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Feasibility Study Report

Peter Cooper Markhams Site
Dayton, New York

July 2006

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FEASIBILITY STUDY REPORT
for
PETER COOPER MARKHAMS SITE

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1.0 INTRODUCTION

1.1 Site Location and Description

The Peter Cooper Markhams Superfund Site, hereinafter referred to as the "Peter Cooper Markhams Site," the "Markhams Site," or the "Site," is located off Bentley Road approximately 6 miles south of the Village of Gowanda in the Town of Dayton, Cattaraugus County, New York (see Figure 1). As illustrated on Figure 2, the Site encompasses approximately 103 acres and is bordered to the northwest by Bentley Road, to the northeast by a wooded property and farm field, to the southeast by a railroad right-of-way, and to the southwest by hardwood forest. Site access is restricted by a locked cable gate at the Bentley Road entrance. Surrounding property is entirely rural, consisting of small farm fields, open meadow, and forests.

In general, the majority of the Site, including the northeastern, northwestern and southwestern areas of the property, is characterized by mature hardwood tree cover, as well as open fields. An approximately 15- to 20-acre area within the central and southeast portions of the Site contains several covered/vegetated fill piles arranged in an elliptical pattern. For the purpose of this report, the terms "waste fill, mounded fill, and fill piles" refer to the elevated piles of material disposed at the Site. Several of the fill piles appear to consist primarily of re-worked native soil. Other fill piles consist of primarily vacuum filter sludge and cookhouse sludge. The fill piles vary in size and elevation, with base dimensions ranging from approximately 1,100 - 160,000 square feet and elevations of 5 to 15 feet above surrounding grade. The total area covered by fill piles (base area) is approximately 7 acres.

Site topography, with the exception of the fill piles, is relatively flat with some natural relief and a moderate grade to the west-southwest. An approximately 5-foot high berm, which provides an elevated bed for the Buffalo and Jamestown Railroad Company (also known as Erie-Lackawanna Railroad) rail track, runs along the entire southeast border of the Site. A dirt access road extends to the fill area from Bentley Road and continues around a portion of the fill area perimeter. The road also appears to provide access to a natural gas wellhead located on the eastern side of the drive, northwest of the fill areas.

1.2 Purpose and Organization of the Report

This Feasibility Study (FS) Report has been prepared to identify and evaluate effective and implementable remedial alternatives for the Peter Cooper Markhams Site; and to develop a recommended remedial approach that is protective of human health and the environment. The FS preparation is consistent with the guidelines presented in "*Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA*" (USEPA, Office of Emergency and Remedial Response, October 1988, OSWER Directive No. 9355.3-01).

The report is composed of seven sections:

- Section 1.0 presents a summary of the Site background including Site history, the nature and extent of contamination, contaminant fate and transport, and potential human health and ecological risks.

- Section 2.0 presents the basis for and develops Remedial Action Objectives for the Site, and identifies potential General Response Actions that potentially satisfy the Remedial Action Objectives. Section 2.0 also identifies the applicable or relevant and appropriate requirements (ARARs) and other regulatory criteria to be considered in the development of candidate remedial alternatives.

- Section 3.0 identifies and "screens" potentially applicable remedial technologies that may be used based to accomplish part or all of each identified General Response Action.

- Section 4.0 combines the remedial technologies that are not eliminated in the screening process into potential remedial alternatives that partially or fully satisfy the established General Response Actions.

- Section 5.0 presents a detailed evaluation of the remedial alternatives against a set of nine criteria.

- Section 6.0 presents a comparative analysis of all the remedial alternatives within each of the nine evaluation criteria.

- Section 7.0 lists referenced cited in this report.

1.3 Site History

1.3.1 Historic Operations

The Peter Cooper Markhams Site was used for the disposal of certain wastes from a former animal glue and adhesives manufacturing company located in Gowanda, New York. Materials disposed at the Markhams Site were reported to consist of residue pile material, vacuum filter sludge, and cookhouse sludge (Reference 1). Residue pile material is described as air-dried cookhouse sludge, which was stabilized to a dry, granular form. Vacuum filter sludge reportedly was produced during primary (settling) treatment of liquid wastes, including liquids generated during gravity dewatering of cookhouse sludge. Cookhouse sludge reportedly was derived from the animal glue manufacturing process, and is comprised of settled sludge resulting from the processing of animal hides, some of which were allegedly chrome-tanned.

Peter Cooper Corporations (PCC) reportedly purchased the Site in 1955. PCC sold the Site in 1976 to a buyer that was subsequently renamed Peter Cooper Corporation (PCCII). PCCII continues to own the Site and is listed as the current landowner on tax assessor maps. From approximately 1955 until September 1971, it was reported that approximately 9,600 tons of residuals were placed at the Peter Cooper Markhams Site over an approximately 15-acre area. Pursuant to a New York State Supreme Court Order dated June 1971, approximately 38,600 tons of previously accumulated residual materials from the Gowanda Plant reportedly were also transferred to the Markhams Site. No further disposal reportedly occurred at the Markhams Site, and the fill area has since re-vegetated.

Review of aerial photographs of the Site for the years 1939, 1956, 1966, 1980 and 1990 indicates anthropogenic disturbance of the Site as well as an extension of the rail spur beginning with the 1956 photograph. Site disturbances, indicative of on-site disposal, are evident in the 1966 photograph. The 1980 and 1990 photographs show significant re-vegetation of the Site.

1.3.2 Previous Investigations and Remedial Measures

In accordance with the June 1971 State Supreme Court Order, PCC initiated transfer of residue pile material to the Markhams Site in August 1971. Shortly thereafter, PCC submitted to the New York State Department of Environmental Conservation (NYSDEC) a Solid Waste Management Report (Reference 1) documenting the means for transfer of these materials to the Markhams Site. Follow-up discussion between PCC and the NYSDEC in August 1972 provided for grading the waste piles to a height of approximately 10 feet and covering them with 6 inches of soil or stabilized residue, followed by seeding to promote fast growing cover vegetation. PCC apparently completed the closure of the Site pursuant to these work plans and to the satisfaction of NYSDEC.

Subsequent to closure, several different parties investigated the Site. The NYSDEC completed Phase I and Phase II Environmental Site Investigations at the Peter Cooper

Markhams Site in 1983 and 1985 (References 2 and 3). In 1986, PCCII, under NYSDEC Consent Order, commissioned O'Brien & Gere Engineers, Inc. (OBG) to perform a Remedial Investigation and Feasibility Study (RI/FS) at the Site, which included a quantitative human health risk assessment (Reference 4), herein referred to as the 1989 OBG RI. In conjunction with the 1989 OBG RI, interim remedial measures were performed in 1989 to remove a number of buried containers that had been disposed within an isolated area of the Site (Reference 5). The containers held off-specification animal glue, PV Emulsion, Dextrin, and oil. The containers and impacted soils were excavated and transported off-site to the BFI Niagara Landfill in Tonawanda, New York for disposal as non-hazardous waste. One drum of animal glue was sent to Chemical Waste Management, Inc. in Model City, New York for disposal as hazardous waste, as the cost of analysis required to demonstrate that the material was not a hazardous waste was not justified.

The 1989 OBG RI indicated the presence of total chromium, hexavalent chromium and arsenic above background levels in waste materials and some adjacent soils. Low levels of these parameters were also detected in groundwater wells installed immediately adjacent to the fill piles. None of the samples tested exhibited hazardous waste (i.e., EP toxicity) characteristics. The 1989 OBG RI concluded that the Site did not pose a risk to human health or the environment. OBG completed a Feasibility Study for the Site in March 1991 (Reference 5). The FS recommended a remedial alternative involving consolidation, compaction, and covering of the waste materials.

NYSDEC apparently did not pursue any remedial action because the Site did not meet the statutory definition of an inactive hazardous waste disposal site. Consequently, the NYSDEC removed the site from its Registry of Inactive Hazardous Waste Sites.

In 1993, the United States Environmental Protection Agency (USEPA) conducted a Site Sampling Inspection, which included the collection and analysis of soil and surface water samples from the Peter Cooper Markhams Site (Reference 6), herein referred to as the 1993 SSI. Chromium and arsenic were detected in soils above background concentrations on and within the waste piles.

In March 1999, USEPA Region II prepared a Hazard Ranking System Model score for the Site and then listed the Peter Cooper Markhams Site on the National Priority List (NPL) in February 2000. On September 29, 2000, USEPA issued a Unilateral Administrative Order (UAO) to several potentially responsible parties (PRPs) directing completion of an updated RI/FS for the Site.

The RI/FS Work Plan (Reference 7) was prepared for the USEPA by Geomatrix Consultants and Benchmark Environmental Engineering & Science, PLLC (Benchmark) on behalf the responding PRPs (the "Respondents") for the Peter Cooper Markhams Site, in accordance with the requirements of Paragraph 23 and Appendix 1 of Administrative Order CERCLA-02-2000-2003 and Respondents Notices of Intent to Comply (February 2001). The revised final Work Plan was submitted to the USEPA in September 2001.

Geomatrix and Benchmark performed Remedial Investigation field activities on several occasions at the Peter Cooper Markhams Site during the period of November 2000 to December 2003. The RI Report (Reference 8), herein referred to as the 2005 RI, was submitted to the USEPA in February 2005.

1.4 Current Conditions

In general, topography and conditions at the Site remain similar to those described in the 2005 RI report. A dense mat of grassy vegetation, low-lying brush, and briar thickets cover the majority of the fill piles and immediate surrounding areas. No seeps or significant erosional features are apparent on the fill piles; however, there were small areas where vegetation or other cover were sparse or absent. Non-contiguous wetland-like areas exist on the subject property west, north, and east of the fill piles. As shown on Appendix B, each of the larger wetland-like areas was assigned an alphabetic designation (Wetland A through G). Standing water is present seasonally (generally from December through April) in all of the wetland areas. Wetland B, located north of the fill piles, retains standing surface water longer than the other wetland areas on the Site. Wetland F, the largest wetland area on-site, contains both wetland vegetation and large trees with high water demand (cottonwoods and poplars). No structures are present on the property, with the exception of a natural gas wellhead located east of the access drive. The access drive is relatively clear from Bentley Road to the fill area and along the northern perimeter of the fill piles, but has re-vegetated around the southern and eastern fill area perimeter - to the point where it is no longer distinguishable.

The rail spur, disconnected from the main Erie-Lackawanna Railroad track, was located during 2005 remedial investigation field activities. The rail spur is camouflaged by heavy vegetative growth, is partially covered with soil, and terminates below grade on the western end of the Site. The switchgear was not observed on the adjacent active rail line, indicating that the siding was disconnected from the main rail following Site closure.

Surrounding demographics are rural and sparsely populated as indicated by both direct observations during site reconnaissance activities and information provided by the Town of Dayton. The Hamlet of Markhams is generally characterized by large-acreage fields and pasture-lands and includes forested property. Agricultural fields (primarily livestock feed) surround the Site. Land use near the Site is consistent with the "agricultural/forestry" zoning designation for surrounding lands. The Site is zoned "Industrial."

1.5 Nature and Extent of Contamination

A summary of findings from the 2005 RI for each of the site media is presented below. Where applicable, findings from the 1989 RI are also discussed for comparative purposes. Appendix A contains tables of historic analytical data and a figure showing historic sample locations. Appendix B contains figures showing RI sample locations and analytical summary tables from the RI report.

1.5.1 Waste Fill

During the 2005 RI, waste fill samples were collected from three borings (i.e., borings B-4, B-5 and B-6 - see Figure 3-1 in Appendix B for locations). The three samples were analyzed for total metal constituents of potential concern (COPCs), identified in the RI Work Plan (Reference 7) as arsenic, chromium, and hexavalent chromium, as well as leachable metal COPCs via USEPA's Synthetic Precipitation Leaching Procedure SPLP. The metal COPCs detected in the waste fill were arsenic (65.6 mg/kg, max. in B-6), chromium (31,200 mg/kg, max. in B-4), and hexavalent chromium (4.7 mg/kg, max. in B-4). Analysis of leachable metal COPCs detected the following maximum concentrations: arsenic (14.2 μg/L), chromium (1,010 μg/L), and hexavalent chromium (22.0 μg/L).

During the 1989 OBG RI, three fill samples were collected for analysis of total chromium, arsenic, and zinc, as well as leachable forms of these metals (via EP-toxicity testing). One composite sample was also collected for analysis of Hazardous Substance List (HSL) organics and TAL metals. The ranges of concentrations of the constituents detected historically are comparable to those detected during the 2005 RI.

1.5.2 Surface Soil/Fill

Top of Fill Piles – Nine surface soil samples were collected from the cover of the fill piles and analyzed for metal COPCs (see Appendix B, Figure 3-1). Arsenic concentrations in two of the nine soil samples and chromium concentrations detected in all cover surface soil samples were above all comparative criteria[1]. Hexavalent chromium concentrations were not detected above Region 9 PRGs. The highest concentrations detected in the cover soils were arsenic (95.5 mg/kg, Lathe #120), chromium (65,300 mg/kg, Lathe #121), and hexavalent chromium (51.8 mg/kg, Lathe #115).

Perimeter area surface soil sample results from previous investigations (i.e., 1981, 1989 OBG RI, 1993 SSI) indicate metal COPC concentrations generally similar to those detected in the 2005 RI (arsenic – 84 mg/kg max., total chromium – 69,300 mg/kg max., and zinc – 1,300 mg/kg max., with the exception of hexavalent chromium (854 mg/kg max.). SVOCs and a few pesticide/PCB parameters were detected in surface soil samples collected by MPI in 1993 primarily at or adjacent to the fill piles. Of those, only two samples detected organic compounds at concentrations above 1 mg/kg.

Perimeter of Fill Piles – A total of 48 discrete surface soil samples were collected adjacent to and downgradient from the waste fill piles (see Appendix B, Figure 3-2) and analyzed for metal COPCs. The metal COPCs detected in perimeter surface soil samples were arsenic (55.1 mg/kg, max. in Lathe #127), chromium (11,800 mg/kg, max. in Lathe #127), and hexavalent chromium (33.0 mg/kg, max. in Lathe #128). All of the 48 samples analyzed for arsenic (as well as background samples) detected concentrations above the PRG soil criteria of 1.6 mg/kg. Of these samples, 42 were within Site background (ND-8.1 mg/kg) or the Eastern USA background range (3-12 mg/kg). Four samples were above the background range for arsenic but below the SSL criteria of 29 mg/kg. Concentrations detected in two samples were above all comparative soil criteria for arsenic (background, SSL, and PRG) at concentrations of 55.1 and 35.6 mg/kg. A total of 10 sample locations (out of 48) analyzed for chromium were detected above all comparative soil criteria. An additional five samples were detected above background and SSL criteria (38 mg/kg), but

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[1] Soil criteria is from NYSDEC Division of Environmental Remediation, Technical and Administrative Guidance Memorandum #4046 for Eastern USA Background Heavy Metals Concentration in Soils (January 1994), USEPA Region 9 Preliminary Remediation Goals (PRGs) for Industrial Soil (October 2004), and USEPA Soil Screening Guidance, Generic Soil Screening Levels (SSLs) for Migration to Groundwater (July 1996).

below the PRG soil criteria (450 mg/kg). Hexavalent chromium concentrations were not detected above the PRG criteria (64 mg/kg) or the SSL criteria (38 mg/kg).

Ten of the samples were also analyzed for TCL VOCs and TCL SVOCs. No VOCs were detected above soil criteria. Five perimeter soil samples detected low concentrations of SVOCs: benzo(a)anthracene (27 μg/kg max.), benzo(b)fluoranthene (82 μg/kg max.), benzo(k)fluoranthene (41 μg/kg max.), benzo(a)pyrene (71 μg/kg max.), and indeno(1,2,3-cd)pyrene (40 μg/kg max.). As a group of chemicals, the SVOCs detected are known as polynuclear aromatic hydrocarbons (PAHs). PAHs are most frequently associated with deposition of emission by-products from petroleum fuel combustion.

Perimeter area surface soil sample results from previous investigations (i.e., 1985 Phase II, 1989 OBG RI, 1993 SSI) indicate metal COPC concentrations of the same order of magnitude as those detected in the 2005 RI with the exception of hexavalent chromium: arsenic (21 mg/kg max.), chromium (25,400 mg/kg max.), and hexavalent chromium (612 mg/kg max.).

1.5.3 Subsurface Soil/Fill

Perimeter of Fill Piles – Perimeter area subsurface soil samples were collected at 29 sample locations from depths of 6 to 12 inches below ground surface (bgs) and analyzed for metal COPCs (see Appendix B, Figure 3-2). The metal COPCs detected in the subsurface samples were arsenic (28.9 mg/kg, max. in Lathe #128) and chromium (19,700 J mg/kg, max. in Lathe #106). None of the arsenic concentrations detected in the soil were above all soil criteria. Of the 29 samples, concentrations of 23 samples were detected within background levels. Arsenic concentrations detected in 6 of the 29 samples were above the background range but below the SSL criteria. Analysis of 9 of the 29 samples detected chromium concentrations above all soil criteria. Concentrations of an additional five samples were detected above the background range and SSLs for chromium. Hexavalent chromium was not detected in any of the perimeter subsurface soil samples.

Samples collected from similar locations and depths (9 to 12 inches bgs) during the 1989 OGB RI were analyzed for arsenic, chromium and hexavalent chromium. The concentrations detected were arsenic (20 mg/kg max.), chromium (10,050 mg/kg max.), and hexavalent chromium (59 mg/kg max.). Results from the 2005 RI for arsenic and chromium are of the same order of magnitude as the 1989 OBG RI data. The detected hexavalent chromium concentrations were below the PRG criteria of 64 mg/kg.

Monitoring Well and Soil Borings – Native soil samples (non-waste fill) were collected below waste fill from four soil borings (B-1A, B-4, B-5, and B-6) at three depth discrete intervals: (1) immediately below the below the waste fill/native soil interface, (2) the subsequent one foot incremental depth, and (3) immediately above the water table. See Appendix B, Figure 3-1 for soil boring locations. A subsurface soil sample was also collected from the unsaturated zone (1 foot above the water table) at monitoring well location MW-8S (see Appendix B, Figure 3-3). The native soil samples were analyzed for metal COPCs.

Arsenic concentrations were detected within or near the range of values considered representative of background. Chromium concentrations were detected above all soil criteria at two boring locations: B-4 (16 to 17 feet below ground surface {depth interval of 1 to 2 feet below the waste fill}) and B-6 (7.5 to 8.5 feet below ground surface {depth interval of 1 to 2 feet below the waste fill}). The chromium concentration at these locations was 1,150 mg/kg (B-4) and 5,860 mg/kg (B-6). Chromium concentrations below these sample depths were within background levels. Hexavalent chromium was not detected in any of the samples analyzed. These data indicate that metal COPCs have not migrated substantially in native soil below the bottom of the waste fill piles.

Similar native subsurface soil samples were not collected during the 1989 OBG RI or the 1993 SSL. Analytical data presented in the 1985 RECRA Phase II indicated samples were collected from depths of ranging from 6 to 18 feet at eight sample locations and analyzed for arsenic and chromium. The concentrations detected were arsenic (11.7 mg/kg max.) and chromium (1,290 mg/kg max.), further supporting the conclusion that migration into native soil has not been significant.

1.5.4 Soil Vapor

Two field-measured soil vapor samples were analyzed using a calibrated multi-gas meter at gas probe GPZ-1 (see Appendix B, Figure 3-1); one during the initial monitoring event of the RI (November 5, 2001) and the other during the second monitoring event (April 22, 2002). The soil vapor monitoring data are summarized as follows:

- The lower explosive limit (percent of methane in air) exceeded the range of the instrument (0 to 5% methane) in all samples, indicating high methane amounts.

- Hydrogen sulfide was detected at low levels (1 to 4 ppm) during the first monitoring event, and ranged from 195 to 305 ppm during the second monitoring event. Hydrogen sulfide has a "rotten egg" odor with a very low concentration threshold.

- Oxygen content was detected near 0% (0.4 to 0.9 %) during the first monitoring event, indicating an anoxic or anaerobic subsurface condition, and ranged from 6.1 to 9.8 % during the second monitoring event.

- Carbon monoxide was detected at low levels (3 to 6 ppm) during the first monitoring event and ranged from 103 to 185 ppm during the second monitoring event.

- No vapors were detected in ambient air on or near the waste fill piles, indicating the elevated hydrogen sulfide and methane detected in the gas probe are not being emitted in significant quantities and/or they are being dispersed in ambient air.

1.5.5 Shallow Overburden Groundwater

Shallow overburden groundwater samples were collected from nine monitoring wells at the Site during two rounds of sampling (see Appendix B, Figure 3-3). To allow for seasonal variations in groundwater quality, the first sampling event occurred during low water table conditions (November 2001) and the second sampling event occurred during high water table conditions (April 2002).

The results indicate that VOCs detected above NYS Division of Water Technical and Operational Series Ambient Water Quality Standards and Guidance Values (groundwater criteria) in downgradient monitoring wells MW-2S and MW-8S were benzene (1.8 μg/L max.) and trichloroethene (4.2 μg/L max.). The SVOCs detected above groundwater criteria in monitoring wells MW-6S and MW-8S were benzo(b)fluoranthene (0.6 μg/L max.) and bis(2-ethylhexyl)phthalate (5 μg/L max.). In addition, phenol was detected in MW-2S at a concentration of 2 μg/L. During the 1989 OBG RI, organic compounds were not detected above groundwater criteria in samples from monitoring wells MW-1S, MW-3S and MW-6S.

The TAL metals detected above groundwater criteria in several samples were iron (11,100 μg/L, max. in MW-15), magnesium (96,400 μg/L, max. in MW-6S), manganese (15,000 μg/L, max. in MW-1S), and sodium (27,800 μg/L, max. in MW-7S). Arsenic and chromium were detected in MW-2S at estimated concentrations of 133 and 981 μg/L, respectively, during the first round of sampling. Hexavalent chromium was not detected in any of the groundwater samples. The metals analytical results for MW-2S vary significantly between the November 2001 and April 2002 sampling events. Considering the age and construction of MW-2S, and the extremely high and variable concentrations of iron and other metals in the RI samples, the 2005 RI report concludes that water samples from this well are no longer representative of groundwater quality in the surrounding formation. Section 1.5.5.1 presents further discussion of the analytical results obtained from MW-2S.

Analysis of groundwater samples collected from six shallow monitoring wells (MW-1S through MW-6S) during the 1989 OBG RI detected arsenic (80 μg/L max.) and chromium (230 μg/L max.) above groundwater criteria in several wells. Unlike the 1989 OBG RI, arsenic and chromium were only detected above groundwater criteria in one monitoring well (MW-2S) during the 2005 RI.

The geochemical parameters resulting in concentrations above groundwater criteria in monitoring well samples included ammonia (2.0 to 2.9 mg/L), nitrate (12.4 to 50.9 mg/L), and sulfate (309 to 1,060 mg/L). Sulfate was analyzed for in one shallow groundwater sample from monitoring well MW-1S during the 1989 OBG RI. The sample result (840 mg/L) was similar to results obtained during the 2005 RI. Geochemical parameters are used to evaluate chemical fate and compare upgradient water quality parameters to constituents detected in downgradient groundwater. Ammonia was not detected in the upgradient shallow monitoring well. Bicarbonate is the form of alkalinity detected in groundwater with concentrations of 143 to 446 mg/L in downgradient wells and 131 mg/L in the upgradient well. Nitrate was detected at concentrations of <0.5 to 50.9 mg/L in downgradient wells and 9.3 mg/L upgradient of the Site. Nitrate is a common component of agricultural fertilizers. Sulfate was detected at concentrations of 25.6 to 1,060 mg/L in downgradient wells and 40 mg/L in upgradient groundwater; sulfide was not detected. Oxygen reduction potential (ORP) readings ranged from 1.8 to 252 mV, and DO concentrations ranged from 0.04 to 8.41 mg/L. The absence of sulfide, the lack of negative ORP readings, and the presence of DO indicate subsurface redox conditions are not anaerobic. TDS ranged from 185 to 2,100 mg/L in downgradient wells and was 232 mg/L in the upgradient well. The TOC concentration in downgradient wells ranged from 1.0 to 15.7 mg/L, and was 1.2 mg/L in the upgradient well. Ferrous iron concentrations measured in the field ranged from non-detection to 8.1 mg/L.

1.5.5.1 Discussion of MW-2S Metals Data

The 2005 RI report concludes that water samples from MW-2S are not representative of groundwater quality in the surrounding formation. This conclusion is based on several pieces of data and evidence collection during the RI. Specifically, the metals analytical results for MW-2S vary significantly between the November 2001 and April 2002 sampling events, with metals detected at concentrations far higher than historically measured in this well. A comparison of metal analytical results for samples collected previously from the well in 1987 and 1988 by OBG and analyzed for arsenic, chromium, hexavalent chromium, and zinc indicated concentrations of these constituents were either not detected or detected at significantly lower concentrations than those detected during the 2005 RI. The sample turbidity in MW-2S was measured by the laboratory at 262 NTUs. Similar to the November 2001 sampling event, the elevated turbidity value indicates a high degree of suspended solids, which imparts a high bias for metals analytical results.

The difficulty in obtaining representative samples from MW-2S may be related to its age and construction materials. The well was installed more than twenty years ago during the 1984 RECRA Environmental Investigation. It is constructed with a carbon-steel riser having a wire wrap well screen. Only one other well (MW-4S) used in the RI has this construction (the newer wells are constructed of PVC) and it was not sampled for most of the metals because it was dry during the first RI sampling event. Considering the age and construction of MW-2S and the extremely high and extremely variable concentrations of iron and other metals in the RI samples, the 2005 RI report concludes that water samples from this well are no longer representative of groundwater quality in the surrounding formation.

Comparison of MW-2S results with those from MW-2D provides further evidence that MW-2S no longer yields representative samples. MW-2D is co-located with MW-2S and monitors an interval approximately 10 feet beneath that monitored by MW-2S. However, it has the newer well construction consisting of PVC well screen and riser. There is no confining layer that would provide a barrier to groundwater flow between the intervals monitored by the two wells. Metals concentrations, and in particular naturally occurring metals concentrations, would be expected to be similar in samples collected from the two wells (as is generally seen in other paired wells across the Site). However, metals concentrations were not elevated in MW-2D and were in fact orders of magnitude lower in comparison to MW-2S. Such a large concentration gradient over 10 feet in granular soil is unlikely.

The groundwater monitored by wells MW-2S and MW-2D is considered the same hydrostratigraphic unit; therefore, groundwater quality in this area of the Site is best represented by data collected from well MW-2D. As discussed below, detections of chemicals in well MW-2D are all below applicable groundwater screening criteria.

Based on the above assessment, it is recommended that MW-2S be properly abandoned (e.g., casing pulled and tremie-grouted) in conjunction with final remedial measures at the site.

1.5.6 Deeper Overburden Groundwater

Deep overburden groundwater samples were collected from nine monitoring wells at the Site during two rounds of sampling (see Appendix B, Figure 3-3). As discussed in Section 1.5.5, the sampling events occurred in November 2001 and April 2002.

One SVOC, bis(2-ethylhexyl)phthalate {BEHP} (19 µg/L), was detected above groundwater criteria [TOGS (5.0 µg/L) and PRG (4.8 µg/L)] in upgradient monitoring well MW-9D during the first sampling event. However, BEHP compound presence may be an artifact of using sampling equipment containing plastic. SVOCs in deep groundwater samples were not analyzed during the second sampling event. During the 1989 OBG RI, organic compounds were not detected in samples collected from two deep wells sampled (MW-3D2 and MW-6D).

The total metals detected during the first sampling event above groundwater criteria in a number of wells were iron (15,500 µg/L max., MW-1D), magnesium (125,000 µg/L max., MW-6D), manganese (2,330 µg/L max., MW-6D), and sodium (22,300 µg/L max., MW-1D). The concentration of hexavalent chromium (321 µg/L) detected in one Round 1 groundwater sample (MW-5D) exceeds TOG and PRG groundwater criteria; however, the result was flagged as estimated by the laboratory and the detected presence was not confirmed during the second sampling event nor was it detected in shallow groundwater. Only total metal COPCs (arsenic, chromium, and hexavalent chromium) were analyzed during the second sampling event and were not detected above groundwater criteria in any of the deep monitoring wells.

Due to elevated sample turbidity, a filtered metals sample was collected from deep monitoring well MW-2D during the first sampling event, which resulted in detections above groundwater criteria for soluble iron (351 µg/L) and selenium (10.6 µg/L). The detection of selenium is suspect since it was not detected in the unfiltered sample. The detection of iron in the filtered sample at a concentration about an order of magnitude lower than the unfiltered sample indicates suspended particulate matter affected the iron concentration in the unfiltered sample. Total and soluble metal COPCs were not detected in the sample collected from MW-2D.

The geochemical parameters resulting in concentrations above groundwater criteria in deep monitoring well samples included ammonia (ND to 150 mg/L) and sulfate (8.5 to 1,040 mg/L). The highest concentrations of these constituents were detected directly downgradient of waste fill piles at MW-1D and MW-6D. Nitrate was not detected in samples collected from the deep overburden wells.

Geochemical parameters are used to evaluate chemical fate and compare upgradient water quality parameters to constituents detected in downgradient groundwater. Bicarbonate is the form of alkalinity detected in groundwater with concentrations of 135 to 608 mg/L in downgradient wells and 108 mg/L in the upgradient well. Sulfate was detected at concentrations of 8.5 to 1,040 mg/L in downgradient wells and 40 mg/L in upgradient groundwater; similar to sulfate levels in the shallow zone. Nitrate and sulfide were not detected. TDS ranged from 133 to 1,770 mg/L in downgradient wells; concentrations were below 225 mg/L in all other wells. TOC concentrations ranged from 4.1 to 17.8 mg/L. Dissolved oxygen (DO) concentrations ranged from 0.03 to 1.2 mg/L. Oxygen reduction potential (ORP) readings ranged from 32 to 399 mV, with no negative readings. These data suggest weak aerobic conditions are present in deeper groundwater. Ferrous iron concentrations measured in the field ranged from non-detection to 7 mg/L.

1.5.7 Surface Water

Surface water samples were collected from wetland areas at the Site (see Appendix B, Figure 3-3) and analyzed for metal COPCs and geochemical parameters. Arsenic and total chromium were not detected in the surface water samples. Hexavalent chromium was detected at 13.0 µg/L in SW-2 during the December 2001 sampling event; however, the result was flagged as estimated by the laboratory and the detected presence was not confirmed during the April 2002 sampling event nor was total chromium detected in the sample above the reporting limit of 10 µg/L.

Sulfate levels (337 mg/L max.) in surface water samples collected from Wetland F were higher than other surface water sample locations. The sulfate concentration in sample SW-1 was above surface water criteria during the December 2001 sampling event but below the criteria during the April 2002 event. Surface water in Wetland F receives groundwater discharge with elevated sulfate concentrations. Sulfate was detected in Wetlands B and D at a maximum concentration of 34.5 mg/L and 27.8 mg/L. Sulfide was not detected in any of the surface water samples. Ammonia was detected during the April 2002 sampling event in sample SW-2 at a concentration of 0.11 mg/L but was not detected at that location during the December 2001 event or at other surface water sample locations. Other geochemical parameters detected in surface water include nitrate (<0.5 to 5.6 mg/L), TDS (111 to 603 mg/L), and TOC (17.8 to 33.0 mg/L). Dissolved oxygen concentrations ranged from 7.03 to 11.8 mg/L during the December 2001 sampling event and 0.66 to 1.09 mg/L during the April 2002 sampling event.

1.5.8 Wetland Sediment

Background wetland sediment samples and sediment samples near the waste fill piles were collected from locations shown on Figure 3-4 in Appendix B. Background wetland sediment samples were collected at nine sample locations during the first sampling event on October 15, 2001, and analyzed for arsenic (10.3 mg/kg max., Lathe #81A) and chromium (23.1 mg/kg max., Lathe #82). Five of the nine background sediment samples analyzed for arsenic were within the range of the Low Effect Level (LEL) and Severe Effect Level (SEL) sediment quality guideline values presented in NYSDEC Division of Fish, Wildlife, and Marine Resources Technical Guidance for Screening Contaminated Sediments. All chromium concentrations were below the LEL. A sediment sample considered representative of wetland sediment background (Sample 17) was collected during the 1989 OBG RI. The metal COPCs detected were arsenic (25 mg/kg) and chromium (31mg/kg).

Fourteen sediment samples were collected from wetland areas near and downgradient from the waste fill piles during the initial sampling event on October 15, 2001, and analyzed for metal COPCs. The metal COPCs detected in wetland sediments were arsenic (11.4 mg/kg max., Lathe #94A), chromium (215 J mg/kg max., Lathe #89), and hexavalent chromium (18.3 mg/kg max., Lathe #89). Chromium concentrations in 2 of the 14 wetland sediment samples were above background and sediment criteria. Arsenic concentrations were below background and sediment criteria. Hexavalent chromium was detected in two of the sediment samples. A sediment quality criterion is not available for hexavalent chromium.

Wetland F is the receptor of groundwater discharge from the Site. Metal COPCs detected in samples collected from this wetland were not elevated compared to Site background.

1.6 Contaminant Fate and Transport

The RI report incorporated the results of the chemical analyses with the characterization of the physical setting of the Site to evaluate the fate and transport of chemical constituents in Site media. The mechanisms by which chemicals could migrate to other areas or media are airborne pathways (fugitive dust generation, volatilization) and waterborne pathways (surface water runoff, leaching, and groundwater transport). Complete exposure pathways are discussed in the Pathways Analysis Report (Reference 9) and Risk Assessment Reports (References 10 and 11). Based on the analysis of chemical fate and transport provided in the RI report, pathways through which Site COPCs could reach receptors off-site at significant exposure point concentrations include:

- Fugitive Dust Emissions from Site soils (i.e., transport of soil particles and sorbed chemical constituents in fugitive dust emissions). This pathway is generally restricted to those limited areas of the Site where vegetation or other cover are not present.
- Volatilization from Site groundwater.

These exposure pathways, along with direct on-site contact scenarios for visitors, trespassers, and future workers were evaluated in the Risk Assessment as summarized below.

1.7 Summary of Risk Assessment Findings

1.7.1 Baseline Human Health Risk Assessment

Remedial investigation data were used to prepare a baseline human health risk assessment (HHRA) for the Site. The HHRA evaluated the potential human health risks due to potential exposure to chemicals in waste fill, soil, groundwater, surface water, wetland sediment, and soil vapor at the Peter Cooper Markhams Site under both current and foreseeable future land uses. The HHRA, prepared by Geomatrix, was submitted in draft to the USEPA in February 2005, revised and submitted as final in June 2006 (Reference 10). The HHRA primarily used a Reasonable Maximum Exposure (RME) approach for all receptors. The RME is defined by USEPA as the highest exposure that could reasonably be expected to occur for a given exposure pathway at a site. Potential adverse non-carcinogenic health affects were evaluated using the hazard index (HI). A HI of less than or equal to 1 indicates acceptable levels of exposure for chemicals having an additive effect. Carcinogenic health risks are defined in terms of the incremental increased probability of an individual developing cancer as the result of exposure to a given chemical at a given concentration. Acceptable exposure levels are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between 1×10^{-4} and 1×10^{-6} using information on the relationship between dose and response. It should be noted that HIs greater than 1 and cancer risks in the 1 x 10^{-4} and 1 x 10^{-6} range do not necessarily mean that adverse health effects will be observed.

The results of the HHRA indicate risks below or within acceptable levels for all complete and potentially complete exposure pathways, with the following exceptions:

- Future Outdoor Industrial Worker: The total RME HI is 230. Groundwater ingestion contributes to nearly all of this HI; 50% is due to ingestion of thallium and 40% is due to ingestion of iron, with questionable results from monitoring well MW-2S contributing substantially to the RME (refer to Section 1.5.5.1). If results from MW-2S are not considered representative of Site groundwater, the HI is 8.0 (primarily due to iron, manganese and hex chrome ingestion). Although the HI still exceeds the acceptable risk level, it is approximately 30 times lower than the original RME estimate. If groundwater is not evaluated as a drinking water source, the total RME HI is 0.17, which is below the acceptable risk level.

  The total theoretical lifetime excess cancer risk is 3 x 10^{-4}, which is above the acceptable risk range. Almost 70 percent of the total RME risk is attributed to ingestion of arsenic in groundwater. If groundwater is not evaluated as a drinking water source, the theoretical lifetime excess cancer risk associated with exposure to soil is 1 x 10^{-5}, which is within the acceptable risk range. If the results from MW-2S are not considered representative of Site groundwater conditions, the total excess cancer risk is 7 x 10^{-5}, which is within the acceptable risk range.

- Future Construction Worker: The total RME HI is 5.2. Approximately 66 percent of the HI is from the dermal contact with thallium and cadmium in groundwater. Potential exposures likely are overestimated. Exposure for the construction worker was related to specific conditions during potential construction over a continuous one-year period. Appropriate health and safety precautions can be taken to protect workers during future construction, thereby mitigating any potential exposures and health risk. If exposure to groundwater is prevented based on dewatering activities, the HI associated with exposure to soil and sediment is below the acceptable risk level at 0.4. If the results from MW-2S are not considered representative of Site groundwater conditions, the HI for the construction worker is at the acceptable risk level of 1.0.

  The total theoretical lifetime excess cancer risk is 3 x 10^{-6}, which is within the acceptable risk range.

In summary, under the assumptions and conditions presented in the HHRA, the estimated HI and theoretical excess cancer risk are generally below or within the acceptable levels of concern. In those limited instances where the estimated HI and/or theoretical excess cancer risk are outside acceptable levels, the exceedance is attributable to the hypothetical assumption that future groundwater consumption is a complete pathway. Although groundwater in the State of New York is classified as "GA," potential potable water supply, groundwater at the Site is not presently used as a potable water supply and is not likely to be used as such in the future. The constituents of concern (COCs) for groundwater are hexavalent chromium, manganese, and iron. The COPCs identified in the RI Work Plan for the waste fill were not identified as significant contributors to unacceptable human health risk.

1.7.2 Screening Level Ecological Risk Assessment

A Screening-Level Ecological Risk Assessment (SLERA) was prepared to assess the potential ecological risks associated with chemicals detected at and adjacent to the Peter Cooper Markhams Superfund Site. The SLERA was prepared pursuant to the USEPA-approved Remedial Investigation/Feasibility Study (RI/FS) Work Plan prepared by Geomatrix and Benchmark (Reference 7). The objective of the SLERA was to fulfill Steps 1 and 2 outlined in the *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (ERAGS, USEPA, 1997b). The draft SLERA, prepared by Environmental Risk Group (EnRG), was submitted to the USEPA in June 2005. The SLERA was prepared as a two-step process, with Step I modeling risks to ecological receptors under maximal (worst case) exposure scenarios, and Step II employing a more realistic food chain model that considered: average concentrations of the constituents of concern; bioavailability of chromium; and, in the case of the modeled omnivorous mammal (raccoon), a distributed diet and typical home range. SLERA findings are summarized below.

1.7.2.1 Terrestrial (Soil/Waste Fill)

Ecological Risk to Terrestrial Plants

The maximum exposure scenario suggests a potential ecological risk due to total chromium; while risk due to hexavalent chromium and arsenic approach the screening threshold. If the analysis is based on average concentrations instead of maximal concentrations, the estimated ecological risk to plants decreases about 9 times. If only bioaccessible (total) chromium is considered, then there is no risk.

Ecological Risk to Terrestrial Invertebrates

The maximal exposure scenario indicates potential ecological risk due to arsenic, total chromium, and hexavalent chromium. If the analysis is based on average concentrations instead of maximal concentrations, the estimated ecological risk to soil invertebrates decreases about 9 times. If only bioaccessible (total) chromium is considered, then there is no risk.

Ecological Risk to Small Mammals

Herbivorous Small Mammal (Deer Mouse): The maximal calculations indicated a limited potential risk due to chromium. The suggested ecological risk for total chromium was driven by soil ingestion. If only average or bioaccessible chromium levels are considered, no risk is indicated.

Insectivorous Small Mammal (Short-tailed Shrew): The maximal calculations indicated a limited potential risk due to total chromium and arsenic. The suggested ecological risk for total chromium was driven by soil ingestion, and the risk due to arsenic was driven by diet; thus, if one considers average concentrations or bioaccessible chromium levels, then no risk is indicated.

Ecological Risk to Omnivorous Mammal (Raccoon)

The maximal screening-level risk calculations indicated a limited potential ecological risk for arsenic with more risk due to total chromium. These risks, for maximal exposure to maximal concentrations, are driven by the dietary pathway. A re-analysis of raccoon exposure using a more normal diet; maximal concentrations of arsenic, benzaldehyde, and hexavalent chromium; and bioaccessible trivalent chromium resulted in no ecological risk. Consideration of median intake and body weight reinforced this conclusion.

Ecological Risk to Birds

Avian Omnivore (American Robin) & Avian Insectivore (Marsh Wren): Maximal screening-level risk calculations indicated potential ecological risk due to arsenic, hexavalent chromium, and total chromium, and primarily via soil ingestion. Dietary arsenic contributed the other significant portion of the risk. A re-analyzing exposure with average and/or bioaccessible concentrations results in a substantial decrease in risk. Consideration of median intake and body weight reinforces this conclusion.

1.7.2.2 Wetland Area

Ecological Risk to Wetland Plants

There was no significant risk indicated for any COPC.

Ecological Risk to Wetland Invertebrates (Macrobenthic Organisms)

Limited potential ecological risk was indicated for maximal arsenic and total chromium, with no risk for hexavalent chromium. There was no significant risk indicated for any COPC at average concentrations, or considering bioaccessible/bioavailable levels of total chromium.

Ecological Risk to Herptiles

<u>Aquatic Herbivore (Painted Turtle) & Aquatic Insectivore (Green Frog)</u>: Potential ecological risk is indicated for maximal arsenic and total chromium, but not hexavalent chromium. The suggested risk due to total chromium is driven by soil ingestion. There was no significant risk indicated for any COPC at average concentrations, or considering bioaccessible/bioavailable levels of total chromium.

1.7.3 Summary

Modeling performed under Step II of the Screening-Level Ecological Risk Assessment suggests only minimal increased ecological hazard to avian omnivores and insectivores preying on invertebrates exposed to elevated COPC concentrations at the Markhams Site, with remaining ecological receptors at or within acceptable risk levels. The SLERA further indicates that the most significant risk, if real, is primarily due to direct soil/fill exposure. Considering the available data, the SLERA concluded that any ecological impact would be highly localized.

2.0 DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES AND GENERAL RESPONSE ACTIONS

The development of an appropriate remedial approach begins with definition of site-specific Remedial Action Objectives (RAOs) to address substantial human health and ecological risk or other significant environmental issues identified in the Remedial Investigation (RI). General Response Actions are then developed as potential means to achieve the RAOs.

2.1 Remedial Action Objectives

Remedial Action Objectives are site-specific statements that convey the goals for minimizing or eliminating substantial risks to public health and the environment as identified in the human health and ecological risk assessments, and from contaminant concentration and migration pathways identified in the RI. The RI identified contaminant migration pathways having potential to reach receptors at significant exposure point concentrations. These included site-specific locations on the Site where potential dust generation could be problematic (i.e., small areas where vegetation or cover soils are sparse or absent) and volatilization from Site groundwater. However, the human health risk assessment concluded that risks from these contaminant exposure pathways are within acceptable ranges. Rather, unacceptable human health risks were limited to site groundwater ingestion for the hypothetical future industrial worker, and dermal contact for the hypothetical future construction worker, with the latter of these only posing unacceptable risk if MW-2S is considered representative of site-wide groundwater conditions. As discussed in Section 1.5.5, MW-2S data is not believed to be representative of Site groundwater for several reasons. As such, Site groundwater ingestion by the hypothetical future industrial worker is the only potential exposure pathway yielding unacceptable risks. The screening-level ecological risk assessment concluded that unacceptable risks are likely highly localized, and are attributable primarily to direct soil/fill exposure.

Based on the results of the RI and risk assessments, the RAOs developed for the Peter Cooper Markhams Site are identified below:

- Mitigate excess risk due to groundwater ingestion at the Site.
- Prevent direct exposure to waste fill materials.
- Mitigate erosion and migration of waste materials from exposed surfaces.

2.2 Constituents of Concern

Constituents of concern (COCs) for media potentially requiring remediation are identified in Table 1 and further described below.

- ***Groundwater:*** As described in Section 1.7, potential unacceptable health risk to hypothetical future outdoor industrial workers exists if groundwater ingestion is a complete pathway. Per Table F-3 of the Human Health Risk Assessment (i.e., revised risk without MW-2S), constituents substantially contributing to the elevated risk include hexavalent chromium, manganese, and iron. To reduce industrial worker risk from groundwater ingestion to within acceptable levels, cleanup goals have been conservatively set to applicable water quality standards (i.e., the lower value of NYSDEC Class GA groundwater quality standards and guidance values or Federal Maximum Contaminant Levels {MCLs}). These values are considered protective of human health assuming groundwater use for potable purposes, including ingestion.

- ***Waste Fill:*** The constituents in the waste fill and soils were not identified as causing unacceptable human health risks due to pathways associated with these media. In addition, SPLP data do not indicate a potential for leaching of site-related metals at concentrations that could cause exceedance of groundwater cleanup goals. Based on this information and given that the Remedial Action Objectives for waste fill (i.e, prevent direct exposure to waste fill and mitigate erosion and migration of waste fill from exposed surfaces) are not chemical-specific, soil/fill cleanup goals are not required. For purposes of evaluating remedial technologies, constituents of potential concern (COPCs) as identified during the Remedial Investigation Work Plan are identified on Table 1.

2.3 General Response Actions

General Response Actions describe broad classes of actions that satisfy the RAOs. General Response Actions form the foundation for the identification and screening of remedial technologies and alternatives. General Response Actions for the affected media are presented in Table 2.

2.4 Identification of Applicable or Relevant and Appropriate Requirements

This section provides a summary of the regulations that are considered applicable or relevant and appropriate (ARARs) to remediation of the Site. Both Federal and State environmental and public health requirements are considered.

2.4.1 Definition of ARARs

The statutory requirements that are directly relevant to the remediation of the Peter Cooper Gowanda Site are identified and discussed using the framework and terminology of Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA). These acts specify that Superfund remedial actions must comply with the requirements and standards of both federal and state environmental laws.

The USEPA defines applicable requirements as "those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site." An applicable requirement must directly and fully address the situation at the Site.

The USEPA defines relevant and appropriate requirements as "those cleanup standards, standards of control, or other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site."

Actions must comply with state ARARs that are more stringent than federal ARARs. State ARARs are also used in the absence of a federal ARAR, or where a state ARAR is broader in scope than the federal ARAR. New York State does not contain ARARs in its Superfund statute. Equivalent screening criteria under New York State inactive hazardous waste disposal site remediation guidance are referred to as New York State Standards, Criteria and Guidance (NYS SCG) Concentrations, which include the more stringent federal ARARs. To avoid confusion, federal and state requirements are jointly referred to herein as ARARs.

ARARs are not currently available for every chemical, location, or action that may be encountered. When ARARs are not available, remediation goals may be based upon other federal or state criteria, advisories and guidance, or local ordinances. In the development of remedial action alternatives, the information derived from these sources is termed "To Be Considered," or TBCs.

Remedial actions performed under Superfund authority must comply with ARARs except in the following circumstances: (1) the remedial action is an interim measure or a portion of the total remedy that will attain the standard upon completion; (2) compliance with the requirement could result in greater risk to human health and the environment than alternative options; (3) compliance is technically impractical from an engineering perspective; (4) the remedial action will attain an equivalent standard of performance; (5) the requirement has been promulgated by the State, but has not been consistently applied in similar circumstances; or (6) the remedial action would disrupt fund balancing.

ARARs and TBCs are classified as chemical-, action-, or location-specific. Chemical-specific ARARs or TBCs are usually health- or risk-based concentrations in environmental media (e.g., air, soil, water), or methodologies that when applied to site-specific conditions, result in the establishment concentrations of a chemical that may be found in, or discharged to, the ambient environment. Location-specific ARARs or TBCs generally are restrictions imposed when remedial activities are performed in an environmentally sensitive area or special location. Some examples of special locations include floodplains, wetlands, historic places, and sensitive ecosystems or habitats. Action-specific ARARs or TBCs are restrictions placed on particular treatment or disposal technologies. Examples of action-specific ARARs are effluent discharge limits and hazardous waste manifest requirements.

2.4.2 Identification of ARARs and TBCs

The National Contingency Plan (NCP) (40 CFR 400.430 and 8666, March 8, 1990) and the SARA/CERCLA Compliance Policy guidance define applicable requirements as the federal and State requirements for hazardous substances that would be legally binding at the Site, if Site response were to be undertaken regardless of CERCLA Sections 104 or 106. Relevant and appropriate requirements are defined as those federal and State requirements that, while not directly applicable, apply to facilities or problems similar to those encountered at this Site. In other words, requirements may be relevant and appropriate if they would be applicable except for jurisdictional restrictions associated with the requirements. With respect to the selection of remedial alternatives, relevant and appropriate requirements are to be afforded the same weight and consideration as applicable requirements.

2.4.2.1 Chemical-Specific ARARs and TBCs

The determination of potential chemical-specific ARARs and TBC criteria for a site is based on the nature and extent of contamination; potential migration pathways and release mechanisms for site contaminants; the presence of human receptor populations; and the likelihood that exposure to site contaminants will occur. The 2001 RI investigation performed on the Site and subsequent risk assessments provide this information. RI sampling events included the collection and analysis of surface soil, surface water, sediment, groundwater, solid waste, and soil vapor samples. Table 3A presents a list of chemical-specific federal and State regulatory standards, requirements, criteria and limitations that may be applicable or relevant and appropriate to the Site based on this information. Advisory and guidance criteria (TBCs) are also identified.

2.4.2.2 Location-Specific ARARs and TBCs

The location of the Site is a fundamental determinant of its impact on human health and the environment. Location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they are in a specific location. Some examples of these unique locations include: floodplains, wetlands, historic places, and sensitive ecosystems or habitats. Table 3B presents the location-specific federal and State regulatory standards, requirements, criteria and limitations that may be applicable or relevant and appropriate to the Site.

2.4.2.3 Action-Specific ARARs and TBCs

Table 3C identifies action-specific ARARs and TBCs that may significantly impact the selection of remedial alternatives for the various media at the Peter Cooper Gowanda Site. This list of potential action-specific ARARs and TBCs is based on the Identification and Screening of Candidate Technologies Memorandum prepared by Benchmark during the Remedial Investigation (Reference 13).

2.5 Volume and Extent of Media Potentially Requiring Remediation

Estimation of the volume and extent of media that may require remediation to satisfy the RAOs or needs to be quantified to facilitate evaluation of remedial alternatives is presented in this section.

2.5.1 Waste Fill

An approximately 15- to 20-acre area within the central and southeast portions of the Site contains several covered/vegetated fill piles arranged in an elliptical pattern. For the purpose of this report, the terms "waste fill, mounded fill, and fill piles" refer to the elevated piles of material disposed at the Site. Several of the fill piles appear to consist primarily of re-worked native soil. Other fill piles consist of primarily cookhouse sludge, vacuum filter sludge, and residue pile material. Cookhouse sludge reportedly was derived from the animal glue manufacturing process, and is comprised of settled sludge resulting from the processing of animal hides, some of which were allegedly chrome-tanned. Vacuum filter sludge reportedly was produced during primary (settling) treatment of liquid wastes, including liquids generated during gravity dewatering of cookhouse sludge. Residue pile material is described as air-dried cookhouse sludge, which was stabilized to a fairly dry, granular form.

The fill piles vary in size and elevation, with base dimensions ranging from approximately 1,100 to 160,000 square feet and elevations of 5 to 15 feet above surrounding grade. The total area covered by fill piles (base area) is approximately 7 acres. It was reported that approximately 48,200 tons of residual materials were placed at the Markhams Site.

2.5.2 Groundwater

Groundwater chemicals of concern were detected in several of the on-site wells. Accordingly, it is not possible to identify a distinct area or areas of the Site where focused remediation could be performed to achieve groundwater cleanup goals. The groundwater flux discharging to Wetland F was calculated in Section 4.5.3 of the 2005 RI. The resulting range of calculated values (1,229 ft^3/day to 18,804 ft^3/day) represents the groundwater discharge volume (upward vertical discharge) to the 11-acre wetland area immediately downgradient from the fill piles. The volume of groundwater flowing laterally beneath the fill piles in the direction of Wetland F was estimated to be approximately 1,060 ft^3/day.

3.0 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

Candidate technologies are specific remedial processes, systems or methods that could potentially, alone or in combination with other technologies, comprise a General Response Action. Candidate technologies considered below include those conventional and innovative processes demonstrated to be potentially capable of mitigating potential human health or environmental impacts from the chemicals of concern in various site media and/or addressing the Remedial Action Objectives. The no action, institutional controls, and excavation/off-site disposal General Response Actions are not associated with specific technologies and, therefore, will be discussed in the context of the remedial alternatives development and screening portions of the FS.

3.1 Waste Fill

As presented in Table 2, waste fill General Response Actions include no action, institutional controls, containment/isolation, and excavation with ex-situ treatment and/or disposal. Soil/fill technology options associated with these General Response Actions are discussed in this section. The no action, institutional controls, and disposal alternatives will be discussed in the remedial alternatives development and screening sections of the FS.

3.1.1 Containment/Isolation

The objectives of containment are to limit the mobility of waste constituents and prevent inadvertent direct contact with waste materials. Several remedial technologies are available to implement this General Response Action.

3.1.1.1 Capping/Covering

Containment of waste fill may be accomplished through capping/covering technologies. Covering typically includes site clearing and possibly grading to facilitate drainage, followed by placement of one or more layers of "clean" material to prevent direct contact with contaminated soil/fill and to prevent erosion and off-site transport of contaminated soil particles. Covering also performs the additional function of reducing infiltration. Covering may potentially follow excavation and consolidation of soil/fill if contamination is spotty or spread across large areas. The capping/covering technologies considered potentially applicable to the Peter Cooper Markhams Site waste fill include enhancement of the existing soil cover; a low-permeability soil or soil-composite cap; and a geosynthetic cap.

> ***Soil Enhancement*** - Soil enhancement would involve the placement of additional soil cover over locations where insufficient cover and/or vegetation exists to prevent wind and surface water erosion, or where additional cover is necessary to provide an effective barrier against direct contact with impacted soil/fill materials. Similar to low permeability capping alternatives, the upper layer of soil under a soil enhancement alternative is typically comprised of a nominal 6-12 inches of topsoil, seeded to promote vegetative growth for erosion control.
>
> ***Low-Permeability Soil or Soil-Composite Cap*** - The initial step in the construction of a soil cap typically involves placing a layer of sand material or geocomposite drainage material for subsurface gas venting purposes. This layer is used to transmit the gases that may accumulate in the subsurface resulting from the decomposition of putrescible wastes or volatilization of organic contaminants in soil/fill. A series of individual gas vents screened in the waste may also be used. The barrier layer for this option is comprised of 12-24 inches of low permeability, recompacted soil. Quality control testing during construction is required to assure proper moisture and compaction during placement of the soil lifts. The barrier protection layer for this cover system is comprised of compacted soil to protect the barrier layer from root penetration, desiccation, and freezing. A final layer of topsoil would then be placed and seeded to maintain vegetative growth for erosion control and promote evapotranspiration.
>
> ***Geosynthetic Cap*** - A geosynthetic cap is similar in principal to a soil cap, however the barrier layer is either replaced by or supplemented with a synthetic membrane. Low-density polyethylene is usually the material of choice due to its flexibility when subjected to differential settlement. As a well-constructed synthetic membrane barrier allows penetration of almost no surface water, a synthetic or sand drainage layer may be constructed over the membrane to prevent saturation and potential side slope failure of the barrier protection layer. Strict quality assurance during construction is necessary to confirm watertight seams and prevent punctures and tears during construction
>
> Both the low-permeability soil and geosynthetic caps can be designed to meet 6NYCRR Part 360 requirements or equivalent.

3.1.2 Ex-Situ Treatment

Ex-situ treatment requires excavation of waste fill, followed by application of an appropriate treatment technology. A discussion of ex-situ treatment technology options potentially applicable to the waste fill is presented below.

3.1.2.1 Soil Washing and Chemical Extraction

Soil washing involves treatment of excavated soils or fill with a wash or extracting fluid. Ex-situ processes typically incorporate agitation to improve contact between soil/fill and the extracting fluid. Large objects and debris are screened from the excavated soil/fill, with remaining soil particles transported to the soil washer. The contaminated soil is vigorously mixed with the wash fluid. Water is a common soil washing fluid, but may include chemical additives such as acids, bases, chelants, or complexing agents for removal of heavy metals (chemical extraction). Treatment of wash fluids by enhanced clarification to remove fines and/or additional treatment to remove or stabilize solubilized contaminants may be required prior to discharge/disposal. Washed soil/fill may also require mechanical dewatering to remove excess water and wash fluids.

3.1.2.2 Solidification/Stabilization (S/S)

Solidification/stabilization (S/S) fixates inorganic compounds by introducing stabilizing agents and cement-based solidification agents into the waste fill. The stabilizing agents react with heavy metal cations. The solidifying agents bind and encapsulate the precipitated cations, substantially reducing the potential for leaching. Ex-situ S/S typically involves excavation and mixing of S/S reagents in a pug mill. The S/S product may be formed in a cubic mold or poured into the excavation to cure into a stable, monolithic solid matrix. A granular, compactable product can also be produced, depending on the reagents and curing process.

3.2 Groundwater

General Response Actions for Site groundwater include no action, institutional controls, containment/isolation, in-situ treatment, and collection with on-site treatment. Technology options associated with containment/isolation, and collection/treatment response actions are discussed below.

3.2.1 Containment/Isolation

3.2.1.1 Subsurface Lateral Barriers

Typical subsurface lateral barriers include slurry walls, compacted clay walls, synthetic barrier walls, grouting, and sheet piling. These technologies are often implemented in conjunction with a cover system and/or groundwater/leachate collection to reduce lateral contaminant migration. The barriers are keyed-in to a confining (i.e., low permeability) unit, if one exists, to prevent downward contaminant migration, and/or may be implemented in conjunction with groundwater pumping to reduce or reverse hydraulic gradients and associated migration potential.

> ***Slurry Wall*** **-** Slurry walls are low-permeability barriers constructed vertically through sub-surface soils. These walls create a subsurface barrier to separate impacted overburden groundwater on-site from un-impacted surrounding media. The slurry is typically soil-bentonite or soil-cement-bentonite. Slurry wall construction involves excavation of a vertical trench while simultaneously filling the excavation and mixing the slurry in it, thereby negating the need for shoring and dewatering. Soils are blended with a bentonite slurry to form the bentonite-slurry wall. In the case of a cement-bentonite wall, portland cement is added to increase the load bearing capacity of the completed trench wall. Quality assurance testing is performed during installation to confirm: the hydraulic conductivity of the placed slurry; proper keying in to the confining layer; and continuity of the slurry. Slurry walls are typically keyed-in to a confining unit to prevent groundwater flow beneath the wall.
>
> ***Compacted Clay Wall*** **-** Compacted clay walls are similar in function to slurry walls, but are constructed using compacted clay soil in an excavated trench. The clay is placed in shallow (i.e., 6-inch) lifts compacted to form a high density, low permeability wall. Dewatering and/or shoring of the trench during compaction are typically required. Quality assurance testing is performed during construction to confirm that required placement and compaction specifications are achieved. Typical construction requirements call for a hydraulic conductivity of less than 1×10^{-7} cm/sec. The clay wall is keyed-in to a confining unit to prevent groundwater flow beneath the wall.
>
> ***Geocomposite/Geosynthetic Barrier Wall*** **-** Geocomposite or geosynthetic barrier walls involve placement of low-permeability engineered materials in an excavated trench to prevent lateral migration of contaminated overburden groundwater. Geocomposite barrier walls such as Bentomat® use bentonite-impregnated filter fabric which, when hydrated, swells to form a low-conductivity layer. Geosynthetic barriers may also be comprised of 40 to 60 mil thick (i.e., 0.040 to 0.060 inches) high-

density polyethylene (HDPE) or low-density polyethylene (LDPE). The geocomposite or geosynthetic membrane is placed along the sidewall of a trench, and is and keyed into the surface soil at the top and a confining layer at the bottom. The remainder of the trench opening may be backfilled with soils. Geosynthetic barriers function identically to slurry walls and compacted clay walls. Similar to compacted clay walls, temporary shoring and/or dewatering of the trench is typically required during construction. The geocomposite or geomembrane must also be protected against tears and punctures with strict quality control to assure all seams are watertight.

Grouting - Grouting or grout curtains involve overlapping injection of one or more viscous fluids into a formation (e.g., cement, clay, bentonite, silicates, polymers etc.) to reduce permeability, thereby reducing groundwater flow. As grout curtains do not necessitate typical trench excavation, they may be used to control the movement of groundwater in bedrock formations or in deep overburden where trenching is generally impractical. Grout curtains are typically used in concert with groundwater collection methods. A grout curtain wall is constructed by pumping grout under high pressure into a series of drilled or direct-push boreholes. As grout is pumped into the borehole, it is forced out into the voids of the surrounding formation to create an interconnected zone of low permeability. Chemical compatibility testing is typically required to assure that the grout permeability will not be adversely affected by subsurface chemical contamination. This technology typically does not work well in fine-grained heterogeneous soils and fill.

Sheet Piling - Steel sheet piling can be used as an overburden groundwater barrier. Interlocking steel sheets are driven into unconsolidated material using a drop hammer or vibrating cathead. However, rocky or extremely dense soil may prevent advancement of the sheet pile or deflect the pile. Standard sheeting is not watertight. Some proprietary steel sheeting has provisions for injection of grout into the seams to reduce leakage. An alternative installation method involves trench excavation followed by placement of sheeting and backfill material. Sheet pile walls are typically keyed-in to a confining unit to prevent the downward groundwater migration underneath the wall. Sheet piling is not applicable as a bedrock groundwater barrier.

3.2.1.2 Capping

Capping or cover system technologies for groundwater remediation consist of placing soil (i.e., clay), geocomposite, and/or geosynthetic layers over impacted soil/fill to reduce infiltration of precipitation and associated contaminant leaching to groundwater. Cover system options considered potentially applicable for Site groundwater include the cover system technologies described in Section 3.1.1.1.

3.2.2 Collection and Treatment

3.2.2.1 Collection

Groundwater collection systems, including vertical pumping wells, horizontal wells, collection trenches and dual vacuum extraction, may be used to control lateral and vertical groundwater migration.

> ***Vertical Pumping Wells*** - Pumping well construction involves drilling a vertical borehole or a series of boreholes, installing a riser and well screen, and equipping the well(s) with a pump and level controls. Pumping wells typically extend through the permeable soil/fill into a confining unit or bedrock. Groundwater withdrawal from the well(s) would draw down the groundwater table in the vicinity of the wells, creating a cone of depression and establishing hydraulic gradient toward the well. The hydraulic influence of groundwater withdrawal controls contaminant migration. Collected groundwater would be treated and discharged. The yield of groundwater from vertical pumping wells in fine-grained overburden or bedrock can often be enhanced through hydraulic, pneumatic or blast fracturing.
>
> ***Horizontal Wells*** - Horizontal wells can be installed in saturated unconsolidated soil to collect groundwater, extract contaminated vapors, or sparge air to volatilize contaminants. Subsurface directional drilling controls navigate the cutting head of the drill to install 2- to 20-inch diameter well screens. The installation depth can vary from a minimum of 2 feet to over 100 feet. In soils, horizontal drilling may be considered a "trenchless technology." Drilling is initiated at a relatively low angle (10 to 20°) from horizontal before the borehole arcs to a horizontal position. Depending on the depth of the horizontal drain, the drilling rig may begin drilling several hundred feet away from the location where the horizontal portion of the well is to be located. Horizontal wells are more applicable to overburden groundwater collection and are generally not used for bedrock installations. They are sometimes employed around and under structures where vertical wells or trenches may not be feasible or effective.
>
> ***Collection Trenches*** - Collection trenches are commonly used to intercept shallow contaminated groundwater within or downgradient of an overburden contaminant plume. Trenches are typically installed using conventional excavation techniques or using innovative trenching machines that excavate and lay drainpipe and permeable backfill material in a single operation. Trenches are generally applicable to unconsolidated materials using conventional excavation techniques. Trenching machines are only effective in less dense soil with some degree of cohesiveness and may or may not require dewatering. The linear drawdown produced by pumping from a sump within an installed trench produces an inward hydraulic gradient toward

the trench creating an area of hydraulic influence that intercepts contaminated groundwater. Collection trenches are generally applicable for overburden groundwater collection and/or shallow weathered bedrock that can be excavated without blasting.

Vacuum Extraction - Vacuum extraction wells remove groundwater using suction lift applied through a vacuum. The vacuum extraction system consists of vertical or horizontal extraction wells; a blower to induce the vacuum; a liquid/vapor separator (i.e., condensate knock-out tank); vapor and groundwater treatment systems (if required); and system controls and instrumentation. Vacuum extraction induces a negative pressure gradient toward the extraction well. The groundwater recovery rate may be increased compared to conventional pumping in fine-grained, unconsolidated materials since the vacuum counteracts capillary forces, allowing groundwater to flow more readily. Groundwater withdrawal from vertical or horizontal extraction wells is limited by maximum achievable vacuum and the efficiency of the vacuum blower. Typically, a maximum water lift of 22 feet can be achieved. Therefore, deeper groundwater zones cannot be remediated using this technology. This technology is typically implemented over conventional suction lift or submersible well pumping when concurrent removal of soil gases is desired.

3.2.2.2 Treatment

Treatment of collected groundwater would be necessary prior to discharge, as neither Markhams nor the Town of Dayton are serviced by a sanitary sewerage system. Treatment technologies for inorganic compounds are categorized as chemical and physical treatment. A description of candidate technologies for treatment of groundwater from the Peter Cooper Markhams Site is presented under each of these categories below.

Chemical treatment technologies potentially applicable for the Peter Cooper Markhams Site groundwater include precipitation and ion exchange as described below.

Precipitation - Precipitation involves modifying the pH and/or adding chemicals (i.e. ferric chloride, ferrous sulfate, etc.) to reduce metal solubility and form solid metal salts. The precipitation process typically uses as lime or caustic soda to increase pH, or sulfuric acid to decrease pH. Multiple pH operating points may be required if precipitation of metals with drastically different optimum pH ranges is desired. Precipitated metal salts are separated from the treated aqueous stream by clarification and/or filtration.

Ion Exchange - Ion exchange involves removing metals or other undesired ions from a solution through substitution with preferred (non-toxic) ions. Ion exchange resins are primarily synthetic organic materials that contain ionic functional groups to which exchangeable ions are attached. The exchange resin is typically housed in a packed reactor column. Water is passed through the column in a manner to maximize contact with the resin. The ion exchange resin may be periodically regenerated with dilute acid or caustic, with the concentrated regeneration solution further treated or disposed. Pretreatment of water high in iron, organics or suspended solids may be necessary to prevent the ion exchange resins from fouling.

Potentially applicable physical groundwater treatment technology options for the Peter Cooper Markhams Site include adsorption using bone char; filtration and membrane separation.

Bone Char Adsorption - Bone char, manufactured from charred cattle bone, has been used extensively by the sugar manufacturing industry for removal of color, with more recent use for trace metals removal in water treatment applications. Metals removal occurs through a combination of physical/chemical phenomena at the bone char surface, including sorption, calcium ion exchange, and chelation. Bone char is packaged and sold commercially by firms engaged in the sale and distribution of granular activated carbon.

Filtration - Filtration may involve the use a granular medium, such as sand, to trap precipitated metals present on suspended solids. As solids accumulate in the filter bed, pressure drop through the bed will increase and flow rate will decrease. The filter is then backwashed with clean water to remove the accumulated solids from the bed. Solids in the backwash stream are concentrated and dewatered before disposal, with water from the dewatering process typically returned to the influent of the treatment system. Other forms of filtration include disposable media, such as cartridge or bag filters, that use paper or polymeric materials as the filtration media. Such systems do not require backwashing and associated solids dewatering; however, the media must be replaced at a greater frequency than a conventional granular media filter.

Membrane Separation - Membrane separation, such as ultrafiltration or reverse osmosis, involves processing collected and pre-filtered groundwater through a semi-permeable membrane to remove dissolved solids and contaminant ions. Contaminants and a portion of the groundwater are rejected by the membrane, with the reject stream being recycled until it becomes concentrated into brine. Purified water passing through the membrane is discharged or disposed. The concentrated brine (i.e., retentate) is then either further treated or disposed. Prefiltration would be required to prevent naturally occurring solids in the collected groundwater from damaging and/or fouling the membrane. Membrane cleaning may be performed via acid washing.

3.3 Screening of Technology Options

The technologies identified above are generally applicable to one or more of the General Response Actions identified for the Peter Cooper Markhams Site. Other site-specific factors to be considered in the potential application of these technologies to the Peter Cooper Markhams Site include:

- Physical features and constraints of the Site and surrounding property.
- Physical attributes of the contaminated environmental medium, such as area and volume.
- Potential for interferences or formation of undesirable byproducts due to chemical properties of the media to be treated.
- Commercial availability of the technology and/or its key process components.
- Compatibility of the technology with potential Site redevelopment and reuse plans.

In addition to these factors, the RI/FS Work Plan states that "technologies that could prove extremely difficult to implement or might not achieve the remedial objective in a reasonable time, or might not be applicable or feasible based on the site-specific conditions will be eliminated from further consideration." The RI/FS Work Plan also provides that where several options exist for a particular technology, the option for which most data exist and that appears best suited to the site-specific needs will be selected for further evaluation.

Based on these criteria, the remedial technologies that will be retained for detailed evaluation as candidate remedial alternatives, in whole or in part, are identified below along with the rationale for their potential applicability.

3.3.1 Waste Fill

3.3.1.1 Containment/Isolation

The low-permeability soil cap alternative, in combination with on-site waste consolidation, is considered applicable for the waste fill piles and will be retained for further evaluation. Although both the geosynthetic and low-permeability soil caps are considered equivalent 6NYCRR Part 360 cover systems, the low-permeability soil cap will be retained for further analysis consistent with the approved cover system for the Elevated Fill Subarea at the nearby Peter Cooper Landfill NPL Site in Gowanda, New York. The low-permeability soil cap is more readily implemented than a geosynthetic cover, requires fewer construction specialties, and has an associated cost benefit. The soil cover enhancement option is considered applicable for covering the waste fill piles in place and, therefore, will be retained for further analysis.

3.3.1.2 Ex-Situ Treatment

Ex-situ treatment technologies identified for soil/fill include solidification/stabilization to fixate and soil washing/chemical extraction to remove inorganic COPCs. SPLP testing has indicated that the inorganic COPCs do not readily leach using the acidic extraction solution called for by the SPLP test. As such, a more aggressive oxidant may be required to effect metals removal, which may result in the undesirable conversion of trivalent chromium to hexavalent chromium. Moreover, no waste fill samples collected during the RI indicated exceedance of the cleanup goals identified on Table 1. As such, employment of any treatment technology might only be required if necessitated by an off-site disposal facility, which is not likely based on the non-hazardous nature of the waste fill. Therefore, ex-situ treatment is not considered applicable for the waste fill and will not be retained for further analysis.

3.3.2 Groundwater

3.3.2.1 Containment/Isolation

Containment/isolation technologies described in Section 3.1.1.1 include various subsurface lateral barrier and capping options.

> ***Subsurface Lateral Barriers*** - Subsurface lateral barriers may reduce, but will not prevent, groundwater migration through the Site, particularly in the absence of a confining layer. Therefore, subsurface lateral barriers will not satisfy the Remedial Action Objective for mitigating excess risk due to groundwater ingestion, as some groundwater would still be available for consumption.
>
> ***Capping*** - Capping options include a low-permeability soil or soil-composite cap; and a geosynthetic cap. Capping will not completely prevent groundwater migration through the waste fill, nor will it prevent impacted groundwater ingestion and,

therefore, will not satisfy the Remedial Action Objective for mitigating excess risk due to groundwater ingestion.

3.3.2.2 Collection and Treatment

Collection system options incorporate horizontal and vertical groundwater pumping wells, a collection trench, and vacuum extraction. Groundwater collection (i.e., pump-and-treat) will not prevent ingestion, as it is not possible to capture all available groundwater within the Site. Accordingly, a groundwater collection system is not considered applicable toward achieving the Remedial Action Objective for mitigating excess risk due to groundwater ingestion.

Aqueous treatment technologies identified in Section 3.2.2.2 include chemical and physical treatment options. Treatment is considered a potentially applicable means to achieve the Remedial Action Objective for mitigating excess risk due to groundwater ingestion if it is provided in the form of point-of-use treatment (i.e., if treatment is provided at the location(s) at which Site groundwater is distributed for potable use).

Chemical Treatment - Precipitation and ion exchange were identified as candidate options to address the inorganic constituents. Chemical precipitation is not effective for trace metals removal and is not typically used or commercially available for point-of-use treatment and will not be retained for further analysis. Ion exchange is applicable for trace metals removal, and can be used to soften water, improve its taste, and mitigate scale formation during subsequent treatment steps. Therefore, ion exchange will be retained for further evaluation as a point-of-use groundwater treatment technology.

Physical Treatment - Physical treatment options include bone char, filtration, and membrane separation. Since bone char has been used primarily for large-scale water and wastewater treatment, and is currently not widely used for small-scale water treatment, it will not be retained for further evaluation. Filtration is applicable as a treatment step to remove precipitated inorganic compounds from softening and other suspended solids in the water column. Membrane separation is generally applicable to situations where a high purity effluent is required, such as in water circulation systems, potable water treatment systems, or zero discharge applications. Accordingly, filtration and membrane separation will be retained for further analysis in the context of point-of-use groundwater treatment.

Table 4 identifies the preliminary list of media-specific remedial alternatives for the Site based on the General Response Actions defined in Section 2.3 and the identification and screening of technologies presented above.

4.0 DEVELOPMENT OF REMEDIAL ALTERNATIVES

In this section of the FS, media-specific remedial alternatives are combined into a list of comprehensive candidate remedial alternatives for the Site. Preliminary screening of the list of potential remedial alternatives may then be performed to arrive at a reasonable number of alternatives for detailed analysis.

For the purpose of developing a list of comprehensive remedial alternatives for evaluation, each of the waste/fill remedial alternatives identified in Table 4, with the exception of the no action alternative, has been expanded to include groundwater management in the form of deed restrictions that would preclude use of Site groundwater for potable purposes (i.e., groundwater institutional controls alternative). Deed restrictions would be protective of human health in that they would mitigate ingestion and direct contact with groundwater containing the COPCs. Deed restrictions represent a typical approach to mitigate potable groundwater use at NPL Sites. However, Section 5.0 discusses the extent to which selection of point-of-use groundwater treatment in lieu of deed restrictions would impact the evaluation of alternatives.

Remedial alternatives slated to undergo evaluation are summarized on Table 5. A description of each of the remedial alternatives is presented in the following sections. Based on the limited number of alternatives, preliminary screening has not been performed; each of the alternatives will be carried through detailed analysis in Section 5.0.

4.1 Alternative 1 – No Action

The no action alternative is defined as taking no further action to address the waste fill piles and Site groundwater, with the exception of groundwater monitoring to detect changes in Site conditions. This alternative provides a baseline for comparison against the other remedial alternatives and justifies the need for any remedial action. As such, the no action alternative will be retained for the detailed analysis of alternatives.

4.2 Alternative 2 – Institutional Controls

The objective of institutional controls is to limit human contact with the contaminated media. Institutional controls for the waste fill would include access restrictions via fencing and appropriate signage to prevent the entry of trespassers onto the area of the Site that contains the waste fill piles; deed restrictions to prevent construction and underground utility work in the areas containing the waste fill piles; maintenance of the existing vegetative cover; and a Soil/Fill Management Plan (SFMP) to provide guidance for handling soil/fill from this area during future Site industrial use. The institutional control alternative for groundwater (i.e., deed restrictions) would be implemented to preclude the use of Site groundwater for potable purposes.

4.3 Alternative 3 – Containment/Isolation with Soil Cover Enhancement

Containment/isolation with soil cover enhancement would involve minor regrading of the waste fill piles followed by placement of 6 to 12 inches of topsoil. A suitable seed mix would be spread and raked into the soil to provide for final vegetative cover following cover soil placement. Some reworking of the fill piles would likely be necessary to ensure uniform coverage. The total base area covered by the waste fill piles is approximately 7 acres. Deed restrictions would be implemented to preclude the use of Site groundwater for potable purposes.

4.4 Alternative 4 – Consolidation/Containment with Low-Permeability Soil (Part 360 Equivalent) Cover

Consolidation and containment with a low-permeability soil cover would first involve clearing and grubbing the area covered by the waste fill piles. The smaller, outlying waste fill piles, which are presently scattered across 20 acres of the site, would be consolidated to the larger piles to create a single waste fill area no greater than 7 acres in size (see Figure 3). The consolidated waste fill would be graded with appropriate side-slopes to promote surface water drainage consistent with 6NYCRR Part 360, and would be covered with 18 inches of low-permeability soil ~~(1x10^{-6} cm/~~sec ~~or less)~~ and 6-inches of topsoil. The waste fill cover would be seeded with an appropriate seed mix to provide a good stand of grass and mitigate erosion. Passive gas vents would be installed at approximately 1 per acre. Outlying areas formerly covered by waste fill would be seeded to promote revegetation. Deed restrictions would be implemented to preclude the use of Site groundwater for potable purposes.

4.5 Alternative 5 – Excavation/Off-Site Disposal at Permitted Landfill

This alternative would encompass removal/excavation of the waste fill piles, with transport of the excavated materials to a permitted, off-site sanitary waste disposal facility.

Following removal of the waste fill piles, the disturbed areas would be seeded to promote vegetative growth. Deed restrictions would be implemented to preclude the use of Site groundwater for potable purposes.

5.0 DETAILED ANALYSIS OF ALTERNATIVES

The remedial alternatives developed in Section 4.0 are evaluated below. The detailed evaluation follows the process specified in the *"Interim Guidance for Conducting RI/FS under CERCLA"* (USEPA, 1988). Per the guidance, nine evaluation criteria are to be applied against each of the remedial alternatives. A brief description of each of these criteria is provided below:

> ***Overall Protection of Human Health and the Environment*** - This criterion provides a final check to assess whether each alternative meets the requirement that it is protective of human health and the environment. The overall assessment of protection is based on a combination of factors assessed under the evaluation criteria, including long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.
>
> ***Compliance with ARARs*** - This criterion is used to determine how each alternative complies with applicable or relevant and appropriate Federal and State requirements, as defined in CERCLA Section 121. For purpose of evaluating the alternatives, only those ARARs and TBC criteria potentially requiring additional or special regulatory approvals, variances or waivers during the remedial design and/or implementation phase are discussed. ARARs that generally govern all of the alternatives (e.g., OSHA worker safety requirements, CERCLA/SARA/NCP) are not discussed, as they do not affect this evaluation.
>
> ***Long Term Effectiveness*** - This criterion addresses the results of a remedial action in terms of the risk remaining at the Site after the response objectives have been met. The primary focus of this evaluation is to determine the extent and effectiveness of the controls that may be required to manage the risk posed by residual contamination. The factors to be evaluated include the magnitude of remaining risk (measured by standards such as reduction in off-site contaminant loadings and associated risk reduction), and the adequacy, suitability and long-term reliability of management controls for providing continued exposure protection from residuals (i.e., assessment of potential failure of the technical components).
>
> ***Reduction of Toxicity, Mobility, or Volume*** - This criterion addresses the statutory preference for selecting remedial actions that permanently and significantly reduce toxicity, mobility or volume of the contaminants. The factors to be evaluated include the remediation process employed, the amount of hazardous material destroyed or treated, the degree of reduction expected in toxicity, mobility or volume, and the type and quantity of residuals.

Short-Term Effectiveness - This criterion addresses the effects of the alternative during the construction and implementation phase until the remedial actions have been completed and the selected level of protection has been achieved. Each alternative is evaluated with respect to its effects on the community and on-site workers during the remedial action, environmental impacts resulting from implementation, and the amount of time until protection is achieved.

Implementability - This criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation. Technical feasibility considers construction and operational difficulties, reliability, ease of undertaking additional remedial action (if required), and the ability to monitor its effectiveness. Administrative feasibility considers activities needed to coordinate with other agencies (e.g., State and local) in regard to obtaining permits or approvals for implementing remedial actions.

Cost - This criterion addresses the capital costs, annual operation and maintenance costs, and present worth analysis. Capital costs consist of direct (construction) and indirect (non-construction and overhead) costs. Direct costs include expenditures for the equipment, labor and material necessary to perform remedial actions. Indirect costs include expenditures for engineering, financial and other services that are not part of actual installation activities but are required to complete the installation of remedial alternatives. Annual operation and maintenance costs are post-construction costs necessary to ensure the continued effectiveness of a remedial action.

All costs will be targeted toward an estimated accuracy of +/ -30 percent in 2006 dollars. Construction costs do not include legal, accounting, insurance, or interest and financing charges that may be incurred in connection with the construction unless otherwise specified. Competitive bidding or market conditions may impact the costs. Estimates of construction cost are made based on Benchmark's experience and qualifications, vendor quotes and standard reference sources. There is no guarantee that proposals, bids, or actual project cost will not vary from the estimates presented herein.

A present worth analysis is used to evaluate expenditures that occur over different time periods by discounting all future costs to the current base year. This allows the cost of remedial action alternatives to be compared on a common basis representing the amount of money that would be sufficient to cover all costs associated with the remedial action over its planned life. Unless otherwise stated, a discount rate of 5 percent before taxes and after inflation is assumed, with a maximum period of performance of 30 years.

State Acceptance - This criterion evaluates the technical and administrative issues and concerns the State of New York may have regarding each of the alternatives.

The factors to be evaluated include those features of alternatives that the state supports, reservations of the state, and opposition of the state. The NYSDEC and NYSDOH are the two primary State agencies expected to provide input to remedy acceptability. This criterion will be assessed following submittal of the draft FS report based on input from these agencies during the regulatory review period.

Community Acceptance - This criterion incorporates public concerns into the evaluation of the remedial alternatives. Typically, community (and also state) acceptance cannot be determined during development of the RI/FS. Accordingly, evaluation of these criteria is postponed until the RI/FS report has been released for state and public review. These criteria are then addressed in the Record of Decision (ROD) and the responsiveness summary.

After each of the remedial alternatives is assessed against the evaluation criteria below, a comparative analysis is performed in Section 6.0. The comparative analysis attempts to qualitatively evaluate the remedial alternatives against each other for each of the criteria. In addition, each of the alternatives assumes long-term groundwater monitoring costs, associated with implementation of the Post-Remedial Groundwater Monitoring Plan in Appendix C, are included with all remedial alternatives with the exception of Alternative 5 – Excavation/Off-Site Disposal.

Table 5 lists the remedial alternatives that will undergo detailed analysis in this section. Tables 6-1 through 6-5 provide remedial cost estimates for each alternative. Since the number of alternatives developed for the Site is reasonable, all alternatives will be retained for further evaluation.

As discussed in Section 4.0, Alternatives 2 through 5 include groundwater management in the form of deed restrictions that would preclude use of Site groundwater for potable purposes (i.e., groundwater institutional controls alternative). Institutional controls appear to be the approach best suited for Site groundwater. This alternative, which represents the typical approach for mitigating ingestion of chemicals of concern in groundwater at NPL sites, would be protective of human health and the environment; and does not rely on maintenance of controls to prevent future excess risk. Point-of-use treatment relies on maintenance of controls to prevent future excess risk, and necessitates a separate institutional control to require implementation of a point-of-use system if groundwater is used for potable purposes. Section 5.6 includes a discussion of point-of-use groundwater treatment, should the use of Site groundwater be required in the future.

5.1 Alternative 1 – No Action

The no-action alternative is defined as taking no further action to address the waste fill piles or groundwater on the Site. However, groundwater monitoring to check for changes in groundwater chemistry surrounding the area containing the waste fill piles would be included under this alternative. The no-action alternative provides a baseline for comparing other remedial alternatives.

> ***Overall Protection of Human Health and the Environment*** - The no-action alternative would partially address the Remedial Action Objectives for preventing direct exposure to waste fill materials and mitigating erosion and migration of waste materials from exposed surfaces, as the waste fill piles are substantially covered with vegetation. This alternative would not address the Remedial Action Objective for mitigating excess risk due to groundwater ingestion at the Site. Therefore, the no-action alternative would not be protective of human health and the environment.
>
> ***Compliance with ARARs*** - *Chemical-Specific ARARs:* The waste fill piles are not subject to chemical-specific ARARs with the exception of "to-be-considered" guidance values. The no-action alternative does not meet chemical-specific ARARs and TBC criteria for groundwater. *Location-Specific ARARs:* The no-action alternative is not subject to location-specific ARARs. *Action-Specific ARARs:* The no-action alternative does not meet action-specific ARARs.
>
> ***Long-Term Effectiveness and Permanence*** - Where insufficient soil cover and/or vegetation are present, the no-action alternative provides no measures to control migration of waste materials via surface erosion or direct contact with waste materials. This alternative provides no long-term management measures with the exception of possible groundwater monitoring. Current and future risks would remain under this alternative.
>
> ***Reduction of Toxicity, Mobility, or Volume Through Treatment*** - This alternative provides no reduction in toxicity, mobility, or volume of constituents in the waste fill piles or groundwater.
>
> ***Short-Term Effectiveness*** - There would be no additional short term risks posed to the community, Site workers, or the environment associated with implementation of this alternative. The groundwater monitoring could be implemented immediately.
>
> ***Implementability*** - No technical or action-specific administrative implementability issues are associated with this alternative.

Cost - No capital costs are associated with the no-action alternative. Groundwater monitoring may be required under this alternative. The estimated annual cost associated with this effort is $12,000, for a present worth of $184,000.

5.2 Alternative 2 – Institutional Controls

Institutional controls would involve fencing and appropriate signage to prevent the entry of trespassers into the waste fill pile area. In addition, the existing vegetation would be inspected annually and maintained to mitigate erosion. A deed restriction would be placed on this portion of the Site to limit future use (e.g., to prevent subsurface construction in this area). If subsurface construction is anticipated, a Soil/Fill Management Plan (SFMP) may be developed to provide guidance for workers involved in handling of soil/fill from this area (e.g., personal protective equipment requirements during underground utilities construction, methods for disposing of soil/fill removed from excavations, etc.). The institutional controls for groundwater would include deed restrictions to preclude the use of Site groundwater for potable purposes and groundwater monitoring to check for changes in groundwater chemistry surrounding the area containing the waste fill piles.

Overall Protection of Human Health and the Environment - In the HHRA, the constituents in the waste fill and soil were not identified as causing unacceptable health risks due to pathways associated with these media. The SLERA indicates that the most significant risk, if real, is primarily due to direct soil/fill exposure. Accordingly, institutional controls such as deed restrictions to prevent subsurface construction in this area and ingestion of groundwater; fencing and cover system maintenance to mitigate direct contact with and erosion of waste fill; or a SFMP identifying safe soil/fill handling procedures would be protective of human health and the environment. The Remedial Action Objectives for the waste fill and groundwater would be substantially met.

Compliance with ARARs - *Chemical-Specific ARARs:* The waste fill piles are not subject to chemical-specific ARARs with the exception of "to-be-considered" guidance values. This alternative does not meet chemical-specific ARARs and TBC criteria for groundwater. *Location-Specific ARARs:* The institutional controls alternative is not subject to location-specific ARARs. *Action-Specific ARARs:* The institutional controls alternative does not meet the "to-be-considered" requirements of 6NYCRR Parts 360 and 375.

Long-Term Effectiveness and Permanence - Installation of fencing would prevent direct contact with the waste fill. Existing cover soil inspection and maintenance would mitigate erosion of the waste fill where there is insufficient cover and/or vegetation. This alternative provides long-term management measures through groundwater monitoring and continued Site inspections to verify no further losses of cover soil\vegetation or damage to fencing. Deed restrictions would prevent future exposure to waste fill and ingestion of groundwater.

Reduction of Toxicity, Mobility, or Volume Through Treatment - The institutional controls alternative would not reduce the toxicity, mobility, or volume of constituents in the waste fill or groundwater.

Short-Term Effectiveness - There would be no substantial risks posed to the community, Site workers, or the environment associated with implementation of this alternative. The alternative would become effective once the fencing has been erected and the deed restrictions have been obtained (est. 2 months).

Implementability - No technical implementability issues are associated with this alternative. Administrative implementability issues may include difficulty in placing deed restrictions on all or a portion of the Site, particularly given the ambiguous nature of Site ownership.

Cost - The estimated capital cost for this alternative is $153,000. Annual OM&M costs for groundwater monitoring, and fence and cover system maintenance are estimated to be $16,000, resulting in an estimated 30-year present worth cost of $392,000.

5.3 Alternative 3 – Containment/Isolation with Soil Cover Enhancement

Containment/isolation with soil cover enhancement would involve: clearing and grubbing the approximate 7-acre waste fill pile area; moderate regrading and/or filling of low spots to facilitate runoff and ensure uniform coverage of the waste fill; placing 6 to 12 inches of topsoil to restore the original cover and provide for at least 12 inches of cover soil; and reseeding of the cover soil to provide for a good stand of grass.

Overall Protection of Human Health and the Environment - This alternative satisfies the waste fill Remedial Action Objectives for preventing direct exposure to waste fill materials, and mitigating erosion and migration of waste materials from exposed surfaces. The institutional controls for groundwater would include deed restrictions to preclude the use of Site groundwater for potable purposes and groundwater monitoring to check for changes in groundwater chemistry surrounding the area containing the waste fill piles. Accordingly, this alternative would be protective of human health and the environment and would fully meet the Remedial Action Objectives for both waste fill and groundwater.

Compliance with ARARs - *Chemical-Specific ARARs:* The waste fill piles are not subject to chemical-specific ARARs with the exception of "to-be-considered" guidance values. This alternative does not meet chemical-specific ARARs and TBC criteria for groundwater. *Location-Specific ARARs:* Approval from NYSDEC may be required for soil cover enhancement activities within 100 feet of the adjacent wetland areas. *Action-Specific ARARs:* The enhanced soil cover alternative provides for repairing and restoring the original cover and, therefore, complies with "to-be-considered" requirements for closure per 6NYCRR Parts 360-2.15 and 375. Waste fill disruption during regrading would necessitate preparation of and adherence to a community air monitoring plan (CAMP) for particulates in accordance with NYSDEC TAGM 4031.

Long-Term Effectiveness and Permanence - Restoration of the soil and vegetative covers would prevent long-term migration of waste fill constituents via surface erosion, and prevent direct contact with exposed waste fill. Regular inspection and maintenance of the soil and vegetative covers would be required to assure cover integrity and provide for long-term permanence of this alternative. Annual groundwater monitoring would be required to confirm no increasing trends in groundwater constituents within the waste fill pile area. Based on the amount of time that has passed (approximately 35 years) since fill was last deposited in this area, it is not anticipated that increasing trends would be identified.

Reduction of Toxicity, Mobility, or Volume Through Treatment - This alternative reduces the mobility of waste fill constituents by adding 6 to 12 inches of topsoil to provide for no less than a foot of vegetated soil between the waste fill and ground surface. The toxicity or volume of constituents in the waste fill would not be reduced under this alternative. This alternative would reduce the volume of constituents in the groundwater by mitigating the potential for leaching of constituents from waste fill, but would not reduce their toxicity or mobility.

Short-Term Effectiveness - Site workers would likely be required to wear personal protective equipment (PPE) during regrading and placement of the soil cover to prevent direct contact with waste fill. Dust control methods would be used to limit the release of particulates during placement of the soil cover. No significant risks to the community or the environment are anticipated under this alternative. Some minor disruption of the neighboring area may occur due to soil deliveries and noise from heavy equipment used to construct the remedy. Some wildlife disruption may occur due to disturbance of the Site during construction. The Remedial Action Objectives would be achieved once the vegetative cover was established (est. 5 months).

Implementability - No significant technical implementability issues are associated with this alternative, apart from the potential difficulty of covering numerous waste fill piles of varying heights. No action-specific administrative implementability issues are associated with this alternative.

Cost - The estimated capital cost for this alternative is $577,000. Annual OM&M costs for groundwater monitoring and maintenance of the cover soil vegetation are estimated to be $15,000, resulting in an estimated 30-year present worth cost of $800,000.

5.4 Alternative 4 – Consolidation/Containment with Low-Permeability Soil (Part 360 Equivalent) Cover

Consolidation/containment with a low-permeability soil cover would involve: clearing and grubbing a consolidation area in the vicinity of the waste fill piles; consolidating the smaller, outlying waste fill piles to the larger piles to create an approximate 7 acre or less consolidated waste/fill area; regrading to promote surface water drainage; and covering the approximately 7-8-acre area encompassing the waste fill piles with 18 inches of low-permeability soil and 6 inches of topsoil (6NYCRR Part 360 equivalent). The outlying areas formerly covered by waste fill and the waste/fill cover would be seeded to promote vegetative growth.

Overall Protection of Human Health and the Environment - This alternative satisfies the Remedial Action Objectives for preventing direct exposure to waste fill materials, and mitigating erosion and migration of waste materials from exposed surfaces. The institutional controls for groundwater would include deed restrictions to preclude the use of Site groundwater for potable purposes and groundwater monitoring to check for changes in groundwater chemistry surrounding the area containing the waste fill piles. Accordingly, this alternative would be protective of human health and the environment and would meet the Remedial Action Objectives for the waste fill and groundwater.

Compliance with ARARs - *Chemical-Specific ARARs:* The waste fill piles are not subject to chemical-specific ARARs with the exception of "to-be-considered" guidance values. This alternative does not meet chemical-specific ARARs and TBC criteria for groundwater. *Location-Specific ARARs:* Approval from NYSDEC may be required for work within 100 feet of the adjacent wetland areas. *Action-Specific ARARs:* The Part 360 equivalent cover alternative complies with "to-be-considered" requirements for site closure per 6NYCRR Parts 360-2.15 and 375. Waste fill disruption during regrading would necessitate preparation of and adherence to a community air-monitoring plan (CAMP) for particulates in accordance with NYSDEC TAGM 4031.

Long-Term Effectiveness and Permanence - Construction of the Part 360 equivalent cover system would prevent long-term migration of waste fill constituents via surface erosion, and prevent direct contact with exposed waste fill. The cover system would provide visual demarcation of the waste fill area, mitigating the potential risk for accidental subsurface work in this portion of the Site. Regular inspection and maintenance of the soil and vegetative covers would be required to assure cover integrity and provide for long-term permanence of this alternative. Annual groundwater monitoring would be required to confirm no increasing trends in groundwater constituents within the waste fill pile area. Based on the amount of time that has passed (approximately 35 years) since fill was last deposited in this area, it is not anticipated that increasing trends would be identified.

Reduction of Toxicity, Mobility, or Volume Through Treatment - This alternative reduces the mobility of waste fill constituents by adding 24 inches of cover soils to provide for no less than 2 feet of vegetated soil between the waste fill and ground surface. The toxicity or volume of constituents in the waste fill would not be reduced under this alternative. This alternative would reduce the volume of constituents in the groundwater by mitigating the potential for leaching of constituents from waste fill, but would not reduce their toxicity or mobility.

Short-Term Effectiveness - Site workers would likely be required to wear PPE during regrading and placement of the cover system to prevent direct contact with waste fill. Dust control methods would be used to limit the release of particulates during regrading work. No significant risks to the community or the environment are anticipated under this alternative. Some minor disruption of the neighboring areas may occur due to soil deliveries and noise from heavy equipment used to construct the remedy. Some wildlife disruption may occur due to disturbance of the Site during construction. The Remedial Action Objectives would be achieved once the vegetative cover was established (est. 7 months).

Implementability - No significant technical implementability issues or action-specific administrative implementability issues are associated with this alternative.

Cost - The estimated capital cost for this alternative is $1 million. Annual OM&M costs for groundwater monitoring and cover maintenance are estimated to be $15,000, resulting in an estimated present worth cost of $1.3 million.

5.5 Alternative 5 – Excavation/Off-Site Disposal at Permitted Landfill

This alternative would encompass removal/excavation of the waste fill piles, with transport of the excavated materials to a permitted, off-site sanitary waste disposal facility. Following removal of the waste fill piles, the disturbed area would be seeded to promote vegetative growth.

Overall Protection of Human Health and the Environment - This alternative would be protective of human health and the environment, as it would eliminate the presence of waste fill on the Site.

Compliance with ARARs - *Chemical-Specific ARARs:* The waste fill piles are not subject to chemical-specific ARARs with the exception of "to-be-considered" guidance values. This alternative does not meet chemical-specific ARARs and TBC criteria for groundwater. *Location-Specific ARARs:* Approvals from NYSDEC may be required for excavation activities within 100 feet of adjacent wetland areas. *Action-Specific ARARs:* Soil/fill excavation would necessitate preparation of and adherence to a community air monitoring plan for particulates in accordance with NYSDEC TAGM 4031. Waste transporter permits would be required (per 6NYCRR Part 364).

Long-Term Effectiveness and Permanence - Under this alternative, no unacceptable residual risk would remain since constituent concentrations would be significantly and permanently reduced with no reliance on continued performance of remedial measures following cleanup.

Reduction of Toxicity, Mobility, or Volume Through Treatment - Excavation and off-site disposal of the waste fill would effectively eliminate the toxicity, mobility, and volume of the waste fill constituents on-site. Once the waste fill is placed in an off-site disposal facility, the mobility of the constituents would be reduced. However, the volume and toxicity of waste fill constituents would not change. This alternative would reduce the volume of constituents in Site groundwater by eliminating the potential for leaching of constituents from waste fill.

Short-Term Effectiveness - Significant short-term risks and disruption of the community are expected under this alternative. These include: excessive truck traffic for an approximate 6-month period; noise from heavy equipment use; the potential for spillage of the waste fill material during transport; strong odors; and biological risks from attraction of vectors (rodents, insects, gulls, etc.) during the excavation work. Site workers would be required to wear personal protective equipment (PPE) to prevent direct contact with the waste fill material during excavation. Wildlife disruption would occur across the Site. Dust and erosion control methods would be required during waste fill handling activities. The Remedial Action Objectives would be achieved once the waste fill material was removed (est. 6 months).

Implementability - Technical implementability issues associated with this alternative would depend in part on the actual volume of waste fill removed from the Site and the corresponding amount of truck traffic resulting from this approach. Based on the estimate of 35,000-40,000 cubic yards (CY) of waste fill and cover soil, approximately 2,500 truckloads (16 CY per truckload) of material would need to leave the Site.

Dust, erosion and odor controls would be required. Administrative implementability issues may be encountered in securing approval for disposal of the material at an off-site facility due to the large volume of material and its physical nature. Contracts with multiple off-site disposal facilities may be required due to potential concerns relative to landfill stability if the waste fill represents a significant percentage of daily disposal volume.

Cost **-** The capital costs associated with this alternative are estimated at $4.8 million, assuming off-site treatment would not be required prior to disposal at the landfill. If off-site treatment were required, costs would be substantially higher. No significant annual OM&M costs are anticipated under this approach.

5.6 Point-of-Use Groundwater Treatment

Currently, the need for a point-of-use groundwater treatment system is remote; however, should circumstances warrant such a system, typical treatment technologies include ion exchange (i.e., water softening), filtration, and membrane separation (i.e., reverse osmosis). Point-of-use treatment would not reduce the toxicity, mobility, or volume of COPCs in Site groundwater, but would reduce groundwater toxicity at the point of exposure. Point-of-use treatment would be protective of human health if it were paired with an institutional control requiring that such a system be installed in conjunction with future groundwater use. Assuming this institutional control was in place, this alternative would meet the Remedial Action Objective for mitigating excess risk due to groundwater ingestion. No significant technical or action-specific implementability issues are associated with this alternative.

The capital cost for installation of a packaged water treatment system at locations where Site groundwater would be distributed and potentially used for potable purposes is approximately $7,000 per system, assuming each system would service a maximum of 10 individuals. Annual OM&M costs are estimated to be $1,200, for a 30-year present worth cost of $25,000.

6.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

In this section, the alternatives are compared to one another with respect to each of the evaluation criteria. The purpose of this comparison is to identify the relative advantages and disadvantages of each of the alternatives. State and community acceptance will be addressed in the ROD following comments on the FS Report and the Proposed Remedial Action Plan (PRAP). Table 7 presents a tabular summary of the detailed analysis for each alternative.

6.1 Overall Protection of Human Health and the Environment

The no action alternative would partially address the Remedial Action Objectives for preventing direct exposure to waste fill materials and mitigating erosion and migration of waste materials from exposed surfaces as the waste fill piles are substantially covered with vegetation. However, the no action alternative would not address the Remedial Action Objective for mitigating excess risk due to groundwater ingestion at the Site. Alternatives 2 through 5 include groundwater management in the form of deed restrictions that would preclude use of Site groundwater for potable purposes, and provide measures for mitigating erosion and migration of fill materials. Alternatives 2 through 5 would be protective of human health and the environment. In terms of reducing risk, Alternative 5 (excavation/off-site disposal) provides for the greatest long-term risk reduction as it would eliminate the presence of waste fill on the Site, whereas the no action alternative provides no further risk reduction. Alternative 5 is associated with greatest short-term risk.

6.2 Compliance with ARARs

Chemical-Specific ARARs: The waste fill piles are not subject to chemical-specific ARARs with the exception of "to-be-considered" guidance values. None of the alternatives meet chemical-specific ARARs and TBC criteria for groundwater.

Location-Specific ARARs: The no action and institutional controls alternatives are not subject to location-specific ARARs. Alternatives 3 through 5 may require approval from NYSDEC for work within 100 feet of the adjacent wetland areas.

Action-Specific ARARs: The no action alternative does not meet action-specific ARARs. The institutional controls alternative does not meet "to-be-considered" criteria under 6NYCRR Parts 360-2.15 and 375. Under Alternative 5, transporter permits would be required for off-site disposal.

6.3 Long-Term Effectiveness and Permanence

All of the alternatives, with the exception of the no action alternative, result in negligible residual risk from untreated media. With Alternatives 2 through 4, regular inspection and maintenance of the soil and vegetative covers would be required to assure cover integrity and provide for long-term permanence. No unacceptable residual risk would remain following excavation and off-site disposal of the waste fill (Alternative 5). Alternatives 1 through 4 provide for effective long-term management measures through groundwater monitoring.

6.4 Reduction of Toxicity, Mobility and Volume

The no action and institutional controls alternatives would not reduce the toxicity, mobility, or volume of constituents in the waste fill. The mobility of waste fill constituents would likely be reduced with cover system Alternatives 3 and 4 by providing for a 1- to 2-foot layer of vegetated soils, respectively, between the waste fill and final grade. Excavation and off-site disposal of the waste fill would effectively eliminate the toxicity, mobility, and volume of the waste fill constituents on-site; however, the net volume and toxicity of the constituents would not change. The mobility of the constituents may be reduced once placed in an off-site disposal facility. With respect to groundwater, deed restrictions would not reduce the toxicity, mobility, or volume of the COPCs.

6.5 Short-Term Effectiveness

The no-action alternative poses no additional short-term risks to the community, workers, or the environment. There would be no substantial risks posed to the community, workers, or the environment associated with implementation of the institutional controls alternative. Under Alternatives 3 and 4, workers would be required to wear PPE to prevent direct contact with the waste fill and airborne particulates. Dust control methods would also be required to limit the release of particulate matter during regrading/excavation of the waste fill and placement of clean soil. Some minor disruption of the neighboring areas may occur due to truck traffic and noise from heavy equipment used to construct the remedy. Some wildlife disruption may occur due to disturbance of the Site during construction.

Implementation of Alternative 5 would result in significant short-term risks and disruption of the community. These include: excessive truck traffic for an approximate 6-month period; noise from heavy equipment use and truck travel; the potential for spillage of the waste fill material during transport; strong odors; and biological risks from attraction of vectors (rodents, insects, gulls, etc.) during the excavation work, and significant wildlife disruption.

The institutional controls alternative would become effective once the fencing has been erected and the deed restrictions have been obtained (est. 2 months). Alternatives 3 and 4 would be constructed and implemented over a similar timeframe (est. 5-7 months). Excavation and topsoil placement (Alternative 5) would be completed in approximately 6 months.

6.6 Implementability

No significant technical implementability issues are associated with the Alternatives 1, 2, 4 and 5. Alternative 3 may face technical implementability issues associated with the potential difficulty of uniformly covering waste fill piles of varying heights.

No action-specific administrative implementability issues are associated with Alternatives 1, 3, and 4. Alternative 2 may encounter difficulty in placing deed restrictions on all or a portion of the Site, particularly given the ambiguous nature of Site ownership. Administrative implementability issues associated with Alternative 5 may be encountered in securing approval for disposal of the material at an off-site facility due to the large volume of material and its physical nature. Contracts with multiple off-site disposal facilities may be required due to potential concerns relative to landfill stability if the waste fill represents a significant percentage of daily disposal volume.

6.7 Cost

A summary of the capital, O&M and present worth costs for each alternative are presented on Table 7. As indicated, the no action alternative has the lowest present worth cost ($184,000). Alternatives 2 and 3 have present worth costs of $392,000 and $800,000, respectively. Alternatives 4 and 5 have present worth costs of $1.3 and $4.8 million, respectively.

7.0 REFERENCES

1. Obrien & Gere Engineers, Inc., November 1971. *Peter Cooper Corporations, Gowanda, NY - Solid Waste Management.*

2. RECRA Research, 1983. *Phase I Investigation Report, Peter Cooper Gowanda and Markhams Site.*

3. RECRA Research, August 1985. *Phase II Investigation Report, Peter Cooper Gowanda and Markhams Site.*

4. Obrien & Gere Engineers, Inc. January 1989. *Remedial Investigation Report, Peter Cooper Corporations, Gowanda, New York.*

5. Obrien & Gere Engineers, Inc. March 1991. *Feasibility Study, Peter Cooper Corporations, Gowanda, New York.*

6. Malcolm Pirnie, Inc., 1993. *Sampling Inspection Report, Peter Cooper Markhams Site.*

7. Geomatrix Consultants, Inc. & Benchmark Environmental Engineering and Science, PLLC, February 2001 and revised September 2001. *Remedial Investigation/Feasibility Study Work Plan, Peter Cooper Markhams Site, Dayton, New York.*

8. Geomatrix Consultants, Inc. & Benchmark Environmental Engineering and Science, PLLC, February 2005. *Remedial Investigation Report, Peter Cooper Markhams Site, Dayton, New York, Volumes I and II.*

9. Geomatrix Consultants, Inc. & Benchmark Environmental Engineering and Science, PLLC, August 2002. *Pathways Analysis Report – Peter Cooper Markhams Site, Dayton, New York.*

10. Geomatrix Consultants, Inc. & Benchmark Environmental Engineering and Science, PLLC, February 2005. *Human Health Risk Assessment, Peter Cooper Markhams Site, Dayton, New York.*

11. Environmental Risk Group, June 2005 and revised July 2006. *Screening Level Ecological Risk Assessment for Peter Cooper Markhams Site, Dayton, New York*

12. Benchmark Environmental Engineering & Science, PLLC, July 2004 and revised June 2005. *Feasibility Study Report – Final, Volume I of II, Peter Cooper Landfill Site, Gowanda, New York.*

13. Benchmark Environmental Engineering and Science, PLLC, December 2002. *Identification and Screening of Candidate Technologies for the Peter Cooper Markhams Site, Dayton, New York.*

TABLES

TABLE 1

PETER COOPER MARKHAMS SITE
FEASIBILITY STUDY

CLEANUP GOALS

Media	Constituents of Concern [1]	Range of Detected Concentrations [2]	Cleanup Goal [3]
Waste Fill Piles	Arsenic Chromium Hexavalent Chromium Zinc	7.1 – 65.6 mg/kg 4,490 – 46,000 mg/kg 4.7 mg/kg 408 – 900 mg/kg	Note 4
Shallow Overburden Groundwater	Hexavalent Chromium Manganese[4] Iron[4]	<10 – 14 μg/L 33 – 15,000 μg/L 218 – 11,100 μg/L	50 μg/L 300 μg/L 300 μg/L
Deep Overburden Groundwater	Hexavalent Chromium Manganese[4] Iron[4]	10 – 321 μg/L[5] 72 – 2330 μg/L 413 – 15,500 μg/L	50 μg/L 300 μg/L 300 μg/L

Notes:

1. For ease of discussion, the term "constituents of concern" (COCs) has been applied to both waste fill and groundwater media. However, the listed constituents for the waste fill were not identified as significant contributors to unacceptable human health risk.

2. Range of detected concentrations does not include analytical results for MW-2S from Nov. 2001.

3. The constituents in the waste fill and soils were not identified as causing unacceptable human health risks due to pathways associated with these media. In addition, SPLP data do not indicate a potential for leaching of site-related metals at concentrations that could cause exceedance of groundwater cleanup goals. Based on this information and given that the Remedial Action Objectives for waste fill are not chemical-specific, soil/fill cleanup goals are not required.

4. The combined Class GA groundwater standard for iron and manganese is 500 μg/L.

5. Concentration of 321 ug/L was detected in MW-5D in Nov. 2001 but was flagged by laboratory as estimated and its presence was not confirmed during Apr. 2002 sampling event.

TABLE 2

PETER COOPER MARKHAMS SITE
FEASIBILITY STUDY

GENERAL RESPONSE ACTIONS

Media	General Response Actions
Waste Fill	▪ No Action ▪ Institutional Controls ▪ Containment/Isolation ▪ Excavation/On-Site Treatment/Disposal ▪ Excavation/Off-Site Disposal
Groundwater	▪ No Action ▪ Institutional Controls ▪ Containment/Isolation ▪ Collection ▪ Treatment

TABLE 3A
POTENTIAL CHEMICAL-SPECIFIC ARARs
PETER COOPER MARKHAMS SITE
FEASIBILITY STUDY

Standard, Requirement, Criteria or Limitation	Citation or Reference	Description/Comments
Surface Water and Groundwater:		
RCRA Groundwater Protection Standards and Maximum Concentration Limits	40 CFR 264, Subpart F	Establishes criteria for groundwater consumption. Groundwater is/will not be used for potable purposes. Potentially relevant for off-site groundwater quality.
NYSDEC Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations	6NYCRR Parts 701- 703	Establishes groundwater and surface water quality criteria. Applicable to existing surface water quality, off-site groundwater quality, and runoff/ groundwater migration. Establishes criteria for groundwater consumption.
NY Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations	TOGS 1.1.1, June 1998 (April 2000 addendum)	Compilation of ambient water quality standards and guidance values. To be considered.
Air:		
New York State Air Quality Classifications and Standards	6NYCRR Parts 256 and 257	Establishes air quality standards protective of public health. Potentially applicable to disruptive activities.
National Primary and Secondary Ambient Air Quality Standards (NAAQS)	40 CFR Part 50	Establishes primary and secondary ambient air quality standards to protect public health and welfare. Potentially applicable to disruptive activities.
Soil and Sediment:		
NYSDEC Determination of Soil Cleanup Objectives and Cleanup Levels	NYSDEC TAGM HWR-94-4046, January 1994 and Dec. 2000 Addendum	Establishes residential soil cleanup goals based on human health criteria, background levels, and groundwater protection. To be considered.
NYSDEC Inactive Hazardous Waste Disposal Sites	6NYCRR Part 375	Establishes procedures for inactive hazardous waste disposal site identification, classification, and investigation activities, as well as remedy selection and interim remedial actions. To be considered.
USEPA Soil Screening Guidance	Technical Background Document and Users Guide, May 1996 revisions	Presents a framework for developing risk-based, soil screening levels for protection of human health. Provides a tiered approach to site evaluation and screening level development for NPL sites. To be considered.
USEPA Preliminary Remediation Goals	EPA Region IX, Oct. 2002, updated per EPA Toxicity Guidance Memo (12/12/04)	Presents residential and non-residential soil cleanup goals based on human health criteria and groundwater protection. To be considered.

TABLE 3A (cont.)
POTENTIAL CHEMICAL-SPECIFIC ARARs
PETER COOPER MARKHAMS SITE
FEASIBILITY STUDY

Standard, Requirement, Criteria or Limitation	Citation or Reference	Description/Comments
Soil and Sediment (cont.):		
NYSDEC Technical Guidance for Screening Contaminated Sediment	NYSDEC, January 1999	Presents preliminary sediment screening criteria for consideration against further ecological assessment. To be considered.
Other:		
USEPA Health Effects Assessment Summary Tables (HEAST)	Risk Assessment Publication Developed by the Radiation Protection Program, April 2001	Radionuclides tables for estimating cancer risks at sites managed under CERCLA.
USEPA Integrated Risk Information System (IRIS)	www.epa.gov/iris	Database of human health effects that may result from exposure to various substances found in the environment.

TABLE 3B
POTENTIAL LOCATION-SPECIFIC ARARs
PETER COOPER MARKHAMS SITE
FEASIBILITY STUDY

Standard, Requirement, Criteria or Limitation	Citation or Reference	Description/Comments
Executive Order 11990, Protection of Wetlands	40 CFR Part 6, Appendix A	Requires evaluation of actions to minimize the destruction, loss, or degradation of wetlands. Potentially applicable to remedial alternatives involving construction near wetland areas.
Wetlands Permit Regulations	40 CFR Part 232	Potentially relevant and appropriate to remedial alternatives involving construction near wetland areas.
National Historic Preservation Act	16 CFR Part 470	Requires avoiding impacts on cultural resources having historical significance. Potentially applicable to remedial alternatives involving construction.
Endangered Species Act	50 CFR Part 402	Actions must not threaten the continued existence of a listed species nor destroy critical habitat. Potentially applicable to remedial alternatives involving construction.
Freshwater Wetlands Act (ECL Article 24 and Article 71, Title 23)	6NYCRR Part 662-665	Requires evaluation of actions to preserve, protect, and conserve freshwater wetlands to prevent the despoliation and destruction of freshwater wetlands, and to regulate use and development of such wetlands to secure the natural benefits of freshwater wetlands. Potentially applicable to remedial alternatives involving construction near wetland areas
Endangered and Threatened Species of Fish and Wildlife	6NYCRR Part 182	Requires evaluation of actions to conserve endangered or threatened species. Potentially applicable to alternatives involving changes in site cover or topography.

TABLE 3C
POTENTIAL ACTION-SPECIFIC ARARs
PETER COOPER MARKHAMS SITE
FEASIBILITY STUDY

Standard, Requirement, Criteria or Limitation	Citation or Reference	Description/Comments
Surface Water and Groundwater:		
Clean Water Act, National Pretreatment Standards	40 CFR 403.5	General pretreatment regulations for discharge to POTWs – potentially applicable for alternatives involving discharges to sanitary sewer.
Air:		
National Emission Standards for Hazardous Air Pollutants (NESHAPs)	40 CFR Part 61	Standards by which owners/operators emitting HAPs must abide. Potentially applicable to alternatives involving air emissions.
Clean Air Act Section 101, Approval and Promulgation of Implementation Plan	40 CFR Parts 52	Requires development of a fugitive and odor emission control plan for implementation during excavation and consolidation actions. Potentially applicable to waste fill remediation alternatives.
NYSDEC Guidance for Fugitive Dust Suppression and Particulate Monitoring at Inactive Hazardous Waste Sites.	NYSDEC TAGM 4031	Establishes guidance for community air monitoring and controls to monitor and mitigate fugitive dusts during intrusive activities at NY State inactive hazardous waste sites – to be considered for disruptive activities.
NY State Air Regulations – General Provisions and General Prohibitions	6NYCRR Parts 200 and 211	Part 201 requires owners of sources to restrict emissions. Part 211 prohibits air emissions that are injurious to humans, plants, animals or property, or which unreasonably interfere with the comfortable enjoyment of life or property. Potentially applicable to alts. involving air emissions.
NY State Air Permits and Certifications	6NYCRR Part 201	Requires owners and/or operators of air contamination sources to obtain a permit or registration certificate. Potentially applicable to alternatives involving air emissions
NYSDEC Division of Air Resources - Guidelines for the Control of Toxic Ambient Air Contaminants	NYSDEC DAR-1, December 2003 (formerly Air Guide 1)	Establishes process emissions guidance limits based on assumed diffusion rates and inhalation by downwind receptor. To be considered for remedial activities having process emissions.
OSHA General Industry Air Contaminants Standard	29 CFR 1910.1000	Establishes Permissible Exposure Limits for workers exposed to airborne contaminants. Applicable to disruptive activities.
Solid, Hazardous, and Non-Hazardous Waste:		
NY State Solid Waste Management Facility Regulations	6NYCRR Part 360-2.15	Establishes procedures for closing regulated landfill facilities. To be considered.

TABLE 3C (cont.)
POTENTIAL ACTION-SPECIFIC ARARs
PETER COOPER MARKHAMS SITE
FEASIBILITY STUDY

Standard, Requirement, Criteria or Limitation	Citation or Reference	Description/Comments
Solid, Hazardous, and Non-Hazardous Waste (cont.):		
NYSDEC Inactive Hazardous Waste Disposal Sites	6NYCRR Part 375	Establishes procedures for inactive hazardous waste disposal site identification, classification, and investigation activities, as well as remedy selection and interim remedial actions. To be considered.
NY State Solid Waste Transfer Permits	6NYCRR Part 364	Establishes procedures to protect the environment from mishandling and mismanagement of all regulated waste transported from a site of generation to the site of ultimate treatment, storage, or disposal. Potentially applicable for alternatives involving off-site disposal.
Criteria for Municipal Solid Waste Landfills	40 CFR Part 258	Establishes minimum national criteria under the RCRA for all municipal solid waste landfill (MSWLF) units and under the Clean Water Act for solid waste landfills that are used to dispose of sewage sludge. Potentially applicable for waste fill piles.
NYSDEC Land Disposal Restrictions	6NYCRR Part 376	Identifies hazardous wastes that are restricted from land disposal and defines those limited circumstances under which an otherwise prohibited waste may be land disposed. Potentially relevant to disposal alternatives for waste fill.
NYSDEC Guidelines for the Selection of Remedial Actions at Inactive Hazardous Waste Sites	TAGM HWR-90-4030, May 1990	Establishes procedures for evaluating remedial alternatives at listed inactive hazardous waste sites undergoing remediation. To be considered.
Proposed Requirements for Hybrid Closures	52 Federal Register 8711	Combined waste-in-place and clean closures. To be considered.
DOT Rules for Hazardous Materials Transport	(49 CFR 107, 171.1 - 171.5).	Establishes requirements for shipping of hazardous materials. Potentially applicable for alternatives involving off-site disposal
Occupational Safety and Health Act (29 USC 651 *et seq.*)	29 CFR Part 1910 and 1926	Describes procedures for maintaining worker safety. Applicable to site construction activities.
Other:		
CERCLA/SARA/NCP	(40 CFR Part 300)	Provides foundation for federal hazardous waste/hazardous material regulations. Applicable to remedial alternative selection.
USEPA Policy on Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action and Underground Storage Tank Sites	OSWER Directive 9200.4-17p, April 1999	Clarifies USEPA's policy regarding the use of monitored natural attenuation for the cleanup of contaminated soil and groundwater. To be considered.

TABLE 4

PETER COOPER MARKHAMS SITE
FEASIBILITY STUDY

SUMMARY OF PRELIMINARY REMEDIAL ALTERNATIVES

Media	Remedial Alternatives
Waste Fill	No Action Institutional Controls Containment/Isolation with Soil Cover Enhancement Consolidation/Containment with Low-Permeability Soil (Part 360 Equivalent) Cover Excavation/Off-Site Disposal at Permitted Landfill
Groundwater	No Action Institutional Controls Point-of-Use Treatment

TABLE 5

PETER COOPER MARKHAMS SITE FEASIBILITY STUDY

SUMMARY OF REMEDIAL ALTERNATIVES FOR DETAILED ANALYSIS

Alternative	Description[1]
1	No Action
2	Institutional Controls
3	Containment/Isolation with Soil Cover Enhancement
4	Consolidation/Containment with Low-Permeability Soil (Part 360 Equivalent) Cover
5	Excavation/Off-Site Disposal at Permitted Landfill

Note:

1. All alternatives assume institutional controls for groundwater.

Table 6-1

Peter Cooper Markhams Site
Remedial Alternative Cost Estimate

Alternative 1: No Action

Item	Quantity	Units	Unit Cost	Total Cost
Annual Operation Maintenance & Monitoring (OM&M):				
Groundwater Sampling/Reporting	2	Event	$ 5,500.00	$ 11,000
CERCLA 5-Year Review[1]	1	Event	$ 1,000.00	$ 1,000
Total Annual OM&M Cost				**$ 12,000**
Number of Years (n):				30
Interest Rate (I):				5%
p/A Value:				15.3725
OM&M Present Worth (PW):				**$ 184,470**

Total Present Worth (PW): Capital Cost + OM&M PW	**$ 184,470**

Notes:
1. Annual cost represents 1/5 of 5-year review cost

Table 6-2

Peter Cooper Markhams Site
Remedial Alternative Cost Estimate

Alternative 2: Institutional Controls

Item	Quantity	Units	Unit Cost	Total Cost
Contractor Mobilization/Demobilization	1	LS	$ 2,500.00	$ 2,500
Health and Safety	1	LS	$ 3,000.00	$ 3,000
Subtotal:				**$ 5,500**
Institutional Controls				
Develop Soil/Fill Management Plan	1	LS	$ 3,500.00	$ 3,500
Fencing	4700	LF	$ 20.00	$ 94,000
Gates	4	EA	$ 250.00	$ 1,000
Deed Restrictions (groundwater)[1]	1	LS	$ 6,500.00	$ 6,500
Deed Restrictions (waste fill)[1]	1	LS	$ 6,500.00	$ 6,500
Subtotal:				**$ 111,500**
Subtotal Capital Cost				**$ 117,000**
Engineering/Contingency (35%)				**$ 36,400**
Total Capital Cost				**$ 153,400**
Annual Operation Maintenance & Monitoring (OM&M):				
Groundwater Sampling / Reporting	2	Event	$ 5,500.00	$ 11,000
Existing Cover Maintenance & Repair	1	Yr	$ 2,500.00	$ 2,500
Fence Maintenance & Repair	1	Yr	$ 1,000.00	$ 1,000
CERCLA 5-Year Review[2]	1	Event	$ 1,000.00	$ 1,000
Total Annual OM&M Cost				**$ 15,500**
Number of Years (n):				30
Interest Rate (I):				5%
p/A Value:				15.3725
OM&M Present Worth (PW):				**$ 238,274**
Total Present Worth (PW): Capital Cost + OM&M PW				**$ 391,674**

Notes:
1. Deed restrictions are not included in Engineering/Contingency costs.
2. Annual cost represents 1/5 of 5-year review cost

Table 6-3

Peter Cooper Markhams Site
Remedial Alternative Cost Estimate

Alternative 3: Containment/Isolation with Soil Cover Enhancement

Item	Quantity	Units	Unit Cost	Total Cost
Contractor Mobilization/Demobilization	1	LS	$ 10,000.00	$ 10,000
12' W Crushed Stone Access Road Reconstruct	1300	LF	$ 12.00	$ 15,600
Health and Safety/Community Air Monitoring	1	LS	$ 15,000.00	$ 15,000
Subtotal:				**$ 40,600**
Institutional Controls				
Deed Restrictions (groundwater)[1]	1	LS	$ 6,500.00	$ 6,500
Subtotal:				**$ 6,500**
Cover System Enhancements				
Clearing/Grubbing	7	Acres	$ 3,000.00	$ 21,000
Reworking Fill Piles	10	Day	$ 2,500.00	$ 25,000
12" Topsoil (includes material/placement)	12907	CY	$ 25.00	$ 322,667
Seeding[2]	8	Acre	$ 2,500.00	$ 20,000
Subtotal:				**$ 388,667**
Subtotal Capital Cost				**$ 429,267**
Engineering/Contingency (35%)				**$ 147,968**
Total Capital Cost				**$ 577,235**
Annual Operation Maintenance & Monitoring (OM&M):				
Groundwater Sampling / Reporting	2	Event	$ 5,500.00	$ 11,000
Cover Maintenance	1	Yr	$ 2,500.00	$ 2,500
CERCLA 5-Year Review[3]	1	Lump Sum	$ 1,000.00	$ 1,000
Total Annual OM&M Cost				**$ 14,500**
Number of Years (n):				30
Interest Rate (I):				5%
p/A Value:				15.3725
OM&M Present Worth (PW):				**$ 222,901**
Total Present Worth (PW): Capital Cost + OM&M PW				**$ 800,136**

Notes:
1. Deed restrictions are not included in Engineering/Contingency costs.
2. Assumes moderate regrading increases area covered by waste fill piles by 1 acre.
3. Annual cost represents 1/5 of 5-year review cost

Table 6-4

Peter Cooper Markhams Site
Remedial Alternative Cost Estimate

Alternative 4: Consolidation/Containment with Low-Permability Soil (Part 360 Equivalent) Cover

Item	Quantity	Units	Unit Cost	Total Cost
Contractor Mobilization/Demobilization	1	LS	$ 25,000.00	$ 25,000
12' W Crushed Stone Access Road Reconstruct	1300	LF	$ 12.00	$ 15,600
Health and Safety/Community Air Monitoring	1	LS	$ 20,000.00	$ 20,000
Subtotal:				**$ 60,600**
Institutional Controls				
Deed Restrictions (groundwater)[1]	1	LS	$ 6,500.00	$ 6,500
Subtotal:				**$ 6,500**
Low-Permeability Soil Cover				
Clearing/Grubbing	12	Acre	$ 3,000.00	$ 36,000
On-Site Consolidation (incl. trucking, place & compact)	17214	CY	$ 5.00	$ 86,071
4" Perforated Gas Vents (1/acre)	120	LF	$ 50.00	$ 6,000
18" Low-Permeability Soil (1×10^{-6} cm/s)	19360	CY	$ 20.00	$ 387,200
6" Topsoil	6453	CY	$ 25.00	$ 161,333
Seeding[2]	12	Acre	$ 2,500.00	$ 30,000
Subtotal:				**$ 706,605**
Subtotal Capital Cost				**$ 773,705**
Engineering/Contingency (35%)				**$ 268,522**
Total Capital Cost				**$ 1,042,226**

Annual Operation Maintenance & Monitoring (OM&M):				
Groundwater Sampling / Reporting	2	Event	$ 5,500.00	$ 11,000
Site Maintenance / Mowing	2	Yr	$ 1,500.00	$ 3,000
CERCLA 5-Year Review[3]	1	Lump Sum	$ 1,000.00	$ 1,000
Total Annual OM&M Cost				**$ 15,000**
Number of Years (n):				30
Interest Rate (I):				5%
p/A Value:				15.3725
OM&M Present Worth (PW):				**$ 230,588**

Total Present Worth (PW): Capital Cost + OM&M PW	**$ 1,272,814**

Notes:
1. Deed restrictions are not included in Engineering/Contingency costs.
2. Includes seeding of areas cleared following consolidation
3. Annual cost represents 1/5 of 5-year review cost

Table 6-5

Peter Cooper Markhams Site
Remedial Alternative Cost Estimate

Alternative 5: Excavation/Off-Site Disposal at Permitted Landfill

Item	Quantity	Units	Unit Cost	Total Cost
Contractor Mobilization/Demobilization	1	LS	$ 20,000.00	$ 20,000
12' W Crushed Stone Access Road Reconstruct	1300	LF	$ 12.00	$ 15,600
Health and Safety/Community Air Monitoring	1	LS	$ 25,000.00	$ 25,000
Subtotal:				**$ 60,600**
Institutional Controls				
Deed Restrictions (groundwater)[1]	1	LS	$ 6,500.00	$ 6,500
Subtotal:				**$ 6,500**
Waste Fill Pile Removal:				
Clearing/Grubbing	7	Acre	$ 3,000.00	$ 21,000
Removal/Excavation	40000	CY	$ 10.00	$ 400,000
Off-Site Disposal (incl. trucking)[2]	60000	TON	$ 50.00	$ 3,000,000
Odor/Vestor Control Measures	1	LS	$ 50,000.00	$ 50,000.00
Seeding (includes material and placement)	7	Acre	$ 2,500.00	$ 17,500
Subtotal:				**$ 3,488,500**
Subtotal Capital Cost				**$ 3,555,600**
Engineering/Contingency (35%)				**$ 1,242,185**
Total Capital Cost				**$ 4,797,785**

Notes:
1. Deed restrictions are not included in Engineering/Contingency costs.
2. Includes some admixing of soil to assure stability in landfill & account for fill intermingled with soil on-site.

TABLE 7

PETER COOPER MARKHAMS SITE
FEASIBILITY STUDY

EVALUATION/COMPARISON OF REMEDIAL ALTERNATIVES

Criteria	**Remedial Alternatives**				
	Alternative 1: No Action	**Alternative 2:** Institutional Controls	**Alternative 3:** Containment/Isolation with Soil Cover Enhancement	**Alternative 4:** Consolidation/ Containment w/ Low-Permeability Soil (Part 360 Equivalent) Cover	**Alternative 5:** Excavation/Off-Site Disposal at Permitted Landfill
Overall Protection of Human Health and the Environment					
	Not protective	Protective	Protective	Protective	Protective
Compliance with ARARs					
Chemical-specific	Waste fill not subject (except for TBCs); GW does not comply	Waste fill not subject (except for TBCs); GW does not comply	Waste fill not subject (except for TBCs); GW does not comply	Waste fill not subject (except for TBCs); GW does not comply	Waste fill not subject (except for TBCs); GW does not comply
Location-specific	Not applicable	Not applicable	Complies (approvals required)	Complies (approvals required)	Complies (approvals required)
Action-specific	Does not comply	Does not comply w/ TBCs	Complies	Complies	Complies (permits required)
Long-Term Effectiveness and Permanence					
Magnitude of Residual Risk	Unchanged from existing	Minimal residual risk	Minimal residual risk	Minimal residual risk	None
Adequacy and Reliability of Controls	Not applicable[1]	Reliable	Reliable	Reliable	Not applicable
Reduction of Toxicity, Mobility & Volume					
Toxicity	Not reduced	Not reduced	Not reduced	Not reduced	Not reduced[3]
Mobility	Not reduced	Not reduced	Reduced	Reduced	Reduced[3]
Volume	Not reduced	Not reduced	Not reduced[2]	Not reduced[2]	Not reduced[3]

TABLE 7

PETER COOPER MARKHAMS SITE
FEASIBILITY STUDY

EVALUATION/COMPARISON OF REMEDIAL ALTERNATIVES

Criteria	Remedial Alternatives				
	Alternative 1: No Action	**Alternative 2:** Institutional Controls	**Alternative 3:** Containment/Isolation with Soil Cover Enhancement	**Alternative 4:** Consolidation/ Containment w/ Low-Permeability Soil (Part 360 Equivalent) Cover	**Alternative 5:** Excavation/Off-Site Disposal at Permitted Landfill
Short-Term Effectiveness					
Community Risks	No additional risks	No additional risks	No significant risks	No significant risks	Potential for serious risk
Community Disruption	None	None	Minor disruption	Minor disruption	Significant disruption
Worker Risks	No additional risks	No additional risks	Controlled with PPE	Controlled with PPE	Controlled with PPE
Environmental Risks	No additional risks	No additional risks	Wildlife disruption during construction	Wildlife disruption during construction	Wildlife disruption during construction
Est. Time to Implement	0 months	2 months	5 months	7 months	6 months
Implementability					
Technical Implementability	No issues	No issues	Possible difficulty covering individual waste fill piles	No significant issues	No significant issues
Administrative Implementability	No issues	May be difficult to place deed restriction on the Site	No issues	No issues	Securing approval for disposal (volume/ nature); disposal at multiple facilities may be necessary.

TABLE 7

PETER COOPER MARKHAMS SITE
FEASIBILITY STUDY

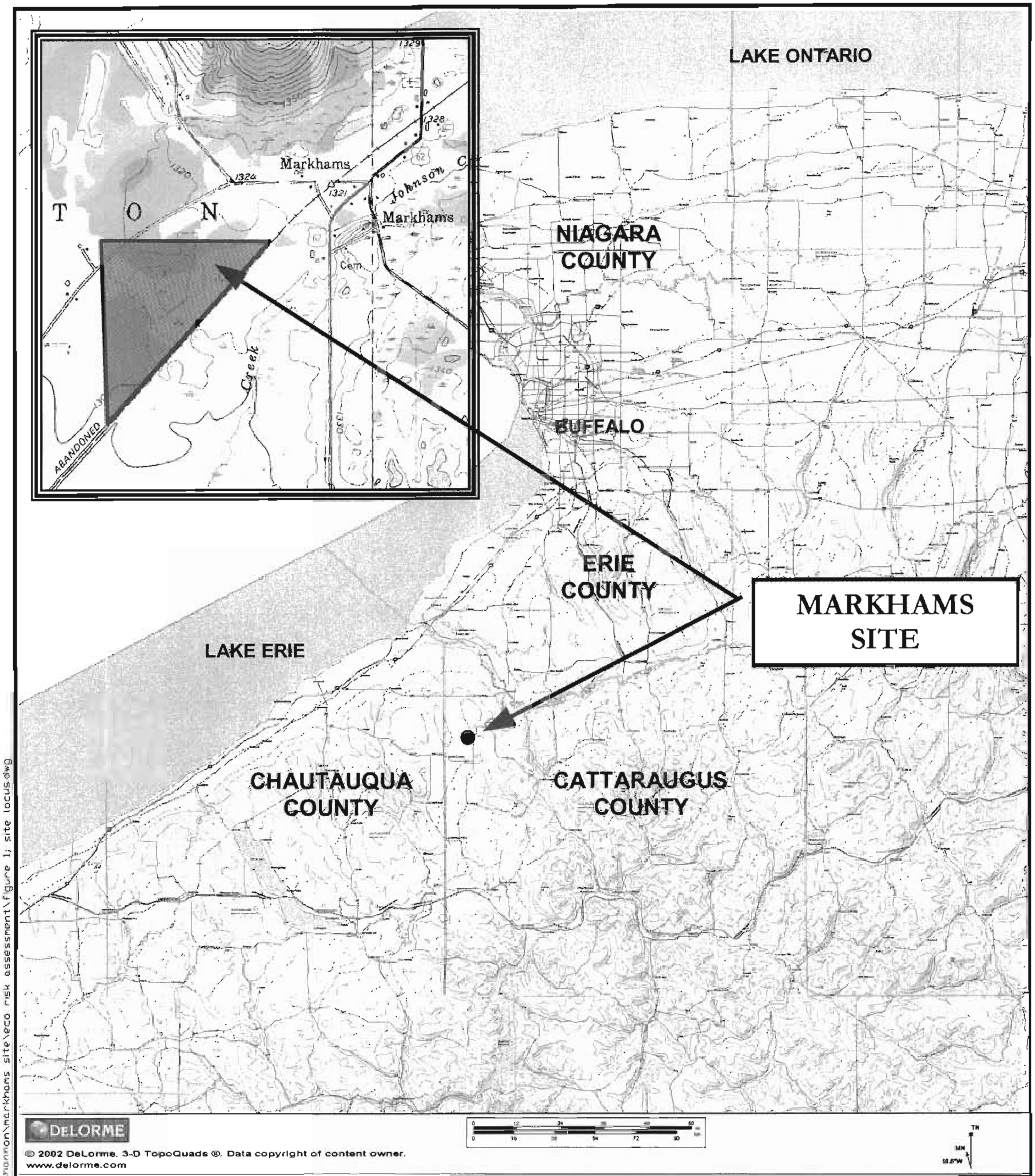
EVALUATION/COMPARISON OF REMEDIAL ALTERNATIVES

Criteria	Remedial Alternatives				
	Alternative 1: No Action	**Alternative 2:** Institutional Controls	**Alternative 3:** Containment/Isolation with Soil Cover Enhancement	**Alternative 4:** Consolidation/ Containment w/ Low-Permeability Soil (Part 360 Equivalent) Cover	**Alternative 5:** Excavation/Off-Site Disposal at Permitted Landfill
Cost					
Capital Cost	$0	$153,000	$577,000	$1 million	$4.8 million
Annual O&M	$12,000	$15,500	$14,500	$15,000	$0
Present Worth	$184,000	$392,000	$800,000	$1.3 million	$4.8 million

Notes:
1 Provides for continued groundwater monitoring.
2 Volume of constituents in groundwater would be reduced with time by mitigating the potential for leaching of constituents from waste fill.
3 The toxicity, volume, and mobility of constituents on the Site would be eliminated.

FIGURES

FIGURE 1



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www.delorme.com

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

50 FOUNTAIN PLAZA
SUITE 1350
BUFFALO, NEW YORK 14202
(716) 856-0599

PROJECT NO.: 0021-003-200

DATE: MARCH 2005

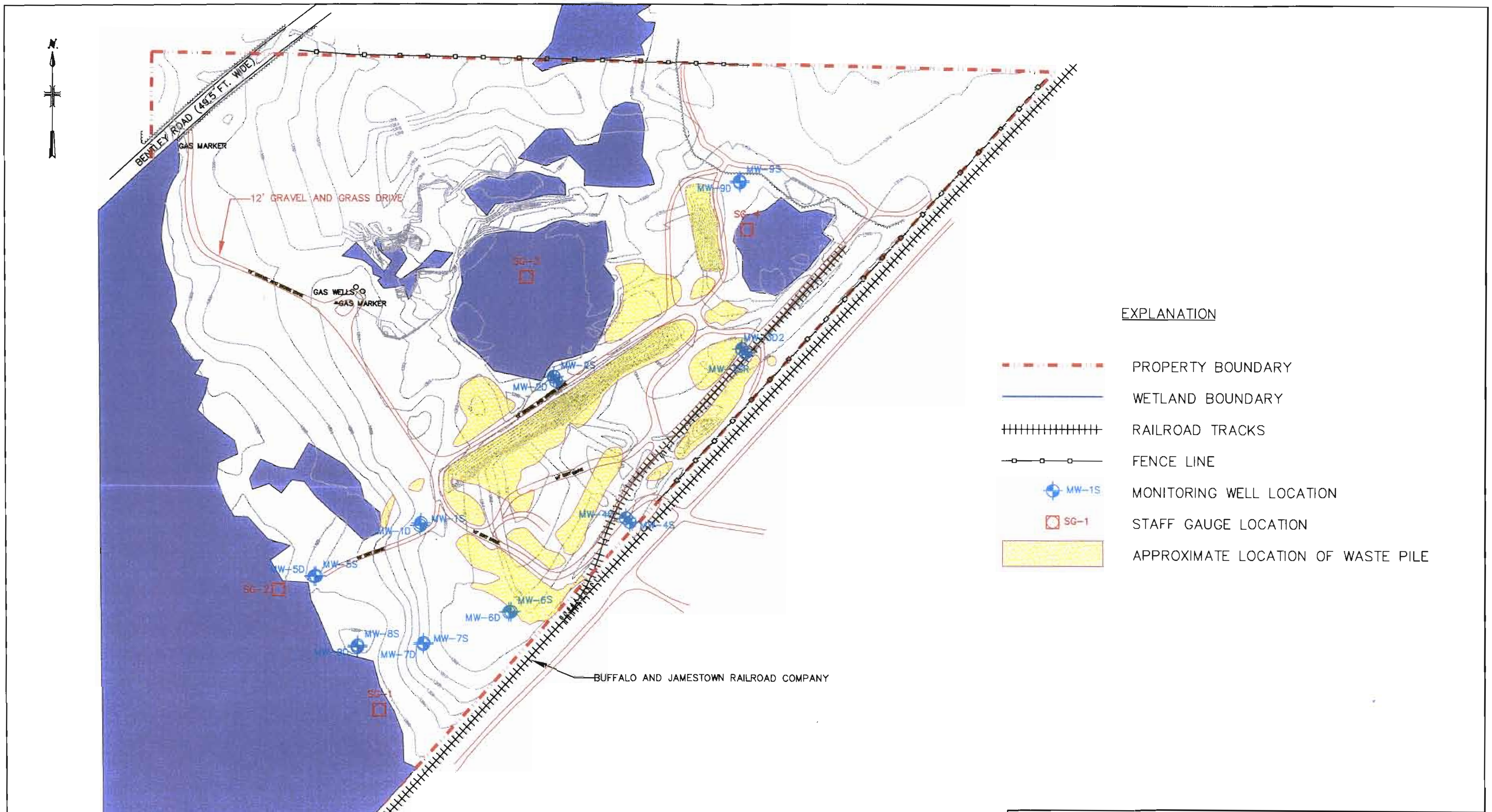
DRAFTED BY: BCH

SITE LOCUS

PETER COOPER MARKHAMS SITE
MARKHAMS, NEW YORK

PREPARED FOR
RESPONDENTS FOR PETER COOPER MARKHAMS SITE

FILEPATH:g:\cad\benchmark\collier shannon\markhams site\eco risk assessment\figure 1; site locus.dwg



SCALE: 1 INCH = 300 FEET

SITE LOCATION MAP
PETER COOPER – MARKHAMS SITE
RI/FS
MARKHAMS, NEW YORK

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

Project No.	Figure
0021–003–200	2

DATE: FEBRUARY 2002
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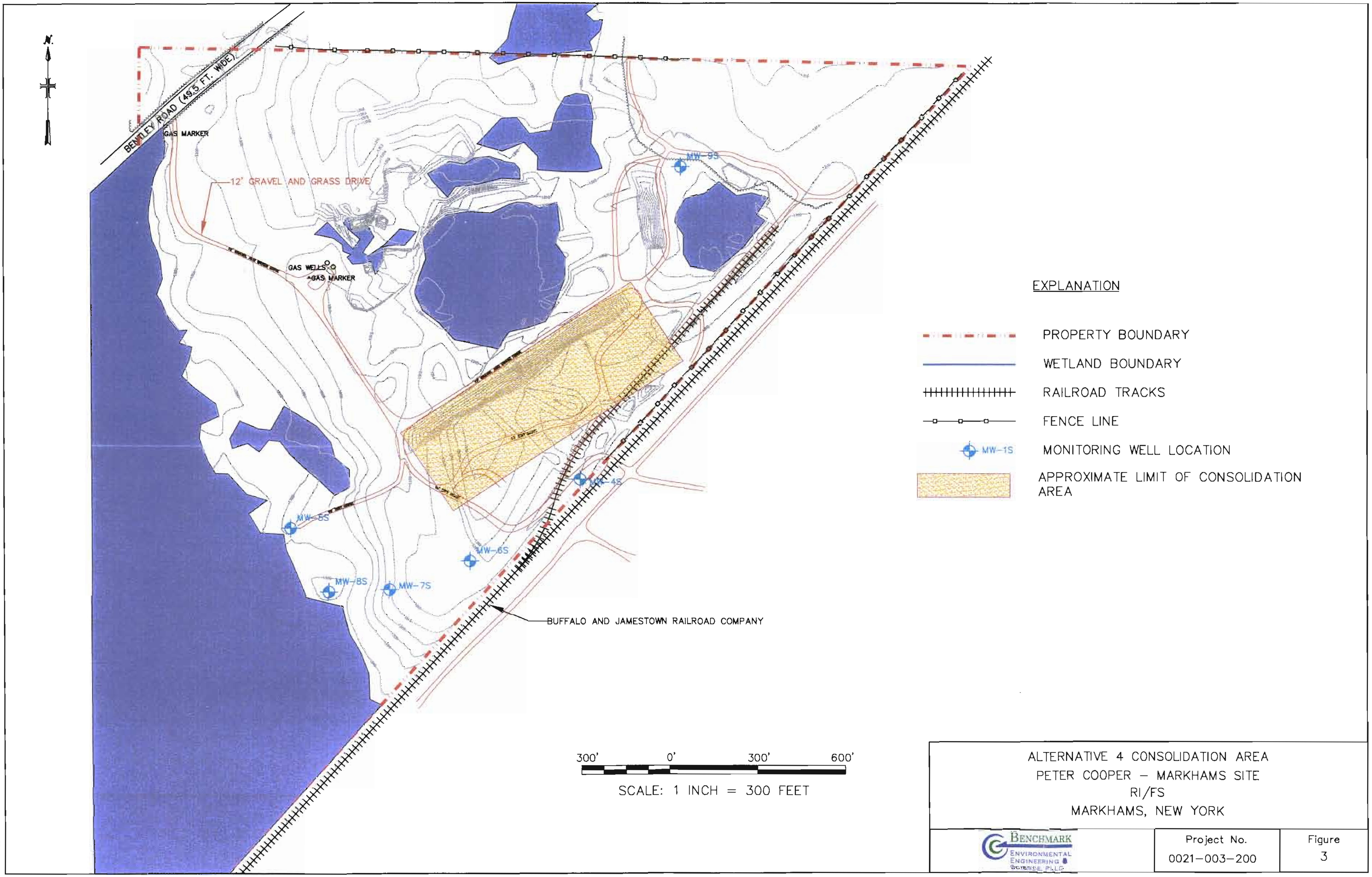
DRAFTED BY: BCH



EXPLANATION

- PROPERTY BOUNDARY
- WETLAND BOUNDARY
- RAILROAD TRACKS
- FENCE LINE
- MW-1S MONITORING WELL LOCATION
- APPROXIMATE LIMIT OF CONSOLIDATION AREA

ALTERNATIVE 4 CONSOLIDATION AREA
PETER COOPER – MARKHAMS SITE
RI/FS
MARKHAMS, NEW YORK

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

Project No.	Figure
0021–003–200	3

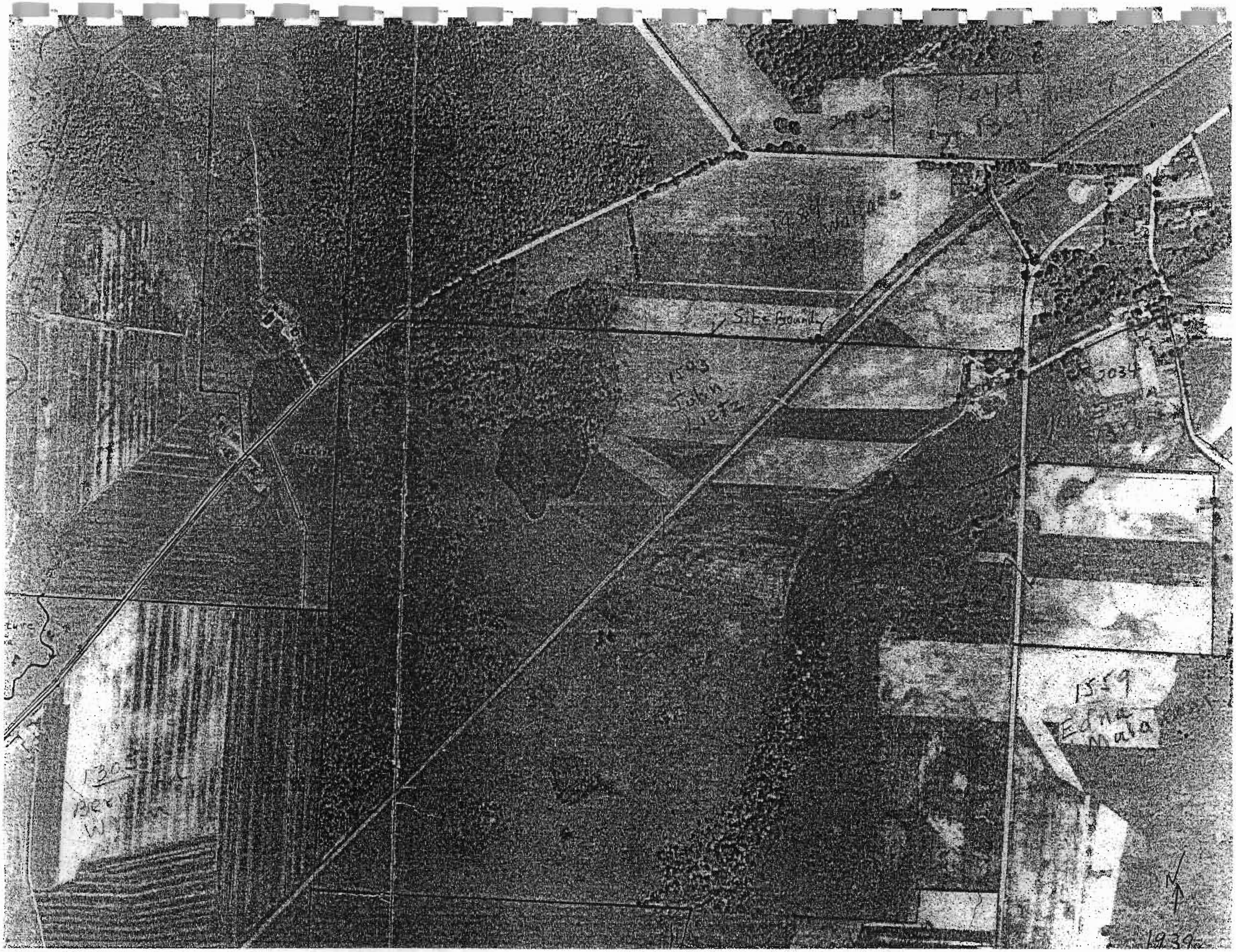
DATE: JULY 2006
FILEPATH: f:\benchmark\cad\collier shannon\markhams\figure 2: site location map.dwg
DRAFTED BY: BCH

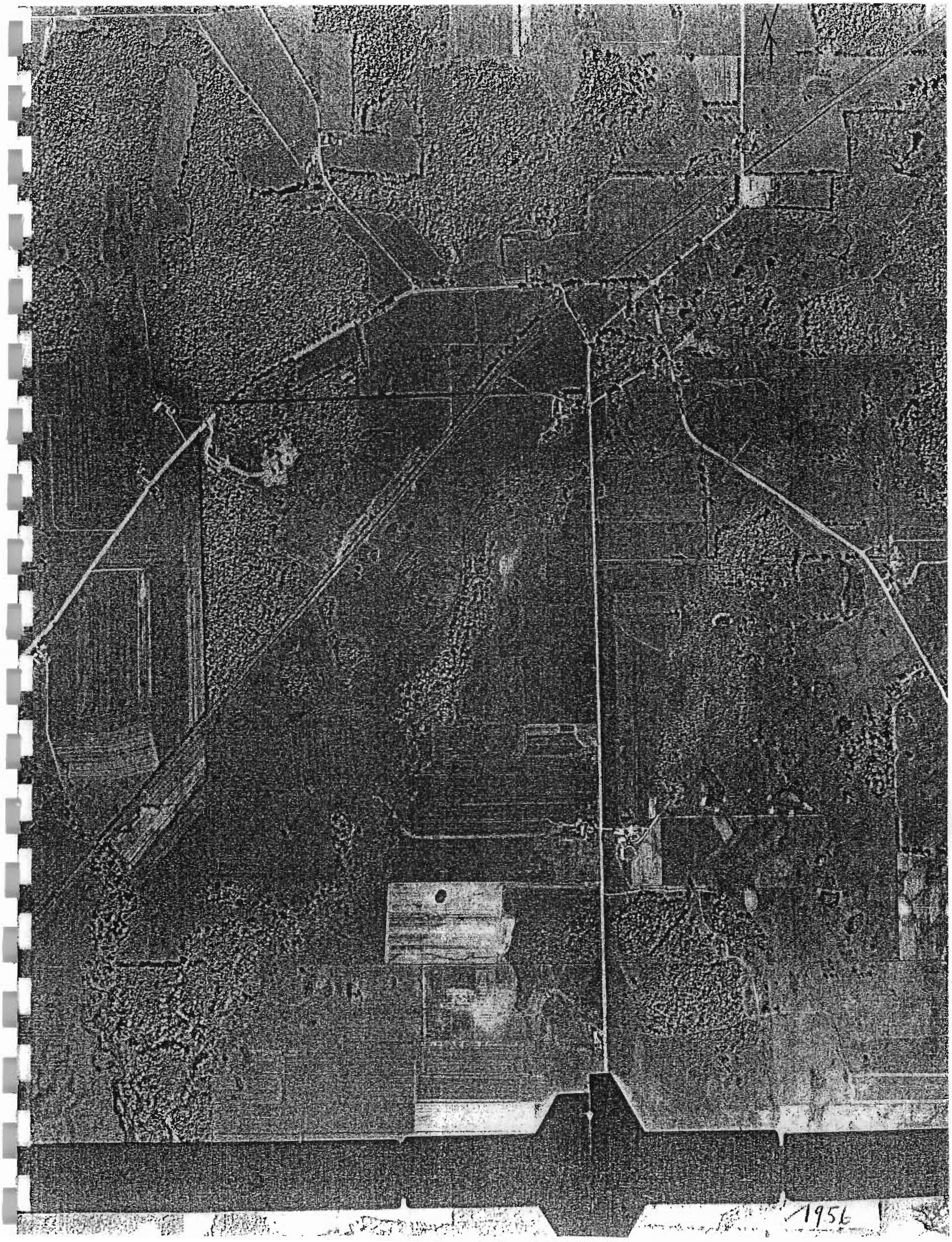
APPENDIX A

HISTORICAL INFORMATION/ANALYTICAL DATA

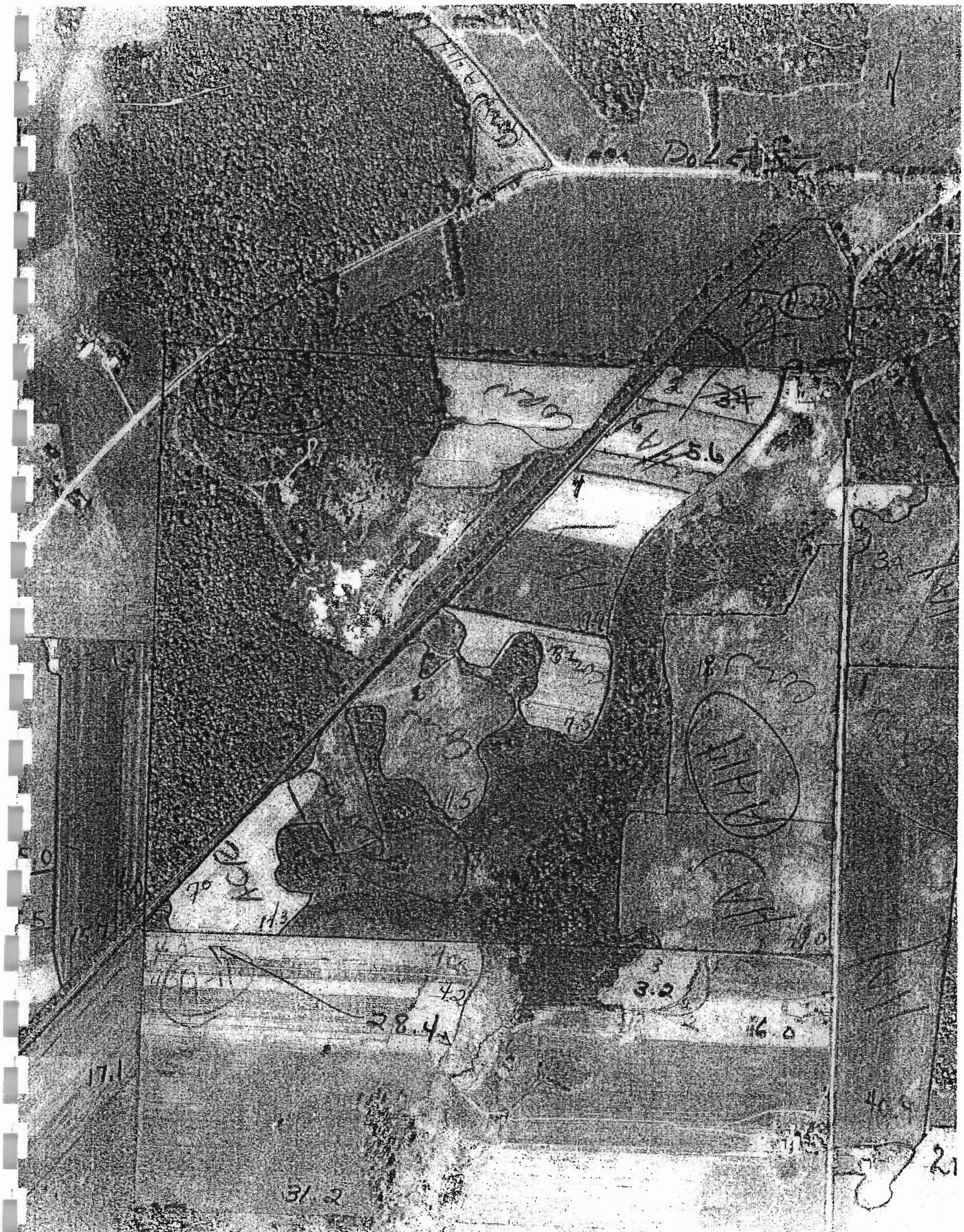
APPENDIX A-1

Historic Aerial Photographs


Site Boundary
1503
John
3034
1559
Edna
Mala
N
1939

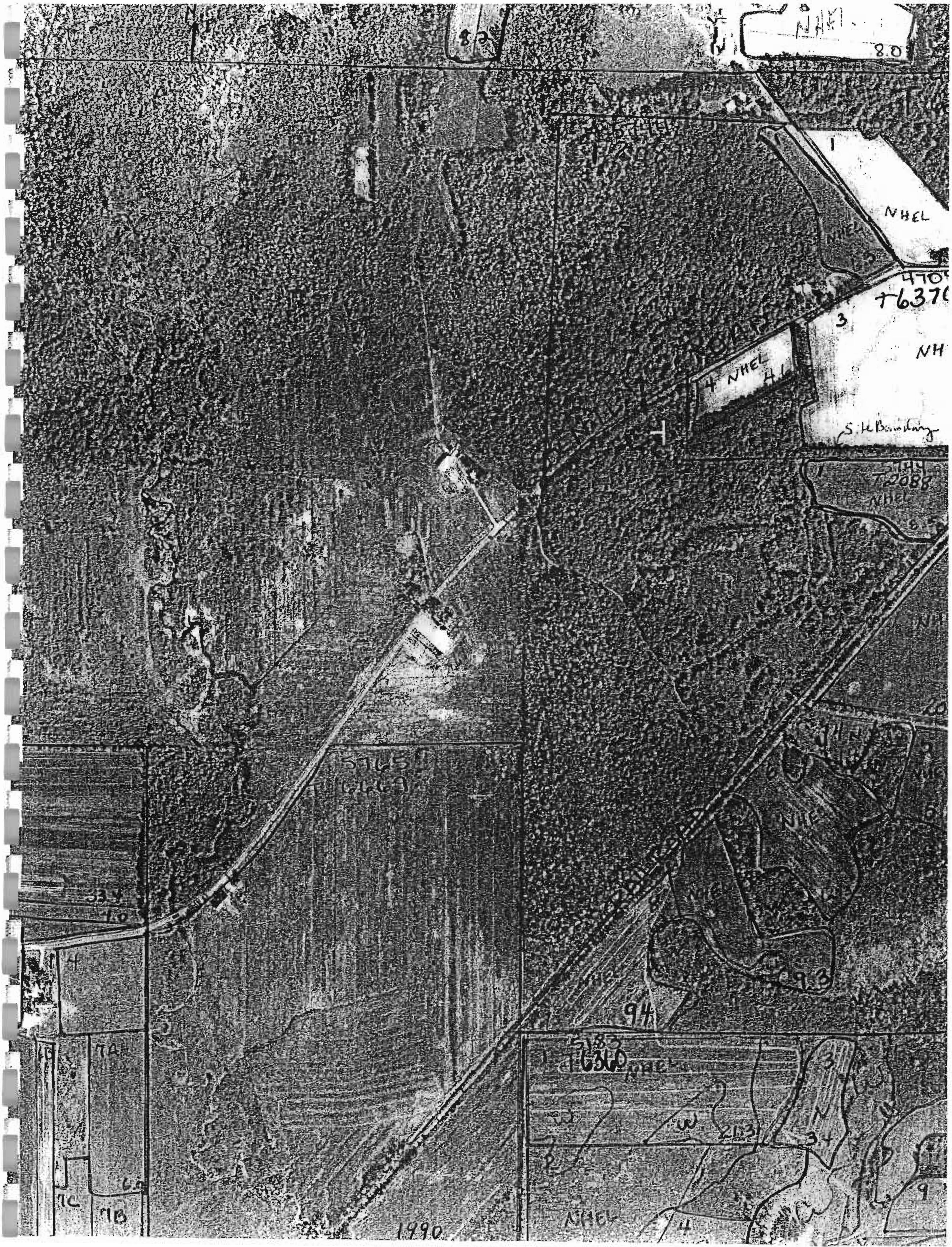


1956



1986

N
T4216
T2088
19.0
5.9
B
SV
20.0
19
51
CRP
9.7
11
123
93
CRP
94
6.2
11.8
1
T44
Crp
3
NI
14
5
3.3
6A
5.5
6B
2.2
7A
7B
6.1
2.2
8
4.3
2
Crp
4
Crp
10
10.1
1980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82
NHEL
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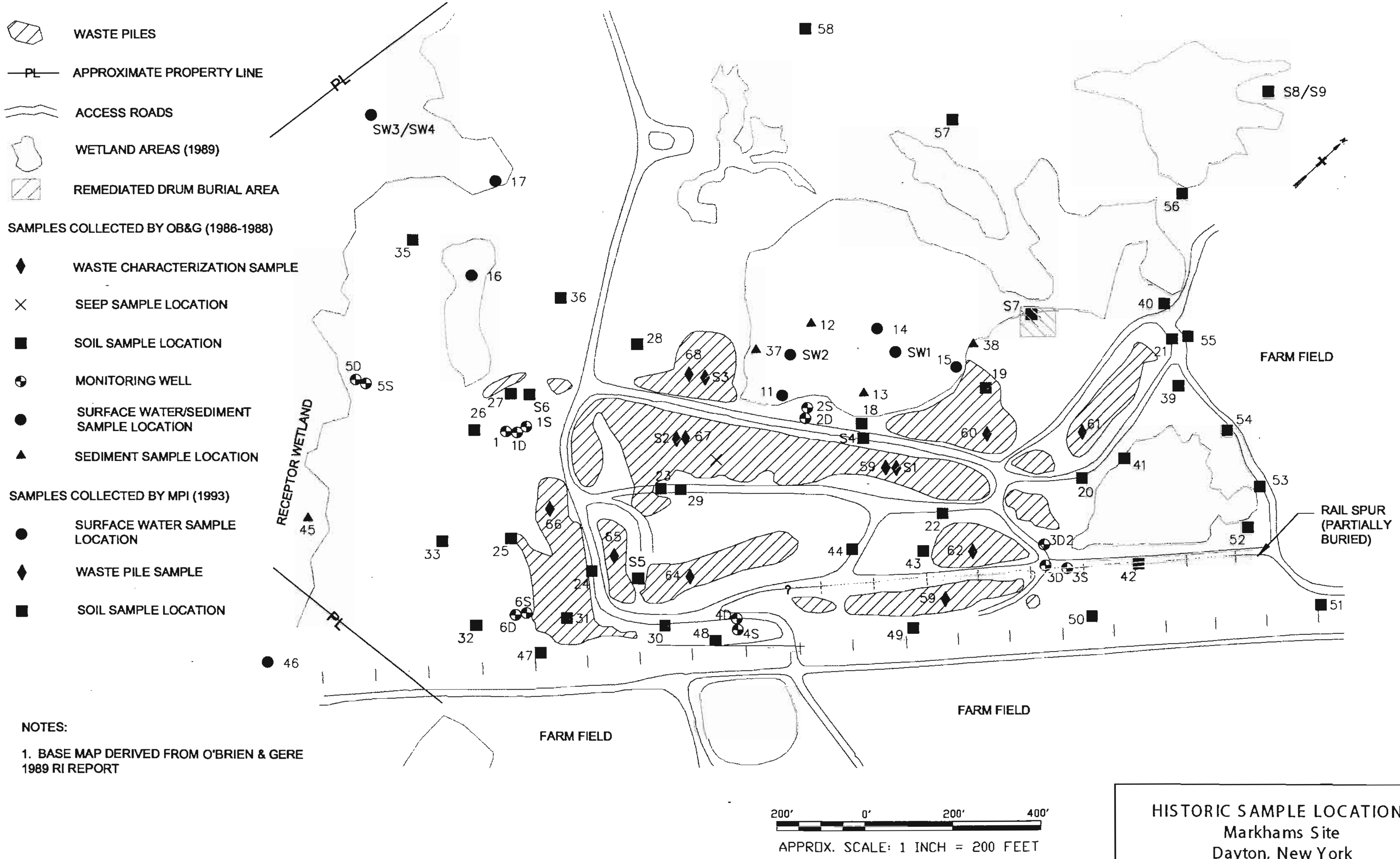
5144
T2981
1
NHEL
NHEL
4709
T6370
3
NH
4 NHEL
4.1
S.H Boundary
5144
T2088
NHEL
8.5
5765
T6669
33.4
1.0
4
60
NHEL
93
94
5183
T6360
NHEL
W
21.3
3
34
R
9
7A
7C
7B
6.0
NHEL
4
1990

APPENDIX A-2

Historic Sample Locations



NOTES:

1. BASE MAP DERIVED FROM O'BRIEN & GERE 1989 RI REPORT

HISTORIC SAMPLE LOCATIONS
Markhams Site
Dayton, New York

GEOMATRIX

Project No.
7603

Appendix A-1

Put network path and drawing No. information here

APPENDIX A-3A

Historical Soil and Sediment Sample Results

Appendix A-3a
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1983 Phase I Data
Surface Soil Characterization[1]

Parameter (mg/kg)	Sample Locations[2]	
	25' of Shed	100' NE of ROY
Antimony		
Arsenic	49	84
Beryllium		
Cadmium	1.2	2.5
Chromium	66	31000
Copper	140	69
Lead	32	120
Mercury		
Nickel	76	21
Selenium		
Silver	1.4	4.1
Thallium		
Zinc	500	1300

NOTES:

1. Samples were also analyzed for total halogenated organics and total halogentated VOCs. Results were all non-detectable.
2. Collected and analyzed in November 1981 by Recra Research
3. Blank space-compound analyzed for but not detected.

Appendix A-3a
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1983 Phase I Data
Sediment Characterization

Parameter	Sample Locations[1]		
(mg/kg)	Swamp -1	Swamp -2	Swamp -3
Antimony			
Arsenic		20	
Beryllium			
Cadmium		0.008	
Chromium	0.336	77.6	0.01
Copper	0.026	3.18	0.018
Lead		0.06	
Mercury			
Nickel		0.23	
Selenium			
Silver	0.008	0.009	0.012
Thallium			
Zinc	0.416	26	0.006

NOTES:

1 Collected and analyzed in 1981 by RECRA Environmental Samples were labeled as 'Swamp Water' however results are reported in mg/kg.

2 Blank space-compound analyzed for but not detected.

Appendix A-3a
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1985 Phase II Data
Surface Soil Characterization

Parameter	Sample Locations(1)						
(mg/kg)	4S	5S	6S	7S	8S	9S	10S
Arsenic	13.6	15.5	16.2	9.2	9.9	20.2	14.8
Beryllium							
Total Chromium	437	955	42.7	25400	2340	1850	162
Copper	34.1	50.1	24.4	124	32.4	43.3	45.1
Lead	20.4	30.1	9.4	60.8	8.8	11.4	12.4
Mercury	0.11	0.12		0.91		0.32	
Silver			0.54				
Zinc	156	380	119	991	135	168	467

NOTES:

1 Collected and analyzed in June 1984 by Recra Research
2 Blank space-compound analyzed for but not detected.

Appendix A-3a
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1985 Phase II Data
Surface Soil Characterization

Parameter (mg/kg)	Sample Locations[1]						
	4S	5S	6S	7S	8S	9S	10S
Halogenated Organic Scan (ECD)[2]	ND	ND	ND	ND	ND	ND	ND
Volatile Halogenated Organic Scan (Coulson's)[3]	ND	ND	ND	ND	ND	ND	ND

NOTES:

1 Collected and analyzed in June 1984 by Recra Research
2 Unit of Measure-ug/l as Chlorine;Lindane Standard
3 Unit of Measure-ug/l as Carbon Tetrachloride Standard
4 ND-Not Detected

Appendix A-3a
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1985 Phase II Data
Subsurface Soil Characterization

Parameter (mg/kg)	Sample Locations and Depths[1]							
	B-1 6-8'	B-1 14-16'	B-2 4-6'	B-2 14-16'	B-3 6-8'	B-3 16-18'	B-4 4-6'	B-4 14-16'
Arsenic	7.8	8.2	8.6	7.5	11.5	5.2	9.1	11.7
Beryllium								
Total Chromium	1290	13	56.1	6.4	13.7	4.9	21.9	10.1
Copper	41.7	16.7	31.3	15.3	43.4	14.5	27.9	24.4
Lead	18.8	2.1	6.7	1.6	7.6	4.9	2.2	1.7
Mercury								
Silver	0.63	2.9		0.77				0.66
Zinc	131	104	141	87.2	269	224	83.3	73.4

NOTES:

1 Collected and analyzed in June 1984 by Recra Research

2 Blank space-compound analzed for but not detected.

Appendix A-3a
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1985 Phase II Data
Subsurface Soil Characterization

Parameter (mg/kg)	Sample Locations and Depths(1)							
	B-1 6-8'	B-1 14-16'	B-2 4-6'	B-2 14-16'	B-3 6-8'	B-3 16-18'	B-4 4-6'	B-4 14-16'
Halogenated Organic Scan (ECD)(2)	ND	ND	ND	ND	ND	ND	ND	ND
Volatile Halogenated Organic Scan (Coulson's)(3)	ND	ND	ND	ND	ND	ND	ND	ND

NOTES:

1 Collected and analyzed in June 1984 by Recra Research
2 Unit of Measure-ug/l as Chlorine;Lindane Standard
3 Unit of Measure-ug/l as Carbon Tetrachloride Standard
4 ND - Not Detected

Appendix A-3a
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1985 Phase II Data
Sediment Characterization

Parameter (mg/kg)	Sample Locations[1]		
	3-C	4-C	5-C
Arsenic	3.9	2.7	3.0
Beryllium			
Total Chromium	27.2	134	100
Copper	55.3	85.2	25.6
Lead	144	5.8	5.3
Mercury			
Silver		6.7	
Zinc	867	161	91.5

NOTES:
1. Collected and analyzed in June 1984 by RECRA Environmental
2. Blank space-compound analzed for but not detected.

Appendix A-3a
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1985 Phase II Data
Sediment Characterization

Parameter (mg/kg)	Sample Locations[1]		
	3-C	4-C	5-C
Halogenated Organic Scan (ECD)[2]	ND	ND	ND
Volatile Halogenated Organic Scan (Coulson's)[3]	ND	ND	ND

NOTES:

1. Collected & analyzed June 1984 by RECRA Environmental
2. Unit of Measure-ug/l as Chlorine;Lindane Standard
3. Unit of Measure-ug/l as Carbon Tetrachloride Standard
4. ND - Not Detected

Appendix A-3a
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1989 RI Data
Soil/Sediment Characterization

Parameter	Sample Locations and Depth																		
	Well 1D		Well 2D		Well 3D		Well 4D		Well 5D		$11^{(3)}$	$12^{(3)}$	$13^{(3)}$	$14^{(3)}$	$15^{(3)}$	$16^{(3)}$	$17^{(3)}$	18	19
(mg/kg)	0-2'	6-8'	0-2'	4-6'	0-2'	4-6'	0-2'	8-10'	0-2'	2-4'	0-3"	0-3"	0-3"	0-3"	0-3"	0-3"	0-3"	0-3"	0-3"
Total Chromium	46	13	11	11	90	12	5280	13	13	11	895	54	1270	11	163	139	31	139	56
Hexavalent Chromium	0.45	0.26			1.8		169	1.1			25	2	14	1.1	12	11	2.1	12	1.4
Arsenic	27	17	23	28	8.3	18	18	11	24	18	7	4.1	8.7		5.9	16	25	17	18
Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NOTES:

1 NA-Not Analyzed
2 Blank Space-compound analyzed for but not detected
3 Collected from wetland area.

Appendix A-3a
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1989 RI Data
Soil/Sediment Characterization

Parameter	Sample Locations and Depth																	
	20	21	22	23	23(Dup)	24	25	26	27	27(Dup)	28	29	30		31		32	
(mg/kg)	0-3"	0-3"	0-3"	0-3"	0-3"	0-3"	0-3"	0-3"	0-3"	0-3"	0-3"	0-3"	0-3"	9-12"	0-3"	9-12"	0-3"	9-12"
Total Chromium	193	401	2710	8560	4070	3230	69300	66	29900	20800	99	10600	890	460	4930	20200	12	10
Hexavalent Chromium	3.1	7.3	612	80	212	41	854	2.4	75	87	19	438	22	59	25	5.8	0.19	
Arsenic	16	15	11	12	5.4	13	2	15	8.7	9.1	10	14	9.4	9.3	11	10	10	20
Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NOTES:

1 NA-Not Analyzed
2 Blank Space-compound analyzed for but not detected

File:..SoilasteSum.xls

Appendix A-3a
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1989 RI Data
Soil/Sediment Characterization

Parameter (mg/kg)	Sample Locations and Depth																	
	33		34		35		36		37[3]		38		39		40		41	
	0-3"	9-12"	0-3"	9-12"	0-3"	9-12"	0-3"	9-12"	0-3"	9-12"	0-3"	9-12"	0-3"	9-12"	0-3"	9-12"	0-3"	3-6"
Total Chromium	13	11	7.9	11	7.4	25	13	12	34	4.7	19	70	40	16	127	24	108	35
Hexavalent Chromium	0.19		0.23	0.08	0.26		0.37	0.12	1.9	0.86	1.9	4.2	2	0.12	10	0.49	0.86	0.11
Arsenic	12	19	9.8	19	19	14	21	18		2.3	11	15	17	13	16	23	12	14
Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NOTES:

1 NA-Not Analyzed
2 Blank Space-compound analyzed for but not detected
3 Collected from wetland area.

Appendix A-3a
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1989 RI Data
Soil/Sediment Characterization

Parameter	Sample Locations and Depth																				
	42		43		44		45	46	47	48	49	50	51	52	53	54	55	56*	57*	58*
(mg/kg)	0-3"	9-12"	0-3"	9-12"	0-3"	9-12"	Sediment	Sediment	0-3"	0-3"	0-3"	0-3"	0-3"	0-3"	0-3"	0-3"	0-3"	0-3"	0-3"	0-3"
Total Chromium	2950	630	8340	10050	84	2080	30	20	1100	83	1200	33	18	46	41	38	420	17	8.6	9.0
Hexavalent Chromium	14	55	183	1.14	2.7	7.5														
Arsenic	7.6	4.7	20	16	15	17	30	9.6	15	15	18	15	4.4	4.7	19	15	16	7.4	1.6	3.7
Zinc	NA	NA	NA	NA	NA	NA	140	180	100	120	330	160	110	100	110	110	190	99	20	49

NOTES:

1 NA-Not Analyzed
2 *Background Sample locations
3 Blank Space-compound analyzed for but not detected

Appendix A-3a
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1993 SSI Data
Surface Soil Characterization

Parameter	Sample Locations(1)								
(mg/kg)	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8*	S-9**
Aluminum	4660 E	291	9610	9000	7530	11200	9790	15700	12500
Antimony	85.2 E	10.3 J	29 E		47.6 E				
Arsenic	25 E	1.1 J	14.3 E	11.6 E	12.9 E	12.7 E	8.3 E	7.7 E	4 E
Barium	226 E	242 E	94.2 E	53.4 E	102 E	71.9 E	89.5 E	105 E	89.2 E
Beryllium	0.45 J			0.27 J	0.35 J	0.66 J	0.54 J	0.36 J	0.27 J
Cadmium									
Calcium	24500 E	65900	65200	3230	79400	4820	1080 J	974 J	751 J
Total Chromium	26800 E	946	11100	389	18100	337	122	19.8	15.7
Cobalt	12.2 J	1.6 J	8.1 J	8.2 J	8.6 J	10.5 J	8.7 J	8.4 J	5.8 J
Copper	467 E	159 E	110 E	43.6 E	139 E	34.6 E	37.8 E	28.6 E	21.3 E
Iron	26700 E	1620	16900	19500	17600	21800	22000	32600	20700
Lead	228 E	243	71.3	18.1	82.5	22.9	26	20.7	14.4
Magnesium	2460 E	43.2 J	3960	2560	3440	3650	2880	3660	2620
Manganese	335 E	4.9	423	658	364	1060	540	183	124
Mercury	3.8 E	4.5	1.4	0.1 J	1.7		0.1 J		
Nickel	25 E		14.6	19.2 E	15.1	26 E	21.8 E	21 E	16.6 E
Potassium	544 J	163 J	448 J	539 J	432 J	979 J	788 J	762 J	634 J
Selenium									
Silver	2.5 J	126	1.7 J	1.2 J			1.2 J		1.4 J
Sodium	96.5 J	40.8 J	163 J	52.9 J	320 J	54.9 J	48.2 J	66 J	36.7 J
Thallium				0.32 J	0.42 J	0.46 J	0.3 J		
Vanadium	37.1 E	3.6 J	24.2 E	15.6 E	26.2 E	19.1 E	18 E	29.2 E	21.5 E
Zinc	2270 E	80.9	645	200	1210	300	160	117	90.7

NOTES:

1 Collected and analyzed in June 1993
2 * Background Sample
3 ** Duplicate of S-8
4 Blank space-compound analzed for but not detected.
5 E-Estimated Value
6 J-estimated value, compound present below CDRL but >IDL

Appendix A-3a
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1993 SSI Data
Surface Soil Characterization

Parameter	Sample Locations(1)								
(ug/kg)	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8*	S-9**
Phenol	730 J								
1,4-Dichlorobenzene	370 J		180 J						
1,2-Dichlorobenzene	2100 E		280 J						
4-Methylphenol	2300 E	3300 J							
1,2,4-Trichlorobenzene	210 J								
Naphthalene	320 J	2600 J	120 J						
2-Methylnaphthalene			57 J						
Acenaphthene	290 J								
Dibenzofuran	220 J								
Fluorene	360 J								
Hexachlorobenzene			120 J						
Pentachlorophenol	120 J	1400 J							
Phenanthrene	4000 E	850 J		52 J	140 J				
Anthracene	790 J								
Carbazole	380 J								
Fluoranthene	5900 E	2000 J		88 J	330 J				
Pyrene	6700 E	2400 J		74 J	240 J				
Benzo(a)anthracene	2900 E	1200 J			190 J				
Chrysene	3600 E	2500 J			260 J				
Benzo(b)fluoranthene	3000 E								
Benzo(k)fluoranthene	2600 E								
Benzo(a)pyrene	2500 E								
Indeno(1,2,3-cd)pyrene	2100 E								

NOTES:

1 Collected and analyzed in June 1993
2 * Background Sample
3 ** Duplicate of S-8
4 Blank space-compound analzed for but not detected.
5 E-Estimated Value
6 J-estimated value, compound present below CDRL but >IDL

Appendix A-3a
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1993 SSI Data
Surface Soil Characterization

Parameter	Sample Locations(1)								
(ug/kg)	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8*	S-9**
Dieldrin			7.2 E						
4,4'-DDE	76 E	610 E	94 E		30 E				
Endrin aldehyde					13 EN				
alpha-Chlordane			31 EN		6.8 EN				
gamma-Chlordane			27 EN						
Arochlor-1254	85 J	150 J			58 EN				
Arochlor-1260			93 EN						

NOTES:

1 Collected and analyzed in June 1993
2 * Background Sample
3 ** Duplicate of S-8
4 Blank space-compound analzed for but not detected.
5 E-Estimated Value
6 J-estimated value, compound present below CDRL but >IDL
7 N-Presumptive evidence of the presence of the material

File:..SoilPirnieData.xls

APPENDIX A-3B

Historical Waste Fill and Seep Sample Results

Appendix A-3b
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1989 RI Data
Waste/Fill Characterization

Parameter	Sample Locations [1]					
(mg/kg)	M-59	M-60 [2]	M-64 [2]	M-66	M-67 [2]	M-68
Total Chromium	4600			20000		46000
Arsenic	7.1			7.2		10
Zinc	680			850		900

NOTES:

1 Samples collected in 1988
2 See Composite Waste Analyses (Table 3b)

Appendix A-3b
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1989 RI Data
Waste/Fill Characterization (EP)

Parameter	Sample Location (1)					
(mg/l)	M-59	M-60	M-64	M-66	M-67	M-68
Total Chromium		0.11	0.08		2.4	
Arsenic						
Zinc	0.4	3.9	0.61	0.31	5.7	0.3

NOTES:

1 Samples collected in 1988

2 Expressed in milligrams/liter in leachate per 40 CFR 261

3 Blank Space-compound analyzed for but not detected

Appendix A-3b
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1989 RI Data
Waste/Fill Characterization(1)(3)

Parameter (mg/kg)	Waste Composite (2)
Aluminum	7910
Antimony	<8.78
Arsenic	10.5
Barium	98.6
Beryllium	<0.732
Cadmium	<0.732
Calcium	69900
Chromium	8780
Cobalt	<0.732
Copper	81.8
Cyanide	0.879
Iron	14300
Lead	61.2
Magnesium	2290
Manganese	211
Nickel	12.4
Potassium	<732
Selenium	<7.32
Silver	<1.46
Sodium	<732
Thallium	<1.46
Vanadium	16.1
Zinc	408
Mercury	0.735
Percent Total Solids	68.3

NOTES:

1 Samples collected in 1988

2 Composite Sample of M-60, M-64 and M-67 .

3 HSL organics all non detect.

File:..SoilasteSum.xls

Appendix A-3b
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1989 RI Data
Seep Quality

Parameter (mg/l)	Unit	Seep Composite Concentration
Total Chromium	mg/l	3.8
Hexavalent Chromium	mg/l	1.7
Arsenic	mg/l	0.022
Zinc	mg/l	0.67
Ammonia	mg NH_3-N/l	300
BOD (5)	mg/l	100
Nitrate	mg NH_2-N/l	0.21
Nitrite	mg NO_2-N/l	Not Detected
TKN	mg/l	400

NOTES: 1. Sampling Date 4/21/87

APPENDIX A-3C

Historical Surface Water Sample Results

Appendix A-3c
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1985 Phase II Data
Surface Water Characterization

Parameter (mg/l)	Sample Locations[1]		
	3-W	4-W	5-W
Arsenic	0.006	0.006	
Beryllium			
Chloride	1.6	2.4	4.2
Total Chromium	0.092	0.118	0.637
Copper	0.017	0.022	0.018
Lead			
Mercury			
Silver			
Zinc	0.054	0.07	0.114

NOTES:

1. Collected & analyzed June 1984 by Recra Research
2. Blank Space-Compound analyzed for but not detected

Appendix A-3c
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1985 Phase II Data
Surface Water Characterization

Parameter (ug/l)	Sample Locations[1]		
	3-W	4-W	5-W
Halogenated Organic Scan (ECD)[2]			
Volatile Halogenated Organic Scan (Coulson's)[3]	30	58	10

NOTES:

1 Collected & analyzed June 1984 by Recra Research
2 Unit of Measure-ug/l as Chlorine;Lindane Standard
3 Unit of Measure-ug/l as Carbon Tetrachloride Standard
4 Blank Space-Compound analyzed for but not detected

Appendix A-3c
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1989 RI Data
Surface Water Characterization

Parameter	Sample Locations[1]						(2)	
(mg/L)	11	14	15	16	17	17(Dup)	46	46*
Total Chromium	2.84	0.02	0.548	0.055	0.196	0.085		
Hexavalent Chromium		0.007					NA	NA
Arsenic	0.104		0.018	0.005	0.061	0.052		0.006
Zinc	NA	NA	NA	NA	NA	NA		

NOTES:

1 Samples collected in Sept. 1986
2 Samples collected in July 1988
3 NA-Not Analyzed
4 *Acid Soluble Results
5 Blank space-compound analyzed for but not detected

Appendix A-3c
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1993 SSI Data
Surface Water Characterization

Parameter (mg/l)	Sample Locations[1]			
	SW-1	SW-2	SW-3	SW-3 Dupe
Aluminum	0.412	0.448	1.8	2.38
Arsenic		0.0046 J	0.0088 J	0.0098 J
Barium	0.0253 J	0.0499 J	0.189 J	0.2 J
Beryllium	0.00057 J		0.00037 J	0.00037 J
Cadmium			0.0021 J	0.0014 J
Calcium	6.16	23.2	23.7	24
Total Chromium	0.0044 J	0.0223		
Cobalt			0.0054 J	0.0054 J
Copper	0.008 J	0.0107 J	0.0149 J	0.0133 J
Iron	0.853	3.57	11	13.1
Lead	0.0171	0.0186	0.0206	0.0243
Magnesium	1.16 J	3.43 J	3.75 J	3.87 J
Manganese	0.066	0.358	1.67	2.04
Nickel		0.0043 J	0.0048 J	
Potassium	0.395 J	0.717 J	1.14 J	1.05 J
Sodium	1.61 J	1.46 J	1.39 J	1.39 J
Vanadium		0.0021 J	0.012 J	0.012 J
Zinc	0.0806	0.0821	0.0793	0.0624

NOTES:

1 Collected and analyzed in June 1993 for TAL Metals using EPA CLP SOW.
2 Blank Space-Compound analyzed for but not detected
3 J-estimated value, compound present below CDRL but >IDI

Appendix A-3c
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1993 SSI Data
Surface Water Characterization

Parameter	Sample Location			
(ug/l)	SW-1	SW-2	SW-3	SW-3 Dupe
Carbon Disulfide		100		

Notes:

1 Collected and analyzed in June 1993

2 Analyzed samples for full TCL organic list using EPA CLP SOW. Carbon Disulfide was the only organic compound detected above the detection limit.

3 Blank space-compound analzed for but not detected.

APPENDIX A-3D

Historical Groundwater Sample Results

Appendix A-3d
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1985 Phase II Data
Shallow Groundwater Characterization

Parameter (mg/l)	Sample Locations and Collection Date[1]			
	B-1(1S)	B-2(2S)	B-3(3S)	B-4(4S)
	6/6/1984	6/4/1984	6/1/1984	6/1/1984
Total Chromium	0.026	ND	ND	0.023
Arsenic	ND	ND	ND	ND
Zinc	58.3	0.791	0.315	5.0
Chloride	39	1.8	6.8	5.4
Beryllium	ND	ND	ND	ND
Copper	ND	ND	ND	0.013
Lead	ND	ND	ND	ND
Mercury	ND	ND	ND	ND
Silver	ND	0.015	ND	ND

NOTES:

1 Collected and analyzed by Recra Research
2 ND-Not Detected

Appendix A-3d
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1985 Phase II Data
Shallow Groundwater Characterization

Parameter (ug/l)	Sample Locations and Collection Date[1]			
	B-1(1S)	B-2(2S)	B-3(3S)	B-4(4S)
	6/6/1984	6/4/1984	6/1/1984	6/1/1984
Halogenated Organic Scan (ECD)[2]	ND	ND	ND	0.023
Volatile Halogenated Organic Scan (Coulson's)[3]	ND	62	18	27

NOTES:

1 Collected and analyzed by Recra Research
2 Unit of Measure-ug/l as Chlorine;Lindane Standard
3 Unit of Measure-ug/l as Carbon Tetrachloride Standard
4 ND-Not Detected

Appendix A-3d
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1989 RI Data
Groundwater Characterization(1)(3) - Unfiltered Samples

Parameter (mg/L)	Sample Locations and Collection Date													
	1-Shallow			1-Deep				2-Shallow			2-Deep			
	9/9/1986	4/15/1987	7/13/1988	9/9/1986	4/15/1987	4/15/1987 Dup	7/13/1988	9/10/1986	4/15/1987	7/13/1988	9/10/1986	9/10/1986 Dup	4/15/1987	7/13/1988
Total Chromium	NA	0.083	0.008	NA	0.027	0.027	0.03	NA	0.033	0.03	NA	NA	0.25	0.02
Hexavalent Chromium	NA	0.008		NA				NA		NA	NA	NA		
Arsenic	NA	0.033	0.08	NA				NA			NA	NA	0.49	
Zinc	NA	NA	0.49	NA	NA	NA	0.01	NA	NA	3.9	NA	NA	NA	0.02
Chloride	NA	9.2	NA	NA	82	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	NA	840	NA	NA	140	NA	NA	NA	NA	NA	NA	NA	NA	NA

Organic Parameter (ug/L)	Sample Location & Collection Date		
	1-Shallow		
	9/10/1986	4/21/1987	7/13/1988
Bis (2-ethylhexyl)phthalate	NA	3.0	NA
N-nitrosodiphenylamine	NA	2.7	NA
Delta-BHC	NA	0.013	NA

NOTES:

1 Sample from Well 1S was also analyzed for HSL organics.
2 NA-Not Analyzed
3 Only those parameters/locations exhibiting detectable concentrations are presented.
4 Blank space-compound analyzed for but not detected.

Appendix A-3d
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1989 RI Data
Groundwater Characterization(1) - Unfiltered Samples

Parameter	Sample Locations and Collection Date												
	3-Shallow			3-Deep		4-Shallow				4-Deep			
(mg/L)	9/17/1986	4/15/1987	7/13/1988	4/15/1987	7/13/1988	9/10/1986	4/15/1987	7/13/1988	8/31/1988	9/10/1986	4/15/1987	7/13/1988	8/31/1988
Total Chromium	NA	0.006	0.01	0.006	0.01	NA	0.17	NA	0.05	NA	0.11	0.02	0.02
Hexavalent Chromium	NA					NA		NA		NA			
Arsenic	NA	0.008	0.006			NA	0.005	NA		NA	0.042	0.005	
Zinc	NA	NA	0.94	NA	0.01	NA	NA	NA	80	NA	NA	0.08	0.04
Chloride	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8.7	NA	NA
Sulfate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	81	NA	NA

NOTES:

1 Groundwater also collected and analyzed for HSL organics from Well 3S, Well 3D, Well 6S, and Well 6D. Results were less than the detection limit.
2 NA-Not Analyzed
3 Only those parameters/locations exhibiting detectable concentrations are presented.
4 Blank space-compound analyzed for but not detected.

Appendix A-3d
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1989 RI Data
Groundwater Characterization(1) - Unfiltered Samples

Parameter	Sample Locations and Collection Date										
	5-Shallow			5-Deep			6-Shallow		6-Deep		
(mg/L)	9/10/1986	4/15/1987	7/13/1988	9/10/1986	4/15/1987	7/13/1988	7/13/1988	8/31/1988	7/13/1988	7/13/1988 Dup	8/31/1988
Total Chromium	NA	0.054	0.02	NA	0.007	0.02	0.23	0.13	0.05	0.04	
Hexavalent Chromium	NA			NA			0.018				
Arsenic	NA	0.059		NA			0.02	0.011			
Zinc	NA	NA		NA	NA	0.02	0.18	0.08	0.03	0.02	0.01
Chloride	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NOTES:

1 Groundwater also collected and analyzed for HSL organics from Well 3S, Well 3D, Well 6S, and Well 6D. Results were less than the detection limit.
2 NA-Not Analyzed
3 Only those parameters/locations exhibiting detectable concentrations are presented.
4 Blank space-compound analyzed for but not detected.

Appendix A-3d
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1989 RI Data
Groundwater Characterization - Filtered Samples

Parameter	Sample Locations and Collection Date													
	1-Shallow			1-Deep				2-Shallow			2-Deep			
(mg/L)	9/9/1986	4/15/1987	7/13/1988	9/9/1986	4/15/1987	4/15/1987 Dup	7/13/1988	9/10/1986	4/15/1987	7/13/1988	9/10/1986	9/10/1986 Dup	4/15/1987	7/13/1988
Total Chromium	0.055	0.035	0.05	0.017	0.021	0.016	0.03	0.009	NA	0.01	0.009		NA	
Hexavalent Chromium	0.017	NA			NA	NA			NA	NA	0.009		NA	
Arsenic	0.025	NA	0.025		NA	NA			NA		0.02	0.021	NA	
Zinc	0.038	NA	0.02	0.045	NA	NA	0.01	8.86	NA	0.04	0.021	0.02	NA	0.02
Calcium	NA	290	NA	NA	220	NA	NA	NA	NA	NA	NA	NA	NA	NA
Magnesium	NA	62	NA	NA	57	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sodium	NA	13	NA	NA	44	NA	NA	NA	NA	NA	NA	NA	NA	NA

NOTES:

1 NA-Not Analyzed
2 Only those parameters/locations exhibiting detectable concentrations are presented.
3 Blank space-compound analyzed for but not detected.

Appendix A-3d
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1989 RI Data
Groundwater Characterization - Filtered Samples

Parameter	Sample Locations and Collection Date											
	3-Shallow			3-Deep		4-Shallow			4-Deep			
(mg/L)	9/17/1986	4/15/1987	7/13/1988	4/15/1987	7/13/1988	9/10/1986	4/15/1987	7/13/1988	9/10/1986	4/15/1987	7/13/1988	8/31/1988
Total Chromium		NA	0.01	NA	0.01		NA			0.007	0.01	
Hexavalent Chromium		NA		NA			NA	NA		NA	0.082	
Arsenic		NA		NA			NA			NA		
Zinc	0.338	NA	0.39	NA		10.5	NA	0.26	0.049	NA	0.08	0.02
Calcium	NA	NA	NA	NA	NA	NA	NA	NA	NA	58	NA	NA
Magnesium	NA	NA	NA	NA	NA	NA	NA	NA	NA	11	NA	NA
Sodium	NA	NA	NA	NA	NA	NA	NA	NA	NA	26	NA	NA

NOTES:

1 NA-Not Analyzed
2 Only those parameters/locations exhibiting detectable concentrations are presented.
3 Blank space-compound analyzed for but not detected.

Appendix A-3d
Peter Cooper Markhams Site
RI/FS Work Plan
Summary of 1989 RI Data
Groundwater Characterization - Filtered Samples

Inorganic Parameter (mg/L)	Sample Locations and Collection Date										
	5-Shallow			5-Deep			6-Shallow		6-Deep		
	9/10/1986	4/15/1987	7/13/1988	9/10/1986	4/15/1987	7/13/1988	7/13/1988	8/31/1988	7/13/1988	7/13/1988 Dup	8/31/1988
Total Chromium		NA	0.02		NA	0.02	0.07	0.05	0.04	0.04	0.03
Hexavalent Chromium					NA		0.014				
Arsenic		NA			NA						
Zinc	0.032	NA		0.022	NA	0.01	0.02	0.03	0.03	0.02	
Calcium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Magnesium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sodium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NOTES:

1 NA-Not Analyzed
2 Only those parameters/locations exhibiting detectable concentrations are presented.
3 Blank space-compound analyzed for but not detected.

APPENDIX B

RI DATA SUMMARY TABLES AND SAMPLE LOCATION MAPS

Table 5-1

ANALYTICAL RESULTS FOR WASTE FILL SAMPLES FROM FILL PILE BORINGS

Peter Cooper Markhams Site
Dayton, New York

	Soil Criteria[3]				*Sample Location, Sample Identification #, and Date Collected*[1]		
Constituent[2]	*Eastern USA Background*	*Region 9 PRG*	*EPA Soil Screening Level*	*Site Background Level*	*B-4, 4-5 fbgs 100501011 10/5/2001*	*B-5, 4-5 fbgs 100901018 10/9/2001*	*B-6, 5.5-6.5 fbgs 100901022 10/9/2001*
Total Metals, milligrams per kilogram							
Arsenic	3 - 12**	1.6	29	ND to 8.1	9.1 J	51.6 J	65.6 J
Chromium	1.5 - 40**	450	38	7.8 to 31.8	8870/31200[5]	4490	6390
Hexavalent Chromium	--	64	38	--	(0.65 U)R/4.7[5]	(0.65 U) R	(0.66 U) R
SPLP Metals, micrograms per liter	*Groundwater Criteria*[4]						
	TOGs	*PRG*					
Arsenic	25	0.045	--	--	10 U	10 UJ	14.2
Chromium	50	55000	--	--	377 J	226	1010
Hexavalent Chromium	50	110	--	--	22 J	10 UJ	10 UJ

Notes:

1. Sample locations provided on Plate 1.

▨ indicates concentration is above all soil criteria.

2. Data qualifications reflect 100% data validation performed by Data Validation Services
3. Soil criteria is from NYSDEC Division of Environmental Remediation, Technical and Administrative Guidance Memorandum #4046 for Eastern USA Background Heavy Metals Concentration in Soil (January 1994), U.S. EPA Region 9 Preliminary Remediation Goals (PRGs) for Industrial Soil (October 2004), and U.S. EPA Soil Screening Guidance, Generic Soil Screening Levels for Migration to Groundwater (July 1996)
4. Groundwater criteria is from NYSDEC Divison of Water, Technical and Operational Guidance Series (TOGs) Ambient Water Quality Standards and Guidance Values (June 1998) and U.S. EPA Region 9 Preliminary Remediation Goals (PRGs) for Tap Water (2004)
5. Confirmation sample, collected December 2003.

** indicates a New York State background concentration

-- indicates no criteria exists

(value) = concentration reported by the laboratory prior to being rejected by data validation

R = rejected concentration as a result of data validation

ND = non-detect

INORGANIC DATA QUALIFIERS:

J = a value greater than or equal to the instrument detection limit, but less than the quantitation limit

Table 5-2

ANALYTICAL RESULTS FOR BACKGROUND SURFACE SOIL SAMPLES

Peter Cooper Markhams Site
Dayton, New York

	Soil Criteria[3]				Sample Location, Sample Identification #, and Date Collected[1]					
Constituent[2]	*Eastern USA Background*	*Region 9 PRG*	*Soil Screening Level*	*Site Background Level*	*Lathe #52* *101501134* *10/15/2001*	*Lathe #55* *101501141* *10/15/2001*	*Lathe #54* *101501142* *10/15/2001*	*Lathe #53* *101501143* *10/15/2001*	*Lathe #51* *101501144* *10/15/2001*	*Lathe #50* *101501145* *10/15/2001*
Total Metals, milligrams per kilogram										
Arsenic	3 - 12**	1.6	29	ND to 8.1	8.1	1.4 U	7.1	5.8	5.2	5.3
Chromium	1.5 - 40**	450	38	7.8 to 31.8	20.7 J	7.8 J	31.8 J	11.1 J	15.6 J	26.4 J

Notes:

1. Sample locations provided on Plate 1
2. Data qualifications reflect 100% data validation performed by Data Validation Services
3. Soil criteria is from NYSDEC Division of Environmental Remediation, Technical and Administrative Guidance Memorandum #4046 for Eastern USA Background Heavy Metals Concentration in Soil (January 1994), U.S. EPA Region 9 Preliminary Remediation Goals (PRGs) for Industrial Soil (October 2004), and U.S. EPA Soil Screening Guidance, Generic Soil Screening Levels for Migration to Groundwater (July 1996)

▨ indicates concentration is above all soil criteria.

** indicates a New York State background concentration

ND = non-detect

INORGANIC DATA QUALIFIERS:

U = element was analyzed for, but not detected; reported with detection limit value

J = a value greater than or equal to the instrument detection limit, but less than the quantitation limit

Table 5-3

ANALYTICAL RESULTS FOR COVER SOIL SAMPLES FROM TOP OF FILL PILES

Peter Cooper Markhams Site
Dayton, New York

	Soil Criteria[3]				*Sample Location, Identification, and Date Collected*[1]								
Constituent[2]	*Eastern USA Background*	*Region 9 PRG*	*Soil Screening Level*	*Site Background Level*	*Lathe #118 101001037 10/10/2001*	*Lathe #117 101101064 10/11/2001*	*Lathe #114 101101065 10/11/2001*	*Lathe #115 101101066 10/11/2001*	*Lathe #116 101101067 10/11/2001*	*Lathe #137 101101068 10/11/2001*	*Lathe #121 101101092 10/11/2001*	*Lathe #119 101101096 10/11/2001*	*Lathe #120 101201097 10/12/2001*
Total Metals, milligrams per kilogram													
Arsenic	3 - 12**	1.6	29	ND to 8.1	9.5	5.8	30.2	18.0	10.3	13.1	7.1	16.9	95.5
Chromium	1.5 - 40**	450	38	7.8 to 31.8	2840	35900/20600[4]	28000	18100/13300[4]	13100	1440/1480[4]	65300/28000[4]	2110	29200 J/22800 J[4]
Hexavalent Chromium	--	64	38	--	(0.62 U) R	(0.93 U)R/6.8[4]	(11.6 U) R	(0.6 U)R/51.8[4]	(3.4 U) R	(0.51 U)R/5.4[4]	(0.89 U)R/18.2[4]	(0.48 U) R	(20.3 U)R/63.3 J[4]
Other Parameters													
Leachable Total Organic Carbon, mg/kg	--	--	--	--	NA	NA	NA	NA	NA	NA	NA	NA	1510
Total Organic Carbon, mg/kg	--	--	--	--	NA	NA	NA	NA	NA	NA	NA	NA	18.8
Total Organic Carbon, %	--	--	--	--	1.1 J	2.2 J	13.2 J	11.2 J	13.2 J	4.2 J	4.5 J	2.5 J	NA

Notes:

1. Sample locations provided on Plate 1
2. Data qualifications reflect 100% data validation performed by Data Validation Services
3. Soil criteria is from NYSDEC Division of Environmental Remediation, Technical and Administrative Guidance Memorandum #4046 for Eastern USA Background Heavy Metals Concentration in Soil (January 1994), U.S. EPA Region 9 Preliminary Remediation Goals (PRGs) for Industrial Soil (October 2004), and U.S. EPA Soil Screening Guidance, Generic Soil Screening Levels for Migration to Groundwater (July 1996)
4. Confirmation sample, collected December 2003

▨ indicates concentration is above all soil criteria.

** indicates a New York State background concentration

-- indicates no criteria exists

(value) = concentration reported by the laboratory prior to being rejected by data validation

ND = non-detect

R = rejected concentration as a result of data validation.

NA = not analyzed

INORGANIC DATA QUALIFIERS:

E = value estimated or not reported due to the presence of interferences.

U = compound was analyzed for, but not detected. Reported with detection limit value.

ORGANIC DATA QUALIFIERS:

J = an estimated value, either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, or when a compound meets the identification criteria but the result is less than the quantitation limit

Table 5-4

ANALYTICAL RESULTS FOR SURFACE SOIL SAMPLES FROM PERIMETER OF FILL PILES

Peter Cooper Markhams Site
Dayton, New York

	Soil Criteria [3]			*Sample Location, Sample Identification #, and Date Collected* [1]									
Constituent [2]	*Eastern USA/ Site Background*	*Region 9 PRG*	*Soil Screening Level*	*Lathe #129 101201098 10/12/2001*	*Lathe #128 101201100 10/12/2001*	*Lathe #127 101201102 10/12/2001*	*Lathe #126 101201104 10/12/2001*	*Lathe #130 101201106 10/12/2001*	*Lathe #131 101201109 10/12/2001*	*Lathe #124 101201111 10/12/2001*	*Lathe #125 101201113 10/12/2001*	*Lathe #123 101201115 10/12/2001*	*Lathe #122 101201118 10/12/2001*
Volatile Organic Compounds, micrograms per kilogram [4]													
Chloromethane	--	2.6	--	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
Bromomethane (Methyl bromide)	--	13	0.20	10 UJ	16 UJ	19 UJ	15 UJ	10 UJ	9 UJ	11 UJ	10 UJ	9 UJ	15 UJ
Vinyl chloride	--	0.75	0.010	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
Chloroethane	--	6.5	--	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
Methylene chloride	--	21	0.020	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
Acetone	--	6000	16	10 U	16 U	54 U	15 U	180 B	190 B	250 B	270 B	210 B	550 B
Carbon Disulfide	--	720	32	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	2 J	15 U
1,1-Dichloroethene	--	410	0.060	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
1,1-Dichloroethane	--	1700	23	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
Chloroform	--	12	0.60	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
1,2-Dichloroethane	--	0.60	0.020	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
2-Butanone (Methyl ethyl ketone)	--	27000	--	10 U	16 U	19 U	15 U	20 U	15 U	21 U	19 U	14 U	50 B
1,1,1-Trichloroethane	--	1200	2.0	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
Carbon Tetrachloride	--	0.55	0.070	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
Bromodichloromethane	--	1.8	0.60	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
1,2-Dichloropropane	--	0.74	0.030	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
cis-1,3-Dichloropropene	--	1.8*	0.004*	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
Trichloroethene	--	0.11	0.060	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
Dibromochloromethane	--	2.6	0.40	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
1,1,2-Trichloroethane	--	1.6	0.020	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
Benzene	--	1.3	0.030	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
trans-1,3-Dichloropropene	--	1.8*	0.004*	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
Bromoform	--	220	0.80	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
4-Methyl-2-pentanone (methyl isobutyl ketone)	--	2800	--	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
2-Hexanone (Methyl butyl ketone)	--	--	--	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
Tetrachloroethene	--	3.4	0.060	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
Toluene	--	520	12	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
1,1,2,2-Tetrachloroethane	--	0.93	0.0030	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
Chlorobenzene	--	530	1.0	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
Ethylbenzene	--	20	13	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
Styrene	--	1700	4.0	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
Total Xylenes	--	420	210	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
cis-1,2-Dichloroethene	--	150	0.40	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
trans-1,2-Dichloroethene	--	230	0.70	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
Dichlorodifluoromethane	--	310	--	6 J	6 J	19 U	3 J	10 U	9 U	11 U	10 U	9 U	15 U
Trichlorofluoromethane	--	2000	--	7 J	6 J	19 U	3 J	10 U	9 U	11 U	10 U	9 U	15 U
Methyl tertbutyl ether	--	160	--	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
1,2-Dibromoethane	--	0.028	--	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
Isopropylbenzene (Cumene)	--	2000	--	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
1,3-Dichlorobenzene	--	63	--	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
1,4-Dichlorobenzene	--	7.9	2.0	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
1,2-Dichlorobenzene	--	370	17	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
1,2-Dibromo-3-chloropropane	--	2.0	--	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U
1,2,4-Trichlorobenzene	--	3000	5.0	10 U	16 U	19 U	15 U	10 U	9 U	11 U	10 U	9 U	15 U

Table 5-4

ANALYTICAL RESULTS FOR SURFACE SOIL SAMPLES FROM PERIMETER OF FILL PILES

Peter Cooper Markhams Site
Dayton, New York

	Soil Criteria[3]			*Sample Location, Sample Identification #, and Date Collected*[1]									
Constituent[2]	*Eastern USA/ Site Background*	*Region 9 PRG*	*Soil Screening Level*	*Lathe #129 101201098 10/12/2001*	*Lathe #128 101201100 10/12/2001*	*Lathe #127 101201102 10/12/2001*	*Lathe #126 101201104 10/12/2001*	*Lathe #130 101201106 10/12/2001*	*Lathe #131 101201109 10/12/2001*	*Lathe #124 101201111 10/12/2001*	*Lathe #125 101201113 10/12/2001*	*Lathe #123 101201115 10/12/2001*	*Lathe #122 101201118 10/12/2001*
Tentatively Identified Compounds, micrograms per kilogram[4]													
Hexane				(6 BJN) R	(9 BJN) R	(12 BJN) R			(5 BJN) R	(6 BJN) R	(6 BJN) R		(8 BJN) R
Unknown Alcohol									5 J				
Unknown									58 J	19 J	39 J	32 J	92 J
Semi-Volatile Organic Compounds, micrograms per kilogram[4]													
Acenaphthene	--	29000	570	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
Acenaphthylene	--	–	–	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
Acetophenone	–	–	–	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
Anthracene	–	100000	12000	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
Atrazine	–	7.8	--	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
Benzo(a)anthracene	--	2.1	2.0	370 U	470 U	520 U	27 J	20 J	360 U	400 U	370 U	380 U	490 U
Benzo(b)fluoranthene	–	2.1	5.0	370 U	46 J	38 J	82 J	44 J	360 U	400 U	370 U	380 U	43 J
Benzo(k)fluoranthene	–	21	49	370 U	28 J	520 U	41 J	370 U	360 U	400 U	370 U	380 U	490 U
Benzo(ghi)perylene	--	--	--	370 U	31 J	520 U	43 J	370 U	360 U	400 U	370 U	380 U	490 U
Benzo(a)pyrene	–	0.21	8.0	370 U	34 J	31 J	71 J	22 J	360 U	400 U	370 U	380 U	490 U
Benzaldehyde	--	62000	–	370 U	470 U	520 U	460 U	370 U	43 J	140 J	170 J	380 U	490 U
Biphenyl (1,1-Biphenyl)	–	350	–	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
Bis(2-chloroethoxy)methane	–	–	–	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
Bis(2-chloroethyl)ether	–	0.55	0.00040	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
2,2'-Oxybis(1-Chloropropane) (Bis(2-chloro-1-methylethyl)ether)	–	7.4	--	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
Bis(2-ethylhexyl) phthalate	--	120	–	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
4-Bromophenyl phenyl ether	–	–	–	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
Butyl benzyl phthalate	--	100000	930	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
4-Chloroaniline	–	2500	0.70	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
4-Chloro-3-methylphenol	--	–	–	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
2-Chloronaphthalene (beta-Chloronaphthalene)	--	23000	--	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
2-Chlorophenol	–	240	4.0	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
4-Chlorophenyl phenyl ether	–	–	–	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
Caprolactam	–	100000	–	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
Carbazole	--	86	0.60	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
Chrysene	--	210	160	370 U	32 J	520 U	34 J	24 J	360 U	400 U	370 U	380 U	490 U
Dibenzo(a,h)anthracene	–	0.21	2.0	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
Dibenzofuran	–	3100	--	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
Di-n-butyl phthalate (Dibutyl phthalate)	--	62000	2300	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
3,3'-Dichlorobenzidine	--	3.8	0.0070	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
2,4-Dichlorophenol	–	1800	1.0	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
Diethyl phthalate	--	100000	–	370 U	1180 U	1300 U	460 U	930 U	360 U	400 U	370 U	380 U	490 U
2,4-Dimethylphenol	–	12000	9.0	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
Dimethyl phthalate	–	100000	–	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
4,6-Dinitro-2-methylphenol	--	–	–	910 U	1180 U	1300 U	1160 U	930 U	900 U	1000 U	930 U	940 U	1210 U
2,4-Dinitrophenol	–	1200	0.30	910 U	1180 U	1300 U	1160 U	930 U	900 U	1000 U	930 U	940 U	1210 U
2,4-Dinitrotoluene	--	1200**	0.0008**	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
2,6-Dinitrotoluene	--	620**	0.0007**	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
Di-n-octyl phthalate	–	25000	10000	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
Fluoranthene	–	22000	4300	370 U	33 J	520 U	40 J	59 J	360 U	400 U	370 U	380 U	51 J
Fluorene	--	26000	560	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
Hexachlorobenzene	–	1.1	2.0	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
Hexachlorobutadiene	–	22	2.0	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
Hexachlorocyclopentadiene	–	3700	400	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
Hexachloroethane	–	120	0.50	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
Indeno(1,2,3-cd)pyrene	--	2.1	14	370 U	470 U	520 U	40 J	370 U	360 U	400 U	370 U	380 U	490 U
Isophorone	--	1800	0.50	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
2-Methylnaphthalene	--	–	–	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
2-Methylphenol	--	31000	15	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
4-Methylphenol	--	3100	–	370 U	40 J	60 J	110 J	370 U	360 U	400 U	370 U	380 U	490 U
Naphthalene	–	190	84	370 U	47 J	46 J	33 J	370 U	360 U	400 U	370 U	380 U	490 U
2-Nitroaniline	–	18	–	910 U	1180 U	1300 U	1160 U	930 U	900 U	1000 U	930 U	940 U	1210 U
3-Nitroaniline	–	–	–	910 U	1180 U	1300 U	1160 U	930 U	900 U	1000 U	930 U	940 U	1210 U

Table 5-4

ANALYTICAL RESULTS FOR SURFACE SOIL SAMPLES FROM PERIMETER OF FILL PILES

Peter Cooper Markhams Site
Dayton, New York

	Soil Criteria[3]			Sample Location, Sample Identification #, and Date Collected[1]									
Constituent[2]	*Eastern USA/ Site Background*	*Region 9 PRG*	*Soil Screening Level*	*Lathe #129 101201098 10/12/2001*	*Lathe #128 101201100 10/12/2001*	*Lathe #127 101201102 10/12/2001*	*Lathe #126 101201104 10/12/2001*	*Lathe #130 101201106 10/12/2001*	*Lathe #131 101201109 10/12/2001*	*Lathe #124 101201111 10/12/2001*	*Lathe #125 101201113 10/12/2001*	*Lathe #123 101201115 10/12/2001*	*Lathe #122 101201118 10/12/2001*
4-Nitroaniline	–	–	--	910 U	1180 U	1300 U	1160 U	930 U	900 U	1000 U	930 U	940 U	1210 U
Nitrobenzene	–	100	0.10	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
2-Nitrophenol	–	–	--	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
4-Nitrophenol	–	–	–	910 U	1180 U	1300 U	1160 U	930 U	900 U	1000 U	930 U	940 U	1210 U
N-nitrosodiphenylamine	–	350	1.0	330 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
N-Nitroso-Di-n-propylamine	–	0.25	0.000050	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
Pentachlorophenol	–	9.0	0.030	910 U	1180 U	1300 U	1160 U	930 U	900 U	1000 U	930 U	940 U	1210 U
Phenanthrene	–	–	--	370 U	470 U	520 U	460 U	24 J	360 U	400 U	370 U	380 U	490 U
Phenol	–	100000	100	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
Pyrene	–	29000	4200	370 U	27 J	520 U	35 J	42 J	360 U	400 U	370 U	380 U	35 J
2,4,5-Trichlorophenol	–	62000	270	910 U	1180 U	1300 U	1160 U	930 U	900 U	1000 U	930 U	940 U	1210 U
2,4,6-Trichlorophenol	–	62	0.20	370 U	470 U	520 U	460 U	370 U	360 U	400 U	370 U	380 U	490 U
Total Metals, milligrams per kilogram													
Arsenic	3 - 12**/ND to 8.1	1.6	29	9.2	35.6	55.1	12.4	10.0	8.2	9.0	9.7	9.2	12.7
Chromium	1.5 - 40**/7.8 to 31.8	450	38	66.5	8990/8800[4]	11800/2600[4]	4460	3050	36.3	43.0	13.7	85.6/58.0[4]	1150/11600[4]
Hexavalent Chromium	–	64	38	(0.45 U) R	(0.57 U)R/33.0[4]	(0.64 U)R/3.8	(0.57 U) R	(0.45 U) R	(0.52 U) R	(0.49 U) R	(0.46 U) R	(0.47 U)R/2.5[4]	(2.0 U)R/7.7[4]
Other Parameters													
Total Moisture Content, %	–	–	–	15.3	31.7	45.9	28.7	19.6	16.7	16.6	17.7	18.1	31.2

Notes:

1 Sample locations provided on Plate 1
2. Data qualifications reflect 100% data validation performed by Data Validation Services
3. Soil criteria is from NYSDEC Division of Environmental Remediation, Technical and Administrative Guidance Memorandum #4046 for Eastern USA Background Heavy Metals Concentration in Soil (January 1994). U.S. EPA Region 9 Preliminary Remediation Goals (PRGs) for Industrial Soil (October 2004), and U.S. EPA Soil Screening Guidance, Generic Soil Screening Levels for Migration to Groundwater (July 1996)
4. Confirmation samples, collected December 2003

▨ indicates concentration is above all soil criteria.

(value) = concentration reported by the laboratory prior to being rejected by data validation
ND = non-detect
R = rejected concentration as a result of data validation
NA = not analyzed

ORGANIC DATA QUALIFIERS:
U = compound was analyzed for, but not detected; reported with detection limit value
J = an estimated value, either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, or when a compound meets the identification criteria but the result is less than the quantitation limit
B = used when the analyte is found in the associated blank, as well as in the sample
N = presumptive evidence of a compound; used only for tentatively identified compounds (TIC), where the identification is based on the Mass Spectral library search; it is applied to all TIC results

* indicates criteria is for 1,3-Dichloropropene (no individual criteria exists for cis- or trans-1,3-Dichloropropene)

** PRG and SSL for mixture of 2,4- and 2,6-dinitrotoluene is 2.5 mg/kg and 0.0008 mg/kg, respectively
** indicates a New York State background concentration

INORGANIC DATA QUALIFIERS:
U = element was analyzed for but not detected; reported with the detection limit

Table 5-5

ANALYTICAL RESULTS FOR SURFACE SOIL SAMPLES FROM PERIMETER OF FILL PILES

Peter Cooper Markhams Site
Dayton, New York

	Soil Criteria[3]				Sample Location, Sample Identification #, and Date Collected[1]							
Constituent[2]	Eastern USA Background	Region 9 PRG	Soil Screening Level	Site Background Level	Lathe #106 101001028 10/10/2001	Lathe #62 101001030 10/10/2001	Lathe #63 101001031 10/10/2001	Lathe #64 101001033 10/10/2001	Lathe #65 101001034 10/10/2001	Lathe #107 101001035 10/10/2001	Lathe #108 101001038 10/10/2001	Lathe #68 10001040 10/10/2001
Total Metals, milligrams per kilogram												
Arsenic	3 - 12**	1.6	29	ND to 8.1	8.8	8.0	8.1	3.0	9.1	11.7	7.1	7.8
Chromium	1.5 - 40**	450	38	7.8 to 31.8	434	12.4	8.9	24.3	19.0	2260/8970[4]	13.1	8.5
Hexavalent Chromium	–	64	38	–	(0.47 U) R	(0.57 U) R	(0.58 U) R	(0.91 U) R	(2.8 U) R	(0.51 U)R/29.6	(2.2 U) R	(0.5 U) R

	Soil Criteria[3]				Sample Location, Identification, and Date Collected[1]							
Constituent[2]	Eastern USA Background	Region 9 PRG	Soil Screening Level	Site Background Level	Lathe #69 101001041 10/10/2001	Lathe #70 101001042 10/10/2001	Lathe #71 101001043 10/10/2001	Lathe #109 101001044 10/10/2001	Lathe #110 101001046 10/10/2001	Lathe #97 101001048 10/10/2001	Lathe #95 101001050 10/10/2001	Lathe #60 101001052 10/10/2001
Total Metals, milligrams per kilogram												
Arsenic	3 - 12**	1.6	29	ND to 8.1	10.8	7.1	9.2	8.1	6.5	10.2	6.6	8.6
Chromium	1.5 - 40**	450	38	7.8 to 31.8	8.7	15.2	7.1	10.6	9.4	12.9	12.5	13.8
Hexavalent Chromium	--	64	38	–	(0.52 U) R	(0.48 U) R	(2.7 U) R	(0.49 U) R	(0.95 U) R	(0.49 U) R	(0.85 U) R	(0.58 U) R

	Soil Criteria[3]				Sample Location, Identification, and Date Collected[1]							
Constituent[2]	Eastern USA Background	Region 9 PRG	Soil Screening Level	Site Background Level	Lathe #59 101001054 10/10/2001	Lathe #98 101001055 10/10/2001	Lathe #61 101001057 10/10/2001	Lathe #58 101001058 10/10/2001	Lathe #57 101001059 10/10/2001	Lathe #96 101001060 10/10/2001	Lathe #99 101001062 10/10/2001	Lathe #105 101001069 10/10/2001
Total Metals, milligrams per kilogram												
Arsenic	3 - 12**	1.6	29	ND to 8.1	1.9	3.7	10.1	7.4	8.1	7.6	7.3	9.0
Chromium	1.5 - 40**	450	38	7.8 to 31.8	11.1	8.8	12.7	14.2	12.8	11.9	333	3520
Hexavalent Chromium	–	64	38	–	(0.54 U) R	(0.53 U) R	(0.48 U) R	(0.45 U) R	(0.52 U) R	(0.48 U) R	(0.63 U) R	(0.52 U) R

Table 5-5

ANALYTICAL RESULTS FOR SURFACE SOIL SAMPLES FROM PERIMETER OF FILL PILES

Peter Cooper Markhams Site
Dayton, New York

Constituent[2]	*Soil Criteria*[3]				*Sample Location, Identification, and Date Collected*[1]							
	Eastern USA Background	*Region 9 PRG*	*Soil Screening Level*	*Site Background Level*	*Lathe #104 101001071 10/10/2001*	*Lathe #103 101001073 10/10/2001*	*Lathe #102A 101001076 10/10/2001*	*Lathe #101 101001078 10/10/2001*	*Lathe #100 101001080 10/10/2001*	*Lathe #56 101001082 10/10/2001*	*Lathe #66 101001083 10/10/2001*	*Lathe #67A 101001084 10/10/2001*
Total Metals, milligrams per kilogram												
Arsenic	3 - 12**	1.6	29	ND to 8.1	8.6	8.1	8.6	6.6	4.7	7.5	6.5	8.1
Chromium	1.5 - 40**	450	38	7.8 to 31.8	315	19.5	13.4	13.4	43.4	14.4	18.4	71.9
Hexavalent Chromium	--	64	38	--	(0.47 U) R	(0.45 U) R	(0.46 U) R	(0.53 U) R	(0.5 U) R	(0.57 U) R	(0.49 U) R	(0.5 U) R

Constituent[2]	*Soil Criteria*[3]				*Sample Location, Identification, and Date Collected*[1]					
	Eastern USA Background	*Region 9 PRG*	*Soil Screening Level*	*Site Background Level*	*Lathe #74 101001085 10/10/2001*	*Lathe #73 101001086 10/10/2001*	*Lathe #72 101001087 10/10/2001*	*Lathe #113 101001088 10/10/2001*	*Lathe #112 101001090 10/10/2001*	*Lathe #111 101001093 10/10/2001*
Total Metals, milligrams per kilogram										
Arsenic	3 - 12**	1.6	29	ND to 8.1	11.4	6.3	9.0	16.9	12.2	11.4
Chromium	1.5 - 40**	450	38	7.8 to 31.8	32.1	23.3	33.9	7660/4760[4]	1090 J/1230[4]	543 J
Hexavalent Chromium	--	64	38	--	(0.51 U) R	(0.54 U) R	(0.47 U) R	(0.64 U)R/19.8[4]	(0.47 U)R/3.8[4]	(0.46 U) R

▨ indicates concentration is above all soil criteria.

Notes
1. Sample locations provided on Plate 1
2. Data qualifications reflect 100% data validation performed by Data Validation Services
3. Soil criteria is from NYSDEC Division of Environmental Remediation, Technical and Administrative Guidance Memorandum #4046 for Eastern USA Background Heavy Metals Concentration in Soil (January 1994), U.S. EPA Region 9 Preliminary Remediation Goals (PRGs) for Industrial Soil (October 2004), and U.S. EPA Soil Screening Guidance, Generic Soil Screening Levels for Migration to Groundwater (July 1996)
4. Confirmation samples, collected December 2003

(value) = concentration reported by the laboratory prior to being rejected during data validation
R = rejected concentration as a result of data validation

INORGANIC DATA QUALIFIERS:
U = element was analyzed for, but not detected; reported with detection limit value
E = value estimated or not reported due to the presence of interferences.

Constituent[2]	*Sample Type, Sample Identification #, and Date Collected*[1]			
	Composite 101501151 10/15/2001	*Composite 101501154 10/15/2001*	*Composite 101501155 10/15/2001*	*Composite 101501156 10/15/2001*
Total Organic Carbon, mg/L	3.6	1.4	1.8	1.2

Notes:
1. Sample locations provided on Plate 1
2. Data qualifications reflect 100% data validation performed by Data Validation Services

Sample 101501151 is a composite of Lathes #62, 72, and 111
Sample 101501154 is a composite of Lathes #108, 68, 70, 109, and 96
Sample 101501155 is a composite of Lathes #106, 104, 56, 129, and 126
Sample 101501156 is a composite of Lathes #63, 64, 65, 66, 69, and 71

Table 5-6

ANALYTICAL RESULTS FOR SUBSURFACE SOIL SAMPLES FROM PERIMETER OF FILL PILES

Peter Cooper Markhams Site
Dayton, New York

	Soil Criteria[3]				Sample Location, Sample Identification #, and Date Collected[1]							
Constituent[2]	*Eastern USA Background*	*Region 9 PRG*	*Soil Screening Level*	*Site Background Level*	*Lathe #106 101001029 10/10/2001*	*Lathe #107 101001036 10/10/2001*	*Lathe #108 101001039 10/10/2001*	*Lathe #109 101001045 10/10/2001*	*Lathe #110 101001047 10/10/2001*	*Lathe #97 101001049 10/10/2001*	*Lathe #95 101001051 10/10/2001*	*Lathe #98 101001056 10/10/2001*
Total Metals, milligrams per kilogram												
Arsenic	3 - 12**	1.6	29	ND to 8.1	8.3 J	10.1 J	8.8 J	10.1 J	6.7 J	9.1 J	7.7 J	3.7 J
Chromium	1.5 - 40**	450	38	7.8 to 31.8	19700 J	652 J	16.4 J	14.0 J	15.8 J	14.2 J	16.2 J	13.9 J
Hexavalent Chromium	--	64	38	--	0.93 UJ	0.48 UJ	0.49 UJ	0.48 UJ	0.50 UJ	0.48 UJ	0.50 UJ	0.53 UJ

	Soil Criteria[3]				Sample Location, Sample Identification #, and Date Collected[1]						
Constituent[2]	*Eastern USA Background*	*Region 9 PRG*	*Soil Screening Level*	*Site Background Level*	*Lathe #96 101001061 10/10/2001*	*Lathe #99 101001063 10/10/2001*	*Lathe #105A 101001070 10/10/2001*	*Lathe #104 101001072 10/10/2001*	*Lathe #103 101001075 10/10/2001*	*Lathe #102A 101001077 10/10/2001*	*Lathe #101 101001079 10/10/2001*
Total Metals, milligrams per kilogram											
Arsenic	3 - 12**	1.6	29	ND to 8.1	8.8 J	7.4 J	19.0 J	10.9 J	17.6 J	9.9 J	8.1 J
Chromium	1.5 - 40**	450	38	7.8 to 31.8	13.9 J	36.0 J	11000 J	48.0 J	16.6 J	14.8 J	16.7 J
Hexavalent Chromium	--	64	38	--	0.63 UJ	0.51 UJ	0.58 UJ	0.45 UJ	0.45 UJ	0.47 UJ	0.50 UJ

	Soil Criteria[3]				Sample Location, Sample Identification #, and Date Collected[1]						
Constituent[2]	*Eastern USA Background*	*Region 9 PRG*	*Soil Screening Level*	*Site Background Level*	*Lathe #100 101001081 10/10/2001*	*Lathe #113 101001089 10/10/2001*	*Lathe #112 101001091 10/10/2001*	*Lathe #111 101001094 10/10/2001*	*Lathe #129 101201099 10/12/2001*	*Lathe #128 101201101 10/12/2001*	*Lathe #127 101201103 10/12/2001*
Total Metals, milligrams per kilogram											
Arsenic	3 - 12**	1.6	29	ND to 8.1	7.9 J	12.6 J	9.2 J	11.5 J	8.4	28.9	26.8
Chromium	1.5 - 40**	450	38	7.8 to 31.8	60.1 J	4820 J	398 J	1150 J	36.7	6460	12400
Hexavalent Chromium	--	64	38	--	0.48 UJ	1.3 UJ	0.66 UJ	0.47 UJ	0.45 UJ	0.58 UJ	0.68 UJ

	Soil Criteria[3]				Sample Location, Identification, and Date Collected[1]						
Constituent[2]	*Eastern USA Background*	*Region 9 PRG*	*Soil Screening Level*	*Site Background Level*	*Lathe #126 101201105 10/12/2001*	*Lathe #130 101201108 10/12/2001*	*Lathe #131 101201110 10/12/2001*	*Lathe #124 101201112 10/12/2001*	*Lathe #125 101201114 10/12/2001*	*Lathe #123 101201116 10/12/2001*	*Lathe #122 101201119 10/12/2001*
Total Metals, milligrams per kilogram											
Arsenic	3 - 12**	1.6	29	ND to 8.1	16.1	8.4	11.1	9.8	7.9	9.5	6.0
Chromium	1.5 - 40**	450	38	7.8 to 31.8	7850	341	30.8	17.3	15.2	12600	126
Hexavalent Chromium	--	64	38	--	0.60 UJ	0.48 UJ	0.45 UJ	0.70 UJ	0.49 UJ	0.58 UJ	0.78 UJ

Notes:

1. Sample locations provided on Plate 1. Sample depth is 6 to 12 inches below ground surface.
2. Data qualifications reflect 100% data validation performed by Data Validation Services.
3. Soil criteria is from NYSDEC Division of Environmental Remediation, Technical and Administrative Guidance Memorandum #4046 for Eastern USA Background Heavy Metals Concentration in Soil (January 1994), U.S. EPA Region 9 Preliminary Remediation Goals (PRGs) for Industrial Soil (October 2004), and U.S. EPA Soil Screening Guidance, Generic Soil Screening Levels for Migration to Groundwater (July 1996)

▨ indicates concentration is above all soil criteria

** indicates a New York State background concentration
-- indicates no criteria exists
ND = non-detect

INORGANIC DATA QUALIFIERS:
N = spike sample recovery is not within the quality control limits
J = a value greater than or equal to the instrument detection limit, but less than the quantitation limit
U = element was analyzed for, but not detected; reported with detection limit value

Table 5-7

ANALYTICAL RESULTS FOR NATIVE SUBSURFACE SOIL SAMPLES FROM MONITORING WELLS AND BORINGS

Peter Cooper Markhams Site
Dayton, New York

	Soil Criteria[3]				*Sample Location, Identification, and Date Collected*[1]						
	Eastern USA Background	*Region 9 PRG*	*Soil Screening Level*	*Site Background Level*	*B-1A; 9-10 fbgs*	*B-1A; 10-11 fbgs*	*B-1A; 17-19 fbgs*	*MW-8S; 4-6 fbgs*	*B-4; 15-16 fbgs*	*B-4; 23-25 fbgs*	*B-4; 16-17 fbgs*
					100201003	*100201004*	*100201005*	*100401007*	*100501009*	*100501010*	*100501013*
Constituent[2]					*10/2/2001*	*10/2/2001*	*10/2/2001*	*10/4/2001*	*10/5/2001*	*10/5/2001*	*10/5/2001*
Total Metals, milligrams per kilogram											
Arsenic	3 - 12**	1.6	29	ND to 8.1	8.1	11.3	9.6	12.7	8.6	4.7	13.4
Chromium	1.5 - 40**	450	38	7.8 to 31.8	32.5	65.1	19.6	12.6	39.2	29.2	1150
Hexavalent Chromium	--	64	38	--	0.44 UJ	0.43 UJ	0.44 UJ	0.46 UJ	0.45 UJ	0.45 UJ	0.48 UJ

	Soil Criteria[3]				*Sample Location, Identification, and Date Collected*[1]					
	Eastern USA Background	*Region 9 PRG*	*Soil Screening Level*	*Site Background Level*	*B-5; 8-9 fbgs*	*B-5; 9-10 fbgs*	*B-5; 14-16 fbgs*	*B-6; 6.5-7.5 fbgs*	*B-6; 7.5-8.5 fbgs*	*B-6; 9-11 fbgs*
					100901019	*100901020*	*100901021*	*100901023*	*100901024*	*100901025*
Constituent[2]					*10/9/2001*	*10/9/2001*	*10/9/2001*	*10/9/2001*	*10/9/2001*	*10/9/2001*
Total Metals, milligrams per kilogram										
Arsenic	3 - 12**	1.6	29	ND to 8.1	9.2	7.6	5.4	8.0	8.9	11.7
Chromium	1.5 - 40**	450	38	7.8 to 31.8	18.4	12.4	9.8	43.9	5860	36.9
Hexavalent Chromium	--	64	38	--	0.43 UJ	0.45 UJ	0.48 UJ	0.46 UJ	0.47 UJ	0.45 UJ

▨ indicates concentration is above all soil criteria

Notes:

1. Sample locations provided on Plate 1
2. Data qualifications reflect 100% data validation performed by Data Validation Services
3. Soil criteria is from NYSDEC Division of Environmental Remediation, Technical and Administrative Guidance Memorandum #4046 for Eastern USA Background Heavy Metals Concentration in Soil (January 1994), U.S. EPA Region 9 Preliminary Remediation Goals (PRGs) for Industrial Soil (October 2004), and U.S. EPA Soil Screening Guidance, Generic Soil Screening Levels for Migration to Groundwater (July 1996)
4. Groundwater criteria is from NYSDEC Divison of Water, Technical and Operational Guidance Series (TOGs) Ambient Water Quality Standards and Guidance Values (June 1998) and U.S. EPA Region 9 Preliminary Remediation Goals (PRGs) for Tap Water (2004)

** indicates a New York State background concentration
-- indicates no criteria exists
NA = not analyzed

INORGANIC DATA QUALIFIERS:
U = element was analyzed for, but not detected; reported with detection limit value
J = a value greater than or equal to the instrument detection limit, but less than the quantitation limit

Table 5-8

ANALYTICAL RESULTS FOR SHALLOW OVERBURDEN GROUNDWATER SAMPLES

Peter Cooper Markhams Site
Dayton, New York

	Groundwater Criteria[3]		Sample Location, Sample Identification #, and Date Collected[1]																	
			MW-1S		MW-2S		MW-3SR		MW-4S		MW-5S		MW-6S		MW-7S		MW-8S		MW-9S	
			110701171	042302196	110701170	042302193	110601161	042202190	dry	042402202	110701168	042502209	110801181	042402208	110801178	042402205	110601165	042302198	110501158	042202187
Constituent[2]	TOG	PRG	11/7/2001	4/23/2002	11/7/2001	4/23/2002	11/6/2001	4/22/2002	11/5/2001	4/24/2002	11/7/2001	4/25/2002	11/8/2001	4/24/2002	11/8/2001	4/24/2002	11/6/2001	4/23/2002	11/5/2001	4/22/2002
Volatile Organic Compounds, micrograms per liter																				
Acetone	50*	610	10 U	5 UJ	NA	21 J	10 U	5 UJ	NA	5 UJ	10 U	5 UJ	10 U	5 UJ	10 U	5 UJ	10 U	5 UJ	10 U	5 UJ
Benzene	1	0.34	10 U	0.22 J	NA	1.8	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Bromodichloromethane	50*	0.18	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Bromoform	50*	8.5	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Bromomethane	5	8.7	10 U	1 U	NA	1 U	10 U	1 U	NA	1 UJ	10 U	1 UJ	10 U	1 UJ	10 U	1 UJ	10 U	1 U	10 U	1 U
2-Butanone (Methyl ethyl ketone)	50*	1900	10 U	5 UJ	NA	3.1 J	10 U	5 UJ	NA	5 UJ	10 U	5 UJ	10 U	5 UJ	10 U	5 UJ	10 U	5 UJ	10 U	5 UJ
Carbon Disulfide	--	1000	10 U	1 U	NA	0.35 J	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	0.28 J	10 U	1 U	10 U	1 U
Carbon Tetrachloride	5	0.17	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Chlorobenzene	5	110	10 U	0.27 J	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Chloroethane	5	4.6	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Chloroform	7	6.2	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Chloromethane (Methyl chloride)	5	1.5	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Dibromochloromethane	50*	0.13	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
1,3-Dichlorobenzene	3	5.5	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
1,4-Dichlorobenzene	3	0.50	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
1,2-Dichlorobenzene	3	370	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
1,2-Dibromo-3-chloropropane	0.04	0.048	10 U	1 UJ	NA	1 UJ	10 U	1 UJ	NA	1 UJ	10 U	1 UJ	10 U	1 UJ	10 U	1 UJ	10 U	1 UJ	10 U	1 UJ
Dichlorodifluoromethane	5	390	10 UJ	1 U	NA	1 U	10 UJ	1 U	NA	1 UJ	10 UJ	1 UJ	10 UJ	1 UJ	10 UJ	1 UJ	10 UJ	1 U	10 U	1 U
1,2-Dibromoethane (Ethylene dibromide)	0.0006	0.00076	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
1,1-Dichloroethane	5	810	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
1,2-Dichloroethane	0.6	0.12	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
1,1-Dichloroethene	5	340	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
1,2-Dichloropropane	1	0.16	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
cis-1,2-Dichloroethene	5	61	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	0.54 J	10 U	1 U
cis-1,3-Dichloropropene	0.4**	0.40	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
trans-1,3-Dichloropropene	0.4**	0.40	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
trans-1,2-Dichloroethene	5	120	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Ethylbenzene	5	2.9	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
2-Hexanone	50*	--	10 U	5 U	NA	5 U	10 U	5 U	NA	5 U	10 U	5 U	10 U	5 U	10 U	5 U	10 U	5 U	10 U	5 U
Isopropylbenzene (Cumene)	5	660	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Methyl tertbutyl ether	–	13	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Methylene chloride	5	4.3	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
4-Methyl-2-pentanone (Methyl isobutyl ketone)	--	160	10 U	5 U	NA	5 U	10 U	5 U	NA	5 U	10 U	5 U	10 U	5 U	10 U	5 U	10 U	5 U	10 U	5 U
Styrene	5	1600	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
1,1,2,2-Tetrachloroethane	5	0.055	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Tetrachloroethene	5	0.66	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Toluene	5	720	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
1,2,4-Trichlorobenzene	5	190	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
1,1,1-Trichloroethane	5	3200	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
1,1,2-Trichloroethane	1	0.20	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Trichloroethene	5	0.028	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	4.2 J	2.8	10 U	1 U
Trichlorofluoromethane	5	1300	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	5	59000	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Vinyl chloride	2	0.020	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Total Xylenes (1,2-, 1,3-, and 1,4-Xylene)	5	210	10 U	3 U	NA	3 U	10 U	3 U	NA	3 U	10 U	3 U	10 U	3 U	10 U	3 U	10 U	3 U	10 U	3 U
Cyclohexane	--	35000	10 U	5 U	NA	5 U	10 U	5 U	NA	5 U	10 U	5 U	10 U	5 U	10 U	5 U	10 U	5 U	10 U	5 U
Methyl acetate	--	6100	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Methylcyclohexane	–	5200	10 U	1 U	NA	1 U	10 U	1 U	NA	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Semi-Volatile Organic Compounds, micrograms per liter																				
Acenaphthene	20*	370	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Acenaphthylene	--	--	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Acetophenone	--	--	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Anthracene	50*	1800	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Atrazine	7.5	0.30	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Benzaldehyde	--	3600	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Benzo(a)anthracene	0.002*	0.092	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Benzo(b)fluoranthene	0.002*	0.092	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	0.6 J	10 U	10 U	NA
Benzo(k)fluoranthene	0.002*	0.92	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Benzo(ghi)perylene	--	--	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Benzo(a)pyrene	ND	0.0092	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Benzoic acid	--	150000	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Benzyl alcohol	--	11000	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Biphenyl (1,1'-Biphenyl)	5	300	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Bis(2-chloroethoxy)methane	5	--	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Bis(2-chloroethyl)ether	1.0	0.010	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
2,2'-Oxybis(1-chloropropane) (Bis(2-chloro-1-methylethyl)ether)	5	0.27	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Bis(2-ethylhexyl) phthalate	5	4.8	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	5 J	NA	10 U	NA	10 U	10 U	10 U	NA

Table 5-8

ANALYTICAL RESULTS FOR SHALLOW OVERBURDEN GROUNDWATER SAMPLES

Peter Cooper Markhams Site
Dayton, New York

	Groundwater Criteria[3]		Sample Location, Sample Identification #, and Date Collected[1]																	
			MW-1S		MW-2S		MW-3SR		MW-4S		MW-5S		MW-6S		MW-7S		MW-8S		MW-9S	
			110701171	042302196	110701170	042302193	110601161	042202190	dry	042402202	110701168	042502209	110801181	042402208	110801178	042402205	110601165	042302198	110501158	042202187
Constituent[2]	TOG	PRG	11/7/2001	4/23/2002	11/7/2001	4/23/2002	11/6/2001	4/22/2002	11/5/2001	4/24/2002	11/7/2001	4/25/2002	11/8/2001	4/24/2002	11/8/2001	4/24/2003	11/6/2001	4/23/2002	11/5/2001	4/22/2002
4-Bromophenyl phenyl ether	--	--	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Butyl benzyl phthalate	50*	7300	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Caprolactam	--	18000	10 U	NA	NA	10 UJ	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 UJ	10 U	NA
Carbazole	--	3.4	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
4-Chloroaniline	5	150	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
4-Chloro-3-methylphenol	--	--	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
2-Chloronaphthalene (beta-Chloronaphthalene)	10*	490	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
2-Chlorophenol	--	30	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
4-Chlorophenyl phenyl ether	--	--	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Chrysene	0.002*	9.2	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Dibenzo(a,h)anthracene	--	0.0092	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Dibenzofuran	--	24	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Di-n-butyl phthalate (Dibutyl phthalate)	50	3600	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
1,2-Dichlorobenzene	3	370	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
1,3-Dichlorobenzene	3	5.5	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
1,4-Dichlorobenzene	3	0.50	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
3,3'-Dichlorobenzidine	5	0.15	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
2,4-Dichlorophenol	5	110	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Diethyl phthalate	50*	29000	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
2,4-Dimethylphenol	50*	730	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Dimethyl phthalate	50*	360000	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
4,6-Dinitro-2-methylphenol	--	--	25 U	NA	NA	25 U	25 U	NA	NA	NA	25 U	NA	25 U	NA	25 U	NA	25 U	25 U	25 U	NA
2,4-Dinitrophenol	10*	73	25 U	NA	NA	25 UJ	25 UJ	NA	NA	NA	25 U	NA	25 U	NA	25 U	NA	25 UJ	25 UJ	25 UJ	NA
2,4-Dinitrotoluene	5	73****	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
2,6-Dinitrotoluene	5	36****	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Di-n-octyl phthalate	50*	1500	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Fluoranthene	50*	1500	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	0.6 J	10 U	10 U	NA
Fluorene	50*	240	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Hexachlorobenzene	0.04	0.042	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Hexachlorobutadiene	0.5	0.86	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Hexachlorocyclopentadiene	5	220	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Hexachloroethane	5	4.8	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Indeno(1,2,3-cd)pyrene	0.002*	0.092	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Isophorone	50*	71	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
2-Methylnaphthalene	--	--	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
2-Methylphenol	--	1800	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
4-Methylphenol	--	180	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Naphthalene	10*	6.2	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
2-Nitroaniline	5	1.0	25 U	NA	NA	25 U	25 U	NA	NA	NA	25 U	NA	25 U	NA	25 U	NA	25 U	25 U	25 U	NA
3-Nitroaniline	5	--	25 U	NA	NA	25 U	25 U	NA	NA	NA	25 U	NA	25 U	NA	25 U	NA	25 U	25 U	25 U	NA
4-Nitroaniline	5	--	25 U	NA	NA	25 UJ	25 U	NA	NA	NA	25 U	NA	25 U	NA	25 U	NA	25 U	25 U	25 U	NA
Nitrobenzene	0.4	3.4	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
2-Nitrophenol	--	--	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
4-Nitrophenol	--	--	25 U	NA	NA	25 UJ	25 U	NA	NA	NA	25 U	NA	25 U	NA	25 U	NA	25 U	25 U	25 U	NA
N-nitrosodiphenylamine	50*	14	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
N-Nitroso-Di-n-propylamine	--	0.010	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Pentachlorophenol	1***	0.56	25 U	NA	NA	25 U	25 U	NA	NA	NA	25 U	NA	25 U	NA	25 U	NA	25 U	25 U	25 U	NA
Phenanthrene	50*	--	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Phenol	1***	22000	10 U	NA	NA	2 J	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Pyrene	50*	180	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	0.5 J	10 U	10 U	NA
1,2,4-Trichlorobenzene	5	190	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
2,4,5-Trichlorophenol	--	3600	25 U	NA	NA	25 U	25 U	NA	NA	NA	25 U	NA	25 U	NA	25 U	NA	25 U	25 U	25 U	NA
2,4,6-Trichlorophenol	--	3.6	10 U	NA	NA	10 U	10 U	NA	NA	NA	10 U	NA	10 U	NA	10 U	NA	10 U	10 U	10 U	NA
Total Metals, micrograms per liter																				
Aluminum	--	36000	200 U	NA	36400 J	536	654	NA	NA	NA	200 U	NA	499	NA	382	NA	200 U	NA	200 U	NA
Antimony	3	15	60.0 U	NA	72.6 J	60.0 U	60.0 U	NA	NA	NA	60.0 U	NA	60.0 U	NA	60.0 U	NA	60.0 U	NA	60.0 U	NA
Arsenic	25	0.045	10.0 U	10 U	133 J	10.0 U	10.0 U	10 U	NA	10 U	10.0 U	10 U	10.0 U	10 U	10.0 U	10 U	10.0 U	10 U	10.0 U	10 U
Barium	1000	2600	200 U	NA	517 J	200 U	200 U	NA	NA	NA	200 U	NA	200 U	NA	200 U	NA	200 U	NA	200 U	NA
Beryllium	3*	73	5.0 U	NA	5.0 U	5.0 U	5.0 U	NA	NA	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA
Cadmium	5	18	5.0 U	NA	50.1 J	5.0 U	5.0 U	NA	NA	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA
Calcium	--	--	318000 J	NA	217000 J	26000	58300 J	NA	NA	NA	250000 J	NA	402000 J	NA	310000 J	NA	205000 J	NA	57500 U	NA
Chromium	50	55000+	10 6	10 U	981 J	17.2	10.0 U	10 U	NA	10 U	10.0 U	10 U	18.8	18.3	10.0 U	10 U	10.0 U	10 U	10.0 U	10 U
Cobalt	--	730	50 0 U	NA	251 J	50.0 U	50.0 U	NA	NA	NA	50 0 U	NA	50.0 U	NA	50.0 U	NA	50.0 U	NA	50.0 U	NA
Copper	200	1500	25.0 U	NA	2220 J	25.0 U	25.0 U	NA	NA	NA	25.0 U	NA	25.0 U	NA	25.0 U	NA	25.0 U	NA	25.0 U	NA
Iron	300++	11000	11100 J	NA	3160000 J	94300	827 J	NA	NA	NA	267 J	NA	1070 J	NA	11000 J	NA	218 J	NA	526 J	NA
Lead	25	--	10.7	NA	1020 J	29.1 J	3.0 U	NA	NA	NA	3.0 U	NA	9.7	NA	3.0 U	NA	3.0 U	NA	3.0 UJ	NA
Magnesium	35000*	--	42000	NA	39400 J	5000 U	9520	NA	NA	NA	36900	NA	96400	NA	75900	NA	30100	NA	9050	NA
Manganese	300++	880	15090 J	NA	9800 J	804	33.7 J	NA	NA	NA	210 J	NA	13500 J	NA	254 J	NA	4220 J	NA	112 J	NA
Nickel	100	730+++	40.0 U	NA	2830 J	83.4	40 0 U	NA	NA	NA	40.0 U	NA	40.0 U	NA	40.0 U	NA	40.0 U	NA	40.0 U	NA
Potassium	--	--	5000 UJ	NA	9290 J	5000 U	5000 UJ	NA	NA	NA	5000 UJ	NA	5000 UJ	NA	5000 UJ	NA	5000 U	NA	5000 U	NA

Table 5-8

ANALYTICAL RESULTS FOR SHALLOW OVERBURDEN GROUNDWATER SAMPLES

Peter Cooper Markhams Site
Dayton, New York

	Groundwater Criteria[3]		Sample Location, Sample Identification #, and Date Collected[1]																	
			MW-1S		MW-2S		MW-3SR		MW-4S		MW-5S		MW-6S		MW-7S		MW-8S		MW-9S	
			110701171	042302196	110701170	042302193	110601161	042202190	dry	042402202	110701168	042502209	110801181	042402208	110801178	042402205	110601165	042302198	110501158	042202187
Constituent[2]	TOG	PRG	11/7/2001	4/23/2002	11/7/2001	4/23/2002	11/6/2001	4/22/2002	11/5/2001	4/24/2002	11/7/2001	4/25/2002	11/8/2001	4/24/2002	11/8/2001	4/24/2002	11/6/2001	4/23/2002	11/5/2001	4/22/2002
Selenium	10	180	5.0 U	NA	39.2 J	7.2	5.0 U	NA	NA	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA
Silver	50	180	10.0 U	NA	10.0 U	10 U	10.0 U	NA	NA	NA	10.0 U	NA	10.0 U	NA	10.0 U	NA	10.0 U	NA	10.0 U	NA
Mercury	0.7	11	0.200 UJ	NA	0.200 U	0.2 U	0.200 UJ	NA	NA	NA	0.200 UJ	NA	0.200 UJ	NA	0.200 UJ	NA	0.200 UJ	NA	0.200 UJ	NA
Sodium	20000	--	5550	NA	8170 J	5000 U	6050	NA	NA	NA	7730	NA	5000 U	NA	27800	NA	7210	NA	11200	NA
Thallium	0.5*	2.4	10.0 U	NA	1300 J	13.5	10.0 U	NA	NA	NA	10.0 U	NA	10.0 U	NA	10.0 U	NA	10.0 U	NA	10.0 U	NA
Vanadium	–	260	50.0 U	NA	50.0 U	50.0 U	50.0 U	NA	NA	NA	50.0 U	NA	50.0 U	NA	50.0 U	NA	50.0 U	NA	50.0 U	NA
Zinc	2000*	11000	20.0 UJ	NA	146000 J	3090	20.0 UJ	NA	NA	NA	20.0 UJ	NA	36.1 N	NA	20.0 UJ	NA	20.0 UJ	NA	20.0 U	NA
Hexavalent Chromium, micrograms per liter																				
Total Hexavalent Chromium	50	110	10 UJ	10 UJ	10 UJ	56 UJ	14 UJ	10 UJ	NA	10 UJ	10 UJ	10 UJ	10 UJ	10 UJ	10 UJ	10 UJ	10 UJ	10 UJ	10 UJ	10 UJ
Other Geochemical Parameters, milligrams per liter																				
Ammonia	2 (NH_3 + NH_4^+ as N)	–	2.8	2.0	NA	0.2	0.10 U	0.10 U	NA	0.33	0.10 U	0.10 U	2.9	0.24	0.10 U	0.10 U	0.57	0.34	0.10 U	0.10 U
Bicarbonate Alkalinity	--	--	409	NA	NA	NA	143 J	NA	NA	NA	435	NA	335	NA	446	NA	308	NA	131	NA
Carbonate Alkalinity	–	--	5.0 U	NA	NA	NA	5.0 U	NA	NA	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA
Nitrate	10 (as N)	10	12.4	8.0	NA	0.5 U	4.0	3.1	NA	32.5	3.7	2.8	42.3	50.9	0.50 U	0.5 U	32.8	14.6	2.9	9.3
Sulfate	250	–	602	616	NA	54.3	34.3	25.6	NA	768	309	159	1060	676	760	695	220	104	40.0	31.4
Sulfide	0.05* (as H_2S)	–	1.0 U	NA	NA	NA	1.0 U	NA	NA	NA	1.0 U	NA	1.0 U	NA	1.0 U	NA	1.0 U	NA	1.0 U	NA
Total Dissolved Solids	--	--	1450	NA	NA	NA	185	NA	NA	NA	1080	NA	2100	NA	1480	NA	677	NA	232	NA
Total Organic Carbon	–	–	9.2	NA	NA	NA	1.0	NA	NA	NA	6.3	NA	15.7	NA	8.8	NA	7.3	NA	1.2	NA
Ferrous Iron	–	–	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.2	NA	0.10 U	NA	NA	NA
Field Measured Parameters																				
Temperature, °C	--	--	11.6	8.07	12.67	6.28	11.26	6.72	NA	8.33	10.9	7.14	9.99	9.41	10.17	8.77	10.8	7.6	10.97	6.02
pH, standard units	--	—	6.34	6.45	6.64	7.19	6.73	6.92	NA	6.42	6.75	6.81	6.45	6.61	6.7	6.8	6.53	6.9	7.49	7.36
Specific Conductivity, µS/cm	--	--	2620	1929	208	844	413	455	NA	1702	2065	822	4024	2428	3109	1959	1236	755	256	540
Dissolved Oxygen, mg/L	–	--	0.36	0.19	0.59	1.7	4.97	3.53	NA	0.61	2.42	0.07	0.35	0.06	0.55	0.04	0.26	0.1	2.84	8.41
Oxidation-Reduction Potential, mV	--	–	117	32.9	218.3	252.5	155.1	55.3	NA	22.3	119	67.3	34.5	13.9	150	169.6	28.9	4.6	197.8	1.8
Turbidity, NTU	--	—	1.91	10	110	262(4)	21	30	NA	15	7.69	2	2.4	0.2	29.1	12.4	11	17	31	11.2
Ferrous Iron, mg/L	--	--	6	8.6	NA	NA	0	0	NA	0.8	0	NA	0	0	6.8	7	0	0	0	0

Notes:

1 Sample locations provided on Plate 1
2. Data qualifications reflect 100% data validation performed by Data Validation Services
3. Groundwater criteria is from NYSDEC Division of Water, Technical and Operational Guidance Series (TOGs), Ambient Water Quality Standards and Guidance Values for Groundwater (June 1998) and U.S EPA Region 9 Preliminary Remediation Goals (PRGs) for Tap Water (2004)
4 Turbidity was measured in the laboratory

µS/cm = microSiemens per centimeter
mg/L = milligrams per liter
mV = millivolts
NTU = Nephlometric Turbidity Unit
NA = not analyzed
ND means a non-detectable concentration by the approved analytical methods

-- indicates no criteria exists
* indicates a guidance value
** applies to the sum of cis- and trans-1,3-dichloropropene
*** applies to the sum of phenolic compounds (total phenols)
**** PRG for mixture of 2,4- and 2,6-dinitrotoluene is 0.099 ug/L
* PRG for Chromium III (no PRG exists for Total Chromium)
** TOG for sum of Iron and Manganese is 500 ug/L
*** PRG for Nickel (soluble salts)

▨ indicates exceedance of groundwater criteria or guidance value

ORGANIC DATA QUALIFIERS:
U = compound was analyzed for, but not detected, reported with detection limit value
J = an estimated value, either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, or when a compound meets the identification criteria but the result is less than the quantitation limit

INORGANIC DATA QUALIFIERS:
U = element was analyzed for, but not detected; reported with the detection limit
J or B = estimated value or value greater than or equal to the instrument detection limit, but less than the quantitation limit

Table 5-9

ANALYTICAL RESULTS FOR DEEP OVERBURDEN GROUNDWATER SAMPLES

Peter Cooper Markhams Site
Dayton, New York

	Groundwater Criteria [3]		Sample Location, Sample Identification #, and Date Collected [1]																	
			MW-1D		MW-2D		MW-3D2		MW-4D		MW-5D		MW-6D		MW-7D		MW-8D		MW-9D	
			110701173	042302194	110601163	042302192	110601162	42202191	110501160	042402201	110701169	042602211	110801180	042402207	110801177	042402203	110601167	042302200	110501157	042202188
Constituent [2]	TOG	PRG	11/7/2001	4/23/2002	11/6/2001	4/23/2002	11/6/2001	4/22/2002	11/5/2001	4/24/2002	11/7/2001	4/26/2002	11/8/2001	4/24/2002	11/8/2001	4/24/2002	11/6/2001	4/23/2002	11/5/2001	4/22/2002
Volatile Organic Compounds, micrograms per liter																				
Acetone	50*	610	10 U	5 UJ	25	5 UJ	10 U	5 UJ	10 U	5 UJ	10 U	5 UJ	10 U	5 UJ	74	5 UJ	10 U	6.3 J	10 U	5 UJ
Benzene	1	0.34	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	0.32 J
Bromodichloromethane	50*	0.18	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Bromoform	50*	8.5	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Bromomethane	5	8.7	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 UJ	10 U	1 UJ	10 U	1 UJ	10 U	1 UJ	10 U	1 U	10 U	1 U
2-Butanone (Methyl ethyl ketone)	50*	1900	10 U	5 UJ	10 U	5 UJ	10 U	5 UJ	10 U	5 UJ	10 U	5 UJ	10 U	5 UJ	10 U	5 UJ	10 U	5 UJ	10 U	5 UJ
Carbon Disulfide	--	1000	1.1 J	1 U	1.2 J	1 U	10 U	0.24 J	2.6 J	1.1	10 U	1 U	10 U	1 U	1.8 J	0.25 J	10 U	0.22 J	1.7 J	12
Carbon Tetrachloride	5	0.17	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Chlorobenzene	5	110	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Chloroethane	5	4.6	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Chloroform	7	6.2	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Chloromethane (Methyl chloride)	5	1.5	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Dibromochloromethane	50*	0 13	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
1,3-Dichlorobenzene	3	5.5	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
1,4-Dichlorobenzene	3	0.50	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
1,2-Dichlorobenzene	3	370	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
1,2-Dibromo-3-chloropropane	0.04	0.048	10 U	1 UJ	10 U	1 UJ	10 U	1 UJ	10 U	1 UJ	10 U	1 UJ	10 U	1 UJ	10 U	1 UJ	10 U	1 UJ	10 U	1 UJ
Dichlorodifluoromethane	5	390	10 UJ	1 U	10 UJ	1 U	10 UJ	1 U	10 U	1 UJ	10 UJ	1 UJ	10 UJ	1 UJ	10 UJ	1 UJ	10 UJ	1 U	10 U	1 U
1,2-Dibromoethane (Ethylene dibromide)	0.0006	0.00076	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
1,1-Dichloroethane	5	810	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
1,2-Dichloroethane	0.6	0.12	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
1,1-Dichloroethene	5	340	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
1,2-Dichloropropane	1	0.16	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U.	1 U	10 U	1 U
cis-1,2-Dichloroethene	5	61	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
cis-1,3-Dichloropropene	0.4**	0.40	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
trans-1,3-Dichloropropene	0.4**	0.40	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
trans-1,2-Dichloroethene	5	120	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Ethylbenzene	5	2.9	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
2-Hexanone	50*	--	10 U	5 U	10 U	5 U	10 U	5 U	10 U	5 U	10 U	5 U	10 U	5 U	10 U	5 U	10 U	5 U	10 U	5 U
Isopropylbenzene (Cumene)	5	660	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Methyl tertbutyl ether	--	13	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Methylene chloride	5	4.3	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
4-Methyl-2-pentanone (Methyl isobutyl ketone)	--	160	10 U	5 U	10 U	5 U	10 U	5 U	10 U	5 U	10 U	5 U	10 U	5 U	10 U	5 U	10 U	5 U	10 U	5 U
Styrene	5	1600	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
1,1,2,2-Tetrachloroethane	5	0.055	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Tetrachloroethene	5	0.66	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Toluene	5	720	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
1,2,4-Trichlorobenzene	5	190	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
1,1,1-Trichloroethane	5	3200	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
1,1,2-Trichloroethane	1	0.20	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Trichloroethene	5	0.028	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Trichlorofluoromethane	5	1300	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	5	59000	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Vinyl chloride	2	0.020	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Total Xylenes (1,2-, 1,3-, and 1,4-Xylene)	5	210	10 U	3 U	10 U	3 U	10 U	3 U	10 U	3 U	10 U	3 U	10 U	3 U	10 U	3 U	10 U	3 U	10 U	3 U
Cyclohexane	--	35000	10 U	5 U	10 U	5 U	10 U	5 U	10 U	5 U	10 U	5 U	10 U	5 U	10 U	5 U	10 U	5 U	10 U	5 U
Methyl acetate	--	6100	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Methylcyclohexane	--	5200	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U	10 U	1 U
Semi-Volatile Organic Compounds, micrograms per liter																				
Acenaphthene	20*	370	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Acenaphthylene	--	--	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Acetophenone	--	--	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Anthracene	50*	1800	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Atrazine	7.5	0.30	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Benzaldehyde	--	3600	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Benzo(a)anthracene	0.002*	0.092	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Benzo(b)fluoranthene	0.002*	0.092	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Benzo(k)fluoranthene	0.002*	0.92	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Benzo(ghi)perylene	--	--	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Benzo(a)pyrene	ND	0.0092	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Benzoic acid	--	150000	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Benzyl alcohol	--	11000	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Biphenyl (1,1'-Biphenyl)	5	300	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Bis(2-chloroethoxy)methane	5	--	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Bis(2-chloroethyl)ether	1 0	0.010	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
2,2'-Oxybis(1-chloropropane) (Bis(2-chloro-1-methylethyl)ether)	5	0.27	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Bis(2-ethylhexyl) phthalate	5	4 8	0.7 J	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	2 J	NA	2 J	NA	19	NA
4-Bromophenyl phenyl ether	--	--	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Butyl benzyl phthalate	50*	7300	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Caprolactam	--	18000	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Carbazole	--	3 4	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA

Table 5-9

ANALYTICAL RESULTS FOR DEEP OVERBURDEN GROUNDWATER SAMPLES

Peter Cooper Markhams Site
Dayton, New York

	Groundwater Criteria[3]		Sample Location, Sample Identification #, and Date Collected[1]																	
			MW-1D		MW-2D		MW-3D2		MW-4D		MW-5D		MW-6D		MW-7D		MW-8D		MW-9D	
			110701173	042302194	110601163	042302192	110601162	42202191	110501160	042402201	110701169	042602211	110801180	042402207	110801177	042402203	110601167	042302200	110501157	042202188
Constituent[2]	TOG	PRG	11/7/2001	4/23/2002	11/6/2001	4/23/2002	11/6/2001	4/22/2002	11/5/2001	4/24/2002	11/7/2001	4/26/2002	11/8/2001	4/24/2002	11/8/2001	4/24/2002	11/6/2001	4/23/2002	11/5/2001	4/22/2002
4-Chloroaniline	5	150	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
4-Chloro-3-methylphenol	--	--	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
2-Chloronaphthalene (beta-Chloronaphthalene)	10*	490	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
2-Chlorophenol	--	30	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
4-Chlorophenyl phenyl ether	--	--	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Chrysene	0.002*	9.2	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Dibenzo(a,h)anthracene	--	0.0092	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Dibenzofuran	--	24	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Di-n-butyl phthalate (Dibutyl phthalate)	50	3600	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	3 J	NA	10 U	NA	10 U	NA
1,2-Dichlorobenzene	3	370	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
1,3-Dichlorobenzene	3	5.5	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
1,4-Dichlorobenzene	3	0.50	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
3,3'-Dichlorobenzidine	5	0.15	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
2,4-Dichlorophenol	5	110	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Diethyl phthalate	50*	29000	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
2,4-Dimethylphenol	50*	730	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Dimethyl phthalate	50*	360000	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
4,6-Dinitro-2-methylphenol	--	--	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA
2,4-Dinitrophenol	10*	73	25 U	NA	25 UJ	NA	25 UJ	NA	25 UJ	NA	25 U	NA	25 U	NA	25 U	NA	25 UJ	NA	25 UJ	NA
2,4-Dinitrotoluene	5	73****	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
2,6-Dinitrotoluene	5	36****	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Di-n-octyl phthalate	50*	1500	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Fluoranthene	50*	1500	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Fluorene	50*	240	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Hexachlorobenzene	0.04	0.042	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Hexachlorobutadiene	0.5	0.86	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Hexachlorocyclopentadiene	5	220	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Hexachloroethane	5	4.8	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Indeno(1,2,3-cd)pyrene	0.002*	0.092	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Isophorone	50*	71	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
2-Methylnaphthalene	--	--	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
2-Methylphenol	--	1800	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
4-Methylphenol	--	180	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Naphthalene	10*	6.2	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
2-Nitroaniline	5	1.0	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA
3-Nitroaniline	5	--	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA
4-Nitroaniline	5	--	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA
Nitrobenzene	0.4	3.4	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
2-Nitrophenol	--	--	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
4-Nitrophenol	--	--	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA
N-nitrosodiphenylamine	50*	14	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
N-Nitroso-Di-n-propylamine	--	0.010	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Pentachlorophenol	1***	0.56	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA
Phenanthrene	50*	--	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	2 J	NA	1 J	NA	10 U	NA
Phenol	1***	22000	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Pyrene	50*	180	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
1,2,4-Trichlorobenzene	5	190	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
2,4,5-Trichlorophenol	--	3600	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA	25 U	NA
2,4,6-Trichlorophenol	--	3.6	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA	10 U	NA
Total Metals, micrograms per liter																				
Aluminum	--	36000	320	NA	5660	NA	200 U	NA	200 U	NA	232	NA	200 U	NA	819	NA	2060	NA	3020	NA
Antimony	3	15	60.0 U	NA	60.0 U	NA	60.0 U	NA	60.0 U	NA	60.0 U	NA	60.0 U	NA	60.0 U	NA	60.0 U	NA	60.0 U	NA
Arsenic	25	0.045	10.0 U	10 U	10.0 U	10 U	10.0 U	10 U	10.0 U	10 U	10.0 U	10 U	10.0 U	10 U	10.0 U	10 U	10.0 U	10 U	10.0 U	10 U
Barium	1000	2600	200 U	NA	519	NA	200 U	NA	200 U	NA	230	NA	200 U	NA	200 U	NA	314	NA	200 U	NA
Beryllium	3*	73	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA
Cadmium	5	18	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA
Calcium	--	--	266000 J	NA	57200 J	NA	52400 J	NA	57300 U	NA	228000 J	NA	356000 J	NA	284000 J	NA	45300 J	NA	55800 U	NA
Chromium	50	55000*	15.1	15.2	15.1	10 U	10.0 U	10 U	10.0 U	10 U	10.0 U	10 U	11.9	13.2	13.3	10 U	10.0 U	10 U	10.0 U	10 U
Cobalt	--	730	50.0 U	NA	50.0 U	NA	50.0 U	NA	50.0 U	NA	50.0 U	NA	50.0 U	NA	50.0 U	NA	50.0 U	NA	10.0 U	NA
Copper	200	1500	25.0 U	NA	25.0 U	NA	25.0 U	NA	25.0 U	NA	25.0 U	NA	25.0 U	NA	25.0 U	NA	25.0 U	NA	25.0 U	NA
Iron	300**	11000	15500 J	NA	7850 J	NA	413 J	NA	1090 J	NA	14100 J	NA	4340 J	NA	10200 J	NA	2660 J	NA	2880 J	NA
Lead	25	--	3.0 U	NA	3.0 U	NA	3.0 U	NA	3.0 UJ	NA	3.0 U	NA	3.0 U	NA	3.1	NA	3.0 U	NA	3.0 UJ	NA
Magnesium	35000*	--	76400	NA	11600	NA	10800	NA	11600	NA	40800	NA	125000	NA	75200	NA	8220	NA	11000	NA
Manganese	300**	880	268 J	NA	299 J	NA	72.1 J	NA	297 J	NA	812 J	NA	2330 J	NA	337 J	NA	114 J	NA	141 J	NA
Nickel	100	730***	40.0 U	NA	40.0 U	NA	40.0 U	NA	40.0 U	NA	40.0 U	NA	40.0 U	NA	40.0 U	NA	40.0 U	NA	40.0 U	NA
Potassium	--	--	19600 J	NA	5000 UN	NA	5000 UJ	NA	5000 U	NA	5000 U	NA	5000 UJ	NA	5000 UJ	NA	5000 UJ	NA	5000 U	NA
Selenium	10	180	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA
Silver	50	180	10.0 U	NA	10.0 U	NA	10.0 U	NA	10.0 U	NA	10.0 U	NA	10.0 U	NA	10.0 U	NA	10.0 U	NA	10.0 U	NA
Mercury	0.7	11	0.200 UJ	NA	0.200 UJ	NA	0.200 UJ	NA	0.200 UJ	NA	0.200 UJ	NA	0.200 UJ	NA	0.200 UJ	NA	0.200 UJ	NA	0.200 UJ	NA
Sodium	20000	--	22300	NA	5000 U	NA	5000 U	NA	5850	NA	15500	NA	7110	NA	20700	NA	11400	NA	5990 U	NA
Thallium	0.5*	2.4	10.0 U	NA	10.0 U	NA	10.0 U	NA	10.0 U	NA	10.0 U	NA	10.0 U	NA	10.0 U	NA	10.0 U	NA	10.0 U	NA
Vanadium	--	260	50.0 U	NA	50.0 U	NA	50.0 U	NA	50.0 U	NA	50.0 U	NA	50.0 U	NA	50.0 U	NA	50.0 U	NA	50.0 U	NA
Zinc	2000*	11000	20.0 UJ	NA	25.9 J	NA	20.0 UJ	NA	20.0 U	NA	20.0 U	NA	20.0 UJ	NA	23.1 J	NA	20.0 UJ	NA	20.0 U	NA
Dissolved Metals, micrograms per liter																				
Aluminum	--	36000	NA	NA	200 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 5-9

ANALYTICAL RESULTS FOR DEEP OVERBURDEN GROUNDWATER SAMPLES

Peter Cooper Markhams Site
Dayton, New York

	Groundwater Criteria[3]		Sample Location, Sample Identification #, and Date Collected[1]																	
			MW-1D		MW-2D		MW-3D2		MW-4D		MW-5D		MW-6D		MW-7D		MW-8D		MW-9D	
			110701173	042302194	110601163	042302192	110601162	42202191	110501160	042402201	110701169	042602211	110801180	042402207	110801177	042402203	110601167	042302200	110501157	042202188
Constituent[2]	TOG	PRG	11/7/2001	4/23/2002	11/6/2001	4/23/2002	11/6/2001	4/22/2002	11/5/2001	4/24/2002	11/7/2001	4/26/2002	11/8/2001	4/24/2002	11/8/2001	4/24/2002	11/6/2001	4/23/2002	11/5/2001	4/22/2002
Antimony	3	15	NA	NA	60.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	25	0.045	NA	NA	10.0 U	10 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Barium	1000	2600	NA	NA	443	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	3*	73	NA	NA	5.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	5	18	NA	NA	5.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Calcium	--	--	NA	NA	45800 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	50	55000*	NA	NA	10.0 U	10 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt	--	730	NA	NA	50.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	200	1500	NA	NA	25.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron	300**	11000	NA	NA	351 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	25	--	NA	NA	3.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Magnesium	35000*	--	NA	NA	8040	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	300**	880	NA	NA	161 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	100	730***	NA	NA	40.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Potassium	--	--	NA	NA	5000 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	10	180	NA	NA	10.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Silver	50	180	NA	NA	10.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	0.7	11	NA	NA	0.200 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sodium	20000	--	NA	NA	5000 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	0.5*	2.4	NA	NA	10.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	--	260	NA	NA	50.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	2000*	11000	NA	NA	20.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexavalent Chromium, micrograms per liter																				
Total Hexavalent Chromium	50	110	10 UJ	10 UJ	(10000 U) R	10 UJ	10 UJ	10 UJ	10 UJ	10 UJ	321 NJ	10 UJ	10 UJ	10 UJ	10 UJ	10 UJ	(10000 U) R	10 UJ	(10000 U) R	10 UJ
Soluble Hexavalent Chromium	50	110	NA	NA	10 UJ	10 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Other Geochemical Parameters, milligrams per liter																				
Ammonia	2 ($NH_3 + NH_4^+$ as N)	--	113	150	0.10 U	0.10 U	0.10 U	0.10 U	0.68	0.58	0.17	0.18	6.2	0.53	0.11	0.10 U	0.14	0.10 U	0.10 U	0.10 U
Bicarbonate Alkalinity	--	--	608	NA	143	NA	135	NA	174	NA	450	NA	519	NA	436	NA	146	NA	108	NA
Carbonate Alkalinity	--	--	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA	5.0 U	NA
Nitrate	10 (as N)	10	0.50 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U	0.50 U	0.50 U	0.50 U	0.5 U	0.50 U	0.5 U	0.50 U	0.5 U
Sulfate	250	--	748	624	12.6	8.5	48.7	53.6	25.0	12.5	288	243	1040	723	603	584	27.4	13.7	57.3	59.7
Sulfide	0.05* (as H_2S)	--	1.0 U	NA	1.0 U	NA	1.0 U	NA	1.0 U	NA	1.0 U	NA	1.0 U	NA	1.0 U	NA	1.0 U	NA	1.0 U	NA
Total Dissolved Solids	--	--	1490	NA	155	NA	178	NA	210	NA	973	NA	1770	NA	1220	NA	133	NA	223	NA
Total Organic Carbon	--	--	17.8	NA	5.6 J	NA	4.9	NA	6.7	NA	9.3	NA	13.3	NA	12.8	NA	4.1	NA	5.5	NA
Soluble Organic Carbon	--	--	NA	NA	14.1 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Field Measured Parameters																				
Temperature, °C	--	--	10.48	10.65	10.45	8.46	10.01	7.48	9.53	8.99	10.2	8.41	9.85	9.55	9.52	8.61	9.43	8.46	10.08	7.83
pH, standard units	--	--	6.73	6.76	7.32	7.61	7.65	7.91	7.5	7.41	6.91	6.89	6.45	6.55	6.72	6.91	7.5	7.79	7.36	7.71
Specific Conductivity, µS/cm	--	--	3718	2700	340	309	369	544	253	373	2024	1056	3619	2148	2891	1865	341	319	237	541
Dissolved Oxygen, mg/L	--	--	0.46	0.03	0.65	0.11	1.2	0.17	0.59	0.09	0.45	0.03	0.44	0.07	0.29	0.06	0.5	0.04	0.77	0.23
Oxidation-Reduction Potential, mV	--	--	190	199	239.1	211.1	230	259.9	159	218.8	208	226.1	76	42.5	160.6	181.4	211	251.2	32	398.9
Turbidity, NTU	--	--	10.17	16	500	130	1 9	12	3.3	4.54	11.9	11	2.97	12	45.8	19.6	48.5	26.7	43	4.36
Ferrous Iron, mg/L	--	--	6.2	7	1.4	0	0	0.5	1 6	1.2	6	5.8	NA	0	4.6	7	NA	0.8	0	1

Notes:

1 Sample locations provided on Plate 1

2 Data qualifications reflect 100% data validation performed by Data Validation Services

3 Groundwater criteria is from NYSDEC Division of Water, Technical and Operational Guidance Series (TOGs), Ambient Water Quality Standards and Guidance Values for Groundwater (June 1998) and U.S. EPA Region 9 Preliminary Remediation Goals (PRGs) for Tap Water (2004)

µS/cm = microSiemens per centimeter
mg/L = milligrams per liter
mV = millivolts
NTU = Nephlometric Turbidity Unit
NA = not analyzed
ND means a non-detectable concentration by the approved analytical methods
(value) = concentration reported by the laboratory prior to being rejected by data validation
R = rejected concentration as a result of data validation

-- indicates no criteria exists
* indicates a guidance value
** applies to the sum of cis- and trans-1,3-dichloropropene
*** applies to the sum of phenolic compounds (total phenols)
**** PRG for mixture of 2,4- and 2,6-dinitrotoluene is 0.099 ug/L
* PRG for Chromium III (no PRG exists for Total Chromium)
** TOG for sum of Iron and Manganese is 500 ug/L
*** PRG for Nickel (soluble salts)

▨ indicates exceedance of groundwater criteria or guidance value

ORGANIC DATA QUALIFIERS:
U = compound was analyzed for, but not detected; reported with detection limit value
J = an estimated value, either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, or when a compound meets the identification criteria but the result is less than the quantitation limit

INORGANIC DATA QUALIFIERS:
U = element was analyzed for, but not detected, reported with the detection limit
J or B = a value greater than or equal to the instrument detection limit, but less than the quantitation limit
E = a value estimated or not reported due to the presence of interferences
N = spike sample recovery is not within the quality control limits

Table 5-10

ANALYTICAL RESULTS FOR WETLAND SURFACE WATER SAMPLES

Peter Cooper Markhams Site
Dayton, New York

		Sample Location, Sample Identification #, and Date Collected[1]							
	Surface Water Criteria[3]	*Surface Water #1*		*Surface Water #2*		*Surface Water #3*		*Surface Water #4*	
Compound[2]		*120301186* *12/3/2001*	*042402206* *4/24/2002*	*120301184* *12/3/2001*	*042502212* *4/25/2002*	*120301183* *12/3/2001*	*042502214* *4/25/2002*	*dry* *12/3/2001*	*042502215* *4/25/2002*
Total Metals, micrograms per liter									
Arsenic	150*	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	NA	10.0 U
Chromium **	48.2	10.0 U	10.0 U	10.0 UJ	10.0 U	10.0 U	10.0 U	NA	10.0 U
Hexavalent Chromium	11*	10 UJ	10.0 UJ	13.0 J	10.0 UJ	10.0 UJ	10.0 J	NA	10.0 UJ
Other Geochemical Parameters, milligrams per liter									
Ammonia	0.08 - 2.5^{+}	0.10 U	0.10 U	0.10 U	0.11 J	0.10 U	0.10 U	NA	0.10 U
Bicarbonate Alkalinity	–	37.9	NA	40.8	NA	10	NA	NA	NA
Carbonate Alkalinity	–	5.0 U	NA	5.0 U	NA	5.0 U	NA	NA	NA
Nitrate	10	0.50 U	5.6	0.50 U	0.50 U	0.50 U	0.50 U	NA	2.1
Sulfate	250	337	190	198	83.2	34.5	18.2	NA	27.8
Sulfide	0.002^{++}	1.0 U	NA	1.0 U	NA	1.0 U	NA	NA	NA
Total Dissolved Solids	1000	603	NA	432	NA	111	NA	NA	NA
Total Organic Carbon	–	17.8	NA	26.4	NA	33.0	NA	NA	NA
Field Measured Parameters									
Temperature, °C	–	NA	16.70	11.30	7.72	10.39	10.54	NA	10.49
pH, standard units	–	NA	7.35	5.85	7.37	3.38	7.16	NA	7.00
Specific Conductivity, μS/cm	–	NA	925	4.44	491	1100	69	NA	242
Dissolved Oxygen, mg/L	–	NA	0.72	7.03	0.66	11.8	1.09	NA	0.85
Oxidation-Reduction Potential, mV	–	NA	-139.8	NA	70.0	NA	-84.6	NA	-34.9
Turbidity, NTU	–	NA	0.30	4.1	11	2.5	NA	NA	NA
Ferrous Iron, mg/L	--	NA	NA	<1	NA	<1	NA	NA	NA

Notes:

▨ indicates concentration above surface water criteria

1. Sample locations provided on Plate 1
2. Data qualifications reflect 100% data validation performed by Data Validation Services
3. Surface water criteria is from NYSDEC Division of Water, Technical and Operational Guidance Series (TOGs), Ambient Water Quality Standards and Guidance Values for Fish Propagation in Fresh Waters (June 1998)

* indicates criteria applies to dissolved form

** indicates criteria is a function of hardness, as follows: (0.86)exp(0.819[ln (ppm hardness)] + 0.6848); applies to dissolved form of trivalent chromium

Maximum alkalinity value substituted for Hardness

$^{+}$ indicates criteria is dependent upon pH and temperature

– indicates no criteria exists

$^{++}$ indicates criteria is for total sulfides, expressed as hydrogen sulfide

NA = not analyzed

INORGANIC DATA QUALIFIERS:

U = element was analyzed for, but not detected; reported with the detection limit value

J = a value greater than or equal to the instrument detection limit, but less than the quantitation limit

ORGANIC DATA QUALIFIERS:

U = compound was analyzed for, but not detected; reported with the detection limit value

J = an estimated value, either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, or when a compound meets the identification criteria but the result is less than the quantitation limit

Table 5-11

ANALYTICAL RESULTS FOR BACKGROUND WETLAND SEDIMENT SAMPLES

Peter Cooper Markhams Site
Dayton, New York

		Sample Location, Sample Identification #, and Date Collected[1]								
Constituent[2]	*Sediment Criteria*[3]	*Lathe # 79A* *101501135* *10/15/2001*	*Lathe # 80* *101501136* *10/15/2001*	*Lathe # 81A* *101501137* *10/15/2001*	*Lathe #82* *101501139* *10/15/2001*	*Lathe #83* *101501140* *10/15/2001*	*Lathe #76* *101501146* *10/15/2001*	*Lathe #75* *101501147* *10/15/2001*	*Lathe #77* *101501148* *10/15/2001*	*Lathe #78* *101501149* *10/15/2001*
Total Metals, milligrams per kilogram										
Arsenic	6.0/33	9.6	7.1	10.3	8.9	1.4 U	5.2	9.3	6.0	4.2
Chromium	26.0/110	13.2 J	14.1 J	9.3 J	23.1 J	8.3 J	13.9 J	7.8 J	11.8 J	16.4 J

Notes:

1. Sample locations provided on Plate 1
2. Data qualifications reflects 100% data validation performed by Data Validation Services
3. Sediment criteria (Low Effect Level/Severe Effect Level) from NYSDEC Division of Fish, Wildlife and Marine Resources, Technical Guidance for Screening Contaminated Sediments (January 1999)

INORGANIC DATA QUALIFIERS:

U = element was analyzed for, but not detected; reported with the detection limit value

Table 5-12

ANALYTICAL RESULTS FOR WETLAND SEDIMENT SAMPLES

Peter Cooper Markhams Site
Dayton, New York

			Sample Location, Sample Identification #, and Date Collected[1]					
			Wetland A	*Wetland B*				
Constituent[2]	*Sediment Criteria*[3]	*Site Background Range*	*Lathe #89* *101501133* *10/15/2001*	*Lathe #86* *101501124* *10/15/2001*	*Lathe #87* *101501126* *10/15/2001*	*Lathe #88* *101501127* *10/15/2001*	*Lathe #90* *101501128* *10/15/2001*	*Lathe #91* *101501129* *10/15/2001*
Total Metals, milligrams per kilogram								
Arsenic	6.0/33	ND to 25	6.4	6.6 U	6.3	6.8 U	5.9 U	6.7 U
Chromium	26.0/110	7.8 to 31	215 J /29.0[4]	6.6 UJ	19.2 J	26.7 J	46.8 J	42.4 J
Hexavalent Chromium	--	NA	(1.3 U) R / 18.3[4]	(2.8 U) R	(2.4 U) R	(2.6 U) R	(2.4 U) R	(1.6 U) R

			Sample Location, Sample Identification #, and Date Collected[1]							
			Wetland D			*Wetland F*			*Wetland G*	
Constituent[2]	*Sediment Criteria*[3]	*Site Background Range*	*Lathe #94A* *101501120* *10/15/2001*	*Lathe #93* *101501121* *10/15/2001*	*Lathe #92A* *101501122* *10/15/2001*	*Lathe #150* *101501130* *10/15/2001*	*Lathe #151* *101501131* *10/15/2001*	*Lathe #152* *101501132* *10/15/2001*	*Lathe #84A* *101501123* *10/15/2001*	*Lathe #85* *101501125* *10/15/2001*
Total Metals, milligrams per kilogram										
Arsenic	6.0/33	ND to 25	11.4	8.6	9.0	4.5	3.2 U	3.9	3.8	2.3
Chromium	26.0/110	7.8 to 31	75.4 J	136 J /97.8[4]	51.8 J	24.4 J	14.6 J	23.9 J	9.2 J	87.4 J / 14.2 J[4]
Hexavalent Chromium	--	NA	(0.47 U) R	(0.52 U) R /1.3[4]	(0.52 U) R	(0.88 U) R	(1.2 U) R	(1.0 U) R	(0.53 U) R	(0.92 U)R /4.0 UJ[4]

Notes:
1. Sample locations provided on Plate 1
2. Data qualifications reflect 100% data validation performed by Data Validation Services
3. Sediment criteria (Low Effect Level/Severe Effect Level) from NYSDEC Division of Fish, Wildlife and Marine Resources, Technical Guidance for Screening Contaminated Sediments (January 1999)
4. Confirmation sample result collected on December 3, 2003.

(value) = concentration reported by the laboratory prior to being rejected during data validation
R = rejected concentration as a result of data validation
ND = non-detect

▨ indicates concentration is above background range and sediment criterion (severe effect)

INORGANIC DATA QUALIFIERS:
U = element was analyzed for, but not detected; reported with the detection limit value

J = a value greater than or equal to the instrument detection limit, but less than the quantitation limit

Table 5-13

ANALYTICAL RESULTS FOR SOIL VAPOR

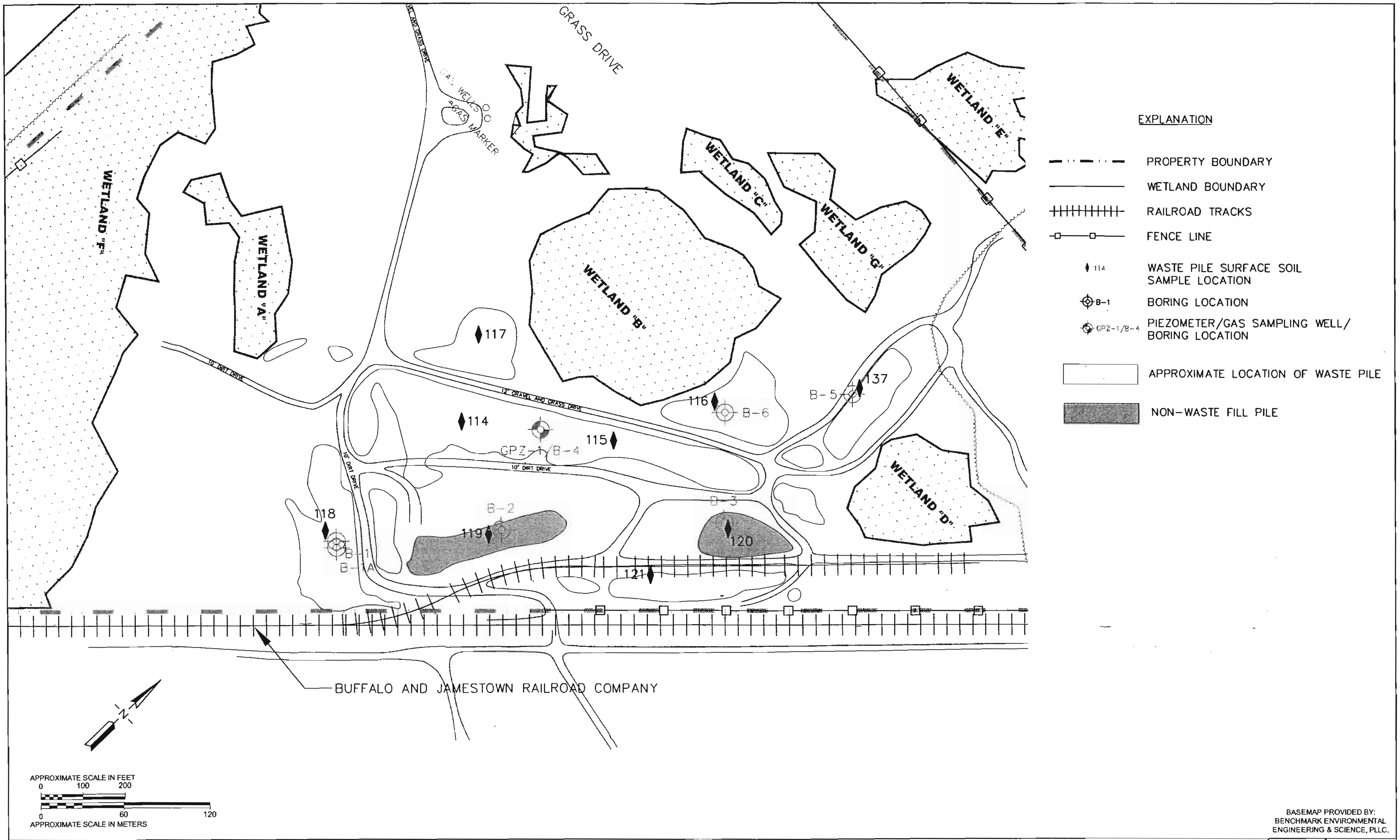
Peter Cooper Markhams Site
Dayton, New York

	Sample Location, Identification, and Date Collected [1]					
	GPZ-1			*GPZ-1*		
	i	*i + 1 min*	*i + 7 min*	*i*	*i + 5 min*	*Maximum Conc.*
Constituent [2]	*11/5/2001*	*11/5/2001*	*11/5/2001*	*4/22/2002*	*4/22/2002*	*4/22/2002*
Field Measured Parameters						
Carbon monoxide, ppm	6	4	3	103	185	185
Oxygen, %	0.8	0.4	0.9	9.8	8.4	6.1
Hydrogen sulfide, ppm	4	1	3	195	305	305
LEL, %	100	100	100	100	100	100

Notes:

1. Sample location provided on Plate 1

i = initial sample result at time zero
min = minutes
ppm = parts per million
LEL = lower explosive limit (a measurement of methane in air)
> = greater than



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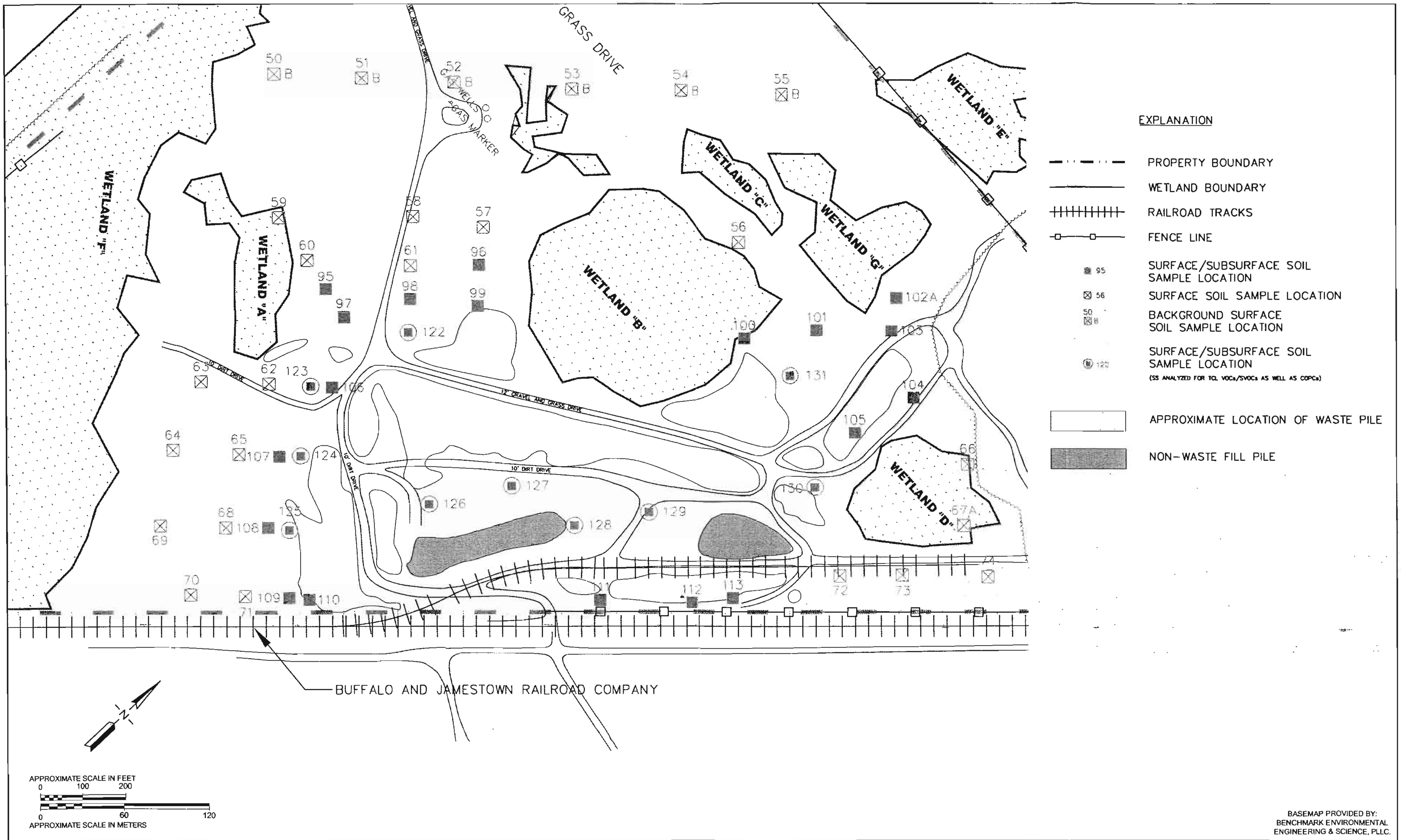
GEOMATRIX

SURFACE AND SUBSURFACE SOIL WASTE FILL PILE SAMPLE LOCATIONS

Peter Cooper Markhams Site
Dayton, New York

Figure By	Project No.
dmh	7603.000
Date	Figure
February 2005	3-1



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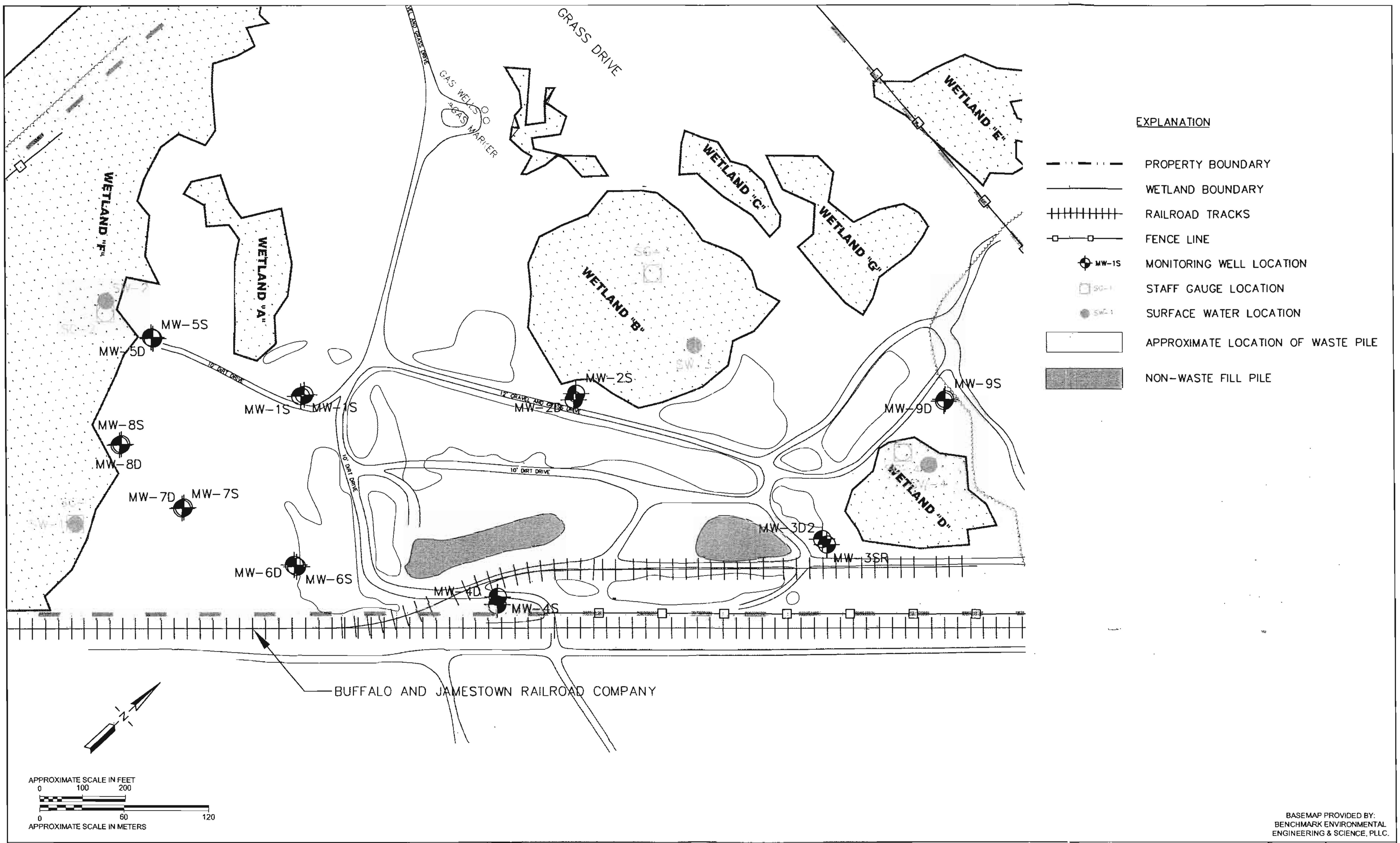
GEOMATRIX

PERIMETER AND BACKGROUND SURFACE AND SUBSURFACE SOIL SAMPLE LOCATIONS

Peter Cooper Markhams Site
Dayton, New York

Figure By	Project No.
dmh	7603.000
Date	Figure
February 2005	3-2



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GEOMATRIX

MONITORING WELL, STAFF GAUGE, AND SURFACE WATER LOCATIONS

Peter Cooper Markhams Site
Dayton, New York

Figure By	Project No.
dmh	7603.000
Date	Figure
February 2005	3-3

BASEMAP PROVIDED BY:
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GEOMATRIX

SEDIMENT AND BACKGROUND SEDIMENT SAMPLE LOCATIONS
Peter Cooper Markhams Site
Dayton, New York

Figure By	Project No.
dmh	7603.000
Date	Figure
January 2005	3-4

APPENDIX C

POST-REMEDIAL MONITORING PLAN

PETER COOPER MARKHAMS SITE
DAYTON, NEW YORK

July 2006 0021-003-200

PETER COOPER MARKHAMS SITE
POST-REMEDIAL GROUNDWATER MONITORING PLAN
DAYTON, NEW YORK

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PETER COOPER MARKHAMS SITE
POST-REMEDIAL GROUNDWATER MONITORING PLAN
DAYTON, NEW YORK

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1.0 PURPOSE AND OBJECTIVES

The purpose of this Post-Remedial Monitoring Plan is to identify and document the methods that will be employed at the Peter Cooper Markhams Site to detect changes in Site conditions following implementation of remedial measures. Accordingly, this Plan identifies groundwater and surface water sampling locations; collection procedures; analytical parameters and methodology; and data reporting and interpretation requirements that will be implemented following construction of the recommended remedial measures.

This Plan contains eight sections:

- Section 2.0 identifies the post-remedial monitoring locations to be sampled.
- Section 3.0 identifies the monitoring parameters and frequency.
- Section 4.0 presents field sampling procedures to be employed at the Site.
- Section 5.0 specifies analytical methods and quality control requirements.
- Section 6.0 presents corrective action measures to be taken in the event of changed field conditions or failure to meet quality assurance goals.
- Section 7.0 identifies data evaluation and reporting requirements
- Section 8.0 presents references cited in this report.

2.0 MONITORING NETWORK

The Remedial Investigation Report for the Peter Cooper Markhams Site indicates that overburden groundwater flows in a southwesterly direction across the Site toward wetland F. There is comparable hydraulic conductivity between shallow and deep wells, with no separating confining layer and similar geochemistry, indicating that the shallow and deeper units represent a single hydrostratigraphic unit. Accordingly, monitoring of select upgradient and downgradient shallow overburden wells and surface water from Wetland F will provide representative data to evaluate changes in site conditions. The planned groundwater and surface water monitoring network is described below.

2.1 Monitoring Locations

Groundwater monitoring will be performed at the following network locations (see Figure 1), where the S identifier indicates a shallow overburden monitoring well:

- Upgradient monitoring well MW-9S.
- Perimeter downgradient monitoring wells MW-5S, MW-7S, and MW-8S.
- Downgradient Wetland F.

In addition, the following locations will be monitored for water elevation information to facilitate preparation of overburden isopotential maps:

- Monitoring wells MW-4S and MW-6S.

Borehole logs for the groundwater monitoring wells identified in this section are included in Appendix A.

3.0 MONITORING PROGRAM

As described in Section 3.0, groundwater monitoring will be conducted at specific monitoring wells and Wetland F at the Site. Details concerning the planned monitoring frequency, parameters and analytical methods are described below. A summary of the monitoring program requirements is presented in Table 1.

Groundwater monitoring will include both water quality and water level monitoring. Water level monitoring is intended to detect seasonal changes in the groundwater flow direction Groundwater elevation monitoring will be performed at all monitoring well/piezometer locations identified on Table 1.

Samples will be collected at the surface water and monitoring well locations identified in Section 2.1 and summarized in Table 1. Procedures for well sampling are discussed in Section 5. Groundwater levels and surface water elevation will be recorded prior to well purging. Samples will be collected on a semi-annual (spring and fall) basis for the first two years of monitoring, and may be reduced to annually thereafter if the data supports the reduction. Samples will be analyzed for the parameters identified on Table 1. Laboratory and field parameters will be evaluated for reduction following two years of monitoring.

4.0 FIELD SAMPLING PROCEDURES

This section describes the sampling procedures that will be implemented at the Peter Cooper Markhams Site during routine environmental monitoring events.

4.1 Pre-Sampling Preparation

Prior to a scheduled sampling event, the following steps will be taken by personnel responsible for sampling:

- Review the sampling procedures;
- Assemble and inspect all field equipment necessary for sample collection;
- Verify that equipment is clean and in proper working order;
- Field test equipment will be calibrated at the beginning of each sampling day, and will be checked and recalibrated according to manufacturer's specifications. Field instrumentation will be maintained and operated according to the applicable guidelines presented in Appendix B;
- Examine shuttles, bottles, labels and preservatives; contact laboratory immediately if any problems are discovered;
- Confirm sample delivery time and method of shipment with the laboratory;
- Establish a sampling team of at least two people; and
- Establish monitoring well evacuation and sampling schedule for the activities of each day.

4.2 Groundwater Sampling

Applicable guidelines to be employed for collecting representative groundwater samples from monitoring wells and surface water samples from the wetland are provided in Appendix B. Applicable guidelines include:

- Groundwater Level Measurement
- Low Flow (Minimal Drawdown) Groundwater Purging Procedures
- Groundwater Sample Collection Procedures
- Surface Water Collection Procedure

Groundwater sample collection equipment will consist of a peristaltic pump and dedicated pump tubing following low-flow purge and sample collection procedures. Prior to sample collection, groundwater will be evacuated from each well at a low-flow rate (approximately 0.1 L/min) and field measurements for pH, Eh, specific conductance, temperature, turbidity, dissolved oxygen, visual and olfactory observations and water level will be periodically recorded and monitored for stabilization. Purging will be considered complete when pH, specific conductivity and temperature stabilize and when the turbidity is measured below 50 NTU, or stabilized above 50 NTU. Stability is defined as the variation between field measurements of 10 percent or less and no overall upward or downward trend in the measurements. Upon stabilization of field parameters, groundwater samples will be collected and analyzed for the parameters presented in Table 1.

Surface warer samples will be collected by carefully immersing a sample collection jar, attached to a dipper, into the water column. The contents of the collection jar will then be transferred to preserved laboratory bottles for analysis.

Prior to and immediately following collection of groundwater samples, field measurements for pH, specific conductance, temperature, turbidity, Eh, dissolved oxygen, as well as visual and olfactory observations and water level, will be recorded.

4.3 Post-Sampling Handling

All collected samples will be placed in pre-cleaned, pre-preserved laboratory provided sample bottles, cooled to 4°C in the field, and transported under proper chain-of-custody command to a qualified testing laboratory for analysis within proper holding times (see Section 6.2). A chain-of-custody form will be completed for each bulk container (i.e., cooler) of collected samples. The chain-of-custody form will be signed and dated by the person who performed sample collection, the person the samples were relinquished to for transport to the laboratory (if applicable) and the laboratory sample custodian who receives the samples. The applicable guideline for sample labeling, storage and shipment is presented in Appendix B. The types and frequencies of field QA/QC samples to be collected are discussed in Section 6.0 of this report.

4.4 Field Equipment Cleaning

Non-dedicated purging equipment and water level monitoring probes will be cleaned before each use in accordance with the procedure for Non-Disposable and Non-Dedicated

Sampling Equipment Decontamination presented in Appendix B. Peristaltic pump tubing will be dedicated to each monitoring well and will not require cleaning other than that provided by the manufacturer. Dedicated equipment must be maintained within the sealed original manufacturer's packaging prior to installation at each monitoring location.

4.5 Documentation of Field Activities

The results of all field measurements and associated calculations will be recorded on standard forms included with the guidelines presented in Appendix B. During all activities, the following general information will be recorded on appropriate data sheets:

- Date
- Field sampling crew members
- Meteorological conditions
- Brief description of field activities planned for date indicated
- Tailgate Health and Safety meeting topics
- Location where work is performed
- Problems encountered and corrective actions taken
- All field measurements or descriptions made
- Any modifications made to sampling procedures

In addition, the following information will be recorded by the Field Team Leader during the collection of all environmental samples:

- Sample Locations and summary of the samples collected
- Completeness of the sampling effort
- Sample descriptions
- Results of all field measurements
- Results of field instrument calibrations
- Sample preservation used (if applicable)
- Chain-of-custody information.

All original forms and field notebooks will be placed in a project record file maintained at an agreed upon location.

5.0 SAMPLE ANALYTICAL PROGRAM

5.1 Parameters for Physical/Chemical Analysis

The analytical parameters that will be analyzed in the monitoring programs discussed in this Plan are listed in Tables 1 and 2.

5.2 Analytical Methods/Protocols

The methods that will be used for chemical analysis of all samples collected during this monitoring program are presented in Table 2. The sampling holding times, preservation and container requirements are also presented.

5.3 Groundwater Monitoring Program Field Quality Control Samples

The following field quality control samples will be analyzed in support of the monitoring program at the Peter Cooper Markhams Site:

- **Blind Duplicate** - One blind duplicate will be collected and analyzed per 20 samples collected during each sampling event. The field sample containers will be returned to the laboratory identified only as the "blind duplicate". The well or sample location will be recorded in the Project Field Book and on the respective Water Sample Collection Log (see Appendix B) and the results will be compared to review analytical precision.

- **MS/MSD** – A sufficient volume of sample will be collected at one sampling location per sampling event for matrix spike/matrix spike duplicate (MS/MSD) analysis. The laboratory will report the results of the MS/MSD analysis, which will be reviewed for sampling and analysis precision and accuracy.

5.4 Laboratory Quality Control/Reporting Requirements

Laboratory quality control and reporting requirements will be as identified in the sections below.

5.4.1 General

- The laboratory will perform all standard in-house QA/QC necessary to control the introduction of contamination in the lab and to insure the accuracy and precision of the data.

- The laboratory will strictly adhere to the quality control requirements specified in the analytical method references presented in Table 2.
- All laboratories involved in the monitoring program must be certified in the New York State Department of Health (NYSDOH) National Environmental Laboratory Approval Program (NELAP) for the parameters being analyzed.

5.4.2 Laboratory Quality Control Analyses

The laboratory will analyze the following quality control samples in addition to the field quality control samples described above:

- **Method Blanks** – Method Blanks will be analyzed at least once per batch. If a particular reagent or piece of analytical equipment used is changed during preparation of a sample batch, additional testing will be required.
- **Surrogates** – For volatile organic analyses, surrogate standards are added to each sample and recoveries are calculated for method performance accuracy. Surrogate standard recoveries will be reported according to USEPA SW-846 reporting and deliverable requirements.

5.4.3 Reporting and Deliverable Requirements

The laboratory(ies) must adhere to USEPA SW-846 reporting and deliverable requirements unless otherwise directed. The laboratory will submit the analytical report within 30 business days of receipt of the last batch of samples. The analytical report will also include for each sample:

- Sample location/sample number
- Date collected
- Date extracted or digested
- Date analyzed
- Analytical methodology (including preparation methodology)
- Method detection limits
- Sample dilution factor (if applicable)
- Chain-of-Custody forms

The analytical report also must contain a case narrative that will describe all QA/QC problems encountered during sample analysis. For each sample for which QA/QC problems are encountered, the following specific information will be reported in the case narrative:

- Sample identification number
- Sample matrix
- Parameters analyzed
- Data acceptance criteria exceeded
- Specific analytical problems that occurred
- Corrective action taken or attempted to resolve the problem(s)

5.5 Custody Procedures

Sample custody is controlled and maintained throughout the sample collection and analysis process. These procedures track and control the possession of sample from their source, in the field, to their final disposition, the laboratory. Laboratory chain-of-custody procedures further track the custody of samples during their tenure at the laboratory. A sample is in custody if it is:

- In someone's physical possession;
- In someone's view after being in physical possession;
- In a designated secure area; or
- Placed in a locked container by an authorized individual.

This section discusses procedures to be used to adequately control and document sample custody.

5.5.1 Chain-of-Custody (COC) Forms

Chain-of-custody (COC) forms will be used to document the possession and transfer of custody of all samples. Typical information that will be supplied on the forms includes, but is not limited to:

- Field sample identification;
- Sample date and time of collection;
- Type of sample container;
- Sample location and depth (if applicable);
- Size and number of containers; and
- Analyses required.

.

The COC form will be initiated and signed by the field sampling team. The method of shipment, name of the courier and any other pertinent information should be entered in the "remarks" section. The original copy accompanies the sample shipment and a copy is retained by the Field Team Leader. The completed COC form will be placed in a resealable plastic bag and taped to the underside of the lid of the cooler containing the samples designated on the form. A copy of the carrier air-bill (if applicable) will be retained as part of the permanent COC documentation.

When relinquishing custody, the transferor and transferee must sign, date and time the COC form. Each person accepting custody of sample(s) will note their condition on the form. This record documents transfer of custody of samples from the sampler to another person, to the laboratory or to/from a secure storage area.

5.5.2 Custody Seals

Custody seals are preprinted adhesive-backed seals with security slots designed to break if the seals are disturbed. Custody seals should be placed on sample shipping containers as necessary to detect tampering. Seals must be signed and dated prior to using. Clear strapping tape should be placed over the seals to ensure that the seals are not accidentally broken during shipment, while maintaining an accurate assessment of the shipment integrity.

5.5.3 Field Custody Procedures

The sample packaging and shipment procedures summarized below will ensure that the samples will arrive at the laboratory with the COC intact. The procedures for sample numbering are included in the field operating procedures presented in Appendix B. The basic COC sequence is as follows:

1. Use laboratory supplied sample containers.
2. Collect and preserve sample (if not pre-preserved) and seal container.
3. Complete sample label and place on container.
4. Document the sampling procedures and related information in the Project Field Book and on a Water Sample Collection Log form.
5. Complete COC record form.
6. Custody transfers from field sampling personnel to anyone else documented with signatures, date and time on COC record form.

7. Pack sample containers for shipment with proper preservatives and custody forms into cooler.

The Field Team Leader is personally responsible for the care and custody of the samples until they are transferred or properly dispatched. All bottles will be identified by the use of sample labels with unique sample numbers. The sample numbering system is presented in the FOP for sample labeling; storage and shipment (see Appendix B). The Field Team Leader is also responsible for the following:

- Ensuring only precleaned sample containers will be used and the coolers and/or boxes containing the empty sample containers are sealed with a custody tape seal during transportation to the field and while in storage prior to use. In the field, the precleaned sample containers will be stored in a secure location.

- Maintaining custody to so that as few individuals as possible handle the samples.

- Accurate recording and maintenance of all sample data in the Project Field Book and ensuring all appropriate forms are completed.

- Determine whether proper custody procedures were followed during the sampling event and decide if additional samples are required.

- Ensure proper completion of COC for each cooler in which samples are shipped. The samples must be shipped to the laboratory as soon as practical and must arrive within 24 hours of shipping.

5.5.4 Laboratory Custody Procedures

Laboratory custody procedures for sample receiving and log-in; sample storage and numbering; tracking during sample preparation and analysis; and storage of data will be performed in accordance with the analytical laboratory's quality assurance/quality control (QA/QC) procedures.

6.0 CORRECTIVE ACTION

Corrective action is the process of identifying, recommending, approving, and implementing measures to counter unacceptable procedures or performance that can affect data quality. Corrective action can occur during field activities, laboratory analyses, data validation (if applicable) and data assessment. All corrective action proposed and implemented will be documented on a Corrective Measures Report (see sample report in Appendix C). Corrective action should be implemented only after approval by the Project Manager, or his or her designee. If immediate corrective action is required, approvals should be secured by telephone from the Project Manager.

It shall be the responsibility of the project team, sampling team and laboratory staff to ensure that all measurement and sampling procedures are followed as specified and that measurement data meet the prescribed acceptance criteria. If problems are discovered, prompt corrective action will be taken.

6.1 Field Corrective Action

If errors in field procedures are found during the observation or review of field activities by project staff, corrective action will be initiated. Nonconformance to the QA/QC requirements of the field procedures will be identified immediately by project staff that know or suspect that a procedure is not being performed in accordance with the requirements. The Project Manager or his/her designee will be informed immediately upon discovery of all deficiencies. Timely action will be taken if corrective action is necessary.

Corrective actions in the field may be required when the sample network is changed or when sampling procedures and/or field analytical procedures require modification, due to unexpected conditions. In general, the Field Team Leader and Project Manager may identify the need for corrective action. The Project Manager will approve the corrective measure that will be that will be implemented by the field team and it will be the responsibility of the Project Manager to ensure that corrective action has been implemented.

Corrective actions will be documented in the Project Field Book and on a Corrective Measures Report (see sample report in Appendix C). No staff member will initiate corrective action without prior communication of findings to the Project Manager. If corrective actions are insufficient, work may be stopped by the Project Manager. Once a corrective action is implemented, the effectiveness of the action will be verified by the Project Manger.

6.2 Laboratory Corrective Action

Corrective actions may be initiated if the quality assurance goals of the project are not achieved. The initial step in a corrective action is to instruct the analytical laboratory to examine its procedures to assess whether analytical or computational errors caused the anomalous result. Sample collection and handling procedures will be concurrently reviewed to assess whether they could have contributed to the anomalous result. If no error in laboratory procedures or sample collection and handling procedures can be identified, then the laboratory Project Director will assess whether reanalysis or resampling is required, or whether any protocol should be modified for future sampling events.

6.3 Corrective Action during Data Assessment

The need for corrective action may be identified during the data assessment process. Potential types of corrective action may include resampling by the field team or reinjection/reanalysis of samples by the laboratory. These actions are dependent upon the ability to mobilize the field team, and whether the data to be collected is necessary to meet the QA objectives (e.g., the holding times for samples is not exceeded, etc.). All required corrective actions will be documented by the Project Manager and/or the laboratory.

7.0 DATA EVALUATION AND REPORTING

Groundwater and surface water monitoring data generated in support of the Peter Cooper Markhams Site post-remedial monitoring program will be entered into a computer spreadsheet. The spreadsheet will be used for generating graphs showing the status and history of individual sampling points and compounds. The graphs and spreadsheets will also be used for historical trend analysis and to track environmental conditions within and offsite, as well as to assess performance of the remedial measures. A letter report will be prepared following the first semi-annual monitoring event. The letter reports will include:

- Sample collection date
- Groundwater elevation data
- Analytical results as compared to Class GA groundwater or surface water quality standards, as appropriare
- Upgradient well designation
- Sample location number
- QA/QC values
- Method detection limits
- Field sampling notes
- Chain-of-custody forms

An annual report will be prepared following the second semi-annual sampling event. In addition to the information described above, the annual report will include the following:

- A groundwater isopotential contour map for shallow overburden groundwater.

- A discussion of sample analytical results including elevations of parameters above background concentrations and historical trends evident from the data.

- A discussion of changes in water quality that has occurred from the previous year.

- A discussion of any proposed changes to the Peter Cooper Markhams Site Post-Remedial Monitoring Plan.

- A review of the data to either reduce the sampling frequency or reduce the parameter list, if warranted.

8.0 REFERENCES

1. Geomatrix Consultants, Inc. & Benchmark Environmental Engineering and Science, PLLC, Revised July 2006. *Remedial Investigation Report – Final, Peter Cooper Markhams Site, Dayton, New York.*

TABLE 1

GROUNDWATER MONITORING PROGRAM

Peter Cooper Markhams Site
Dayton, New York

Sample Location	Est. Number of Samples Per Event[1]	Parameters	Frequency
Upgradient Monitoring Well			
MW-9S	1	Total Metals[2] Field Measurements[3] Water Quality Parameters[4]	Semi-Annually
Monitoring Network Wells (water level and quality)			
MW-5S	1	Total Metals2 Field Measurements3 Water Quality Parameters4	Semi-Annually
MW-8S	1		
MW-7S	1		
Wetland F (Surface Water)	1		
QA/QC Samples[1]			
Blind Duplicate	1	Total Metals[2]	Semi-Annually
Matrix Spike	1		
Matrix Spike Duplicate	1		
Monitoring Network Wells (water level only)			
MW-6S	--	--	Semi-Annually
MW-4S			

Notes:

1. QA/QC samples will be collected at a frequency of 1 per 20 for each matrix.
2. Total metals include: arsenic, chromium, hexavalent chromium, manganese and iron; if field measured turbidity is greater than 50 NTU, dissolved metals will also be collected.
3. Field measurements include: pH, temperature, specific conductance, turbidity, Eh
4. Water quality parameters include: ammonia, nitrate, alkalinity, and total sulfide.

TABLE 2

SAMPLE CONTAINER, VOLUME, PRESERVATION & HOLDING TIME REQUIREMENTS

Peter Cooper Markhams Site
Dayton, New York

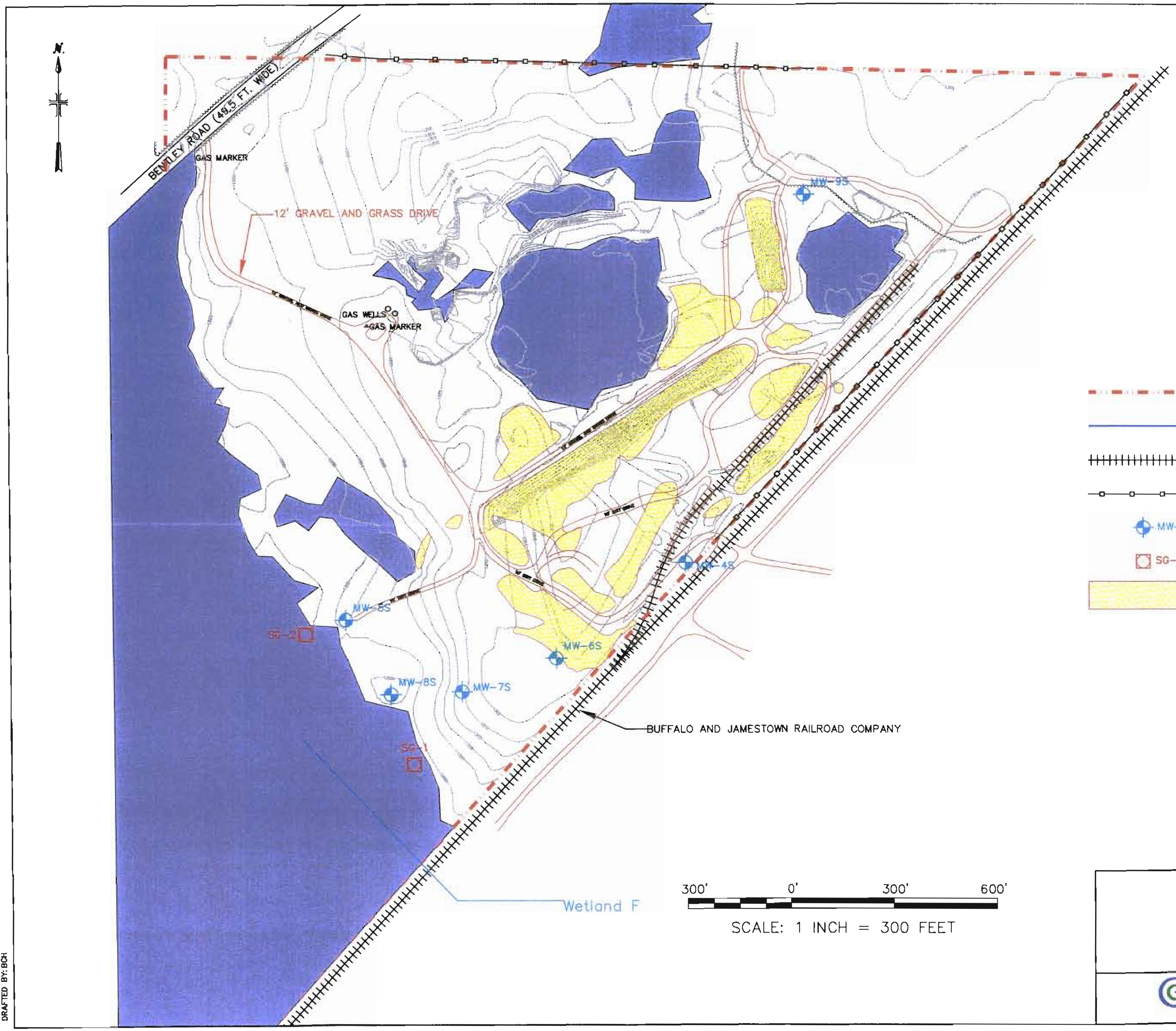
Matrix	Parameter	Method (Reference 1)	Container Type	Minimum Volume	Preservation (Cool to 4 °C for all samples)	Holding Time from Sample Date
Groundwater/Surface Water	Total Metals (excluding Hex Chrome)	6010B	plastic	600 ml	HNO_3 to pH<2	6 months
	Hexavalent Chromium	7196A	plastic	400 ml	Cool to 4 °C	24 hours
	Ammonia	350.1	plastic	500 ml	H_2SO_4 to pH<2	28 days
	Nitrate	300	plastic	100 ml	H_2SO_4 to pH<2	48 hours
	Alkalinity	310.1	plastic	100 ml	Cool to 4 °C	14 days
	Sulfide, Total	9030B	plastic	500 ml	$C_4H_6O_4Zn+NaOH$ to pH 9	7 days

References:

1. Test Methods for Evaluating Solid Wastes, USEPA SW-846, Update III, 1991.

Notes:

1. Total metals include: arsenic, chromium, manganese and iron; if field measured turbidity is greater than 50 NTU, dissolved metals will also be collected.



EXPLANATION

‐ · ‐ · ‐	PROPERTY BOUNDARY
―	WETLAND BOUNDARY
┼┼┼┼┼┼┼	RAILROAD TRACKS
─□─□─	FENCE LINE
⊕ MW-9S	MONITORING WELL LOCATION
☐ SG-1	STAFF GAUGE LOCATION
🟨	APPROXIMATE PRE-REMEDIAL LOCATION OF WASTE PILE

SITE MONITORING NETWORK
PETER COOPER – MARKHAMS SITE
RI/FS
MARKHAMS, NEW YORK

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC	Project No. 0021-003-200	Figure 1

DATE: JULY 2006
FILEPATH: f:\benchmark\cad\collier shannon\markhams\figure 2: site location map.dwg
DRAFTED BY: BCH

Appendix C-A

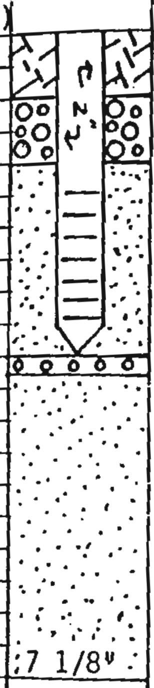
Borehole Logs for Network Monitoring Wells

MW-45

DATE STARTED 5/29/84 DATE FINISHED 5/29/84 SHEET 1 OF 1	RECRA RESEARCH, INC. SUBSURFACE LOG	HOLE NO. B-4 SURFACE ELEV. 1307.90 G.W. DEPTH 1302.99 6/20/84

PROJECT Peter Cooper Markhams
2EM84001.5000

LOCATION 150' West of Railroad
80' North of B-1



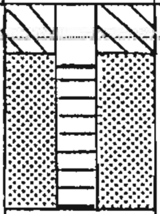
DEPTH (ft)	LOG	SAMPLE TYPE	SAMPLE #	BLOWS ON SAMPLER 0-6 / 12-18	BLOWS ON SAMPLER 6-12 / 18-24	DESCRIPTION	NOTES
			1	4	8	Clayey silt dark brown, organic	
				4	6	grading to reddish brown clayey	
			2	7	7	silt, moist occasional gravel	S#3 retained for
				7	5	grading to abundant gravel and	chemical analysis
5			3	6	5	coarse sand	sand
				5	4		
			4	5	3	Silty sand greyish brown saturated	
				5	4		Screened material
			5	2	1	Coarse sand greyish brown red-	clayey silt, silty
10				1	1	dish brown, saturated	sand and coarse sand
			6	1	3	Fine-medium sand, grey, layers	
				5	9	of black and reddish brown	Permeability:
			7	12	20	medium sand	2.0×10^{-7}
				22	21	Silty fine sand grey	S#8 retained for
15			8	8	11		chemical analysis
				7	7		
			9	3	5		
				7	15		
			10	5	17		
20				25	40		
25							
30							

CLASSIFICATION ASTM D-2488
METHOD OF INVESTIGATION ASTM D1452-80
D1586-74

O'BRIEN & GERE ENGINEERS, INC.	TEST BORING LOG File Name: PC013B.BL	Report of Boring No. B-5 Sheet 1 of 1 MW-5
Project Location: Markhams, NY Client: Peter Cooper Corporations	SAMPLER Type: SPLIT SPOON Hammer: 140 lbs. Fall: 30"	Ground Water Depth 1299.43 Date 12/17/86 Depth Date File No. 1171-005-130

Boring Co.: Parratt-Wolfe
Foreman: Mark Beck
OBG Geologist: Peter Bogardus

Boring Location: Southwest Area: Wooded Area
Ground Elevation: 1300.50'
Dates: Started:08/28/86 Ended:08/28/

Depth	Sample				Sample Description	Stratum Change Depth	Equipment Installed	Field Testing		
	"N" Value	Penetrn/ Recovery	Depth	Blows /6"				Sal. 0/00	So. Cond.	HNU
0										
5										
10										
15										
20										
25					NOT SAMPLED (SEE 5D)					
30										
35										
40										
45										
50										
55										

5' screen installed from 7.85' to 2.85'
5.85' of packed sand installed from 7.85' to 2'
2' of bentonite pellets installed from 2' to surface
4" protective lockable cover installed

O'BRIEN & GERE ENGINEERS, INC.	TEST BORING LOG	Report of Boring No.: MW-6D, 6S
Project Location: Markhams, NY Client: Peter Cooper Corporation	SAMPLER Type: Split-Spoon Hammer: 140 lbs. Fall: 30 inches	Ground Water Depth Date Depth Date File No.: 1171.005

Boring Co.: Buffalo Drilling
Foreman: Keith Scott
OBG Geologist: Peter Bogardus

Boring Location: South East Corner of Site
Ground Elevation:
Dates: Started: 6/1/88 Ended: 6/6/88

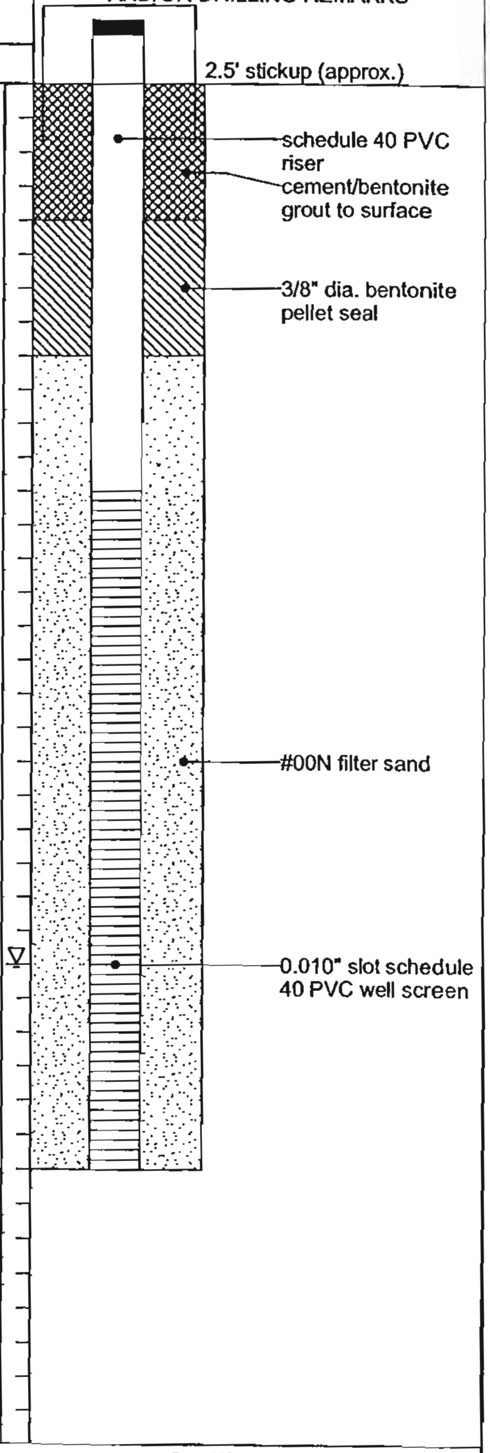
Depth	Sample					Sample Description	Stratum Change General Descript	Equipment Installed	Field Testing			Rmks*
	No	Depth in ft.	Blows /6"	Penetr/ Recovry	"N" Value				pH	Sp Cond	HNU	
0	1	0-2	3-2-3-4	12	5	Rusty Brown moist silt, little fine to medium sand, trace of medium gravel.					.2	
							3				.2	
	2	2-4	4-5-6-7	15	13	Brown moist, medium to coarse sand, trace of silt.						
	3	4-6	4-5-5-3	15	10		4				.2	
5												
											.2	
	4	6-8	4-5-8-4	15	13	Brown moist fine to medium gravel, fine to coarse sand, little silt.						
							8				.2	
	5	9-11	2-6-10-5	15	16	Brown Very moist medium to coarse sand, some fine to medium gravel, little silt.						
10												
	6	14-16	11-14	15	42	Brown Wet fine to medium sand, trace of silt.					.4	
15			28-28									
							18				.4	
						Gray Wet fine sand and silt.						
	7	19-21	14-40	15	84							
20			44-47									
	8	24-26	12-20	15	40	Same as above, 3 ft of blow up in auger.					.2	
25			20-24									
		29-31				Same as above, 3 ft of blow up in auger.						
30												

*6D	33-28	.010" Slot Screen	6S	18.5 - 13.5	.010" Slot Screen
	33-26	2 q Washed Silica Sand		18.5 - 11.0	2 q Washed Silica Sand
	26-23	Bentonite Pellets		11.0 - 10.2	Bentonite Seal
	23-0	Cement/Bentonite Grout		10.2 - 0	Cement/Bentonite Grout

PROJECT: Peter Cooper Markhams R.I. Dayton, New York	**Log of Well No. MW-7S**	
BORING LOCATION: See Site Plan for MW locations	TOP OF RISER ELEVATION: 1312.52 fmsl	DATUM: NAD 83
DRILLING CONTRACTOR: Nothnagle Drilling, Inc.	DATE STARTED: 10/9/01	DATE FINISHED: 10/9/01
DRILLING METHOD: 4 1/4" dia. Hollow Stem Augers	TOTAL DEPTH: 16.0 fbgs	SCREEN INTERVAL: 6-16 fbgs
DRILLING EQUIPMENT: CME 750 ATV	DEPTH TO WATER: FIRST 13 ft COMPL.	CASING: 2" dia. PVC
SAMPLING METHOD: Not sampled for lithology	LOGGED BY: MAC	
HAMMER WEIGHT: Autohammer DROP: NA	RESPONSIBLE PROFESSIONAL: Richard H. Frappa	REG. NO.

DEPTH (feet)	SAMPLES: Sample No.	SAMPLES: Sample	SAMPLES: Blows/ foot	OVM (ppm)	DESCRIPTION NAME (USCS Symbol): color, moist, % by weight, plast., structure, cementation, react. w/HCl, geo. inter.
					Surface Elevation: 1309.62 fmsl
0-16					MW-7S not logged for lithology. See log of MW-7D for lithologic descriptions.
16					End of boring at 16.0 fbgs.

WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS

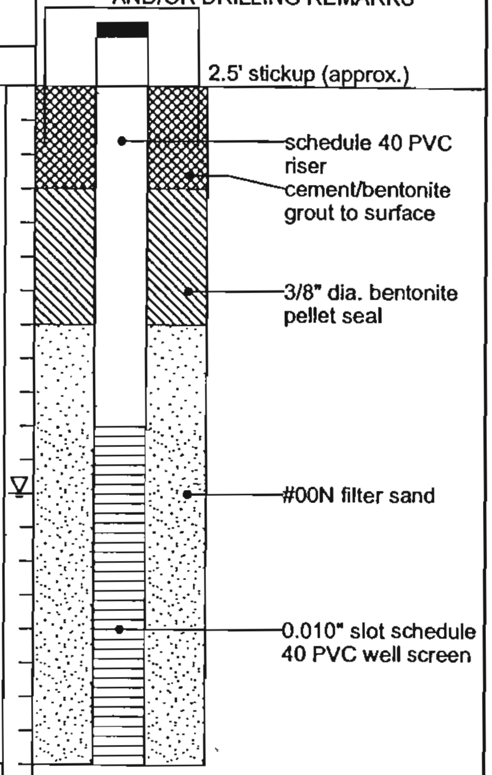


WELL_OVM MARKHAMS MWS.GPJ (2/05)

PROJECT: Peter Cooper Markhams R.I. Dayton, New York	**Log of Well No. MW-8S**

BORING LOCATION: See Site Plan for MW locations		TOP OF RISER ELEVATION: 1303.93 fmsl	DATUM: NAD 83
DRILLING CONTRACTOR: Nothnagle Drilling, Inc.		DATE STARTED: 10/5/01	DATE FINISHED: 10/5/01
DRILLING METHOD: 4 1/4" dia. Hollow Stem Augers		TOTAL DEPTH: 10.0 fbgs	SCREEN INTERVAL: 5-10 fbgs
DRILLING EQUIPMENT: CME 750 ATV		DEPTH TO WATER: FIRST 6 ft COMPL.	CASING: 2" dia. PVC
SAMPLING METHOD: Not sampled for lithology		LOGGED BY: MAC	
HAMMER WEIGHT: Autohammer	DROP: NA	RESPONSIBLE PROFESSIONAL: Richard H. Frappa	REG. NO.

DEPTH (feet)	SAMPLES Sample No.	Sample	Blows/ foot	OVM (ppm)	DESCRIPTION NAME (USCS Symbol): color, moist, % by weight, plast., structure, cementation, react. w/HCl, geo. inter. Surface Elevation: 1301.06 fmsl	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS
1						
2					MW-8S not logged for lithology. See log of MW-8D for lithologic descriptions.	
3						
4						
5						
6						
7						
8						
9						
10					End of boring at 10.0 fbgs.	
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						



WELL_OVM MARKHAMS MWS.GPJ (2/05)

Project No. 7603 | Geomatrix Consultants |

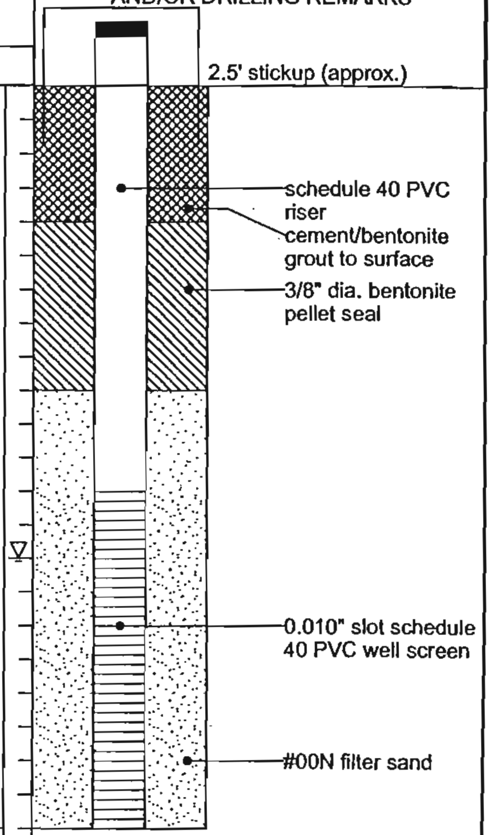
Log of Well No. MW-9S

PROJECT: Peter Cooper Markhams R.I. Dayton, New York		
BORING LOCATION: See Site Plan for MW locations	TOP OF RISER ELEVATION: 1313.95 fmsl	DATUM: NAD 83
DRILLING CONTRACTOR: Nothnagle Drilling, Inc.	DATE STARTED: 10/2/04	DATE FINISHED: 10/2/01
DRILLING METHOD: 4 1/4" dia. Hollow Stem Augers	TOTAL DEPTH: 11.0 fbgs	SCREEN INTERVAL: 6-11 fbgs
DRILLING EQUIPMENT: CME 750 ATV	DEPTH TO WATER: FIRST 7 ft COMPL.	CASING: 2" dia. PVC
SAMPLING METHOD: 2" dia. S.S. Split Spoons	LOGGED BY: MAC	
HAMMER WEIGHT: Autohammer DROP: NA	RESPONSIBLE PROFESSIONAL: Richard H. Frappa	REG. NO.

DEPTH (feet)	SAMPLES: Sample No.	SAMPLES: Sample	SAMPLES: Blows/foot	OVM (ppm)	DESCRIPTION NAME (USCS Symbol): color, moist, % by weight, plast., structure, cementation, react. w/HCl, geo. inter. Surface Elevation: 1311.49 fmsl
0–11					MW-9S not logged for lithology. See log of MW-9D for lithologic descriptions.
11					End of boring at 11.0 fbgs.

Depth scale: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS



WELL_OVM MARKHAMS MWS.GPJ (2/05)

Appendix C-B

Field Operating Procedures

FOP 008.0

CALIBRATION AND MAINTENANCE OF PORTABLE FIELD pH/Eh METER

PURPOSE

This guideline describes a method for calibration of a portable pH/Eh meter. The pH/Eh meter measures the hydrogen ion concentration or acidity of a water sample (pH function), and the oxidation/reduction potential of a water sample (Eh function). Calibration is performed to verify instrument accuracy and function. All field instruments will be calibrated, verified and recalibrated at frequencies required by their respective operating manuals or manufacturer's specifications, but not less than once each day that the instrument is in use. Field personnel should have access to all operating manuals for the instruments used for the field measurements. This procedure also documents critical maintenance activities for this meter.

ACCURACY

The calibrated accuracy of the pH/Eh meter will be:

pH	± 0.2 pH unit, over the temperature range of ± 0.2 C.
Eh	± 0.2 millivolts (mV) over the range of ± 399.9 mV, otherwise ± 2 mV.

PROCEDURE

Note: Meters produced by different manufacturers may have different calibration procedures. These instructions will take precedence over the procedure provided herein. This procedure is intended to be used as a general guideline, or in the absence of available manufacturer's instructions.

1. Obtain and active the meter to be used. As stated above, initial calibrations will be performed at the beginning of each sampling day.

2. Immerse the sensing probe in a container of certified pH 7.0 buffer solution traceable to the National Bureau of Standards.

3. Measure the temperature of the buffer solution, and adjust the temperature setting accordingly.

4. Compare the meter reading to the known value of the buffer solution while stirring. If the reading obtained by the meter does not agree with the known value of the buffer solution, recalibrate the meter according to the manufacturer's instructions until the desired reading is obtained. This typically involves accessing and turning a dial or adjustment screw while measuring the pH of the buffer solution. The meter is adjusted until the output agrees with the known solution pH.

5. Repeat Steps 2 through 5 with a pH 4.0 and 10.0 buffer solution to provide a three-point calibration. Standards used to calibrate the pH meter will be of concentrations that bracket the expected values of the samples to be analyzed, especially for two-point calibrations (see note below).

Note: Some pH meters only allow two-point calibrations. Two-point calibrations should be within the suspected range of the groundwater to be analyzed. For example, if the groundwater pH is expected to be approximately 8, the two-point calibration should bracket that value. Buffer solutions of 7 and 10 should then be used for the two-point calibration.

6. Document the calibration results and related information in the Project Field Book and on an **Equipment Calibration Log** (see attached sample). Information will include, at a minimum:

   - Time, date, and initials of the field team member performing the calibration
   - The unique identifier for the meter, including manufacturer, model, and serial number
   - The brand and expiration dates of buffer solutions
   - The instrument readings
   - The instrument settings (if applicable)

- Pass or fail designation in accordance with the accuracy specifications presented above
- Corrective action taken (see Maintenance below) in the event of failure to adequately calibrate

MAINTENANCE

- When not in use, or between measurements, keep the pH/Eh probe immersed in or moist with buffer solutions.
- Check the meter batteries at the end of each day and recharge or replace as needed.
- Replace the pH/Eh probe any time that the meter response time becomes greater than two minutes or the meeting system consistently fails to retain its calibrated accuracy for a minimum of ten sample measurements.
- If a replacement of the pH/Eh probe fails to resolve instrument response time and stability problems, obtain a replacement instrument (rental instruments) and/or order necessary repairs/adjustment.

ATTACHMENTS

Equipment Calibration Log (sample)

BENCHMARK
ENVIRONMENTAL
ENGINEERING &
SCIENCE, PLLC

EQUIPMENT CALIBRATION LOG

PROJECT INFORMATION:

Project Name:
Project No.:
Client:
Date:
Instrument Source: ☐ BM/TK ☐ Rental

METER TYPE	UNITS	TIME	MAKE/MODEL	SERIAL NUMBER	CAL. BY	STANDARD	READING	SETTINGS
☐ pH meter	units					4.00		
						7.00		
						10.01		
☐ Turbidity meter	NTU					< 0.5		
						20		
						100		
						800		
☐ Sp. conductance meter	uS/mS					1413 μS @ 25 °C		
☐ PID	ppm					open air		
						100 ppm Iso. Gas		
☐ Particulate meter	mg/m^3					zero air		
☐ Oxygen	%					open air		
☐ Hydrogen sulfide	ppm					open air		
☐ Carbon monoxide	ppm					open air		
☐ LEL	%					open air		
☐ Radiation Meter	uR/H					background area		
☐								
☐								

ADDITIONAL REMARKS:

PREPARED BY:

DATE:

FOP 012.0

CALIBRATION AND MAINTENANCE OF PORTABLE SPECIFIC CONDUCTANCE METER

PURPOSE

This guideline describes a method for calibration of a portable specific conductance meter. This meter measures the ability of a water sample to conduct electricity, which is largely a function of the dissolved solids within the water. The instrument has been calibrated by the manufacturer according to factory specifications. This guideline presents a method for checking the factory calibration of a portable specific conductance meter. A calibration check is performed to verify instrument accuracy and function. All field test equipment will be checked at the beginning of each sampling day. This procedure also documents critical maintenance activities for this meter.

ACCURACY

The calibrated accuracy of the specific conductance meter will be within ± 1 percent of full-scale, with repeatability of ± 1 percent. The built-in cell will be automatically temperature compensated from at least 32° to 160° F (0° to 71°C).

PROCEDURE

Note: The information included below is equipment manufacturer- and model-specific, however, accuracy, calibration, and maintenance procedures for this type of portable equipment are typically similar. The information below pertains to the Myron L Company Ultrameter Model 6P. The actual equipment to be used in the field will be equivalent or similar.

1. Calibrate all field test equipment at the beginning of each sampling day. Check and recalibrate the specific conductance meter according to the manufacture's specifications.

2. Use a calibration solution of known specific conductivity and salinity. For maximum accuracy, use a Standard Solution Value closest to the samples to be tested.

3. Rinse conductivity cell three times with proper standard.

4. Re-fill conductivity cell with same standard.

5. Press **COND** or **TDS**, then press **CAL/MCLR**. The "CAL" icon will appear on the display.

6. Press the **↑/MS** or **MR/↓** key to step the displayed value toward the standard's value or hold a key down to cause rapid scrolling of the reading.

7. Press CAL/MCLR once to confirm new value and end the calibration sequence for this particular solution type.

8. Repeat steps 1 through 7 with additional new solutions, as necessary.

9. Document the calibration results and related information in the Project Field Book and on an **Equipment Calibration Log** (see attached sample), indicating the meter readings before and after the instrument has been adjusted. This is important, not only for data validation, but also to establish maintenance schedules and component replacement. Information will include, at a minimum:
    - Time, date and initials of the field team member performing the calibration
    - The unique identifier for the meter, including manufacturer, model, and serial number
    - The brand and expiration date of the calibration standards
    - The instrument readings: before and after calibration

- The instrument settings (if applicable)
- The overall adequacy of calibration including the Pass or fail designation in accordance with the accuracy specifications presented above.
- Corrective action taken (see Maintenance below) in the event of failure to adequately calibrate.

MAINTENANCE

NOTE: Ultrameters should be rinsed with clean water after use. Solvents should be avoided. Shock damage from a fall may cause instrument failure.

Temperature Extremes

Solutions in excess of 160°F/71°C should not be placed in the cell cup area; this may cause damage. Care should be exercised not to exceed rated operating temperature. Leaving the Ultrameter in a vehicle or storage shed on a hot day can easily subject the instrument to over 150°F voiding the warranty.

Battery Replacement

Dry Instrument THOROUGHLY. Remove the four bottom screws. Open instrument carefully; it may be necessary to rock the bottom slightly side to side to release it from the RS-232 connector. Carefully detach battery from circuit board. Replace with 9-volt alkaline battery. Replace bottom, ensuring the sealing gasket is installed in the groove of the top half of case. Re-install screws, tighten evenly and securely.

NOTE: Because of nonvolatile EEPROM circuitry, all data stored in memory and all calibration settings are protected even during power loss or battery replacement.

Cleaning Sensors

The conductivity cell cup should be kept as clean as possible. Flushing with clean water following use will prevent buildup on electrodes. However, if very dirty samples — particularly scaling types — are allowed to dry in the cell cup, a film will form. This film reduces accuracy. When there are visible films of oil, dirt, or scale in the cell cup or on the electrodes, use a foaming non-abrasive household cleaner. Rinse out the cleaner and your Ultrameter is ready for accurate measurements.

NOTE: Maintain a log for each monitoring instrument. Record all maintenance performed on the instrument on this log with date and name of the organization performing the maintenance.

ATTACHMENTS

Equipment Calibration Log (sample)

BENCHMARK
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SCIENCE, PLLC

EQUIPMENT CALIBRATION LOG

PROJECT INFORMATION:

Project Name:

Date:

Project No.:

Client:

Instrument Source: ☐ BM/TK ☐ Rental

METER TYPE	UNITS	TIME	MAKE/MODEL	SERIAL NUMBER	CAL. BY	STANDARD	READING	SETTINGS
☐ pH meter	units					4.00		
						7.00		
						10.01		
☐ Turbidity meter	NTU					<0.5		
						20		
						100		
						800		
☐ Sp. conductance meter	uS/mS					1413 µS @ 25 °C		
☐ PID	ppm					open air		
						100 ppm Iso. Gas		
☐ Particulate meter	mg/m^3					zero air		
☐ Oxygen	%					open air		
☐ Hydrogen sulfide	ppm					open air		
☐ Carbon monoxide	ppm					open air		
☐ LEL	%					open air		
☐ Radiation Meter	uR/H					background area		
☐								
☐								

ADDITIONAL REMARKS:

PREPARED BY:

DATE:

FOP 009.0

CALIBRATION AND MAINTENANCE OF PORTABLE FIELD TURBIDITY METER

PURPOSE

This guideline describes the method for calibration of the HACH 2100P portable field turbidity meter. Turbidity is one water quality parameter measured during purging and development of wells. Turbidity is measured as a function of the samples ability to transmit light, expressed as Nephelometric Turbidity Units (NTUs). The turbidity meter is factory calibrated and must be checked daily prior to using the meter in the field. Calibration is performed to verify instrument accuracy and function. This procedure also documents critical maintenance activities for this meter.

ACCURACY

Accuracy shall be ± 2% of reading below 499 NTU or ± 3% of reading above 500 NTU with resolution to 0.01 NTU in the lowest range. The range key provides for automatic or manual range selection for ranges of 0.00 to 9.99, 0.0 to 99.9 and 0 to 1000 NTU. Another key provides for selecting automatic signal averaging. Pressing the key shall toggle signal averaging on or off.

PROCEDURE

Calibration of the 2100P Turbidimeter is based on formazin, the primary standard for turbidity. The instrument's electronic and optical design provides long-term stability and minimizes the need for frequent calibration. The two-detector ratioing system compensates for most fluctuations in lamp output. **A formazin recalibration should be performed at least once every three months,** more often if experience indicates the need. During calibration, use a primary standard such as StablCal™ Stabilized Standards or formazin standards.

Note: Meters produced by different manufacturers may have different calibration check procedures. These manufacturers' instructions will take precedence over the procedure provided here. This procedure is intended to be used as a general guideline, or in the absence of available manufacturer's instructions.

Note: Because the turbidity meter measures light transmission, it is critical that the meter and standards be cared for as precision optical instruments. Scratches, dirt, dust, etc. can all temporarily or permanently affect the accuracy of meter readings.

Preparing StablCal Stabilized Standards in Sealed Vials

Sealed vials that have been sitting undisturbed for longer than a month must be shaken to break the condensed suspension into its original particle size. Start at *step 1* for these standards. If the standards are used on at least a weekly interval, start at *step 3*.

Note: These instructions do not apply to < 0.1 NTU StablCal Standards; < 0.1 NTU StablCal Standards should not be shaken or inverted.

1. Shake the standard vigorously for 2-3 minutes to re-suspend any particles.
2. Allow the standard to stand undisturbed for 5 minutes.
3. Gently invert the vial of StablCal 5 to 7 times.
4. Prepare the vial for measurement using traditional preparation techniques. This usually consists of oiling the vial (see *Section 2.3.2 on page 11 of the manual*)

and marking the vial to maintain the same orientation in the sample cell compartment (see *Section 2.3.3 on page 12 of the manual*). This step will eliminate any optical variations in the sample vial.

5. Let the vial stand for one minute. The standard is now ready for use in the calibration procedure.

Calibration Procedure

1. Turn the meter on.
2. Shake pre-mixed formazin primary standards in accordance with the above procedure.
3. Wipe the outside of the < 0.1 NTU standard and insert the sample cell in the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment.
4. Close the lid and press **I/O**.
5. Press the **CAL** button. The **CAL** and **S0** icons will be displayed and the 0 will flash. The four-digit display will show the value of the **S0** standard for the previous calibration. If the blank value was forced to 0.0, the display will be blank. Press the right arrow key (→) to get a numerical display.
6. Press **READ**. The instrument will count from 60 to 0, read the blank and use it to calculate a correction factor for the 20 NTU standard measurement. If the dilution water is ≥ 0.5 NTU, E 1 will appear when the calibration is calculated (*see Section 3.6.2.3 on page 31 of the manual*). The display will automatically increment to the next standard. Remove the sample cell from the cell compartment

Note: The turbidity of the dilution water can be "forced" to zero by pressing → rather than reading the dilution water. The display will show "S0 NTU" and the ↑ key must be pressed to continue with the next standard.

7. Repeat steps 1 through 7 for the 20, 100 and 800 standards.
8. Following the 800 NTU standard calibration, the display will increment back to the **S0** display. Remove the sample cell from the cell compartment.
9. Press **CAL** to accept the calibration. The instrument will return to measurement mode automatically.
10. Document the calibration results and related information in the Project Field Book and on an **Equipment Calibration Log** (see attached sample). Information will include, at a minimum:
    - Time, date, and initials of the field team member performing the calibration
    - The unique identifier for the meter, including manufacturer, model, and serial number
    - The brand of calibration standards
    - The instrument readings
    - The instrument settings (if applicable)
    - Pass or fail designation in accordance with the accuracy specifications presented above
    - Corrective action taken (see Maintenance below) in the event of failure to adequately calibrate.

Note: Pressing CAL completes the calculation of the calibration coefficients. If calibration errors occurred during calibration, error messages will appear after CAL is pressed. If E 1 or E 2 appear, check the standard preparation and review the calibration; repeat the calibration if necessary. If "CAL?" appears, an error may have

occurred during calibration. If "CAL?" is flashing, the instrument is using the default calibration.

NOTES

- If the **I/O** key is pressed during calibration, the new calibration data is lost and the old calibration will be used for measurements. Once in calibration mode, only the **READ, I/O, ↑** , and →keys function. Signal averaging and range mode must be selected before entering the calibration mode.

- If **E 1** or **E 2** are displayed, an error occurred during calibration. Check the standard preparation and review the calibration; repeat the calibration if necessary. Press **DIAG** to cancel the error message (**E 1** or **E 2**). To continue without repeating the calibration, press **I/O** twice to restore the previous calibration. If "**CAL?**" is displayed, an error may have occurred during calibration. The previous calibration may not be restored. Either recalibrate or use the calibration as is.

- To review a calibration, press **CAL** and then ↑ to view the calibration standard values. As long as **READ** is never pressed and **CAL** is not flashing, the calibration will not be updated. Press **CAL** again to return to the measurement mode.

MAINTENANCE

- **Cleaning**: Keep the turbidimeter and accessories as clean as possible and store the instrument in the carrying case when not in use. Avoid prolonged exposure to sunlight and ultraviolet light. Wipe spills up promptly. Wash sample cells with non-abrasive laboratory detergent, rinse with distilled or demineralized water, and air dry. Avoid scratching the cells and wipe all moisture and fingerprints off the cells before inserting them into the instrument. Failure to do so can give inaccurate readings. See *Section 2.3.1 on page 11 of the manual* for more information about sample cell care.

- **Battery Replacement**: AA alkaline cells typically last for about 300 tests with the signal-averaging mode off, about 180 tests if signal averaging is used. The "battery" icon flashes when battery replacement is needed. Refer to *Section 1.4.2 on page 5 of the manual* for battery installation instructions. If the batteries are changed within 30 seconds, the instrument retains the latest range and signal average selections. If it takes more than 30 seconds, the instrument uses the default settings. If, after changing batteries, the instrument will not turn off or on and the batteries are good, remove the batteries and reinstall them. If the instrument still won't function, contact Hach Service or the nearest authorized dealer.

- **Lamp Replacement**: The procedure in *Section 4.0 on page 49 of the manual* explains lamp installation and electrical connections. Use a small screwdriver to remove and install the lamp leads in the terminal block. The instrument requires calibration after lamp replacement.

ATTACHMENTS

Equipment Calibration Log (sample)

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EQUIPMENT CALIBRATION LOG

PROJECT INFORMATION:

Project Name:
Project No.:
Client:
Date:
Instrument Source: ☐ BM/TK ☐ Rental

METER TYPE	UNITS	TIME	MAKE/MODEL	SERIAL NUMBER	CAL. BY	STANDARD	READING	SETTINGS
☐ pH meter	units					4.00		
						7.00		
						10.01		
☐ Turbidity meter	NTU					< 0.5		
						20		
						100		
						800		
☐ Sp. conductance meter	uS/mS					1413 µS @ 25 °C		
☐ PID	ppm					open air		
						100 ppm Iso. Gas		
☐ Particulate meter	mg/m³					zero air		
☐ Oxygen	%					open air		
☐ Hydrogen sulfide	ppm					open air		
☐ Carbon monoxide	ppm					open air		
☐ LEL	%					open air		
☐ Radiation Meter	uR/H					background area		
☐								
☐								

ADDITIONAL REMARKS:

PREPARED BY:

DATE:

FOP 007.0

CALIBRATION AND MAINTENANCE OF PORTABLE DISSOLVED OXYGEN METER

PURPOSE

This guideline describes a method for calibration of a portable dissolved oxygen meter. This meter measures the concentration of dissolved oxygen within a water sample. This parameter is of interest both as a general indicator of water quality, and because of its pertinence to fate and transport of organics and inorganics. This guideline presents a method for calibration of this meter, which is performed to verify instrument accuracy and function. All field instruments will be calibrated, verified and recalibrated at frequencies required by their respective operating manuals or manufacturer's specifications, but not less than once each day that the instrument is in use. Field personnel should have access to all operating manuals for the instruments used for the field measurements. This procedure also documents critical maintenance activities for this meter.

ACCURACY

The calibrated accuracy of the dissolved oxygen meter will be within ± 1% of full-scale over the temperature range of 23° to 113° F (-5° to +45° C).

PROCEDURE

1. Calibrate the dissolved oxygen meter to ambient air based on probe temperature and true local atmospheric pressure conditions (or feet above sea level). Because procedures vary with different brands and models of meters, refer to the manufacturer's recommended calibration procedures.

2. In the event of a failure to adequately calibrate, follow the corrective action directed by the manufacturer.
3. If calibration cannot be achieved or maintained, obtain a replacement instrument (rental instruments) and/or order necessary repairs/adjustment.

4. Document the calibration results and related information in the Project Field Book and on an **Equipment Calibration Log** (see attached sample). Information will include, at a minimum:
    - Time, date, and initials of the field team member performing the calibration
    - The unique identifier for the meter, including manufacturer, model, and serial number
    - The brand and expiration dates of calibration solutions
    - The calibration readings
    - The instrument settings (if applicable)
    - The approximate response time
    - The overall adequacy of calibration including the Pass or fail designation in accordance with the accuracy specifications presented above
    - Corrective action taken (see Step 5 above) in the event of failure to adequately calibrate

MAINTENANCE

- When not in use or between measurements, the dissolved oxygen probe will be kept immersed in or moist with deionized water.

- The meter batteries will be checked prior to each meter's use and will be replaced when the meter cannot be redline adjusted.

- The meter response time and stability will be tracked to determine the need for instrument maintenance. When response time becomes greater than two minutes, probe service is indicated.

ATTACHMENTS

Equipment Calibration Log (sample)

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EQUIPMENT CALIBRATION LOG

PROJECT INFORMATION:

Project Name:

Project No.:

Client:

Date:

Instrument Source: ☐ BM/TK ☐ Rental

METER TYPE	UNITS	TIME	MAKE/MODEL	SERIAL NUMBER	CAL. BY	STANDARD	READING	SETTINGS
☐ pH meter	units					4.00		
						7.00		
						10.01		
☐ Turbidity meter	NTU					< 0.5		
						20		
						100		
						800		
☐ Sp. conductance meter	uS/mS					1413 μS @ 25 °C		
☐ PID	ppm					open air		
						100 ppm Iso. Gas		
☐ Particulate meter	mg/m^3					zero air		
☐ Oxygen	%					open air		
☐ Hydrogen sulfide	ppm					open air		
☐ Carbon monoxide	ppm					open air		
☐ LEL	%					open air		
☐ Radiation Meter	uR/H					background area		
☐								
☐								

ADDITIONAL REMARKS:

PREPARED BY:

DATE:

FOP 022.0

GROUNDWATER LEVEL MEASUREMENT

PURPOSE

This procedure describes the methods used to obtain accurate and consistent water level measurements in monitoring wells, piezometers and well points. Water levels will be measured at monitoring wells and, if practicable, in supply wells to estimate purge volumes associated with sampling, and to develop a potentiometric surface of the groundwater in order to estimate the direction and velocity of flow in the aquifer. Water levels in monitoring wells will be measured using an electronic water level indicator (e-line) that has been checked for operation prior to mobilization.

PROCEDURE

1. Decontaminate the e-line probe and a lower portion of cable following the procedures referenced in the Benchmark Field Operating Procedure for Non-Disposable and Non-Dedicated Sampling Equipment Decontamination. Store the e-line in a protected area until use. This may include wrapping the e-line in clean plastic until the time of use.

2. Unlock and remove the well protective cap or cover and place on clean plastic.

3. Lower the probe slowly into the monitoring well until the audible alarm sounds. This indicates the depth to water has been reached.

4. Move the cable up and down slowly to identify the depth at which the alarm just begins to sound. Measure this depth against the mark on the lip of the well riser used as a surveyed reference point (typically the north side of the riser).

5. Read depth from the graduated cable to the nearest 0.01 foot. Do not use inches. If the e-line is not graduated, use a rule or tape measure graduated in 0.01-foot increments to measure from the nearest reference mark on the e-line cable.

6. Record the water level on a Water Level Monitoring Record (sample attached).
7. Remove the probe from the well slowly, drying the cable and probe with a clean paper wipe. Be sure to repeat decontamination before use in another well.
8. Replace well plug and protective cap or cover. Lock in place as appropriate.

ATTACHMENTS

Water Level Monitoring Record (sample)

REFERENCES

Benchmark FOPs:

040 Non-Disposable and Non-Dedicated Sampling Equipment Decontamination

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WATER LEVEL MONITORING RECORD

Project Name:
Client:
Project No.:
Location:
Field Personnel:
Date:
Weather:

Well No.	Time	Top of Riser Elevation (fmsl)	Static Depth to Water (fbTOR)	Groundwater Elevation (fmsl)	Total Depth (fbTOR)	Last Total Depth Measurement (fbTOR)

Comments/Remarks:

FOP 031.0

LOW FLOW (MINIMAL DRAWDOWN) GROUNDWATER PURGING & SAMPLING PROCEDURES

PURPOSE

This procedure describes the methods used for performing low flow (minimal drawdown) purging, also referred to as micro-purging, at a well prior to groundwater sampling to obtain a representative sample from the water-bearing zone. This method of purging is used to minimize the turbidity of the produced water. This may increase the representativeness of the groundwater samples by avoiding the necessity of filtering suspended solids in the field prior to preservation of the sample.

Well purging is typically performed immediately preceding groundwater sampling. The sample should be collected as soon as the parameters measured in the field (i.e., pH, specific conductance, dissolved oxygen, Eh, temperature, and turbidity) have stabilized.

PROCEDURE

1. Water samples should not be taken immediately following well development. Sufficient time should be allowed to stabilize the groundwater flow regime in the vicinity of the monitoring well. This lag time will depend on site conditions and methods of installation but may exceed one week.

2. Prepare the electronic water level indicator (e-line) in accordance with the procedures referenced in the Benchmark's Groundwater Level Measurement FOP and decontaminate the e-line probe and a lower portion of cable following the procedures referenced in the Benchmark's Non-disposable and Non-dedicated Sampling Equipment Decontamination FOP. Store the e-line in a protected area until use. This may include wrapping the e-line in clean plastic until the time of use.

3. Calibrate all sampling devices and monitoring equipment in accordance with manufacturer's recommendations, the site Quality Assurance Project Plan (QAPP) and/or Field Sampling Plan (FSP). Calibration of field

instrumentation should be followed as specified in Benchmark's Calibration and Maintenance FOP for each individual meter.

4. Inspect the well/piezometer for signs of vandalism or damage and record condition on the Groundwater Well Purge & Sample Collection Log form (sample attached). Specifically, inspect the integrity of the following: concrete surface seal, lock, protective casing and well cover, well casing and J-plug/cap. Report any irregular findings to the Project Manager.

5. Unlock and remove the well protective cap or cover and place on clean plastic to avoid introducing foreign material into the well.

6. Monitor the well for organic vapors using a PID, as per the Work Plan. If a reading of greater than 5 ppm is recorded, the well should be allowed to vent until levels drop below 5 ppm before proceeding with purging.

7. Lower the e-line probe slowly into the monitoring well and record the initial water level in accordance with the procedures referenced in Benchmark's Groundwater Level Measurement FOP. Refer to the construction diagram for the well to identify the screened depth.

8. Decontaminate all non-dedicated pump and tubing equipment following the procedures referenced in the Benchmark's Non-disposable and Non-dedicated Sampling Equipment Decontamination FOP.

9. Lower the purge pump or tubing (i.e., low-flow electrical submersible, peristaltic, etc.) slowly into the well until the pump/tubing intake is approximately in the middle of the screened interval. Rapid insertion of the pump will increase the turbidity of well water, and can increase the required purge time. This step can be eliminated if dedicated tubing is already within the well.

   Placement of the pump close to the bottom of the well will cause increased entrainment of solids, which may have settled in the well over time. Low-flow purging has the advantage of minimizing mixing between the overlying stagnant casing water and water within the screened interval. The objective of low-flow purging is to maintain a purging rate, which minimizes stress (drawdown) of the water level in the well. Low-flow refers to the velocity with which water enters the pump intake and that is imparted to the formation pore water in the immediate vicinity of the well screen.

10. Lower the e-line back down the well as water levels will be frequently monitored during purge and sample activities.

11. Begin pumping to purge the well. The pumping rate should be between 100 and 500 milliliters (ml) per minute (0.03 to 0.13 gallons per minute) depending on site hydrogeology. Periodically check the well water level with the e-line adjusting the flow rate as necessary to stabilize drawdown within the well. If possible, a steady flow rate should be maintained that results in a stabilized water level (drawdown of 0.3 feet or less). If the water level exceeds 2 feet below static and declining, slow the purge rate until the water level generally stabilizes. Record each pumping rate and water level during the event.

    The low flow rate determined during purging will be maintained during the collection of analytical samples. At some sites where geologic heterogeneities are sufficiently different within the screened interval, high conductivity zones may be preferentially sampled.

12. Measure and record field parameters (pH, specific conductance, Eh, dissolved oxygen (DO), temperature, and turbidity) during purging activities. In lieu of measuring all of the parameters, a minimum subset could be limited to pH, specific conductance, and turbidity or DO.

    Water quality indicator parameters should be used to determine purging needs prior to sample collection in each well. Stabilization of indicator parameters should be used to determine when formation water is first encountered during purging. In general, the order of stabilization is pH, temperature, and specific conductance, followed by Eh, DO and turbidity. Performance criteria for determination of stabilization should be based on water-level drawdown, pumping rate and equipment specifications for measuring indicator parameters. An in-line flow through cell to continuously measure the above parameters may be used. The in-line device should be disconnected or bypassed during sample collection.

13. Purging will continue until parameters of water quality have stabilized. Record measurements for field indicator parameters (including water levels) at regular intervals during purging. The stability of these parameters with time can be used to guide the decision to discontinue purging. Proper adjustments must be made to stabilize the flow rate as soon as possible.

14. Record well purging and sampling data in the Project Field Book or on the attached Groundwater Well Purge & Sample Collection Log (sample attached). Measurements should be taken approximately every three to five minutes, or as merited given the rapidity of change.

15. Purging is complete when field indicator parameters stabilize. Stabilization is achieved after all field parameters have stabilized for three successive readings. Three successive readings should be within ± 0.1 units for pH, ± 3% for specific conductance, ± 10 mV for Eh, and ± 10% for turbidity and dissolved oxygen. These stabilization guidelines are provided for rough estimates only, actual site-specific knowledge may be used to adjust these requirements higher or lower.

    An in-line water quality measurement device (e.g., flow-through cell) should be used to establish the stabilization time for several field parameters on a well-specific basis. Data on pumping rate, drawdown and volume required for parameter stabilization can be used as a guide for conducting subsequent sampling activities.

16. Collect all project-required samples except for volatile organic compounds (VOCs) from the discharge tubing at the flow rate established during purging in accordance with Benchmark's Groundwater Sample Collection Procedures FOP. Continue to maintain a constant flow rate such that the water level is not drawn down as described above. Fill sample containers with minimal

turbulence by allowing the ground water to flow from the tubing along the inside walls of the container.

17. If field filtration is recommended as a result of increased turbidity, an in-line filter equipped with a 0.45-micron filter should be utilized.

18. VOCs shall be collected using the following procedure.

    a. Once all other required sample containers have been filled, turn off the peristaltic pump. Groundwater remaining within the dedicated tubing assembly has not been altered by the negative pressure effects of the pump head and as such, this groundwater can be collected for VOC analysis.

    b. Remove the tubing from the well taking care to prevent the tubing from coming in contact with the ground surface and without allowing groundwater to escape or drain from the tubing intake.

    c. Once the tubing is carefully removed, reverse the pump direction so that the groundwater within the tubing will be "pushed" out of the intake end (i.e., positive displacement) and not "pulled" through the original discharge end (i.e., negative displacement). Groundwater pulled through the pump head assembly CANNOT be collected for VOC analysis.

    d. Turn pump on using the same flow rate during initial sample collection and allow groundwater within the tubing to fill the VOC vials slowly. VOC sample collection shall be conducted with as minimal disturbance as possible.

    e. Cap the VOC vials leaving no visible headspace (i.e., air-bubbles).

19. Replace the dedicated tubing down the well taking care to avoid contact with the ground surface.

20. Restore the well to its capped/covered and locked condition.

21. Upon purge and sample collection completion, slowly lower the e-line to the bottom of the well/piezometer. Record the total depth to the nearest 0.01-foot and compare to the previous total depth measurement. If a significant discrepancy exists, re-measure the total depth. Record observations of purge water to determine whether the well/piezometer had become silted due to inactivity or damaged (i.e., well sand within purge water). Upon confirmation of the new total depth and determination of the cause (i.e., siltation or damage), notify the Project Manager following project field activities.

ATTACHMENTS

Groundwater Well Purge & Sample Collection Log (sample)

REFERENCES

United States Environmental Protection Agency, 540/S-95/504, 1995. *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures.*

Benchmark FOPs:

007	*Calibration and Maintenance of Portable Dissolved Oxygen Meter*
008	*Calibration and Maintenance of Portable Field pH/Eh Meter*
009	*Calibration and Maintenance of Portable Field Turbidity Meter*
011	*Calibration and Maintenance of Portable Photoionization Detector*
012	*Calibration and Maintenance of Portable Specific Conductance Meter*
022	*Groundwater Level Measurement*
024	*Groundwater Sample Collection Procedures*
040	*Non-Disposable and Non-Dedicated Sampling Equipment Decontamination*
046	*Sample Labeling, Storage and Shipment Procedures*

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LOW FLOW METHOD GROUNDWATER PURGE & SAMPLE COLLECTION LOG

Project Name:	WELL LOCATION:
Project Number:	Sample Matrix: groundwater
Client:	Weather:

WELL DATA:

DATE:

TIME:

Casing Diameter (inches):		Riser Material:	PVC
Screened interval (fbTOR):	-	Screen Material:	PVC
Static Water Level (fbTOR):		Bottom Depth (fbTOR):	
Elevation Top of Well Riser (fmsl):		Ground Surface Elevation (fmsl):	
Elevation Top of Screen (fmsl):	0.00	Stick-up (feet):	0.00

Standing volume in gallons:

[(bottom depth - static water level) x vol calculation in table per well diameter]:

Volume Calculation

Well Diameter	Volume gal/ft
1"	0.041
2"	0.163
3"	0.367
4"	0.653
5"	1.020
6"	1.469

PURGING DATA:

Pump Type:

Is equipment dedicated to location? yes no	Is tubing dedicated to location? yes no
Depth of Sample (i.e. Level of Intake) (fbTOR):	Approximate Purge Rate (gal/min):

Time	Water Level (fbTOR)	Accumulated Volume (gallons)	pH (units)	Temperature (degrees C)	Specific Conductance (μS/cm)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Appearance & Odor
	Initial								

SAMPLING DATA:

DATE:

START TIME:

END TIME:

Method: low-flow with dedicated tubing	Was well sampled to dryness? yes no
Initial Water Level (fbTOR):	Was well sampled below top of sand pack? yes no
Final Water Level (fbTOR):	Field Personnel:

PHYSICAL & CHEMICAL DATA:

Appearance:	
Color:	
Odor:	
Sediment Present?	

WATER QUALITY MEASUREMENTS

pH (units)	TEMP. (°C)	SC (uS)	TURB. (NTU)	DO (ppm)	ORP (mV)

REMARKS:

PREPARED BY:

FOP 064.0

SURFACE WATER SAMPLING PROCEDURES

PURPOSE

This procedure describes a method for collecting surface water samples. Sediment samples typically are collected in conjunction with surface water samples as dictated by the site-specific work plan. It should be noted, however, sediment sample collection procedures are not presented herein and Benchmark's sediment sampling FOPs 049 and 050 should be reviewed prior to sediment sample collection. This surface water sampling method incorporates the use of the laboratory provided sample bottle for collecting the sample, which eliminates the need for other equipment and hence, reduces the risk of introducing other variables into a sampling event.

PROCEDURE

1. Locate the surface water sample location.
2. Calibrate all field meters (i.e., pH/Eh, turbidity, specific conductance, dissolved oxygen, PID etc.) in accordance with the Benchmark Field Operating Procedure for Calibration and Maintenance of the specific field meter.
3. Wearing appropriate protective gear (i.e., latex gloves, safety glasses), as required in the Project Health and Safety Plan, prepare sample bottles for use.
4. If samples are to be collected from a stream, creek or other running water body, collect downstream samples first to minimize impacts on sample quality.
5. Surface water samples should be collected during a dry (non-precipitation) event to avoid any dilution effect from precipitation.
6. Pre-label all sample bottles in the field using a waterproof permanent marker in accordance with the Benchmark Sample Labeling, Storage and Shipment

FOP. The following information, at a minimum, should be included on the label:

- Project Number;
- Sample identification code (as per project specifications);
- Date of sample collection (mm, dd, yy);
- Time of sample collection (military time only) (hh:mm);
- Specify "grab" or "composite" sample type;
- Sampler initials;
- Preservative(s) (if applicable); and
- Analytes for analysis (if practicable).

7. Collect the surface water sample from the designated location by slowly submerging each sample bottle with minimal surface disturbance. If the sample location cannot be sampled in this manner due to shallow water conditions, a small depression can be created with a standard shovel to deepen the location to facilitate sample collection by direct grab. It should be noted, prior to disturbing sediment at any location for this purpose, all required sediment samples should be collected. All sediment cuttings will be removed from the area and the surface water allowed to flow through the depression for several minutes prior to collecting samples until clear (i.e., no visible sediment).

8. Collect samples from near shore. If water body is over three feet deep, check for stratification. Check each stratum for contamination using field measured water quality parameters. Collect samples from each stratum showing evidence of impact. If no stratum shows signs of impact, collect a composite sample having equal parts of water from each stratum.

9. Collect samples into pre-cleaned bottles provided by the analytical laboratory with the appropriate preservative(s) added based on the volatilization sensitivity or suite of analytical parameters required, as designated below:

   - Volatile Organic Compounds (VOCs)
   - Total Organic Halogens (TOX)

- Total Organic Carbon (TOC)
- Extractable Organic Compounds (i.e., BNAs, SVOCs, etc.)
- Total metals (Dissolved Metals)
- Total Phenolic Compounds
- Cyanide
- Sulfate and Chloride
- Turbidity
- Nitrate and Ammonia
- Radionuclides

10. For pre-preserved bottles, avoid completely submerging the bottle and overfilling to prevent preservative loss. Pre-preserved VOC vials should be filled from a second, unpreserved, pre-cleaned glass container. Never transfer samples from dissimilar bottle types (i.e., plastic to glass or glass to plastic).

11. Collect a separate sample of approximately 200 ml into an appropriate container prior to collecting the first and following the last surface water sample collected to measure the following field parameters:

Parameter	Units
Dissolved Oxygen	parts per million (ppm)
Specific Conductance	μmhos/cm or μS or mS
pH	pH units
Temperature	°C or °F
Turbidity	NTU
Eh (*optional*)	mV
PID VOCs (*optional*)	ppm

Record all field measurements on a Surface Water Quality Field Collection Log form (sample attached).

12. Record available information for the pond, stream or other body of water that was sampled, such as its size, location and depth in the Project Field Book and

on the Surface Water Quality Field Collection Log form (sample attached). Approximate sampling points should be identified on a sketch of the water body.

13. Label, store and ship all samples in accordance with the Benchmark Field Operating Procedure for Sample Labeling, Storage and Shipment Procedures.

ATTACHMENTS

Surface Water Quality Field Collection Log (sample)

REFERENCES

<u>Benchmark FOPs:</u>

007	*Calibration and Maintenance of Portable Dissolved Oxygen Meter*
008	*Calibration and Maintenance of Portable Field pH/Eh Meter*
009	*Calibration and Maintenance of Portable Field Turbidity Meter*
012	*Calibration and Maintenance of Portable Specific Conductance Meter*
046	*Sample Labeling, Storage and Shipment Procedures*

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SURFACE WATER QUALITY FIELD COLLECTION LOG

PROJECT INFORMATION

Project Name:

Project No.:

Client:

SAMPLE DESCRIPTION

I.D.:

Matrix:

Location:

SAMPLE INFORMATION

Date Collected:

Time Collected:

Date Shipped to Lab:

Collected By:

Sample Collection Method:

LABORATORY ANALYSIS

SAMPLING INFORMATION

Weather:

Air Temperature:

Depth of Sample:

Parameter	First	Last	Units
pH			units
Temp.			°C
Cond.			µS
Turbidity			NTU
Eh			mV
D.O.			ppm
Odor			olfactory
Appearance			visual

LOCATION SKETCH

(not to scale, dimensions are approximate)

EXACT LOCATION (if applicable)

Northing (ft)	Easting (ft)	Surface Elevation (fmsl)

ADDITIONAL LABORATORY ANALYSIS:

ADDITIONAL REMARKS:

PREPARED BY:

DATE:

FOP 040.0

NON-DISPOSABLE AND NON-DEDICATED SAMPLING EQUIPMENT DECONTAMINATION

PURPOSE

This procedure is to be used for the decontamination of non-disposable and non-dedicated equipment used in the collection of environmental samples. The purpose of this procedure is to remove chemical constituents from previous samples from the sampling equipment. This prevents these constituents from being transferred to later samples, or being transported out of controlled areas.

HEALTH AND SAFETY

Nitric acid is a strong oxidizing agent as well as being extremely corrosive to the skin and eyes. Solvents such as acetone, methanol, hexane and isopropanol are flammable liquids. Limited contact with skin can cause irritation, while prolonged contact may result in dermatitis. Eye contact with the solvents may cause irritation or temporary corneal damage. Safety glasses with protective side shields, neoprene or nitrile gloves and long-sleeve protective clothing must be worn whenever acids and solvents are being used.

PROCEDURE

Bailers, split-spoons, steel or brass split-spoon liners, Shelby tubes, submersible pumps, soil sampling knives, and similar equipment will be decontaminated as described below.

1. Wash equipment thoroughly with non-phosphate detergent and potable-quality water, using a brush where possible to remove any particulate matter or surface film. If the sampler is visibly coated with tars or other phase-separated hydrocarbons, pre-wash with acetone or isopropanol, or by steam cleaning. Decontamination will adhere to the following procedure:

  a. Rinse with potable-quality water;
  b. Rinsed with 10% nitric acid (HNO_3) solution (see ***Note 1***);
  c. Rinse with potable-quality water;
  d. Rinse with pesticide grade acetone or methanol (see ***Note 2***);
  e. Rinse with pesticide grade hexane (see ***Note 2***);
  f. Rinse with deionized water demonstrated analyte-free, such as distilled water;
  g. Air dry; and
  h. Store in a clean area or wrap in aluminum foil (shiny side out) or new plastic sheeting as necessary to ensure cleanliness.

2. All non-dedicated well evacuation equipment, such as submersible pumps and bailers, which are put into the well, must be decontaminated following the procedures listed above. All evacuation tubing must be dedicated to individual wells (i.e., tubing cannot be reused). However, if submersible pump discharge tubing must be reused, the tubing and associated sample valves or flow-through cells used in well purging or pumping tests will be decontaminated as described below:

   a. Pump a mixture of potable water and a non-phosphate detergent through the tubing, sample valves and flow cells, using the submersible pump.
   b. Steam clean or detergent wash the exterior of the tubing, sample valves, flow cells and pump.
   c. Pump potable water through the tubing, sample valve, and flow cell until no indications of detergent (e.g. foaming) are observed.

   d. Double rinse the exterior of the tubing with potable water.

   e. Rinse the exterior of the tubing with distilled water.

   f. Store in a clean area or wrap the pump and tubing assembly in new plastic sheeting as necessary to ensure cleanliness until ready for use.

3. All unused sample bottles and sampling equipment must be maintained in such a manner that there is no possibility of casual contamination.

4. Manage all waste materials generated during decontamination procedures as described in the Benchmark Field Operating Procedure for Management of Investigation Derived Waste.

ATTACHMENTS

none

REFERENCES

<u>Benchmark FOPs:</u>
032 Management of Investigation-Derived Waste

NOTES

(1) Omit this step if metals are <u>not</u> being analyzed. For carbon steel split spoon samplers, a 1% rather than 10% HNO_3 solution should be used.

(2) This solvent rinse can be omitted if organics are <u>not</u> being analyzed. Alternatively, if approval from the NYSDEC has been granted, use pesticide grade isopropanol as the cleaning solvent. Isopropanol is better suited as a cleaning solvent that acetone, methanol and hexane for the following reasons:

- Acetone is a parameter analyzed for on the Target Compound List (TCL); therefore the detection of acetone in samples collected using acetone rinsed equipment is suspect;

- Almost all grades of methanol contain 2-butanone (Methyl Ethyl Ketone, MEK) contamination. As for acetone, 2-butanone is a TCL compound. Thus, the detection of 2-butanone in samples collected using methanol rinsed equipment is suspect. In addition, methanol is much more hazardous than either isopropanol or acetone.

- Hexane is not miscible with water (hydrophobic) and therefore, is not an effective rinsing agent unless the sampling equipment is dry. Isopropanol is extremely miscible in water (amphoteric), making it an effective rinsing agent on either wet or dry equipment.

FOP 046.0

SAMPLE LABELING, STORAGE & SHIPMENT PROCEDURES

PURPOSE

The collection and analysis of samples of environmental media, including soils, groundwater, surface water, and sediment, are the central activities of the field investigation. These samples must be properly labeled to preserve its identity, and properly stored and shipped in a manner that preserves its integrity and chain of custody. This procedure presents methods for these activities.

SAMPLE LABELING PROCEDURE

1. Assign each sample retained for analysis a unique 9-digit alphanumeric identification code or as indicated in the Project Work Plan. Typically, this code will be formatted as follows:

Sample I.D. Example: GW051402047	
GW	**Sample matrix** GW = groundwater; SW = surface water; SUB = subsurface soil; SS = surface soil; SED = sediment; L = leachate; A = air
05	Month of sample collection
14	Day of sample collection
02	Year of sample collection
047	Consecutive sample number

2. Consecutive sample numbers will indicate the individual sample's sequence in the total set of samples collected during the investigation/sampling event. The sample number above, for example, would indicate the 47th sample retained for analysis during the field investigation, collected on May 14, 2002.

3. Affix a non-removable (when wet) label to each sample container. The following information will be written on the label with black or blue ink that will not smudge when wet:

   - Project number
   - Sample ID (see Step 1 above)
   - Date of sample collection
   - Time of sample collection (military time only)
   - Specify "grab" or "composite" sample with an "X"
   - Sampler initials
   - Preservative(s) (if applicable)
   - Analytes for analysis (if practicable)

4. Record all sample label information in the Project Field Book and on a Sample Summary Collection Log (see attached samples), keyed to the sample identification number. In addition, add information regarding the matrix, sample location, depth, etc. to provide a complete description of the sample.

SAMPLE STORAGE PROCEDURE

1. Immediately after collection, placement in the proper container, and labeling, place samples to be retained for chemical analysis into resealable plastic bags.

2. Place bagged samples into an ice chest filled approximately half-full of double bagged ice. Blue ice is not an acceptable substitute for ice.

3. Maintain samples in an ice chest or in an alternative location (e.g. sample refrigerator) as approved by the Benchmark Field Team Leader until time of shipment. Periodically drain melt-water off coolers and replenish ice as necessary.

4. Ship samples on a daily basis, unless otherwise directed by the Benchmark Field Team Leader.

5. Maintain appropriate custody procedures on coolers and other sample storage containers at all times. These procedures are discussed in detail in the Project Quality Assurance Project Plan, Monitoring Plan or Work Plan.

6. Samples shall be kept in a secure location locked and controlled (i.e., locked building or fenced area) so that only the Project Field Team Leader has access to the location or under the constant visual surveillance of the same.

SAMPLE SHIPPING PROCEDURE

1. Fill out the chain-of-custody form completely (see attached sample) with all relevant information. The white original goes with the samples and should be placed in a resealable plastic bag and taped inside the sample cooler lid; the sampler should retain the copy.

2. Place a layer of inert cushioning material such as bubble pack in the bottom of cooler.

3. Place each bottle in a bubble wrap sleeve or other protective wrap. To the extent practicable, then place each bottle in a resealable plastic bag.

4. Open a garbage bag (or similar) into a cooler and place sample bottles into the garbage bag (or similar) with volatile organic analysis (VOA) vials near the center of the cooler.

5. Pack bottles with ice in plastic bags. At packing completion, cooler should be at least 50 percent ice, by volume. Coolers should be completely filled, so that samples do not move excessively during shipping.

6. Duct tape (or similar) cooler drain closed and wrap cooler completely in two or more locations to secure lid, specifically covering the hinges of the cooler.

7. Place laboratory label address identifying cooler number (i.e., 1 of 4, 2 of 4 etc.) and overnight delivery waybill sleeves on cooler lid or handle sleeve (Federal Express).

8. Sign the custody seal tape with an indelible soft-tip marker and place over the duct tape across the front and back seam between the lid and cooler body.

9. Cover the signed custody seal tape with an additional wrap of transparent strapping tape.

10. Place "Fragile" and "This Side Up" labels on all four sides of the cooler. "This Side Up" labels are yellow labels with a black arrow with the arrowhead pointing toward the cooler lid.

11. For coolers shipped by overnight delivery, retain a copy of the shipping waybill, and attach to the chain-of-custody documentation.

ATTACHMENTS

Soil/Sediment Sample Summary Collection Log (sample)
Groundwater/Surface Water Sample Summary Collection Log (sample)
Wipe Sample Summary Collection Log (sample)
Air Sample Summary Collection Log (sample)
Chain-Of-Custody Form (sample)

REFERENCES

none

BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC
TURNKEY ENVIRONMENTAL RESTORATION, LLC

GROUNDWATER/SURFACE WATER SAMPLE COLLECTION SUMMARY LOG

Field ID	Location	QC Type	Depth (feet)		Analytical Parameters	Containers	Date	Time	Sampler Initials	Comments (e.g. problems encountered, ref. to variance, location changes, depth changes, important matrix observations or description, gravel thickness, etc.)
			from	to						

Equipment Rinsate Blanks - *Pour clean deionized water over or through decontaminated sampling equipment into sample containers. Collect at a frequency of 1 per sampling method per day. Analyze for all those parameters analyzed for in the samples collected the same day. HSL Metals can be substituted by only the Metals analyzed for that day (except Hexavalent Chromium which needs a separate container). Match equipment used for constituents of concern to rinsate analyte. Note deionized water lot # or distilled water manufacturers info & date.*

MS/MSD/MSB - *Collect at a frequency of 1 per 20 samples of each matrix per day. Analyze for all those parameters analyzed for the samples collected the same day.*

Field Blank - *Pour clean deionized water (used as final decon rinse water) into sample containers [illegible] the sampling site. Collect field blanks at a frequency of 1 per lot of deionized water. Note water lot number and dates in use for decon in 'Comments' section.*

Investigation Derived Waste (IDW) Characterization samples - *One composited sample from all drums of decon fluids and soil. Please note number of drums and labels on collection log.*

Notes:

1. See QAPP for sampling frequency and actual number of QC samples.
2. CWM - clear, wide-mouth glass jar with Teflon-lined cap.
3. HDPE - high density polyethylene bottle.
4. FD - Field Duplicate.
5. MS/MSD/MSB - Matrix Spike, Matrix Spike Duplicate, Matrix Spike Blank.
6. BD - Blind Duplicate.

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CHAIN OF CUSTODY RECORD

Project No.	Project Name
Samplers (Signature)	

No.	Date	Time	comp	grab	Sample Identification	Number of Containers	VOCs	SVOCs	Metals						REMARKS

Possible Hazard Identification:
Non-haz Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐

Sample Disposal:
Return to Client ☐ Disposal by Lab ☐ Archive ____________(mos.)

Turnaround Time Required:
Normal ☐ Rush ☐

QC Level:
I. ☐ II. ☐ III. ☐ Project Specific (specify):____________

Relinquished by: (Signature)	Date	Time	Relinquished by: (Signature)	Date	Time	REMARKS:
Relinquished by: (Signature)	Date	Time	Relinquished by: (Signature)	Date	Time	

Appendix C-C

Corrective Measures Report (sample form)

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DAILY LOG	DATE			
	REPORT NO.			
	PAGE	OF		

CORRECTIVE MEASURES REPORT

Date:

Project:

Job No:

Location:

CQA Monitor(s):

Client:

Contractor:

Contractor's Supervisor:

WEATHER CONDITIONS:

Ambient Air Temp. - A.M.:

Ambient Air Temp. - P.M.:

Wind Direction:

Wind Speed:

Precipitation:

Corrective Measures Undertaken (reference Problem Identification Report No.)

Retesing Location:

Suggested Method of Minimizing Re-Occurrence:

Approvals (initial):

CQA Engineer:

Project Manager:

Signed:

CQA Representative