File

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May 22, 2008
File #46336.008

Nick Acampora
New York State Department of Environmental Conservation
Division of Environmental Remediation - Region 1
SUNY Campus
Building 40 Loop Road
Stony Brook, NY 11790-2356

Re: Final Remedial Investigation Report
Former Cibro Petroleum Terminal Site
Harbor Island, New York
BCP Site #C130153 / BCA Index #W1-1075-05-09

Dear Mr. Acampora:

On behalf of Posillico Development Company at Harbor Island, Inc. (PDC), I have enclosed two copies of Gannett Fleming's Final Remedial Investigation Report for the above-referenced property. The report was prepared in general conformance with the requirements in the Brownfield Cleanup Agreement between PDC and the New York State Department of Environmental Conservation (NYSDEC) and outlined in the Department's DER-10 guidance document.

Please call if you have any questions or require additional information.

Very truly yours,

GANNETT FLEMING ENGINEERS, P.C.

Gary A. Rozmus

GARY A. ROZMUS, P.E.
Vice President

cc: M. Posillico
E. Koch

POSILLICO DEVELOPMENT COMPANY AT HARBOR ISLAND, INC.
ISLAND PARK, NEW YORK

FINAL REMEDIAL INVESTIGATION REPORT

BCP Site # C130153
BCA Index # W1-1075-05-09

May 2008

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EXECUTIVE SUMMARY

The Former Cibro Brothers Terminal Site on Washington Avenue in Island Park, New York (hereinafter the "Site") was used for oil bulk storage and distribution until site operations were terminated in or around 1990. The Site is an approximately 11-acre peninsula at the southern terminus of Washington Avenue on Harbor Island, Nassau County, New York. Petroleum releases caused by Cibro's former operations at the Site created the need for environmental investigation and remediation. In 1988, a New York State Department of Environmental Conservation (NYSDEC) Spill Number (#88-05691) was opened to address these releases, which was the same year Cibro filed for bankruptcy. The results of the remedial investigation (RI) and pilot study, which evaluated a variety of remedial technologies to address the contamination discovered at the Site is covered in this Remedial Investigation Report (RIR).

Blue Island Development, LLC (Blue Island) purchased the property from the Bankruptcy Court on November 2, 2000. Posillico Development Company at Harbor Island, Inc (PDC), the applicant and contract vendee, retained Gannett Fleming, Inc. (GF) to provide environmental engineering services in support of its proposed remediation and redevelopment of the property under the New York State Department of Environmental Conservation (NYSDEC) Brownfield Cleanup Program (BCP).

On behalf of PDC, GF prepared this Final Remedial Investigation Report in general conformance with the requirements in the Brownfield Cleanup Agreement and outlined in NYSDEC's DER-10 guidance document. The purpose of the report is to:

- Summarize the completed site characterization by defining the nature and extent of contamination on and likely to be emanating from the site, and finalize the remedial investigation using all data;
- Document the results of a soil vapor study performed at the request of the New York State Department of Health (NYSDOH);
- Present the results of a Qualitative Exposure Assessment (QEA), which evaluated the actual or potential exposure of humans, fish and wildlife to constituents of concern on and adjacent to the property; and

- Document the results of extensive soil and groundwater remediation pilot tests to evaluate remedial feasibility of several technologies, which were developed by GF and Posillico Environmental and approved by NYSDEC.

Remedial Investigation (RI)

A summary of the results of the RI are as follows:

Site Characterization

Prior studies performed in 2000 delineated the boundary of the contaminated portion of the property using total petroleum hydrocarbons (TPH) as the surrogate for petroleum hydrocarbon content. In the December 2000 study, comprehensive chemical data was collected outside of this boundary to document the absence of contaminants. The supplementary Remedial Investigation (RI) performed by GF in 2006-2007 collected the comprehensive chemical data needed to complete the characterization of the petroleum-contaminated area required by the Brownfield Cleanup Agreement (BCA) pursuant to ECL Title 14 and applicable regulations in 6 NYCRR §375 Subparts 1 and 3. These more recent investigation results have been combined with the earlier results to produce this Remedial Investigation Report (RIR).

In 2006, soil from eight (8) test pit excavations was stockpiled and subsequently used for feedstock for the first two rounds of pilot tests. Comprehensive chemical analyses of samples from the pilot test feedstock provided data describing the chemical quality of soil in each of the eight test pits. In 2007, more comprehensive soil samples were taken at three depths, in eighteen (18) different test pit locations. The test pits were positioned to obtain soil samples with the highest TPH content based on results from the earlier studies. The soil samples were analyzed for semi-volatile organic constituents (SVOCs), volatile organic constituents (VOCs), and metals. The data set was compared to the BCP soil cleanup objectives (SCOs) in order to determine the level of cleanup needed for the current permitted heavy industrial use of the property, as well as a potential change to residential use that as of date is in effect. (see attached Newsday article Appendix A1)

The laboratory results for the soil samples from the feedstock test pit excavations and the subsequent eighteen test pits confirm previous information regarding the presence of petroleum constituents that exceed standards. The chemicals identified in the samples were all consistent with virgin petroleum releases.

Soil Vapor Study

The generation of soil vapors is a potential issue with petroleum-contaminated soil, and, therefore, soil vapor was tested along the northern property line near the residential neighborhood at four (4) locations, and on post-treated soil from the ex situ oxidation methodology explained ahead. Although, in general, soil vapors from the test pits in the petroleum-contaminated area were evident, no soil vapors were detected above applicable standards along the northern property line. NYSDOH has not yet developed guidance on petroleum related vapors. Therefore, a conservative approach to evaluating the results was taken. Indoor air standards were compared to the outside soil vapor results. If outside soil vapor constituents did not exceed the indoor air standards, then this RI assumed such levels would exist at lower concentrations if detected indoors. Therefore, GF compared United States Environmental Protection Agency (USEPA) and New Jersey residential indoor air standards to the results of both sets of samples and found that no constituents exceeded the target indoor air concentrations used by either agency.

Groundwater Study

Previous studies collected groundwater quality information from eighteen different monitoring wells installed at various locations on the property. Groundwater at two of these locations had petroleum constituents that exceeded groundwater standards. Groundwater flows radially away from the northwest portion of the Site towards the east-southeasterly direction, generally away from the adjacent residential areas. Only one of the four groundwater monitoring wells located along the residential/industrial boundary had one chemical detected that was related to the petroleum releases, and that detection was below the applicable standards.

Qualitative Exposure Assessment (QEA)

A QEA was performed to determine the qualitative health risks posed to humans, fish and wildlife by the chemicals identified in the soil and groundwater on the Site and at the Site's property boundary line. The analysis determines if an exposure pathway exists, and if so, the extent to which it can be mitigated. If there is no pathway, there is no quantifiable risk.

The QEA found a pathway for industrial use that could be mitigated with a proper soil management plan and various cap and cover techniques. However, the QEA identified pathways that would require more extensive mitigation under a potential residential use scenario due to the long-term habitation of the Site with different exposure rates. In general, the QEA found that the exposure potential will be adequately mitigated once the contaminated soil is remediated to applicable residential SCOs.

<u>Pilot Tests</u>

Groundwater

GF performed a pilot test on a treatment technology using dissolved nitrate to reduce the chemical load in the affected groundwater. The results were favorable and showed that this technology could be used to remediate the groundwater in the part of the property where the dissolved constituents currently exceed the standards, and in areas post-remediation that may require treatment.

Soil

Three treatment technologies were tested during the pilot program: land farming, engineered biopile, and ex situ chemical oxidation. Feedstock soil used for the tests was excavated from areas of the Site that were delineated in earlier studies as having high TPH content. The land farm and biopile tests used approximately 50 cubic yards (CY) of soil each, whereas the oxidation test used approximately 1800 CY of soil.

The land farm was constructed by spreading the soil in a 6 to12-inch thick layer over a liner and tilling it periodically. The test area was covered with a polyethylene tarp in between tilling operations. Samples were taken several times throughout the year to monitor the results. The findings from this test indicated the ability to remove chemical constituents on a cost-effective basis to Track 1 SCOs. However, time and practical application may be limiting factors in applying its use.

The biopile was a 20-ft wide x 15-ft long x 5-ft high mound of soil constructed on a liner that had a network of air distribution piping weaved throughout the biopile to deliver oxygen to the microbes responsible for reducing the petroleum content in the soil. The pile was covered by a tarp and a blower was operated continuously until the end of the test. The findings from this test also indicated the ability to remove chemical constituents to desired Track 1 SCOs. However, operational requirements and the space required to implement this technology is generally greater than the other technologies.

Ex-situ oxidation was tested to see if thorough mixing of the petroleum-impacted soil with oxidizers via a pugmill would produce favorable results in a short period of time. The oxidation tests were run in November and December 2006, and July 2007. Tests were revised later in December 2006 and July 2007 when the data from the previous test was reviewed. The supplemental testing was performed to develop optimum performance and verify predictability. This methodology proved to be the most predictable and effective in reducing contamination and associated soil vapors in the least amount of time. It is also most likely to achieve the greatest elimination of contamination, and is likely to achieve Track 1 SCOs. However, it was the most expensive of the technologies tested. Despite its increased cost this is the methodology preferred by PDC since it is likely to achieve the best result in the least amount of time.

INTRODUCTION

The Former Cibro Brothers Terminal Site on Washington Avenue in Island Park, New York (hereinafter the "Site") was used for oil bulk storage and distribution until site operations were terminated in or around 1990. The Site is an approximately 11-acre peninsula at the southern terminus of Washington Avenue on Harbor Island, Nassau County, New York. Petroleum releases caused by Cibro's former operations at the Site created the need for environmental investigation and remediation. In 1988, a NYSDEC Spill Number (#88-05691) was opened to address these releases, which was the same year Cibro filed for bankruptcy. The results of the remedial investigation (RI) and pilot study, which evaluated a variety of remedial technologies to address the contamination discovered at the Site is covered in this Remedial Investigation Report (RIR).

Blue Island Development, LLC (Blue Island) purchased the property from the Bankruptcy Court on November 2, 2000. Posillico Development Company at Harbor Island, Inc (PDC), the applicant and contract vendee, retained Gannett Fleming, Inc. (GF) to provide environmental engineering services in support of its proposed remediation and redevelopment of the property under the NYSDEC BCP, and Blue Water Environmental, Inc. to provide contracting services for the pilot test under the oversight of GF.

On behalf of PDC, GF prepared this Final Remedial Investigation Report (RIR) in general conformance with the requirements in the Brownfield Cleanup Agreement and NYSDEC's DER-10 guidance document. The purpose of the report is to:

- Summarize the completed site characterization by defining the nature and extent of contamination on and likely to be emanating from the site, and finalize the remedial investigation using all data;
- Document the results of a soil vapor study performed at the request of the NYSDOH;
- Present the results of a Qualitative Exposure Assessment (QEA), which evaluated the actual or potential exposure of humans, fish and wildlife to constituents of concern on and adjacent to the property; and

- Document the results of extensive soil and groundwater remediation pilot tests to evaluate remedial feasibility of several technologies, which were developed by GF and Posillico Environmental and approved by NYSDEC.

A. Site Location and Description

The Site has the following characteristics:

- Eleven-acre site bordered by water on three sides, and thus constitutes a peninsula, which is largely protected by a bulkhead;
- Adjacent to residential property on its northern border;
- Previously zoned for heavy industrial use and recently rezoned for residential use subject to final site plan approval;
- Currently vacant, but covered with soil stockpiles, concrete tank bases, roadways, and one small building.

The Site, which is located at the southern terminus of Washington Avenue on Harbor Island, Nassau County, New York, is depicted on Figure 1. According to Nassau County tax maps, the Site is identified as Block 381, Lots 35, 36, 102, 314 and 323. Surface water bodies border the Site on three sides: Island Park Canal to the east; Wreck Lead Channel to the south; and Simmons Hassock Creek to the west. As noted above, residential properties border the site to the north and northwest, and an operating marina borders the site to the southwest. The property was zoned Y Industrial District at the beginning of this BCP Project. PDC recently received a zoning change from Y-Industrial to CA-Residential with the support of the adjacent residential neighbors who did not want the Site to be operated for as-of-right industrial uses. The Town of Hempstead recently approved the zoning change, which still requires numerous approvals relative to the final site plan.

The Site layout is shown on Figure 2. With the exception of a small building to the south and several concrete bases used to support aboveground storage tanks (ASTs) that are no longer on the property, all above-grade structures were removed prior to Blue Island's purchase. Most of the Site is covered by vegetation, soil stockpiles, recycled concrete aggregate stockpiles or exposed soil, with the remainder covered by asphalt-paved roadways and the previously-mentioned concrete tank bases. Most of the shoreline is supported by a bulkhead, except for a portion to the west, which is at sea level and contains a mapped wetland as defined under Article 25 of the NYS Environmental Conservation Law.

B. Site History

The Site history briefly is as follows:

- Site was first used as an oil terminal in 1940's by Oil Products, Inc.;
- Cibro purchased property in 1973, and continued use as an oil terminal until early 1990's, including 14 ASTs with 17,675,000 gallon storage capacity;
- Cibro declared bankruptcy in 1988;
- NYSDEC issued a spill number in 1988;
- Blue Island Development, LLC bought the Site in 2000; and
- PDC (contract vendee) submitted a BCP application in 2005, and Site investigation began thereafter pursuant to a fully executed BCA.

As noted above, Oil Products Inc. (OPI) began operating a bulk fuel storage and distribution facility on the Site as early as the 1940s. In 1973, OPI sold the Site to Cibro Petroleum (Cibro), which continued to operate the facility until approximately 1988, but continued to own and conduct limited operations after they declared bankruptcy as a debtor in possession at this facility and its Albany terminal. No operations were being conducted at the Site, other than maintaining an oil boom, when Blue Island first visited the Site in the late 1990's.

Based on facility records and Site maps, the Site contained 14 above ground storage tanks (ASTs) with a total storage capacity of 17,675,000 gallons and one 3,000-gallon underground storage tank (UST), all of which were used to store various petroleum products, including fuel oil, kerosene and gasoline. Historical use of the Site as a petroleum bulk storage facility resulted in releases of stored materials that impacted soil, groundwater and surface water quality. Under OPI's ownership a spill of #4 fuel oil took place in the 1960's, and another spill that was quickly cleaned up occurred in 1979 into Wreck Lead Channel. However, details about the nature and extent of these earlier releases are not well documented. In 1988, a NYSDEC Spill Number 88-05691 was opened to address a new spill and these historic releases. However, this was the same year that Cibro filed for bankruptcy.

Blue Island purchased the Site in November 2000 after all petroleum related operations had ceased on the Site. Prior to this date, Cibro had demolished and removed from the Site all the ASTs, with the exception of the tanks' concrete bases. According to reports prepared by prior consultants, the 3,000 gallon UST had been removed from the property prior to Cibro taking ownership. On November 17, 2000, Blue Island entered into a Stipulation Agreement with NYSDEC to remediate the property. Following a series of investigations to better establish the nature and extent of environmental impacts, Blue Island entered into a contract with PDC, who decided to process the remediation of the Site through the Department's recently enacted statutory BCP. An application to the BCP was prepared by PDC, and submitted to NYSDEC on March 23, 2005. The application was approved and a BCA was executed by NYSDEC on April 14, 2006.

C. Physical Setting

The Site topography is relatively flat. According to the United States Geological Survey (USGS) 7.5-minute series topographic map (Lawrence, New York quadrangle) the Site is approximately seven feet above mean sea level. Surface water bodies, consisting of Island Park Canal, Wreck Lead Channel, and Simmons Hassock Creek, border the property to the east, south and west, respectively. Stormwater percolates through the soil or ponds on land surface during heavy storm events.

D. Geology and Hydrogeology

The Site is underlain by Cretaceous and Quaternary sediments, which rest unconformably on weathered Precambrian-aged biotite schist and gneissic bedrock. Depth to bedrock in the Long Island area ranges between 200 and 1,800 feet below grade. The late Cretaceous deposits are predominately associated with the Raritan and Magothy Formations, consisting of interbedded sand, gravel, silt and clay. Quaternary sediments of Pleistocene and younger age form the surficial deposits throughout the region and consist of sand, gravel, glacial till and associated outwash.

Site-specific hydrogeologic conditions consist of a tidally influenced, unconfined aquifer within the shallow fill and glacial fluvial deposits underlying the property. Prior investigations encountered a peat layer approximately nine feet below grade. Depth to the watertable varies as a result of tidal effects, but is approximately four to six feet below grade. Groundwater flows from the northwest corner of the property towards the east-southeast, and diffuses into the adjacent saltwater bodies.

E. Remedial Investigation Summary

Highlights of the historical investigations of the Site and the Remedial Investigation (RI) include:

- Remedial investigations conducted from 1990's through 2007
- Subsurface Investigations, Inc (SI) was commissioned by Cibro's Corporate Counsel in the early 1990's to conduct an environmental evaluation of the Site. They produced a draft RI/FS dated August 1993 with a transmittal letter dated June 21, 1994.
- First comprehensive studies done on the Site by LawGibb in 2000 were commissioned by Blue Island.
- Gannett Fleming completed the full BCP RI in 2007 commissioned by PDC.

As noted above, a series of environmental investigations were performed on the Site since at least the early 1990's, which initially identified the nature of petroleum-related contamination in soil and groundwater. GF completed the full nature and extent of Site characterization activities in 2007.

Prior Subsurface Investigations, Inc. (SI) Study

As summarized in the BCP application, and in the LawGibb reports attached to the application, SI evaluated soil and groundwater conditions on behalf of Cibro and issued a draft Remedial Investigation/Feasibility Study report in 1993, and a supplemental soils and groundwater cover letter on June 21, 1994. PDC was not able to locate the SI RI/FS Report referred to in the June 21, 1994 cover letter. However, the letter summarized the investigation and presented the conclusions. The cover letter summarized the SI RI/FS report and the results of prior environmental investigations and its own investigations, and contained recommendations for remedial actions (more fully discussed in Appendix A2). Although all of the data was not available from this early report, the investigation finding summary indicated that releases of petroleum hydrocarbons from historical site operations resulted in impacts to soil and groundwater quality.

<u>Remedial Investigation and Proposed Cleanup Plan- LawGibb Group (LAW)</u>

LAW performed two comprehensive studies in late 2000 and early to mid 2001, the results of which were summarized in the following reports: *Cleanup Plan for Soil and Groundwater at the Former Cibro Island Park Site, February 2001*; and *Results of Supplemental Soil and Groundwater Investigation, Former Cibro Petroleum Terminal, August 6, 2001*. Both reports were provided to NYSDEC as part of PDC's application to the BCP. A summary of LAW's findings is provided in Appendix B, and further discussed under Section 2.

In the February 2001 study, LAW delineated a three-dimensional area affected by petroleum releases using Total Petroleum Hydrocarbon (TPH). The objectives of this study were to delineate the TPH content and remediate all areas that exceeded 500 parts per million TPH content. LAW also installed groundwater monitoring wells and characterized the groundwater quality under the Site.

The NYSDEC requested confirmation that the boundary shown in the February 2001 report represented the extent of the contaminated area. NYSDEC also specifically requested subsequent analysis for the presence of the individual chemicals in petroleum, not merely TPH content. In the August 2001 report, LAW used VOC and SVOC chemical analyses to verify the boundaries of the area affected by the petroleum releases. However, the area previously delineated by TPH was not resampled to determine the presence and concentration of the individual VOC/SVOC chemicals.

Gannett Fleming (GF) Supplemental Remedial Investigation

The remaining RI work performed by GF in 2006 – 2007, included the following:

- Further characterize the soil quality in the TPH-delineated area;
- Analyze soil and groundwater samples for the individual VOC and SVOC chemical constituents associated with petroleum hydrocarbons;
- Evaluate the potential risks posed by petroleum hydrocarbons in soil and groundwater to soil vapor quality, human health and ecological receptors; and
- Collect soil vapor data on the northern property boundary near the residential area.

As part of the BCP approved RI Work Plan, the NYSDEC directed PDC to perform additional work necessary to finalize a complete nature and extent remedial investigation (RI) of the Site pursuant to BCP requirements, and to develop the information needed to evaluate and select an appropriate remedy pursuant to a Pilot Test Work Plan submitted with the BCP application. PDC retained GF to review the historical monitoring database, establish the scope of work necessary to complete the RI, and evaluate the feasibility of alternative remedial options to address soil and groundwater contamination at the Site pursuant to an approved Pilot Test Work Plan. The soil and groundwater pilot tests and associated site investigation work were performed by GF in October 2006 through July 2007 in accordance with the approved work plans. The initial RI work plan was approved in July 2006; and a modification was approved on October 5, 2006. The RI was designed to conform to the new regulations in Part 375, and all relevant guidance documents, including the NYSDOH Vapor Intrusion guidance document and NYSDEC's DER-10 guidance document. The RI included resampling the area delineated by TPH, and analyzing the samples for the individual VOC and SVOC constituents. The new data would then be compared to the SCOs in the Part 375 regulation to determine the level of cleanup needed for the intended use of the property.

Soil Vapor Study

The NYSDOH also requested a soil vapor study be conducted along the northern property boundary adjacent to the residential area. In May 2006, NYSDOH and NYSDEC approved the *Supplemental Data Collection Addendum to the Pilot Test Work Plan,* which was implemented by GF in 2006.

Sediment Sampling Request

In 2006, NYSDOH requested PDC to sample sediment in adjacent water bodies for the purpose of assessing petroleum-related impacts to these surface water receptors. PDC responded that it is not possible to separate those adverse effects that could potentially be caused from the Former Cibro Terminal Site from those impacts caused by other adjacent and nearby historical or current land and water use activities with any degree of certainty. On July 7, 2007, the NYSDEC notified PDC that the NYSDOH deferred its final decision on whether sediment sampling was necessary and reserved its right to request this work if field conditions warrant.

F. Pilot Test

In March 2005, GF submitted to the NYSDEC the *Interim Remedial Measure Pilot Test Work Plan and Supplemental Data Collection* report. The work plan documented the technical approach and scope for a pilot test program, which would be used to develop the information necessary to evaluate two technologies for soil (an engineered biopile technology and land farm technology) and one in-situ bioremediation technology for groundwater using nitrate compounds.

In further analyzing available technologies, PDC and GF petitioned the NYSDEC for approval to include a third ex-situ chemical oxidation technology into the pilot test. The NYSDEC approved this request via e-mail in October 2006. Preliminary protocols were developed and refined during the pilot test program with DEC approval.

REMEDIAL INVESTIGATION

The Site has been thoroughly characterized by LAW and GF, and the results are presented in this RI Report (RIR):

A. Soil Quality Characterization

Data collected from wells, borings and test pits were used to delineate the VOC and SVOC content of the soil and groundwater at the Site. The confidence in the delineation of clean and contaminated areas increased as the quality and comprehensiveness of the data expanded from multiple studies conducted at the Site from the early 1990's through this RIR.

1. Methodology

- 1990's - Subsurface Investigations, Inc.'s (SI's) investigation generally confirmed petroleum contamination in the southerly and eastern portions of the property. They also installed groundwater monitoring wells and described the groundwater quality using existing and new wells.
- 2000 - LAW further delineated the petroleum-contaminated areas using TPH results from over 200 samples taken from seventy borings. They also updated the groundwater quality description using existing wells and newly-installed wells.
- 2001- LAW further refined the "clean" area using VOC/SVOC/metals data from soil samples collected 0 to 2-ft below grade at 21 locations. An area containing PCBs delineated by SI was also resampled in 8 locations and found not to exceed the then current TAGM 4046 guidance soil cleanup objectives. Additional groundwater sampling was done to further characterize the quality.
- 2006-2007 – GF performed comprehensive laboratory analyses of stockpiles used for the pilot test and eighteen test pits that further defined contamination in the impacted.
- Each soil sample was analyzed for TPH using Method 418.1. LAW designated a "clean area" where TPH concentrations were typically less than 500 mg/kg, and performed additional soil sampling in May 2001 to confirm and refine the proposed "clean area" TPH boundary (Appendix B).
- 2006-2007 - GF further characterized soil in the former LAW TPH delineated area and groundwater in the area of the in situ testing using samples from two monitoring wells analyzed for VOCs, SVOCs, metals, and other inorganic parameters.

In December 2000, LAW installed seventy soil borings at the locations shown in Appendix B. Soil samples were collected from cores taken generally at 0 to 18-inches below grade (shallow unsaturated zone); 24 to 48-inches below grade (watertable/smear zone); and near the top of the underlying peat layer (typically seven to nine-feet below grade) using a Geoprobe (SB-1 through B). The work included sampling soil from 0 to 2-feet below grade at 21 locations (SS-1 through SS-21) for STARS list VOCs and SVOCs; analyzing 20-percent of the samples for RCRA metals; and sampling eight additional borings for PCBs in the area of the PCB-impacted soil identified by SI/EG.

LAW's groundwater investigation included installing six new groundwater monitoring wells (LMW-1 through LMW-5 and MW-3R – Appendix B) in December 2000, sampling the new wells, resampling other pre-existing wells for NYSDEC STARS list VOCs and SVOCs and evaluating natural attenuation indicator parameters. A second round of sampling was performed in May 2001, and consisted of sampling "clean area" monitoring wells LMW-3, LMW-4, OW-1, W-2, MW-1, MW-2, MW-3R, W-11 and W-12 for VOCs and SVOCs.

In the fall of 2006, GF began the Pilot Test. The test used petroleum-contaminated soil from the areas where LAW delineated the highest TPH concentrations. Soil obtained from eight pits (shown in Figure 6) was segregated on one of the unused concrete tank bases, and combined in various composite batches to serve as feedstock for the various tests. The individual soil piles were initially characterized using TPH. Once the various feedstock composite piles were created a baseline soil quality was obtained by analyzing samples of the various piles for the full suite of chemicals in the Method 8260 and Method 8270 protocols. A more detailed description of how the soil was prepared for the pilot tests is found in the "Remedial Technology Pilot Test Program" section of this RIR.

In 2007, GF sampled eighteen test pits in the area formerly characterized by only TPH at the locations shown on Figure 4. Soil samples from each test pit were collected at intervals generally corresponding to 0 to 2-ft below grade; 2 to 4-ft below grade; and 4 to 7-ft below grade to describe the lithology, and better assess the vertical distribution of petroleum residuals. Each sample was analyzed for TPH, SVOC and VOC content. The TPH data was collected at the request of the NYSDEC to compare with the data collected by LAW in 2000.

2. Sampling Results

- 2000: LAW confirmed the boundaries of the unaffected area, which did not contain VOCs, SVOCs, metals, or PCBs that exceeded the TAGM 4046. Law also found that the area containing PCBs above standards delineated by SI did not exceed the standards in use at that time and recommended that it not be excavated.
- 2006-2007: GF data further characterized the petroleum-contaminated area that LAW delineated using only TPH data, and found VOC and SVOC contamination in this area. GF also found that the maximum depth affected by the petroleum releases was generally four feet below ground surface (bgs).

LAW used TPH as a screening parameter for its initial investigation of petroleum hydrocarbon impacts to soil. The reliability of the analysis to accurately characterize and quantify petroleum hydrocarbon conditions, however, is limited. It is well documented that the analytical method is susceptible to matrix interference, and other effects from naturally-occurring organic material unrelated to petroleum hydrocarbons. These conditions commonly result in false positive errors, which tend to mischaracterize or overestimate the petroleum hydrocarbon mass in the sampled material. Subsequently VOC and SVOC contaminant sampling performed by GF better delineated the area of contamination preliminarily established by LAW. The specific VOCs and SVOCs discovered now have established environmental and health-based SCOs in the Part 375 regulations, which will be relied on to clearly define the areas of the Site that need to be remediated for residential development. The Site-specific chemical data also showed that a poor correlation exists between TPH content data and the concentrations of the underlying individual VOC and SVOC constituents. As a result, interpretation of environmental impacts at the Site and decisions concerning the need for and scope of remedial actions rely on the more recent VOC and SVOC sampling results. In addition, TPH values have no regulatory benchmark.

In the subsequent study done by LAW in 2001, they did not find VOCs exceeding the NYSDEC cleanup criteria at that time (TAGM 4046) in any soil sample, and the SVOC data generally confirmed the initial "clean area" TPH boundary. Only a few samples contained a limited number of chemical constituents at concentrations greater than the then applicable TAGM 4046 cleanup guidelines at that time for chrysene; benzo(b)fluoranthene; benzo(a)anthracene; dibenzo(a,h)anthracene; benzo(a)pyrene; and benzo(k)fluoranthene. Except for chromium, RCRA metals were not found at concentrations exceeding the TAGM 4046 soil cleanup guidelines. Chromium was detected in sample SS-6 at a concentration that marginally exceeded the applicable cleanup guideline (10.1 μg/kg vs. 10 μg/kg guideline). Soil samples from the PCB impacted area did not reveal the presence of PCBs at concentrations exceeding the applicable TAGM 4046 soil cleanup guidelines.

In 2007, the soil characterization in the impacted area had varied results, which were compared to the new regulatory 6 NYCRR Part 375 SCOs. While most of the 45 samples taken from the eighteen test pits in June 2007 did not exceed Track 1 SCOs, several composite samples made from soil taken in September 2006 from the eight test pits used for the initial oxidation test did exceed Track 1 SCOs. There are several theories for these varied results. First, the potential that undocumented releases occurred in the delineated area, which were not previously identified, is possible. Second, and a more likely explanation, is that there has been some redistribution of the petroleum product by frequent flooding of the Site by tidal and storm events. This likely movement of product by weather influences makes it difficult to definitively delineate every location in the more contaminated part of the Site. Even if more sampling were conducted, contaminant conditions can be altered. PDC and GF believe sufficient investigation has been performed to commence remediation within the boundary line previously-described (see Figure 3). Site remedial efforts will involve soil excavation and screening, which will locate and remediate all areas of contaminated soil on the Site.

The laboratory data indicate that the highest concentration of SVOCs was found in the shallow and mid zone soil. Soil samples from test pit locations TP-1, TP10, TP-11 and TP-17, all contained SVOC constituents at a total concentration exceeding 10 mg/kg. The SVOC content decreased markedly at four feet below grade.

Pretreatment chemical results for the feedstock soil samples are shown in Table 4. Stockpiles RS 1, 7, 8 and RS 6, which were prepared by combining soil from several test pits, reveal that SVOCs are present in the areas where the soil was taken for the feedstock. A more detailed explanation of the feedstock preparation is present in the RIR Pilot Test section.

B. Groundwater Study

The highlights of the groundwater studies are as follows:

- LAW sampled 13 wells in 2000 to determine groundwater flow and quality and compared the groundwater sample results to the New York State Ambient Water Quality Standards.
- Groundwater is not a source of drinking water in this part of Nassau County.
- Three of these wells contained dissolved petroleum-related contaminants above the standards. These wells were located in the loading rack area and near former Tank 9.
- Groundwater flows radially from the northwest corner of the Site to the east-southeast where it diffuses into the surrounding saltwater bodies.
- GF used the results of LAW's groundwater sampling and monitoring program to support an evaluation of remedial options including the feasibility of groundwater treatment using nitrate amendments to enhance biodegradation in the vicinity of LMW-1, LMW-2 and MW-3R where the highest concentrations of dissolved petroleum-related chemicals were identified.

In the February 2001 LAW report, the chemical quality results for water samples taken in thirteen wells is reported, and the results are shown in Tables 4-3 and 4-4 of the LAW report, which is in Appendix B. In addition, water levels were also measured to determine groundwater flow directions. According to LAW, groundwater flow at the time of sampling was predominantly east and south from a northeast/southwest-trending groundwater divide near the southwest corner of the property. Groundwater quality along the northern boundary of the site with the residential areas was delineated by samples from wells LMW-4, OW-1, W-11 and W-12. No VOCs or SVOCs were detected in any of the samples from these wells except for naphthalene, which was detected in W-11 at 5.8 micrograms per liter (ug/l) that slightly exceeded the groundwater standard of 5 ug/l. Four SVOC constituents in W-11 and three SVOC constituents in W-12 were present but did not exceed the standards.

With respect to the laboratory results for the other samples, BTEX constituents were detected in samples from two of the 13 wells, LMW-1 (159.1 μg/l) near the former loading racks, and LMW-2 (59.99 μg/l) on the east side of former Tank 9. The concentration of benzene and ethylbenzene in LMW-1 and ethylbenzene and xylenes in LMW-2 exceeded the NYSDEC groundwater standards. Total VOC concentration (excluding BTEX) ranged from less than the laboratory reporting limits to approximately 446 µg/l in LMW-1. One or more individual VOC constituents (excluding BTEX) were detected in each of the samples from wells MW-3R, LMW-1 and LMW-2 at concentrations exceeding NYSDEC groundwater standards.

SVOCs were detected in samples from 9 of the 13 wells. Except for naphthalene, none of the individual SVOC constituents were found at concentrations exceeding the groundwater standards. Naphthalene was detected in samples LMW-1, LMW-2 and MW-3R at concentrations exceeding NYSDEC groundwater standards. The results of the natural attenuation parameter analyses indicated that the saturated zone provided favorable conditions for supporting biodegradation activity.

In the LAW Supplemental Soil and Groundwater Investigation report (LAW 2001), nine of the previously-sampled wells were sampled. Wells MW-6, LMW-1, LMW-2, and LMW-5 were not sampled. Of the sampled wells, only MW-3R had benzene at 3.8 ug/l and naphthalene at 67.1 ug/l, which was above the standards of 1 and 10 ug/l respectively; and W-11 had acenaphthene at 37.5 ug/l, Benzo(a)anthracene at 0.72 ug/l, and Chrysene at 0.55 ug/l, which were above the standards of 0.002, 0.002, and 20 ug/l, respectively. The other water samples may have had SVOCs and VOCs detected, but none exceeded the standards. The results can be found in the LAW reports in Appendix B.

GF used LAW's groundwater sampling results to support an evaluation of remedial options. As more fully discussed in the Remedial Technology Pilot Test Program section, GF assessed the feasibility of groundwater treatment using nitrate amendments to enhance biodegradation. A pilot test was performed in the southern portion of the property, in the vicinity of wells LMW-1, LMW-2 and MW-3R, where the highest petroleum hydrocarbon content in groundwater was found during LAW's study.

C. Soil Vapor Study

- GF performed a soil vapor investigation at four locations along the northeast property line near the residential community.
- The samples were taken outside any structures, and the detected VOCs did not exceed USEPA or New Jersey Department of Environmental Protection indoor air quality standards. There are no outdoor air quality standards or indoor air quality standards for petroleum related VOCs and SVOCs present at this Site in New York State.
- Vapor from treated ex situ oxidation test stockpiles #1, #3A, and #8 was also sampled to evaluate soil vapor, if any, in the contaminated soil.
- VOCs and SVOCs were detected. However, none exceeded the same indoor air quality standards mentioned above.

As requested by NYSDEC and NYSDOH, soil vapor along the northeast property boundary was sampled to assess the potential for off-site migration impacts to the adjacent residences. Three temporary vapor probes were installed using a Geoprobe at the locations shown on Figure 5. A fourth probe was added at the time of sampling to provide adequate coverage along the property boundary. The probes were installed to a depth shallower than originally proposed, approximately 2 to 2.5 feet below grade, due to high water table conditions. After the rods were driven to the desired depth, a stainless steel vapor probe connected to polyethylene tubing was inserted through the rods and set in place. The annulus between the vapor probe and borehole was filled to approximately one-foot above the top of the probe with glass beads and the remaining volume was filled to grade with bentonite chips. Distilled water was used to hydrate the chips to form a seal. The probe was removed from the ground after the sample was collected.

Soil vapor samples were collected in Summa Canisters that were pre-cleaned and prepared for use by the laboratory. Each canister was fitted with a controlled-rate orifice that was calibrated for a maximum flow rate of 0.2 liters per minute. Prior to sampling, a portable pump was used to purge one to three volumes of air in the sample probe and tubing to ensure that a representative soil vapor sample was obtained. Helium was used as a tracer gas for quality assurance/quality control purposes to ensure that short circuiting and dilution by ambient air did not occur. Each sample was analyzed for BTEX constituents using USEPA Method TO-15.

On April 18, 2007, soil vapor was extracted from treated soil piles 1, 3A and 8 (See Pilot Test Section). The samples were collected by uncovering the pile in one corner and driving a 1.5-inch diameter pry bar to a depth of 2.5-3 ft. Clear plastic, 3/8-in diameter tubing was placed into the hole until it reached the bottom. The tubing was then extracted so that approximately 3 inches of clear space existed between the tubing inlet and the bottom of the hole. The soil at the top of the hole was then collapsed around the tubing. A depression was made around the collapsed area and bentonite slurry was poured into the depression to seal the top of the hole preventing ambient air from entering the annulus. The standard protocol for collecting soil vapor samples was not followed at this point as leakage around the tubing was not checked with a tracer gas. Therefore, the results can be considered illustrative of the soil vapor quality in the soil piles, and not completely quantitative.

The vapor in the hole around the tubing was evacuated with a PID until the readings reached steady state. At that point, the regulator for the summa canister was attached to the tubing. The one-liter summa canister was then attached and the gauge on the regulator was checked to make sure a vacuum was created. The regulator was calibrated at the laboratory to control the fill rate of the canister to approximately a 60-minute period.

The field readings were as follows:

Field Readings for Treated Stockpile Soil Vapor Collection Event

Sample #	PID reading at start (PPM)	Vacuum at start	Start time	Finish time
1	140	-30	1630	1730
3A	4400	-25	1640	1735
8	292	-25	1650	1740

The laboratory results for the vapor samples are in Table 12. They show that none of the detected constituents exceed the New Jersey indoor air quality standards as described in the next section.

1. Soil Vapor Sampling Results

The soil vapor samples from the testing locations along the property perimeter adjacent to the residential area were analyzed by EcoTest Laboratories. The laboratory results are summarized below and the laboratory data reports are included in Appendix C.

NYSDOH has not established health-based soil vapor criteria for these BTEX constituents. As a proxy, the data were compared to the current EPA Region III Risk-Based Concentrations for Ambient Air, and generic vapor intrusion screening values for indoor air and soil gas presented in the New Jersey Department of Environmental Protection's (NJDEP) October 2005 (Updated May 2006) Vapor Intrusion Guidance. As a worst-case scenario, the maximum soil vapor concentration for each constituent was compared to the USEPA and NJDEP target indoor air concentrations for residential exposure to BTEX compounds.

The USEPA target indoor air concentration is a residential-based value that satisfies a prescribed cancer risk of 1×10^{-6} or a noncarcinogenic hazard index of 1.0. As shown below, none of the detected constituents exceeded the target indoor air concentrations. The sampling results were compared to the current EPA Region III Risk-Based Concentrations for Ambient Air as shown in the following table. As prescribed in EPA530-D-02-004, an attenuation factor of 0.1 was applied to soil vapor concentrations from sampling depths less than 5 feet. An excess risk level of 10^{-6} for indoor air was evaluated. Soil vapor concentrations did not exceed the Region III RBC for ambient air.

Comparison of Soil Vapor Results to USEPA Standards

Parameter	Region III Risk-Based Concentration for Ambient Air (ug/m3)	EPA Attenuation Factor	Soil Vapor Screening Concentration (ug/m3)	Maximum Detected Soil Vapor Concentration (ug/m3)
Benzene	0.23	0. 1	2.3	0.9
Toluene	5,100	0.1	51,000	4.9
Ethyl Benzene	1,100	0.1	11,000	1.1
Xylenes	110	0.1	1,100	3.7

The maximum soil vapor concentration for each constituent was also compared to the NJDEP target indoor air concentrations for residential exposure. The target indoor air concentration is a residential-based value that satisfies a prescribed cancer risk of 1 x 10^{-6} or a noncarcinogenic hazard index of 1.0. As shown below, none of the detected constituents exceeded the target indoor air concentrations.

Comparison of Soil Vapor Results to NJDEP Standards

Parameter	Maximum Detected Soil Vapor Concentration (ppbv)	Comparison Criteria(1) (ppbv)
Benzene	0.9	5
Toluene	4.9	68,000
Ethylbenzene	3.7	12,000
m/p Xylenes	3.7	1,300
o Xylenes	1.8	1,300

(1) New Jersey Department of Environmental Protection's (NJDEP) October 2005 (Updated May 2006) Vapor Intrusion Guidance.

Similarly, the soil vapor results from the treated soil piles did not exceed these standards.

QUALITATIVE EXPOSURE ASSESSMENT

The Qualitative Exposure Assessment (QEA) assesses the potential for humans and wildlife to come in contact with the contaminants at the Site. The QEA is separated into two sections: a Human Health QEA and a Fish and Wildlife QEA. The assessments were prepared in accordance with NYSDEC's DER-10 guidance.

A. Objectives of Human Qualitative Exposure Assessment

- Exposures were assessed using a conceptual model of the Site.
- The model permits exposure to soil, groundwater, surface water, vapor and dust to be evaluated.
- The model looks at exposure potential for human receptors on-site and off-site.
- Under the former industrial use (construction materials storage), there is a pathway for human receptors who enter the Site to potentially be exposed to contaminants through dust and/or dermal contact during excavation of soils generally below the surface layer and pavement. These pathways can be mitigated through the use of safety procedures and engineering controls. These risks generally dissipate with distance from the potential source.
- Under the current residential reuse, there is risk to construction workers during site build out based on the exposure pathways noted above, but no exposure pathway once the Site is remediated and redeveloped to Track 1 residential SCOs. If the Site is not remediated to Track 1 levels, then any residual contamination would be properly managed through a Site Management Plan to prevent any exposure. However, based on the pilot study results described below, Track 1 cleanup levels are likely to be achieved.
- Under the current residential reuse, site workers performing the remediation will be potentially exposed, but such exposure can be mitigated through the health and safety plan and once the contaminants are removed, the risk will be eliminated.

A Conceptual Site Model (Model) was created to test actual or potential human exposures to contaminated soil, groundwater, surface water, vapor and dust emissions before, during and after remediation. The Model describes potential links between contaminant source(s) and human populations both on-site and off-site. The objective of the human health portion of the QEA is to provide a qualitative estimate of the risk posed to human receptors through exposure to contaminated media. By evaluating the pathways for the contaminants found on the Site, human receptors' exposure risk can be assessed.

Overall, five factors are considered in defining exposure pathways. Each factor must be present in order for an exposure pathway to be considered complete and, thus, for a contaminated site to pose a risk to human health:

1. A source of contamination;
2. Contaminant transport from the source, through any environmental medium;
3. Receptors who may be exposed to contamination;
4. A point of contact; and
5. An exposure route or routes for contaminants to be taken in by the receptor (dermal contact, ingestion, and/or inhalation).

B. Organization of Qualitative Exposure Assessment Report

- The report follows a proscribed format.
- Certain contaminants found at the Site are of concern due to their concentration.
- In soil, VOC concentrations have and will continue to decrease over time, whereas SVOCs are more persistent.
- In groundwater, dissolved contaminants will flow with the groundwater to a discharge point.
- No surface water bodies are present on the Site but are present adjacent to the Site.
- Soil vapor was not deemed a concern, as the concentration of contaminants in the soil vapor does not exceed applicable standards.
- An exposure pathway is present for both the existing industrial use and a future residential use if the Site is left unremediated.

Exposure pathways created by Site access and soil excavation can be managed through a health and safety plan, and will be eliminated once the future build out is completed.

- The QEA report follows a proscribed format as follows:
  - Nature and Extent of Site Contaminants;
  - Contaminant Fate and Transport;
  - Human Health Exposure Pathways at the Site;
  - Fish and Wildlife Qualitative Exposure Assessment; and
  - Conclusions of the QEA.

C. Nature and Extent of Contaminants

The results of previous site investigations indicate that certain petroleum related VOCs and SVOCs were found in soil and groundwater at concentrations that exceeded regulatory threshold values. Most notably, benzene, which is a carcinogen, 1,2,4-Trimethylbenzene, Ethylbenzene, Isopropylbenzene, Benzo(a)anthracene, Chrysene, Benzo(b0fluoranthese, Benzo(k)fluoranthene, Benzo(a)pyrene, and Indeno(1,2,3-cd)pyrene. Therefore, these constituents were determined to be chemicals of concern (COCs) for the purposes of the human health QEA.

D. Contaminant Fate and Transport

The following analysis of contaminant fate and transport takes into account the physical characteristics and surroundings of the Site, the interaction of the adjacent surface water and groundwater hydrology, and the documented nature, extent and chemical properties of the COCs. The environmental media on the Site that currently may serve as pathways for contaminant migration are soil, groundwater, and soil gas.

1. Soil

SVOCs and VOCs are present in subsurface soil at concentrations that exceed Track 1 regulatory SCOs (Tables 1, 2, 6, and 7). Over time, VOCs decrease in concentration due to biodegradation, volatilization and other processes. SVOCs will also biodegrade over time, but are generally more persistent, and remain sorbed to soil. SVOCs have very low solubility limits and do not readily dissolve into groundwater.

2. Groundwater

VOCs and SVOCs were detected in groundwater at concentrations exceeding the NYSDEC Ambient Water Quality standards. Dissolved organic constituents tend to migrate with groundwater. However, the rate of migration and overall mobility are affected by the chemical and physical properties of the COCs and the soil matrix.

3. Soil Gas

VOC vapors derived from impacted soil and groundwater can migrate to the surface or laterally beyond the site boundaries. Soil vapor can migrate into structures that exhibit negative pressure compared to the pressure conditions in the subsurface.

Soil vapor samples were collected along the northern property boundary and analyzed for VOCs as discussed under Section 2.3. The sampling results were compared to the current EPA Region III Risk-Based Concentrations for Ambient Air as shown in the following table. As prescribed in EPA530-D-02-004, an attenuation factor of 0.1 was applied to soil vapor concentrations from sampling depths less than 5 feet. An excess risk level of 10-6 for indoor air was evaluated. Soil vapor concentrations did not exceed the Region III RBC for ambient air.

Comparison of Soil Vapor Results to USEPA Standards

Parameter	Region III Risk-Based Concentration for Ambient Air (ug/m3)	EPA Attenuation Factor	Soil Vapor Screening Concentration (ug/m3)	Maximum Detected Soil Vapor Concentration (ug/m3)
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Xylenes	110	0.1	1,100	3.7

E. Exposure Pathways

An exposure pathway describes the route a chemical or physical agent takes from its source to an exposed individual. If needed, a fate and transport analysis identifies complete exposure pathways, which will be evaluated in the risk assessment. The fate and transport analysis considers the site-specific land use, and any institutional or engineering controls to be employed to eliminate pathways.

A complete exposure pathway generally consists of these elements:

1. A source or chemical release from a source;
2. An exposure point where contact can occur; and
3. An exposure route (i.e., ingestion) at the contact point.

If any component is missing, the pathway is deemed incomplete, and is not quantitatively evaluated in the risk assessment (EPA, 1989). Elimination of exposure pathways may occur based on professional judgment and evaluation of site-specific conditions. For example, if the probability of exposure occurring is low or if the impact of the exposure pathway is expected to be minor in comparison to other exposure pathways, the exposure pathway may be eliminated (EPA, 1989.)

1. Current Uses

Under current site conditions, trespassers and on-site industrial workers may come in contact with COCs in soil or groundwater if they dig into the ground. Access to the site is controlled by a lockable fence, which minimizes the possibility of unauthorized entry and casual or indirect contact with impacted soil. Potential risks to site workers are controlled by the use of a site-specific health and safety plan and engineering controls to mitigate exposure to impacted soil, groundwater and fugitive dust.

The soil vapor exposure pathway was also determined to be complete. Results of the soil vapor study indicate, however, that COCs were not present in the soil vapor at concentrations exceeding applicable guidance criteria. As a result, soil vapor is not expected to pose an unacceptable risk to trespassers, on-site workers or adjacent property owners/users.

2. Future Use Identified in BCP Application

At the time the BCP application was submitted, the anticipated future use of the property was anticipated to remain unchanged as industrial. Engineering controls and a soil management plan would be required to eliminate the exposure pathways for construction workers and employees working on the premises to the extent residual contamination remained after remediation. Complete exposure pathways exist for Site construction workers who may come in contact with residually impacted soil, groundwater and fugitive dust as part of their routine work activities. Potential risks would be controlled through a soil management plan, including a site-specific health and safety plan and engineering controls to mitigate exposure to and direct contact with residually impacted soil and groundwater if they remain present. For example, a demarcation barrier would be placed under the clean soil cover to mark the area where contaminated soil may be encountered.

3. Residential Use

Under a residential land use scenario, complete exposure pathways exist for Site construction workers who may come in contact with impacted soil, groundwater and fugitive dust as part of their routine work activities. The site needs to be remediated to eliminate the residential exposure risk to future residents. Potential risks would be controlled through the use of a site-specific health and safety plan, engineering controls and, institutional controls to mitigate exposure to and direct contact with residually impacted soil and groundwater that may remain after remediation. If the Site is remediated to Track 1 SCOs, there will be no remaining risk. If the Site is not remediated to Track 1 SCOs, then engineering controls to mitigate exposure to and direct contact with residually impacted soil and groundwater will be required. Also, groundwater quality will improve once the soils are remediated and the groundwater is treated to remove the dissolved chemicals that are currently found in this medium. For practical purposes groundwater at the property will not be used for potable purposes due to the proximity to saline surface water. Groundwater will become saline if pumped and furthermore, the availability of abundant municipal water should preclude the need for accessing this water body for any purpose. However, if residual groundwater contamination remains, it could be mitigated. Other than the construction worker scenario, the groundwater exposure pathway under both current and proposed and potential future land use scenarios was deemed incomplete because local shallow groundwater is not used as a potable source. In addition, this pathway is currently eliminated by the impracticality of installing wells for potable purposes adjacent to saltwater bodies subject to saltwater intrusion and regulatory restrictions against using water with salinity greater than the standards for drinking water supplies.

F. Fish and Wildlife Qualitative Exposure Assessment

- Risks are evaluated using a conceptual ecological site model.
- Only surface soil and surface water were considered in the model.
- Old-field vegetation and tidal wetlands were evaluated.
- None of the chemicals in the soil exceeded the Fish and Wildlife standards.
- Constituents in the groundwater will need to be removed.

Ecological exposures to contaminated Site surface soil or surface water during and after the remediation are evaluated in the context of an Ecological Conceptual Site Model (Ecological Model). Subsurface soil and groundwater were not considered in the Fish and Wildlife QEA because ecological receptors are not typically exposed to these media. The Ecological Model describes potential links between contaminant source(s) and ecological resources. The Ecological Model considers potential exposures to contamination and potential transport of contamination off-site.

1. Fish and Wildlife Resources

The Site contains 1.5-acres of old field vegetation and 0.12-acres of vegetated tidal wetlands. The remainder of the Site is gravel and dirt associated with previous demolition activities and impervious surfaces such as roadways and building foundations. According to the Fish and Wildlife Resources Impact Analysis Decision Key presented in Appendix 3C of NYSDEC's DER-10 guidance, the old field vegetation area and the tidal wetlands area are considered fish and wildlife resources that could support populations of ecological receptors, and requires further evaluation.

2. Exposure Pathways

The great blue heron and marsh wren are typically species that could be found in the tidal wetland area. Great blue herons inhabit a variety of freshwater and marine areas, including freshwater lakes and rivers, brackish marshes, lagoons, mangroves, and coastal wetlands, particularly where small fish are plentiful in shallow areas. They are often seen on tidal flats and sandbars (EPA, 1993). It is important to note that the feeding area of a great blue heron can be up to 20 acres in size. While the 0.12-acre tidal wetland is a suitable habitat for the great blue heron, the likelihood of it spending a substantial amount of time in this area and being exposed to Site-related contamination is considered minimal. Incidental ingestion of surface soil and the ingestion of prey are two potentially complete routes of exposure for the great blue heron. In addition, the tidal wetland was found not to be contaminated and is part of the "clean area" of the property.

Marsh wrens inhabit freshwater and saltwater marshes and standing water as its preferred habitat from several centimeters to nearly a meter in size (EPA, 1993). Feeding areas for marsh wrens are usually less than half an acre, making exposure to site-related contamination more likely. Incidental ingestion of surface soil and the ingestion of prey are the two potentially complete routes of exposure for the marsh wren.

Deer mice inhabit nearly all types of dry-land habitats within their range including short-grass prairies, grass-sage communities, coastal sage scrub and other habitats (EPA, 1993). Feeding areas for deer mice are up to 1.5 acres, which is the approximate size of the old field vegetation area. Incidental ingestion of surface soil and the ingestion of prey are the two potentially complete routes of exposure for the deer mouse.

3. Chemicals of Potential Ecological Concern

Petroleum hydrocarbon-related constituents were detected in groundwater and surface soil (see list of constituents in section C of the QEA). Surface water quality has not been evaluated during previous site investigations. Since groundwater beneath the Site discharges to the surrounding water bodies, it was assumed for the purposes of the ecological assessment that constituents in groundwater were also in surface water at the same concentration. This is an overly conservative assumption since it does not take into account the effects of dilution and dispersion that occurs as groundwater discharges to surface water. To focus the Fish and Wildlife QEA on contaminants that may pose a risk to the ecological resources, Contaminants of Potential Ecological Concern (COPECs) were selected.

Ecological Soil Cleanup Objectives have been promulgated by NYSDEC in the Part 375 regulations for several COPECs. Based on an evaluation of the datasets from the June 2007 test pit sampling event performed by GF, and the 2001 sampling event performed by LAW, none of the detected constituents in surface soil (0 to 2 feet below grade) were found at concentrations exceeding the Department's ecological threshold values.

NYSDEC has not published ecological cleanup objectives for surface water. The Department uses the Ambient Water Quality Standards. Based on the same GF/LAW dataset, a limited number of VOCs and SVOCs have been found in groundwater at concentrations exceeding these standards (see chemical list in Section C of the QEA), thereby creating a potentially complete exposure pathway. The proposed remedial activities, however, will mitigate groundwater conditions and, as a result, should eliminate the exposure pathway

Unfortunately, marine use and roadway stormwater runoff from the existing community into in the surrounding waterways will likely continue to impact these water bodies and marine habitats.

G. Summary

Potentially complete exposure pathways for human and ecological receptors were identified under the current use, construction/remediation phase and future/potential future use scenarios. All exposure pathways can either be managed or effectively eliminated. Under the current use scenario (industrial), minor remedial actions would be necessary to satisfy NYSDEC SCOs, and complete exposure pathways to petroleum-impacted soil and groundwater would essentially be eliminated through the implementation of a health and safety plan and a soil management plan. Under the potential future residential reuse scenario, contaminants in soil and groundwater will need to be reduced to levels less than either the Track 1 unrestricted use SCOs, which would eliminate any exposure pathway, or restricted Track 2 residential SCOs to result in an incomplete exposure pathway and an absence of quantifiable risk.

QUALITY ASSURANCE/QUALITY CONTROL

- Data generated during the soil, soil vapor, and groundwater sampling events were deemed usable for their intended purpose.

Analytical services in support of the 2000, 2001, 2006 and 2007 soil vapor study and soil and groundwater pilot test programs were provided by laboratories accredited under the NYSDOH Environmental Laboratory Approval Program (ELAP). Soil and groundwater analyses were performed in accordance with or based on acceptable modifications to the methodologies described under the United States Environmental Protection Agency (USEPA) publication SW-846 entitled *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.* Laboratory quality assurance/quality control (QA/QC) and analytical data reporting followed the requirements outlined in the NYSDEC's Analytical Services Protocol (ASP). Soil vapor analyses were performed in accordance with the methodology described under the USEPA publication *Compendium of Method for the Determination of Toxic Organics Compounds in Ambient Air- Second Edition.*

QA/QC sampling performed as part of the 2000-2007 Site investigation and pilot test programs included the following:

- Field and trip blanks to document sampling equipment decontamination effectiveness and to identify contamination introduced during sample transport;
- Laboratory method blanks to document contamination introduced by the laboratory analytical equipment or processes; and
- Site specific and batch matrix spike and matrix spike duplicate samples to document analytical interference caused by matrix effects and analytical reproducibility.

Usability and reliability of data generated by the sampling programs were evaluated through a review of the laboratory case narratives, which outline problems encountered, if any, during laboratory analysis, and the analytical data summary reports. The case narratives are included with the laboratory data reports in Appendix C. Based on this review, data generated during the soil, groundwater and soil vapor sampling programs were considered usable for their intended purpose.

REMEDIAL TECHNOLOGY PILOT TEST PROGRAM

The objective of the pilot test program was to compare various best available on-Site treatment technologies for the reduction and elimination of hydrocarbon contamination created from petroleum releases in soil and groundwater. All feedstock material for the soil tests was taken from various locations in the impacted areas of the Site to best replicate full scale remediation of the Site from selected technologies.

A. Feedstock Preparation

- Feedstock for the pilot tests was created by combining various amounts of soil from several stockpiles created through two sets of test pits to make a more homogeneous material for the proscribed testing protocols. The resulting composite feedstock batches were analyzed for VOCs and SVOCs to create a baseline sample profile just before the feedstock was sent through the pug mill and processed.
- The results of the baseline sampling for the first and second rounds of pilot tests were also used qualitatively in the soil-quality characterization in the RI.
- In the second and third rounds of testing, the feedstock was screened to remove rocks and debris and break up clumps of soil. It was then thoroughly mixed to insure a consistent chemical quality throughout the feedstock, which would improve the likelihood that the treatment objectives would be reached and increase the reproducibility of the results.

The goal of the pilot test was to determine the efficacy of treating petroleum contaminated soil using one of the selected technologies, and to quantify the design considerations for each successful technology. The baseline conditions of the VOC and SVOC content in the soil used in the tests were important parameters that needed to be ascertained and compared to the concentrations after treatment. It was thought that TPH would be a good general indicator of chemical content, and it was initially used to characterize the feedstock soil.

The data in the LAW February 2001 report showed TPH content varied throughout the property. The goal of any selected technology was to make sure it was effective for the highest average petroleum content on the Site. Therefore, 400 CY stockpiles of soil were excavated from the locations shown on Figure 6 and stored on the concrete tank pad adjacent to a pugmill. A composite sample for TPH analysis was collected from each stockpile.

The feedstock for the November and December tests was prepared by blending soil from the various stockpiles in the pugmill to produce a homogeneous feedstock with a goal of having a TPH of approximately 1000 ppm for each test. Once the feedstock was prepared, just prior to treatment, another composite sample was collected to document the baseline VOC and SVOC content of the soil using Method 8260 and Method 8270. The feedstock was then processed and moved to its post-treatment location where it was covered so the chemical reactions could continue to degrade the contaminants. Three weeks later, the first post-treatment composite samples were taken from the treated stockpiles and analyzed for the same chemicals to document how well each technology reduced the contaminant content. VOCs were detected in all feedstock samples except RS-1, 7, 8, with total content ranging from approximately 0.6 mg/kg (RS-4,3) to 8.28 mg/kg (RS-5). Only the RS-5 sample contained an individual VOC (benzene) hit at a concentration exceeding its applicable Track 1 SCO.

Due to the time needed for the laboratory to complete the analyses of the baseline samples, and the need to treat the feedstock immediately after the baseline samples were taken (to reduce any post sampling contaminant reductions from volatilization and microbial degradation), it was not possible to choose which feedstock pile would have the best contaminant mix for each pilot test. In addition, it was not until the baseline results were compared to the TPH values that the inconsistency between TPH and contaminant concentration was identified. Therefore, for each of the first two rounds of oxidation tests, the biopile and the land farm the feedstock batches did not have the same chemical profile. This problem was addressed in the third oxidation test by more thoroughly mixing the feedstock to produce homogeneous test batches, as shown in the chemical data for those tests, which are presented ahead.

The locations of each pilot test plot shown on Figure 6 are slightly different from the locations shown in the approved pilot test work plan due to standing water in some of the areas where test plots were originally positioned and space limitations. In addition, the locations were moved to decrease disturbance to the residential neighborhood.

<u>**B. Biopile and Land Farm**</u>

A description of the biopile and land farm pilot test results is contained in the following sections.

1. Biopile

A 50-cubic yard soil biopile, approximately 20-feet wide, by 15-feet long and approximately 5-feet high, was constructed using soil derived from three of the stockpiles, as described below. Nutrients, microbes and lime were mixed into the soil by the pugmill. The soil was then placed on top of an 8-mil polyethylene liner in one- to two-foot lifts. A network of four-inch diameter slotted PVC air distribution piping was woven throughout the soil as it was constructed. The pile was covered with a black, nylon, reinforced tarp for weather protection, and to keep the soil warm, consistent with the protocols outlined in NYSDEC-STARS #2, 1996. Hay bales placed under the tarp were used to promote air circulation between the soil and cover. Moisture content was monitored during the testing period, and adjusted as necessary to sustain microbial activity. The liner was surrounded by an earthen berm to control stormwater run-on and runoff. Soil was sampled and analyzed for TPH, SVOCs and VOCs after several weeks to monitor and track the remedial progress.

<u>Biopile Testing Results</u>

- The feedstock contained TPH and SVOCs at total concentrations of 900 mg/kg and 12.4 mg/kg respectively.
- The test was successful at reducing SVOC contaminants to Track 1 SCOs.
- No VOCs were detected in the treated biopile.
- Although the technology reduced the contaminant levels to Track 1 SCOs, TPH still remained high, indicating an interference with the laboratory procedure caused by non-petroleum constituents in the soil.

Feedstock for the biopile was derived from a mixture of soil from stockpiles 1, 7 and 8. A composite sample created to characterize the pre-treated soil was collected on October 30, 2006. The laboratory data are summarized in Table 4 and the laboratory data reports are included in Appendix C. Sample RS-1, 7, 8 contained TPH and SVOCs at total concentrations of approximately 900 mg/kg and 12.4 mg/kg, respectively. Two SVOC constituents, benzo(k)fluoranthene and indeno(1,23-cd)pyrene exceeded the NYSDEC Track 1 Soil Cleanup Objectives (SCO). VOCs were not detected.

On December 18, 2006 a post-treatment composite sample from the biopile was collected for TPH, SVOCs and VOC analysis (Table 1). The laboratory data indicate that sample BIO-121806 contained TPH at a total concentration higher than the pre-treatment sample (approximately 3,168 mg/kg vs. 900 mg/kg). However, post-treatment SVOC concentration of all individual constituents were lower than pre-treatment levels, and total SVOC concentrations decreased by nearly 30-percent, from approximately 12.4 mg/kg to 8.6 mg/kg. The concentration of both benzo(k)fluoranthene and indeno(1,23-cd)pyrene was reduced to less than the Track 1 SCO. The pre- and post-treatment VOC data were essentially the same, with the concentration of all individual VOC constituents less than the laboratory reporting limit except for p-isopropyltoluene, which was detected in the post-treatment sample at 16.7 μg/kg.

A second round of post-treatment testing was performed on June 22, 2007 and consisted of collecting two samples for TPH, SVOC and VOC analysis. Both samples contained TPH at a concentration less than the initial post treatment sample from December 2006 but still higher than baseline. A further reduction in total SVOC concentration occurred over time, with the concentration of all individual SVOC constituents less than the levels reported in December. VOCs were not detected in the June samples at concentrations exceeding the laboratory reporting limit.

2. Land Farm

A land farming treatment plot, approximately 50-feet wide, 50-feet long, and 0.5-feet thick, was constructed on a liner system similar to the biopile and consisted of approximately 50-cubic yards of soil derived from the same stockpiles used for the biopile test. Calcium peroxide, nitrate and microbes to enhance biological activity, were spread over the treatment area.

Soil sampling was performed immediately after construction to establish baseline conditions. The soil was then covered with a tarp until follow-up sampling was performed several weeks later to monitor and track the remedial progress. Endpoint samples were collected in June 2007. The samples were analyzed for TPH, SVOCs and VOCs.

Land Farming Testing Results

- The test was successful at reducing both TPH and SVOC levels to Track 1 SCOs.
- SVOCs initially increased during the first round of sampling but later decreased in the second round. The increase was attributed to inhomogeniety in the feedstock that produced different composite samples each time sampling was done.
- VOCs were reduced to Track 1 SCOs.

Feedstock for the land farm was also derived from stockpiles RS-1, 7 and 8. The baseline sampling results are discussed in the previous section. A post-treatment composite sample from the land farm was also collected on December 18, 2006 for TPH, SVOC and VOC analysis (Table 5). The laboratory data indicate that the December 18 sample contained TPH at a lower concentration than the pre-treatment sample (approximately 2.11 mg/kg vs. 900 mg/kg). However, the concentration of nearly all SVOC constituents was higher on December 18 than pre-treatment levels, with total SVOC concentration increasing from approximately 12.4 mg/kg to 25.6 mg/kg. The concentration of Benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, and indeno(1,23-cd)pyrene was greater than the Track 1 SCOs on December 18. The VOC concentration on December 18 was consistent with the biopile results, in that VOCs were not detected in pre- and post-treatment samples, except for p-isopropyltoluene, which was detected in the December 18^{th} sample at 8.85 μg/kg.

Two soil samples were collected from the land farm on June 22, 2007 and analyzed for TPH, SVOCs and VOCs. TPH in both samples was at a concentration similar to baseline levels of 900 mg/kg. Total SVOC concentration was much lower than the December 18 samples, with all individual SVOC constituents being less than the Track 1 SCOs. VOCs were not detected in the June samples.

C. Ex Situ Oxidation

- The pilot test of this technology successfully demonstrated its ability to reduce contaminant levels to Track 1 SCOs consistently in the shortest timeframe as compared to the other pilot technologies.

The ex situ oxidation pilot test consisted of using the pugmill to mix and blend petroleum-impacted soil from the various stockpiles with a chemical oxidant (Regen Ox^{TM}). A technical description of the chemical oxidation process is included in Appendix D. In general, this technology was evaluated by running several batches of soil through the pugmill system using varying stockpile volumes, reagent dosages and through-put iterations to assess how these variables affect the remedial outcome. Treated soil was returned to a holding area then sampled at various times to evaluate changes in chemical content compared to baseline conditions. Figure 6 shows the test area layout. The pugmill was setup on one of the concrete tank support pads in the southwest corner of the property. Stockpile soil was stored on the concrete tank pad immediately north of the pugmill, and the treated soil was stored at several locations: on a liner system adjacent to the biopile and land farm units; next to the pugmill; and on the stockpile storage pad. The oxidation testing was carried out in three phases as described below.

1. Phase 1 Testing

- Initially conducted in November 2006.
- The concentration of reagent needed to reduce the chemical content was calculated based on the baseline feedstock results.
- Various reagent loadings and pugmill runs were chosen to test how these parameters would affect treatment outcome.

The first phase was used to evaluate the overall feasibility of this technology. Soil from the eight test stockpiles discussed above, was used as feedstock and processed in six test batches that had different amounts of reagents and different numbers of runs through the pug mill as shown below. A description of which test piles were used to create each test batch is found ahead.

Correlation of Reagent Concentration and Pugmill Runs to Test Batch Number

Test Batch Number	Quantity (cubic yard)	Reagent Amount (1)	Pugmill Runs (2)
1	500	1X	1
2	250	1/2X	1
3	250	1/2X	2
4	500	1/2X	2
5	35	1X	2
6	250	2X	1

(1) X represents the calculated concentration of reagent (10 pounds per cubic yard, consisting of 5 pounds of Part A and 5 pounds of Part B mixed with approximately 1 gallon of water per cubic yard) necessary to reduce the concentration of petroleum hydrocarbon content to less than the Track 1 soil cleanup objectives.
(2) Indicates the number of times the batch is processed through the pugmill.

Baseline conditions were established in October 2006 prior to processing. To assess the overall remedial effectiveness, and the need to adjust oxidant application rates, the treated soil was sampled in November 2006, and then again in December 2006 for TPH and STARS list VOC and SVOC analyses.

Phase 1 Testing Results

- The progress samples collected three weeks after adding the reagents, and in December 2006 showed all of the SVOCs and VOCs were below Track 1 SCOs in all batches.
- VOC concentrations were reduced to undetectable levels in the December 2006 samples for Test Batches 2 and 3, and in the November and December samples for Test Batch 4.

The concentration of benzene in Test Batch 2 was reduced to less than the laboratory reporting limit in the November sample.

In October 2006, composite samples of feedstock were analyzed for TPH and STARS list SVOCs and VOCs to establish baseline levels for each test batch prior to treatment. Post treatment samples were collected in November and December of the same year. The table below correlates the test batch number to the raw stock soil pile and associated pre-treatment and post-treatment sample identification. The laboratory data are summarized in Table 6 and the laboratory data reports are included in Appendix C.

Phase 1 Sample Number Correlation Table

Test Batch ID	Source of Feedstock	Feedstock Baseline Sample ID	Post Treatment Sample ID
1	Stockpile #6	RS-6	OTC-1, -8(1), -9(1)
2	Stockpile #5	RS-5	OTC-2
3	Stockpiles #5	RS-5	OTC-3A
4	Stockpiles #3, 4	RS-4,3	OTC-3B
5	Stockpiles #3, 4	RS-4,3	OTC-4
6	Stockpiles #1, 7, 8	RS-1,7,8;	OTC-5

(1) The treated soil resulting from Test Batch 1 was processed a second time through the pugmill using the same reagent dosage. Sample OTC-8 characterizes the second run post treatment soil. Sample OTC-9 characterizes the same material that was amended with a pH buffer in the laboratory prior to analysis.

The remedial effectiveness was assessed through an evaluation of the SVOC and VOC sampling results, as there is no regulatory benchmark for TPH. The total concentration of SVOCs in the pre-treatment samples ranged from approximately 1.4 mg/kg (RS-4, 3) to 12.4 mg/kg (RS-1, 7, 8). Individual SVOC constituents exceeded the Track 1 SCOs in samples RS-6 and RS-1,7,8. The post-treatment sampling results show SVOCs were reduced the greatest in total value and percentage terms under Test Batch 1. Samples collected in November 2006, approximately three weeks after treatment, showed SVOC content was reduced nearly 84 percent, with all individual SVOC constituents at concentrations less than the Track 1 SCOs. Similar reductions were found in the second round post treatment samples collected in December 2006. Test Batch 2 also showed a nearly 50-percent total SVOC content reduction. Individual SVOC constituents that exceeded the SCOs in the feedstock for Test Batch 6 (RS-1, 7, 8) were reduced to levels that were less than the SCOs (sample OTC-5).

Even though VOCs were detected in all feedstock samples except RS-1, 7, 8, with total content ranging from approximately 0.6 mg/kg (RS-4,3) to 8.28 mg/kg (RS-5), only sample RS-5 contained an individual VOC (benzene) at a concentration exceeding the Track 1 SCO. Test Batches 2, 3 and 4 all resulted in over a 99-percent reduction in total VOC concentration. VOC content was reduced to less than the laboratory reporting limit in the second round post treatment samples for Test Batches 2 and 3 and in the initial and second round post treatment samples for Test Batch 4. The benzene in sample RS-5 was reduced to less than the laboratory-reporting limit in the initial post treatment sample for Test Batch 2. A limited number of post treatment samples (OTC-4 and OTC-5 from Test Batches 5 and 6) contained VOCs greater than baseline, but less than Track 1 SCOs.

2. Phase 2 Testing

- Conducted in December 2006.
- It consisted of mechanically screening the feedstock to remove large rocks, debris, and clumps of organic soil to provide for a more homogeneous feedstock.
- Pugmill runs were conducted with a reduced amount of reagent and additional pugmill mixing.

Based on the November 2006 Phase 1 sampling results, ex-situ oxidation was considered a feasible remedial option warranting additional study. Therefore, a second phase of testing was performed in December 2006 to assess the effect of homogenizing the feedstock and alternative oxidant dosages on the treatment process. Two test batches were run as shown below.

One of the observations made in the Phase 1 testing is the feedstock soil needed to be screened prior to mixing in the pugmill to remove any large pieces of debris (stones, wood, and metal) and break up clods of soil that may shield petroleum from coming in contact with the reagents. Therefore, prior to adding reagent in the pugmill, the Test Batch 2 soil was run through a mechanical screen to remove debris. The screened feedstock was then run through the pugmill to mix it thoroughly and the set up of the two test runs are shown in the following table:

Phase 2 Sample Number Correlation Table

Test Batch Number	Quantity (cy)	Reagent Amount (1)	Pugmill Runs (2)
1	250	0.1X	1
2	250	0.2X	1

(1) X represents the calculated concentration of reagent (10 pounds per cubic yard, consisting of 5 pounds of Part A and 5 pounds of Part B mixed with approximately 1 gallon of water per cubic yard) necessary to reduce the concentration of petroleum hydrocarbon content to less than the remedial cleanup objectives.
(2) Indicates the number of times the batch is processed through the pugmill.

Phase 2 Testing Results

- The results showed that homogenizing the material enhances the process' ability to meet the Track 1 remediation goals.
- Addition of smaller dosage amounts of reagent was effective with the more homogeneous material due to increased contact area for the oxidant and creating a consistent contaminant concentration that would not deplete the oxidant before complete oxidation was achieved.

Feedstock for Phase 2 was derived from the RS-1, 7, 8 stockpiles. The table below correlates the test batch number to the raw stockpile soil and associated pre-treatment and post-treatment sample identification. The laboratory data are summarized in Table 7 and the laboratory data reports are included in Appendix C.

Phase 2 Test Batch Number vs. Raw Stockpile Number Correlation Table

Test Batch ID	Source of Feedstock	Baseline Sample ID	Post Treatment Sample ID
1	Stockpiles #1, 7, 8	RS-1,7,8 (Unscreened)(1);	OTC-6
2	Stockpiles #1, 7, 8	RS-1,7,8 (Screened)(1)	OTC-7

(1) RS-1, 7, 8 (unscreened) represents a second test batch from the RS-1, 7, 8 stockpiles collected in December and processed as-is through the pugmill. RS-1, 7, 8 (screened) was collected at the same time, but mechanically screened prior to processing.

The Phase 2 testing results showed that the screened feedstock had better results than the unscreened feedstock when the Test Batch 1 and 2 results are compared (Table 5). These results support the conclusion that contaminant concentrations can be significantly reduced by homogenizing the feedstock prior to pugmill processing for both VOCs and SVOCs. The results also concluded that a lower oxidant loading was more effective when the material was homogeneous to achieve Track 1 SCOs.

3. Phase 3 Testing

- Conducted in June 2007.
- Reconfirmed the earlier tests for highest average contaminated materials.
- The Phase 3 testing procedure was developed from the Phase 2 test results.
- The Phase 3 results were repeatable and achieved Track 1 SCOs.

After the positive results from the Phase 2 testing were observed, a third phase of testing was proposed to fine-tune the remedial process and build upon the findings of the two prior phases. Two of the findings from the first two phases were the importance of removing all large debris from the feedstock and thoroughly mixing the soil to make sure it is homogeneous. Through this screening process, the ratio of oxidant to chemical loading is more consistent, and the results of individual tests can be compared to each other without regard to interferences produced by non-homogeneous feedstock materials.

Phase 3 testing was performed in June and July 2007 in concert with the additional RI sampling in the area formerly delineated by TPH only. Data from the 18 test pits installed for the RI were used to identify additional areas where soil could be excavated for the Phase 3 testing.

Soil derived from 6 of 18 test pits dug to collect soil samples for the RI (TP-1, -10, -11, -13, -15 and -17) was used to create the stockpiles from which the feedstock was prepared (Figure 4). Approximately 20 cubic yards of soil from each test pit was screened to remove rocks and other debris and then combined into a single stockpile. The composite stockpile was then thoroughly homogenized using a backhoe and Payloader to produce a consistent quality. The material was then segregated into five approximately 20-cubic yard piles, sampled and analyzed to determine the variations in chemical quality of each stockpile. The original intent was to use each stockpile as a separate feedstock for each pugmill run. However, the chemical results showed that the stockpiles were fairly close to each other in chemical quality. This allowed all of the stockpiles to be combined into one feedstock pile adjacent to the pugmill from which 20-yd batches were taken for the test runs. These batches were processed as follows:

Phase 3 Test Batch Numbering Matrix and Test Specifications

Test Batch Number	Quantity (cubic yard)	Reagent Amount (1)	Pugmill Runs (2)
1	20	0X (No reagent)	1
2	20	1/4X	1
3	20	1/2X	1
4	20	3/8X	1
5	35	1.1X	1

(1) X represents the calculated concentration of reagent (10 pounds per cubic yard, consisting of 5 pounds of Part A and 5 pounds of Part B mixed with approximately 1 gallon of water per cubic yard) necessary to reduce the concentration of petroleum hydrocarbon content to less than the remedial cleanup objectives.
(2) Indicates the number of times the batch is processed through the pugmill.

Phase 3 Test Results

- The total concentration of SVOCs in baseline samples ranged from approximately 21.3 mg/kg to 25.7 mg/kg.
- Of the individual SVOC components detected, 2-methylnaphthalene, naphthalene, acenaphthene, anthracene, fluorene, and phenanthrene experienced the greatest reduction in concentration.
- VOCs were detected in all baseline samples ranging from approximately 12 mg/kg to 16.9 mg/kg. The only VOC that exceed Track 1 SCOs was 1,2,4-trimethylbenzene and it was found in all samples at roughly the same concentration.
- 1,2,4-trimethylbenzene was not detected in the post treatment samples.
- The total concentration of TPH in the baseline samples was fairly consistent from pile to pile, ranging from 2,772 mg/kg to 3,297 mg/kg. There was little change in TPH concentration in the post treatment samples.

Initially, the feedstock was separated into five stockpiles that were sampled in June 2007 for SVOC, VOC and TPH analyses to establish baseline levels for each test batch prior to treatment. As mentioned above, the five stockpiles were combined because the chemical results for each pile were practically identical. Two post treatment samples from each test batch were collected in July. The table below correlates the test batch number to the feedstock and associated pre-treatment sample identification. The laboratory data are summarized in Tables 8 through 10 and the laboratory reports are included in Appendix C.

Phase 3 Pretreatment Sample Number Matrix

Test Batch ID	Source of Raw Stock	Baseline Sample ID
1	Recombined Stockpile	Comp1
2	Recombined Stockpile	Comp2
3	Recombined Stockpile	Comp3
4	Recombined Stockpile	Comp4
5	Recombined Stockpile	Comp5

The post treatment sample results cannot be compared to an individual Baseline Sample, as the baseline sample feedstock piles were combined into one pile after their chemical results showed they were essentially similar. The post treatment results can be compared to the average feedstock results and the Part 375 cleanup standards to determine the effectiveness of the various treatment procedures.

The post-treatment test batches were positioned on the concrete tank base and separated from each other. Samples were taken from each treated pile and numbered using the identifiers in the table below.

Phase 3 Post Treatment Sample ID

Pile1 (1), Pile 1 (2)*
Pile 2 (1), Pile 2 (2)
Pile 3 (1), Pile 3 (2)
Pile 4 (1), Pile 4 (2)
Pile 5 (1), Pile 5 (2)

*The (1) and (2) designations refer to the two sampling rounds

The total SVOC content in the pre-treatment samples ranged from approximately 21.3 mg/kg (Comp3) to 25.7 mg/kg (Comp1) (Table 8). Using the average results of the two post-treatment samples, the data indicate that total SVOC content was reduced between 74-percent and 89-percent compared to baseline. Of the individual SVOC components, 2-methylnaphthalene, naphthalene, acenaphthene, anthracene, fluorene, and phenanthrene experienced the greatest reduction in concentration over the treatment period.

VOCs were detected in all pre-treatment samples, at a total content ranging from approximately 12 mg/kg (Comp2) to 16.9 mg/kg (Comp1) (Table 9). 1,2,4-trimethylbenzene was found in all samples. The concentration of 1,2,4-trimethylbenzene ranged from approximately 4.9 mg/kg (Comp2) to 5.8 mg/kg (Comp1). Using the average of the results of the two post-treatment samples, the data indicate that total VOC content was reduced between 95-percent and 99-percent compared to baseline, with all individual VOC constituents less than the Track 1 SCOs. 1, 2, 4-trimethylbenzene was not detected in the post treatment samples.

Total TPH content in the baseline samples was fairly consistent from pile to pile, ranging from 2,772 mg/kg (Comp2) to 3,297 mg/kg (Comp3) (Table 10). There was little change in TPH concentrations in the post treatment samples.

4. Assessment of the Technologies

All of the technologies were evaluated to assess their use for reducing the contaminants found in the soil to levels appropriate for the proposed future use of the property. A brief summation of the technologies follows, and a preliminary ranking table is at the end of this section to numerically rank the three technologies.

<u>Assessment of Biopile and Land Farm Technologies</u>

- An assessment of the remedial progress approximately eight months after initiating the tests indicated that the biopile and land farming technologies were successful in reducing the concentration of individual SVOC constituents to levels less than the Track 1 SCOs.
- Both of these technologies, however, were time consuming, and did not provide consistent or better results compared to the more aggressive ex-situ chemical oxidation process. As a result, no further testing of the biopile or land farming technologies was performed.

Assessment of the Ex-Situ Remedial Technology

- Ex situ oxidation, combined with mechanical screening, was consistently successful in reducing the concentration of VOC and SVOC petroleum hydrocarbon contaminants to less than the Track 1 SCOs.

Technology Ranking

- Ex situ oxidation ranks higher than the other two technologies in this preliminary ranking. However, as all of the technologies can meet the cleanup goals, the Feasibility Study will select the appropriate technology when land use and other ranking factors are considered.

Preliminary Ranking (Land Use not considered)

Technology/Rating Factor	Land Farming	Biopile	Ex situ Oxidation
Potential to eliminate contamination	5	5	5
Ability to Produce Consistent Results	3	4	5
Time Needed to Achieve Remediation Goals	1	2	5
Cost	5	3	1
Total Rating	14	14	16

Rating is based on 1-5 scale with 5 being the best results and 1 being the worst results

D. Groundwater Treatment Using Nitrate Amendment

- The pilot test showed this technology could remediate groundwater at the property.
- A 50-sf test plot in a high-TPH location where groundwater contained detectable petroleum constituents was selected for the test.
- Baseline conditions for VOCs, SVOCs ammonia, TPH, and TKN were determined prior to starting the test.
- Nitrate salts were irrigated into the ground.
- Groundwater was sampled after several months to measure the effectiveness of the technology and obtain design data.

A description of the nitrate remediation process is in Appendix D. Nitrate compounds applied to soil or groundwater can enhance biological activity by serving as a terminal electron acceptor for indigenous anaerobic and facultative anaerobic bacteria. Petroleum hydrocarbons and nitrate are depleted over time as the nitrate molecule is used as the terminal electron acceptor by microbes during anaerobic metabolization.

An approximately 50 x 50 foot plot of undisturbed soil adjacent to an area that showed moderate to high TPH residual content was selected as the test plot (Figure 6). The test plot was also near the only monitoring wells that showed elevated constituents in the groundwater. Two monitoring wells were installed upgradient and downgradient of the test area to establish background groundwater quality and to track groundwater conditions during the test period.

Prior to starting the test, baseline conditions were determined by analyzing groundwater samples from the two new wells for TPH, SVOCs, VOCs, ammonia, and TKN. Nitrate salts were then applied to the ground and irrigated to promote percolation through the soil column, which is akin to directly applying them to the groundwater. Post treatment groundwater monitoring for the same constituents was used to evaluate the remedial progress and to supply feedback data on the need to adjust nitrate dosages over time.

<u>Nitrate Amendment Results</u>

The results summarized in the following tables, showed nitrate addition could remediate residual petroleum constituents in groundwater.

Groundwater Treatment Results

PTW-1	Baseline	December 2006	July 2007
TPH	0.023 mg/l		
VOCs, total	7.7 ug/l	ND	ND
SVOCs, total		> baseline	< baseline
Acenaphthene	< standards		

PTW-2	Baseline	December 2006	July 2007
TPH	0.026 mg/l		
VOCs, total	7.5 ug/l	Only benzene detected	ND
Benzene	> standards	> standards	ND
SVOCs	ND	> baseline < standards	> baseline < standards

Groundwater samples from monitoring wells PTW-1 and PTW-2 were collected in November 2006, prior to the application of nitrate salts, to establish baseline conditions. The laboratory data are summarized in Table 11 and the laboratory data reports are included in Appendix C.

TPH was detected in samples from both wells at relatively low concentrations, 0.023 mg/l and 0.026 mg/l respectively. Acenaphthene was the only SVOC constituent detected in PTW-1, and it was found at a concentration well below the NYSDEC groundwater cleanup standard. SVOCs were not detected in PTW-2 at a concentration exceeding the laboratory reporting limits. A limited number of VOC constituents were detected, with total concentrations at 7.7 µg/l (PTW-1) and 7.5 µg/l (PTW-2). The PTW-2 sample contained one constituent (benzene) at a concentration exceeding the NYSDEC groundwater cleanup standard.

Total SVOC concentration increased slightly at PTW-1 during the first round of post-treatment sampling in December 2006 then decreased to less than baseline in July 2007. At PTW-2, total SVOC concentration was slightly higher than baseline during both post treatment-sampling rounds. Total VOC concentration at PTW-1 was reduced to less than the laboratory reporting limit during the first post treatment sampling round and remained at this concentration as of the second sampling round. At PTW-2, benzene remained at a concentration exceeding the NYSDEC groundwater cleanup standard as of December 2006, and it was the only VOC constituent detected in this sample. VOCs were not detected in the second round post treatment sample from PTW-2 in July 2007 at a concentration exceeding the laboratory-reporting limit.

Assessment of the Nitrate Amendment Technology

The post treatment sampling results indicate that the direct application of nitrate compounds to groundwater successfully reduced the concentration of petroleum hydrocarbon constituents. Nitrate amendment is recommended as a remedial technology if achievement of Track 1 SCOs is selected for the site. However, groundwater quality will also improve over time when the impacted soil is remediated. The extent of groundwater treatment will be determined in the

Remedial Action Work Plan (RAWP), based on the SCO selected for unrestricted or restricted residential use.

FINAL REMEDIAL INVESTIGATION AND PILOT TEST RESULTS

The findings and conclusion of the remedial investigation, pilot test activities and qualitative exposure assessment are as follows:

A. Soil

Site investigations performed in the early 1990s identified the presence of petroleum hydrocarbon residuals in soil at concentrations exceeding the then-current NYSDEC cleanup criteria. These earlier assessments relied on the analysis of TPH (Method 418.1) as a way to broadly characterize petroleum hydrocarbon-related impacts with a subset of samples also analyzed for individual SVOC and VOC constituents. While certain individual organic constituents were found at concentrations exceeding cleanup guidelines, the bulk of detected compounds fell into the "tentatively identified compounds" category.

The more recent comprehensive soil investigations performed in 2000 and beyond determined that the majority of residual petroleum hydrocarbons, formerly characterized by TPH, were present in the upper four-foot zone of soil and east of the "clean area" boundary established by LAW. However, the feedstock baseline data, and the detailed analyses of soil throughout the property conducted to complete the RI, showed the continuing presence of petroleum chemicals exceeding standards that need to be addressed for its current industrial use or proposed future residential uses.

The baseline sampling for test pits 1, 6, 7, and 8 showed the presence of VOCs and SVOCs exceeding Track 1 SCOs. The more comprehensive sampling conducted throughout the property showed that petroleum-contaminated soil is not uniformly distributed throughout the "impacted" area. First, the potential that undocumented releases occurred in the delineated area, which were not previously identified, is possible. Second, and a more likely explanation, is that there has been some redistribution of the petroleum product by frequent flooding of the Site by tidal and storm events. This likely movement of product by weather influences makes it difficult to definitively delineate every location in this more contaminated part of the Site. Even if sampling were conducted, contaminant conditions can be altered. PDC and GF believe sufficient investigation has been performed to commence remediation. Site remedial efforts will involve soil excavation and screening, which will locate and remediate all areas of contaminated soil on the Site.

The only other contaminants found at the site over the Track 1 SCOs were PCBs in soil along the southwest property boundary during the early 1990s site investigations. Confirmatory soil sampling in and around this area in 2001 showed that the concentration did not exceed Track 2 Industrial SCOs. However, the sample results revealed the presence of these constituents at concentrations slightly exceeding the Track 1 Residential SCOs (see Figure 3). The current PCB content should be determined during the implementation of the RAWP when soil is removed from this area. This area of the Site is part of the wetland area. Wetland impacts will be addressed in the RAWP. If the residential standards are exceeded, they can be addressed in the remedial action plan. RCRA metals were not present at concentrations warranting further evaluation.

Based on the combined environmental database developed by GF and other parties, the nature and extent of petroleum hydrocarbon residuals in soil has been adequately characterized, and the data are sufficient to support remedial action decisions that will be made based on current industrial and now contemplated residential land use for the Site.

B. Groundwater

Groundwater flows radially to the surrounding water bodies and is tidally influenced. The monitoring well network provides sufficient coverage across the property to assess groundwater quality downgradient of the former ASTs and other petroleum-handling areas. Sampling over time has indicated that individual semi-volatile and volatile organic constituents have been found at concentrations exceeding groundwater cleanup standards. However, the results show that petroleum hydrocarbon-related impacts were limited in nature and extent. Two of nine monitoring wells sampled as part of LAW's site investigation in 2001 contained individual

SVOCs and VOCs at concentrations exceeding groundwater standards. If Track 1 SCO unrestricted cleanup levels are selected for the remedy, existing dissolved contaminants can be further treated if necessary as shown in the pilot study.

C. Soil Vapor

Soil vapor sampling performed in 2006 along the northeast property boundary, where the nearest residential homes are located, did not reveal the presence of VOCs at concentrations exceeding the selected comparison criteria (USEPA Region III Risk-Based Concentrations for Ambient Air and the NJDEP Vapor Intrusion Guidance). As a result, no further investigation of soil vapor migration is warranted.

However, the potential for soil vapor was documented with the vapor samples taken from the treated stockpiles. Therefore, soil gas concentrations should be re-evaluated after source removal is achieved.

D. Soil and Groundwater Pilot Test Results

Of the three soil pilot test technologies tested by GF (biopile, land farming and ex-situ oxidation), ex-situ oxidation produced the most reliable results in the shortest amount of time. Chemical oxidation was successful in reducing the concentrations of SVOCs and VOCs in soil to less than the Track 1 SCOs, especially when combined with mechanical screening and homogenization to reduce treatment variations. The biopile and land farming technologies were also successful in reducing the concentration of individual SVOC constituents to levels less than the Track 1 SCOs. Both technologies, however, were time consuming and did not provide consistent or better results compared to the more aggressive ex-situ chemical oxidation process.

Post treatment groundwater sampling indicated that the application of nitrate compounds to groundwater was successful in enhancing biodegradation, and in reducing the concentration of

SVOCs and VOCs. This treatment can be applied if Track 1 SCOs are selected for the remedial alternative.

E. QEA

The QEA concluded that, under current site conditions, the soil and groundwater exposure pathways were considered complete. Trespassers and on-site workers may come in contact with constituents of concern in soil or groundwater if excavation occurs. Access to the site is controlled by a lockable fence, which minimizes the possibility of unauthorized entry and casual or indirect contact with affected soil. Potential risks to Site workers are controlled by the use of a site-specific health and safety plan and engineering controls to mitigate exposure to impacted soil, groundwater and fugitive dust. The soil vapor exposure pathway was also determined to be complete. However, the results of GF's soil vapor study indicate that chemical constituents were not present in the soil vapor at concentrations exceeding the comparison criteria. As a result, it is not expected that the soil vapor poses an unacceptable risk to the adjacent property users. The presence of soil vapor in the treated stockpiles did not exceed the standards, and reduction of the vapor components would occur during remediation, further reducing the potential for these vapors to become a nuisance during future use.

Under a future use residential scenario, complete exposure pathways exist for Site construction workers who may come in contact with impacted soil, groundwater and fugitive dust as part of their routine work activities until remediation is complete. However, potential risks would be controlled through the use of a site-specific health and safety plan and engineering controls to mitigate exposure. Site remediation would be needed to enable soil conditions to satisfy the appropriate Track 1 unrestricted or Track 2 restricted residential SCOs for the intended residential use. Based on the results of the pilot tests, unrestricted Track 1 SCOs can be achieved.

Other than worker exposure, the groundwater exposure pathway under both the current, future and proposed future land use scenarios was deemed incomplete because local shallow groundwater is not used as a potable source.

The ecological component of the QEA concluded that current site conditions can support certain sensitive ecological receptors. A review of the environmental monitoring database indicates that none of the contaminants in surface soil were found at concentrations exceeding the ecological threshold values established by NYSDEC. As a result, the exposure pathway is deemed incomplete. If industrial uses were to continue at the Site, remedial actions would not be necessary to satisfy NYSDEC soil cleanup objectives. Under the future residential use scenario contaminants in soil and groundwater would need to be reduced to permissible levels for the intended unrestricted or restricted use. The pilot tests showed Track 1 SCOs, if selected, can be achieved if both the preferred soil and groundwater remedial technologies were implemented, which will result in an incomplete exposure pathway and an absence of quantifiable risk.

NYSDEC has not published ecological cleanup objectives for surface water, but relies on the Ambient Water Quality Standards. A limited number of VOCs and SVOCs have been found in groundwater at concentrations exceeding the cleanup standards, thereby creating a potentially complete exposure pathway to surface water. However, the surface water is tidally affected, and connected to the surrounding bays and the Atlantic Ocean. Groundwater discharge into the adjacent surface water will likely result in sufficient dilution of dissolved constituents to render them undetectable in the surface water. In addition, the proposed remedial activities will mitigate groundwater conditions and, as a result, eliminate the exposure pathway.

CONCLUSION

The RI of the Site is complete. Upon the NYSDEC and NYSDOH approval of this RIR, subject to public comment, PDC is prepared to draft the RAWP. A schedule for the activities associated with the remedial action will be included in the RAWP.