSDEC Environmental Restoration Projects (Brownfields) Program, the work plan was developed in accordance with Section 5.1 of the May 2002 Municipal Assistance Environmental Restoration Projects "Brownfields Program" Procedures Handbook and NYSDEC's Draft DER-10 Technical Guidance for Site Investigation and Remediation (December 2002). CHA submitted a revised work plan to the NYSDEC in December of 2003 to address the comments provided in the NYSDEC's letter addressed to CHA, dated November 21, 2003.

The July 2004 RAR for the DeLaval property was based on data derived from Phase I and II environmental assessments of the property completed by TCC. However, the Final RAR incorporates TCC's data as well as the results presented in CHA's *Supplemental Investigation Summary Report,* dated January 2005.

While the NYSDEC had reviewed the Phase I and II reports for the site and initially agreed that the data and conclusions presented in the TCC reports adequately characterized the site for the purposes of the preparation of initial RAR, during the course of preparing the initial RAR a series of data gaps were identified, and CHA identified the need for additional investigation in order to accomplish the following objectives:

1. Evaluation of the surface soil quality to determine the need for the installation of soil cover over non-paved surfaces on the redeveloped site to eliminate the potential for exposure to contaminants in the surface soils.
2. Determination of current groundwater quality beneath the site.
3. Delineate the extent of impacted soils in the vicinity of the four on-site AOCs.
4. Determination of the vertical extent of the waste in AOC-1.

5. Determine if methane gas is being generated in AOC-1 as a result of the degradation of the putrescible wastes in this area.

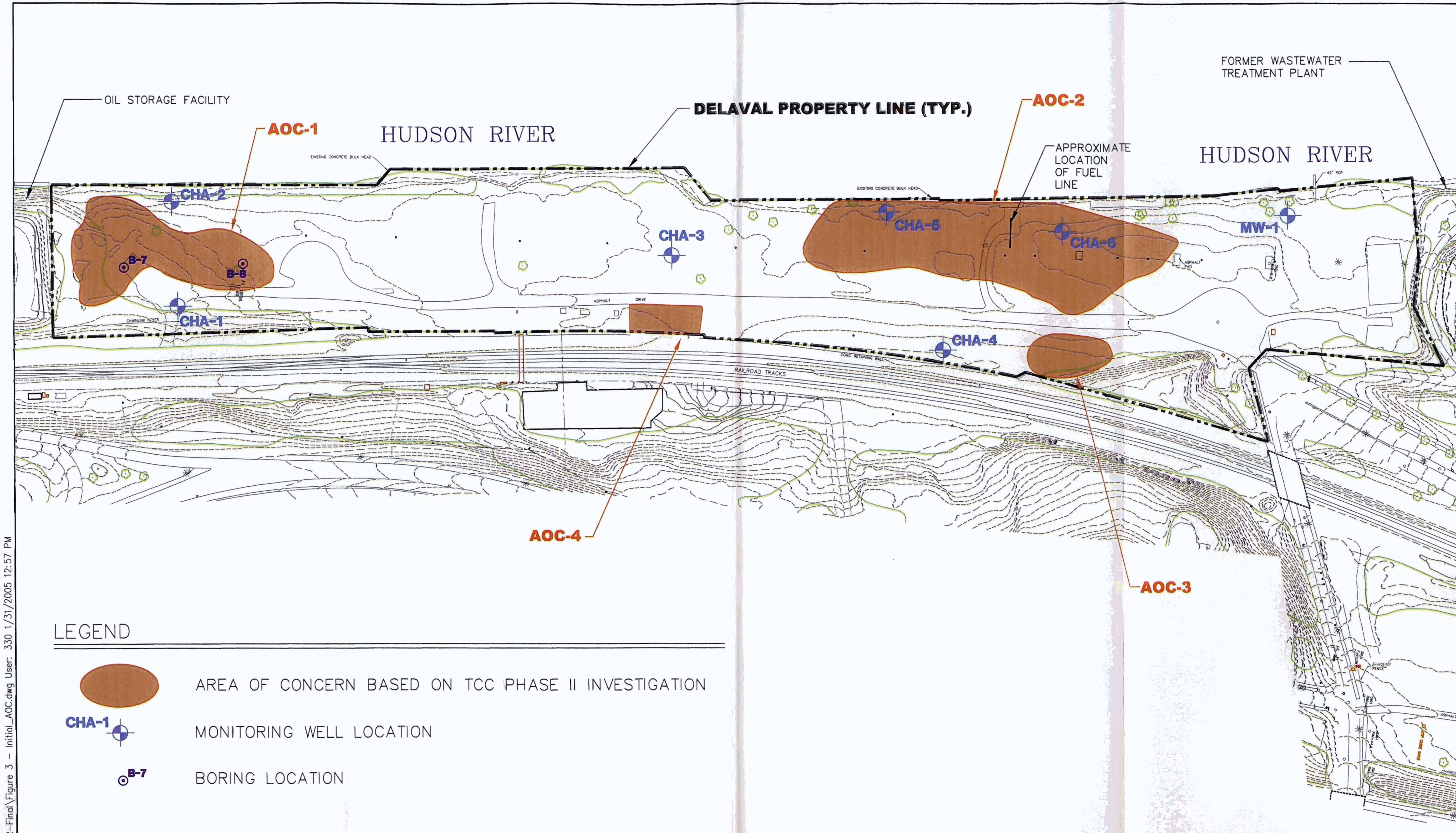
After completing the initial RAR, CHA met with the NYSDEC to discuss the remedial alternatives and discuss the scope of a supplemental investigation that would provide the additional data necessary for the State to prepare a Proposed Remedial Action Plan (PRAP). CHA submitted a *Draft Supplemental Remedial Investigation Work Plan* on May 2, 2004 to the NYSDEC for their review. After incorporating their comments into the draft work plan, CHA issued a revised *Supplemental/Pre-Design Remedial Investigation Work Plan* on July 13, 2004, which was verbally approved by the NYSDEC on July 20, 2004.

The supplemental investigation was to include a test pit program, Geoprobe® boring program, ground water monitoring program, and methane gas survey. CHA's *Supplemental Investigation Summary Report*, dated January 2005, and provides a detailed discussion of the supplemental investigation. It should be noted, however, that based upon the debris encountered during the test pit program, the Geoprobe® investigation was not performed. Instead, additional test pits were installed at the DeLaval property to refine the limits of the subsurface contamination.

2.4 AREAS OF CONCERN

Based upon the results of TCC's Phase II investigation, the following four areas of environmental concern (AOCs) associated with the DeLaval property were identified by TCC. The location and limits of the AOC, identified by TCC are identified in Figure 3:

- **AOC-1:** An industrial landfill/construction & demolition debris disposal area located along the southern end of the property.
- **AOC-2:** An area of petroleum-impacted soil and groundwater in the central portion of the site that parallels the Hudson River.
- **AOC-3:** An area of petroleum-impacted soil located in the northeastern portion of the site, due east of AOC-2. TCC indicated that this AOC may be an extension of the petroleum-impacted soil and groundwater which parallels the Hudson River (AOC-2).



NOTE:

BASEMAP PROVIDED FROM THE CHAZEN COMPANIES (TCC) PHASE SUBSURFACE INVESTIGATION REPORT, DATED MAY 2001.

0 150 300
Scale in feet

CHA
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11205.1011.1102

DATE: JANUARY 2005

FIGURE 3

EXISTING CONDITIONS & INITIAL AOCs

DELAVAL PROPERTY
CITY OF POUGHKEEPSIE
DUTCHESS COUNTY, STATE OF NEW YORK

File: M:\11205\Rpt\RAR-Final\Figure 3 - Initial_AOC.dwg User: 330 1/31/2005 12:57 PM

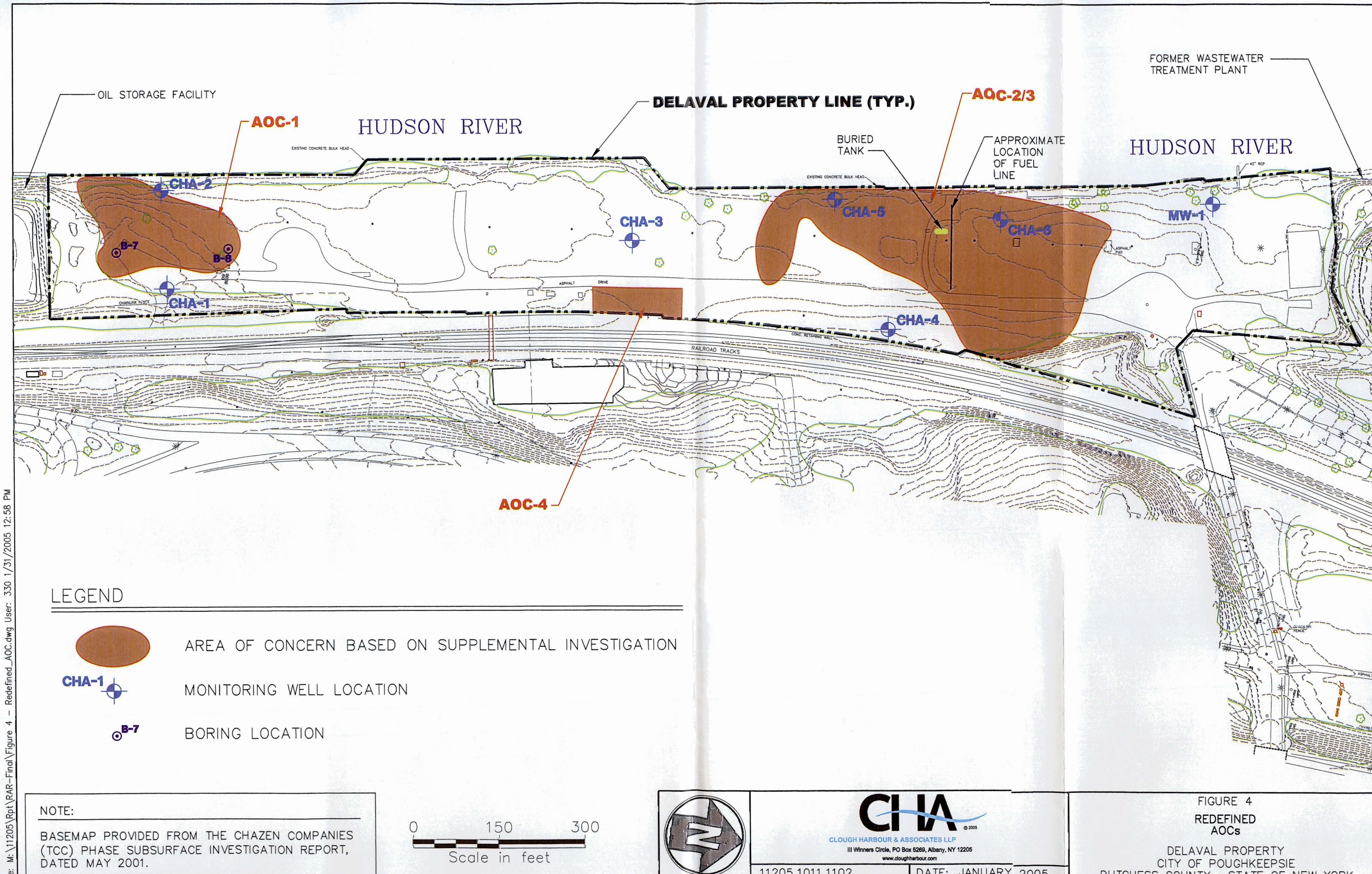
- **AOC-4:** An area adjacent to a former Paint Shop along the eastern border of the site.

Based upon the additional test pits excavated on the DeLaval property during the supplemental investigation, CHA was able to refine the limits of the AOCs, as shown on Figure 4. One significant change to the AOCs is that CHA believes that there is sufficient information to indicate that AOC-2 and AOC-3 are part of one larger impacted area as opposed to separate AOCs. The following subsections provide a physical description of each AOC, while Section 2.5 provides a summary of the analytical results.

2.4.1 AOC-1: Construction & Demolition Debris Disposal Area

AOC-1 is an area that is suspected of being used as an industrial landfill for the disposal of construction and demolition debris. This area is located near the south end of the DeLaval property and is estimated to be approximately 0.8-acres (35,000 square feet) in area. The depth to the contamination in this area typically ranged from five to fifteen feet below the ground surface, although waste materials were encountered as shallow as 0.7-feet below the ground surface along the west side of AOC-1. As indicated in TCC's report, the south end of the site was likely a depression or low-lying area on the parcel that was filled in over time.

A variety of materials were encountered in the TCC test pits excavated along the southern portion of the property, including concrete, bricks, glass, clay pipe, wooden railroad ties, flawed machinery and car parts, scrap tires, municipal solid waste (MSW)/household trash, boulders, an empty rusted-out drum, an unidentified slag-like material with a slight sulfur odor and other construction debris. CHA encountered a variety of fill and waste materials in most of AOC-1, including silt, sands, cobbles, metal lathe millings, brick, fire brick, concrete, scrap metal, glass, ceramic tile, wood, asphalt roofing material, slag, and tires. However, in areas along the western side and near the center of AOC-1, CHA also encountered concrete, tires, steel tire rims, plastic, glass, scrap metal, a rusted and crushed drum, a plastic pool liner, wood, and metal shavings covered with a white grease-like lubricant, which would be considered more typical of MSW.



File: M:\11205\Rpt\RAR-Final\Figure 4 - Redefined_AOC.dwg User: 330 1/31/2005 12:58 PM

The most significant evidence of petroleum contamination was encountered along the western edge of AOC-1. CHA noted strong petroleum odors, heavy black staining of the soils, and photoionization detector (PID) readings ranging up to 58 parts per million (PPM) in several of the test pits excavated in along the west side. In addition, CHA noted a petroleum odor and sheen on the groundwater observed in some of the test pits excavated along the west side of AOC-1.

2.4.2 AOC-2/AOC-3: Northwest Petroleum-Impacted Area

AOC-2 and AOC-3 were previously considered to separate petroleum impacted areas located near the center of the DeLaval property. However, as previously indicated, AOC-2 and AOC-3 are actually considered to be one large area of impacted based upon the results of the supplemental investigation. As shown of Figure 3, AOC-2/AOC-3 has an approximate area of 2.4-acres (105,000 square feet). The petroleum impacted soils were typically encountered at a depth between two to five feet below the ground surface. The vertical extent of the contamination was not verified in several of the test pits due to the presence of concrete or brick structures encountered and the instability of the trench below the water table, especially where coarse slag material or cobbles were encountered. While the test pits were typically not excavated deep enough to determine the vertical extent or bottom depth of the impacted soils, petroleum odors were noted as deep as fourteen feet below the ground surface.

During the excavation of the test pits in AOC-2, TCC observed grossly contaminated soils and noted that the soils had a petroleum odor. Grossly contaminated soils, referred to throughout the RAR, are defined as soils containing free product or residual contamination which is identifiable, through the perception of odor or elevated contaminant vapor levels as indicated by field instrumentation, or otherwise readily detectable.

The water table was typically encountered at a depth of four to eight feet below the ground surface depending upon the ground surface elevation and the tide in the Hudson River at the time that the test pits were installed. In several of the test pits excavated in AOC-2/AOC-3, the groundwater was black in color with a moderate to strong petroleum odor. Sheen was also observed on the water table surface in several of the test pits. The sheen ranged from free product and discoloration on the groundwater surface to the formation of small oil droplets on the water surface. The term "free product" in this report is intended to refer to the presence of a less-dense than water, non-aqueous phase liquid (LNAPL) floating on the surface of the water. It is unclear whether the black color observed in association with the groundwater was attributable to the petroleum contamination, the presence of slag and other fill materials in the subsurface or septic conditions associated with potential anaerobic breakdown of the contaminants. However, a petroleum odor did typically coincided with the presence of the sheen.

TCC also observed grossly-contaminated soils and free product adjacent to a six-inch diameter steel pipe discovered near the center of AOC-2/AOC-3. TCC believed the pipe contained weathered No. 4 or No.6 fuel oil. This finding is consistent with the observations made by CHA during the supplemental investigation. Given the uncertainty with respect to the condition of the six-inch diameter steel pipe observed by TCC during their Phase II investigation, CHA directed our excavation subcontractor to excavate a trench along the pipeline. A test pit (No. TP-19) was excavated along the south side of the six-inch steel pipe in AOC-2 on August 4, 2004. As suspected, based upon review of TCC's report, the pipe was in relatively poor condition and the soils surrounding the pipe appeared saturated with fuel oil (reportedly No. 6 fuel oil). In addition to elevated readings measured with a PID instrument, CHA noted that the soils were stained black and exhibited a relatively strong petroleum odor.

The fuel oil pipeline was located approximately four feet below grade and was apparently installed over a concrete slab. While the slab is believed to have reduced the vertical migration of the petroleum contamination, the pad was noted to be in poor condition or absent in some locations. During the test pit program, CHA determined that the top two feet of fill material was relatively free of petroleum contamination, while approximately two feet of contaminated soil located immediately above the pipe were stained and had a strong petroleum odor. In locations where the concrete slab was broken up or missing, the petroleum contamination was identified to extend deeper than four feet.

The horizontal extent of contamination is estimated to be between fifteen to twenty-five feet north and south of the pipe line. It is suspected that this petroleum area was spread along the waterfront due to the tidal influence and rapidly changing groundwater elevations along the western edge of the property. The contamination is present along the majority of the length of the pipeline, which extends from the bulkhead along the Hudson River eastward to a point approximately twenty feet east of the gravel access road that traverses the property from north to south.

While excavating along the pipe line, an approximately 4,000-gallon underground storage tank (UST) containing fuel oil, sludge, and/or groundwater was encountered along the south side of the pipeline. A majority of the tank was not unearthed at the time of the investigation, and therefore, the overall condition of the tank is unknown. Since the overall condition of the tank is unknown, the tank will not be unearthed until after all contents of the tank have been removed. CHA also encountered a number of brick-lined walls just north of the tank. While the purpose of these walls was not clear, CHA suspects that they may have been associated with a former furnace in a boiler room that was fueled from oil stored in the underground tank. The walls encountered are within the footprint of the former large on-site building.

A representative of the NYSDEC was on-site during the excavation along part of the pipeline, subsequent to the discovery of the UST. Given the presence of grossly-contaminated/oil-saturated soils, apparent free product on the surface of the water table, and the presence of the UST, the NYSDEC directed CHA to prepare an Interim Remedial Measures (IRMs) work plan to remove the pipeline, the UST, and any grossly-contaminated soils. While the removal of the pipeline and grossly-contaminated soils was incorporated into Alternative 3 in the RAR, the NYSDEC was interested in expediting the removal activities given the proximity of the contamination to the Hudson River and the periodic sheen which was noted on the surface of the Hudson River adjacent to the west side of the bulkhead during the excavation activities.

At the NYSDEC's direction, on behalf of the City of Poughkeepsie, CHA reported the observed conditions to the State Spills Hotline on August 5, 2004, and Spill Number 0404948, was assigned to the site.

On August 25, 2004, CHA submitted an IRM plan to the NYSDEC for their review and approval. However, after reviewing the IRM and realizing the complexity of the IRM, the NYSDEC decided that the IRM would be completed under the overall remedial design and construction program for the DeLaval site which will be initiated following the issuance of a ROD by NYSDEC.

2.4.3 AOC-4: Former Paint Shop Area

AOC-4 is located adjacent to the location of a former paint shop on the DeLaval property. The impacted area delineated by TCC was estimated to be approximately 0.14-acres (6,000 square feet) in size; however, based upon the presence of contaminants in the sample collected from test pit TP-101, CHA has presumed that impacted area extends northward, encompassing an area approximately 0.45-acres (20,000 square feet) in size. The impacted soils were typically encountered at an interval of two to eight feet below the ground surface.

Although TCC noted a strong solvent-like odor while excavating the test pits in AOC-4, the analytical results for the soil samples collected in this area did not indicate the presence of any VOCs or chlorinated-VOCs (CVOCs). However, several SVOCs were detected in the soil samples collected from AOC-4 at concentrations above NYSDEC Soil Cleanup Objectives.

2.5 NATURE & EXTENT OF CONTAMINATION

As previously discussed, TCC completed a Phase II subsurface investigation of the DeLaval property in May 2001 with the intent of defining the nature and extent of the contamination on the site. The field work associated with this investigation was completed during the month of December 2000. The following paragraphs and sections are intended to provide a brief summary of the results provided in TCC's Phase II report. The Phase II investigation included a magnetometry survey, a test pit pogrom, a soil boring program, and a groundwater monitoring program; however, the details of the investigation methodology were provided in TCC's Phase II report and CHA's RAR Work Plan, and therefore, are not repeated in this report.

To supplement the data collected in TCC's Phase II report and resolve some of the previously identified data gaps, CHA conducted a supplemental investigation during July and August of 2004. This investigation consisted of evaluating the surface soil quality on the property, installing additional test pits and borings to refine the AOCs previously identified by TCC, the collection of groundwater samples to reevaluate the groundwater quality beneath the property, and completing a soil gas survey across the southern end of the property to determine if methane gas was actively being generated in that portion of the site. Descriptions of the methodology associated with each activity completed during this additional investigation are summarized in CHA's *Supplemental Investigation Summary Report*, dated January 2005, and have not been repeated in this report. However, the results of this investigation are summarized in the following sections. A more detailed discussion of the results is provided in the referenced summary report.

2.5.1 Surface Soils

TCC did not investigate surface soil quality as part of their December 2000 Phase II investigation. However, on July 22, 2004, CHA collected a total of thirty discrete surface soil samples from across the DeLaval Property as part of the supplemental investigation to evaluate the surface soil quality at the site. Each of the surface soil samples was analyzed for the base/neutral fraction of semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), and the eight toxicity characteristic metals identified by the Resource Conservation and Recovery Act (RCRA) as characteristic hazardous waste constituents. These eight metals are commonly referred to as RCRA-8 metals, and include arsenic, barium, cadmium, chromium, lead, mercury, silver, and selenium. VOC analysis was omitted from the surface soil samples as these compounds readily volatilize into the atmosphere and would unlikely be present in surface soils, given that the site had been vacant for several years.

The analytical results for the surface soil samples were compared to the NYSDEC's Recommended Soil Cleanup Objective concentrations listed in Technical and Guidance Memorandum (TAGM) No. 4046, which the NYSDEC has established as the surface soil SCG values for surface soils at the DeLaval property. Refer to Section 3.2.3 of this RAR for a discussion of the SCGs established for the DeLaval property. Using the analytical results and the SCGs, CHA prepared the following table to summarize the contaminants of concern, the range in concentrations of contaminants detected in the surface soil samples, and the total number of samples exceeding the SCGs out of the total number of samples collected.

Table 1. Summary of Analytical Results for Surface Soils

Contaminant of Concern	Standard, Criteria and Guidance Value	Concentration Range Detected	Frequency of Samples Exceeding SCGs
SVOCs (units in micrograms per kilogram (µg/kg))			
Acenaphthylene	41,000	140-8,000	0 of 30
Acenaphthene	50,000	120-430	0 of 30
Anthracene	50,000	74-18,000	0 of 30
Benzo(a)anthracene	224	85-150,000	23 of 30
Benzo(a)pyrene	61	160-100,000	24 of 30
Benzo(b)fluoranthene	1,100	85-180,000	18 of 30
Benzo(g,h,i)perylene	50,000	110-25,000	0 of 30
Benzo(k)fluoranthene	1,100	150-64,000	10 of 30
Bis(2-Ethylhexyl)phthalate	50,000	220-6,100	0 of 30
Carbazole		79-490	Detected in 7 of 30
Chrysene	400	81-130,000	21 of 30
Dibenz(a,h)anthracene	14	100-120	2 of 30
Dibenzofuran	6,200	110-230	0 of 30
Fluoranthene	50,000	140-320,000	2 of 30
Fluorene	50,000	80-280	0 of 30
Indeno(1,2,3-cd)pyrene	3,200	88-16,000	2 of 30
2-Methylnapthalene	36,400	160-310	0 of 30
Naphthalene	13,000	250-420	0 of 30
Phenanthrene	50,000	130-92,000	1 of 30
Pyrene	50,000	130-260,000	2 of 30
PCBs (units in micrograms per kilogram (µg/kg))			
Aroclor-1260	1,000	50-3600	3 of 30
METALS (units in milligrams per liter (mg/L))			
Arsenic	7.5	4.89-24.8	20 of 30
Barium	300	15.1-374	2 of 30
Cadmium	1 or SB (1.93)	0.973-8.7	25 of 30
Chromium	10 or SB (15.8)	5.94-627	17 of 30
Lead	500	22.8-908	22 of 30
Selenium	2	0.602-3.20	6 of 30
Silver	SB (0.117)	0.149-240	12 of 30
Mercury	0.1	0.02-1.30	21 of 30

A number of SVOCs, namely polycyclic aromatic hydrocarbons (PAHs), were detected in the surface soil samples collected across the DeLaval property. With the exception of the soil samples collected from a location down-gradient of AOC-4, locations along the east side of AOC-3, and the northeast corner of the Property, at least one SVOC was detected in excess of the cleanup objective concentration in all samples collected across the site. It appears that the contamination is fairly widespread across much of the DeLaval property, rather than being limited to a few isolated areas. CHA suspects that the SVOC contamination in the surface soil samples is attributable to the historical use of the property and site grading operations rather than individual spill events.

Aroclor-1260 was the only PCB congener detected in the surface soils on the DeLaval property. It was detected in eleven of the thirty surface soil samples collected from the DeLaval property, mainly along north and west sides of AOC-1 and the northern one-third of the property. However, Aroclor-1260 was only detected at concentrations in excess of NYSDEC recommended soil cleanup objectives in three samples collected along the north end of AOC-1. Given that site is currently vacant and there are no current sources of PCBs on the ground surface, the origin of the PCB contamination in the surface soils is not clear.

A number of heavy metal contaminants were also identified in a majority of the surface soils collected from the DeLaval property. Of the eight RCRA metals, arsenic, barium, and cadmium were the three metals that were most often detected in the surface soil samples at concentrations in excess of the background concentrations. With the exception of the background sample and a sample collected approximately three-hundred feet south of the background sample, there were at least three metals in excess of the background concentrations in all of the surface soil samples on the DeLaval property. While the degree of heavy metal impact varies across the DeLaval site, the data indicates that heavy metal contamination in the surface soils is widespread across the property, as was the case with the detected semi-volatile organic contaminants.

It appears that impacted surficial soils, with both organic and inorganic contaminants, are widespread across much of the DeLaval property, possibly due to past site grading operations and the historic industrial use of the property.

2.5.2 Subsurface Soils

The subsurface soils beneath the DeLaval property were investigated in both TCC's Phase II investigation and CHA's supplemental investigation. To supplement the subsurface data provided by TCC, CHA collected an additional twenty-two subsurface soil samples for analysis during the supplemental investigation. Based upon the analytical results from both investigations, the following table was developed to summarize the contaminants of concern, the range in concentration of the detected contaminants, and the number of samples that exceeded the SCG values established by the NYSDEC. Table 2 provides this summary for each investigation, while the final two columns represent the cumulative results of both investigations.

Table 2. Summary of Analytical Results for Subsurface Soils

Contaminant of Concern	Standard, Criteria and Guidance Value	TCC Data		CHA Data		Cumulative Results	
		Conc. Range Detected[1]	Frequency of Samples Exceeding SCGs	Conc. Range Detected[1]	Frequency of Samples Exceeding SCGs	Conc. Range Detected[1]	Frequency of Samples Exceeding SCGs
VOCs (units in micrograms per kilogram (µg/kg))							
Acetone	200	NA	NA	34-3,500	4 of 22	34-3,500	4 of 22
Benzene	60	160	1 of 9	43-2,300	2 of 22	43-2,300	3 of 31
n-Butylbenzene	10,000	20-34	0 of 9	NA	NA	20-34	0 of 9
sec-Butylbenzene	10,000	9-18	0 of 9	NA	NA	9-18	0 of 9
tert-Butylbenzene	1,300	5-9	0 of 9	NA	NA	5-9	0 of 9
Carbon Disulfide	2,700	ND	0 of 3	1.6-56	0 of 22	1.6-56	0 of 25
Chlorobenzene	1,700	490	0 of 7	13,000	1 of 22	490-13,000	1 of 29
Ethylbenzene	5,500	18	0 of 9	3.5-530	0 of 22	3.5-530	0 of 31
p-Isopropylbenzene	10,000	9	0 of 9	NA	NA	9	0 of 9
Methylene Chloride	100	32	0 of 5	2.6-67	0 of 22	2.6-67	0 of 27
Naphthalene	13,000	6-170	0 of 9	91-490	0 of 22	6-490	0 of 31
n-Propylbenzene	3,700	5-14	0 of 9	NA	NA	5-14	0 of 9
Tetrachloroethene	1,400	NA	NA	4.1-110	0 of 22	4.1-110	0 of 22
Toluene	1,500	10	0 of 12	2.8-320	0 of 22	2.8-320	0 of 34
Trichloroethylene	700	10	0 of 5	ND	0 of 22	10	0 of 27
1,2,4-Trimethylbenzene	3,300	5-51	0 of 9	NA	NA	5-51	0 of 9
1,3,5-Trimethylbenzene	200	13	0 of 9	NA	NA	13	0 of 9
Xylene (Total)	1,200	20-490	0 of 12	1.6-6,200	3 of 22	1.6-6,200	3 of 34
SVOCs (units in micrograms per kilogram (µg/kg))							
Acenaphthylene	41,000	ND	0 of 9	210-850	0 of 21	210-850	0 of 30
Acenaphthene	50,000	704	0 of 12	140-1,500	0 of 21	140-,1500	0 of 33
Anthracene	50,000	400	0 of 11	62-3,300	0 of 21	62-3,300	0 of 32
Benzo(a)anthracene	224	430-2,400	5 of 12	130-11,000	13 of 21	130-11,000	18 of 33
Benzo(a)pyrene	61	630-7,100	6 of 12	96-14,000	11 of 21	96-14,000	17 of 33
Benzo(b)fluoranthene	1,100	500-2,900	3 of 12	77-19,000	5 of 21	77-19,000	8 of 33
Benzo(g,h,i)perylene	50,000	430-1,900	0 of 12	48-3,200	0 of 21	48-3,200	0 of 33
Benzo(k)fluoranthene	1,100	550-3,200	4 of 12	65-7,100	4 of 21	65-7,100	8 of 33
Bis(2-Ethylhexyl)phthalate	50,000	ND	0 of 10	44-280	0 of 21	44-280	0 of 31
Carbazole	--	NA	NA	100-550	Detected in 4 of 21	100-550	Detected in 4 of 21
Chrysene	400	450-2,800	5 of 12	120-13,000	10 of 21	120-13,000	15 of 33
Dibenz(a,h)anthracene	14	ND	0 of 10	95-420	3 of 21	95-420	0 of 31
Dibenzofuran	6,200	ND	0 of 10	59-160	0of 21	59-160	0 of 31

Contaminant of Concern	Standard, Criteria and Guidance Value	TCC Data		CHA Data		Cumulative Results	
		Conc. Range Detected[1]	Frequency of Samples Exceeding SCGs	Conc. Range Detected[1]	Frequency of Samples Exceeding SCGs	Conc. Range Detected[1]	Frequency of Samples Exceeding SCGs
Fluoranthene	50,000	620-3,000	0 of 12	250-18,000	0of 21	250-18,000	0 of 32
Fluorene	50,000	3,500	0 of 11	49-1,800	0of 21	49-3,500	0 of 32
Ideno(1,2,3-cd)pyrene	3,200	1,700	0 of 11	56-2,200	0 of 21	56-2,200	0 of 32
2-Methylnapthalene	36,400	7,900	0 of 11	54-7,500	0of 21	54-7,900	0 of 32
Naphthalene	13,000	3,300	0 of 11	91-490	0 of 21	91-3,300	0 of 32
Phenanthrene	50,000	590-3,900	0 of 12	180-10,000	0 of 21	180-10,000	0 of 33
Pyrene	50,000	540-2,700	0 of 12	61-18,000	0 of 21	61-18,000	0 of 33
PCBs (units in micrograms per kilogram (µg/kg))							
Aroclor-1254	10,000	NA	NA	97-11,000	1 of 21	97-11,000	1 of 21
Aroclor-1260	10,000	NA	NA	60-340	0 of 21	60-340	0 of 21
Inorganics (units in milligrams per liter (mg/kg), TCLP metal units (mg/L))							
Arsenic	7.5	NA	NA	0.306-35.5	12 of 21	0.306-35.5	12 of 21
Barium	300	NA	NA	10.1-1,900	4 of 21	10.1-1,900	4 of 21
Cadmium	1 or SB (1.93)	NA	NA	0.307-21.7	11 of 21	0.307-21.7	11 of 21
Chromium	10 or SB (15.8)	NA	NA	4.17-1,730	13 of 21	4.17-1,730	13 of 21
Lead	500	NA	NA	16.4-17,200	12 of 21	16.4-17,200	12 of 21
Selenium	2	NA	NA	0.564-9.18	7 of 21	0.564-9.18	7 of 21
Silver	SB (0.11)	NA	NA	0.206-1.13	7 of 21	0.206-1.13	7 of 21
Mercury	0.1	NA	NA	0.01-1.4	7 of 21	0.01-1.4	7 of 21
TCLP Barium	100	0.755-1.45	0 of 5	NA	NA	0.755-1.45	0 of 5
TCLP Cadmium	1	0.006-0.012	0 of 5	NA	NA	0.006-0.012	0 of 5
TCLP Chromium	5	0.010	0 of 5	NA	NA	0.010	0 of 5
TCLP Lead	5	0.149-0.526	0 of 5	NA	NA	0.149-0.526	0 of 5
TCLP Mercury	0.2	0.0012-0.0053	0 of 5	NA	NA	0.0012-0.0053	0 of 5
Cyanide (Total)	0.1	0.0053-0.0064	0 of 3	NA	NA	0.0053-0.0064	0 of 3

Note: 1. If a single value is noted, the referenced parameter was detected either only one time, or multiple times at the same concentration.
NA = Parameter not analyzed for.
ND = Parameter not detected.

As indicated in Table 2, a number of VOCs were detected in the subsurface samples collected at the DeLaval Property, but only four VOCs were detected at concentrations in excess of the SCGs and only in a limited number of samples. A number of SVOCs, namely PAHs, were detected at concentrations in excess of the SCGs in both TCC's and CHA's investigations, including benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, carbazole, and chrysene. The most significant SVOC contamination was limited to three primary areas of concern, which were previously identified in Section 2.4. PCBs were absent from the subsurface soils except for in AOC-1 along the southern end of the DeLaval property and one location along the western side (AOC-2) of the Property. While PCBs were almost always detected at concentrations below the SCGs, one subsurface soil sample collected from AOC-1 had an Aroclor-1254 concentration in excess of the SCG.

While no significant heavy metal contamination was identified in TCC's investigation, CHA found that all of the RCRA-8 metals were present in the subsurface soils at concentrations in excess of the SCGs. However, although the metal contamination is fairly widespread across all of the AOCs, the most significant contamination was identified in AOC-1 and AOC-2. Arsenic, cadmium, chromium and lead were the heavy metals most often detected at concentrations in excess of the SCGs.

2.5.3 Groundwater

TCC collected a total of sixteen (16) groundwater samples to investigate the groundwater quality beneath the DeLaval property during the Phase II investigation. To confirm the results of TCC investigation and reassess the current groundwater quality beneath the property, CHA collected groundwater samples from one existing on-site monitoring well and six newly installed monitoring wells during the supplemental investigation. Table 3 provides a summary of the analytical results for the groundwater samples collected from both TCC's and CHA's investigations.

The groundwater results have been evaluated by comparing the data to the NYSDEC's *Technical and Operational Guidance Series (TOGS) 1.1.1 of "Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations" for fresh (Class GA) Groundwater (1998).* Although a Class GA groundwater is considered a source of drinking water, it is the only set of standards and guidance values established for groundwater in TOGS 1.1.1. Parameter concentrations exceeding the standard or guidance values presented in TOGS 1.1.1 are shaded in Table 3. The results of the ground water sample analyses are discussed below and are summarized in the following table.

Table 3. Summary of Analytical Results for Groundwater

Contaminant of Concern	Standard, Criteria and Guidance Value	TCC Data		CHA Data		Cumulative Results	
		Conc. Range Detected[1]	Frequency of Samples Exceeding SCGs	Conc. Range Detected[1]	Frequency of Samples Exceeding SCGs	Conc. Range Detected[1]	Frequency of Samples Exceeding SCGs
VOCs (units in micrograms per liter (µg/L))							
n-Butylbenzene	5	1	0 of 16	NA	NA	1	0 of 16
tert-Butylbenzene	5	2	0 of 16	NA	NA	2	0 of 16
Naphthalene	10	7-79	1 of 16	NA	NA	7-79	1 of 16
n-Propylbenzene	5	1	0 of 16	NA	NA	1	0 of 16
1,2,4-Trimethylbenzene	5	5-15	2 of 16	NA	NA	5-15	2 of 16
1,3,5-Trimethylbenzene	5	5	1 of 16	NA	NA	5	1 of 16
o-Xylene	5	1-3	0 of 16	ND	0 of 8	1-3	0 of 16
p- & m-Xylene	5	3-14	1 of 16	ND	0 of 8	3-14	1 of 16
cis-1,2-Dichloroethene	5	ND	0 of 2	0.77 - 49	1 of 8	0.77 - 49	1 of 10
Trichloroethene	5	ND	0 of 2	0.67 - 5.0	1 of 8	0.67 - 5.0	1 of 10
SVOCs (units in micrograms per kilogram (µg/L))							
Acenaphthene	20[2]	ND	0 of 15	2.6	0 of 8	2.6	0 of 23
Bis(2-Ethylhexyl)phthalate	5	ND	0 of 15	1.2-1.8	0 of 8	1.2-1.8	0 of 23
Di-n-butylphthalate	50[2]	ND	0 of 15	3.9	0 of 8	3.9	0 of 23
Fluorene	50[2]	ND	0 of 15	2.2	0 of 8	2.2	0 of 23
Naphthalene	10	ND	0 of 15	1.5	0 of 8	1.5	0 of 23
Phenanthrene	50[2]	ND	0 of 15	1.1	0 of 8	1.1	0 of 23
PCBs (units in micrograms per kilogram (µg/L))							
Aroclor-1260	0.09	NA	NA	0.31 - 4.7	2 of 9	0.31 - 4.7	2 of 9
Inorganics (units in milligrams per liter (mg/L))							
Barium	1,000	NA	NA	16.1-204	0 of 8	16.1-204	0 of 8
Chromium	50	NA	NA	1.8-3.1	0 of 8	1.8-3.1	0 of 8
Lead	25	NA	NA	21-39.2	1 of 8	21-39.2	1 of 8
Mercury	0.7	NA	NA	0.03-0.08	0 of 8	0.03-0.08	0 of 8

Note: 1. If a single value is noted, the referenced parameter was detected either only one time, or multiple times at the same concentration.
2. Indicates value is a guidance value rather than a standard.
NA = Parameter not analyzed for.
ND = Parameter not detected.

Of the sixteen groundwater samples analyzed during TCC's report, only four VOCs were detected at levels in excess of the SCGs. Similarly, only two VOCs were detected in excess of the SCGs in the groundwater samples analyzed as part of CHA's investigation. A limited number of SVOCs, namely PAHs, were detected in the groundwater samples, but none were detected at concentrations in excess of the SCGs. Aroclor-1260 was the only PCB congener detected in the groundwater monitoring wells at the DeLaval site and was only detected in a well located near the southern end of the property. While the table indicates that Aroclor-1260 was detected at a concentration in excess of the SCG two times, it should be noted that both exceedances are for the same monitoring well, as a second sample was collected to verify the first result.

Barium, chromium, lead, and mercury were the only heavy metals identified in the groundwater samples collected from the DeLaval property. However, only the concentration of lead in one well along the west side of the AOC-2/AOC-3 was detected in excess of the groundwater standard established in TOGS 1.1.1. Overall, the analytical results from both TCC's and CHA's investigations indicates that the impact to the groundwater quality beneath the DeLaval property has been minimal.

2.5.4 Soil Gas

Based upon some of the putrescible wastes previously identified by TCC in AOC-1, a soil gas survey was performed in this area on July 30, 2004 to measure concentrations of combustible gas. The gas surveys included monitoring gas concentrations along a modified fifty-foot by fifty-foot grid in the vicinity of AOC-1. The grid began at the southern property boundary of the DeLaval property and extended northward three hundred feet. No detectable levels of soil gas were measured within or in the vicinity of AOC-1.

2.5.5 Supplemental Investigation Conclusions

As a result of the supplemental investigation, CHA was able to compile sufficient field and analytical data to significantly address the data gaps referenced in Section 2.3. The following list summarizes the conclusions derived from the supplemental investigation relative to the data gaps:

- The surficial soil sampling program identified site-wide SVOC and heavy metal contamination in the surface soil samples collected from across the DeLaval Property. In addition, PCBs were identified in the surface soils collected from the northwest corner of AOC-1.

- Based upon the additional test pits excavated on the DeLaval property, CHA was able to refine the limits of the AOCs, as previously shown on Figure 3. One significant change to the AOCs is that CHA believes that there is sufficient information to indicate that AOC-2 and AOC-3 are part of one larger impacted area as opposed to separate AOCs.

In addition to the six-inch diameter fuel oil pipeline previously identified in AOC-2, CHA also discovered the presence of an approximately 4,000-gallon underground storage tank adjacent to the south side of the pipeline. Another discovery made from the supplemental investigation was the presence of PCBs in the subsurface soils near the northern portion of AOC-1. However, the concentration of PCBs only exceeded the NYSDEC recommended soil cleanup objective concentrations in one sample.

- Based upon the groundwater samples collected from six newly installed monitoring wells and an existing on-site monitoring well, it appears that although there is visual and olfactory evidence of petroleum contamination on the DeLaval site, there has been little impact to the groundwater quality beneath the site. However, PCBs were detected at a concentration in excess of the NYSDEC groundwater standard in monitoring well CHA-2. Based upon the location well CHA-2, there appears to be some correlation between the groundwater results and the PCBs identified in the surface and subsurface soils in this area.
- There appears to be no evidence of active methane gas generation in the vicinity of AOC-1.

2.6 EXPOSURE ASSESSMENT

As part of this RAR, CHA developed a site characterization summary for the site-specific conditions associated with the DeLaval Property. This site characterization includes a review of the contaminants of concern within each AOC on the subject site in Section 2.6.1 and the identification of Exposure Pathways and Routes of Exposure for the site in Section 2.6.2.

2.6.1 Contaminants of Concern

The contaminants found on the subject property that would require remedial action include petroleum-related volatile organic compounds (VOCs) and SVOCs, contaminated fill material, lead, mercury, barium and cadmium. A detailed review of the contaminants at each AOC has previously been provided in the January 2005 *Supplemental Investigation Summary Report.*

2.6.2 Exposure Pathways and Routes of Exposure

Soil: Since a majority of the site is not paved and residual soil contamination is fairly close to the surface, the contact with surficial soils would represent a potential exposure pathway for the contaminants of concern on the subject property. Possible routes of exposure for the soil contamination would be ingestion, inhalation of dusts from the site, and adsorption through the skin.

Groundwater and Surface Water: Exposure to the groundwater may occur when construction personnel come in contact with site groundwater if dewatering is required during the course of the planned improvements. In addition, contaminated groundwater could migrate to the Hudson River which is located adjacent and to the west of the DeLaval property. Possible routes of exposure for contaminated groundwater and/or surface water include ingestion and skin adsorption.

Soil Gases: Contaminants from the soil and groundwater can partition into the soil gases in the vadose zone and migrate along underground utility lines and monitoring well piping to the ground surface. The possible route of exposure for contaminated soil gases is limited to inhalation.

The contamination currently present on-site does appear to pose an unacceptable risk to public health and the surrounding environment based on the existing site conditions at the DeLaval property. Although most of the contamination was observed in the soil media, the potential for migration of the contamination on-site to the Hudson River may exist.

3.0 IDENTIFICATION & DEVELOPMENT OF ALTERNATIVES

3.1 INTRODUCTION

The purpose of identifying remedial alternatives for the DeLaval property is to identify and evaluate the most appropriate remedial action for a contaminated AOC or specific media on the site. The goal of all remedial alternatives evaluated is to eliminate or mitigate conditions which represent a threat(s) to public health and the environment associated with the contaminants present at the site through proper application of scientific and engineering principles.

3.2 REMEDIAL ACTION OBJECTIVES

The remedial action objectives (RAOs) of future cleanup actions at the DeLaval property are medium-specific or operable-unit specific objectives that are established for the protection of human health and the environment. RAOs are typically narrative statements that identify the contaminants and environmental media of concern, the potential exposure pathways to be addressed by remedial actions, the exposed populations and environmental receptors to be protected, and the acceptable contaminant concentrations/remediation goals in each environmental medium.

3.2.1 Contaminants of Concern & Potential Exposure Pathways

The primary contaminants of concern (COCs) at the DeLaval property include a number of SVOCs, namely PAHs. While slight VOC contamination was identified in the subsurface soils and groundwater beneath the site, only a limited number of VOCs were detected in the samples at concentrations in excess of the SCGs (refer to Section 3.2.3). PCBs were detected in at low concentrations in the surface soils across much of the site, three subsurface soils samples, and one groundwater sample. However, PCBs were only detected in excess of the SCGs near the northern half of AOC-1. Overall, no significant impact of organic contaminants was identified in the groundwater.

A number of heavy metals were detected in excess of the SCGs in the surface and subsurface soils. Arsenic, barium, and chromium were the metals most commonly detected at concentrations in excess of the SCGs in the surface soils and arsenic, cadmium, chromium, and lead were the metals most commonly detected at concentrations in excess of the SCGs in the subsurface soils. No significant metal contamination was identified in the groundwater beneath the DeLaval Property.

3.2.2 Sensitive Environmental Receptors

As part of the RAR Work Plan developed by CHA for the DeLaval project, CHA researched sensitive environmental receptors in the vicinity of the DeLaval property. The City of Poughkeepsie has a population of 29,871 people and occupies an area of 5.14-square miles. The corresponding population density is 5,811 people per square mile based on the 2000 Census information obtained from the Dutchess County Website.

3.2.2.1 Groundwater & Surface Water Characterization

Aquifer Protection Zones were reviewed for the DeLaval property at the Dutchess County Planning and Development Department by CHA personnel. The water resources map indicated that the property was not in a Zone I, Zone II, or Zone III aquifer area. Furthermore, the site is not located near any wellhead protection areas designated as primary or secondary management areas. In addition, the NYSDEC document entitled "Potential Yields of Wells in Unconsolidated Aquifers in Upstate New York – Lower Hudson Sheet" indicates that there are no state-protected aquifers in the vicinity of the subject site.

The current groundwater characteristics on the subject site are not suitable for a primary drinking water supply. Since the site is located within an industrial/urban area of the City of Poughkeepsie that is provided with municipal potable water service, the groundwater on the site is not expected to be utilized as a potable source.

There are no surface waters located on the property; however, the site is located adjacent to the Hudson River. The Hudson River in the vicinity of the subject property is designated as Class A Surface Water. Class A Surface Waters are designated as a source of water supply for drinking, culinary or food processing purposes, primary and secondary contact recreation, and fishing. Surface waters of this classification are suitable for fish propagation and survival.

3.2.2.2 Sediment Characterization

The investigations completed to date at the DeLaval Property have not included sampling of the Hudson River sediments along the west side of the property. However, the soil and groundwater data suggest that significant migration of contaminants from the DeLaval site to the sediments in the Hudson River is unlikely. Given that there is no significant evidence of impact from the DeLaval site and that there are numerous potential sources of sediment contamination upstream of the site, remediation of the river sediments will not be addressed in this report.

However, since a portion of AOC-2/AOC-3 abuts the existing bulkhead along the Hudson River and a slight sheen was observed on the water surface of the river during the excavation of the test pits during the 2004 supplemental investigation, the potential migration of contaminants into the Hudson River will be considered in the remedial alternatives evaluated for the DeLaval site. Should significant evidence of localized contaminated river sediments be encountered during the implementation of the selected site remedy, it is understood that confirmatory samples of the sediments immediately down-gradient of the impacted soils will be required at that time by NYSDEC.

3.2.2.3 Wetland and Floodplain Delineation

The federal and state wetlands mapping was reviewed for the subject site and shows that the bank of the Hudson River is considered to be a national wetland area. There were no state regulated wetland areas in the vicinity of the subject site.

The FEMA floodplain mapping for the City of Poughkeepsie indicates that the DeLaval property is located within the 100-year flood plain.

3.2.2.4 Public and Private Water Supply Wells

The Dutchess County Health Department was contacted regarding any private or public water supply wells located in the vicinity of the DeLaval Property. The Dutchess County Health Department has not responded to our request for information; however, based on the location of the subject site, CHA does not anticipate that this site will adversely impact any public or private drinking water supply wells as the site is located adjacent to the Hudson River, and all adjacent properties are either hydrologically up-gradient or cross-gradient of the DeLaval site.

3.2.2.5 Other Sensitive Receptors

The City of Poughkeepsie Assessors Office provided CHA with a list of properties that are located within two-hundred feet of the DeLaval property. A review of this list of properties indicates that there are no schools, hospitals, day care centers, or retirement homes in the vicinity of the subject site. However, the Hudson River and the aquatic life that it supports are identified as sensitive environmental receptors relative to the subject site.

3.2.3 Remedial Goals

Remedial goals (or targets) are typically considered the maximum acceptable contaminant concentrations in each environmental medium that a selected remedial program must meet. Remedial goals are usually based on Applicable or Relevant and Appropriate Requirements (ARARs) unless ARARs are not available for a particular chemical or medium, or the ARARs are not considered sufficiently protective of human health and the environment. Standards, Criteria, and Guidance (SCG) values are similar to ARARs, except these standards and guidance values have been established and/or accepted by the NYSDEC. As a result, the terms ARARs and SCGs are considered equivalent throughout the RAR.

For the DeLaval project, the appropriate ARARs for soil remediation will be considered to be the NYSDEC's TAGM 4046 Soil Cleanup Objectives. Similarly, the ARARs for groundwater will be the NYSDEC's Technical and Operational Guidance Series (TOGS) 1.1.1 groundwater standards and guidance values.

It should be noted that many of the remedial alternatives evaluated herein may take a number of years before reaching the applicable remedial goals. Although ideally all contamination would be eliminated from the DeLaval property immediately, the goal of the remediation is to reduce or eliminate human exposure of the contaminants at the site and to achieve the ARARs to the extent practicable. In addition, the remediation should minimize contaminant migration to groundwater and minimize future migration of contaminated groundwater to surface water bodies. At a minimum, this typically includes removal of the source of contamination, including but not limited to, any free product and any grossly contaminated soils, to the extent technically and practically feasible.

Based upon the site characteristics of the DeLaval property and the remedial goals, the following RAOs have been established for the site:

1. Prevent incidental ingestion and direct contact with the petroleum contamination present in the subsurface soils.
2. Prevent ingestion or contact of contaminated groundwater.
3. Prevent inhalation of VOCs volatilizing from the subsurface soil or groundwater to indoor environments and, to a lesser degree, the ambient air.
4. Remove the source of the petroleum contamination to ensure no additional contaminants are released into the environment, and thereby reducing potential impacts to the water quality of the Hudson River.
5. Restore the subsurface soil and groundwater quality to a degree which is consistent with the proposed uses of the DeLaval property and achieves the ARARs to the extent practical.

3.3 GENERAL RESPONSE ACTIONS

After establishing the remedial objectives established for the DeLaval property, several general response actions were evaluated based upon the ability of the response to address the remedial objectives. These actions are intended to mitigate potential exposure to the COCs, control the migration of the COCs on the DeLaval property, and/or remediate the COCs. The purpose of establishing general response actions is to begin to evaluate basic methods of protecting human health and the environmental, such as treatment and/or containment of the site contaminants. The general response actions may then be combined to form alternatives, such as treating grossly contaminated media and providing containment or post-treatment monitoring of any residual contaminants.

The following list summarizes the general response actions that will be considered for the DeLaval property, each of which are described in more detail in the following subsections:

1. No Action
2. Risk & Hazard Management
3. Natural Attenuation
4. Extraction with Ex-situ Treatment
5. In-situ Treatment
6. Containment
7. Hydraulic Control
8. Removal & Disposal

3.3.1 No Action

The no action response action/alternative is considered to be the baseline alternative that will provide the basis for comparison for other response actions and resultant remedial alternatives, as required under the National Contingency Plan (NCP). Under this scenario, all ongoing activities associated with remediation of the subject site would cease and no future cleanup would be planned. The only way that the site contaminants would be addressed would be through the natural processes of biodegradation, dispersion, adsorption, dilution, and volatilization.

3.3.2 Risk and Hazard Management

Risk and hazard management responses typically include institutional, administrative, and ventilation controls, as well as ecological resource surveys to reduce or eliminate exposure risks associated with the on-site contaminants. Although risk and hazard management may be acceptable as the sole remedy for sites that pose minimal risk to human health and the environment, these actions are more commonly used in conjunction with other actions, such as monitoring or limited active responses.

3.3.2.1 Institutional and Administrative Controls

Institutional controls (ICs) may reduce or eliminate exposure risk by restricting some or all access to the impacted areas on the site. ICs can be used when the contamination is first discovered, when remedies are ongoing, and when residual contamination remains onsite at a level that does not allow for unrestricted use and unlimited exposure after cleanup is complete. Examples of ICs include the posting of signs, installation of fences or other barriers, security systems, etc. Administrative controls typically restrict the type of uses permitted on the site and/or may restrict the use of groundwater/surface water on the site. Example of administrative controls include zoning changes, easements, and covenants/deed restrictions to limit future land use or prohibit activities that may compromise specific engineering remedies. ICs and administrative controls may be considered an appropriate component of a remedy or may be necessary to ensure that a remedy is protective under the following situations:

- The cleanup is protective for industrial/commercial reuse, but not residential exposures.
- The groundwater will remain contaminated for a period of time such that potable water well drilling should be prevented.
- Soils are remediated at the surface, but contamination at higher concentrations remains in the subsurface.
- The contamination is covered with clean soil to prevent exposure and/or reduce the leaching of the contamination to groundwater, and activities that could potentially degrade the soil cover must be prohibited.

3.3.2.2 Ventilation Controls

Ventilation controls are typically utilized to disperse VOC contaminants. The most typical application of ventilation controls is placement of an engineered ventilation system beneath a building that is constructed over residual petroleum contaminants where there could be an inhalation risk if the VOCs are not dispersed.

While this technology is often unacceptable as a sole remedial alternative, it may be combined with other technologies. Depending upon the extent and concentrations of residual contaminants remaining at the DeLaval site following cleanup, installing sub-slab depressurization systems beneath any new structures designed for human occupancy may be appropriate.

3.3.3 Natural Attenuation

Natural attenuation is defined as a remedial method that reduces the mass and concentration of contaminants in the environment without human intervention. However, unlike a "take no action" or "walk-away" approach to site cleanup, this approach requires long-term monitoring of the site conditions to confirm whether or not the contaminants are being degraded at reasonable rates to ensure protection of human health and the environment. Site data should clearly indicate whether concentrations of soil and groundwater contaminants are being adequately reduced without active remediation. If not, more aggressive remedial technologies may be necessary. Natural attenuation occurs through a variety of physical, chemical, and/or biological processes, including:

- Biodegradation
- Adsorption
- Volatilization
- Evapotranspiration
- Dispersion
- Dilution
- Chemical or biological stabilization
- Destruction of contaminants

One of the most important components of natural attenuation is biodegradation, which typically involves the transformation of a compound to a less toxic substance(s) by subsurface microorganisms through biotic reactions. Because natural attenuation typically allows contaminants to migrate further than active remedial measures, it is also important to determine whether individual or sensitive environmental receptors may be affected by the release.

3.3.4 Extraction with Ex-situ Treatment

Extraction involves the removal of subsurface contaminates in soil, groundwater, and other media for treatment above ground. The goal of ex-situ treatment is to separate, destroy, or convert contaminants in extracted soil, groundwater, and/or vapor. However, if treatment only separates the contaminants for the impacted media, the contaminants will still require proper disposal. Ex-situ treatment typically requires shorter periods of time to complete the cleanup of a site than in-situ treatment, but extraction of the contaminants typically costs more than in-situ techniques. One potential component of extraction with ex-situ treatment is the excavation of subsurface soils.

The main advantage to excavating soils is that there is typically a higher degree certainty about the uniformity of treatment because of the ability to homogenize, screen, and continuously mix the soils prior to treatment. The soils can then be treated using a variety of techniques, including biological methods (e.g. biopiles, composting, land farming), physiochemical processes (e.g. dehalogenation, soil washing, solidification), or thermal treatments (e.g. thermal desorption, incineration).

Groundwater may be extracted by pumping groundwater from a series of wells or collection trenches. The groundwater can then be treated by a variety of methods including sorption to granular activated carbon (GAC), air stripping, ion exchange, oxidation, constructed wetlands, etc. Gaseous vapors extracted from the subsurface, such as those removed using a dual-phase or soil-vapor extraction (SVE) system, can be treated using GAC sorption, thermal oxidation, UV oxidation, etc. After treatment is complete, the soil can be returned to the excavation and the treated groundwater can be discharged to a sanitary sewer system, discharged to surface water, or reinjected beneath the subsurface.

3.3.5 In-Situ Treatment

In-situ treatment techniques involve the destruction or conversion of contaminants in subsurface soils, bedrock, and groundwater to less toxic compounds without the removal. There are a variety of biological, chemical, and physical techniques available for in-place treatment of petroleum-impacted soils. While the costs associated with in-situ techniques are often less than those associated with ex-situ techniques, in-situ methods typically require longer periods of time to reach the remedial objectives established. In addition, it is more difficult to determine whether contaminants have been destroyed using in-situ treatment methods.

Bioremediation treatment techniques involve the use of microorganisms to grow and utilize the contaminants as food source and thereby converting the contaminants to less toxic substances. Although natural microorganisms exist in the subsurface and can often break down the subsurface contaminants, such as in the case of sites where natural attenuation is the selected remedy, the microorganisms often require stimulation or creation of favorable environment to have a significant role in site cleanup. In some instances, biodegradation of contaminants is also enhanced by the addition of microorganisms that are specifically adapted to degrade a particular contaminant or by supplementing the naturally-occurring microorganisms with nutrients to stimulate their growth rates. While bioremediation has been proven effective for treating petroleum contaminants, the bioremediation techniques are not used for the treatment of inorganic contaminants. Bioremediation techniques include natural attenuation, enhanced bioremediation, phytoremediation, and bioventing.

In-situ chemical treatment techniques rely on the injection of a chemical(s) to degrade, immobilize, desorb/flush out contaminants, including techniques such as chemical oxidation, soil flushing using treatment reagents, polymerization, precipitation, etc. An example of a physical in-situ treatment method is air sparging, where air is injected into the saturated zone of a contamination plume to remove contaminants through volatilization and perhaps enhance biodegradation of contaminants by increasing the concentrations of dissolved oxygen in the groundwater. A passive reactive barrier (PRB), also referred to as a "treatment wall," may involve both physical and chemical treatment techniques. When a funnel and gate type PRB is utilized, the groundwater is intercepted by a impermeable or low-permeability wall and directed through a man-made wall of reactive media for chemical treatment.

3.3.6 Containment & Hydraulic Control

Containment and/or hydraulic control measures are used to control the migration of contaminants in subsurface soils and groundwater. Although it is often impossible to prevent any migration of contaminants, the goal of containment is to at least significantly reduce the migration. Containment techniques are typically utilized at sites where the contaminants are intended to be buried or left in place at the site. For example, containment systems are often used at sites where the subsurface contamination is extensive and removal of the contaminants is precluded by the potential hazards associated with the removal and/or excessive costs. Extensive monitoring of containment systems is necessary to ensure the competency of the system and ensure that the system has no leaks or is being short-circuited.

The most common surface containment systems involve the use of capping systems. While capping systems reduce the infiltration of precipitation and run-off on the surface of the site into the contaminated area, they also provide a barrier to reduce the likelihood of human contact with the subsurface contaminants and inhalation of potentially hazardous vapors. The type of capping used at a site is based upon the site contaminants present, the physical characteristics of the site, and the intended future use of the site. Gas collection and treatment is critical component of cap design at sites where volatile contaminants or putrescible wastes are present to prevent the buildup of hazardous concentrations of volatile gases or methane beneath the cap. Based upon the results of the supplemental investigation, it is likely that a one foot thick soil cover rather than an engineered cap will be sufficient to meet the remedial goals and objectives for the DeLaval Property.

Subsurface containment systems typically include vertical barriers installed near the limits of the plume area to inhibit further migration of contaminants. Examples of vertical barriers include slurry walls, grout curtain walls, watertight sheeting, etc. While vertical barriers primarily restrict the horizontal migration of contaminants, the barriers are often "keyed" into bedrock or an aquitard to reduce vertical movement of the contaminants beneath the barrier. Vertical barriers may be used to contain contaminated groundwater, divert contaminated groundwater around potable water supplies, divert uncontaminated groundwater around the impacted area, and/or provide a permeable treatment wall. Depending upon the geometry of the vertical barrier, it may be necessary to remove the groundwater up-gradient of the barrier or within a closed barrier and treat the groundwater.

3.3.7 Removal and Disposal

Source removal involves excavation of the contaminated soil, rock, debris, etc. and transportation of the material to a permitted off-site treatment and/or disposal facility. Although on-site disposal in contained systems is sometimes considered, it is typically not favorable for sites where redevelopment is planned. Depending upon the objective of the removal, either partial or total waste removal may be necessary to prevent further releases into the environment. There are many issues that must be considered if source removal and disposal are considered, including consideration of odors, fugitive dust emissions, depth and composition of the material being excavated, transportation methods, the transportation of the material through populated areas, pretreatment, waste characterization as dictated by land disposal restrictions (LDRs), temporary storage of the waste on-site, etc.

3.4 EVALUATION & SCREENING OF REMEDIAL TECHNOLOGIES

As previously discussed, the primary contaminants of concern include a number of SVOCs and a few heavy metals. Table 4 on the following page(s) provides a summary of the technology process options considered for managing the vadose zone soils at the DeLaval site and Table 5 provides a summary of the technology process options considered for managing contaminated groundwater. While technology processes were evaluated for each of the previously identified general response actions, the tables are not intended to include screening of every available remedial technology. The process options were evaluated based upon their expected effectiveness and implementability, given the site-specific conditions. If a technology was considered to be an effective remedy and implementable, the technology was then evaluated based upon cost; however, some higher costs technologies were retained for further evaluation if no other available technologies were available or appropriate for the DeLaval property.

As discussed earlier, the City of Poughkeepsie is planning to redevelop the DeLaval site in 2005. Given that the City wants to expedite the redevelopment of the site, the ability to expedite remediation will be considered a primary component of each remedial alternative evaluated. Since the site will be open to the public, it will also be important to limit human contact with the subsurface contaminants. If long-term remedies are selected as the desired alternative for the site, it will be important to make any remedial equipment and/or monitoring equipment unobtrusive to the planned public use of the site.

3.4.1 No Action

The depth to petroleum impacted soils is relatively shallow at the DeLaval property and will likely be encountered and potentially displaced during excavation activities associated with the redevelopment of the site. Given that free product and grossly contaminated soils were identified at

Table 4. Screening of Technology Process Options for Vadose Zone Soils

General Response Action	Remediation Technology Type	Technology Process Options	Effectiveness	Implementability	Cost	Retained	Comments
No Action	None	Natural decay, biodegradation, dispersion, adsorption, volatilization	Limited. Not considered sufficiently protective of human health and the environment.	No additional action necessary.	None (no additional costs)	Yes	Retained as baseline for comparison to alternatives.
Risk & Hazard Management	Administrative Controls	Land Use Restrictions; Fencing & Signs; Security Guards	Protects Human Health. Provides no protection to environment unless used in conjunction with other remedies.	Easily implemented. Fencing or raised railroad bed surround most of site already. Land use restrictions may require zoning changes and legal consultation.	Low to Moderate	Yes	Will likely be implemented to some degree with all alternatives unless all contaminant levels reduced below ARARs.
	Ventilation Controls	Building ventilation systems for future on-site structures	Reduces human exposure to VOCs inside buildings. No significant mass removal or protection of environment.	Site currently vacant, but could be implemented in design for future on-site buildings.	Moderate	Yes	May be necessary if residual contaminants in soils and groundwater within the footprint of proposed structures.

Table 4. Screening of Technology Process Options for Vadose Zone Soils

General Response Action	Remediation Technology Type	Technology Process Options	Effectiveness	Implementability	Cost	Retained	Comments
Natural Attenuation	Biological	Natural decay, biodegradation, dispersion, adsorption, volatilization	Limited. Not considered sufficiently protective of human health and the environment for managing grossly stained soils & product.	Easily implemented.	Low to moderate. Requires long-term monitoring and capital costs to install monitoring wells.	Yes	Considered for residual contamination after grossly stained soils are treated or removed, but not as sole remedy.
Ex-situ Treatment	Biological	Biopiles, composting, land farming	Effective for VOCs & SVOCs	Implementable.	High. Excavation & moderately long-term treatment process.	No	Insufficient area on site to stage excavated soils. Potential extended treatment duration.
	Physiochemical	Chemical Redox	Typically used for inorganics. Less effective on organics.	Potentially implementable.	High due to contaminant levels at site - will require large volumes of oxidizing agent.	No	Not cost-effective approach for VOCs/SVOCs.

Table 4. Screening of Technology Process Options for Vadose Zone Soils

General Response Action	Remediation Technology Type	Technology Process Options	Effectiveness	Implementability	Cost	Retained	Comments
Ex-situ Treatment (con't.)	Physiochemical	Soil Washing	Not effective on several VOCs.	Difficult with mixed organic/ inorganic contaminants.	High. Washing fluid requires significant treatment.	No	Debris in soils also increases difficulty with this technique.
	Thermal	Thermal Desorption	Effective for VOCs & SVOCs. Not effective for soils with high moisture content or containing PCBs.	Implementable.	Moderate due to handling and fuel costs. Processing of soils can significantly increase costs.	Yes	Size of site may result in limited areas to setup equipment and process/store soils.
In-situ Treatment	Biological	Enhanced biodegradation	Effective for VOCs & SVOCs.	Implementable. Difficult to control and predict due to variability of subsurface. Re-injection of amendments/ nutrients difficult after redevelopment complete.	Moderate to high. High levels of contaminants result in need for more amendments.	Yes	Potential need to retreat over time increases cost. Future structures may limit location of future enhancements and site may result in the need for significant site restoration.

Table 4. Screening of Technology Process Options for Vadose Zone Soils

General Response Action	Remediation Technology Type	Technology Process Options	Effectiveness	Implementability	Cost	Retained	Comments
In-situ Treatment (con't.)	Physiochemical	Chemical oxidation	Only effective on compounds readily subject to oxidation.	Difficult. Technology not proven and must handle hazardous chemicals.	High. Significant costs for chemicals.	No	Too many unknowns with technology to consider for DeLaval site.
Containment	Surface Caps	Asphalt/Concrete	Minimizes surface exposure. Reduces surface water infiltration and reduce potential generation of leachate.	Implementable. Parking lots are planned as part of site redevelopment already.	Low to moderate.	Yes	Applicable for residual contaminants.
		Soil Cover	Minimizes surface exposure to contaminants. Reduces infiltration.	Implementable. Considered for green space areas in redevelopment. Demarcation from impacted soils necessary.	Low to moderate.	Yes	Applicable for residual contaminants. May be used beneath green space areas not covered by asphalt or structures.
		Synthetic Membrane Liner/Engineered Caps	Reduces surface water infiltration and VOC emissions to atmosphere.	Implementable. Construction would have to be coordinated with redevelopment.	High.	Yes	May be used beneath green space areas not covered by asphalt or structures.

Table 4. Screening of Technology Process Options for Vadose Zone Soils

General Response Action	Remediation Technology Type	Technology Process Options	Effectiveness	Implementability	Cost	Retained	Comments
Removal & Disposal	Excavation	On-site disposal	Effective. Places impacted soil in contained area.	Implementable, but limited by hydrogeological conditions of site and cost.	High to excessively high.	No	Movement of contaminated material from one area to another is not compatible with site redevelopment.
		Off-site disposal	Effective. Soils typically not treated, only disposed at permitted landfill.	Implementable.	High to excessively high. (Dependent on volume).	Yes	Considered only for grossly stained soils.

Table 5. Screening of Technology Process Options for Groundwater

General Response Action	Remediation Technology Type	Technology Process Options	Effectiveness	Implementability	Cost	Retained	Comments
No Action	None	Biodegradation, dispersion, adsorption, volatilization, dilution, etc.	Limited. Not considered sufficiently protective of human health and the environment.	No additional action necessary.	None (no additional costs)	Yes	Retained as baseline for comparison to alternatives.
Risk & Hazard Management	Administrative Controls	Land Use Restrictions; Fencing & Signs; Treatment at point of use.	Protects Human Health on-site only. Provides no protection to environment unless used in conjunction with other remedies.	Easily implemented. Must make municipal water supply available at site so there is no demand for using groundwater on site.	Low	Yes	Will likely be implemented to some degree with alternatives unless all contaminant levels are reduced below ARARs.
Natural Attenuation	Groundwater sampling & analysis along with modeling	Natural decay, biodegradation, dispersion, dilution, adsorption, volatilization, evapotranspira-tion	Effective for VOC/SVOC contaminants, if groundwater chemistry conducive to biological degradation.	Easily implemented, but takes substantial time. Long-term monitoring necessary to evaluate effectiveness. Monitoring wells already present.	Low to moderate. Requires long-term monitoring and possible capital costs to install additional monitoring wells.	Yes	Considered for residual contamination after grossly stained soils treated or removed, but not as sole remedy. Wells installed as part of supplemental investigation.

Table 5. **Screening of Technology Process Options for Groundwater**

General Response Action	Remediation Technology Type	Technology Process Options	Effectiveness	Implementability	Cost	Retained	Comments
Ex-situ Treatment	Groundwater Pump & Treatment	Groundwater Extraction Wells	Effectiveness may be reduced by tidal influence at site.	Implementable. Viewable extraction infrastructure not compatible with site redevelopment.	Low to moderate installation costs. High O&M and treatment costs.	No	All groundwater pump & treatment options result in long-term treatment, excessive costs, and are incompatible with the proposed redevelopment of the site, especially given low levels of contaminants identified in the groundwater. Also requires permits to discharge treated groundwater to surface water.
		Groundwater Collection Trench	May reduce contaminant migration towards Hudson River, but would also collect surface waters.	Requires significant excavation & dewatering to install. Tidal influence could impact performance of the system	Excessively high installation costs & long-term treatment costs.	No	
		Funnel & Gate Type Vertical Barrier with Single Extraction Well	Not effective at site given the low concentrations of contaminants & the expected quantities of groundwater.	Still requires significant excavation for installation of funnel & gate.	Excessively high installation costs & long-term treatment costs.	No	

Table 5. Screening of Technology Process Options for Groundwater

General Response Action	Remediation Technology Type	Technology Process Options	Effectiveness	Implementability	Cost	Retained	Comments
Ex-situ Treatment (con't.)	Dual-Phase Extraction	Dual-Phase Extraction	Effectiveness may be reduced by tidal influence at site.	Implementable. Viewable extraction infrastructure not compatible with site redevelopment. Air treatment equipment would need to be located on-site.	High to Excessively High. High energy cost for vacuum system. Must treat extracted groundwater and air.	No.	Not considered due to excessive costs, system complexity, and incompatibility with site redevelopment. Also, limited source removal should remove second phase.
In-situ Treatment	Biological	Enhanced biodegradation (ORC & HRC injections)	Effective for VOCs & SVOCs.	Implementable. Difficult to control and predict due to variability of subsurface and tidal influence. Reapplication may not be possible after site development.	Moderate to high. Free product, if not removed, results in need for more amendments.	Yes	Potential need to retreat over time increases cost. Developed structures may limit location of future enhancements and site may need restoration.
	Physiochemical	Air Sparging	Effective for VOCs & SVOCs with permeable, uniform soils.	Implementable. Viewable equipment not compatible with site redevelopment.	Moderate to High. May require air permit.	No	Increasing volatilization of contaminants not compatible with site redevelopment.

Table 5. Screening of Technology Process Options for Groundwater

General Response Action	Remediation Technology Type	Technology Process Options	Effectiveness	Implementability	Cost	Retained	Comments
In-situ Treatment (con't.)		Permeable Reactive Barrier (PRB)	Marginally effective for certain fuel hydrocarbons.	PRBs designed for one-directional flow. Tidal influence at site limits applicability of this technique.	Moderate to high. High cost for reactive media and installation.	No	Insufficient data available for PRBs influenced by tidal waters.
Containment	Groundwater Containment	Slurry Walls/Grout Curtains/Sheeting	Effective for controlling horizontal migration of contaminants in groundwater. Does not treat contaminants.	Long barriers along river or perimeter of AOCs difficult to implement. The depth to bedrock and/or aquitard is unknown, and pump & treat would be needed to alleviate groundwater surcharging behind the barrier. Small barriers may be effective.[1]	High. In additional to wall costs, significant costs associated with pumping and treating groundwater. Small barriers more cost-effective and will not require pump and treat.	Yes[1]	Costs too excessive for long vertical barriers when considering technology would have to be used in conjunction with pump & treat. Small bulkheads may be installed down-gradient of the AOCs to impede flushing of impacted soils by the tidal effect of the Hudson River.

Note: 1. *May be considered for small areas (e.g. AOC-1) if bedrock or aquitard is shallow and a barrier could be designed such that long-term pump & treat is unnecessary. Similarly, small sections of bulkhead may be installed down-gradient of the AOCs to impede groundwater flow into the Hudson River. Such barriers will not be keyed into a low-permeability material and will not incorporate pump & treat systems. Such barriers will reduce the washing effect of the tide in the AOCs but will not impede groundwater movement around the sides or beneath the barrier, and therefore, are not considered a containment system.*

the site, taking no action at the site will not be considered, but will be included in the detailed analysis as a baseline alternative for comparison of other alternatives. This alternative has been included in keeping with the conditions of the National Contingency Plan to serve as a baseline comparison in reference to other alternatives considered in the RAR.

3.4.2 Risk and Hazard Management

One possible consideration for controlling human exposure to the site contaminants is restricting access to the site. As previously discussed, the DeLaval property is currently secured by a retaining wall and iron fencing along the north side, a concrete wall associated with an elevated railroad corridor along the east side, chain link fencing along the south side, and the Hudson River along the west side. There is currently a gate near the northeast corner of the site restricting vehicular access to the site near the intersection of Pine Street and Rinaldi Boulevard; however, the gate provides little restriction to trespassers. Although the site is vacant and there is no apparent attraction of boaters to the site, access to the site from the Hudson River is almost completely unrestricted.

The current fencing around the DeLaval property may be useful during any active remedial work at the site to limit human access. The existing fencing and gates could be supplemented with signage to warn potential trespassers to keep off the site. However, the site will ultimately be open to the public after redevelopment, and therefore, restricting access to the site is not considered a permanent remedy for managing the site.

Another risk management technology that will be considered for the DeLaval site is sub-slab ventilation controls. If residual petroleum contamination remains at the site after the primary remedial activities are complete, it may be necessary to install sub-slab depressurization systems beneath any on-site structures to reduce human exposure to VOCs while inside these structures. The need for sub-slab depressurization will be based upon the proposed location of the structures relative to the residual contaminants and the type of residual contaminants remaining on the site, but will be likely needed for all proposed structures on the DeLaval site.

While institutional controls will not be utilized as the principal remedy for the DeLaval site given the presence of grossly contaminated soils and free product on the site and the City's desire to redevelop the site for public use, ICs will be used in conjunction with remedial actions to reduce human exposure and impacts to the environment. ICs that may be used on the DeLaval property include restricting access to AOC-1 and residual contaminants remaining in AOC-2/AOC-3 and AOC-4, development of health and safety procedures to implement during construction activities, and restrictions on the use of the groundwater beneath the site as a drinking water source.

3.4.3 Natural Attenuation

Given the presence of grossly contaminated soils and potential presence of free product on the DeLaval property and the City's desire to redevelop the site within a short timeframe, none of the previous natural attenuation mechanisms (e.g. biodegradation, dilution, dispersion, etc.) alone, would be considered sufficient to reduce the threat posed to human health and the environment to an acceptable level within the required short timeframe. In addition to the potential human exposure to the site contaminants, natural attenuation would provide little reduction in the volume and concentration of contaminants migrating to the Hudson River unless combined with another remedial technology. Therefore, although natural attenuation may be utilized to remediate residual contaminants, it will not be considered as the sole remedy for the site.

3.4.4 Extraction with Ex-situ Treatment

Several biological technologies are effective for remediating soils contaminated with VOCs and SVOCs. However, there are high costs associated with these technologies and they generally take a substantial amount of time to implement. In addition, there is likely insufficient room on the DeLaval site to excavate each of the AOCs and still have room on-site to setup biopiles, composting areas, etc. Therefore, biological ex-situ technologies will not be considered for remediating the soils on the DeLaval site. No physiochemical ex-situ technologies were considered as an appropriate remedy for the DeLaval site given the high costs associated with implementing these technologies and their lack of effectiveness on treating VOCs and SVOCs.

One ex-situ remedial technology used for treating impacted soils retained for further evaluation was low-temperature thermal desorption (LTTD). LTTD involves heating the impacted soil to volatilize organic contaminants and the water in the soil. The off-gas is then treated prior to being discharged to the atmosphere. Although the costs associated with LTTD can be quite high due to fuel and equipment costs, LTTD was retained as a viable technology because of relatively short timeframe required to remediate the impacted soils. LTTD will not be considered for treatment of the soils in AOC-1 due to the presence of PCBs in this location.

All ex-situ techniques available for remediating groundwater require that the groundwater be extracted from either extraction wells, collection/interceptor trenches, or a funnel and gate system with a single extraction well. Although a number of technologies have been shown effective for the treatment of the extracted groundwater, the costs associated with these technologies is typically high to excessively high. In addition to the capital costs to install a groundwater pump and treat system, there are also substantial costs associated with the operation and maintenance (O&M) of this long-term treatment method. Given that pump and treat systems are costly, require long treatment periods, visible extraction and/or treatment equipment is incompatible with the proposed redevelopment, and that the contaminant concentrations detected in the groundwater from most samples was relatively low, groundwater pump and treatment systems will not be considered as an appropriate remedial technology for the DeLaval site.

3.4.5 In-Situ Treatment

One in-situ remedial technology retained for further evaluation is enhanced biodegradation. Although there are several alternatives for enhancing biodegradation, one technology that is gaining in popularity is the injection of oxygen-releasing compounds (ORC®) into the subsurface. By providing the naturally occurring microorganisms with oxygen and other nutrients, the microorganisms grow in population and break the contaminants down in a shorter timeframe than would be required for natural attenuation.

This technology will be evaluated further for treatment of the petroleum contaminants on the DeLaval site; however, given the variability of the subsurface and the lack of wet chemistry data for the site, it is difficult to predict the effectiveness of this technology. Previous studies have shown that re-treatment with ORC® is sometimes necessary; however, the re-injection of ORC® may not be feasible after the property is redeveloped, or may result in excessive costs to restore the site after the re-injection is complete. The potential for re-injection is not compatible with the redevelopment of the site, especially given the proposed public use of site. Furthermore, ORC® is primarily used for treating impacted groundwater rather than soil, and the analytical results from the subsurface investigations performed at the DeLaval site show that there has only been a minor impact to the groundwater beneath the site. Therefore the benefits associated with this technology are not expected to offset the cost of implementing this remedy.

Chemical oxidation has been shown to be effective for treating compounds that are readily subject to oxidation. However, the effectiveness of this technology has not been widely demonstrated to date and the method requires the handling of expensive hazardous chemicals. Therefore, chemical oxidation will not be evaluated further as a possible remedy for the DeLaval property, given the intended public use of the property.

A physiochemical process used for reducing VOC and SVOC contaminant levels in groundwater is air sparging. Air sparging involves injecting air into the saturated zone beneath the site to remove the organic compounds via volatilization. Although air sparging could be utilized to remediate a site within a reduced timeframe compared to some of the biological methods, the site redevelopment would likely be completed before this technology could be fully effective. If the site development was completed prior to the air sparging system being active for up to two years, any structures or other impermeable surfaces could restrict the volatilization of the contaminants and it is likely that the volatiles would migrate into on-site structures. In addition, any visible equipment on the surface would be incompatible with the redevelopment due to public concern and overall unsightliness. Thus, air sparging will not be considered as a potential remedial technology for the DeLaval site.

Passive reactive barriers (PRBs) were also considered as an in-situ technique for treating the site contaminants. However, past studies have shown that the technology is only marginally effective for treating certain petroleum hydrocarbons. In addition, the walls are designed for one-directional flow. The tidal influence from the Hudson River would likely result in a significant component of flow passing through the barrier coming from the Hudson River towards the DeLaval site. Since this technology has not been proven effective for treating some fuel oils, and since it would be difficult to implement a PRB adjacent to a tidally influenced surface water, this technology will not be evaluated further.

3.4.6 Containment

A variety of surface capping technologies are available to minimize the surface exposure of the contaminants at the DeLaval site. Although installation of a surface cap would not reduce the contaminant mass, caps are useful for controlling human exposure to the contaminants while certain types of remedies are being implemented. Capping the contaminant areas will not suffice as the sole remedy for the site due to the presence of grossly contaminated soils beneath the site, but it may be useful for controlling the exposure to residual contaminants, especially if natural attenuation or enhanced biodegradation are selected to treat the residual contaminants. If capping is only utilized for preventing exposure to residual containments, it is likely that the asphalt/concrete surfaces associated with parking areas, walkways and structures/buildings will be sufficiently protective. Low permeability soil cover with a thickness of one foot will be sufficiently protective in vegetated areas coincidental with the AOCs.

Vertical containment systems, such as slurry walls, grout curtain walls, and watertight sheeting, are often used to control the horizontal migration of contaminants resulting from groundwater movement. These barriers are typically costly and difficult to install, especially immediately adjacent to surface waters. While installing vertical barriers up-gradient of the AOCs may direct a substantial amount of groundwater migrating toward the DeLaval site around the AOCs, it would not prevent the tidal effect of the Hudson River from pulling contaminants back towards the river as the tidal waters recede.

If a vertical barrier were to be constructed down-gradient of the plume along the entire western boundary of the site, the groundwater would surcharge behind the barrier. Since significant surcharging of the groundwater behind the wall is undesirable, it would then be necessary to install a groundwater collection trench, a system of extraction wells, or other similar system to control the water levels up-gradient of the barrier. However, the groundwater extracted from behind portions of the barrier would likely be impacted from the contaminants in the AOCs and require treatment prior to be discharged. The treatment of groundwater would require significant capital costs to install the required infrastructure as well as significant O&M costs to operate, maintain, and monitoring the removal system..

Given the high costs and design challenges associated with constructing a continuous vertical barrier around the perimeter of the AOCs or along the entire western side of property, this type of barrier system will not be considered in the remedial alternatives for the DeLaval property. However, as indicated in Table 5, constructing relatively small bulkheads down-gradient of the AOCs will still be considered as part of the remedial design for the DeLaval site.

Construction of small bulkheads down-gradient of the AOCs would restrict the contaminant from migrating into the Hudson River, especially during the implementation of a remedy that would include the excavation of soils in the vicinity of the river. However, since a pump and treat system would not be installed up-gradient of the bulkheads under this design scenario, it is possible that groundwater flowing towards the bulkhead will surcharge slightly and flow beneath or around the ends of the bulkhead. While the bulkheads will not isolate the contamination, they will serve to reduce the washing effect of the impacted soils caused by the tidal fluctuations in the groundwater table and significantly restrict the movement of contaminants into the river. In addition, limiting the bulkhead construction to areas immediately down-gradient of the AOCs will significantly reduce the overall remedial costs for the site.

3.4.7 Removal & Disposal

Removal and disposal of the contaminated soils on the DeLaval site is considered an effective and implementable approach for managing the impacts to the site. The main drawback to removal and disposal is cost. Although disposing of/managing the contaminated materials in a corrective action management unit (CAMU) cell on-site will not be considered due to the proposed redevelopment on the site, off-site disposal will be retained for further evaluation. However, rather than disposing all contaminated materials off-site, disposal will likely be limited to grossly contaminated soils in attempt to minimize the disposal costs. In addition to excessive disposal costs, additional drawbacks associated with disposing all soils with contaminant levels present in excess of SCGs include temporary increased truck traffic through area communities and the long-term liability associated with disposing waste at another location.

3.5 DEVELOPMENT OF ALTERNATIVES

Based upon the preliminary evaluation and screening of available remedial technologies, a number of options remain for managing the site contaminants. The following list summarizes the technologies that were retained for further evaluation:

- Institutional & Ventilation Controls
- Natural Attenuation
- Low Temperature Thermal Desorption
- Enhanced Biodegradation
- Soil Cover
- Localized Vertical Barriers/Bulkheads
- Removal with Off-site Disposal

As indicated in previous sections, a majority of the retained technologies will not be considered sufficient as the sole remedy for the DeLaval site. Instead, some remedial alternatives will combine a number of these technologies to provide an effective, implementable, and cost-effective approach to remediating the site. The alternatives considered for the DeLaval site are presented in Section 4.0 of this report.

4.0 DETAILED ANALYSIS OF ALTERNATIVES

4.1 INTRODUCTION

The purpose of this section is to provide a detailed analysis of several remedial alternatives for managing the subsurface contaminants present at the DeLaval property. Section 4.2 provides a detailed analysis of each alternative while Section 4.3 is used to compare the alternatives to each other. The alternatives evaluated for the DeLaval site include the following:

1. No Action
2. Removal & Disposal of All Subsurface Contaminated Media
3. Source Removal, Soil Cover, Bulkheads & Natural Attenuation
4. Source Removal, Soil Cover, Bulkheads & Enhanced Biodegradation
5. Source Removal, Soil Cover, Bulkheads & LTTD

After the description of each alternative in Section 4.2, an assessment of the alternative is made, evaluating the alternative relative to the seven criteria established in Section 1.1 of this report. The NYSDEC will evaluate the eighth criterion, Community Acceptance, after the Public Comment period is complete. It should be noted, with the exception of the "No Action" alternative, each of the alternatives combines a number of process technologies to formulate a viable alternative for remediating the DeLaval site. Detailed costs estimates for each alternative have been included in Appendix A.

4.2 INDIVIDUAL ANALYSIS OF ALTERNATIVES

4.2.1 Alternative 1 – No Action

4.2.1.1 Description of Alternative 1

The "No Action" alternative was retained as a basis for comparison of other remedial alternatives. However, this alternative will not be selected as the site remedy because of the unacceptable levels of risk posed by the complete exposure pathways that result in a threat to human health and the environment by the DeLaval property. Natural processes, including degradation, dispersion, dilution, adsorption, volatilization, etc., would provide the only source of contaminant removal and there would be no active reduction in toxicity, mobility, or volume of the contaminants. Although cost estimate associated with this alternative does not include any additional monitoring of the site, CHA has assumed that it would cost approximately $30,000 for the City to implement institutional controls at the site to protect the public from the site as well as approximately $2,000 on an annual basis in operation and maintenance costs for these controls over the next 30 years, should development not proceed.

4.2.1.2 Assessment of Alternative 1

An analysis of the feasibility of the "No Action" alternative relative to the DeLaval site is included in Table 6.

Table 6. Evaluation of Alternative 1.

Criterion	Discussion
Protection of Human Health & the Environment	*Advantages:* ▪ Some institutional controls (e.g. signing, fencing) may be installed to deter trespassers from the site. *Disadvantages:* ▪ Remedial objectives not met. Unacceptable exposure levels for planned redevelopment to workers and community. Provides no reduction in subsurface contaminants or the potential for additional impact to the Hudson River. ▪ May take several years for site contaminants to attenuate, but unknown unless this alternative accompanied by monitoring.
Compliance with SCGs/ARARs	▪ Does not meet SCGs and will not likely meet them for several years (potentially well in excess of 30 years)
Long-Term Effectiveness & Permanence	*Advantages:* ▪ No significant advantages. *Disadvantages:* ▪ Not effective in meeting SCGs or ARARs within a reasonable length of time. ▪ Not effective in reducing future exposure levels to human health and the environment. Potential exists for continued contamination migration. ▪ Significant institutional controls and land-use restrictions necessary to ensure long-term protectiveness from contaminants and redevelopment of site for public access areas not feasible.
Reduction in Toxicity, Mobility, & Volume	*Advantages:* ▪ No advantages. *Disadvantages:* ▪ No reduction in toxicity, mobility, or volume of contaminants beyond natural attenuation. All contaminated media remains on site and site cannot be redeveloped.

Criterion	Discussion
Short-Term Effectiveness	*Advantages:* ▪ No intrusive activity eliminates exposures to workers during implementation of an intrusive remedial project. ▪ Hazards associated with open excavations avoided, such has fugitive dust emissions, storm water management, open trench hazards, hauling contaminated soils through residential communities, etc. ▪ No handling of chemical additives necessary. *Disadvantages:* ▪ Offers no protection to human health or the environment upon implementation.
Implementability	*Advantages:* ▪ Readily implemented with no significant technical requirements. *Disadvantages:* ▪ Significant institutional controls and administration needed to restrict current and future land-use at the site.
Cost	▪ Present Worth = $70,000. Lowest cost option. No active remediation or monitoring of site.

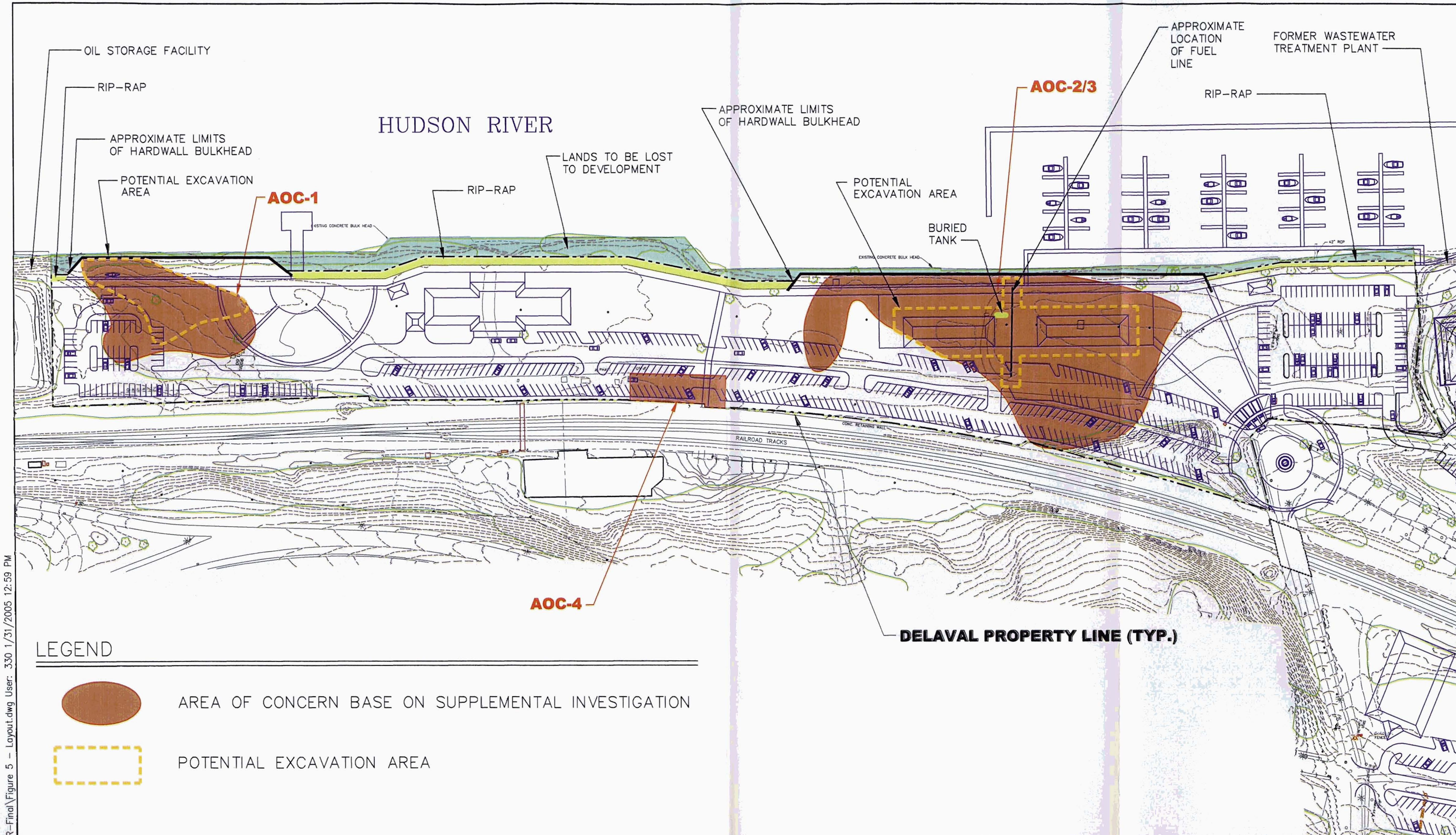
4.2.2 Alternative 2 – Removal & Disposal of All Subsurface Contaminated Media

4.2.2.1 Description of Alternative 2

Under Alternative 2, all contaminated soils in all of the AOCs, as well as the UST and six-inch pipe containing weathered fuel oil in AOC-2/AOC-3, would be excavated and disposed in a permitted off-site facility. However, an extensive dewatering system would likely need to be implemented to facilitate soil excavation beneath the water table, especially given the permeable soils beneath the site and the tidal influence of the Hudson River. In addition, all groundwater extracted from the site during the remedial action would be assumed to be contaminated and require treatment. In order, to minimize tidal effects from the Hudson River, it would be necessary to install watertight sheeting or other similar permanent or removable barrier around the perimeter of the AOCs. As previously noted, construction of a CAMU cell and on-site disposal of the contaminated media is restricted by the limited area on the property and the proposed redevelopment of the site.

Based upon the proposed redevelopment for the DeLaval property shown in Figure 5, the following areas were measured in an effort to estimate the costs associated with Alternatives 2 through 5:

- Total Property Area: 13.2± acres
- Total Planned Impervious Area: 8.1± acres
- Total Planned Green Space: 5.1± acres



NOTE:

BASEMAP PROVIDED FROM THE CHAZEN COMPANIES (TCC) PHASE SUBSURFACE INVESTIGATION REPORT, DATED MAY 2001.

0 150 300
Scale in feet

CHA
CLOUGH HARBOUR & ASSOCIATES LLP
III Winners Circle, PO Box 5269, Albany, NY 12205
www.cloughharbour.com

11205.1011.1102

DATE: JANUARY 2005

FIGURE 5
PROPOSED LAYOUT PLAN
&
POTENTIAL EXCAVATION AREAS
DELAVAL PROPERTY
CITY OF POUGHKEEPSIE
DUTCHESS COUNTY, STATE OF NEW YORK

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Given the type and concentration of contaminants found in the surface soils during the supplemental investigation, CHA is of the opinion that it would be unnecessary to place an engineered or synthetic cap over the DeLaval site. Instead, it is likely that placement of low-permeability surfaces, such as asphalt parking lots or concrete surfaces, would be sufficient to reduce human and some environmental exposures to the surface soils and residual contaminants. In the impervious areas, CHA has assumed that approximately one-half foot of soil will be excavated prior to the installation of the impervious surface.

In areas where proposed parking lots and other impervious surfaces are not installed (green space areas), an approximately one-foot thick soil cover would likely be sufficient to significantly reduce human exposure to the subsurface contaminants. In green space areas, CHA has also assumed that one-half foot of material will need to be removed to facilitate the installation of a soil cover. Therefore, approximately 10,650 cubic yards (18,700 tons) of soil would be excavated and disposed of off-site prior to the installation of the impervious surfaces or soil cover.

It should be noted that CHA has assumed that removing and disposing of the top one-half foot of soil across the entire site is necessary for Alternatives 2, 3, 4, and 5. However, this estimate is conservative and can likely be reduced during the design phase of the project. While some areas may not require any excavation, an average cut of one-half foot as been assumed. CHA has also assumed, for simplicity, that all of this material requires off-site disposal. While this is a conservative approach, it may be possible to use this excavated material elsewhere on the site as fill prior to placement of a soil cover system.

The combined footprint of all four AOCs is approximately 3.7-acres. Although additional investigation would be needed within each AOC to verify the vertical extent of the contamination beneath the DeLaval site, an average of twelve-feet has been assumed for the depth of the excavation. Excluding the top one-half foot of soil previously excavated for the soil cover, an excavation of this magnitude would result in the generation of approximately 68,700 cubic yards or on the order of 120,500 tons of soil and debris to dispose of. Thus, a total of approximately 79,350 cubic yards (139,200 tons) of soil and debris would require disposal for Alternative 2.

In order to backfill the AOCs, the same 86,600 cubic yards (152,200 tons) of soil would need be imported to the site. However, in order to install a one-foot thick soil cover over the green space areas, an additional 8,200 cubic yards (14,400 tons) of soil would need to be imported. Thus, a total of 94,800 cubic yards (166,400 tons) would need to be imported to the DeLaval site for Alternative 2. CHA has also included a lump sum cost for dust suppression during the excavations due to the presence of heavy metal-impacted surface soils on the DeLaval property. The costs for dust suppression are more significant with this Alternative compared to others because the magnitude of the excavation in this alternative and the estimated time to complete the excavations.

To effectively dewater the excavations and facilitate the excavations beneath the water table, CHA has estimated that approximately 43,500 square feet of sheeting (2,900 lineal feet around AOCs by fifteen feet deep) and approximately ten pumping wells around the AOCs would be required. It has been assumed that the extracted groundwater can be treated using GAC to remove the contaminants. The exact depth of the excavations, the location of the sheeting, the location of the dewatering wells, etc. would be determined during the design phase, should this alternative be selected as a remedy for the site.

CHA has assumed that the comprehensive analysis of four waste characterization samples would also be needed prior to a permitted disposal facility accepting the contaminated soils. It is anticipated that the excavation of all the impacted soils would require eight to twelve weeks of time to complete. After confirmatory samples are taken to ensure removal of the contaminated media, non-contaminated fill would then be trucked to the site and placed in the excavations. As a final measure, it will be necessary to replace three monitoring wells on the site and sample all of the on-site monitoring wells on a quarterly or semi-annual basis for a minimum period of two years to verify the success of the remedial program.

4.2.2.2 Assessment of Alternative 2

The following table provides a summary of the detailed assessment for removing and disposing all contaminated media from the DeLaval Property.

Table 7. Evaluation of Alternative 2.

Criterion	Discussion
Protection of Human Health & the Environment	*Advantages:* ▪ Removal of all contaminants will prevent further exposure risks to human health and the environment after remediation complete. ▪ Takes a relatively short period of time to achieve cleanup goals that will provide protection of human health and the environment. ▪ No secondary waste generated after remedial activities complete. *Disadvantages:* ▪ Alternative may not address all dissolved contaminants and some residual contaminants may continue to migrate towards the Hudson River.
Compliance with SCGs/ARARs	▪ Remedial objectives would be met following remediation because contaminated media will be replaced with clean fill. However, may not meet groundwater cleanup goals due to residual contaminants in the groundwater. ▪ Would have to collect samples to confirm that soil would not have to be managed as a hazardous waste. Disposing the impacted soils as hazardous waste could significantly increase disposal costs. ▪ May need to obtain a State Pollutant Discharge Elimination System (SPDES) permit to discharge treated groundwater.
Long-Term Effectiveness & Permanence	*Advantages:* ▪ Effective. Threats posed by site contaminants removed from site. ▪ Remedy is permanent because soils disposed off-site. *Disadvantages:* ▪ Residual contaminants may remain in groundwater for an extended period of time.
Reduction in Toxicity, Mobility, & Volume	*Advantages:* ▪ Volume of contaminants at DeLaval site reduced in short-time frame. *Disadvantages:* ▪ Contaminant mobility may be increased during excavation. Mobility of residual contaminants may be increased long-term depending upon hydraulic conductivity of soils used to backfill excavations. ▪ The overall volume and toxicity of the contaminants is not reduced, but rather transferred to a disposal facility.
Short-Term Effectiveness	*Advantages:* ▪ No chemical additives required for remediation. ▪ If impacted soils are disposed off-site, future exposure during redevelopment of the property would be substantially reduced. *Disadvantages:* ▪ Has potential to generate fugitive dust emissions and volatile emissions to air. Significant human exposure possible during intrusive excavations as well as safety hazards associated with deep excavations. ▪ Significant engineering controls required to reduce human and environmental exposures during intrusive excavation activities. ▪ Difficult to control storm water runoff during excavation. ▪ Large volume of excavated soil will likely result in increased truck traffic in local communities.

Criterion	Discussion
Implementability	*Advantages:* ▪ Readily implemented, except for installation of dewatering system. ▪ No long-term maintenance or utilities required. ▪ No construction of surface structures required to house remedial equipment that may impact future redevelopment of the site. ▪ Requires less extensive site characterization. *Disadvantages:* ▪ Designing a dewatering system to facilitate excavation beneath the water table difficult adjacent to a tidally influenced surface water. Removal of deep contaminated media (greater than fifteen feet) may not be feasible. ▪ Significant engineering controls required during excavation to reduce exposure to humans and the environment from volatile emissions, fugitive dust, deep excavation hazards, storm water runoff control, etc. ▪ Removing large quantities of soil off-site and importing clean fill will likely result in a significantly increased amount of truck traffic through local communities. ▪ No other activities or development will be supported until excavation and removal activities are complete. ▪ Technically difficult to remove impacted soils immediately adjacent to the Hudson River, some impacted soils may be left in place. Also, must use caution so that deep excavations do not damage adjacent foundations, such as the elevated railroad tracks along the east side of the site.
Cost	▪ Present Worth = $17.35 Million. Excessively high costs due to large quantity of material requiring off-site disposal and need to dewater AOCs prior to excavation. ▪ Typically higher overall remediation costs than other passive remediation methods. Not cost effective where significant quantities of impacted media are present and/or excavation beneath the water table is necessary.

4.2.3 Alternative 3 – Source Removal, Soil Cover, Bulkheads & Natural Attenuation

4.2.3.1 Description of Alternative 3

As with Alternative 2, excavation would be required for Alternatives 3, 4 and 5. However, rather than excavating all impacted soils for off-site disposal, the only soils grossly-impacted with petroleum in AOC-1 and AOC-2/AOC-3 would be excavated and disposed off-site. No excavation in AOC-4 will be conducted as part of Alternatives 3, 4, or 5, but this area will be covered by an asphalt parking area and one foot of clean soil cover in order to prevent direct exposure to surface soils. As a result of this screening process, the amount of soil requiring could be greatly reduced. After the source(s) of the petroleum contamination are removed, including the UST and six-inch diameter pipe containing weathered fuel oil, the residual soil and groundwater contaminants would be addressed. The excavation would be limited to the unsaturated (vadose) zone in each of these three alternatives, but any free product, if encountered, would be collected for treatment. Given the documented impact to surface soils on the DeLaval property, Alternatives 3, 4, and 5 will also include the installation of a soil cover over all green space areas to reduce human exposure to the contaminants found to be present in the surface soils. As with Alternative 2, the top one-half foot of soil across the DeLaval site, or approximately 10,650 cubic yards (18,700 tons) of soil, would be excavated from the surface prior to the installation of the impervious surfaces or soil cover (approximately one-half foot across the entire DeLaval property).

The soil volumes stated above are meant to represent a simplistic/conservative estimate. Depending upon the site grades selected during the design phase of the project, it is likely that less surface soil will require excavation and off-site disposal prior to the installation of the soil cover. A viable alternative to off-site disposal of surface soils would be to utilize some or all of this material on-site as fill beneath the soil cover where site conditions warrant and fill is needed. This could occur in the south west portion of the site on the land side of the bulkhead as well as at other locations along the shoreline where finished grades are to be increased and filling will be required in order to satisfy the site development design. As a result, the actual fate of this material will be determined during the design phase of the project and will greatly depend on final site development grades.

CHA has previously estimated that the source removal excavation zone will be approximately 35,000 square-feet in area within AOC-2/AOC-3, based upon the length of the identified pipeline, location of the UST, and the footprint of the buildings to be constructed in this area (refer to Figure 5). CHA has also estimated that the excavation area in AOC-1 will be approximately 18,600-square feet in area. If the grossly impacted soils are removed to the groundwater table (an assumed depth of seven feet below the ground surface), a total of approximately 12,900 cubic yards (22,650 tons) of grossly-contaminated soil and debris would be removed from AOC-1 and AOC-2/AOC-3, excluding the top one-half foot of soil already included in the quantity likely to be removed for the soil cover installation.

As a result, Alternatives 3, 4, and 5 may require the excavation and disposal of a total of approximately 23,550 cubic yards (41,350 tons), including grossly contaminated soil and the material which may have to be removed in order to ready the site for soil cover installation. In addition, it is anticipated that approximately 175 tons of concrete would need to be removed and disposed with the six-inch pipe and UST. CHA notes that additional delineation of the grossly contaminated soils in AOC-1 and AOC-2/AOC-3 and/or field screening activities conducted during construction could result in a further reduction in the quantity of soil requiring off-site disposal.

After all excavations are complete, AOC-1 and AOC-2/AOC-3 will be backfilled using roughly 12,900 cubic yards (22,650 tons) of clean fill or surface soils. As with Alternative 2, a one-foot thick soil cover will be installed over only the green space areas, requiring an additional 8,200 cubic yards (14,400 tons) of clean soil to be imported to the site. Therefore, a total of 21,100 cubic yards (37,050 tons) of imported fill will be necessary for Alternative 3, 4 and 5 if none of the surficial soils are used as fill beneath the soil cover.

Although this is a significant quantity of material to dispose and import, it represents an approximately eighty (80) percent reduction when compared to Alternative 2. To restrict potential migration of contaminants migrating towards the Hudson River, a ballasted bulkhead wall will be installed down-gradient of AOC-1 and AOC-2/AOC-3 adjacent to the Hudson River. The construction of the bulkhead will require the installation of a temporary turbidity curtain in the river. The use of turbidity curtain and floating boom system will contain any contaminants that may be release from the DeLaval site as the new bulkhead is installed and portions of the old bulkhead are removed.

Alternatives 3, 4 and 5 would also require the use of ICs to protect human health and the environment against the residual contaminants. The most important ICs would be land use restrictions (e.g. the site cannot be use for an elementary school, daycare center, etc.), restrictions on the use of groundwater beneath the site, and restrictions of any future excavations at the site. Any structures placed in the AOCs would require a sub-slab depressurization system to prevent potential human exposure to volatiles migrating into the structures. CHA has included costs to install sub-slab depressurization systems for the two proposed buildings located within the footprint of AOC-2/AOC-3 and extract and treat any free product encountered during the excavation of AOC-1 and AOC-2/AOC-3.

Since residual contaminants will remain at the DeLaval property after the source removal is complete, it will also be necessary to use the recently installed monitoring wells on the DeLaval property to monitor the site after the active remedial activities are complete. It is expected that six newly installed monitoring wells will be used to monitor the attenuation of the residuals; however, the contaminant concentrations are expected to reach the cleanup goals quicker given that the most contaminated soils will have been removed from the site. Therefore, only ten years of post-action monitoring have been included in the Alternative 3 costs.

Alternative 3 differs from Alternatives 4 & 5 in that the residual soil and groundwater contamination would be remediated by natural attenuation. While natural attenuation is not appropriate for the sole remedy for the site given the reported presence of grossly contaminated soils on the site and desired timeframe for site redevelopment, it has been considered as a potential alternative for managing residual contaminants.

4.2.3.2 Assessment of Alternative 3

The following table provides a summary of the detailed assessment for removing the source of the petroleum contamination, installing soil cover over the residual contaminated areas, installing bulkheads down-gradient of AOC-1 and AOC-2/AOC-3, and utilizing monitored natural attenuation to manage the residual contaminants.

Table 8. Evaluation of Alternative 3.

Criterion	Discussion
Protection of Human Health & the Environment	*Advantages:* ▪ The most significantly impacted soils will be removed and disposed of off-site. ▪ The source of the petroleum contamination will be removed and there will be no additional contaminants introduced to the environment. ▪ Technology expected to protect human health and the environment by reducing contaminant concentrations in groundwater as well as the soils. ▪ Alternative generates no surface water discharge from pump & treat system. ▪ No chemical additives required for remediation. ▪ Short timeframe required for achieving cleanup goals compared to natural attenuation as a sole remedy, PRBs, etc. *Disadvantages:* ▪ Alternative will not immediately address all dissolved contaminants and some residual contaminants may continue to migrate towards the Hudson River. However, after the source of the contamination is removed, it is likely that the residual contaminants could be remediated by natural attenuation, given sufficient time.

Criterion	Discussion
Compliance with SCGs/ARARs	▪ Majority of the soils with contaminant concentrations exceeding the ARARs would be removed and replaced with clean fill. ▪ Natural attenuation would continue to reduce contaminant concentrations towards cleanup criteria after active remediation is complete. ▪ Would have to collect samples to confirm that soil would not have to be managed as a hazardous waste. Disposing the impacted soils as hazardous waste could significantly increase disposal costs.
Long-Term Effectiveness & Permanence	*Advantages:* ▪ Effective. The most significantly impacted media would be permanently removed from the site. ▪ Significantly reduces the amount of contaminants that could potentially migrate towards the Hudson River and the amount of contaminants requiring attenuation. ▪ Placing a low permeability surface or soil cover over the residually contaminated soils would reduce human exposure to the residual subsurface contaminants. ▪ Less restrictive land use controls necessary after remedial work complete. *Disadvantages:* ▪ Residual contaminants may remain in groundwater for an extended period of time. Longer timeframes required to reach cleanup goals. ▪ If additional contaminants desorb from the soil after the active remediation is complete, there could be temporary increase in the contaminant concentrations in the groundwater. ▪ Further evaluation of the groundwater chemistry is necessary to determine if the existing groundwater quality is supportive of biodegradation without amendments. ▪ Land use controls may be necessary to ensure long-term protectiveness.
Reduction in Toxicity, Mobility, & Volume	*Advantages:* ▪ Most heavily impacted soils would be removed for off-site disposal, reducing the level of toxicity of the contaminants on the DeLaval site. Toxicity of residuals will be reduced by natural attenuation and biodegradation. ▪ Removal of grossly contaminated soils and free product will significantly reduce the amount of contaminants potentially migrating towards the Hudson River. ▪ Volume of contaminants at DeLaval site reduced in short-time frame. *Disadvantages:* ▪ Contaminant mobility may be increased during excavation. May be increased long-term depending upon hydraulic conductivity of soils used to backfill excavations. ▪ A significant portion of the reduction in toxicity and mobility is not attributable to the breakdown or destruction of the contaminants, but rather transferred to a disposal facility. ▪ Natural biodegradation of the residual contaminants is a relatively slow process.

Criterion	Discussion
Short-Term Effectiveness	*Advantages:* ▪ Potential exposures during the redevelopment of the site would be significantly reduced. ▪ Risks to community and workers could be reduced by establishing buffer zones, limiting work hours, conducting air monitoring, developing a site-specific health and safety plan (HASP), etc. *Disadvantages:* ▪ Significant engineering controls required to reduce human and environmental exposures during intrusive excavation activities. ▪ Has potential to generate fugitive dust emissions and volatile emissions to air. Significant human exposure possible during intrusive excavations as well as safety hazards associated with excavations. ▪ Difficult to control storm water runoff during excavation. ▪ Large volume of excavated soil will likely result in increased truck traffic in local communities.
Implementability	*Advantages:* ▪ Readily implemented and technically feasible, although the number of components to the cleanup is somewhat complex. ▪ No long-term maintenance or utilities required, except for sub-slab depressurization systems, which require little energy or maintenance and are readily available. ▪ No construction of surface structures required to house remedial equipment that may impact future redevelopment of the site. ▪ Requires less extensive site characterization. *Disadvantages:* ▪ Requires additional subsurface investigation to delineate areas of grossly contaminated soils/free product, where excavation is needed. ▪ Significant engineering controls required during excavation to reduce exposure to humans and the environment from volatile emissions, fugitive dust, deep excavation hazards, storm water runoff control, etc. ▪ Removing large quantities of soil off-site and importing clean fill will likely result in an increased amount of truck traffic through local communities, although not as much as would be associated with complete removal. ▪ No other activities or development will be supported until excavation and removal activities complete. ▪ Technically difficult to remove impacted soils immediately adjacent to the Hudson River, some impacted soils may be left in place.
Cost	▪ Present Worth = $7.86 Million. ▪ Given the high costs of land disposal, it is practical to attempt to reduce the quantity of soil being disposed off-site, while also reducing the potential threats to receptors within a timeframe that will support redevelopment. ▪ Some long-term monitoring of the groundwater quality beneath the DeLaval site will be required, but the monitoring period has been reduced to ten years given the removal of grossly-contaminated soils and free product from the site.

4.2.4 Alternative 4 – Source Removal, Soil Cover, Bulkheads & Enhanced Biodegradation

4.2.4.1 Description of Alternative 4

Alternative 4 is similar to Alternative 3, with the main difference being that chemicals/nutrients would be injected into the subsurface to enhance the natural biodegradation process for the residual contaminants remaining in the ground water associated with AOCs-2, 3 & 4. Depending upon the existing groundwater chemistry at the site and the type of residual contaminants, various compounds could be injected into the groundwater to provide additional nutrients to the naturally occurring microorganisms. The nutrients will not necessarily increase the rate of these biotic reactions, but rather increase the growth rate of the microorganisms. As the biomass increases, there are more and more microorganisms available to breakdown a fixed amount of contaminants to less toxic or non-toxic compounds.

The difference in cost between Alternative 3 and Alternative 4 is based upon the additional cost to inject the nutrients (assumed ORC®) versus the reduced monitoring time. Since the biodegradation of the residual contaminants in the groundwater would be enhanced, CHA has assumed that the remedial goals could be met sooner and the monitoring time could be reduced to five years.

4.2.4.2 Assessment of Alternative 4

The assessment of Alternative 4 is similar to the assessment presented previously in Table 8 for Alternative 3. However, the main differences are as follows:

- Enhancing the natural biodegradation process will likely expedite the breakdown of the residual contaminants and shorten the timeframe required to achieve the cleanup goals. For the purposes of comparison, CHA has assumed that the post-action monitoring period could be shortened to five years.
- One trade-off with this alternative is that chemicals will be brought onto the site. However, most of these chemicals are non-hazardous materials and nutrients and pose no threat to human health or the environment.

- Given the amount of debris observed beneath the site, it is unclear how well the injections will be dispersed. In addition, the depth to bedrock or a confining soil is unknown, and therefore, it is unknown how deep the injections would need to be. Increasing the number or depth of the injections could significantly raise the costs associated with this alternative.

- The nutrients injected may be exhausted before the contaminants are completely broken down. However, after the site redevelopment is complete, the addition of more chemicals via injection may not be feasible or result in excessive costs to restore the site.

- The cost for Alternative 4 is estimated to be approximately $8.68 Million. Based upon the preliminary cost estimates, the shortened post-action monitoring period does not offset the costs associated with the nutrient injections.

- The focus of this technology is on the remediation of groundwater. Since the analytical results for the site derived from the recent supplemental investigation indicate that there has been a slight impact to the groundwater quality beneath the site, the benefits of using ORC®, if any, are not offset by the additional cost.

4.2.5 Alternative 5 – Source Removal, Sol Cover, Bulkheads & LTTD

4.2.5.1 Description of Alternative 5

Alternative 5 is similar to Alternative 3, with the main difference being that residually contaminated soils in AOCs-2, 3 & 4 would be treated by low temperature thermal desorption (LTTD). In order to treat the residually contaminated soils, they must first be excavated and processed. The processing may include removal of all material larger than two-inches in any one dimension, drying the soils, applying water mist to control dust, etc. Given the significant amount of debris in AOC-1 and the presence of PCBs along the northwest side of AOC-1, LTTD will not be considered for this area.

After the soils are processed, they must be loaded into a hopper for treatment, and then handled again to place the treated soil into stockpiles. All stockpiles would likely need to be covered with polyethylene sheeting until analytical results confirmed satisfactory treatment. Upon successfully treating the soils, they could be placed back into the excavations in a controlled fashion (e.g. proper compaction), thus reducing the amount of clean fill that must be imported to the site and the cost of the fill material. However, imported fill will still be required to fill the areas where grossly contaminated soils are excavated and removed off-site for disposal. In addition, any debris or large objects not treated with LTTD would require appropriate decontamination and/or off-site disposal.

The items included in the cost estimate for Alternative 5 are also similar to Alternative 3. However, the costs associated with mobilizing a LTTD system and thermally treating the soil has been included in this alternative. For simplicity, CHA has not included any costs for infrastructure improvements, special permits, disposal or special treatment for screened-out debris, etc. Unlike enhanced biodegradation, LTTD does little to promote the biodegradation of the contaminants in the groundwater. Since the grossly impacted soils/free product would be removed from the site and the vadose zone soils would be treated, CHA has assumed that the required timeframe for monitoring the groundwater quality beneath the site could be reduced to approximately five years. Although the top seven (7) feet of soil in AOCs-2/AOC-3 and AOC-4 would be considered remediated, it would still be necessary to place a soil cover over the green space areas outside the limits of the excavation area to limit the potential for human exposure from the contaminants identified in the surface soils.

4.2.5.2 Assessment of Alternative 5

The assessment of Alternative 5 is similar to the assessment previously summarized in Table 8 for Alternative 3. However, the main differences are as follows:

- Applying LTTD to treat residually contaminated vadose zone soils will shorten the timeframe required to achieve the cleanup goals. Although cleanup of the vadose zone soils would be completed after the active remedial phase is finished, the contaminants in the groundwater would be left to natural attenuation. Even soils with elevated moisture content may require pretreatment or lime supplementation prior to treating with the LTTD system. Soil properties, such as plasticity, particle size, quantity of humic material, etc., would need to be determined for the site to better determine the requirements of a soil processing operation prior to treatment.

- It would still be necessary to cover green space areas outside the limits of the excavation area on the DeLaval site given the presence of elevated levels of contaminants in the surface soils. However, by treating the top seven feet of soil in each AOC, it would be less likely that impacted soils would be encountered in excavations for utilities and foundations installed as part of the site redevelopment.

- Requires significant pre- and post-treatment sampling to verify effectiveness of treatment. Must keep all stockpiles covered until satisfactory treatment is demonstrated through analytical testing.
- Monitoring of the groundwater to evaluate the effectiveness of natural attenuation of residuals may extend for as much as five (5) years or more.
- May extend the timeframe needed for perimeter air monitoring and site security because the excavations will be required to be open longer while awaiting confirmatory analytical results to verify treatment.
- Some metals may desorb from the soil during the heating process, resulting in an apparent increase in the metal concentrations in the soil and groundwater.
- While the most significant PCB impact was identified in AOC-1 where no LTTD treat is anticipated, low-levels of PCBs were identified elsewhere on the site. Therefore, appropriate air treatment equipment would need to be installed on the LTTD system.
- Large-scale LTTD equipment would have to be mobilized to the site and there is limited room on site to excavate the AOCs, setup the LTTD equipment, manage and store soil stockpiles (pre- and post-treatment), etc. In addition to the lack of room on site, there may be insufficient infrastructure on-site to facilitate a LTTD operation. While an alternative fuel source from natural gas (e.g. propane) may be shipped into the project area, a LTTD system would also require a fairly substantial electric source and source of potable water. If the utilities are not yet available, funding to install them may not be available until the project redevelopment begins.
- LTTD treatment of fuel oils may require higher operating temperatures to achieve the desired treatment, resulting in higher fuel consumption and fuel costs.
- Typically, LTTD systems cannot process any materials larger than two inches in any dimension. Given the amount of debris encountered in some of the test pits excavated by TCC, it is likely that a substantial amount of the material will be segregated out of the LTTD process that will require separate decontamination or treatment and/or disposal.
- Pilot-testing of a LTTD could be expensive.
- May require the construction of secondary containment pad to reduce the likelihood of cross-contaminating uncontaminated surface soils.
- The cost for Alternative 5 is estimated to be approximately $9.60 Million. Since this alternative provides no active remediation of the groundwater, it is assumed that at least five years of post-remedial groundwater monitoring will be necessary. Therefore, there is no significant long-term cost savings realized by implementing LTTD at the site.

4.3 COMPARATIVE ANALYSIS

Table 9 provides a comparative summary of each remedial alternative relative to the seven criteria presented in Section 1.2 of this report. The following subsections provide a brief comparison of the alternatives relative to the same seven criteria used to evaluate the alternatives individually. As previously identified in Section 1.1 of this RAR, the alternatives have been compared based upon the following seven criteria:

1. Overall protection of human health and the environment
2. Compliance with Standards, Criteria, and Guidance
3. Long-term effectiveness and permanence
4. Reduction in toxicity, mobility, and volume
5. Short-term effectiveness
6. Implementability
7. Cost
8. Community Acceptance

The community acceptance criterion will be evaluated by the NYSDEC after the public comment period is complete. More specifically, concerns of the community regarding the SI/RAR reports and the Proposed Remedial Action Plan (PRAP) will be evaluated. A responsiveness summary will be prepared that describes public comments received and the manner in which the NYSDEC will address the concerns raised. If the selected remedy differs significantly from the proposed remedy, notices to the public will be issued describing the differences and reasons for the changes.

4.3.1 Protection of Human Health & the Environment

As previously discussed, Alternative 1 – No Action was maintained for a baseline comparison of the alternatives and is not considered sufficiently protective of human health and the environment given the presence of free product and grossly contaminated soils at the site. Therefore, Alternative 1 will not be selected as the preferred alternative for managing the contamination at the DeLaval site. Complete removal and off-site disposal of all contaminated media (Alternative 2) would provide the

Table 9. Comparative Analysis of Alternatives.

Criterion	Alternative 1 – No Action	Alternative 2 – Remove & Dispose All Contaminated Media	Alternative 3 – Source Removal, Soil Cover, Bulkheads & Natural Attenuation	Alternative 4 – Source Removal, Soil Cover, Bulkheads & Enhanced Biodegradation	Alternative 5 – Source Removal, Soil Cover, Bulkheads & Low Temperature Thermal Desorption
Protection of Human Health & the Environment	*Advantages:* • Some institutional controls (e.g. signing, fencing) may be installed to deter trespassers from the site. *Disadvantages:* • Remedial objectives not met. Unacceptable exposure levels if planned redevelopment occurs. Also, no protection to adjacent surface water (Hudson River). • May take several years for site contaminants to attenuate, but unknown unless this alternative accompanied by monitoring.	*Advantages:* • Removal of all contaminants will prevent further exposure risks to human health and the environment after remediation complete. • Takes a relatively short period of time to achieve cleanup goals. • No secondary waste generated after construction complete. • Short timeframe required for achieving cleanup goals compared to natural attenuation as a sole remedy, PRBs, etc. *Disadvantages:* • Alternative may not address all dissolved contaminants and some residual contaminants may continue to migrate towards the Hudson River.	*Advantages:* • The most significantly impacted soils will be removed and disposed of off-site. • The source of the petroleum contamination will be removed and there will be no additional contaminants introduced to the environment. • Soil cover will reduce for potential human contact with residuals after redevelopment complete and reduce surface water infiltration. • Technology expected to protect human health and the environment by reducing contaminant concentrations in groundwater as well as the soils. • Alternative generates no surface water discharge from pump & treat system. • No chemical additives required for remediation. *Disadvantages:* • Alternative will not immediately address all dissolved contaminants and some residual contaminants may continue to migrate towards the Hudson River. However, after the source of the contamination is removed, it is likely that the residual contaminants could be remediated by natural attenuation, given sufficient time.	*Advantages:* • The most significantly impacted soils will be removed and disposed of off-site. • The source of the petroleum contamination will be removed and there will be no additional contaminants introduced to the environment. • Soil cover will reduce for potential human contact with residuals after redevelopment complete and reduce surface water infiltration. • Technology expected to protect human health and the environment by reducing contaminant concentrations in groundwater as well as the soils. • Alternative generates no surface water discharge from pump & treat system. • Alternative will address dissolved contaminants and reduce amount of residual contaminants that may continue to migrate towards the Hudson River. *Disadvantages:* • Alternative will not immediately address all dissolved contaminants and some residual contaminants may continue to migrate towards the Hudson River. However, after the source of the contamination is removed, it is likely that the residual contaminants could be remediated by natural attenuation, given sufficient time.	*Advantages:* • The most significantly impacted soils will be removed and disposed of off-site. • The source of the petroleum contamination will be removed and there will be no additional contaminants introduced to the environment. • Soil cover will reduce for potential human contact with residuals after redevelopment complete and reduce surface water infiltration. • Technology expected to protect human health and the environment by reducing contaminant concentrations in groundwater as well as the soils. • Alternative generates no surface water discharge from pump & treat system. • No chemical additives required for remediation. *Disadvantages:* • Alternative will not immediately address all dissolved contaminants and some residual contaminants may continue to migrate towards the Hudson River. However, after the source of the contamination is removed, it is likely that the residual contaminants could be remediated by natural attenuation, given sufficient time.
Compliance with SCGs/ARARs	Does not meet SCGs and will not likely meet them for several years (potentially in excess of 30 years)	• Remedial objectives would be met following remediation because contaminated media will be replaced with clean fill. However, may not meet groundwater cleanup goals due to residuals. • Would have to collect samples to confirm that soil would not have to be managed as a hazardous waste. Disposing the impacted soils as hazardous waste could significantly increase disposal costs. • May need to obtain a State Pollutant Discharge Elimination System (SPDES) permit to discharge treated groundwater.	• Majority of the soils with contaminant concentrations exceeding the ARARs would be removed and replaced with clean fill. • Natural attenuation would continue to reduce contaminant concentrations towards cleanup criteria after active remediation complete. • Would have to collect samples to confirm that soil would not have to be managed as a hazardous waste. Disposing the impacted soils as hazardous waste could significantly increase disposal costs.	• Majority of the soils with contaminant concentrations exceeding the ARARs would be removed and replaced with clean fill. • Enhanced Natural attenuation would continue to reduce contaminant concentrations levels towards cleanup criteria after active remediation complete at faster rate than Alternative 3. • Would have to collect samples to confirm that soil would not have to be managed as a hazardous waste. Disposing the impacted soils as hazardous waste could significantly increase disposal costs.	• Majority of the soils with contaminant concentrations exceeding the ARARs would be removed and replaced with clean fill. • Natural attenuation would continue to reduce contaminant concentrations in groundwater towards cleanup criteria after active remediation complete. • Would have to collect samples to confirm that soil would not have to be managed as a hazardous waste. Disposing the impacted soils as hazardous waste could significantly increase disposal costs. • Requires significant pre- and post-treatment sampling to verify effectiveness of treatment. • May need permit for air discharge.
Long-Term Effectiveness & Permanence	*Advantages:* • No significant advantages. *Disadvantages:* • Not effective in meeting SCGs or ARARs within a reasonable length of time. • Not effective in reducing future exposure levels to human health and the environment. Potential exists for continued contamination migration. • Significant institutional controls and land-use restrictions necessary to ensure long-term protectiveness from contaminants and redevelopment of site for public access areas not feasible.	*Advantages:* • Effective. Threats posed by site contaminants removed from site. • Remedy is permanent because soils disposed off-site. • Less restrictive land use controls necessary after remedial work completed. *Disadvantages:* • Residual contaminants may remain in groundwater for an extended period of time.	*Advantages:* • Effective. The most significantly impacted media would be permanently removed from the site. • Significantly reduces the amount of contaminants that could potentially migrate towards the Hudson River and the amount of contaminants requiring attenuation. • Placing a low permeability surface or soil cover over the residually contaminated soils would reduce human exposure to the residual subsurface contaminants. *Disadvantages:* • Residual contaminants may remain in groundwater for an extended period of time. Longer timeframes required to reach cleanup goals. • If additional contaminants desorb from the soil after the active remediation is complete, there could be temporary increase in the contaminant concentrations in the groundwater. • Further evaluation of the groundwater chemistry may be necessary to determine if the existing groundwater quality is supportive of biodegradation without amendments. • Land use controls may be necessary to ensure long-term protectiveness.	*Advantages:* • Effective. The most significantly impacted media would be permanently removed from the site. • Significantly reduces the amount of contaminants that could potentially migrate towards the Hudson River and the amount of contaminants requiring attenuation. • Placing a low permeability surface or soil cover over the residually contaminated soils would reduce human exposure to the residual subsurface contaminants. *Disadvantages:* • Residual contaminants may remain in groundwater for an extended period of time. However, enhancing natural biodegradation will reduce timeframes required to reach cleanup goals. • If additional contaminants desorb from the soil after the active remediation is complete, there could be temporary increase in the contaminant concentrations in the groundwater. • Further evaluation of the groundwater chemistry is necessary to determine if the existing groundwater quality is supportive of biodegradation. • Land use controls may be necessary to ensure long-term protectiveness.	*Advantages:* • Effective. The most significantly impacted media would be permanently removed from the site. • Significantly reduces the amount of contaminants that could potentially migrate towards the Hudson River and the amount of contaminants requiring attenuation. *Disadvantages:* • Residual contaminants may remain in groundwater for an extended period of time. Longer timeframes required to reach cleanup goals. • If additional contaminants desorb from the soil after the active remediation is complete, there could be temporary increase in the contaminant concentrations in the groundwater. • Some metals may desorb from the soil during the treatment process resulting in an increase in metal contaminant concentrations. • Further evaluation of the soil properties is necessary to determine what level of soil processing necessary prior to treatment. • Land use controls may be necessary to ensure long-term protectiveness. • Placement of a soil cover over most green space still required due to contaminants in surface soils.
Reduction in Toxicity, Mobility & Volume	*Advantages:* • No advantages. *Disadvantages:* • No reduction in toxicity, mobility, or volume of contaminants beyond natural attenuation. All contaminated media remains on site and site cannot be redeveloped.	*Advantages:* • Volume of contaminants at DeLaval site reduced in short-time frame. *Disadvantages:* • Contaminant mobility may be increased during excavation. Mobility of residual contaminants may be increased long-term depending upon hydraulic conductivity of soils used to backfill excavations. • The overall volume and toxicity of the contaminants is not reduced, but rather transferred to a disposal facility.	*Advantages:* • Most heavily impacted soils would be removed for off-site disposal, reducing the level of toxicity of the contaminants on the DeLaval site. Toxicity of residuals will be reduced by natural attenuation and biodegradation. • Removal of grossly stained soils and free product will significantly reduce the amount of contaminants migrating towards the Hudson River. • Volume of contaminants at DeLaval site reduced in short-time frame. *Disadvantages:* • Contaminant mobility may be increased during excavation. May be increased long-term depending upon hydraulic conductivity of soils used to backfill excavations. • A significant portion of the reduction in toxicity and mobility is not attributable to the breakdown or destruction of the contaminants, but rather transferred to a disposal facility. • Natural biodegradation of the residual contaminants is a relatively slow process.	*Advantages:* • Most heavily impacted soils would be removed for off-site disposal, reducing the level of toxicity of the contaminants on the DeLaval site. Toxicity of residuals will be reduced by natural attenuation and biodegradation. • Removal of grossly stained soils and free product will significantly reduce the amount of contaminants migrating towards the Hudson River. • Volume of contaminants at DeLaval site reduced in short-time frame. • Natural biodegradation of the residual contaminants is a relatively slow process, but faster when enhanced w/ nutrients. *Disadvantages:* • Contaminant mobility may be increased during excavation. May be increased long-term depending upon hydraulic conductivity of soils used to backfill excavations. • A significant portion of the reduction in toxicity and mobility is not attributable to the breakdown or destruction of the contaminants, but rather transferred to a disposal facility.	*Advantages:* • Most heavily impacted soils would be removed for off-site disposal, reducing the level of toxicity of the contaminants on the DeLaval site. Toxicity of residuals will be reduced by natural attenuation and biodegradation. • Removal of grossly stained soils and free product will significantly reduce the amount of contaminants migrating towards the Hudson River. • Volume of contaminants at DeLaval site reduced in short-time frame. *Disadvantages:* • Contaminant mobility may be increased during excavation. May be increased long-term depending upon hydraulic conductivity of soils used to backfill excavations. • A significant portion of the reduction in toxicity and mobility is not attributable to the breakdown or destruction of the contaminants, but rather transferred to a disposal facility. • Natural biodegradation of the residual contaminants is a relatively slow process.

Criterion	Alternative 1 – No Action	Alternative 2 – Remove & Dispose All Contaminated Media	Alternative 3 – Source Removal, Soil Cover, Bulkheads & Natural Attenuation	Alternative 4 – Source Removal, Soil Cover, Bulkheads & Enhanced Biodegradation	Alternative 5 – Source Removal, Soil Cover, Bulkheads & Low Temperature Thermal Desorption
Short-Term Effectiveness	*Advantages:* • No intrusive activities eliminates exposures to workers during implementation. • Hazards associated with open excavations avoided, such has fugitive dust emissions, storm water management, open trench hazards, hauling contaminated soils through residential communities, etc. • No handling of chemical additives necessary. *Disadvantages:* • Offers no protection to human health or the environment during the construction associated with the redevelopment of the property.	*Advantages:* ▪ No chemical additives required for remediation. ▪ If impacted soils are disposed off-site, future exposure during redevelopment of the property would be substantially reduced. *Disadvantages:* ▪ Has potential to generate fugitive dust emissions and volatile emissions to air. Significant human exposure possible during intrusive excavations as well as safety hazards associated with deep excavations. ▪ Significant engineering controls required to reduce human and environmental exposures during intrusive excavation activities. ▪ Difficult to control storm water runoff during excavation. ▪ Large volume of excavated soil will likely result in increased truck traffic in local communities.	*Advantages:* ▪ Potential exposures during the redevelopment of the site would be significantly reduced. ▪ Risks to community and workers could be reduced by establishing buffer zones, limiting work hours, conducting air monitoring, developing a site-specific health and safety plan (HASP), etc. ▪ Excavations open for short-periods of time reducing the amount of site control, stormwater management, etc. need for remedial work. *Disadvantages:* ▪ Has potential to generate fugitive dust emissions and volatile emissions to air. Significant human exposure possible during intrusive excavations as well as safety hazards associated with deep excavations. ▪ Significant engineering controls required to reduce human and environmental exposures during intrusive excavation activities. ▪ Large volume of excavated soil will likely result in increased truck traffic in local communities.	*Advantages:* ▪ If most heavily impacted soils are disposed off-site. future exposure during redevelopment of the property would be substantially reduced. ▪ Short timeframe required for achieving cleanup goals compared to natural attenuation as a sole remedy, PRBs, etc. ▪ Risks to community and workers could be reduced by establishing buffer zones, limiting work hours, conducting air monitoring, developing a site-specific health and safety plan (HASP), etc. *Disadvantages:* ▪ Has potential to generate fugitive dust emissions and volatile emissions to air. Significant human exposure possible during intrusive excavations as well as safety hazards associated with deep excavations. ▪ Significant engineering controls required to reduce human and environmental exposures during intrusive excavation activities. ▪ Difficult to control storm water runoff during excavation. ▪ Large volume of excavated soil will likely result in increased truck traffic in local communities. ▪ Requires handling of chemicals/nutrients during implementation of remedial activities.	*Advantages:* ▪ If most heavily impacted soils are disposed off-site. future exposure during redevelopment of the property would be substantially reduced, especially since almost all contaminants in vadose zone are removed. ▪ Short timeframe required for achieving cleanup goals compared to natural attenuation as a sole remedy, PRBs, etc. ▪ Risks to community and workers could be reduced by establishing buffer zones, limiting work hours, conducting air monitoring, developing a site-specific health and safety plan (HASP), etc. *Disadvantages:* ▪ Has potential to generate fugitive dust emissions and volatile emissions to air. Significant human exposure possible during intrusive excavations as well as safety hazards associated with deep excavations. ▪ Significant engineering controls required to reduce human and environmental exposures during intrusive excavation activities. ▪ Difficult to control storm water runoff during excavation. ▪ Large volume of excavated soil will likely result in increased truck traffic in local communities. ▪ Excavations left open for longer time periods. Must cover excavation faces and stockpiles to reduce fugitive dust and volatilization of contaminants. Additional perimeter air monitoring may be necessary.
Implementability	*Advantages:* • Readily implemented with no significant technical requirements. *Disadvantages:* • Significant institutional controls and administration needed to restrict current and future land-use at the site.	*Advantages:* ▪ Readily implemented, except for installation of dewatering system. ▪ No long-term maintenance or utilities required. ▪ No construction of surface structures required to house remedial equipment that may impact future redevelopment of the site. ▪ Requires less extensive site characterization. *Disadvantages:* ▪ Designing a dewatering system to facilitate excavation beneath the water table difficult adjacent to a tidally influenced surface water. Removal of deep contaminated media (greater than fifteen feet) may not be feasible. ▪ Significant engineering controls required during excavation to reduce exposure to humans and the environment from volatile emissions, fugitive dust, deep excavation hazards, stormwater runoff control, etc. ▪ Removing large quantities of soil off-site and importing clean fill will likely result in a significantly increased amount of truck traffic through local communities. ▪ No other activities or development will be supported until excavation and removal activities are complete. ▪ May be difficult to obtain sufficient "clean" soils for backfilling excavations. ▪ Technically difficult to remove impacted soils immediately adjacent to the Hudson River, some impacted soils may be left in place. Also, must use caution so that deep excavations do not damage adjacent foundations, such as the elevated railroad tracks along the east side of the site.	*Advantages:* ▪ Readily implemented and technically feasible, although the number of components to the cleanup is somewhat complex. ▪ No long-term maintenance or utilities required, except for sub-slab depressurization system, which require little energy or maintenance and are readily accessible. ▪ No construction of surface structures required to house remedial equipment that may impact future redevelopment of the site. ▪ Requires less extensive site characterization. *Disadvantages:* ▪ Requires additional subsurface investigation to delineate areas of grossly stained soils/free product, where excavation is needed. Also, wet chemistry analyses are necessary to determine if groundwater conditions are conducive to biodegradation. ▪ Significant engineering controls required during excavation to reduce exposure to humans and the environment from volatile emissions, fugitive dust, deep excavation hazards, stormwater runoff control, etc. ▪ Removing large quantities of soil off-site and importing clean fill will likely result in an increased amount of truck traffic through local communities, although not as much as would be associated with complete removal. ▪ No other activities or development will be supported until excavation and removal activities are complete. ▪ Technically difficult to remove impacted soils immediately adjacent to the Hudson River, some impacted soils may be left in place.	*Advantages:* ▪ Readily implemented and technically feasible, although the number of components to the cleanup is somewhat complex. ▪ No long-term maintenance or utilities required, except for sub-slab depressurization systems, which require little energy or maintenance and are readily available. ▪ No construction of surface structures required to house remedial equipment that may impact future redevelopment of the site. ▪ Requires less extensive site characterization. *Disadvantages:* ▪ Requires additional subsurface investigation to delineate areas of grossly contaminated soils/free product, where excavation is needed. ▪ Significant engineering controls required during excavation to reduce exposure to humans and the environment from volatile emissions, fugitive dust, deep excavation hazards, stormwater runoff control, etc. ▪ Removing large quantities of soil off-site and importing clean fill will likely result in an increased amount of truck traffic through local communities, although not as much as would be associated with complete removal. ▪ No other activities or development will be supported until excavation and removal activities complete. ▪ Technically difficult to remove impacted soils immediately adjacent to the Hudson River, some impacted soils may be left in place.	*Advantages:* ▪ Difficult to implement, but technically feasible, although the number of components to the cleanup is somewhat complex. ▪ No construction of surface structures required to house remedial equipment that may impact future redevelopment of the site. *Disadvantages:* ▪ Must test soils for PCBs to determine if dioxin formation a concern. ▪ Requires additional subsurface investigation to delineate areas of grossly stained soils/free product, where excavation is needed. ▪ Must analyze soil properties to determine what level of pretreatment soil processing necessary. ▪ Little room on site to support LTTD equipment, stockpiles, excavations, etc. ▪ May have to install utilities at site to support fuel, electric, and water consumption of LTTD system. ▪ May have to construct decontamination pads, secondary containment pads to temporarily store stockpiles, etc. ▪ Fuel consumption may be excessive due to need for higher operating temperatures to volatilize fuel oils. ▪ Cannot process debris or objects greater than 2-inches in any dimension. Debris may require separate treatment and/or disposal. ▪ Significant engineering controls required during excavation to reduce exposure to humans and the environment from volatile emissions, fugitive dust, deep excavation hazards, stormwater runoff control, etc. ▪ Removing large quantities of soil off-site and importing clean fill will likely result in an increased amount of truck traffic through local communities, although not as much as would be associated with complete removal. ▪ No other activities or development will be supported until excavation and removal activities are complete. ▪ Technically difficult to remove impacted soils immediately adjacent to the Hudson River, some impacted soils may be left in place.
Cost	▪ Present Worth = $70,000. Lowest cost option. No active remediation or monitoring of site.	▪ Present Worth = $17.35 Million. Excessively high costs due to large quantity of material requiring disposal and need to dewater AECs prior to excavation. ▪ Typically higher overall remediation costs than other passive remediation methods. Not cost effective where significant quantities of impacted media are present and/or excavation beneath the water table is necessary.	▪ Present Worth = $7.86 Million. ▪ Given the high costs of land disposal, it is practical to attempt to reduce the quantity of soil being disposed off-site, while also reducing the potential threats to receptors within a timeframe that will support redevelopment.	▪ Present Worth = $8.68 Million. ▪ Shortened post-action monitoring does not offset the costs associated with the nutrient injections. ▪ Some long-term monitoring of the groundwater quality beneath the DeLaval site will be required, but the monitoring period has been reduced to ten years given the removal of grossly-contaminated soils and free product from the site.	▪ Present Worth = $9.60 Million. ▪ Since this alternative provides no active remediation of the residual contaminants in the groundwater beneath the site, it is unlikely that the post-treatment monitoring could be reduced to a shorter timeframe than that needed for Alterative 3 (5 years). However, even if the post-monitoring time was reduced, it is unlikely that the LTTD costs could be offset by a reduction in long-term monitoring.

greatest overall protection of human health and the environment, although this alternative poses relatively high exposure risk during the excavation process.

Alternative 3 includes the removal and off-site disposal of the most heavily impacted soils. While some residuals are left on the site, the threat to human health and the environment would be significantly reduced. Alternative 4 would reduce the necessary attenuation timeframe to breakdown the residual contaminants in groundwater, but the residuals are not considered to pose a threat to human health and/or the environment. Alternative 5 would reduce the residual contaminants in the vadose zone soils after the initial source removal, but would not actively reduce the contaminant levels in the groundwater. However, human (worker) exposure to the residual contaminants would be reduced during the installation of utilities and foundations associated with the site redevelopment.

4.3.2 Compliance with SCGs/ARARs

Alternative 1 does not meet the SCGs and is likely that the remedial goals would not be achieved for in excess of 30 years due to the presence of free product and grossly contaminated soils at the site. Alternative 2 would achieve the remedial goals the quickest because almost all of the contaminants would be removed from the site during the active remediation phase. Alternatives 3, 4 and 5 include passive remediation after the initial removal of heavily impacted soils. Alternative 4 would achieve the remedial goals in a shorter timeframe than Alternatives 3 and 5 because the natural biodegradation of the contaminants in the groundwater would likely be broken down faster. Alternative 5 would reduce the residual contaminant levels in the vadose soils quicker than Alternative 3, but neither of these alternatives actively addresses the residual contaminants in the groundwater.

4.3.3 Long-Term Effectiveness & Permanence

Alternative 1 provides no active remedy for the contaminants at the DeLaval site, and therefore, provides no long-term effectiveness in reducing exposure of the site contaminants to humans and the environment. Alternative 2 provides the most long-term effective and permanent remedy to the site contamination because all contaminated soil is disposed off-site reducing potential exposure to humans after the remediation is complete. By removing all impacted soil, the impacts to groundwater and surface water quality would be reduced, which would ultimately reduce the potential exposure to humans through potential contact with groundwater and surface water.

Alternatives 3, 4 and 5 would also provide an effective remedy because the most impacted soils would still be disposed of off site, thus reducing exposure of these contaminants to humans and the environment. The placement of a soil cover over the residually impacted areas would also reduce the potential exposure of the surface soil and residual contaminants to humans after the redevelopment is complete, including direct contact with impacted media or potential inhalation of soil gases. Although residual contaminants would remain in the groundwater with each of these three alternatives, Alternative 4 would provide the most long-term effectiveness for managing the residuals in the groundwater by enhancing the rate of the biodegradation of the residual contaminants. Alternative 5 provides faster treatment of the residually contaminated vadose zone soils and would provide a permanent remedy for all soils in the vadose (unsaturated) zone, but would only reduce contaminant levels in the groundwater to levels similar to that which would be expected if Alternative 3 were to be implemented.

4.3.4 Reduction in Toxicity, Mobility & Volume

Alternative 1 provides no reduction in toxicity, mobility or volume of contaminants at the DeLaval site. Alternative 2 provides the greatest reduction in the volume and toxicity of contaminants at the DeLaval site by removing all contaminants from the property. Alternatives 3, 4 and 5 also involve the removal of free product and grossly contaminated soils from the DeLaval Property, but these alternatives also include the reduction in residual contaminant toxicity and volume via natural attenuation, enhanced biodegradation, and low-temperature thermal desorption, respectively. By removing free product and grossly contaminated soils from the site, the mobility of the most concentrated contaminants at the DeLaval site would be eliminated.

4.3.5 Short-Term Effectiveness

Alternative 1 does not involve the risks associated with active remediation, but provides no short-term effectiveness in protecting workers or future site occupants from potential exposures during redevelopment of the site. By removing the grossly contaminated soils and free product from the

DeLaval site, Alternatives 2, 3, 4 and 5 all substantially reduce the potential exposure to workers and the environment during the redevelopment of the site, but only after the remedial program is complete.

The large excavations that would be associated with Alternative 2 would result in the least short-term effectiveness in terms of protection of human health and the environment. In addition to worker safety around deep excavations, this task has the potential to generate the greatest amount of fugitive dust emissions, require the greatest amount of storm water management/treatment, and would likely cause the greatest increase in the amount of truck traffic within local communities.

Alternatives 3, 4, and 5 will also result in the need to control dust emissions, manage storm water, and control truck traffic in the neighborhood; however, because the magnitude of the excavations associated with these alternatives will be significantly less than Alternative 2, the impacts could be mitigated more easily. The excavations associated with Alternatives 3 and 4 would likely be backfilled more rapidly than with Alternative 5 due to the need for waiting for analytical results confirming adequate treatment, and thus, minimize the engineering controls needed during the remediation.

Alternatives 2 and 5 are considered to pose the most potential threat to workers during the remedial actions due to the deep excavations and large excavation equipment associated with Alternative 2, and the hazards of working with hot equipment, fuel sources, and large soil processing equipment associated with Alternative 5. Alternative 4 is the only alternative that requires the handling of chemicals/nutrients on site.

4.3.6 Implementability

Alternative 1 is readily implemented, but would require a significant amount of institutional controls to protect human health, even if the DeLaval site was not redeveloped. Alternative 3 is the most readily implementable alternative. This alternative involves excavating unsaturated soils and disposing of them off-site, but does not require significant infrastructure or long-term operation and maintenance to treat the groundwater. Although it will significantly reduce the immediate threat to human health and the environment to support redevelopment of the site, it will also serve as an effective remedy to reduce the groundwater contaminant levels over time.

Alternative 4 is similar to Alternative 3; however, significant additional characterization of the site (wet chemistry of the groundwater, soil properties, depth to bedrock/aquitard, etc.) is needed to implement this remedy. Also, it is unclear how well the nutrient injections would be dispersed given the amount of debris encountered in the test pits excavated during TCC's and CHA subsurface investigations. Another concern with this alternative is that the nutrients may be exhausted before the remedial goals are achieved and re-injection of additional nutrients after redevelopment of the site may be difficult.

Alternative 2 is implementable, but it would be challenging to install a dewatering system adjacent to a tidally influenced surface water. Other concerns with Alternative 2 include the ability to drive sheeting at a site where significant debris is present, excavations as deep as twenty feet require significant bracing/shoring, a significant source of clean fill may not be available locally, etc.

Alternative 5 is also implementable, but the complexity of the LTTD system is high. The lack of room on the site would limit room to setup the LTTD equipment, stockpiles, excavations, etc. The need for infrastructure improvements (gas, water, and electric utilities), construction of temporary soil containment pads, etc. elevated the difficulty in implementing this alternative.

4.3.7 Cost

Alternative 1 is the lowest cost alternative, but does not achieve the remedial goals. Given the large volume of soil at the DeLaval site, the cost for removal of all impacted media (Alternative 2) is clearly excessive. Therefore, Alternatives 3, 4 and 5 evaluated the option of only removing the most highly impacted soils for off-site disposal. Alternative 3 provides the most cost-effective alternative that will still achieve the remedial goals for the site. While the post-treatment monitoring time for the site may be able to be reduced if Alternatives 4 or 5 are implemented, the costs associated with the injection of nutrients or LTTD are not offset by the reduced monitoring time. CHA also notes that the costs associated for special air discharge permits, infrastructure improvements, etc. have not been included with Alternative 5, but could add an additional ten to twenty-five percent to the estimated cost.

4.4 DESIGN CONSIDERATIONS

With the exception of the first alternative, all other alternatives involve the excavation of large quantities of soils on the DeLaval site. In order to reduce erosion and protect the Hudson River surface water quality from potential sedimentation resulting from runoff from the DeLaval site during active remediation and construction activities, it will be necessary to install appropriate erosion control devices on the site. However, because Alternatives 2 through 5 involve excavations (refer to Section 4.2 for alternative descriptions), it is likely that similar types of erosion control measures will be necessary for each alternative, and therefore, the specific measures will be selected as part of the remedial design process and were not considered in detail during the initial evaluation of each alternative.

The remediation and ultimate development of the DeLaval site will be completed in concert with the remediation and development of the adjacent property to the north, the former site of the City's wastewater treatment plant. The remediation of the adjacent site is being conducted by others under the NYSDEC's Brownfield Cleanup Program (BCP). It is understood that concerns regarding the management of storm water on both sites have arisen due to the relatively flat and narrow characteristics of the DeLaval site in particular. As a result, the general remedial approach and the specifics associated with the design of the remedial program will be coordinated with the BCP site's consultant to ensure that the remedial approach and program address the storm water requirements for the development, while still being protective of human health and the environment. This cooperative approach to the remediation and development of these sites will ensure that the storm water management and remedial programs are implemented in an efficient manner.

More specifically, while storm water management would be a component of any development project along the waterfront, any residual contamination left in the AOCs (Alternatives 3, 4 & 5) may potentially add to the complexity of future storm water management designs. For example, it is possible that residual contamination will be encountered after the active remediation is complete when future excavations are made for utilities and/or foundations. In these instances, it may be necessary to dispose of additional soils off-site, encase waterlines, etc. to contend with the residual contaminants. In addition, it will be important to limit the amount of groundwater recharge from any storm water runoff in the vicinity of the AOCs to reduce the migration of the contaminants. While some of the specific design elements of a storm water management system may vary by alternative, consideration will be given to the residual contamination during the design process, unless complete removal of all contaminated media (Alternative 2) is selected.

Finally, it should be noted that the site characterization work completed to date relative to the DeLaval site did not include sampling of the sediments of the Hudson River. While soil and ground water data suggests that significant contaminant migration from the site to the river is unlikely, the remedial program will incorporate provisions to characterize/address contaminant migration pathways and associated impacted sediments that are discovered during the course of the implementation of the remedial program. This issue is addressed in the RAR, and it is anticipated that the requirement to characterize and remediate significantly impacted sediments from obvious on-site sources will be incorporated into the remedial alternative specified in the ROD.

5.0 RECOMMENDATIONS

5.1 RECOOMMENDED ALTERNATIVE

CHA recommends the selection of Alternative 3, Source Removal, Soil cover, Bulkheads, and Natural Attenuation, as the preferred remedy for the DeLaval site. The data derived from the investigations discussed herein, together with the fact that the conceptual design for the redevelopment of the site has been completed, has enabled CHA to refine the scope of Alternative 3 to include the provisions of the August 2004 IRM Work Plan and the construction of a bulkhead sections consisting of sheet pilling which will be located immediately to the west of AOC-1 and AOC-2/AOC-3. Figure 5 illustrates the extent of the planned development for the site relative to the limits of the AOCs. The limits of the proposed bulkhead and the anticipated extent of source area removal are also presented on Figure 5.

While residual contaminants may remain at the site for several years if Alternative 3 is implemented, the grossly contaminated soils and free product would be removed from the site for off-site disposal. Removing the grossly-impacted soils, fuel oil pipeline, and the UST from AOC-1 and AOC-2/AOC-3 will reduce or eliminate, to the extent practical, threats to human health and the environment. This is particularly important to community and worker safety, given that the City of Poughkeepsie wants to redevelop the site and include public areas. If the soils within the building footprints that are remote from the pipeline and tank prove not to be saturated with free product and are not grossly contaminated, it may be possible to relocate the displaced soils under a paved area or the soil cover. As a result, the volume of soil requiring off-site disposal may be able to be reduced.

The planned development of the site will include the construction of buildings, walkways and parking areas, which will cover approximately 8.1-acres of the DeLaval property. These impervious features will serve to limit exposure to the underlying contaminated soils. Approximately 5.1 acres of green space is planned in the site redevelopment. It anticipated that these areas will be covered with a twelve to eighteen inch thick vegetated soil cover which will be placed over geotextile fabric. The fabric would serve to demarcate the interface between the soil cover and the impacted soil located below. During future maintenance or development activities, the provisions of the OM&M

Plan would be observed if the full thickness of the cover is breached. In addition, sub-slab ventilation systems will be installed below the foundations of any building located with the impacted zones will eliminate/mitigate any vapors that could potentially migrate into the future buildings.

Prior to initiating excavation activities in AOC-1 and AOC-2/AOC-3, the bulkhead sheeting will be installed. The bulkheads will serve as a barrier which will prevent contamination in the soils as well as residual contaminated groundwater from impacting the Hudson River during and following the remedial activities. As indicated on Figure 5, both sections of bulkhead will be keyed into the preserved land area to provide a barrier to the flow of residually contaminated ground waters into the river. At this time, it is anticipated that the bulkhead will consist of 370-foot and 720-foot sections of ballasted vinyl sheeting adjacent and to the west of AOC-1 and AOC-2/3, respectively. Rip-rap will be placed along the balance of the shoreline to provide shoreline stabilization.

It is likely that residual contaminants remaining in the groundwater after the active remedial work is completed will be treated via natural attenuation over time and that all remedial action objectives will eventually be achieved. Although monitoring will be required for several years, the water quality beneath the site will likely be restored much quicker if the most heavily impacted soils and free product are removed. A long-tem groundwater monitoring program will serve to evaluate the effectiveness of the remedy.

An Operation, Maintenance and Monitoring (OM&M) Plan will be prepared to provide the framework for a post-remedial program that will be instituted after remediation is complete. The plan and resultant program will safeguard against exposure to residual contaminants during future development or maintenance work completed on-site. The OM&M plan will also outline the require monitoring to facilitate the evaluation of the effectiveness of the remedy.

Based upon the results of the supplemental investigation program, it is CHA's opinion that the additional data which is presented and discussed herein supports the selection of Alternative 3 as an appropriate remedial approach that will both facilitate the planned redevelopment of the DeLaval property and protect human health and the environment. While the results of this supplemental investigation revealed the need for some additional remedial measures (e.g. placement of a soil cover across entire property, installation of bulkheads down-gradient of AOC-1 and AOC-2/AOC-3, etc), these measures would also be necessary for Alternatives 2, 3, 4, and 5. However, as indicated on Table 9, these measures and the costs associated with them have not changed the overall ranking of the alternatives discussed in the RAR.

At this time, no source removal or excavation is planned in AOC-4. This is the least impacted AOC and no evidence of gross contamination (e.g. strong odors, heavily stained soils, high photoionic detected readings, etc.) was identified in the test pits excavated in this AOC. Since no evidence of a source in AOC-4 was encountered during the supplemental investigation, the NYSDEC has indicated that excavating this area may not be necessary; however, the NYSDEC will require long-term monitoring of the groundwater quality down-gradient of AOC-4.

The remedial measures necessary to implement Alternative 3 have been discussed in concept in this report. However, the details of the remedial program would be finalized during the design stage of the redevelopment project. While the previously submitted IRM provides detail on site controls, health and safety measures, etc. associated with the source removal in AOC-2/3, the design report will also include details of the proposed excavation areas in AOC-1, the soil cover system, the vinyl sheeting bulkhead, sub-slab ventilation systems, etc.

5.2 EVALUATION OF ALTERNATIVE 3

In addition to eliminating/mitigation the human exposure pathways to the contaminants at the site, Alternative 3 will provide a long-term effective and permanent remedy for the site. Although complete removal of all contaminated media was considered more effective in the comparative analysis, the extensive construction effort (low implementability) and potential contaminant exposure associated with Alternative 2 resulted in the elimination of that alternative. After the primary sources of the contamination are removed from the DeLaval site, a majority of the threat posed by the site will be eliminated. Installation of a soil cover in green space areas will eliminate or mitigate the potential exposure to the residual contaminants at the DeLaval site. Installation of the bulkheads down-gradient of AOC-1 and AOC-2/AOC-3 will greatly impede the migration of contaminants into the Hudson River.

Alternative 3 is readily implementable, although some additional remedial measures have been proposed in addition to those previously proposed. However, this alternative does not require significant infrastructure improvements, and will not result in the installation of permanent remedial equipment that would be obtrusive and incompatible with the future redevelopment of the site.

Alternative 3 also provides a cost-effective approach to managing the contaminants at the DeLaval site. While Alternatives 4 and 5 offer the potential reduction in post-treatment monitoring, the additional costs associated with the treatment methods in these alternatives are not offset by the reduced monitoring time/cost. While there may be some additional costs associated with this alternative that were not itemized in the preliminary cost estimate, such costs would also apply to Alternatives 3, 4 and 5, and therefore, said costs will not impact the overall ranking of Alternative 3. A detailed cost estimate will be prepared when the preliminary remedial design is completed.

5.3 SUPPLEMENTAL RECOMMENDATIONS

In order to provide a comprehensive remedial approach to managing the contaminants at the DeLaval site, CHA has identified the following additional recommendations for the project, regardless of the selected remedy:

1. Institutional controls will be required. More specifically, the site Imposition of an institutional control in the form of an environmental easement that would (a) require compliance with the approved site management plan, (b) limit the use and development of the property to commercial or recreational uses only, (c) restrict use of groundwater as a source of potable or process water without necessary water quality treatment as determined by the Dutchess County Department of Health, and (d) require the property owner to complete and submit to the NYSDEC an IC/EC certification.

2. Based upon the information obtained from subsurface investigations performed at the site, it appears that the soils on the DeLaval site consist of silty sand with a significant amount of coarse fill materials present. This unit results in a relatively high hydraulic conductivity at the site. Therefore, CHA does not anticipate a significant build up of volatilized contaminates beneath the paved or vegetated areas. Instead, it is likely that any gases, although expected to be minimal from the remaining residual contaminants, would migrate laterally beneath paved areas to the atmosphere through vegetated areas.

Although significant soils gases are not expected to be generated in the AOCs based upon the results of the site investigations and the soil gas survey conducted in AOC-1, as a precaution, CHA recommends that sub-slab depressurization systems be installed beneath the slabs of any future structures constructed within the limits of the AOCs. Appropriate sub-slab depressurization systems would mitigate any gases that might otherwise migrate into the buildings. CHA also recommends that all root mats and topsoil with high organic content be stripped from the site prior to the placement of low permeability surfaces to reduce the potential buildup of methane resulting from the degradation of the organics associated with existing vegetative growth. Given the impact to the surface soils identified in the supplemental investigation, CHA has assumed that the top six inches of soil on the DeLaval site would be removed and disposed prior to the installation of impervious surfaces or the soil cover. However, as the design for the remedial action progresses and site grades are determined, it is likely that there will be areas where less soil removal will be necessary, if any.

3. Given the range of waste types and large construction & demolition waste encountered in AOC-1 during the supplemental investigation, CHA recommends that no large structures be constructed in that area. In addition, CHA recommends that excavations associated with utility installation be minimized in the vicinity of AOC-1.

4. After a remedial alternative is formally selected, erosion and sediment control plans, storm water management plans, and final site development plans should be evaluated as part of the remedial design. This coordinated effort should include the City of Poughkeepsie and their consultants, the developer and his consultants, the NYSDEC, and the NYSDOS.

6.0 SCHEDULE

As stated previously, it is important to note that the success of this project is contingent upon the phasing of the remediation and development work. The tabular schedule provided below provides a framework for the coordination effort. While the specific dates may be shifted slightly due to administrative or construction delays, it is important that certain site remediation and development activities follow one another in rapid succession.

Work Item	Work Item End Date or Work Period
1. Final Remedial Alternatives Report complete and Submitted to NYSDEC	Late January 2005
2. Proposed Remedial Action Plan (PRAP) prepared by NYSDEC	Late January 2005
3. Public Meeting to discuss the Remedial Alternatives Report and PRAP	February 2005
4. 45-day Public Comment Period	March 2005
5. Responses to Public Comments	March 2005
6. ROD prepared by NYSDEC & Submission of Application for Clean-up Funding	March 2005
7. Remedial Design	March – May 2005
8. Site Development Design	February – June 2005
9. Remedial Construction	June – August 2005
10. Site Development Construction	July – November 2005

APPENDIX A

Detailed Cost Estimates

Table A
Cost Estimate Summary Table
DeLaval Property

Alternative	Description	Initial Capital Cost	Annual Costs	Total Present Worth	Rank
1	No Action	$38,550	$2,000	$70,000	1
2	Remove & Dispose All Contaminated Media	$17,329,998	$10,000	$17,350,000	5
3	Source Removal, Soil Cover, Bulkheads & Natural Attenuation	$7,778,593	$10,000	$7,860,000	2
4	Source Removal, Soil Cover, Bulkheads & Enhanced Biodegradation	$8,636,973	$10,000	$8,680,000	3
5	Source Removal, Soil Cover, Bulkheads & LTTD	$7,437,380	$10,000	$9,600,000	4

Table A-1
Alternative 1 - No Action
Cost Estimate
DeLaval Property

Item No.	Description	Unit Cost	Unit	Quantity	Cost
CAPITAL COSTS					
1	Institutional Controls	$ 20,000	LS	1	$ 30,000
			Capital Costs Total		$ 30,000
			Mob/Demob, General Conditions (4%)		$ 1,200
			Health & Safety (1.5%)		$ 450
			Engineering Consulting Services (10%)		$ 3,000
			Construction Inspection (5%)		$ 1,500
			Legal and Administrative (8%)		$ 2,400
			Capital Costs Total		$ 38,550
ANNUAL COSTS					
2	O&M of Institutional Controls	$ 2,000	YEAR	1	$ 2,000
			Annual Costs Total		$ 2,000
			Present Worth of Annual Costs Assuming 30 Years of O&M		$ 30,744
			Total Cost for Alternative 1		**$ 70,000**

Table A-2
Alternative 2 - Remove Dispose All Contaminated Media
Cost Estimate
DeLaval Property

Item No.	Description	Unit Cost	Unit	Quantity	Cost
CAPITAL COSTS					
1	Clear & Grub	$ 2,000	AC	13.2	$ 26,400
2	Install Silt Fence	$ 1.50	LF	4,000	$ 6,000
3	Containment & Decontamination Pads	$ 5,000	LS	1	$ 5,000
4	Install Temporary Watertight Sheeting	$ 18	SF	43,500	$ 783,000
5	Install Dewatering Wells	$ 900	EA	10	$ 9,000
6	Pump & Treat Groundwater w/ GAC, Discharge	$ 500	DAY	60	$ 30,000
7	Dust Suppression During Excavations	$ 20,000	LS	1	$ 20,000
8	Excavate & Dispose UST & 6" Fuel Oil Pipe	$ 10,000	LS	1	$ 10,000
9	Excavate & Dispose Impacted Soil	$ 70	TON	139,200	$ 9,744,000
10	Replacement of Clean Soil in Excavations & Cap Installation	$ 20	TON	139,200	$ 2,784,000
11	Seed Green Space after Soil Cap Installation	$ 3,800	AC	5.1	$ 19,380
12	Waste Characterization Samples	$ 500	EA	4	$ 2,000
13	Extend Monitoring Wells	$ 300	EA	4	$ 1,200
14	Installation of Monitoring Wells	$ 800	EA	3	$ 2,400
15	Engineer Assistance in Soliciting Disposal Bids, Permits, Admin, etc.)	$ 75	HR	40	$ 3,000
16	On-site engineer: monitoring and sample collection (12 weeks)	$ 75	HR	480	$ 36,000
17	Institutional Control Administration	$ 5,000	LS	1	$ 5,000
				Capital Costs Total	$ 13,486,380
				Mob/Demob, General Conditions (4%)	$ 539,455
				Health & Safety (1.5%)	$ 202,296
				Engineering Consulting Services (10%)	$ 1,348,638
				Construction Inspection (5%)	$ 674,319
				Legal and Administrative (8%)	$ 1,078,910
				Capital Costs Total	$ 17,329,998
ANNUAL COSTS					
16	Quarterly Groundwater Sampling w/ Letter Summary Report	$ 8,000	YEAR	1	$ 8,000
17	Annual report	$ 2,000	YEAR	1	$ 2,000
				Annual Costs Total	$ 10,000
	Present Worth of Annual Costs Assuming 2 Years of Monitoring and 5% Discount Rate				$ 18,594
				Total Cost for Alternative 2	**$ 17,350,000**

Table A-3
Alternative 3 - Source Removal, Soil Cover, Bulkheads Natural Attenuation
Cost Estimate
DeLaval Property

Item No.	Description		Unit Cost	Unit	Quantity		Cost
CAPITAL COSTS							
1	Clear & Grub	$	2,000.00	AC	13.2	$	26,400
2	Install Silt Fence	$	1.50	LF	4,000	$	6,000
3	Containment & Decontamination Pads	$	2,500	LS	1	$	2,500
4	Demolition, Removal and Disposal of Contaminated Concrete	$	175	TON	1,000	$	175,000
5	Absorbent Booms and Temporary Turbidity Curtain	$	10	LF	350	$	3,500
6	Ballasted Hardwall Bulkhead	$	1,900	LF	1,090	$	2,071,000
7	Sub-Slab Depressurization Systems (2 buildings in AOC-2 footprint)	$	8,000	EA	2	$	16,000
8	Pump & Treat Free Product (AOC-2)	$	5	GAL	2,000	$	10,000
9	Dust Suppression During Excavations	$	5,000	LS	1	$	5,000
10	Excavate & Dispose UST & 6" Fuel Oil Pipe	$	10,000	LS	1	$	10,000
11	Excavate & Dispose Impacted Soil	$	70	TON	41,350	$	2,894,500
12	Replacement of Clean Soil in Excavations & Cap Installation	$	20	TON	37,050	$	741,000
13	Seed Green Space after Soil Cap Installation	$	3,800	AC	5.1	$	19,380
14	Waste Characterization Samples	$	500	EA	4	$	2,000
15	Extend Monitoring Wells	$	300	EA	7	$	2,100
16	Engineer Assistance in Soliciting Disposal Bids, Permits, Admin, etc.)	$	75	HR	40	$	3,000
17	On-site engineer: monitoring and sample collection (12 weeks)	$	75	HR	480	$	36,000
18	Delineation of Grossly Impacted Soils in AOC-2/AOC-3	$	25,000	LS	1	$	25,000
19	Institutional Control Administration	$	5,000	LS	1	$	5,000
					Capital Costs Subtotal	$	6,053,380
					Mob/Demob, General Conditions (4%)	$	242,135
					Health & Safety (1.5%)	$	90,801
					Engineering Consulting Services (10%)	$	605,338
					Construction Inspection (5%)	$	302,669
					Legal and Administrative (8%)	$	484,270
					Capital Costs Total	$	7,778,593
ANNUAL COSTS							
16	Quarterly Groundwater Sampling w/ Letter Summary Report	$	8,000	YEAR	1	$	8,000
17	Annual report	$	2,000	YEAR	1	$	2,000
					Annual Costs Total	$	10,000
	Present Worth of Annual Costs Assuming 10 Years Monitoring and 5% Discount Rate					$	77,217
					Total Cost for Alternative 3	**$**	**7,860,000**

Table A-4
Alternative 4 - Source Removal, Soil Cover, Bulkheads Enhanced Biodegradation
Cost Estimate
DeLaval Property

Item No.	Description		Unit Cost	Unit	Quantity		Cost
CAPITAL COSTS							
CAPITAL COSTS							
1	Clear & Grub	$	2,000.00	AC	13.2	$	26,400
2	Install Silt Fence	$	1.50	LF	4,000	$	6,000
3	Containment & Decontamination Pads	$	2,500	LS	1	$	2,500
4	ORC Material	$	10.00	LB	60,000	$	600,000
5	ORC Installation via Geoprobe®	$	1,500	DAY	40	$	60,000
6	Pump for ORC Injection	$	200	DAY	40	$	8,000
7	Demolition, Removal and Disposal of Contaminated Concrete	$	175	TON	1,000	$	175,000
8	Absorbent Booms and Temporary Turbidity Curtain	$	10	LF	350	$	3,500
9	Ballasted Hardwall Bulkhead	$	1,900	LF	1,090	$	2,071,000
10	Sub-Slab Depressurization Systems (2 buildings in AOC-2 footprint)	$	8,000	EA	2	$	16,000
11	Pump & Treat Free Product (AOC-2)	$	5	GAL	2,000	$	10,000
12	Dust Suppression During Excavations	$	5,000	LS	1	$	5,000
13	Excavate & Dispose UST & 6" Fuel Oil Pipe	$	10,000	LS	1	$	10,000
14	Excavate & Dispose Impacted Soil	$	70	TON	41,350	$	2,894,500
15	Replacement of Clean Soil in Excavations & Cap Installation	$	20	TON	37,050	$	741,000
16	Seed Green Space after Soil Cap Installation	$	3,800	AC	5.1	$	19,380
17	Waste Characterization Samples	$	500	EA	4	$	2,000
18	Extend Monitoring Wells	$	300	EA	7	$	2,100
19	Engineer Assistance in Soliciting Disposal Bids, Permits, Admin, etc.)	$	75	HR	40	$	3,000
20	On-site engineer: monitoring and sample collection (12 weeks)	$	75	HR	480	$	36,000
21	Delineation of Grossly Impacted Soils in AOC-2/AOC-3	$	25,000	LS	1	$	25,000
22	Institutional Control Administration	$	5,000	LS	1	$	5,000
					Capital Costs Subtotal	$	6,721,380
					Mob/Demob, General Conditions (4%)	$	268,855
					Health & Safety (1.5%)	$	100,821
					Engineering Consulting Services (10%)	$	672,138
					Construction Inspection (5%)	$	336,069
					Legal and Administrative (8%)	$	537,710
					Capital Costs Total	$	8,636,973
ANNUAL COSTS							
19	Quarterly Groundwater Sampling w/ Letter Summary Report	$	8,000	YEAR	1	$	8,000
20	Annual report	$	2,000	YEAR	1	$	2,000
					Annual Costs Total	$	10,000
	Present Worth of Annual Costs Assuming 5 Years Monitoring and 5% Discount Rate					$	43,295
					Total Cost for Alternative 4	**$**	**8,680,000**

Table A-5
Alternative 5 - Source Removal, Soil Cover, Bulkheads LTTD
Cost Estimate
DeLaval Property

Item No.	Description		Unit Cost	Unit	Quantity		Cost
CAPITAL COSTS							
CAPITAL COSTS							
1	Clear & Grub	$	2,000.00	AC	13.2	$	26,400
2	Install Silt Fence	$	1.50	LF	4,000	$	6,000
3	Containment & Decontamination Pads	$	2,500	LS	1	$	2,500
4	LTTD System Mobilization	$	100,000.00	LS	1	$	100,000
5	LTTD Treatment of Residually Contaminated Soils	$	40	TON	31,850	$	1,274,000
6	Demolition, Removal and Disposal of Contaminated Concrete	$	175	TON	1,000	$	175,000
7	Absorbent Booms and Temporary Turbidity Curtain	$	10	LF	350	$	3,500
8	Ballasted Hardwall Bulkhead	$	1,900	LF	1,090	$	2,071,000
9	Sub-Slab Depressurization Systems (2 buildings in AOC-2 footprint)	$	8,000	EA	2	$	16,000
10	Pump & Treat Free Product (AOC-2)	$	5	GAL	2,000	$	10,000
11	Dust Suppression During Excavations & Soil Processing Operations	$	10,000	LS	1	$	10,000
12	Excavate & Dispose UST & 6" Fuel Oil Pipe	$	10,000	LS	1	$	10,000
13	Excavate & Dispose Impacted Soil	$	70	TON	41,350	$	2,894,500
14	Replacement of Clean Soil in Excavations & Cap Installation	$	20	TON	37,050	$	741,000
15	Seed Green Space after Soil Cap Installation	$	3,800	AC	5.1	$	19,380
16	Waste Characterization Samples	$	500	EA	4	$	2,000
17	Extend Monitoring Wells	$	300	EA	7	$	2,100
18	Engineer Assistance in Soliciting Disposal Bids, Permits, Admin, etc.)	$	75	HR	40	$	3,000
19	On-site engineer: monitoring and sample collection (12 weeks)	$	75	HR	480	$	36,000
20	Delineation of Grossly Impacted Soils in AOC-2/AOC-3	$	25,000	LS	1	$	25,000
21	Institutional Control Administration	$	5,000	LS	1	$	5,000
22	Institutional Control Administration	$	5,000	LS	1	$	5,000
					Capital Costs Subtotal	$	7,437,380
					Mob/Demob, General Conditions (4%)	$	297,495
					Health & Safety (1.5%)	$	111,561
					Engineering Consulting Services (10%)	$	743,738
					Construction Inspection (5%)	$	371,869
					Legal and Administrative (8%)	$	594,990
					Capital Costs Total	$	9,557,033
ANNUAL COSTS							
18	Quarterly Groundwater Sampling w/ Letter Summary Report	$	8,000	YEAR	1	$	8,000
19	Annual report	$	2,000	YEAR	1	$	2,000
					Annual Costs Total	$	10,000
	Present Worth of Annual Costs Assuming 5 Years Monitoring and 5% Discount Rate					$	43,295
					Total Cost for Alternative 5	**$**	**9,600,000**