REVISED
FEASIBILITY STUDY REPORT

Operable Unit No. 2 (OU-2)
Off-Site Areas
Former Columbia Cement Company, Inc. Facility
159 Hanse Avenue
Freeport, New York

Site # 1-30-052

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1.1 INTRODUCTION AND SCOPE

This Feasibility Study ("FS") Report presents the development, evaluation and recommendation of a remedial alternative to address environmental impacts at Operable Unit No. 2 (OU-2) of the former Columbia Cement Company (CCC) site located at 159 Hanse Avenue in Freeport, New York ("Site"). URS Corporation (URS) has prepared this FS report on behalf of the Atlantic Richfield Company, a BP affiliate and in response to requests from the New York State Department of Environmental Conservation (NYSDEC) as partial fulfillment of requirements of the New York State Inactive Hazardous Waste Disposal Site (State Superfund) Program. This FS addresses impacts identified in the September 2012 *Revised Remedial Investigation Report, Operable Unit No. 2 (OU-2) Off-Site Areas, Former Columbia Cement Company, Inc. Facility, 159 Hanse Avenue, Freeport, New York* (URS, 2012a) and the *Supplemental Remedial Investigation Report, Operable Unit No. 2, Former Columbia Cement Company Facility, Freeport, New York* submitted to NYSDEC on February 19, 2015, and the *Vapor Intrusion Sampling Report, Operable Unit No. 2, Former Columbia Cement Company Facility, Freeport, New York* submitted to NYSDEC on February 25, 2016.

1.2 APPLICABLE REGULATIONS

The FS has been prepared in accordance with the Title 6 of the New York Code of Rules and Regulations (NYCRR) Part 375 Environmental Remediation Programs Subparts 375-1 to 375-4 & 375-6, and the NYSDEC "Division of Environmental Remediation (DER-10)/Technical Guidance for Site Investigation and Remediation" dated May 2010.

1.3 PURPOSE AND REPORT ORGANIZATION

The purpose of this FS is to identify and evaluate remedial alternatives to address environmental impacts at OU-2 resulting from the 1988 spill of 1,1,1-trichloroethane (1,1,1-TCA) in OU-1. The FS process begins with the establishment of remedial action objectives (RAOs) to address the risks posed by the presence of contaminants at concentrations in excess of the cleanup objectives and cleanup levels established for the Site. General response actions (GRAs) are then developed for the impacted media that can address the RAOs. The identification and screening of technologies applicable to each GRA is the next step in the FS process. Following the identification of process options for the retained technologies, representative process options are combined to form a remedial alternative. The remedial alternatives are screened to determine which alternatives are candidates for detailed evaluation consistent with the guidelines established in DER-10. The detailed evaluation is conducted by applying the following criteria:

- Overall protection of public health and the environment;
- Compliance with Standards, Criteria and Guidelines (SCGs);
- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility or volume through treatment;
- Short-term impact and effectiveness;

- Implementability;
- Cost effectiveness;
- Land use; and
- Community Acceptance

The results of this FS will be used for the selection of a final remedial action for the Site, the preparation of a Record of Decision (ROD) by NYSDEC, and the preparation of a remedial design.

This FS Report is comprised of seven sections and was organized in accordance with Section 4.4(b) of DER-10 “Remedy Selection Reporting Requirements”. The organization and content of the report are as follows:

- Section 1 - Introduction and Scope - This section describes the scope of this report.
- Section 2 - Site Description and History- This section describes the Site features, location, surrounding area and other historical site information.
- Section 3 - Summary of Remedial Investigations and Exposure Assessments - This section summarizes the previous site and remedial investigations (including contaminants of concern and area extent) and potential exposures to contaminated media.
- Section 4 - Remedial Action Goals and Objectives - This section lists the goals and objectives of the remedial alternatives evaluated for this Site.
- Section 5 - General Response Actions - This section describes the general types of remedial actions that were evaluated for this Site.
- Section 6 - Identification and Screening of Remedial Technologies - This section includes a listing of potential remedial technologies that met the general response actions and a preliminary evaluation of each technology with regard to effectiveness, implementability and cost. It also includes a description of the remedial alternatives assembled from the technology screening, the evaluation of each remedial alternative with regard to the evaluation criteria in DER-10 and a preferred alternative.
- Section 7 - References - This section includes a list of documents used in preparation of the FS.

2.1 SITE HISTORY

The former Columbia Cement Company, which was owned by Burmah Castrol, produced adhesives for a variety of applications. In 1988, while CCC operated the facility, approximately 1,760 gallons of 1,1,1-TCA was released to an unlined storm drain during filling of a storage tank due to a failure of a contractor's tanker truck. The spill was reported and response measures were performed under regulatory oversight. In 1996, the property was sold to Illinois Tool Works (ITW). In 1998, Burmah Castrol entered into a Consent Agreement (Index WI #W2-02-0813-98-05) with the NYSDEC regarding the 1,1,1-TCA spill. In 2001, BP purchased all Burmah Castrol holdings and assumed responsibility for the 1,1,1-TCA spill.

Numerous phases of a Remedial Investigation were conducted by Delaware Engineering (1997 through 2003) and URS (2003 through 2006). In December 2006, URS submitted a Supplemental Remedial Investigation Report, summarizing all data obtained up to that time. In January 2007, URS submitted a Feasibility Study Report ("FSR") that evaluated remedial alternatives to address subsurface impacts. In its March 8, 2007 letter, NYSDEC requested installation of monitoring wells adjacent to Freeport Creek to assess the extent of the plume.

In September 2007, BP installed two monitoring wells (MW-07-16S and MW-07-17D) downgradient from the Site and adjacent to Freeport Creek. Sampling results indicated that chloroethane (CA) was present in well MW-07-16S at a concentration exceeding the NYSDEC Ambient Groundwater Quality Standard. Based on these results, NYSDEC divided the site into two Operable Units. Operable Unit No. 1 (OU-1) consists of the on-site project area owned by ITW, located at 159 Hanse Avenue, which is approximately 2 acres in size. OU-2 consists of the offsite areas immediately surrounding OU-1. In October 2008, BP presented a Remedial Investigation Work Plan (RIWP) to NYSDEC. The RIWP presented a scope of work to evaluate subsurface impacts to OU-2 resulting from the 1988 1,1,1-TCA spill in OU-1.

A Remedial Investigation (RI) was conducted at OU-2 in 2008 and 2009. A Draft RI/FS was submitted to NYSDEC on December 23, 2009. Pilot testing and remedial action were conducted at OU-1 from 2009 through 2012, documented in separate reports. Following the positive results of these actions, NYSDEC requested BP to revise the OU-2 Remedial Investigation Report to incorporate newly acquired data and to revise the FS to take into consideration the effectiveness of the remedy at OU-1. The *Revised Remedial Investigation Report, Operable Unit No. 2 (OU-2) Off-Site Areas, Former Columbia Cement Company, Inc. Facility, 159 Hanse Avenue, Freeport, New York* (RIR) was submitted to NYSDEC on September 18, 2012. On February 18, 2015, a Supplemental Remedial Investigation Report for OU-2 was submitted to NYSDEC summarizing the results of groundwater sampling conducted in 2013 and 2014 in OU-2. A Revised OU-2 FS was submitted to NYSDEC on June 15, 2015. Subsequently, NYSDEC and NYDSOH requested that BP attempt to gain access to two OU-2 properties (178 Hanse Avenue and 272 Buffalo Avenue) where vapor intrusion (VI) sampling was not conducted in 2009. BP collected VI samples at the 178 Hanse Avenue property on January 27, 2016.

2.2 SITE DESCRIPTION

The former Columbia Cement facility consists of approximately 2 acres in an area of Freeport, New York that is highly developed with commercial and industrial facilities. Freeport is located in Nassau County on the south shore of Long Island. The site location is shown on Figure 1. The Site building covers approximately 65,000 square feet, and consists of former offices, material storage, production rooms, and warehousing. Ten 8,000-gallon underground storage tanks (USTs) were located near the southeast corner of the property. The Site is bordered by a recycling facility to the north. The BA272 LLC property (formerly Rohm & Haas Electronic Components) borders the property to the east. Apollo Fine Spirits is located to the south of the property. The property is bordered by Hanse Avenue to the West. Farber Plastics and Love & Quiches bakery are located on the opposite (west) side of Hanse Avenue. A Site Plan is presented as Figure 2.

The Site is located on a peninsula on the south side of Long Island. Freeport Creek is located 500 feet west of the Site, and Stadium Park Canal is 1,000 feet east of the site. Stadium Park Canal merges with Freeport Creek approximately 1,500 feet southeast of the site. From this point, surface water flows south through tidal marshes to the Atlantic Ocean, approximately 5 miles south of the Site. The Site is very flat, ranging from 5 to 8 feet above Mean Sea Level (MSL). Surface water at the site drains to the west toward Freeport Creek. Storm drains located on site, also drain to Freeport Creek.

2.2.1 Operable Unit No. 2 Properties

OU-2 consists of the offsite areas immediately surrounding OU-1. OU-2 includes the following properties:

<u>143 Hanse Avenue</u>: Immediately north of OU-1 is 143 Hanse Avenue. This property is currently occupied by Gershow Recycling, a scrap metal recycling facility. Prior to 2010, this property was utilized as a waste transfer facility. When the Columbia Cement facility was in operation, 143 Hanse Avenue served as a warehouse for the manufacturing facility.

<u>191 Hanse Avenue</u>: Immediately south of OU-1 is 191 Hanse Avenue. This property is currently occupied by Apollo Fine Spirits, a wine and spirits distributor. Prior to 2008, this property was utilized as warehouse space for various businesses.

<u>162 Hanse Avenue</u>: On the opposite side of Hanse Avenue, directly west of OU-1, is 162 Hanse Avenue. This property is currently occupied by Farber Plastics, Inc. Farber Plastics manufactures plastic sheeting products from pellets.

<u>178 Hanse Avenue</u>: On the opposite side of Hanse Avenue, southwest of OU-1, is 178 Hanse Avenue. This property is currently occupied by Love & Quiches, Inc. Love & Quiches is a large-scale bakery that produces quiches and desserts for commercial food service operations.

<u>272 Buffalo Avenue</u>: 272 Buffalo is located immediately east of OU-1. This property is currently owned by BA272 LLC and is currently undergoing renovation. Until September 2015, the property was owned by Dow Corporation (formerly Rohm & Haas Electronic Materials). This facility produced electronic components, but the facility ceased operations in the fall of 2009. The property was previously occupied by Lea Ronal, which performed similar activities.

3.1 SUMMARY OF REMEDIAL INVESTIGATION

The Revised RIR for OU-2 was submitted to NYSDEC in September 2012 and addressed four off-site properties and public right-of-way areas adjacent to and near the OU-2. The purpose of the RI, as stated in the RIR, was to assess impacts to human and ecological receptors resulting from a release of 1,1,1-TCA at OU-1. The RI included groundwater screening, installation of groundwater monitoring wells, groundwater sampling, surface water and sediment sampling in Freeport Creek, tidal monitoring and vapor intrusion sampling. Details of the RI and its results are available in the RIR. The Supplemental RIR, documenting additional groundwater sampling events in 2013 and 2014, was submitted to NYSDEC in February 2015. A report summarizing the January 2016 vapor intrusion sampling at 178 Hanse Avenue was submitted to NYSDEC and NYSDOH on February 26, 2016. The summaries of RI and Supplemental RI results are presented in the following section.

3.1.1 Groundwater

The spill of 1,1,1-TCA resulted in soil and groundwater contamination in the southeast portion of OU-1. The RI conducted at OU-1 revealed that soil and groundwater impacts from several other compounds were present in the spill area. The OU-2 RI focused on select Contaminant of Concerns (COCs) that represent spill-related compounds (1,1,1-TCA, 1,1-dichloroethane (1,1-DCA) and chloroethane). Acetone and chlorobenzene are also included as potential COCs as per previous discussion with NYSDEC.

Based on the results of the groundwater screening samples, nine monitoring wells were installed at three OU-2 properties. These more recently installed wells, four previously existing OU-2 wells and four OU-1 wells were sampled in September 2009, September 2010 and October 2011. Well locations and results are presented on Figure 3. In 2009, in four wells on the east side of Hanse Avenue, only chloroethane and chlorobenzene were detected. The highest chloroethane concentration detected was 3,000 micrograms per liter (µg/l) in MW-98-9D. In six wells on the west side of Hanse Avenue, chloroethane, chlorobenzene and 1,1,-DCA were detected. 1,1-DCA was detected in only one well (MW-09-19D) at a concentration below the NYSDEC Groundwater Quality Standards Class GA (GWQS). The highest chloroethane concentration was 170 µg/l. In six wells along Freeport Creek, chloroethane was detected at concentrations up to 52 µg/l and chlorobenzene was detected at concentrations up to 13 µg/l.

In 2009, the highest chloroethane concentrations were detected along the centerline of the plume (MW-98-9D, MW-05-15D and MW-07-16S). Lower concentrations were detected along the northern edge of the plume (MW-09-25D) and along the southern edge of the plume (MW-09-23D), effectively defining the width of the chloroethane impacts. The distribution of chlorobenzene, however, is variable across the area. In some cases, the chlorobenzene concentrations were higher at the plume edges (MW-97-2S and MW-09-23D) than in the center of the plume (MW-98-9D) where the highest chloroethane concentrations are found. This distribution indicates that the source of the chlorobenzene is not related to a point source release at OU-1, like the chloroethane. The chlorobenzene concentrations detected in offsite wells are greater than any that have been detected in OU-1 source area wells.

During the 2009 groundwater sampling event, chloroethane was detected in eight OU-2 monitoring wells. In seven of these eight wells, chloroethane was detected at lower concentrations or not detected during the 2010 sampling event. In eight of the ten OU-2 wells in which chlorobenzene was detected in 2009, the concentration detected in 2010 was lower or not detected.

The OU-2 wells closest to the OU-1 loading dock injections are MW-05-14S and MW-05-15D. Chloroethane concentrations have decreased in these two wells since the initiation of ISCO injections on the east side of Hanse Avenue. MW-05-14-S decreased from 8.4 µg/l in September 2009 to non-detect in 2013 and 2014. In MW-05-15D, chloroethane decreased from a high of 490 µg/l in September 2009 to 13 µg/l in 2013 and non-detect in 2014.

Superstorm Sandy struck the Freeport area in October 2012. Being located on tidal water bodies, OU-1 and OU-2 were flooded. The former Columbia Cement building had over one foot of water in the building and the spill area remained flooded for several months. To assess the impact of the storm on groundwater conditions, OU-1 and OU-2 wells were sampled in April and May of 2013. The data are displayed on Figure 3. At the downgradient boundary of OU-1, on the east side of Hanse Avenue, chloroethane was not detected in wells MW-97-1S, MW-98-9D, or OW-1 through OW-4. When sampled in January 2012, chloroethane concentrations ranged from 20 µg/l to 200 µg/l in these wells. On the west side of Hanse Avenue, the chloroethane concentration in MW-05-15D decreased from 100 µg/l in January 2012 to 13 µg/l in May 2013. MW-05-15D is the OU-2 well closest to where the 2010 and 2011 ISCO injections occurred on the west side of OU-1. Decreases in chloroethane concentration from January 2012 to May 2013 were observed in wells MW-09-81S, MW-09-24D and MW-09-26D, while increases were observed in wells MW-09-19D, MW-09-21D and MW-09-25D. Chloroethane was not detected in either round in wells MW-05-14S, MW-09-20S, MW-09-22S and MW-09-23D.

It is possible that the chloroethane decreases observed in the wells on the west side of OU-1 were related to the flooding and associated groundwater flow changes. However, in OU-2 wells that are located closer to Freeport Creek than the OU-1 wells, chloroethane concentrations increased in as many wells as they decreased (three) from January 2012 to May 2013. It is more likely that the observed concentration decreases are related to continued effects of the ISCO injections at OU-1.

The OU-2 monitoring wells were sampled in May 2014. During this sampling event, the only confirmed detections of spill-related VOCs were 20 µg/l of 1,1-DCA and 280 µg/l of chloroethane in MW-09-19D. Chloroethane was not detected at laboratory detection limits in any other OU-2 wells.

Groundwater at OU-1 and OU-2 is tidally influenced, but primarily flows to the west (Delaware Engineering, 2003). In addition to native soils, the soils beneath the site include peat and municipal landfill material. These materials have created very anaerobic groundwater conditions, which are conducive to the breakdown of 1,1,1-TCA. The reductive dechlorination of 1,1,1-TCA yields 1,1-DCA, which subsequently degrades to chloroethane by the same process. As the sequential dechlorination proceeds, the less chlorinated ethane is relatively more difficult to degrade under reducing and anaerobic conditions compared to the parent compound. Chloroethane follows the same path and it degrades relatively easily under aerobic conditions. In groundwater monitoring wells at the western boundary (MW-97-1S and MW-98-9D and OW-1 through OW-4) and southern boundary (MW-97-6S), 1,1-DCA and chloroethane were the only spill-related compounds detected in 2014. Chlorobenzene is also detected but it is not related to any chemicals known to have been used at OU-1 and its distribution is erratic. Therefore, 1,1-DCA and chloroethane are the only spill-related compounds that have migrated toward OU-2.

As stated in the RIR, OU-2 groundwater is encountered in the water table aquifer which encompasses a sand unit, as well as the former municipal landfill, tidal marsh deposits (peat) and fill material, and extends to a depth of approximately 35 feet. Freeport is also along the southern shore of Long Island and subject to salt water encroachment. For these reasons, the water table aquifer at OU-2 is not utilized for water supply. The Village of Freeport obtains its water supply from 11 supply wells drilled into the Magothy Aquifer, ranging from 550 to 750 feet below grade (ft bg). The wells are at multiple locations in Freeport, including Lakeview Avenue and Jessie Street; West Sunrise Highway and North Bayview Avenue; and Prince Avenue and North Long Beach Avenue. The well field closest to the Site is at Lakeview Avenue and Jessie Street, which is located approximately 1.3 miles north (side-gradient) from the Site. Thus, the groundwater constituents do not represent a risk to, nor do they have the potential to impact public water supply.

A well search was requested from the NYSDEC Division of Water to locate any industrial or residential water supply wells in the vicinity of the site. An extraction well and diffusion well are located at 100 Doxsee Drive, approximately 800 feet southeast of the Site, but the wells are screened below the lower clay unit, from 120 to 135 ft bg and from 72 to 95 ft bg, respectively. A former electronics manufacturer located at 56 Mill Road (1,800 feet north of the Site) installed two extraction wells and two diffusion wells for cooling water in the 1950's. These wells were also screened below the clay unit, but have been out of service or closed for at least 25 years, as the current owner is not aware of any wells on the property. The locations of the public and industrial water supply wells are shown on Figure 4.

3.1.2 Tidal Monitoring

Tidal monitoring was conducted from December 2 to December 4, 2009. Water levels were monitored in wells MW-97-1S, MW-98-9D, MW-05-14S, MW-05-15D, MW-09-18S, MW-09-19D, MW-09-24S and MW-09-25D. Surface water levels were also measured in Freeport Creek near wells MW-09-24S and MW-09-25D. Barometric pressure was monitored over the same period so that water levels could be corrected for barometric pressure effects.

All of the wells monitored during tidal monitoring displayed tidal influence, which was greater in wells closer to Freeport Creek. The tidal range in Freeport Creek was 5.41 feet;

the range in MW-09-24S and MW-09-25D was approximately 3 feet; the tidal range in the remaining wells along Hanse Avenue was between 0.41 feet and 0.59 feet. The lag time between high or low tides in Freeport Creek and those on Hanse Avenue was generally about 1 hour.

At low tide, groundwater flow is to the west (toward Freeport Creek) and the hydraulic gradient between Hanse Avenue and Freeport (across OU-2) was 2.3 x 10^{-3} ft/ft, which is very low and similar to gradients observed in OU-1. At high tide, the elevation of Freeport Creek is higher than the elevation of the OU-2 wells and groundwater flow is to the east (toward OU-1) with a hydraulic gradient of 6.67 x 10^{-3} ft/ft. When the mean tide is calculated from this data (Serfes, 1991), the overall groundwater flow gradient and direction at OU-2 is 2.33 x 10^{-3} ft/ft toward the west. This indicates that the overall flow direction at OU-2 is to the west (from OU-1 toward OU-2), but with a very low hydraulic gradient. A groundwater elevation contour map showing mean tide elevations is presented as Figure 5.

3.1.3 Surface Water and Sediment

Surface water and sediment samples were collected from six locations in Freeport Creek west of OU-2. Samples were analyzed for chloroethane and chlorobenzene, the only compounds detected in wells adjacent to Freeport Creek. These compounds were not detected in any of the surface water or sediment samples at the laboratory detection limits. This indicates that groundwater impacts resulting from the 1,1,1-TCA release at OU-1 have not impacted Freeport Creek.

3.1.4 Soil Vapor

Since groundwater sampling indicated that chloroethane groundwater impacts underlay three OU-2 buildings (162, 178 and 191 Hanse Avenue), sampling was conducted to assess the potential for vapor intrusion. Sub-slab vapor and indoor air sampling was conducted at 162 and 191 Hanse Avenue in March 2009. Access was not granted, at the time, to conduct sampling at 178 Hanse Avenue. Outdoor sub-slab sampling was conducted at 272 Buffalo Avenue in November 2009.

Compounds detected in sub-slab vapor and/or indoor air at 162 Hanse Avenue include acetone, methylene chloride, benzene, toluene, ethylbenzene and xylene (BTEX), tetrachloroethene (PCE), 1,1,1-TCA, vinyl chloride and carbon tetrachloride. At 191 Hanse Avenue, compounds detected in sub-slab vapor and/or indoor air include acetone, heptane, hexane, methylene chloride, BTEX, PCE, 1,1,1-TCA, vinyl chloride and carbon tetrachloride. Compounds detected in groundwater samples collected from 162 and 191 Hanse Avenue during the 2009 sampling event (chloroethane, chlorobenzene and 1,1-dichloroethane) were not detected in any of the sub-slab vapor or indoor air samples collected at 162 or 191 Hanse Avenue.

In November 2009, two outdoor sub-slab vapor samples and one ambient air sample were collected at the 272 Buffalo Avenue property, immediately east of the OU-1 spill area. Compounds detected in the sub-slab vapor samples include acetone, 1,1-DCA, cis-1,2-

dichloroethylene (cis-1,2-DCE), trans-1,2-DCE, Freon 114, heptane, hexane, methyl ethyl ketone (MEK), pentane, PCE, toluene, 1,1,1-TCA and trichloroethylene (TCE). The compounds detected in the ambient air sample include acetone, MEK, pentane and toluene. These compounds were also detected in nearby soil gas and sub-slab vapor samples at OU-1. The TCE concentration in SS-272-02 of 86 microgram per cubic meter ($\mu g/m^3$) is more than an order of magnitude greater than the TCE concentration in SS-272-01 (5.9 $\mu g/m^3$), although SS-272-01 is 80 feet closer to the OU-1 spill area. Of the four compounds detected in both SS-272-01 and SS-272-02, all four had higher concentrations in SS-272-02, which is further from the spill area.

In January 2016, access to the 178 Hanse Avenue was received and two sub-slab vapor samples and three indoor air samples were subsequently collected. Chloroethane was detected in one sub-slab vapor sample at 0.4 $\mu g/m^3$, but was not detected in any indoor air samples. Chlorobenzene and 1,1-DCA were not detected in any sub-slab vapor or indoor air samples.

Sub-slab vapor and indoor air samples indicate that the 1,1-DCA, chloroethane and chlorobenzene detected in OU-2 groundwater are not impacting indoor air in buildings south and west of OU-1.

3.2 QUALITATIVE HUMAN HEALTH EXPOSURE ASSESSMENT

This section summarizes the Human Health Exposure Assessment (HHEA) for OU-2 of the Former Columbia Cement Company Site. The contaminant source is dissolved phase Volatile Organic Compounds (VOCs) in groundwater migrating from OU-1 to OU-2. The primary COCs include 1,1-DCA, chloroethane and chlorobenzene. The environmental media evaluated include groundwater, soil vapor and Freeport Creek surface water and sediment. A summary for each of these media is presented below.

3.2.1 Groundwater

Sampling data indicate that groundwater at 162, 178 and 191 Hanse Avenue has been impacted by 1,1-DCA, chloroethane and chlorobenzene. No groundwater data is available from 272 Buffalo Avenue but groundwater sampling data from OU-1 wells near the property boundary (MW-98-8S and MW-98-8D) had dissolved residual constituents in the past, but were non-detect in 2014.. Groundwater in the area is saline and the saturated zone includes former landfill debris, so no potable water supply wells are present near the Site and are not likely to be installed in the foreseeable future. As stated above, public water supply wells are located at least 1.3 miles from the Site and receive water from the Magothy aquifer, approximately 550 to 750 feet below grade. A facility located at 100 Doxsee Drive, approximately 800 feet southeast of the Site uses one extraction well and one diffusion well for non-contact cooling water. These wells are located side-gradient of the Site and the extraction well is screened from 120 to 135 ft bg, below a 30-feet thick clay unit. Another facility located at 56 Mill Road had two extraction wells and two diffusion wells installed in the 1950s for non-contact cooling water. The current owner, however, has owned the property for approximately 25 years and is unaware of any wells on the property, suggesting the wells were decommissioned some time before 1990. OU-2 groundwater discharges to Freeport Creek, but sampling data indicates that the groundwater has not impacted Freeport Creek surface water quality. For these reasons, there is no current point of exposure and, therefore, no completed exposure pathway associated with groundwater. One potential exposure would be to workers at an excavation that intercepts the water table within the limits of the plume. Exposures for this pathway could be mitigated using personal protective equipment.

3.2.2 Freeport Creek Surface Water and Sediment

The west side of Freeport is lined by several marinas. Freeport Creek and downstream water bodies are utilized for recreational boating and fishing. Surface water and sediment data collected by Delaware Engineering in 2000 and by URS in 2009 both indicate that OU-2 contamination has not affected Freeport Creek surface water or sediment quality. Therefore, the surface water and sediment, as well as fish and shellfish collected in Freeport Creek do not represent a completed exposure pathway. Since the OU-1 spill occurred in 1988 and remedial measures are being implemented at OU-1, future completed exposure pathways in these media are not anticipated.

3.2.3 Soil Vapor

The compounds detected in sub-slab vapor and indoor air at 162 and 191 Hanse Avenue were not detected in the nearest groundwater samples at the time of the VI sampling in 2009. Similarly, with the exception of 0.4 $\mu g/m^3$ in one sub-slab vapor sample, the compounds historically detected in OU-2 groundwater were not detected in sub-slab vapor or indoor air at 178 Hanse Avenue in 2016. At 272 Buffalo Avenue, shallow soil gas samples collected outside the site building contained compounds detected in soil and groundwater in the OU-1 spill area. The sub-slab vapor near the 272 Buffalo Avenue building had higher VOCs concentrations than the sample collected near the OU-1 property boundary. However, due to access restrictions, no sub-slab vapor samples beneath the 272 Buffalo Avenue site building or indoor air samples were collected. Therefore, the conditions within this building are not known. The 272 Buffalo Avenue building was recently purchased. At the request of NYSDEC, BP had requested access to conduct additional VI sampling at 272 Buffalo Avenue, but access has not been granted to date. Based on available data, soil vapor intrusion is a potential exposure pathway and should be evaluated should access to this building be obtained.

3.3 FISH AND WILDLIFE IMPACT ANALYSIS

NYSDEC Division of Fish and Wildlife approved Fish and Wildlife Impact Assessment (FWIA) was included in the Remedial Investigation Report for the Columbia Cement Company Site in December 2003. Because of the proximity of OU-1 and OU-2, NYSDEC agreed that the previous FWIA may be used as a basis for an FWIA updated with newly collected data. The following sections presents a summary of the 2003 FWIA and an updated evaluation of the findings of that FWIA with respect to data collected during the OU-2 Remedial Investigation.

3.3.1 2003 FWIA

The existing FWIA (Delaware Engineering, 2003) provided a Site Description, which included a review of site topography and drainage, local land use, a review of New York State regulated wetlands and potential wildlife habitats within one-half mile of the site and identification of potential fish, wildlife and plant species in the area. Because of the highly developed nature of the area, leaving little open space, along with development along both Freeport Creek and Stadium Park Canal, very little fish and wildlife habitat was identified near the site. Within one-half mile of OU-2, the banks of Freeport Creek have been developed with bulkheads and are occupied by industrial and commercial facilities or marinas. Tidal wetlands are present within one-half mile of OU-2 along Stadium Park Canal, in East Bay, on Fighting Island and in Cow Meadow Preserve. Due to the setting, these tidal wetlands are likely of moderate quality.

The components of an exposure pathway include: 1) a contaminant source; 2) contaminants of concern; 3) potential pathways of contaminant migration; and 4) habitats and fish and wildlife resources that could potentially be impacted by the contaminants of concern. As presented in the 2003 FWIA, the contaminant sources included soil, storm drain sediment and groundwater impacts at OU-1 and the contaminants of concern include the VOCs related to the 1988 TCA spill and other site-related contaminants. Based on the fact that the OU-2 land surface is largely paved, the only potential exposure point for fish and wildlife identified in the 2003 FWIA is Freeport Creek surface water and sediment. The results of surface water and sediment sampling conducted in 2000 indicated that contamination originating from OU-1 has not adversely impacted Freeport Creek surface water and sediment. Based on these conditions, Delaware Engineering concluded that ecological receptors associated with Freeport Creek have not been significantly impacted by contamination from OU-1 and that, based on the age of the releases, OU-1 did not represent a potential threat to Freeport Creek fish and wildlife habitats.

3.3.2 FWIA Update

This section presents an update to the FWIA presented in the 2003 OU-1 RIR. This update focuses only on aspects applicable to OU-2 and incorporates relevant data collected since the 2003 RI. The site description provided in the 2003 FWIA is still applicable as land use in the area has not changed notably since 2003. As such, the only potential ecological receptor habitats are those associated with Freeport Creek.

The pathway analysis for OU-2 differs from that for OU-1. Whereas contaminant sources in the existing FWIA included subsurface soils and storm drains at OU-1 as contaminant sources, the only contaminant source associated with OU-2 is shallow groundwater migrating from OU-1 toward OU-2. The contaminants of concern consist of 1,1-DCA and chloroethane, daughter products related to the 1,1,1-TCA spill, and chlorobenzene. Again, since OU-2 is largely paved, the only potential point of exposure for ecological receptors is Freeport Creek, where shallow OU-2 groundwater discharges. Sampling conducted by Delaware Engineering in 2000 indicated that Freeport Creek habitats had not been significantly impacted through releases from the storm sewer associated with the 1,1,1-TCA spill. In 2009, URS collected surface water samples and sediment samples at six locations in Freeport Creek, immediately west of OU-2. The samples were analyzed for chloroethane and chlorobenzene. Chloroethane and chlorobenzene were not detected at laboratory detection limits in any of the six surface water or sediment samples collected.

The 2003 FWIA concluded that contamination originating from OU-1 had not impacted nearby ecological receptors, namely Freeport Creek and associated habitats. The FWIA update narrowed the focus to OU-2 groundwater discharging to Freeport Creek and included an evaluation of data from surface water and sediment samples collected in 2009. Based on this evaluation, groundwater impacts at OU-2 have not had significant impacts on ecological habitats in Freeport Creek. In addition, considering the age of the OU-1 release and the implementation of remedial measures at OU-1, it is not likely that OU-2 groundwater impacts represent a potential future threat to fish and wildlife habitats in Freeport Creek. A completed Fish and Wildlife Resource Impact Analysis Decision Key (Appendix 3C of DER-10) is included as Appendix E of 2012 RI Report for OU-2. Based on available data, BP concluded a Fish and Wildlife Resources Impact Analysis is not needed at this time.

3.4 SITE CONCEPTUAL MODEL

Soil borings advanced during investigation activities at OU-1 and OU-2 encountered five stratigraphic units beneath the site. In order of increasing depth, these units are: fill material; tidal marsh deposits; gravelly sand; gray clay and silt; and gray sand. Each of these units is discussed below.

- The fill material is encountered across the entire site and consists of reworked native soil and debris related to previous Site use as a municipal landfill. The fill material ranges in thickness from 3.1 ft to 22.9 ft, with an average thickness of about 11 ft at OU-1.
- The tidal marsh deposits are encountered beneath the fill material in most areas of OU-1, but are absent in some areas, including the UST/spill area. The tidal marsh deposits consist of brown, dark gray and black organic clayey silt with some fine to medium sand and varying amounts of roots, wood and peat. Where present, the tidal marsh material is encountered at an average depth of 9.5 ft and has an average thickness of 4 ft.
- The gravelly sand is a relatively thick and flat-lying unit encountered beneath the tidal marsh deposits, and beneath the fill material where the tidal marsh deposits are absent. The unit consists of medium dense, brown to light gray, coarse to fine sand, with little medium to fine subrounded gravel. Minor amounts of silt and clay were found in isolated samples. The gravelly sand thickness ranges from 15 ft to 30 ft and is thickest in the western portion of the site. The base of the gravelly sand is relatively flat and is encountered at about 35 ft below grade.
- The gray clay and silt underlies the gravelly sand. It consists of a medium gray clayey silt to silt and clay with little to trace sand and becomes clayier with depth. In the two borings at OU-1 that penetrated the entire clay unit, the thickness ranged from

14 ft to 15.3 ft. The gray clay and silt unit likely acts as a lower confining unit beneath the site, preventing shallow impacts from migrating to deeper units.

- An undifferentiated light gray fine sand underlies the gray clay and silt. It is described as a gray to light gray, medium to fine sand with little silt. Based on a literature review, this unit ranges in thickness from 20 ft to 30 ft beneath the Site.

The shallow water-bearing units beneath the Site are not utilized as a drinking water source. Deeper confined units include the Jameco, Magothy and Lloyd aquifers, which are used for drinking water in some areas of Long Island. Due to saltwater encroachment near the southern shore of Long Island, these units are not a source of drinking water near the Site. Despite this, groundwater beneath the site is classified by NYSDEC as Class GA (fresh groundwater).

Shallow groundwater at OU-1 is encountered in the fill material at depths ranging from 5.5 to 8.0 ft bgs. In various areas of the site, the water table is encountered in the fill material, the tidal marsh deposits, or the gravelly sand. Due to this fact and extensive connectivity between these units, particularly where the tidal marsh unit is thin or absent, these units have been treated collectively as a single unconfined aquifer. Some shallow monitoring wells at OU-1 are screened across all three units. Deep monitoring wells screened at the base of the gravelly sand have nearly identical groundwater elevations as adjacent shallow wells, showing little or no vertical gradient. Groundwater from the shallow unconfined unit discharges to Freeport Creek. The gray clay and silt unit acts as a lower confining layer or aquitard, separating the water table aquifer from the underlying gray sand. The gray sand is a separate confined water-bearing unit.

Groundwater flows primarily to the west, however, due to the Site’s location, groundwater levels exhibit tidal influences, as described below. As is typical in coastal areas, shallow groundwater at the site is influenced by two tidal cycles per day.

As part of the RI, Delaware Engineering performed tidal monitoring of OU-1 monitoring wells. During tidal monitoring, groundwater level changes of 1 ft or less were recorded on Site. The tidal range is greatest to the west, suggesting a greater hydraulic connection to Freeport Creek than to Stadium Park Canal. The timing and degree of tidal response between the shallow and deep wells suggests that in some areas of OU-1, the tidal marsh unit may restrict flow between the fill material and the gravelly sand.

During high tide, flow was generally to the west with a very shallow hydraulic gradient of 0.00095 ft/ft. During low tide, a groundwater divide forms in the north-central portion of the site. Groundwater east of this divide flows to the east and groundwater west of the divide flows to the west. Based on this observation, the gradient in the spill area alternates from east to west with a very minimal gradient in both directions. This alternating flow direction should serve to minimize contaminant transport from OU-1. The mean tide flow direction is east to west, with a hydraulic gradient of 0.0002 ft/ft net flow to the west. These gradients are lower than those observed in OU-2 (Section 3.1.2), where proximity to Freeport Creek results in somewhat higher gradients.

As noted previously, a 1988 spill of 1,1,1-TCA resulted in soil and groundwater contamination on OU-1. Numerous rounds of investigation were performed from 1997 through 2007. Results of the investigations indicate that:

- Spill-related soil contamination is restricted to the area immediately around the spill and former USTs;
- 1,1,1-TCA in OU-1 groundwater degrades fairly rapidly to 1,1-DCA, and then to chloroethane;
- At the downgradient OU-1 boundary, chloroethane is typically the only spill-related compound present at levels exceeding the GWQS (chlorobenzene is also present, but is not related to the 1,1,1-TCA spill);
- The groundwater chloroethane impacts are restricted to the gray sand water-bearing unit. The gray clay at approximately 35 ft bg to 38 ft bg acts as a lower confining layer.

To date, the only spill-related compound consistently detected in OU-2 groundwater is chloroethane (1,1-DCA has been detected in five of 74 monitoring well samples collected at OU-2 since 2009). No potable wells are located in the vicinity of OU-1 or OU-2 (Delaware Engineering, 2003). Freeport Creek, approximately 500 feet from the spill location, represents a potential groundwater discharge point and ecological receptor.

3.5 SUMMARY OF THE IMPACTED MEDIA AND CONTAMINANTS OF CONCERN

As presented in Section 3.1, BP conducted a RI at four offsite properties and public right-of-way adjacent to and near the former Columbia Cement Company site (OU-1) at 159 Hanse Avenue in Freeport, New York. The objective of the RI was to assess impacts to human and ecological receptors resulting from a release of 1,1,1-TCA at OU-1. The results of the RI identified that chloroethane impacts are present in groundwater at properties south and west of OU-1 at concentrations exceeding NYSDEC Class GA Groundwater Quality Standard.

- Chloroethane and 1,1-DCA are products of the breakdown of 1,1,1-TCA, a compound that was released to a storm drain at OU-1 in 1988. Chlorobenzene, although not related to the spill, is also present in OU-2 groundwater at concentrations exceeding GWQS.
- The groundwater is not utilized for public water supply. Local drinking water comes from wells that are 500 ft to 700 ft deep. The impacted water-bearing unit is underlain by a clay unit approximately 20 ft to 30 ft thick, which acts as a lower confining layer. The impacted water-bearing unit is partially composed of municipal landfill debris and is subject to salt water encroachment.
- Sub-slab vapor and indoor air samples indicate that the 1,1-DCA, chloroethane and chlorobenzene detected in OU-2 groundwater are not impacting indoor air in buildings south and west of OU-1.

- Results from surface water and sediment samples indicate that these compounds have not impacted Freeport Creek.

The OU-2 RI focuses on select COCs. The COCs include the spill related compounds 1,1,1-TCA, and its degradation products 1,1-DCA and chloroethane. In addition to the spill related compounds, acetone is also included as a COC for OU-2. Acetone has not been detected in OU-2 groundwater to date. However, following the in-situ chemical oxidation (ISCO) Pilot Test at OU-1, acetone was detected in wells in OU-1 near Hanse Avenue. Given the proximity to OU-2 and the potential for migration, and as per discussions with NYSDEC, acetone is included as a COC for OU-2.

In addition to the COCs, other compounds that have been detected in or near OU-2 are noted where appropriate and will be monitored during future sampling events at OU-2. These compounds include chlorobenzene. Chlorobenzene has been detected in OU-2 groundwater, but has no history of use or storage at OU-1. The groundwater distribution of chlorobenzene does not suggest a release from OU-1 and it may be related to the former use of the area as a municipal landfill.

4.1 REMEDIAL ACTION GOALS

The NYSDEC remedial program identifies the goal for site remediation under 6 NYCRR Sub-Part 375-2.8(a) as "…restore that site to pre-disposal conditions, to the extent feasible. At a minimum, the remedy selected shall eliminate or mitigate all significant threats to the public health and to the environment presented by contaminants disposed at the site through the proper application of scientific and engineering principles and in a manner not inconsistent with the national oil and hazardous substances pollution contingency plan as set forth in section 105 of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended as by SARA."

Where site restoration to pre-release conditions is not feasible, the NYSDEC may approve alternative criteria based on the site specific conditions as stated in 6 NYCRR Sub-Part 375-2-8(b)(1): "The remedial party may propose site-specific soil cleanup objectives which are protective of public health and the environment based upon other information."

4.2 REMEDIAL ACTION OBJECTIVES

As defined in DER-10 and USEPA CERCLA guidance, Remedial Action Objectives (RAOs) are medium-specific or operable unit-specific objectives for the protection of public health and the environment and requires a review of remedial action objectives and evaluation of treatment alternatives. Each objective is derived from site-related contaminants of concern, exposure pathways and human and/or environmental receptors. Preliminary remediation goals are used to permit a range of treatment and containment alternatives to be considered. The preliminary remediation goals are developed on the basis of New York State Standards, Criteria and Guidelines (SCGs). The potentially applicable SCGs are identified in the sections below.

4.2.1 Location-Specific SCGs

Location-specific SCGs are restrictions placed on the concentrations of hazardous substances or the conduct of remedial activities solely because they occur in a specific geographical or physiographic location. For example, restrictions may include requirements that relate to wetland protection, floodplain management, fish and wildlife conservation, and historic preservation. A list of potential SCGs are identified below.

1. Use and protection of Waters (6 NYCRR Part 608; ECL 15-0501 and 15-0505): This regulation requires a permit to change, modify or disturb any protected stream, its bed or banks, sand, gravel, or any other material; or to excavate or place fill in any marsh, estuary or wetland contiguous to any of the navigable waters of the State.
2. New York State Ambient Water Quality Standards (6 NYCRR Parts 700-705): This regulation defines surface water and aquifer classification and lists specific chemical standards.

3. Endangered and Threatened Species of Wildlife (6 NYCRR Part 182): This regulation requires that site activities must minimize impact on identified endangered or threatened species of fish or wildlife.
4. Water Quality Certification: State certification is required if a federal permit is needed for discharge into navigable waters.
5. Clean Water Act Section 404 (b)(1)/US Army Corps of Engineers Nationwide Permit Program (33 CFR 330): This Act regulates activities involving dredging or filling, or the construction or alteration of bulkheads or dikes in navigable waters, including wetlands, are regulated by the Corps of Engineers.
6. Fish and Wildlife Coordination Act (16 USC 662): This Act regulates any action that proposes to modify a body of water or wetland requires consultation with the US Fish and Wildlife Service.
7. Endangered Species Act (50 CFR 200, 402): This Act requires that site activities must minimize impacts on identified endangered plant and animal species.

4.2.2 Chemical-Specific SCGs

Chemical-specific SCGs are Federal or State standards or health/risk-based numerical values which, when applied to site-specific conditions, result in the establishment of acceptable amounts or concentrations of constituents in the environment. A list of potential chemical-specific SCGs is presented below.

1. New York State DEC Water Quality Regulations for Surface Waters and Groundwaters (6 NYCRR Parts 700-705): This regulation establishes Standards for surface water and groundwater quality.
2. New York State DEC Identification and Listing of Hazardous Waste (6 NYCRR Part 371): This regulation defines and regulates PCB's in New York State.
3. New York State DOH Drinking Water Standards (10 NYCRR Part 5): This regulation enforces New York State drinking water standards.
4. Toxic Substance Control Act; TSCA (40 CFR 761): This Act regulates management and disposal of material containing PCB's.
5. Resource Conservation and Recovery Act, Land Disposal Restrictions (40 CFR 268): This Act regulates management and disposal of hazardous wastes.
6. New York State Department of Health (NYSDOH), Center for Environmental Health, Bureau of Environmental Exposure Investigation. “Guidance for Evaluating Soil Vapor Intrusion in the State of New York”, October 2006.

4.2.3 Action-Specific SCGs

Action-specific SCGs are usually technology or activity based requirements or limitations on actions taken with respect to hazardous waste management and site cleanup. They apply to specific treatment and disposal activities, and may set controls or restrictions on the design, performance and implementation of the remedial actions taken at a site. A list of potential action-specific SCGs are identified below.

1. New York State DEC Division of Fish and Wildlife, "Technical Guidance for Screening Contaminated Sediments"
2. New York State Analytical Detectability for Toxic Pollutants
3. New York State Air Guidelines for the control of Toxic Air Contaminants (Air Guide 1)
4. New York State DEC Strategy for Groundwater Remediation Decision Making at Inactive Hazardous Waste Site and Petroleum Contaminated Sites in New York State, April 1996
5. Polychlorinated biphenyls (PCB's) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions (40 CFR 761)
6. Clean Water Act (CWA) NPDES Permitting Requirements for Discharge of Treatment System Effluent
7. CWA Discharge to Publicly Owned Treatment Works; POTW (40 CFR 403)
8. Occupational Safety and Health Standards for Hazardous Response and General Construction Activities (29 CFR 1904, 1910, 1926)
9. NYSDEC “CP-51/ Soil Cleanup Guidance”, October 21, 2010.

General Response Actions (GRAs) describe the broad categories of remedial measures that can potentially achieve the RAOs. GRAs may encompass many remedial technologies and remedial technology process options. For example, in-situ active restoration is a GRA, in-situ bioremediation is a remedial technology, and in-situ chemical oxidation is a remedial technology process option. The GRAs applicable to the Site groundwater are:

5.1 NO ACTION

The National Contingency Plan (NCP) and CERCLA, as amended, require the evaluation of "No Action" alternatives as a baseline for comparison with other remedial alternatives. The "No Action" alternative does not involve any concrete remedial action; therefore, environmental media at the site or emanating from the site remain contaminated. For this reason, CERCLA, as amended, requires a review of site conditions every five years.

5.2 LIMITED ACTION

Limited Action (LA) responses are implemented to reduce the probability of physical contact with contaminated media or minimize or eliminate the mobility to environmentally sensitive receptors. LA technologies consist of institutional controls (IC), engineering controls (EC), and long-term monitoring (LTM).

ICs include environmental easements, access restrictions, public education and emergency provisions. LTM includes monitoring of groundwater, surface water, sediments, soils, and soil vapor. LTM also includes monitored natural attenuation (MNA). MNA monitors selected groundwater parameters in order to ensure that COCs are attenuating due to the naturally occurring processes of volatilization, adsorption, abiotic transformation, dispersion and/or biodegradation without any enhancements. It differs from the "No Action" alternative in that it requires comprehensive documentation of the attenuating processes along with extensive monitoring of groundwater parameters. Furthermore, it requires that attenuation be evaluated, by using site-specific data. Also included in LTM is No Further Action with Groundwater Monitoring. This remedy is similar, to MNA, but the monitoring is limited to the contaminants of concern, and not additional parameters that document the processes responsible for their decrease.

5.3 EX-SITU ACTIVE RESTORATION

Ex-situ active restoration consists of groundwater extraction, treatment and discharge/disposal technologies. The main advantage of ex-situ treatment is that there is more certainty about the effectiveness of the treatment of extracted groundwater. However, groundwater extraction systems are used primarily for hydraulic control.

5.4 IN-SITU ACTIVE RESTORATION

In-Situ Active Restoration consists of technologies that remove, destroy or stabilize the contaminant mass without being brought to the surface, resulting in significant cost savings.

The potentially applicable technology types and process options (grouped by their GRA) are further discussed in Section 6.

In accordance with USEPA guidance (USEPA, 1988), this FS includes an identification and screening of potentially applicable remedial technologies with respect to technical implementability. Specific technologies are further evaluated based on effectiveness, implementability (technical and administrative), and relative cost in achieving the RAOs. No action and institutional action are included, as suggested by National Contingency Plan (NCP) and USEPA guidance.

The following factors will be considered under the remedial technology screening criterion:

Implementability

- Technical feasibility of implementing the technology;
- Availability of the technology;
- Administrative feasibility of implementing the technology.

The NCP instructs that 'alternatives that are technically or administratively infeasible or that would require equipment, specialists, or facilities that are not available within a reasonable period of time may be eliminated from further consideration' [40CFR300.430(e)(7)(ii)].

Effectiveness

- The remedial technology reduces toxicity, mobility, or volume through treatment;
- The remedial technology minimizes residual risks;
- The remedial technology affords long-term protection;
- The remedial technology complies with NYSDEC SCGs;
- The remedial technology minimizes short-term impacts; and
- The remedial technology achieves protection in a reasonable timeframe.

The NCP instructs, "alternatives providing significantly less effectiveness than other, more promising alternatives, may be eliminated. Alternatives that do not provide adequate protection of human health and the environment shall be eliminated from further consideration" [40CFR300.430(e)(7)(ii)].

Cost

- Cost of construction, and
- Long-term costs to operate and maintain.

The NCP instructs, "costs that are grossly excessive compared to the overall effectiveness of the alternatives may be considered as one of several factors used to eliminate alternatives. Alternatives providing effectiveness and implementability similar to that of another alternative by employing a similar method of treatment or engineering control, but at greater cost, may be eliminated" [40CFR300.430(e)(7)(ii)].

In addition, remedial technologies will be screened by evaluation of their overall environmental impact. Remedial technologies may require significant utilization of fossil fuels and water, and may result in the generation of greenhouse gasses and other waste materials. The process of evaluating remedial technologies for their overall environmental impact, known as "Green Remediation," is described in DER-31 (NYSDEC, 2010).

6.1 REMEDIAL TECHNOLOGIES FOR GROUNDWATER

The screening matrix for remedial alternatives for groundwater is presented in Table 1. The technologies are evaluated for effectiveness, implementability and cost. Based on site-specific knowledge, bench-scale and pilot tests conducted at OU-1, an initial applicability screening was conducted. During the screening, all technologies that were found to be technically feasible were deemed potentially applicable. Technologies that were determined to be technically infeasible were eliminated. A discussion of the technologies that were eliminated is provided below:

- Institutional Control (IC) was eliminated from further consideration because ICs cannot be imposed on off-site properties, making them inapplicable in OU-2.

- Monitored Natural Attenuation (MNA) was eliminated from further consideration. MNA involves monitoring of groundwater to document the degradation of contaminants through natural processes. Groundwater contaminant concentrations are monitored along with specific geochemical parameters involved in the degradation process. The proximity to Freeport Creek results in tidal fluctuations, as discussed in Section 3.4, and groundwater mixing with the brackish creek water. These factors, combined with the tidal marsh and landfill debris in the subsurface, create a complex hydrogeological and geochemical environment. The exact mechanism(s) causing the degradation are not well understood, although the groundwater treatment in OU-1 is at least partially responsible for the concentration decreases. MNA requires a thorough understanding of the physical and chemical processes causing the contaminant attenuation and documentation of their effectiveness. Since these processes are not fully understood, MNA is not carried forward for further evaluation.

- The ex-situ response action of Pump and Treat with On-Site Treatment (P&T) was eliminated from further consideration. P&T is usually effective and used as a hydraulic containment technology. At lower contaminant concentrations, P&T is not an effective treatment technology as it provides treatment only by pore volume flushes which require a long time. Under the current site settings, chloroethane is not impacting the downgradient receptor (Freeport Creek). Consequently, a hydraulic containment alternative is not applicable. In addition, P&T may mobilize contaminants in OU-2 from surrounding areas in the highly industrial settings around the site, the high levels of iron (up to 25 mg/l) will add to operational and maintenance cost as well as a reduced treatment efficiency. Finally, chloroethane is difficult to treat via adsorption on granular activated carbon which limits the treatment options that can be integrated with the extraction system.

- The in-situ treatment technology of Air Sparging (AS) was eliminated from further consideration. AS treats contaminants via two processes, i) air stripping and ii) aerobic biodegradation. In the case of chloroethane, air-stripping would have limited effectiveness due to the physical properties of chloroethane (low Henry's Law constant). The RI data also shows that groundwater at OU-2 has high levels of dissolved iron. Sparging in the presence of the high dissolved iron in groundwater will result in frequent fouling requiring a high level of maintenance, reduced operational time and a reduced radius of influence.

- Enhanced Anaerobic Bioremediation via reductive dechlorination was eliminated after the bench-scale tests from OU-1 groundwater and soil samples concluded that no significant enhancements in the degradation of chloroethane were attained with the substrates that were tested (URS, 2008). The high levels of methane (up to 12 mg/l) indicate that the methanogenic processes are controlling and any organic amendment injected will only aid the methanogens and not the *Dehalococcoides* bacteria that are typically involved in the reductive dechlorination of chloroethane. This is also supported by the fact there were no significant detections of ethane, a product of chloroethane degradation under reducing conditions.

- Enhanced Aerobic Bioremediation was eliminated after the pilot test conducted at OU-1 indicated that effective aerobic conditions could not be created and maintained at the site which is extremely anaerobic and reducing in nature. This is due to the presence of both landfill and tidal marsh deposits. Although, chloroethane can degrade under aerobic conditions, almost all of the dissolved oxygen will be preferentially used up by the oxygen demand of reduced inorganics and organic matter.

- Permeable Reactive Barriers (PRBs) employ in-situ treatment technologies to either treat or remove the contaminants as groundwater flows through the barrier. For the PRBs to be effective, groundwater must flow at a reasonable rate, and it requires a treatment or adsorptive media that can be introduced in the barrier to preferentially destroy or remove chloroethane. In addition, the treatment or adsorptive media must have longevity of more than six months before it has to be replaced or augmented. No such treatment or adsorptive media are available for chloroethane. Also, due to tidal fluctuations in groundwater and a low hydraulic gradient, the flow rate and direction are not suitable for a PRB. Consequently, PRBs were eliminated from further consideration.

The remaining treatment technologies that will be considered for groundwater treatment are presented below.

6.1.1 No Action

No Action is carried forward for comparative purposes as suggested by NCP and USEPA guidance even though it is not effective in meeting the RAO for the Site.

6.1.2 In-Site Chemical Oxidation (ISCO)

In-situ treatment technologies can be based on chemical, physical or biological processes. In-situ chemical oxidation (ISCO) is a technology that falls under the Active In-situ Restoration GRA and is discussed below.

ISCO is based on the delivery of chemical oxidants to contaminated media in order to achieve destruction or breakdown of contaminants into non-toxic products. Treatment time with ISCO technologies is very rapid. Liquid oxidants are injected through injection wells or injection points. The type of oxidant to use depends on the mixture of contaminants and their concentrations. Typical oxidants include activated hydrogen peroxide (for petroleum hydrocarbons), potassium permanganate (for chlorinated solvents) and most recently, activated sodium persulfate (for both petroleum hydrocarbons and chlorinated solvents). Hydrogen peroxide is very reactive and in the presence of iron generates the hydroxyl radical, which is a very reactive compound and instantaneously oxidizes any organic matter and reduced minerals. The products of the oxidation of chlorinated VOCs are carbon dioxide, water and chloride. Sodium persulfate is relatively less reactive. When activated with hydrogen peroxide or heat, it generates the persulfate free radical. The persulfate radical has a relatively longer half-life when compared to the hydroxyl radical. Sodium persulfate is relatively safe to handle when compared to hydrogen peroxide. When hydrogen peroxide activated persulfate is used, the benefits of both the persulfate and hydroxyl radicals are achieved. This combination has been successful at treating both soil and groundwater in OU-1. Potassium permanganate directly oxidizes the contaminants and other reduced metals unlike the very efficient free radical based oxidation that can be realized with hydroxyl and persulfate radicals. Consequently, the permanganate oxidant demand is high. Potassium permanganate is not very effective when a mixture of CVOCs and petroleum hydrocarbons is present. Hydrogen peroxide-activated sodium persulfate has been used to treat soil and groundwater at OU-1.

<u>Effectiveness</u>

Many field applications of the ISCO technology have been conducted using potassium permanganate, Fenton's reagent and activated sodium persulfate for CVOCs. ISCO using sodium persulfate and hydrogen peroxide has been successful in treating groundwater at OU-1.

<u>Implementability</u>

With sufficient space for storage and mixing of chemicals, the oxidants can be easily injected into the subsurface soils at the Site with a relatively moderate radius of influence in the sand and fill geology. However, the space available for injection in OU-2 is limited. Use of the ISCO chemicals and the generation of soil vapor present a safety risk to the public in OU-2.

<u>Cost</u>

Cost for ISCO technologies are low to moderate and depend on the oxidant demand from non-contaminant related constituents in the soil matrix, which include reduced metals and natural organic matter. The oxidant demand is high in silty/clayey soils, which are rich in minerals and organic matter, and low in sandy aquifers.

Overall Evaluation

ISCO treatment via activated sodium persulfate is carried forward into the development and screening of alternatives. Based on Site geochemistry, ISCO is the only technology proven to reduce groundwater VOC concentrations in OU-1. However, the space limitations and safety risks in OU-2 will present implementation challenges.

6.1.3 No Further Action with Groundwater Monitoring (NFA-GWM)

NFA-GWM falls under the Limited Action GRA. NFA-GWM is a process of long-term monitoring of groundwater to show stability of the plume and a decrease in the concentration of contaminants over time. Unlike MNA, with NFA-GWM, sampling to document the specific processes responsible for contaminant attenuation is not performed. Contaminant concentration decreases may occur because the source was removed or treated. In some cases, the mechanism responsible for the contaminant decrease may not be known or the data collected to date is not sufficient to definitively support it. At OU-2, groundwater concentrations of chloroethane have decreased, particularly near the previous ISCO injections in OU-1. Due to the degradation properties of chloroethane and the unique geochemical conditions resulting from groundwater in a tidal marsh/landfill debris aquifer mixing with brackish surface water, the exact mechanism of chloroethane attenuation is not entirely understood, but the decrease can be monitored and confirmed over time.

Effectiveness

NFA-GWM can be an effective technology for long-term monitoring of contaminant reduction in groundwater. Decreases in concentrations of site-related VOCs in OU-2 have been documented. NFA-GWM does, however, have a longer time-frame for effectiveness as opposed to other, more active technologies. The source control measures implemented in OU-1 will reduce the overall time-frame in OU-2. The time-frame is dependent on the success of remedial measures at OU-1 that would limit the flux of contaminants into OU-2. These remedial measures, documented in reports previously submitted to NYSDEC, reduced contaminant concentrations in both the spill area and at the downgradient property boundary on the east side of Hanse Avenue. As of May 2014, spill-related VOCs were present in only one OU-2 monitoring well above the laboratory detection limit.

Implementability

Thirteen monitoring wells are currently present in OU-2 and, if necessary, additional wells could be installed to verify contaminant reductions. Supplemental sample collection and data interpretation are necessary to support NFA-GWM. These services and technical resources are easily and readily available.

Cost

Overall costs for NFA-GWM over time at the Site are low.

Overall Evaluation

Given that no human and ecological receptors are being exposed to chloroethane under the current site conditions, and chloroethane was recently detected in only one OU-2 well, NFA-GWM can be an effective alternative, particularly in conjunction with the remedial measures being implemented at OU-1. It can be readily implemented and is carried forward into the development and screening of alternatives.

6.2 DETAILED ANALYSIS OF RETAINED TECHNOLOGIES

The detailed analysis of alternatives presents the information needed to select a site remedy. The evaluation criteria are described in Section 6.2.1. The results of this assessment are summarized in Table 2 and described in detail in Sections 6.2.2 through 6.2.4 Capital, O&M, and present worth costs for all alternatives are presented on Table 3.

6.2.1 Evaluation Criteria

In this section, alternatives are subjected to a detailed evaluation with respect to seven of the nine evaluation criteria (Section 6.0) specified in the NCP and discussed in detail in RI/FS guidance (USEPA, 1988). Two of the criteria, state acceptance and community acceptance, are not addressed in this section, but will be addressed in the Record of Decision (ROD) after comments on the FS and the Proposed Remedial Action Plan are received. The seven criteria used to evaluate alternatives in this section are described below.

1. *Overall Protection of Human Health and the Environment* - Evaluation of this criterion involves an assessment of how each alternative achieves protection over time and how site risks are reduced.

2. *Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)/New York State Standards, Criteria and Guidelines (SCGs)* - Compliance with ARARs/SCGs includes compliance with chemical-specific, action-specific, and location-specific requirements, as defined earlier.

3. *Long-term Effectiveness and Permanence* - This criterion focuses on the impacts of the remedial action after remedial objectives have been met. Key components of the criteria include: (a) the magnitude of residual risk after remediation; and (b) the adequacy of controls to meet required performance specifications and the reliability of controls from an operational standpoint.

4. *Reduction of Toxicity, Mobility, or Volume (TMV)* - This criterion addresses the statutory preference, expressed in the Superfund Amendments and Reauthorization Act (SARA), for remedies that employ treatment as a principal element. It includes

an assessment of the magnitude, significance, and irreversibility of treatment, as well as an evaluation of the type and quantity of residual contamination remaining after treatment.

5. *Short-Term Effectiveness* - This criterion includes the short-term impacts of the alternatives (i.e., during implementation) upon the surrounding community, on-site workers, and the environment. It also addresses the time required for the alternative to satisfy remedial action objectives.

6. *Implementability* - Implementability includes many of the practical aspects associated with implementation of the remedial alternative, such as the ability to construct and operate remedial technologies, the reliability of the technologies, ease of undertaking additional remedial actions if necessary, ability to monitor the alternative's effectiveness, availability of required material and services, permit requirements, and need to coordinate with other agencies.

7. *Cost Effectiveness* – This evaluation includes consideration of the overall cost effectiveness of a remedy and whether the costs are proportional to its overall effectiveness. This quantitative evaluation criterion includes the capital and O&M costs associated with each alternative, as well as its total present worth. Detailed cost estimates for each technology are provided in Appendix A.

8. *Land Use* – This evaluation includes consideration of current, intended and reasonably anticipated future use of the site, and the potential impact of the remedy on that land use.

9. *Community Acceptance* – This criterion includes an evaluation of public comments received after presentation of the proposed remedy to the public.

6.2.2 Alternative 1 - No Action for Groundwater

6.2.2.1 Description

The no action alternative means there is no active remediation or monitoring at the Site for groundwater. In the absence of remediation, current Site conditions would remain the same, except insofar as natural attenuation processes reduce concentrations. In the absence of monitoring, confirmation of natural attenuation would not be available.

6.2.2.2 Analysis

Overall Protection of Human Health and the Environment

Alternative 1 does not prevent or mitigate the future potential impacts of contaminated groundwater on human health and/or the environment.

Compliance with New York SCGs

Because no monitoring action is being taken, Alternative 1 would not confirm the effectiveness of natural attenuation in meeting the groundwater cleanup criteria in the short-term.

Long-Term Effectiveness and Permanence

This alternative does not measure long-term effectiveness or permanence.

Reduction of Toxicity, Mobility, or Volume

This alternative provides no confirmation of reduction in toxicity, mobility, or volume of CA in groundwater through treatment.

Short-Term Effectiveness

There are no short-term impacts on the community, workers, or the environment since no action would be taken.

Implementability

There are no implementability concerns posed by this remedy.

Cost Effectiveness

Although there are no costs associated with the no action alternative, since no monitoring is performed to evaluate natural attenuation, cost effectiveness cannot be evaluated

Land Use

The land use in OU-2 is commercial and industrial and is anticipated to remain so for the foreseeable future. There are no impacts to land use associated with the no action alternative.

Community Acceptance

Community Acceptance can only be evaluated following the public comment period.

6.2.3 Alternative 2 - ISCO

6.2.3.1 Description

Residual groundwater contamination in OU-2, downgradient from the source would be treated through ISCO, as it has been treated at OU-1. In-situ chemical oxidation (ISCO) is a technology that falls under the Active In-situ Restoration GRA and is discussed below.

ISCO is based on the delivery of chemical oxidants to contaminated media in order to achieve destruction or breakdown of contaminants into non-toxic products. Treatment time with ISCO technologies is very rapid. Liquid oxidants ate injected through injection wells or injection points. The type of oxidant to use depends on the mixture of contaminants and their concentrations. Typically used oxidants include activated hydrogen peroxide (for petroleum hydrocarbons), potassium permanganate (for chlorinated solvents) and most recently, activated sodium persulfate (for both petroleum hydrocarbons and chlorinated solvents). Hydrogen peroxide is very reactive and in the presence of iron generates the hydroxyl radical, which is a very reactive compound and instantaneously oxidizes any organic matter and reduced minerals. The products of the oxidation of chlorinated VOCs are carbon dioxide, water and chloride. Sodium persulfate is relatively less reactive. When activated with hydrogen peroxide or heat, it generates the persulfate free radical. The persulfate radical has a relatively longer half-life when compared to the hydroxyl radical. Sodium persulfate is relatively safe to handle when compared to hydrogen peroxide. When hydrogen peroxide activated persulfate is used, the benefits of both the persulfate and hydroxyl radicals are achieved. Potassium permanganate directly oxidizes the contaminants and other reduced metals unlike the very efficient free radical based oxidation that can be realized with hydroxyl and persulfate radicals. Consequently, the permanganate oxidant demand is high. Potassium permanganate is not very effective when a mixture of CVOCs and petroleum hydrocarbons is present.

6.2.3.2 Analysis

Overall Protection of Human Health and the Environment

ISCO, using sodium persulfate activated with hydrogen peroxide has been effective at reducing both soil and groundwater VOC levels at OU-1, without producing more toxic intermediates. In that respect, ISCO is protective of human health and the environment. The use of the ISCO chemicals during the injection process and immediate time frame after injections in the public areas of OU-2, however, presents potential near-term safety risks. The risks include potential generation of vapors, including methane, hydrogen sulfide and carbon dioxide, which could present a vapor intrusion risk at OU-2 buildings. ISCO does not require significant expenditure of natural resources to conduct and does not generate additional waste. Therefore, it does not have a large negative environmental impact.

Compliance with New York SCGs

The primary objective of ISCO is to destroy VOCs through oxidation, producing non-toxic end-products. Any residual VOCs could then degrade naturally. Groundwater quality is actively protected using ISCO, and the alternative will comply with the NYSDEC SCGs in the long-term.

Long-Term Effectiveness and Permanence

The magnitude of residual risk is already low under the current site conditions. This alternative will be protective over the long-term by reducing groundwater VOC levels. Further reduction in concentration of chloroethane by biotic and abiotic processes is a permanent and irreversible remedy. The area of OU-2 available to conduct ISCO injection is limited, so only a small portion of the plume will be addressed. ISCO is generally not effective to treat dilute concentrations of VOCs, as observed at OU-2 because the dissolved VOCs represent a small portion of the overall oxidant demand. At OU-1, while the ISCO injections have resulted in an overall decrease in VOC concentrations, they are typically followed by some degree of rebound, and multiple rounds of injections have been required.

Reduction of Toxicity, Mobility, or Volume through Treatment

ISCO is an active treatment technology that employs oxidation to treat VOCs, which will reduce toxicity and volume of the contaminant.

Short-Term Effectiveness

ISCO would produce short-term safety risks to the community and the environment during the implementation of this alternative. The ISCO chemicals and the potential generation of sub-slab vapors would present a risk during implementation. Additional injection points and monitoring wells will be installed and periodic groundwater sampling will be conducted. Exposure to contaminated groundwater during these activities will be addressed by conducting the work using the best health and safety practices.

Implementability

The implementation of ISCO requires the installation of injection points and the use of large tanks and equipment during implementation. The free space around the OU-2 buildings is extremely limited and the process would disrupt those businesses. Modifications to the existing monitoring well network that would be needed present challenges, including siting wells, site access and potential disruption to businesses. However, installation of monitoring wells and injection points and sampling of groundwater can be fairly easily implemented. The ISCO injections would require the presence of hazardous chemicals in public areas along Hanse Avenue and could result in generation of carbon dioxide, methane, and hydrogen sulfide vapors beneath occupied OU-2 businesses. The owner of 272 Buffalo Avenue did not grant access to BP for vapor intrusion sampling, so they may not grant access for ISCO injections either. Space limitations, access issues and safety concerns make implementation of ISCO at OU-2 extremely challenging.

Cost Effectiveness

The capital cost for Alternative 2 is $168,279 per injection, including injection point installation and the ISCO injections. For costing purposes, one round of injections is assumed, although multiple injections may be required. The annual O&M costs are $32,000. The total present worth costs assuming 5 years of monitoring are estimated at $112,740. Capital, O&M, and present worth costs for this alternative are presented on Table 3. The cost estimate assumes that 14 existing wells would be sampled semi-annually for 5 years after the injections pending remedy review. Well locations to be sampled are shown on Figure 7. Groundwater samples will be analyzed for VOCs.

ISCO requires direct contact between the amendments and the contaminants to be effective. Since the majority of the OU-2 properties are occupied by buildings, the area available for injection is limited, which reduces the potential for direct contact. Also, following the ISCO injections at OU-1, the relative impact of the injections on low dissolved VOC concentrations is less than on the higher source area concentrations. Because of the nature of the subsurface materials (landfill debris and marsh deposits), the majority of the ISCO amendments would address the oxidant demand from these materials, and not the part-per-billion concentrations of the VOCs. Also, as of May 2014, only one OU-2 well had detectable concentrations of spill-related VOCs. An injection program to treat such a small portion of the aquifer is not practical. Therefore, ISCO would not be a cost effective remedy for OU-2 groundwater.

Land Use

Implementation of ISCO involves installation of wells and injection points, the mixing and injecting of ISCO chemicals and follow-up groundwater monitoring. The implementation of ISCO would not have an impact on current or anticipated future land use in OU-2.

Community Acceptance

Community Acceptance can only be evaluated following the public comment period.

6.2.4 Alternative 3 – No Further Action with Groundwater Monitoring

6.2.4.1 Description

Residual groundwater contamination in OU-2, downgradient from the source, would attenuate over time by natural processes following the reduction/elimination of additional contamination through active treatment in OU-1. No Further Action with Groundwater Monitoring (NFA-GWM) documents the decrease in groundwater chloroethane over time. The remedy assumes:

- Installation of a shallow monitoring well adjacent to MW-09-26D;
- Semi-annual sampling of 14 monitoring wells for 5 years for VOCs; and
- Re-evaluation of MNA in light of contaminant conditions in OU-1 and OU-2 at that time.

Data collected from OU-2 over several years has shown that, in general, concentrations are stable or decreasing, particularly following the ISCO injections at the downgradient boundary of OU-1. A summary of sampling data from multiple groundwater sampling events is presented below.

The historic concentrations of chloroethane in OU-2 have ranged from less than 5 µg/L to a high of 490 ug/L. The highest concentration was observed in well MW-05-15D, which is located to the east of 178 Hanse Ave and is immediately downgradient from OU-1. Wells MW-05-14S and MW-05-15D are directly across Hanse Avenue from the loading dock area where ISCO injections were conducted in 2010 and 2011. A graph of chloroethane concentrations in wells MW-05-14S and MW-05-15D is presented as Figure 6. Following the 2010 injections, the chloroethane concentration in MW-05-15D decreased from 490 µg/l to 140 µg/l, and to 100 µg/l in 2011, to 13 µg/l in 2013, and was not detected in 2014. When wells were sampled in May 2013, the highest VOC concentration was 94 µg/l in MW-09-18S, at the northeast corner of 162 Hanse Avenue. In May 2014, the only detections of spill-related VOCs in OU-2 were 1,1-DCA (20 µg/l) and chloroethane (280 µg/l) in well MW-09-19D. No spill-related VOCs were detected in other OU-2 wells at laboratory detection limits

The groundwater data collected to date in OU-2 show that the extent of contaminants originating from OU-1 is limited to low levels of chloroethane and occasionally 1,1-DCA. Chloroethane concentrations in most OU-2 wells have decreased over time. Although the exact mechanism for this decrease is unclear, it is likely due to the unique geochemical conditions resulting from groundwater in a tidal marsh/landfill debris aquifer mixing with brackish surface water under tidally fluctuating conditions, coupled with the remedial efforts at OU-1 that have effectively eliminated continued input of chloroethane to OU-2. Recent data shows that the ISCO injections in the loading dock area of OU-1 have successfully reduced chloroethane concentrations migrating from OU-1. This was one of the goals of the ISCO injections. Evidence of the ISCO injections can be seen in OU-2 well MW-05-15D, where the chloroethane concentration has decreased from 490 µg/l to non-detect following the ISCO injections. This result, coupled with the increased ORP and sulfate concentration observed in MW-05-15D, indicates the injections have manifested themselves in OU-2.

In addition to the concentration decreases noted in the loading dock area, the ISCO injections in the spill area have decreased source area concentrations by several orders of magnitude. Additional ISCO injections will continue to reduce source concentrations in the spill area and reduce or eliminate the flux of chloroethane from OU-1 into OU-2.

Groundwater moving westward from OU-1 is subject to tidal fluctuations, as discussed in Section 3.1.2. This results in alternating flow directions, increased dispersion, mixing with surface water and discharging to Freeport Creek.

Taken together, the above lines of evidence suggest that the decreasing chloroethane concentrations observed in OU-2 should continue until they meet applicable cleanup standards. The implementation of NFA-GWM would require periodic groundwater monitoring to document CA concentration decreases during implementation of this alternative. These requirements are discussed later in this report.

6.2.4.2 Analysis

<u>Overall Protection of Human Health and the Environment</u>

NFA-GWM, as proposed in Alternative 4, reduces the levels of chloroethane in groundwater to meet chemical-specific groundwater criteria through natural degradation processes, thus providing protection to human health and the environment from possible future exposures. Based on results from the active groundwater treatment conducted at OU-1, NFA-GWM, in conjunction with continued groundwater treatment in OU-1, should reduce groundwater contaminant levels. NFA-GWM is a “Green” remedial alternative, as it consists primarily of groundwater sampling which produces very little environmental impact.

<u>Compliance with New York SCGs</u>

The primary objective of NFA-GWM is to document the reduction of chloroethane concentrations in groundwater to levels at which receptors are not impacted. Long-term monitoring of groundwater quality will be conducted to make sure that the concentration of chloroethane continues to decrease as a result of natural processes and the additional source reduction activities in OU-1. Groundwater quality is passively protected by NFA-GWM, and the alternative will comply with the NYSDEC SCGs in the long-term.

Long-Term Effectiveness and Permanence

The magnitude of residual risk is already low under the current site conditions. This alternative will be protective over the long-term by periodic monitoring of the groundwater quality. Reduction in concentration of chloroethane by biotic and abiotic processes is a permanent and irreversible remedy.

Reduction of Toxicity, Mobility, or Volume through Treatment

NFA-GWM, although passive and natural, documents the CA concentration decrease, which will reduce toxicity and volume of the contaminant.

Short-Term Effectiveness

There would be minimal impacts to the community and the environment during the implementation of this alternative. An additional monitoring well will be installed and periodic groundwater sampling will be conducted. Exposure to contaminated groundwater during these activities will be addressed by conducting the work using the best health and safety practices.

Implementability

Modifications to the existing monitoring well network may be needed. However, installation of monitoring wells and sampling of groundwater can be easily implemented. NFA-GWM can be effectively implemented, as it has in the past in OU-2. The services and resources required to implement NFA-GWM are readily available.

Cost Effectiveness

The capital cost for Alternative 4 is $14,560, including monitoring well installation. The annual O&M costs are $21,130. The total present worth costs assuming 5 years of monitoring are estimated at $73,973. Capital, O&M, and present worth costs for this alternative are presented on Table 3. The cost estimate assumes that 14 existing and new wells would be sampled semi-annually for 5 years pending remedy review. Well locations to be sampled are shown on Figure 7. Groundwater samples will be analyzed for VOCs.

NFA-GWM will take advantage of natural processes (degradation and dispersion) to reduce contaminant levels with minimal intrusive activity and the progress of the remedy will be documented through periodic monitoring. In conjunction with the reduction of contaminant levels observed in OU-1, this is a cost effective remedy for the dissolved phase VOCs in OU-2.

Land Use

NFA-GWM involves a program of groundwater monitoring for a number of years. This will have no impact on the current or anticipated future land use for OU-2.

Community Acceptance

Community Acceptance can only be evaluated following the public comment period.

6.2.6 Preferred Remedial Alternative

The selected remedial alternative for groundwater at OU-2 is Alternative 3, No Further Action with Groundwater Monitoring (NFA-GWM). Given the low on-going risk (no exposure to human and ecological receptors) from residual contamination, coupled with source control measures undertaken in OU-1, NFA-GWM provides the most effective alternative to reduce the concentration of VOCs in OU-2 groundwater. As noted in Section 3.1.1, the ISCO program has been successful at reducing VOC concentrations at the downgradient boundary of OU-1 and additional ISCO injections are contemplated. The decrease in CA concentration in OU-2 well MW-05-15D (490 µg/l to non-detect since 2009) is an indication that the effects of the ISCO injections are being manifested in OU-2. Over time, these decreases should also be observed in other areas of OU-2. The proposed NFA-GWM program will verify and document VOC decreases in OU-2 groundwater.

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TABLE 1
IDENTIFICATION AND SCREENING OF TECHNOLOGIES
FORMER COLUMBIA CEMENT COMPANY SITE
OPERABLE UNIT NO. 2
FREEPORT, NEW YORK

Groundwater Evaluation					
GENERAL RESPONSE ACTION	**REMEDIAL TECHNOLOGY**	**EFFECTIVENESS**	**IMPLEMENTABILITY**	**COST**	**ACTION**
NO ACTION	None	Does not achieve remedial action objectives	Not acceptable to the community and regulators	None	Retained
NO FURTHER ACTION WITH GROUNDWATER MONITORING	Monitoring	Potentially effective for short and long-term, pending source depletion.	Monitoring only is easy to implement.	Low Capital, Low O&M	Retained
MONITORED NATURAL ATTENUATION	Monitoring/NA Evaluation	Potentially effective for short and long-term, pending source depletion.	Monitoring only is easy to implement. Complex hydrogeologic and geochemical environment makes identification and monitoring of actual attenuation mechanism(s) difficult.	Low Capital, Low O&M	Not Retained
PUMP AND TREAT WITH EX SITU GROUNDWATER TREATMENT	Pump and Treat with On-Site Treatment	Effective and reliable in short-term for hydraulic control.	Pumping may result in capture and mobilization of contaminants from adjacent properties in this industrial area. Not very reliable in the long-term due to high inorganic (dissolved iron etc.) content in groundwater. This will result in the formation of large volumes of iron sludge which will lead frequent fouling and inefficient operation. Chloroethane is a small molecule, very similar to vinyl chloride and does not adsorb to activated carbon. Treatment of chlororthane in the gaseous phase after air stripping or in the liquid-phase directly with activated carbon will be ineffective.	Moderate Capital, High O&M	Not Retained

TABLE 1
IDENTIFICATION AND SCREENING OF TECHNOLOGIES
FORMER COLUMBIA CEMENT COMPANY SITE
OPERABLE UNIT NO. 2
FREEPORT, NEW YORK

Groundwater Evaluation					
GENERAL RESPONSE ACTION	**REMEDIAL TECHNOLOGY**	**EFFECTIVENESS**	**IMPLEMENTABILITY**	**COST**	**ACTION**
IN-SITU GROUNDWATER TREATMENT	Chemical Oxidation	Innovative technology used successfully for aromatic and chlorinated solvent compounds. Effective for treating source area and primarily contaminated soils (as in OU-1). Not effective in treating diffused, dissolved-phase plumes with less than 1 ppm to dissolved contaminants due to lower reaction rates. At lower dissolved concentrations of the organic contaminants, almost 90% of the oxidant demand will come from the soil matrix and less than 10% from the contaminants.	Technically difficult to implement given existence of subsurface utilities, above ground structures, roads and other interferences within the footprint of the dissolved-phase chloroethane plume.	Moderate Capital, Low O&M	Retained
	Air Sparging	Air Sparging has been used successfully used to treat petroleum hydrocarbon related VOCs as they are readily degraded under aerobic conditions. CA can degrade under aerobic conditions so this technology can be effective in reducing the toxicity and mass.	Air Sparging will be difficult to implement because of the presence of above-ground structures over the impacted area and the inability to develop a sparging network.	Moderate Capital, High O&M	Not Retained
	Enhanced Bioremediation	Bench-scale testing with anaerobic enhancements in OU-1 showed that chloroethane will not degrade under reducing conditions. Pilot testing at OU-1 with an aerobic, oxygen release product showed that treatment of chloroethane was not possible due to excessive oxygen demand from other dissolved oxygen sinks in the aquifer. Is not likely to reduce the mobility, toxicity and volume of contaminants.	Technically difficult to implement given existence of subsurface utilities, above ground structures, roads and other interferences within the footprint of the dissolved-phase chloroethane plume.	Moderate Capital, Low O&M	Not Retained

TABLE 2
EVALUATION OF ALTERNATIVES
FORMER COLUMBIA CEMENT COMPANY SITE
OPERABLE UNIT NO. 2
FREEPORT, NEW YORK

CRITERIA	Groundwater		
	ALTERNATIVE 1 No Actions	**ALTERNATIVE 2 In-Situ Chemical Oxidation**	**ALTERNATIVE 3 No Further Action with Groundwater Monitoring**
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME (TMV)			
Treatment Process(es)	None required.	Injection of ISCO Chemicals	None. Groundwater quality passively protected.
Reduction of TMV by Treatment	None. Current conditions exist.	Groundwater quality actively protected. VOCs destroyed on contact with ISCO chemicals.	Groundwater quality passively protected and the mobility, toxicity and volume is reduced naturally.
Types and Quantity of Residuals Remaining After Treatment	Current conditions exist.	Residuals remaining will attenuate slowly over time.	Residuals remaining will attenuate slowly over time.
OVERALL PROTECTIVENESS			
Protect Human Health and Environment	Does not protect human health and the environment	Implementaion produces short-term risk through exposure to ISCO chemicals and generation of soil vapors. Health and Safety measures during monitoring activities would be protective against short-term risks from exposure to contaminants. Current conditions continue to exist in short-term but do not pose signficant risk to community.	Health and Safety measures during monitoring activities would be protective against short-term risks from exposure to contaminants. Current conditions continue to exist in short-term but do not pose signficant risk to community.
COMPLIANCE WITH NYSDEC REQUIREMENTS			
Groundwater Cleanup Criteria	Does not meet remedial action objectives.	Groundwater contamination actively reduced and eventually expected to meet remedial action objectives.	Groundwater contamination passively reduced and eventually expected to meet remedial action objectives.
LONG-TERM EFFECTIVENESS AND PERMANENCE			
Magnitude of Residual Risk	Remains at current levels.	Magnitude of risk reduced through destruction of contaminants, followed by natural reduction of residual contaminant concentrations.	Magnitude of risk reduced through natural reduction of contaminant concentrations.
SHORT-TERM EFFECTIVENESS			
Community and Worker Protection	Current conditions continue to exist.	Implementaion produces short-term risk to workers and the public through exposure to ISCO chemicals and generation of soil vapors. Health and Safety measures during monitoring activities would be protective against short-term risks from exposure to contaminants. Current conditions continue to exist in short-term but do not pose signficant risk to community.	Health and Safety measures during monitoring activities would be protective against short-term risks from exposure to contaminants. Current conditions continue to exist in short-term but do not pose signficant risk to community.
Environmental Impacts	Current conditions continue to exist.	Minimal impacts from drilling activities and generation of vapors.	No environmental impacts from monitoring activities.
IMPLEMENTABILITY			
Ability to Construct and Operate	No construction or operation.	Limited space in OU-2 reduces area available to conduct injections, particularly in public areas.	Installation of monitoring wells and sampling of wells can be easily conducted.
Ease of Undertaking Additional Action if Needed	None required.	Additional actions would be difficult because of space restrictions.	None required
Availibility of Equipment, Specialists, and Materials	NA	ISCO chemicals and injection contractors and equipment are available. Drilling equipment for wells and sampling equipment is readily available.	Drilling equipment for wells and sampling equipment is readily available.
Ability to Monitor Effectiveness	None required.	Groundwater monitoring can be readily implemented.	Groundwater monitoring can be readily implemented.
Ability to Obtain Approvals and Coordinate with Other Agencies	None required.	Some OU-2 property owners have not granted access for investigation activities. Access for disruptive ISCO injections unlikley.	Co-ordination of site access with property owners will be required.
SCHEDULE			
Time Until Action is Complete (months)	Not applicable.	Injections can be conducted within 6 months of approval. Follow-up monitoring indeterminate (assumed 10 years for costing)	Indeterminate (assumed 15 years for costing)
COST - TOTAL PRESENT WORTH	$0	$281,019	$88,533

TABLE 3
SUMMARY OF COSTS
FORMER COLUMBIA COMPANY SITE
OPERABLE UNIT No. 2
FREEPORT, NEW YORK

Alternative No.	Components	Capital Cost	O&M Phase	O&M Phase Cost	Time Period of Operations (years)	Annual O&M Cost	Total O&M Cost	Present Worth O&M Cost [1]	Total Present Worth of Alternative [2]
1	No Action	**$0**	**NA**	**NA**	**0**	**NA**	**$0**	**$0**	**$0**
2	In-Situ Chemical Oxidation	**$168,279**	**Bi-Annual Sampling for 5 Years**	**$160,000**	**5**	**$32,000**	**$145,700**	**$112,740**	**$281,019**
3	No Further Action with Groundwater Monitoring	**$14,560**	**Bi-Annual Sampling for 5 Years**	**$105,650**	**5**	**$21,130**	**$95,600**	**$73,973**	**$88,533**

Notes:
1. For the present worth cost; a 5% annual interest rate has been assumed.
2. Total Present Worth is equal to the sum of the capital cost plus the present worth O&M cost.

TABLE 3
REVISED SUMMARY OF COSTS
FORMER COLUMBIA COMPANY SITE
OPERABLE UNIT No. 2
FREEPORT, NEW YORK

DESCRIPTION	Alternative 1 No Action	Alternative 2 In Situ Chemical Oxidation	Alternative 3 No Further Action With Monitoring
Total Project Duration (Years)	30	30	30
Capital Cost	$0	$194,770	$6,219
Annual O&M Cost	$0	$12,352	$12,150
Total Present Value of Alternative	**$0**	**$384,645**	**$192,987**

N

0 2000 4000

SCALE IN FEET

SITE LOCATION MAP
FORMER COLUMBIA CEMENT COMPANY, INC.
SITE NO. 130052

159 HANSE AVENUE

FREEPORT, NEW YORK

REFERENCE:
U.S.G.S. 7.5 MINUTE QUADRANGLE:
FREEPORT, NY (2010)

URS

1255 Broad Street
Clifton, New Jersey 07013
PHONE: (973) 883-8500
FAX: (973) 883-8501

DATE: 01/23/15

JOB: 11130912

FIGURE 1

K:\Cadd\Columbia Cement\Columbia Cement-Unit No.2\11130912\Unit.No.2\30912.01-FIG.1.dwg

SITE PLAN WITH SAMPLING LOCATIONS
OPERABLE UNIT No. 2

FORMER COLUMBIA
CEMENT COMPANY, INC.
159 HANSE AVENUE
FREEPORT, NEW YORK

URS
WAYNE, NEW JERSEY

DR. BY	ET	SCALE AS SHOWN	DWG. NO. 30912.01	PROJ. NO. 11130912
CK'D. BY	MB		DATE FEBRUARY 21, 2014	FIG. NO. 2

MW-09-18S	Sept-09	Oct-10	Oct-11	Jan-12	May-13	May-14
Chlorobenzene	< 1.4	< 1.6	1.6	< 1.6	< 1.6	< 6.4
Chloroethane	**77**	**37**	**79R**	**130**	**94**	< 10

MW-09-24S	Sept-09	Oct-10	Oct-11	Jan-12	May-13	May-14
1,4-Dichlorobenzene	NA	1.8 J	1.7	1.8	1.4 J	1.6 J
Chlorobenzene	4.5 J	3.3 J	< 1.6	< 1.6	< 1.6	< 1.6
Chloroethane	**11**	< 2.5	**13 R**	**14**	4.4 J	< 2.5
MTBE	NA	0.79 J	0.79	< 0.46	< 0.46	< 0.46

MW-09-19D	Sept-09	Oct-10	Oct-11	Jan-12	May-13	May-14
1,1-Dichloroethane	4.1	< 1.7	**130**	< 6.8	< 6.8	**20**
Chlorobenzene	**7 J**	**5.2 J**	< 1.6	< 6.4	**7.1**	< 6.4
Chloroethane	**170**	**58**	**340 R**	< 10	**30**	**280**

MW-09-25D	Sept-09	Oct-10	Oct-11	Jan-12	May-13	May-14
1,4-Dichlorobenzene	NA	1.8 J	1.9	1.6	1.7 J	< 4.4
Chlorobenzene	**6.3 J**	**5.5 J**	< 1.6	< 1.6	< 1.6	< 6.4
Chloroethane	**24**	**6.5 J**	**16 R**	**19**	**23**	< 10

MW-05-15D	Apr-05	Jun-06	Sept-07	Oct-07	Sept-09	Oct-10	Oct-11	Jan-12	May-13	May-14
1,1-DCA	< 10	< 0.3	< 50	< 10	< 1.6	< 1.7	**140**	< 6.8	< 6.8	< 6.8
Carbon Disulfide	< 10	< 0.3	< 50	< 10	ND	< 2.1	< 8.4	9.6 J	31 J	25 J
Chloroethane	**120**	**200**	**190**	**390**	**490 D**	**140**	**430 R**	**100**	**13**	< 10
Chlorobenzene	3 J	2.4	< 50	< 10	**7 J**	< 1.6	< 6.4	< 6.4	< 6.4	< 6.4
Methylene Chloride	< 10	<0.5	< 50	< 25	**13**	< 1.3	< 6..8	< 6..8	< 6..8	< 6..8
Xylene	< 10	0.5	< 20	< 15	NA	< 0.82	< 3.3	< 3.3	< 3.3	< 3.3

MW-05-14S	Apr-05	Jun-06	Sept-07	Oct-07	Sept-09	Oct-10	Oct-11	Jan-12	May-13	May-14
Chloroethane	**13**	1	< 5.0	< 1	< 3.5	< 2.5	4.7 R	< 2.5	< 2..5	< 10
Chlorobenzene	**24**	**7.7**	**9.2**	**11**	**8.4 J**	**6.2 J**	< 1.6	< 1.6	< 1.6	< 6.4
Carbon Disulfide	< 10	0.4	< 5.0	< 1	NA	< 2.1	< 2.1	< 2.1	< 2.1	9.0
Benzene	< 10	0.4	< 1.0	< 0.5	NA	< 1.6	< 1.6	< 1.6	< 1.6	< 6.4

MW-97-2S	Jun-97	Jan-99	Apr-00	May-03	Jun-04	Jun-06	Oct-07	Sept-09	Sept-10	Oct-11	Apr-13	May-14
Chloroethane	3.6	< 10	< 10	**7**	< 10	< 0.2	< 1	< 0.69	< 2.5	< 2.5	< 2.5	< 2.5
Chlorobenzene	**18**	**20**	**15**	**12**	**16**	**16**	**27**	**15**	**16**	**13**	**11**	**10**
Acetone	9.4	< 10	8 J	< 10	< 10	7.3	< 10	NA	< 1.9	< 1.9	< 1.9	< 1.9
Benzene	<40	< 10	1 J	< 5.0	< 10	< 0.3	< 0.5	NA	< 1.6	< 1.6	< 1.6	< 1.6
Carbon Disulfide	26	<10	< 5	< 50	< 10	< 0.3	< 1	NA	< 2.1	< 2.1	< 2.1	< 2.1
Isopropylbenzene	2.3	NA	NA	NA	NA	NA	2.1	NA	2.0 J	3.4	1.3	1.8
1,4-Dichlorobenzene	**3.2**	NA	NA	NA	NA	NA	< 1	NA	2.5 J	2.6	2.3	2.6
Methylene Chloride	< 1.0	< 10	15	< 5.0	< 10	< 0.5	< 2.5	< 0.46	< 1.3	< 1.3	< 1.3	< 1.3
Ethylbenzene	< 1.0	< 10	< 10	< 5.0	< 10	< 0.5	< 1	NA	< 1.6	< 1.6	< 1.6	< 1.6
Xylenes	< 1.0	< 10	2	< 5.0	< 10	0.4	< 1.5	NA	< 0.82	< 0.82	< 0.82	0.86

MW-98-10D	Jan-99	Apr-00	May-03	Jun-04	Jun-06	Oct-07	Sept-09	Sept-10	Oct-11	Apr-13	May-14
Chloroethane	< 10	< 10	**11**	< 10	< 0.2	< 1	< 0.69	< 2.5	< 2.5	< 2.5	< 2.5
Methylene Chloride	< 10	**23**	< 5.0	< 10	< 0.5	< 2.5	< 0.46	< 1.3	< 1.3	< 1.3	< 1.3
Chlorobenzene	< 10	**6**	**6**	**7**	**7.3**	**6.8**	5 J	3.5 J	< 1.6	**9.3**	**12**
1,4-Dichlorobenzene	NA	NA	NA	NA	NA	< 1	NA	1.4 J	1.4 J	2 J	2.4
Isopropylbenzene	NA	NA	NA	NA	NA	< 1	NA	< 0.37	< 0.37	1.3 J	1.4

MW-98-9D	Jan-99	Apr-00	May-03	Jun-04	Apr-05	Jun-06	Sept-07	Oct-07	Sept-09	Oct-09	Nov-09	Feb-10	Mar-10	Sept-10	Dec-10	Jan-11	Feb-11	Mar-11	Oct-11	Nov-11	Dec-11	Jan-12	13-May	Apr-14
1,1-DCA	< 10	< 5.0	< 50	< 10	< 10	< 3.2	< 50	< 10	< 0.31	< 1.6	< 0.31	< 0.31	< 1.6	< 17	< 17	< 17	< 17	< 3..4	< 8.5	< 8.5	< 6..8	< 6.8	< 6.8	**91**
Carbon Disulfide	< 10	< 5.0	< 50	< 10	< 10	< 3.4	< 50	< 10	< 0.33	2.6	1.5 J	< 0.33	< 1.6	< 21	64 J	77 J	43 J	13 J	< 11	170	130	92	< 8.5	9.7
Chloroethane	**38**	**290**	**810**	**510**	**910**	**730**	**670**	**780**	**3000**	**330**	**880**	**2900**	**970**	**790**	**470**	**250**	**350**	**300**	**41**	**47**	**62**	**59**	< 10	< 10
Chlorobenzene	< 10	**5.0**	< 50	**7.0**	**9.0**	**12**	< 50	< 10	**8.5**	4.2	**6.0**	**7.0**	**6.3**	< 16	< 16	< 16	< 16	< 3.2	< 8.0	< 8.0	< 6.4	< 6.4	< 6.4	< 6.4
Acetone	< 10	< 10	< 100	< 10	< 10	< 13	< 250	< 100	1.0 J	< 3.4	< 0.64	< 0.64	< 3.2	< 19	**370**	**160**	**140**	7.8	**98**	**220**	**130**	**95**	< 7.6	< 7.6

MW-97-1S	Jun-97	Jan-99	Apr-00	May-03	Jun-04	Apr-05	Jun-06	Sept-07	Oct-07	Sept-09	Oct-09	Nov-09	Feb-10	Mar-10	Sept-10	Dec-10	Jan-11	Feb-11	Mar-11	Oct-11	Nov-11A	Nov-11B	Dec-11	Jan-12	May -13	Apr-14
Chloroethane	**100**	**120**	**320**	**220**	**430**	**170**	**120**	**100**	**120**	**87**	**54**	**68**	**250**	**98**	**73**	**260**	**10**	< 2.5	< 2.5	**360**	**51**	**38**	**17**	**17**	< 2.5	**39**
Chlorobenzene	**6.9**	< 10	**11**	< 10	4	3	2.5	< 25	**5.2**	2.9	3.4	3.5	3.3	3.1	3.5	2.2	< 1.6	< 1.6	< 1.6	< 1.6	**8.4 J**	< 3.2	< 3.2	< 1.6	**8.7**	< 6.4
Methylene Chloride	< 2.0	< 10	**20**	< 10	< 10	< 10	< 0.5	< 25	**14**	< 0.46	< 2.3	< 0.46	< 0.46	< 0.46	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	< 1.3	0.58 JB	< 2.6	< 2.6	< 1.3	< 1.3	< 5.2
Acetone	< 10	< 10	7	< 20	< 10	< 10	< 1.3	< 120	< 50	< 0.64	< 3.2	< 0.64	< 0.64	< 0.64	< 1.9	< 1.9	1.9 R	< 1.9	< 1.9	< 1.9	0.55	< 3.8	< 3.8	< 1.9	< 1.9	< 7.6

MW-07-16S	Sept-07	Oct-07	Sept-09	Oct-10	May-14
Chloroethane	**91**	**86**	**52**	**13**	< 10
Chlorobenzene	**5.8 J**	**9.3**	**6.8 J**	**6.5 J**	< 6.4

MW-07-17D	Sept-07	Oct-07	Sept-09	Oct-10	May-14
Chloroethane	< 5.0	1.0	**5.1 J**	**31 J**	< 10
Chlorobenzene	< 5.0	< 1.0	**8.9 J**	**9.1 J**	< 6.4
MTBE	2.7	2.6	NA	< 0.46	< 1.8

MW-09-26D	Sept-09	Oct-10	Oct-11	May-13	May-14
1,4-Dichlorobenzene	NA	2.1 J	2.4	2.5 J	< 4.4
Chlorobenzene	**13**	**14**	**13**	**13**	< 6.4
Chloroethane	**36**	4.2 J	**35**	**6.7 J**	< 10

MW-09-20S	Sept-09	Oct-10	Oct-11	May-13	May-14
1,4-Dichlorobenzene	NA	< 5.5	1.0	< 4.4	< 4.4
Chlorobenzene	< 1.4	< 8.0	1.7	< 6.4	< 6.4
Chloroethane	< 3.5	< 12	< 0.10	< 10	< 10
Carbon Disulfide	NA	< 10	0.25 JB	< 8.4	57

MW-09-21D	Sept-09	Oct-10	Oct-11	May-13	May-14
1,4-Dichlorobenzene	NA	< 5.5	1.5	< 4.4	< 4.4
Chlorobenzene	5.0 J	< 8.0	4.4	< 6.4	< 6.4
Chloroethane	**9.8 J**	< 12	**29**	**41**	< 10

MW-03-13S	May-03	Jun-04	Jun-06	Sept-09	Oct-11	May-13	May-14
Carbon Disulfide	1.0	< 10	< 0.3	NA	< 2.1	< 2.1	< 8.4
1,1-Dichloroethane	< 5.0	< 10	<0.3	< 1.6	**5.1**	< 1.7	< 6..8
MTBE	NA	NA	NA	NA	0.71	1.7	< 1.8

MW-09-22S	Sept-09	Oct-10	Oct-11	Jan-12	May-13	May-14
1,4-Dichlorobenzene	NA	< 1.1	2.6	< 2.2	< 2.2	< 2.2
Chlorobenzene	**5.9 J**	2.9 J	< 3.2	< 3.2	< 3.2	< 3.2
Chloroethane	< 3.5	< 2.5	< 5.0 R	< 5.0	< 5.0	< 5.0

MW-09-23D	Sept-09	Oct-10	Oct-11	Jan-12	May-13	May-14
1,4-Dichlorobenzene	NA	2.9 J	< 2.2	2.4	< 2.2	< 2.2
Chlorobenzene	**13 J**	**14**	< 3.2	< 3.2	< 3.2	< 3.2
Chloroethane	< 3.5	3.1 J	< 5.0 R	< 5.0	< 5.0	< 5.0

LEGEND:

- MW-98-9D — MONITORING WELL
- PROPERTY BOUNDARY LINE
- CREEK LINE
- J — QUANTITATIVELY ESTIMATED VALUE
- NA — NOT ANALYZED
- R — RESULT REJECTED DURING QA/QC REVIEW

NOTE:

ALL RESULTS IN µg/L. BOLD INDICATES RESULT EXCEEDS NYSDEC GROUNDWATER STANDARD.

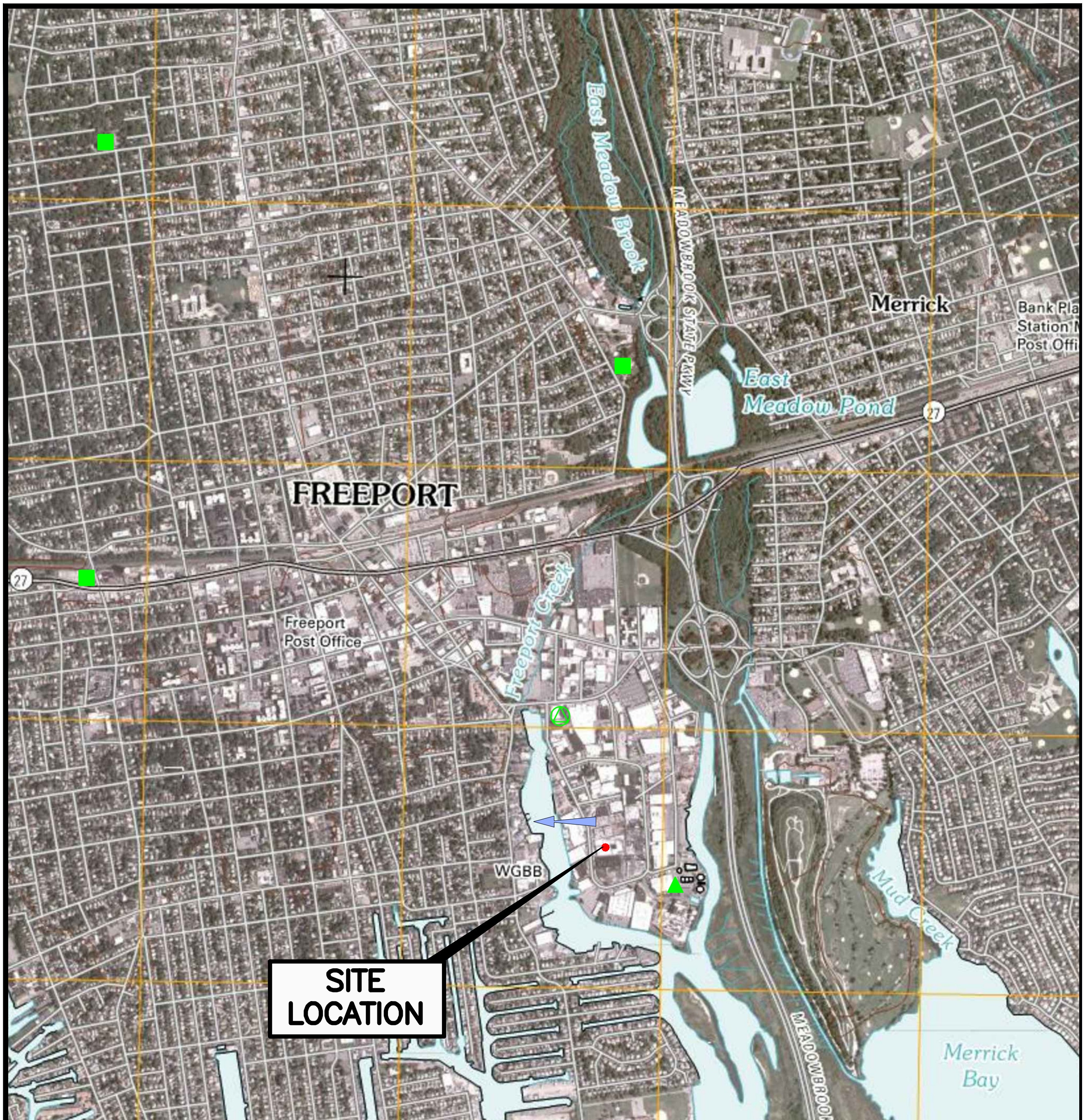
GROUNDWATER VOC SAMPLING RESULTS
OPERABLE UNIT No. 2

FORMER COLUMBIA
CEMENT COMPANY, INC.
159 HANSE AVENUE
FREEPORT, NEW YORK

URS
CLIFTON, NEW JERSEY

DR. BY ET	SCALE AS SHOWN	DWG. NO. 11130915.01–Fig.2&3	PROJ. NO. 11130915
CK'D. BY MB		DATE MARCH 10, 2015	FIG. NO. 3

K:\Cadd\Columbia Cement\11130915(Columbia Cement-OU2)\11130915-01-Fig.2&3.dwg, Fig.3, 3/31/2015 9:24:11 AM



0 2000 4000

SCALE IN FEET

N

LEGEND

- FREEPORT PUBLIC WATER SUPPLY WELL LOCATION
- INDUSTRIAL WATER SUPPLY WELL LOCATION (ACTIVE)
- INDUSTRIAL WATER SUPPLY WELL LOCATION (INACTIVE OR CLOSED)
- GROUNDWATER FLOW DIRECTION

REFERENCE:
U.S.G.S. 7.5 MINUTE QUADRANGLE:
FREEPORT, NY (2010)

PUBLIC AND INDUSTRIAL SUPPLY WELL LOCATIONS

FORMER COLUMBIA CEMENT COMPANY, INC.

159 HANSE AVENUE

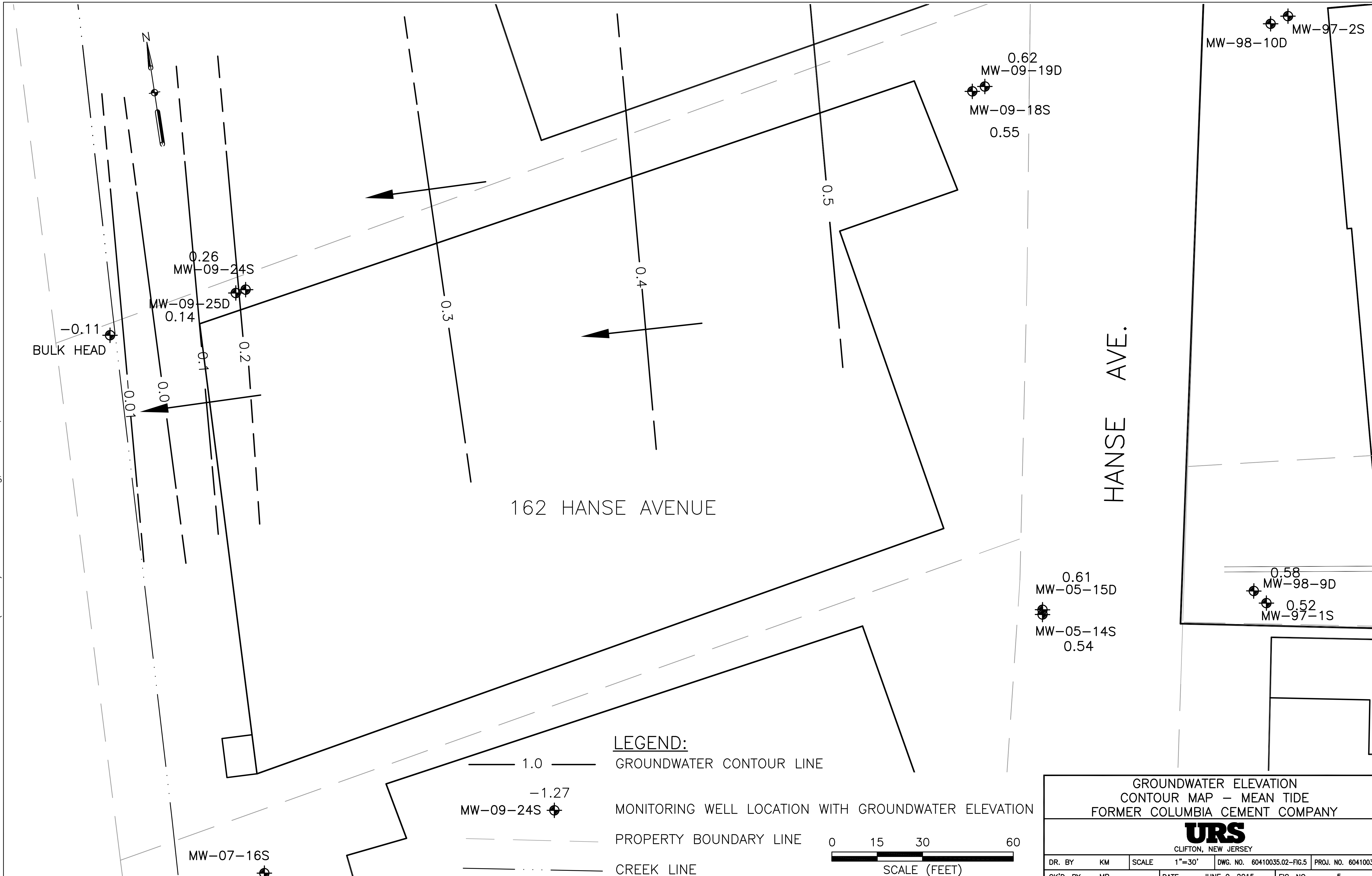
FREEPORT, NEW YORK

URS
1255 Broad Street
Clifton, New Jersey 07013
PHONE: (973) 883-8500
FAX: (973) 883-8501

DATE: 06/05/15

JOB: 60410035

FIGURE 4



GROUNDWATER ELEVATION CONTOUR MAP – MEAN TIDE
FORMER COLUMBIA CEMENT COMPANY

URS
CLIFTON, NEW JERSEY

DR. BY	KM	SCALE	1"=30'	DWG. NO. 60410035.02-FIG.5	PROJ. NO. 60410035
CK'D. BY	MB	DATE	JUNE 9, 2015	FIG. NO.	5

K:\Cadd\Columbia Cement\Columbia Cement-Unit No.2\111130912(Unit.No.2)\60410035.02-FIG.5.dwg, 11X17 FIG 4, 6/9/2015 3:37:08 PM

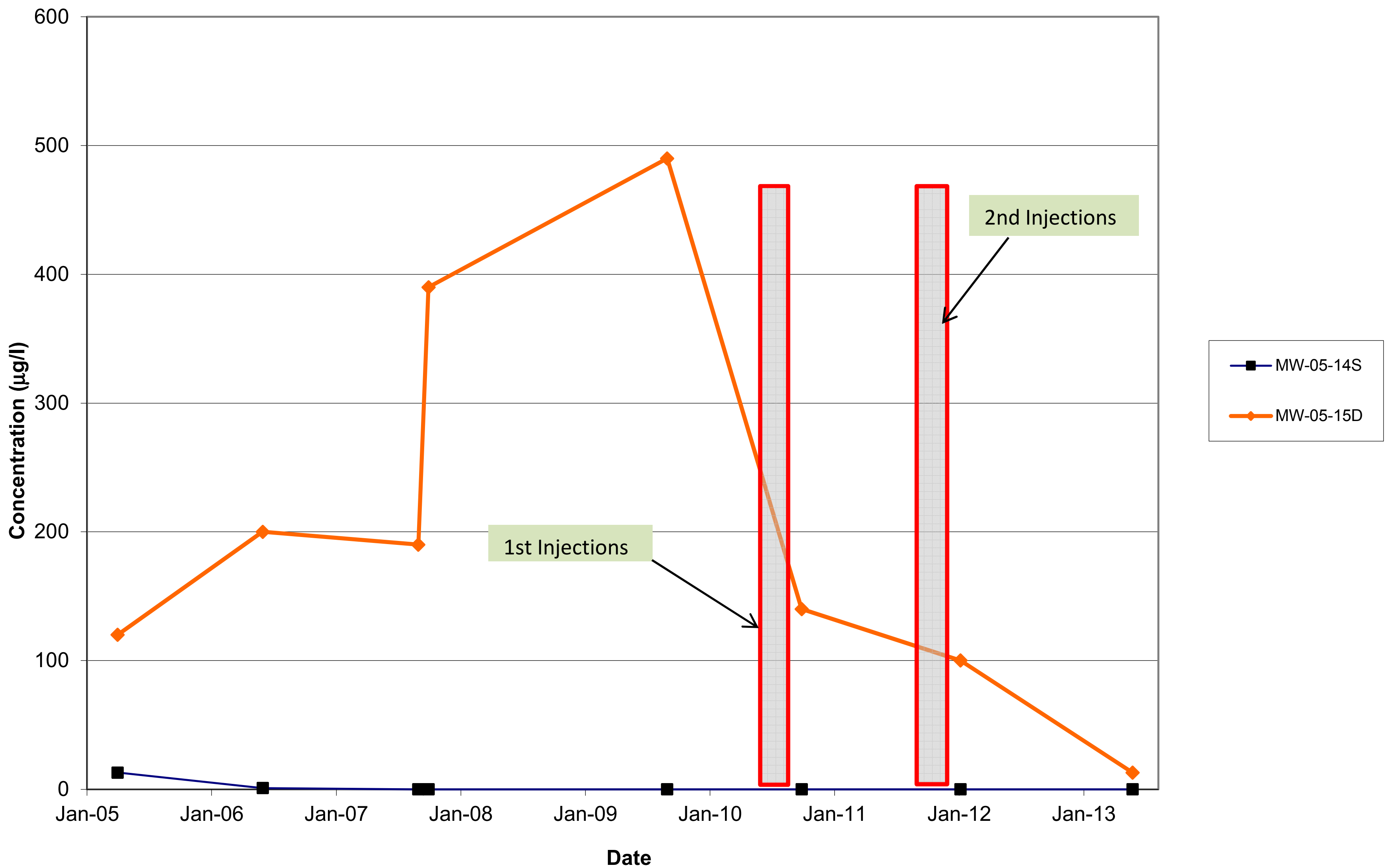


FIGURE 6
CHLOROETHANE CONCENTRATIONS IN WELLS MW-05-14S AND MW-05-15D
FORMER COLUMBIA CEMENT COMPANY SITE
FREEPORT, NEW YORK


N
146 HANSE AVENUE
143 HANSE AVENUE
272 BUFFALO AVENUE
FORMER COLUMBIA CEMENT BUILDING
159 HANSE AVENUE
(OPERABLE UNIT No. 1)
162 HANSE AVENUE
HANSE AVE.
191 HANSE AVENUE
178 HANSE AVENUE
FREEPORT CREEK
MW-09-19D
MW-09-18S
MW-09-24S
MW-09-25D
MW-05-15D
MW-05-14S
MW-10-28S
MW-10-29D
MW-10-27S
MW-09-26D
MW-09-20S
MW-09-21D
MW-09-23D
MW-09-22S
MW-03-13S
APPROX. 200' SOUTH
0 15 30 60
SCALE (FEET)
LEGEND:
MW-98-9D
EXISTING MONITORING WELL TO BE USED IN OU-2 MONITORING PROGRAM
MW-10-27S
PROPOSED MONITORING WELL TO BE USED IN OU-2 MONITORING PROGRAM
PROPERTY BOUNDARY LINE
CREEK LINE
PROPOSED MONITORING PROGRAM
OPERABLE UNIT No. 2
FORMER COLUMBIA CEMENT COMPANY, INC.
159 HANSE AVENUE
FREEPORT, NEW YORK
URS
CLIFTON, NEW JERSEY
DR. BY ET
SCALE AS SHOWN
DWG. NO. 60410035.03.Fig.7
PROJ. NO. 60410035
CK'D. BY MB
DATE JUNE 9, 2015
FIG. NO. 7

APPENDIX A
COST ESTIMATE

Former Columbia Cement Site, Freeport New York
Cost Estimate

Alternative 2
In Situ Chemical Oxidation of Groundwater

Assumptions

1. All costs include labor, materials, and equipment unless otherwise stated.
2. In Situ Chemical Oxidation with Sodium Persulfate activated with Hydrogen Peroxide
3. Injection into 20 injection points in OU-2.
4. Injections followed by 5 years of semi-annual monitoring.

Direct Capital Costs		Qty	Units	Unit Rate	Cost	Reference
1. Rental Equipment						
Injection point installation		20.00	each	$2,500	**$50,000**	*Experience*
Injection pumps and equipment		2	LS	$25,000	**$50,000**	*Lump sum*
2. Chemical Costs						
Sodium permanganate		10,000	LBS	$1.48	**$14,800**	*Vendor Quote*
Hydrogen peroxide		64,000	LBS	$0.1532	**$9,805**	*Vendor Quote*
Freight costs for chemicals		1	EACH	$6,500	**$6,500**	*Vendor Quote*
3. Equipment charges						
Tanker truck for peroxide		1	/MONTH	$1,200	**$1,200**	*Vendor Quote*
Mixing pump with tanker truck		1	/MONTH	$600	**$600**	*Vendor Quote*
Shipping		1	LS	$1,000	**$1,000**	*Vendor Quote*
Total Direct Capital Costs					**$83,905**	
Direct Expenses						
1. ISCO Supplies						
Equipment (pumps, mixers)		2.00	LS	$5,000	**$10,000**	*Estimate*
Consumables (PPE, sampling equipment, etc)		2.00	LS	$1,000	**$2,000**	*Estimate*
4. Field Oversight (total for two events)						
mob/demob/chemical storage area (2 days)	2 day	40	hours	$55	**$2,200**	*Estimate*
ISCO injection oversight (10 days)	10 days	200	hours	$75	**$15,000**	*Estimate*
Site restoration (1 day/event)	1 day	30	hours	$55	**$1,650**	*Estimate*
5. Field Oversight Expenses						
13 days X $100/day		13	days	$100	**$1,300**	*Estimate*
Total Direct Expenses					***$32,150***	
Indirect Capital Costs						
1. Engineering (15% of total direct capital costs)					**$17,408**	
2. Project Management (10% of total direct and capital costs)					**$11,605**	
3. Contingency (20% of total direct capital costs)					**$23,211**	
Total Indirect Capital Costs					***$52,225***	
Total Capital Cost					***$168,279***	
Operations And Maintenance Costs						
1. Groundwater sampling of 15 wells for five years						
2 samples per well per year for 5 years, 12 QA samples per year		210.00	samples	$150	**$31,500**	*Experience*
2. Consumables and Expenses for sampling						
$ 1000 per event, 10 events		10.00	events	$1,000	**$10,000**	*Estimate*
3. Sampling Labor 60 hr/event, 10 events		600.00	hours	$95	**$57,000**	*Experience*
4. Modeling 8 hr/event, 10 events		80.00	hours	$115	**$9,200**	*Experience*
5. Progress reports 40 hr/event, 10 events		400.00	hours	$95	**$38,000**	*Experience*
Total Operations And Maintenance Costs					***$145,700***	

REVISED REMEDIAL COST SUMMARY

FORMER COLUMBIA CEMET COMPANY SITE

OPERABLE UNIT No. 2

ALTERNATIVE 2

IN SITU CHEMICAL OXIDATION

CAPITAL COSTS:

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Well Installization					
Mobilization/Demobilization	1	LS	$500	$500	Install 1 Monitoring well at
Well Install/Develop	1	LS	$2,400	$2,400	191 Hanse Avenue
CAMP Monitoring	1	LS	$750	$750	
IDW Handling	1	LS	$500	$500	
Drilling Oversight/CAMP	1	Day	$1,000	$1,000	
SUBTOTAL				$5,150	
Pre-Design Sampling					
Mobilization/Demobilization	1	LS	$500	$500	Sample 14 monitoring wells for
Monitoring Well Sampling	14	EA	$250	$3,500	VOCs and design parameters
Sample Analysis	16	EA	$300	$4,800	
Data Validation	16	EA	$75	$1,200	
IDW Handling	1	LS	$350	$350	
SUBTOTAL				$10,350	
Remedial Design					
RAW	1	LS	$15,000	$15,000	
HSSE	1	LS	$2,500	$2,500	
Permitting	1	LS	$1,000	$1,000	
SUBTOTAL				$18,500	
ISCO Injections					
Pre-Planning / Procurement	1	LS	$2,500	$2,500	
Mob/Demod	2	LS	$3,000	$6,000	
Injection Point Installation	20	EA	$1,250	$25,000	
Installation Oversight	20	EA	$325	$6,500	
ISCO Materials	20	EA	$1,810	$36,200	
Mixing/Injecting	20	EA	$1,250	$25,000	
Injection Oversight	20	EA	$750	$15,000	
SUBTOTAL				$116,200	
Post-Injection Sampling					
Mobilization/Demobilization	2	LS	$500	$1,000	Sampe 6 wells on Hanse Ave.
Monitoring Well Sampling	12	EA	$250	$3,000	at 1 month and 2 months after
Sample Analysis	18	EA	$300	$5,400	injections.
Data Validation	18	EA	$75	$1,350	
IDW Handling	1	LS	$350	$350	
SUBTOTAL				$11,100	
SUBTOTAL				$161,300	
Contingency	15%			$24,195.00	
SUBTOTAL				$185,495.00	
Project Management	5%			$9,274.75	
TOTAL CAPITAL COST				**$194,769.75**	

REVISED REMEDIAL COST SUMMARY
FORMER COLUMBIA CEMET COMPANY SITE
OPERABLE UNIT No. 2
ALTERNATIVE 2
IN SITU CHEMICAL OXIDATION

OPERATION & MAINTENANCE COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Annual Sampling					
Mobilization/Demobilization	30	LS	$500	$15,000	Thirty years of annual
Monitoring Well Sampling	420	EA	$250	$105,000	sampling of 14 monitoring wells
Sample Analysis	480	EA	$95	$45,600	+ QA/QC samples
Data Validation	480	EA	$75	$36,000	Analysis and validation
EDD Preparation	30	LS	$350	$10,500	
IDW Handling	30	LS	$400	$12,000	
SUBTOTAL				$224,100	
Well Abandonment					
Mobilization/Demobilization	1	LS	$500	$500	Abandon 20 Injection points and
Well Abandonment	1	LS	$11,500	$11,500	14 monitoring wells
Oversight	1	LS	$5,000	$5,000	
SUBTOTAL				$17,000	
Reporting					
Annual Progress Report	30	LS	$3,000	$90,000	
Construction Completion Rep	1	LS	$5,000	$5,000	
SUBTOTAL				$95,000	
SUBTOTAL				$336,100	
Contingency	5%			$16,805.00	
SUBTOTAL				$352,905.00	
Project Management	5%			$17,645.25	
TOTAL O&M COST				**$370,550.25**	

COST SUMMARY

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR 5%	PRESENT VALUE
Capital	0	$194,770	$194,770	1.000	$194,770
O&M Cost	30	$370,550	$12,352	15.372	$189,876
		$565,320			**$384,645**

Former Columbia Cement Site, OU-2, Freeport New York
Cost Estimate

Alternative 3
No Further Action with Groundwater Monitoring

Assumptions

1. All costs include labor, materials, equipment and O&M unless otherwise stated.
2. MNA is assumed for 10 years.
   Semi-annual sampling for 5 years, followed by annual sampling for 5 years.

Direct Capital Costs		**Qty**	**Units**	**Unit Rate**	**Cost**	***Reference***
1. Additional Wells for MNA						
One monitoring well		1.00	each	$5,000	**$5,000**	*Experience*
Well development		1.00	each	$500	**$500**	*Experience*
Total Direct Capital Costs					**$5,500**	
Direct Expenses						
1. Field Oversight						
Well Installation	2 days	40.00	hours	$85	**$3,400**	*Estimate*
Well development	1 day	20.00	hours	$85	**$1,700**	*Estimate*
2. Field Oversight Expenses						
3 days X $200/day		3.00	days	$200	**$600**	*Estimate*
Total Direct Expenses					**$5,700**	
Indirect Capital Costs						
1. Engineering (10% of total direct and capital costs)					**$1,120**	
2. Project Management (10% of total direct and capital costs)					**$1,120**	
3. Contingency (10% of total direct and capital costs)					**$1,120**	
Total Indirect Capital Costs					***$3,360***	
Total Capital Cost					***$14,560***	
Operations And Maintenance Costs						
1. VOC sampling of 14 wells for five years						
2 samples per well per year for 5 years, 12 QA samples per year		200.00	samples	$95	**$19,000**	*Experience*
2. Consumables and Expenses for sampling						
$ 1500 per event, 10 events		10.00	events	$1,500	**$15,000**	*Estimate*
3. Sampling Labor 40 hr/event,120 events		400.00	hours	$85	**$34,000**	*Experience*
4. Progress reports 24 hr/event, 10 events		240.00	hours	$115	**$27,600**	*Experience*
Total Operations And Maintenance Costs					***$95,600***	

REVISED REMEDIAL COST SUMMARY

FORMER COLUMBIA CEMET COMPANY SITE

OPERABLE UNIT No. 2

ALTERNATIVE 3

NO FURTHER ACTION WITH GROUNDWATER MONITORING

CAPITAL COSTS:

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Well Installization					
Mobilization/Demobilization	1	LS	$500	$500	Install 1 Monitoring well at
Well Install/Develop	1	LS	$2,400	$2,400	191 Hanse Avenue
CAMP Monitoring	1	LS	$750	$750	
IDW Handling	1	LS	$500	$500	
Drilling Oversight/CAMP	1	Day	$1,000	$1,000	
SUBTOTAL				$5,150	
SUBTOTAL				$5,150	
Contingency	15%			$772.50	
SUBTOTAL				$5,922.50	
Project Management	5%			$296.13	
TOTAL CAPITAL COST				**$6,218.63**	

OPERATION & MAINTENANCE COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Annual Sampling					
Mobilization/Demobilization	30	LS	$500	$15,000	Thirty years of annual
Monitoring Well Sampling	420	EA	$250	$105,000	sampling of 14 monitoring wells
Sample Analysis	480	EA	$95	$45,600	+ QA/QC samples
Data Validation	480	EA	$75	$36,000	Analysis and validation
EDD Preparation	30	LS	$350	$10,500	
IDW Handling	30	LS	$400	$12,000	
SUBTOTAL				$224,100	
Well Abandonment					
Mobilization/Demobilization	1	LS	$500	$500	Abandon 14 monitoring wells
Well Abandonment	1	LS	$7,500	$7,500	
Oversight	1	LS	$3,500	$3,500	
SUBTOTAL				$11,500	
Reporting					
Annual Progress Report	30	LS	$3,000	$90,000	
Construction Completion Report	1	LS	$5,000	$5,000	
SUBTOTAL				$95,000	
SUBTOTAL				$330,600	
Contingency	5%			$16,530.00	
SUBTOTAL				$347,130.00	
Project Management	5%			$17,356.50	
TOTAL O&M COST				**$364,486.50**	

REVISED REMEDIAL COST SUMMARY

FORMER COLUMBIA CEMET COMPANY SITE

OPERABLE UNIT No. 2

ALTERNATIVE 3

NO FURTHER ACTION WITH GROUNDWATER MONITORING

COST SUMMARY

COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR 5%	PRESENT VALUE
Capital	0	$6,219	$6,219	1.000	$6,219
Anual O&M Cost	30	$364,487	$12,150	15.372	$186,768
		$370,705			**$192,987**