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Executive Summary

A Remedial Investigation (RI) of the Three Star Anodizing Site (Three Star Site, Site #314058) was completed by O'Brien & Gere Engineers, Inc. (O'Brien & Gere) on behalf of the New York State Department of Environmental Conservation (NYSDEC). The "Site RI/FS" identified historic operations on the Three Star Site that is located on the south portion of the Market Street Industrial Park on McKinley Street in the Village of Wappingers Falls. During the original site development activities approximately 9 to 11 ft of material that included coal cinders were used to fill the Three Star Site. The area occupied by the Market Street Industrial Park has been the site of industrial/commercial operations since the 1830s.

The Three Star Site was originally developed as a cloth dye manufacturing facility called the Dutchess Bleachery. During the operation of the Dutchess Bleachery, the facility also manufactured ammunition, leather products, and felt hats. Other activities included plastic mold injection. A portion of the Three Star Site was used for the operation of a manufactured gas plant (MGP) over the period of the 1830s to approximately 1913. The Three Star Anodizing Company also operated a metal plating facility at the Three Star Site from the late 1950s to 1995. During operation of the Dutchess Bleachery, hydropower was used at the facility. An inactive raceway borders the property to the south (former raceway) and drains from east (upper raceway) to west (lower raceway) toward a former industrial lagoon (Three Star lagoon). The Three Star lagoon then drains north toward Wappingers Creek, bordering the Three Star Site to the north and west.

Current uses of the Three Star Site include a warehouse and an area used for storage of tractor-trailers. A fire in May 2004 destroyed three of the buildings at the Three Star Site. The area affected by the fire contains ruins of three buildings and debris associated with the fire. Twenty-three former metal plating vats that were contained in one of the buildings are exposed to the environment. Five buildings presently occupy the Three Star Site.

For the *Site RI*, the Three Star Site was conceptually subdivided into two areas, the *Main Site* and *MGP Site* which are separated by the Three Star lagoon. The Main Site is located on the east portion of the Three Star Site and contains buildings formerly associated with industrial activities and includes the Three Star lagoon. The MGP Site is located on the west portion of the Three Star Site and contains the ruins of gas holders that were associated with the MGP operations and undeveloped areas that include miscellaneous debris and fill. Wappingers Creek is located adjacent to the Three Star Site to the north and west. The potential impacts of the Three Star Site to Wappingers Creek were evaluated separately from the Three Star Site in the *Creek RI Report* (O'Brien & Gere 2007b). Contaminant sources, potential migration pathways, potential exposure pathways identified on the Three Star Site are summarized below.

Contaminant Sources and Extent

The results of the Site RI indicated that concentrations of VOCs, PAHs, and inorganics detected in site media do not suggest wide-spread contamination that would potentially impact the surrounding community. However, the Site RI identified five focused source areas associated with specific features of the Main Site and consisting of the lower raceway, the Three Star lagoon, media in the vicinity of a drywell and former drum storage area, and exposed soil along the creek bank. A Supplemental Remedial Investigation (SRI) of the vats on the Main Site also identified the exposed former metal plating vats (the vats) as a newly exposed potential source. The results of the SRI are

reported separately in the *SRI Report* (O'Brien & Gere 2007c). These five primary sources identified at the Three Star Site are discussed below. Four other comparatively minor sources that were identified are also summarized subsequently.

- The lower raceway is a source of mercury, naphthalene, and a wide range of other inorganics. The levels of mercury, naphthalene, and cyanide in ground water distinguish this source from other sources detected on the Three Star Site. Surface soil from this area also contains a wide range of inorganics at elevated levels including the highest concentrations of mercury and cyanide detected at the Three Star Site. Elevated concentrations of inorganics detected in surface and subsurface soil, and shallow and deep ground water suggest that this structure is a pathway for potential off-site migration. In addition, the surface soil concentrations may represent an exposure pathway for small animals.

- The Three Star lagoon has been impacted by an unknown chlorobenzene (CB) source. The presence of trichloroethene (TCE) in the surface water of the Three Star lagoon and the sediment at the confluence of the Three Star lagoon with Wappingers Creek provides evidence that off-site migration of chlorinated VOCs from site source(s) may be occurring. The sediment in the Three Star lagoon contains elevated levels of VOCs, PAHs, and metals.

- The dry well and former drum storage area located south of the Axton-Cross Building contains a source of chlorinated VOCs (tetrachloroethene (PCE), TCE, dichlorbenzene (DCB)) and xylene to ground water. The highest levels of VOCs detected in soil and ground water from the Three Star Site are associated with this area. The VOC plume likely extends under the Axton-Cross Building and may be a source of VOCs to indoor air in that building.

- The SRI (O'Brien & Gere 2007c) identified liquid and sludge in the vats as potential sources of zinc, chromium, copper, and other constituents to subsurface media. The detection of elevated levels of metals in ground water downgradient of the vats suggests that the vats have leaked. However, the elevated metals were generally associated with turbidity and particulate matter which may limit their potential for migration. Although metals may be concentrated in soil under the vats, soil under the vats was not sampled due to complicated access. Phthalates were also associated with vat liquids and sludge. Other inorganics, total phenol, and acetone were detected in vat liquids at lower concentrations relative to the primary constituents cited above (O'Brien & Gere 2007c).

- The area of the MGP Site bordering the creek contains benzene, PAHs, and separate phase globules that suggest the presence of MGP wastes. In addition, the detection inorganics and chlorinated VOCs in that area suggest that the MGP wastes may be mixed with industrial residues.

The four other comparatively minor sources identified at the Three Star Site are summarized below.

- Fill material is a source of PAHs and inorganics, mostly at levels within one order of magnitude of background. The fill material is widespread and extends to approximately 10 ft below grade. Soil samples collected at the MGP Site generally contained higher levels of PAHs compared to concentrations detected at the Main Site suggesting contribution of byproducts from the MGP.

- TCA was detected in ground water in the vicinity of Buildings 15 and 16. The source of the TCA, however, was not identified.

- As would be expected, the surface soil at the MGP Site contained PAH levels that distinguish it from other portions of the Three Star Site. In addition, the surface soil at the MGP Site also contains inorganics.

- The soil adjacent to the west side of the Axton-Cross Building contained elevated levels of nickel in surface soil and lead in subsurface soil relative to other areas of the Three Star Site. PCE was also detected in shallow soil above levels detected elsewhere on the Three Star Site. Drain holes on that side of the Axton-Cross Building are a potential contaminant pathway from the interior of the building.

Other sporadic detections of constituents in soil at levels above screening values for commercial uses were also detected at the Three Star Site. The detection of PCBs and pesticides in soil and pesticides in lagoon sediment did not identify a source of PCBs or pesticides specific to the Three Star Site.

Potential Migration Pathways

Sources of VOCs were identified in shallow ground water beneath the Main Site, as discussed above. There are several areas where chemical signatures in the ground water suggest that sources are present. However, the concentrations detected in the soil did not identify multiple source areas. Inorganics were also detected in shallow ground water within the former raceway and deep ground water under the Main Site. Although the source of these constituents may be concentrated in the lower raceway or another unidentified source, the mechanism for vertical migration of inorganics to deep ground water has not been established. Furthermore, transport of inorganics to deep ground water may not be currently active.

The presence of elevated concentrations of inorganics in deep ground water adjacent to the creek suggests that the creek channel may provide a migration pathway with the potential for ground water to migrate downgradient within the sediment of Wappingers Creek. The volume of ground water seepage to the creek may be small in comparison to creek and river flows reducing the ability to observe these interactions.

Erosion of site soil could occur along the unprotected banks that could contribute to the migration of PAHs and inorganics to the creek. The stone block retaining wall located upstream of the west bridge located on the Three Star Site protects that portion of the Three Star Site from scouring along the creek bank. Adjacent to the Axton-Cross Building and the MGP Site, the exposed soil may be subject to erosion.

Potential Exposure Pathways

Future uses of the site are expected to be consistent with its current use, which is commercial. Current potential human exposure pathways are primarily associated with the inhalation of indoor air by workers inside the Axton-Cross Building due to the VOC plume located in the vicinity of it and indoor air of other buildings on the Three Star Site. Additional pathways include potential human contact with surface soil and fugitive dust at the Three Star Site, and surface water and sediment of the Three Star lagoon. The size of the exposed soil area and uses of the Three Star Site limit the potential contact with surface soil on the Main Site. Surface water and sediment of the Three Star lagoon are potential exposure routes for trespassers, site workers, or recreational visitors. Exposure to subsurface materials is a potential pathway for construction workers. Due to the availability of a public water supply, the village prohibits the use of ground water from private wells for potable

water. Therefore, contact to ground water will be limited. Other potential uses of the Three Star Site are recreational uses primarily associated with the proximity to the creek, and future residential uses, if they were permitted. Exposure to surface soil is a pathway for both of these potential receptors. Potential exposures for residences would also include breathing indoor air.

The Three Star Site contains limited ecological habitat. Most of the Main Site is occupied by buildings, ruins of buildings, and paved parking areas that represent poor quality ecological habitat. However, wildlife that may be present on the Main Site may be exposed to metals, PAHs, and VOCs that were detected in surface soil above ecological screening values. The Three Star lagoon provides limited aquatic habitat on the Three Star Site. Aquatic receptors that visit the Three Star lagoon may be exposed to metals, PAHs, and chlorobenzene concentrations that were detected in surface water or sediment above ecological screening values. The MGP Site consists primarily of vegetated areas with grasses, trees, and shrubs that may be suitable habitat for wildlife. Wildlife that may be present on the MGP Site may be exposed to PAHs and metals concentrations that were detected above ecological screening values in surface soil.

1. Introduction

1.1. Site Background

On behalf of the New York State Department of Environmental Conservation (NYSDEC), O'Brien & Gere Engineers, Inc. performed a Remedial Investigation (RI) to investigate and evaluate potential environmental contamination of the Three Star Anodizing Site (Three Star Site) located in Wappingers Falls, New York (Figure 1-1). The Three Star Site is listed as a Class 2 site on NYSDEC's Registry of Inactive Hazardous Waste Disposal Sites (Site #314058). This report presents the results of the RI. The Feasibility Study (FS) is presented as a separate report (O'Brien & Gere 2007a).

The Three Star Site consists of an 8.5-acre industrial facility on the south bank of the upper tidal reach of Wappingers Creek (Figure 1-2). Several buildings, paved parking areas, and access roadways are present on the site. The Three Star Site is located on the 100-year flood plain along an oxbow of the tidal creek. The tidal creek discharges to the Hudson River approximately 1.5 miles downstream, and it is subjected to tidal influences of the river (NYSDEC 2000). A RI of Wappingers Creek (Creek RI) associated with the RI of the Three Star Site was reported separately (O'Brien & Gere 2007b).

During storm events, runoff from the Three Star Site to the tidal creek occurs via a former raceway that drains from east (upper raceway) to west (lower raceway) toward a lagoon on the southeast portion of the site (Three Star lagoon). The Three Star lagoon then drains to the tidal creek (Figures 1-2 and 1-3). In the past, industrial discharges from the facility to both the former raceway and the tidal creek reportedly occurred. The Three Star lagoon also formerly received stormwater runoff from the village via a pipe. However, in 2005 the pipe was observed to primarily discharge to ground surface along the southeast portion of the site through a break in the pipe. The general direction of drainage from this portion of the Three Star Site is toward the west. Surface drainage could eventually make its way to the former raceway and Three Star lagoon.

Historical information for the site was obtained from a number of sources:

- Aerial photographs of the site were obtained from the Dutchess County Soil and Water Conservation District for the years 1935, 1946, 1967, 1980, and 1995 (DCSWCD 2000).

- A historic account of activities at the site was provided in *The Birth & Growth of an Old Village, Wappinger Falls 1707-1977* (Popper 1991).

- Memoranda obtained from files of Dutchess County Department of Health provided maps that identified tenants of the site in 1967 and 1971. The memoranda also provided a brief account of activities at the site at that time.

- Sanborn Maps of the site also provided some information on past uses of the site.

- A previous Phase I investigation completed in the 1980s provided screening level data of the site (EA 1986).

The RI/FS Work Plan for the site provided a review of these data sources (O'Brien & Gere 2001).

The Three Star Site has been the location of industrial activities for over 150 years. Primary past uses of the site included dye operations, manufactured gas plant (MGP) operations, and metal plating (EA 1986; O'Brien & Gere 2001). A number of other smaller scale industrial activities also took place at the site. Dye operations, known as the Dutchess Bleachery, operated at the site between 1832 and 1955 (Section 1.1.1). The Dutchess Bleachery and Wappinger Water, Gas, and Electric Companies operated a coal fired MGP that included activities on the west portion of the subject site from the late 1800s to approximately 1913 (Section 1.1.2). Three Star and later Watson Metals Products Corporation operated a metal plating facility at the site from 1958 to approximately 1995 (Section 1.1.3). This report hereafter refers to Three Star as consisting of both of these operations. Information pertaining to the other commercial operations, including those conducted since the Three Star operations closed, is presented separately (Section 1.1.4).

According to information obtained from Dutchess County Department of Health memoranda (DCDH 1967, 1971), several buildings at the Three Star Site had discharges that led to the tidal creek in the past. Site buildings at the Three Star Site that were tested by Dutchess County Department of Health had floor drains that discharged directly to the tidal creek. Most of the buildings had sanitary facilities that also discharged directly to the tidal creek. In 1971, a survey conducted by Dutchess County Department of Health indicated that the Axton-Cross (bulk chemical sales) building at the site had floor drains that discharged to a lagoon adjacent to the building (DCDH 1971).

Rinse water from plating tanks in the Three Star facility was reportedly discharged to the back of the plant and subsequently overflowed to the former raceway and lagoon. Paint stripping caustics were discharged to the floor drains of the plant and to the ground behind the facility. In that area, the ground slopes toward the southeast, in the direction of the former raceway and Three Star lagoon. Page Print Systems, which occupied one of the buildings at the east end of the site (EA 1986), also reportedly discharged via a pipe, rinse water from photographic development sinks to the ground adjacent to the building (DCDH 1971). From the account of building design and industrial activities in the 1970s, it is assumed that previous operations at the site also discharged industrial wastes to the ground, former raceway/Three Star lagoon, and/or the tidal creek. The locations of the pipes are not known.

In the immediate area around the Three Star Site, Olah Associates occupied a building on the north side of the tidal creek and reportedly performed plating and stripping operations and discharged rinse water from plating tanks directly to the tidal creek. In 1967, Hanover Print Works was also located on the north side of the tidal creek and reportedly discharged approximately three quarts of paint per day to a lagoon (north lagoon) located next to the building (DCDH 1967).

1.1.1. Dutchess Bleachery, 1832 to 1958

Dutchess Print Works, also known as the Dutchess Bleachery, operated under several ownerships. The Dutchess Bleachery was the first calico print works in America. The plant was originally located on the north bank of the tidal creek and later occupied land that was reportedly filled in on the south side of the tidal creek. By the late 1800s, buildings on the north side of the tidal creek were utilized for manufacturing acids and chemicals associated with the dye operations and the remainder of the operations were performed in buildings located on the south bank (Popper 1991).

Operations consisted of dyeing and finishing of rough cotton cloth from mills in New England and the south. Cloth was bleached and dyed at the Bleachery and wastewater was reportedly discharged into a raceway that emptied into the tidal creek (EA 1986). Mercuric chloride and arsenic pentoxide may have been used to dye cloth at the facility (NYSDEC 2000). Aniline dye was also made at the facility during World War I (Popper 1991).

For powering the facility, the Bleachery used several operations. For a period of time, coal fired steam boilers were used for powering equipment to process cloth (Popper 1991). From the late 1800s to approximately 1913, the MGP also burned coal to produce gas to operate boilers for the facility and the nearby community (Section 1.1.2). After operation of the MGP ceased, boilers were operated by coal until approximately the 1940s when a switch to fuel oil was made (Popper 1991). Several fuel oil tanks were located at the Bleachery (Popper 1991). From historic aerial photographs, it appears that three tanks were located on the north bank of the tidal creek and one tank may have been present as early as 1935 (O'Brien & Gere 2001), suggesting earlier use than the historical account by Popper (1991). Later, a hydroelectric facility was constructed and operated on the north bank of the tidal creek at the upstream portion of the site.

1.1.2. Manufactured Gas Plant Operations, Circa 1875 to 1913

The main portion of the MGP reportedly operated on the south bank of the tidal creek at the subject site (Popper 1991). The brick remains of two former gas holders are visible on the west portion of the site (Figure 1-2). The approximate locations of coal sheds and boiler house were identified on a map of the site dated approximately 1867 (DCHS 2000). According to the map, the coal shed was located in the vicinity of Building 16 and the Boiler House was located in the vicinity of former Building 11 (Figure 1-2).

During operation of the MGP, coal was reportedly barged up the tidal creek from the D&H Canal, and stored in large coal sheds located on the north and south banks of the tidal creek as early as the 1870s (EA 1986, Popper 1991, DCHS 2000). NYSDEC files indicate that approximately 16 acres, beyond the boundary of the Three Star Site, were filled with coal cinders (NYSDEC 2000). Most of these areas are either paved or developed. In a historical account of the area, Popper (1991) indicated that coal cinders were used to fill behind the retaining wall built on the south bank of the tidal creek at the site and an area downstream in the vicinity of Creek Road. Historic maps indicate topographic changes have occurred in those areas as well as the southwest portion of the former Bleachery property on the north bank.

1.1.3. Metal Plating Operations, 1958 to 1995

The Three Star facility (including Watson Metals Products Corporation) anodized aluminum from 1958 to when the facility closed, around 1995. Beginning in 1972, the facility also reconditioned electronic equipment that involved a water rinse of gold components (NYSDEC 2000). Operations also included paint stripping using caustics (DCDH 1971). Three Star plating processes included the use of mild non-etching alkali cleaners, a proprietary mix of sodium dichromate or chromic acid, sulfuric acid with the addition of soda ash to adjust the pH to 5 or 6, and a dying process which required ferric ammonium oxide and synthetic dyes. The paint stripping operation reportedly used chlorinated solvent with fluoride, caustic soda, and kerosene.

The waste from Three Star was reportedly discharged to the lagoon (DCDH 1967). Prior to the development of the lagoon in 1962, it is presumed that the waste was discharged to the former raceway. The sanitary facilities in the Three Star buildings failed a dye test performed in 1971. At

that time, wastewater was found to discharge via floor drains to the lagoon and the tidal creek. Rinse water from plating tanks reportedly discharged to the back of the plant, which subsequently drained into the former raceway and the Three Star lagoon (DCDH 1971).

A Phase I site investigation was completed in the mid-1980s to evaluate these issues (EA 1986). The Phase I investigation found that the waste stream from the Three Star operations at the site contained sulfuric and phosphoric acids, caustic dyes, soaps, and various trace metals including copper, nickel, chromium, aluminum, and zinc. Processes also included rinsing of gold components. In 1975, the facility was required to obtain a State Pollution Discharge Elimination System (SPDES) permit to continue discharging via the former raceway. SPDES permitted discharges occurred from 1975 to 1980. From the mid-1950s to 1980, waste was reportedly discharged to the tidal creek at a rate of 20,000 to 60,000 gallons per day (EA 1986).

The Dutchess County Department of Health documented wastewater discharge from Three Star to the former raceway and subsequently to the tidal creek as early as 1967. The practice of discharging a diluted waste stream directly to the tidal creek reportedly continued for many years. After the SPDES permit was issued, NYSDEC documented that Three Star occasionally exceeded SPDES effluent limitations for nickel and copper in 1977 and 1979. Analyses of Three Star effluent, provided by the New York State Department of Health (NYSDOH) Division of Laboratories and Research, indicated that metal concentrations were occasionally high with respect to the United States Environmental Protection Agency (USEPA) surface water criteria.

Subsequently in 1979, NYSDEC issued a consent order that required Three Star to address SPDES excursions. It is not known how wastewater was handled after that time. However, it appears that the materials were managed on-site since the facility is not connected to the village sewerage system (Kolb 2003).

From November 1978 to the summer of 1983, trailers stored on the Three Star Site contained powdered raw product in 55-gal drums. The powdered product contained in the 55-gal drums included aluminum, oxide, nickel, and cadmium. Reportedly, these materials were from Marathon Battery, formerly of Cold Spring, New York. In 1983, the trailers were removed under supervision of NYSDEC and the Dutchess County Department of Health (NYSDEC 2000). In the 1986 Phase I Investigation, it was reported that a pipe discharged to a puddle near the south corner of the plating facility, behind Building 17. The standing water in the puddle was sampled and found to contain metals and solvents (EA 1986).

An inspection of the facility by USEPA in 1993 indicated that it was not in compliance with applicable metal finishing pretreatment standards. The discharge of zinc from the facility was 4.1 mg/l compared to a discharge limit of 2.6 mg/l. A leaking PVC pipe that conveyed wastewater was also identified. The storage of metal waste sludge in concrete holding tanks at the facility was also noted in the report (USEPA 1993).

In May 2004, a fire at the Three Star Site destroyed Buildings 15,16, and 21. The destruction of the buildings exposed to the environment twenty-three former metal plating vats that were located in Building 16. An evaluation of the vats was completed as a Supplemental Remedial Investigation (SRI). Results of the SRI are reported separately (O'Brien & Gere 2007c).

1.1.4. Other Commercial Uses of the Site

Currently, the site is known as the Market Street Industrial Park. Realty corporations that lease space to the various tenants reportedly own the majority of the property. Several buildings are vacant or used as warehouse space.

Recent tenants of the Market Street Industrial Park consist of the following (O'Brien & Gere 2001):

- Riverview Transmission.
- Axton-Cross Company occupied the building located next to the lagoon in the 1960s. The company manufactured and distributed chemical products (Popper 1991).
- Fabricare Products occupied the building located next to the lagoon (Axton-Cross building) in the 1970s.
- Cresthill Industries, Inc.
- Lighting and Electronics, Inc.
- Sears mail order was located in one of the main buildings (Building 22) at the Three Star Site.
- Page Print Systems occupied a building next to the tidal creek, at the east end of the Three Star Site.
- Tupperware.

The main current tenant of the site is a floor tile distributor located in the former Axton-Cross Building. Other tenants include a wood shop in the small building next to the old bridge and tractor trailer parking; both located in the Building 12 Area. In 2002, an automobile was being restored near Building 17. Other uses of the site include storage in the buildings (NYSDEC 2003).

1.1.5. Nearby Properties and Potential Impacts to Subject Site and Wappingers Creek

The portion of the Market Street Industrial Park located on the north bank (north parcel) is approximately 5 acres and features old factory buildings that are currently occupied by commercial tenants. The parcel also contains a large storage tank, an abandoned smoke stack, a recently constructed personal storage building, and paved parking areas (NYSDEC 2000). Previous operations on the north bank included Dutchess Bleachery, Hanover Print Works, Olah Associates (metal plating), Kemp & Beatley, and IBM. The Dutchess County Department of Health records indicate that Hanover Print Works was located on the north bank of the tidal creek in a building on the west portion of that site. As previously cited, the facility reportedly discharged approximately three quarts of paint per day to the north lagoon that drains from the north parcel to the tidal creek (Section 1.1.5). A realty corporation reportedly owns the property. According to NYSDEC spill files, which were reviewed in 2001, two spills were reported nearby:

- In 1999, a citizen logged a complaint to report that a 5,000-gal oil tank may be buried on the Three Star Site. The citizen complained of oil observed in the creek (O'Brien & Gere 2001).

- An active leaking underground storage tank (UST) for gasoline was located within one mile of the subject property. It is unknown if this spill has affected the subject site (O'Brien & Gere 2001).

These off-site releases of contaminants to the environment represent possible sources of constituents to the subject site and the creek.

1.2. Physical Features of the Site

The Three Star Site consists of two areas defined for the RI/FS as the Main Site and the former manufactured gas plant (MGP Site), as shown in Figure 1-3. The Main Site occupies the east portion of the Three Star Site where the buildings that housed the industrial operations were located. The MGP Site is located on the west portion of the Three Star Site and contains two former gas holders where MGP operations occurred. The lagoon is located along the west part of the Main Site between the Main Site and the MGP Site. The physical features of the Three Star lagoon are discussed further in Section 1.2.2.

The Three Star Site is located within an oxbow of the tidal creek below Wappingers Falls (Figure 1-1). The tidal creek borders the site to the north and flows toward the west to its confluence with the Hudson River located approximately 1.5 miles downstream of the site. The former raceway and residences border the site to the south. A steep embankment is located next to the former raceway (Figure 1-2). According to village records, the facility is not connected to the village sewage system (Kolb 2003). In a 1967 aerial photograph (DCSWCD 2000), what appears to be drainage ditches from buildings were observed due north of the lagoon and raceway.

Rock retaining walls located along the tidal creek bordering the site are approximately 10 feet (ft) high (Popper 1991). Based on historic information, the Three Star Site contains fill material from MGP activities that was placed behind the retaining walls (Section 1.1). During site excavation in the 1960s for construction of the building formerly occupied by Axton-Cross, coal wastes up to 9 ft deep were reported (EA 1986). The brick remains of two former gas holders are visible on the MGP Site (Figure 1-2). The approximate locations of a coal shed and boiler house were identified on a map of the site dated approximately 1867 (DCHS 2000). According to the map, the coal shed was located in the vicinity of Building 16 and the Boiler House was located in the vicinity of former Building 11 (Figure 1-2). Coal wastes were reportedly used to fill 16 acres of land in the area, including the Three Star Site (EA 1986).

1.2.1. Geology and Hydrogeology

Regional reports indicated that, except for a small area, glacial outwash/alluvial sand and gravel deposits that are present along both sides of the tidal creek directly underlie the Three Star Site. These deposits average about 2,000 ft in width adjacent to, and south of the Three Star Site, and increase to more than 6,000 ft in width northeast of the site. The area of exception is located generally beneath the tidal creek in the west portion of the Three Star Site where exposed bedrock and/or less than 3 ft of glacial till overlying bedrock are present.

Approximately 3,000 ft north-northeast of the site, a similar sand and gravel deposit is reportedly 108 ft thick at the Village of Wappingers Falls well field (Well DU-760) located approximately 3,000 ft

north-northeast of the site, near Route 9D (Figure 1-1)[1]. This sand and gravel sediment is bounded to the east by deposits consisting of at least 3 ft of glacial till overlying bedrock, and to the west across the tidal creek by deposits consisting of less than 3 ft of glacial till and/or exposed bedrock (NYSDEC 2000).

A thrust sheet of bedrock that predominantly comprises autochthonous graywacke and shale of the Ordovician Age Austin Glen Formation underlies the unconsolidated sand and gravel sediment. Just west of the Three Star Site, bedrock consists of limestone and dolostone of the Cambro-Ordovician Age Wappinger Group (NYSDEC 2000).

Based upon the available information, the glacial/alluvial sediment aquifer on either side of the tidal creek is designated as the aquifer of concern with regard to the Three Star Site. The only wells reportedly completed in the glacial/alluvial sediment portion of the aquifer of concern are those of the Wappingers Falls well field located northeast of the Three Star Site (Figure 1-1). In general, under natural conditions, the ground water in this aquifer beneath the Three Star Site will discharge to the tidal creek, which flows southwest to the Hudson River. The ground water table is approximately equal to the level of the tidal creek. A graywacke/shale bedrock aquifer located on either side of the tidal creek is not expected to be an aquifer of concern regarding the Three Star Site.

North and east of the Three Star Site, the Village of Wappingers Falls developed the bedrock aquifer with wells for public water supply (Figure 1-1). This portion of the aquifer of concern is bounded to the east and south by a thrust fault, and to the west where the bedrock type changes from graywacke/shale to limestone/dolomite west of the tidal creek. Information from wells in the area indicate the ground water table in the bedrock aquifer ranges from 14 ft below grade at Well DU-369 to 40 ft below grade at Well DU-343 (EA 1986).

1.2.2. Three Star Lagoon

The former raceway located on the Three Star Site was reportedly constructed in the early 1900s by Dutchess Bleachery to discharge facility wastes (EA 1986). Three Star also reportedly discharged wastewater to the former raceway during its operations at the site (EA 1986). The Three Star lagoon located on the property is reportedly unlined and covers approximately 0.5 acres of the site. Village storm water formerly drained to the Three Star lagoon via a pipe located along the former raceway bordering the site to the south (Section 1.1.3). The Three Star lagoon reportedly also received industrial wastes during operation of Three Star (Section 1.1.3). Prior to that, when the raceway was operational, it may also have received waste from site industrial activities. Other industrial wastes may have also drained in the direction of the former raceway and the Three Star lagoon.

1.3. Environmental Chemistry

The properties of the chemicals and physical attributes of the Three Star Site contribute to the fate and transport of the chemicals once exposed to the environment (Table 1-1). Chemicals used at the site included volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), metals and cyanide. Constituents associated with coal and MGPs are primarily SVOCs consisting of PAHs. However, additional constituents may consist of benzene (VOCs), phenolic compounds (SVOCs), and inorganics, in particular cyanide.

[1] According to the Village of Wappingers Falls, construction of wells for use of ground water as a potable water supply is prohibited because a public water supply is available. There are no known wells in the vicinity of the Three Star Site.

1.3.1. Volatile Organic Compounds

Tetrachlroethene (PCE), trichloroethene (TCE), trichloroethane (TCA), dichlorobenzene (DCB), and chlorobenzene (CB) are chlorinated VOCs that are commonly used in industry as solvents or degreasing agents. When PCE, TCE, and TCA are released to the environment they may degrade over time resulting in the formation of related compounds that are referred to as daughter compounds. PCE may degrade to TCE, which in turn may degrade to DCE and finally vinyl chloride. Likewise, TCA may degrade to dichloroethane (DCA), and DCB may degrade to CB. Although some of these compounds may be used individually as solvents, they are commonly related as degradation byproducts. Benzene, toluene, ethylbenzene, and xylene (BTEX) are compounds that are often associated because they are components of hydrocarbon combustion sources, but these compounds may also be used as industrial solvents independently. In summary, ethenes, ethanes, chlorobenzenes, and BTEX are four unrelated types of VOCs or classes of compounds representing different sources when present in the environment.

1.3.2. Semivolatile Organic Compounds

Semivolatile organic compounds (SVOCs) detected at the Three Star Site consist of PAHs, chlorobenzenes, and phenols, as discussed below

Polycyclic Aromatic Hydrocarbons

PAHs are common environmental constituents, generally associated with incomplete combustion processes. Typically, PAHs exist as mixtures with up to sixteen individual compounds measured by standard analytical methods. The molecular structure of individual PAH compounds vary in size from two to seven attached benzene rings that exhibit a wide range of chemical properties. Similarly, PAH mixtures have a wide range of properties reflecting the composition of individual compounds contained in the specific mixture. Chemical and physical processes involved in weathering of organic compounds in the environment may sequester PAHs within a soil or sediment matrix by mechanisms that are poorly understood (Alexander 2000; Luthy *et al.* 1997; Hatzinger and Alexander 1995).

Sources of PAHs consist of both natural and anthropogenic (originating from human activities) origins. Natural sources include fires from sources such as volcanoes, forests, and prairies. Anthropogenic sources exceed natural sources and include emissions from combustion of fossil fuels (Menzie *et al.* 1992, Van Metre *et al.* 2000). Residential wood combustion accounts for greater than 30% of the anthropogenic emission in North America (USEPA 1994). Use of asphalt materials is also a source of PAHs in the environment (Van Metre *et al.* 2000). Specific to the Three Star Site, past MGP operations are a potential source of materials containing PAHs that exceed background levels.

Urban sprawl and specifically the associated increased use of motor vehicles has been implicated as a source of increased PAH concentrations in aquatic sediment over the past 40 years (Van Metre *et al.* 2000). Sources of PAHs related to automobiles include tire wear, crankcase oil, roadway wear, and car soot and exhaust (Van Metre *et al.* 2000). Total PAH concentrations reported in surface sediment sampled from 10 reservoirs and lakes in metropolitan areas of the US had median and mean concentrations of 31 and 46 mg/kg, respectively, and ranged from 3 to 224 mg/kg (Van Metre *et al.* 2000). For urban soils, typical background concentrations of total PAHs reportedly range from 1 to 3 mg/kg, with higher concentrations of 8 to 36 mg/kg attributed to road dust (Menzie *et al.* 1992). Concentrations of individual PAHs in urban sediment attributed to sources of combustion reported to range from 10 μg/kg to 10 mg/kg (Gustafsson *et al.* 1997).

Chlorobenzenes
Industrial and commercial uses of chlorobenzenes include use as an intermediate in the manufacture of other organic chemicals, dyestuffs and insecticides; as a solvent for adhesives, drugs, rubber, paints, and dry-cleaning; and miscellaneous uses that include an agent for swelling fibers in textile processing. Other uses of CB have also included the production of phenol, DDT, and aniline; and the use as a tar and grease remover in cleaning and degreasing operations. In the environment, CB may be subjected to biodegradation with 2- and 4-clorobiphenyl as byproducts (USEPA 1995). Under anaerobic conditions DCB can degrade to CB (Ramanand *et. al*. 1993).

Phenolic Compounds
Phenol is mainly man-made, however, it is also found naturally in animal waste and vegetative organic material. The largest use of phenol is to make plastics (phenolic resins), but is also used to make caprolactam (nylon 6 and other man-made fibers) and bisphenol (used to make epoxy and other resins) (ATSDR 1999). Phenolic compounds are also used in industry as antioxidants, chemical intermediates, slimicides, disinfectants, tanning agents, photographic developers, and additives to lubricants and gasoline. They are widely used in the industries of photography, petroleum, paint, explosives, rubber, plastics, pharmaceuticals and agriculture. The manufacture of phenolic resins, bisphenol a, and caprolactam are three major uses of phenols in industry (ATSDR 1999, International Labour Organization 1998).

1.3.3. Inorganics
Most metals and cyanide are ubiquitous in the environment, but are used for a variety of purposes (Table 1-1). As elements, metals do not degrade. Environmental conditions such as pH, oxidation-reduction (redox) potential, organic carbon content, and particulate interactions affect the fate and toxicity of inorganics in the environment (Yin and Allen 2000). Valence state affects mobility, bioavailability, and toxicity of metals. Each inorganic constituent has a unique chemistry that is a factor in its fate and transport. Total metals or total cyanide concentrations may not be indicative of toxicity. Some specific examples are cited below:

- Chromium in the environment is generally present as trivalent chromium that is much less toxic than hexavalent chromium, a less common form of chromium in the environment. Hexavalent chromium is rapidly reduced to trivalent chromium in the presence of oxygen.
- Mercury is present in the environment in elemental, and inorganic and organic bound forms. Methyl mercury (a form of organically bound mercury) is the most toxic form (USEPA 2000).
- Cyanide in the environment is measured as total and amenable cyanide. The amenable cyanide fraction represents the biologically available cyanide.

1.4. Conceptual Site Model

A conceptual model of the Three Star Site identifies potential sources and migration pathways that were evaluated during the RI (Figure 1-4).

For over 150 years, the Three Star Site has been the location of a number of industrial activities that may have impacted the site. Surface soil adjacent to buildings may have been impacted by industrial waste that was discharged to floor drains inside the buildings (Section 1.1.3) or pipes directed to the former raceway or the tidal creek (Section 1.2.2). Discharges of wastes to surface soils could result in migration of contaminants to subsurface soils and ground water, and seepage of ground water to the tidal creek. The sanitary system for the buildings also allowed seepage to the tidal creek. During the period of 1958 to 1980 Three Star reportedly discharged wastes from industrial processes to surface

soil of the Three Star Site and allowed them to drain to the former raceway, the Three Star lagoon, and the tidal creek (NUS 1986a,b, 1988). It is not known what disposal practices were used after that. However, previous reports of the facility being connected to the village sanitary sewer system (NUS 1986a,b, 1988) could not be corroborated with the village records (Kolb 2003).

Although previous waste disposal activities at the Three Star Site were not documented, it is likely that industrial wastes from operations at the Three Star Site for the period from the 1830s to the start of the Three Star operations in 1958 were handled in a similar manner. In addition to industrial discharges from industrial operations in buildings at the site, coal cinder wastes from the use of coal fired boilers at the site were reportedly used to fill portions of the Three Star Site and may have been used to fill off-site areas. Due to past disposal practices, site contaminants were investigated in soil, ground water, surface water and sediment. As discussed in the SRI Report (O'Brien & Gere 2007c), exposure of the vats to the environment after the fire of 2004 was evaluated as a potential source of metal plating wastes to subsurface media.

From review of site topography, industrial wastes discharged from on-site buildings to surface soil would primarily drain to the south and west toward the former raceway and Three Star lagoon and then to the tidal creek (Figures 1-2 and 1-3). However, redistribution of constituents may have occurred in surface soil and the lagoon sediment due to the past flooding because the site is within 100-year flood plain. Historic records indicate that the site has been flooded at least three times since 1900. Flooding can mobilize contaminants from the site or deposit contaminants originating elsewhere. Once in Wappingers Creek, constituents may have migrated to the Hudson River, located approximately 1.5 miles downstream.

1.5. Current and Future Uses of the Site

Current uses of the Three Star Site consist of warehouse operations in the former Axton-Cross Building and parking areas for tractor trailers. The destruction of Buildings 15, 16 and 21 in the fire of May 14, 2004 and the associated debris remaining on the Three Star Site limits the potential uses of the Three Star Site. Debris from the fire remains on the Three Star Site. The former MGP site is currently not used and remains undeveloped with trees and other vegetation.

It is anticipated that in the future, the Main site may be redeveloped for commercial uses. The MGP site could also be developed in the future. At this time, there are no restrictions in place that would restrict the type of development that could take place.

1.6. Remedial Investigation Objectives

Contamination of surface and subsurface soil, and ground water of the Three Star Site, and surface water and sediment of the Three Star lagoon were investigated for the Site RI. The objectives of this Site RI are presented below:

- Evaluate current site conditions and evaluate potential migration pathways.
- Evaluate the potential for site impacts to fish and wildlife.
- Evaluate potential pathways for human exposure to site constituents.

- Evaluate the ground water below the site for potential contamination, including evaluation of the vertical and horizontal extent.

- Evaluate local background soil concentrations of SVOCs and inorganics to support evaluation of the soil data for the Three Star Site.

- Evaluate the potential for surface soil contamination at the Three Star Site due to past disposal practices and site flooding.

- Evaluate potential subsurface soil contamination at the Three Star Site.

- Evaluate the Three Star lagoon for potential surface water and sediment contamination. Evaluation of the Three Star lagoon included development of sediment volume estimates and measurement of water levels for potential tidal effects. In addition, the connection of the lagoon with the shallow aquifer was evaluated.

The investigation of the Three Star Site was completed according to State Superfund guidance and the RI/FS work plan and addendum (O'Brien & Gere 2001, 2002).

1.7. Approach

The activities completed for the Site RI focused on three general areas consisting of the Off-Site Areas and two areas within the Three Star Site referred to as the Main Site and the MGP Site.

Off-Site Areas
The Off-Site Areas were selected to represent background locations where samples of surface soil were collected and analyzed for comparison with soil data collected from the Three Star Site. In addition, three samples of soil were collected from one residence to evaluate surface soil on that property. That residence may contain soil that reportedly may have originated as fill material from the Three Star Site.

Main Site
The Main Site consists of the buildings associated with past uses as the Bleachery, metal plating operations, and other industrial activities; it also includes the former Axton-Cross Building and the Three Star lagoon. Due to the size of the Main Site, six broadly defined sub-areas were identified to focus the investigation (Figure 1-3):

- Former Axton-Cross Building
- Buildings 21/22 Area
- Buildings 15/16/17 Area
- Former raceway
- Building 12 Area
- Three Star lagoon.

The identification of these areas of the Main Site aided the understanding of potential sources of contaminants and helped to focus the discussions of site data.

MGP Site
The MGP Site consists of the ruins of gas holders and the adjacent land. The MGP Site included an area with debris consisting of metal cans, pieces of concrete, an old truck, and other miscellaneous materials. Most of this area is heavily vegetated with trees and grasses.

Investigation of the Three Star Site was completed using a phased approach to collect samples and data for evaluation. The purpose of the first phase was to identify constituents at the Three Star Site that may be present in ground water, surface soil, surface water and sediment. Results of the first phase were used to focus the number of analytical parameters required in subsequent work aimed to evaluate horizontal and vertical extent of impacts.

Several environmental media were sampled during the Site RI. Soil samples were collected from the surface as well as from the subsurface during completion of soil borings and excavation of test pits. Shallow and deep wells were installed and ground water samples were collected on the Main Site and MGP Site. Ground water sampling locations on the Main Site were selected to evaluate the direction of flow across the site. Investigation of the Three Star lagoon consisted of sediment probing, and surface water and sediment sampling.

Samples collected for the Site RI were analyzed for VOCs and SVOCs, of the Target Compound List (TCL) including tentatively identifiable compounds or TICs, and Target Analyte List (TAL) inorganics. Additional analyses consisted of the following:

- Samples collected during the first phase of the RI were analyzed for TCL pesticides and polychlorinated biphenyls (PCBs). Results of these analyses did not identify the Three Star Site as a source of these constituents (Sections 5.1 and 6.1).

- Soil and sediment samples included analysis of hexavalent chromium and total organic carbon (TOC). Amenable cyanide (considered to be the biological available factor of cyanide) was also analyzed in soil and sediment samples where total cyanide was detected.

- Surface and ground water field analyses included pH, conductivity, temperature, turbidity, dissolved oxygen, and salinity. Ground water field analyses also included oxidation-reduction potential (ORP). Laboratory analyses of surface water and ground water samples included hardness and total suspended solids. Laboratory analyses of surface water also included dissolved organic carbon (DOC) and alkalinity.

- One sample of sediment from the Three Star lagoon was extracted using the toxicity characteristic leaching procedure (TCLP) and analyzed. Grain size distribution was also sampled and analyzed.

O'Brien & Gere Laboratories in Syracuse, New York analyzed the samples, except for samples collected for analysis of hexavalent chromium, TOC, and sediment physical parameters. Hexavalent chromium and TOC samples were analyzed by Columbia Analytical Services in Rochester, New York (Phase I RI) or Ecology & Environment, Inc. in Lancaster, New York (Phase I/II RI). Physical parameters in sediment were analyzed by PW Laboratories, Inc. in Syracuse, New York.

2. Methods

The Site RI was conducted in two phases that were completed in 2001 and 2002. Phase I of the Site RI was completed according to the Work Plan (O'Brien & Gere 2001) from April to July 2001. Phase II of the Site RI was completed according to the Work Plan Addendum (O'Brien & Gere 2002) from November to December 2002. Prior to sampling each location, the sampling equipment were decontaminated according to the work plan (O'Brien & Gere 2001).

Details of investigations of surface soil, subsurface soil, and ground water are presented in separate sections below (Sections 2.1 through 2.3, respectively). In addition, the surface water and sediment samples collected to investigate the Three Star lagoon are presented (Section 2.4). The sample quantities analyzed for the investigation of Off-Site Areas, the Main Site, and the MGP Site are presented in Table 2-1. Descriptions of site features and associated samples are presented for the Off-Site Investigation, and investigations of the Main Site and MGP Site in Tables 2-2, 2-3, and 2-4, respectively.

Guidance followed for completion of risk assessment activities is summarized in Section 2.5. Data interpretation methods are also discussed in Section 2.6.

2.1. Surface and Shallow Soil Sampling

2.1.1. Sample Locations

The locations were selected to evaluate potential issues associated with observed industrial features (Table 2-3). Surface soil samples were collected from the 0- to 2-inch depth interval. Shallow soil samples were collected from some of the locations, generally from the 0- to 2-ft depth interval. However, samples collected for the subsurface soil investigation (Section 2.1.2) from within 2.5 ft of the ground surface were also included in the evaluation of shallow soil.

Surface and shallow soil sampling was completed on July 11, 2001 and December 5 through 9, 2002. Surface soil and shallow samples were collected at locations identified on Figure 2-1. Surface and shallow soil samples collected off-site consisted of nine background locations, and two locations at Off-Site Location 1 (Figure 2-1, Table 2-2). On the Main Site, fifteen samples were collected (Figure 2-1, Table 2-3):

- Four samples were collected in the vicinity of the former Axton-Cross Building (SS-9 through SS-12).
- Two samples were collected in the Building 21/22 Area (SS-7 and SS-8).
- Three samples were collected in the former raceway (SS-1, SS-5, and SS-18).
- Three samples were collected in the Building 15/16/17 Area (SS-3, SS-4, and SS-6).
- Three samples were collected in the Building 12 Area (SS-15 through SS-17).

On the MGP Site, eleven surface and shallow soil samples were collected at various locations around the site, including two test pits (Figure 2-1 and Table 2-4).

2.1.2. Sample Processing and Analysis

At each surface soil sampling location, composite soil samples were collected at one or two depth intervals using a stainless steel hand auger or sampling trowel. In vegetated areas, the vegetation and humus were removed prior to sample collection. Each location included sampling of the 0- to 2-inch interval. At locations where two depth intervals were collected, the second sample consisted of the 0- to 24-inch depth interval. At locations where refusal was encountered at depths less than 24 inches below grade, the sampling location was moved slightly to try to improve sample recovery. When refusal was encountered repeatedly, the sampling interval was composited accordingly. Sample observations were documented in field logs (Appendix A).

Surface soil samples were analyzed for TCL SVOCs, TAL inorganics, and TOC. In addition, samples collected during the Phase I RI were analyzed for TCL VOCs, pesticides, and PCBs. VOC and SVOC analyses included the identification of tentatively identifiable compounds (TICs). Inorganic analyses included hexavalent chromium. Total cyanide analyses were completed with an expedited turnaround to provide for analysis of amenable cyanide, if total concentrations were detected.

2.2. Subsurface Soil Investigation

2.2.1. Sample Locations

The investigation of subsurface soil at the site was completed from April 24 to May 3, 2001, November 18 through 22, 2001 and December 2 through 11, 2002. Subsurface soil sample locations for the Main Site and MGP Site are described in Tables 2-3 and 2-4, respectively. The locations of subsurface soil samples are identified on Figure 2-2.

On the Main Site, eighteen soil borings were completed and four test pits were excavated (Figure 2-2, Table 2-3):

- Four soil borings were completed to evaluate the Axton-Cross Building Area including what appear to be floor drain holes (1 boring), the drywell south of the building (2 borings), and an underground storage tank (UST, 1 boring).
- Three borings were completed to evaluate the above ground storage tanks (ASTs) in the Building 21/22 Area.
- Three borings were completed to evaluate the former raceway.
- Four borings were completed to evaluate the area around Buildings 15/16/17.
- Four borings were completed in the Building 12 Area, including one located near a UST.

The soil borings completed on the Main Site also included two deep borings. Four test pits were located along the area adjacent to the tidal creek. Two of the test pits were located in the former Axton-Cross Building Area and the other two were located in the Building 12 Area (Figure 2-2).

On the MGP Site, eight soil borings were completed and six test pits were excavated (Figure 2-2, Table 2-4). Soil borings included one deep boring. Shallow soil borings SB-3-01 and SB-4-01 were completed in the center of the former gas holders located in the MGP Site (Figure 2-2). Although drilling at the SB-2 location was supposed to result in the completion of a monitoring well, shallow bedrock prevented the construction of this well. The soil borings included one deep boring at BMW-1.

2.2.2. Sample Processing and Analysis

The soil borings were completed using conventional hollow stem auger drilling methods according to the work plan (O'Brien & Gere 2001). The shallow borings were completed to depths of approximately 10 to 30 ft. The deep borings were completed to the top of bedrock (approximately 50 to 65 ft). Soil samples were collected continuously to the base of each boring. On average, test pits were excavated to a maximum depth of approximately 11 to 12 ft below grade. Descriptions of soil sample texture, composition, color, consistency, moisture content and recovery were recorded on the field logs (Appendix A).

Field screening of soil samples for the presence of VOCs was completed with a photoionization detector (PID). Soil samples from each depth interval collected during the completion of soil borings were placed into field screening containers with an air headspace. The results of headspace analyzed with the PID were used to assist selecting samples for laboratory analysis. Generally, two to three soil samples were selected as depth composites from each soil boring for laboratory analysis. Soil samples from some of the test pits were also submitted for laboratory analysis based on stratigraphy, evidence of possible contamination, and degree of saturation.

Subsurface soil analyses consisted of TCL VOCs and SVOCs (including TICs), and TAL inorganics (Table 2-1). Total cyanide was analyzed with a one-week turn around time. If total cyanide was detected, amenable cyanide was also analyzed. A subset of samples (Phase I RI) also included analysis of TCL PCBs and pesticides (Table 2-1).

O'Brien & Gere Laboratories in Syracuse, New York analyzed the soil samples, except for samples collected for analysis of hexavalent chromium and TOC. Those samples were analyzed by Columbia Analytical Services in Rochester, New York (Phase I RI) or Ecology & Environment, Inc. in Lancaster, New York (Phase I/II RI).

2.3. Ground Water Investigation

Soil borings completed at sample locations designated "MW-" were converted to monitoring wells to investigate the ground water. Wells were generally constructed of 2-inch diameter PVC well screen and riser casing. The screened interval of the shallow wells typically consisted of 15-ft screens set to straddle the water table. For the deep wells (designated "BMW-"), 5-ft screen lengths were used. Well construction details are included as Appendix B. Wells were developed prior to sampling.

2.3.1. Main Site Well Construction and Development

Ground water monitoring wells MW-1, MW-6, MW-7, and MW-8 were constructed in 2001 and developed on May 7 and 8, 2001. Wells MW-9, MW-10, MW-11, MW-12, MW-13, BMW-2, and BMW-3 were constructed in 2002 and developed on December 6 through 11, 2002. Well development consisted of removing a minimum of ten well volumes of water from the wells. During monitoring well development fine grained sediment was removed from each of the monitoring wells. Turbidity levels typically exceeded the scale of the turbidity field meter (>1000 NTUs) during the start of well development, but improved as well development progressed. The turbidity levels in monitoring wells MW-6, MW-9, BMW-2 and BMW-3 were outside the scale of the turbidity meter during the entire well development process. Monitoring well development logs are included in Appendix B.

During well development, ground water was observed as summarized below.

- A sheen was noticed during the development of monitoring wells MW-6 and MW-7, and a noticeable "sweet" odor was observed when developing MW-6.
- Development water from MW-11 appeared black and had a minor "oily odor."
- A slight fuel oil odor was also noted during the development of MW-10.
- A heavy sheen and strong "oil like" odor was observed during the development of MW-9 in the Axton Cross building area.

PID levels in MW-9, MW-10 and MW-11 wellheads were below detection limits. However, cold temperatures and high winds most likely affected field measurements. PID levels measured at all other monitoring wells were less than the detection limits.

2.3.2. MGP Site Well Construction and Well Development

Shallow ground water monitoring wells MW-2, MW-3, MW-4, and MW-5 were installed in 2001 and developed on May 8 and 9, 2001. The bedrock ground water monitoring well BMW-1 was installed in 2002 and developed on December 7, 2002. Generally, well development consisted of removing a minimum of ten well volumes of water from the wells. However, due to limited recharge, two well volumes of water (2.4 gallons) were removed from MW-3. In wells MW-2, MW-3, MW-5 and BMW-1, the turbidity levels measured during well development exceeded the scale of the turbidity meter (> 1000 NTUs) due to the fine grained composition of the native soil (high fraction of fine sand and silt). After well development, turbidity levels in those wells were visually observed to be much lower, but still remained outside detection limits (>999 NTU).

During well development, ground water was observed and PID readings of wellhead air were obtained. A mothball (naphthalene) odor was noticeable during the development and ground water sampling at wells MW-4 and MW-5 located on the MGP Site. Development and purge water removed from MW-4 and MW-5 was black in color, contained a petroleum sheen, and contained a strong mothball odor. Well development and purge water removed from MW-4 and MW-5 was containerized on-site in a labeled 55-gallon drum. PID air monitoring performed in the wellhead prior to and following well development had readings ranging from 1.0 to 5.0 ppm in wells MW-4 and MW-5. In the BMW-1, MW-2 and MW-3 wellheads, the PID readings were less than the detection limit.

2.3.3. Ground Water Sampling

Two sets of ground water samples were collected during the Site RI. The first event was completed on May 16, 2001 and consisted of sampling of monitoring wells MW-1 through MW-8. The second ground water sampling event was completed on December 8 through 11, 2002. For that sampling event, monitoring wells MW-1 through MW-8 were sampled again along with monitoring wells MW-9 through MW-13 and BMW-1 through BMW-3 that were constructed in 2002. The monitoring wells produced sufficient quantities of ground water for sampling with only nominal drawdown, except for MW-3, which was bailed dry during both ground water sampling events.

2.3.4. Sample Processing and Analysis

For both ground water sampling events completed for the Site RI, ground water samples were analyzed for field and laboratory parameters as discussed below.

Field parameters were measured during collection of ground water samples using a Horiba® U-10 water quality meter for pH, conductivity, dissolved oxygen, salinity, temperature, and turbidity. A Hanna® 9025 meter was used to measure the ORP. Field parameters were collected at the beginning of monitoring well purging, during the removal of each well volume, and prior to laboratory sample collection using bailers. Field instrumentation operating procedures were provided in the operations manual for the instrument. Field parameters, water level data, and general field observations were recorded on ground water sampling and ground water monitoring well purging field data sheets.

O'Brien & Gere Laboratories in Syracuse, New York performed the laboratory analyses. For both sampling events completed for the Site RI, TCL VOCs (including TICs). The ground water sampling completed in 2001 (Phase I RI) included analysis of TCL SVOCs (including TICs), pesticides and PCBs and TAL inorganics.

2.4. Investigation of the Three Star Lagoon

The investigation of the lagoon was completed on May 9, 2001 and November 11 through 13, 2002. Sediment locations and depths encountered during the investigation of the lagoon are presented in Appendix C.

2.4.1. Surface Water Investigation

Surface water samples were collected from the approximate center of the lagoon on November 11, 2002 using a Kemmerer® sampler. The water samples were collected from three separate water depths to represent upper, middle, and lower portions of the water column of the lagoon. Field analyses consisted of water temperature, conductivity, turbidity, salinity, pH, and dissolved oxygen.

For laboratory analyses, a single water column sample was collected as a depth composite sample from the center of the lagoon. For that sample, aliquots collected from the surface, middle, and lower portions of the water column were combined into a single sample for laboratory analysis. O'Brien & Gere Laboratories in Syracuse, New York analyzed the water column sample. Laboratory analyses consisted of TCL VOCs and SVOCs (including TICs), TAL inorganics, TSS, dissolved organic carbon (DOC), hardness, and alkalinity (Table 2-1). The sample collected for DOC analysis was filtered in the field using a 0.45 micron glass fiber filter and then analyzed for TOC.

A staff gauge was installed in the lagoon to evaluate potential water level variations due to ground water infiltration and creek tides. Water levels were obtained from December 7 through 10, 2002.

2.4.2. Sediment Investigation

Prior to sediment sampling, sediment probing was completed to evaluate depths of sediment in the lagoon. Reconnaissance of lagoon sediment depths was performed to identify suitable sampling locations and obtain a preliminary estimate of the volume of sediment present in the lagoon. The bottom of the lagoon was probed with a 20-ft calibrated pipe at twenty-four locations, spaced at approximately 25-ft intervals. Depths of sediment in the lagoon that were penetrated with the pipe are presented in Appendix C.

Seven sediment cores were collected from the lagoon:

In 2001 (Phase I RI), one sediment core was collected and sectioned into three depth intervals, each approximately 1.5 ft in length. The upper and bottom portions of the core were analyzed for TCL

VOCs and SVOCs (including TICs), pesticides, PCBs, and TAL metals (Table 2-1). The middle section of the sediment core was extracted using the Target Compound Leaching Procedure (TCLP) and then analyzed for TCL VOCs, SVOCs, pesticides/PCBs and TAL inorganics.

In 2002 (Phase II RI), six additional sediment cores were collected from along the longitudinal center of the lagoon. Each of the six sediment cores was sectioned into three depth intervals to represent the upper, middle, and lower depths of the sediment profile for a total of eighteen sample aliquots. According to the work plan, the aliquots representing the same depth intervals (upper, middle, or lower) from three locations were combined to form depth composite samples. Two sets of depth composite samples were formed in this manner. That is, six samples were collected for laboratory analysis consisting of two composite samples from each of the depth intervals.

O'Brien & Gere Laboratories in Syracuse, New York analyzed the sediment samples for TCL VOCs and SVOCs, and TAL inorganics. The TCL VOC and SVOC analyses also included identification of TICs. In addition, hexavalent chromium and TOC were analyzed by Columbia Analytical Services in Rochester, New York (Phase I RI) or Ecology & Environment, Inc. in Lancaster, New York (Phase I/II RI). Two samples were analyzed for physical parameters consisting of particle size distribution and bulk density. PW Laboratories, Inc. in Syracuse, New York completed the physical parameter analyses. The sediment samples collected during 2001 (Phase I RI) were also analyzed for TCL pesticides and PCBs by O'Brien & Gere Laboratories.

2.5. Exposure Assessment

Exposure assessment activities completed for the Site RI consisted of two evaluations:

- To evaluate potential exposures to humans, a qualitative exposure pathway analysis was completed according NYSDEC DER-10 guidance (NYSDEC 2002) in USEPA Risk Assessment Guidance for Superfund (RAGS) D format (USEPA 2002).
- To evaluate potential ecological impacts, A Fish and Wildlife Impact Analysis (FWIA) was completed according to NYSDEC (1994a) guidance. The FWIA was completed through Step II C, Toxic Effects Analysis (NYSDEC 1994a).

2.6. Data Interpretation

Data interpretation completed for the RI consisted of a data quality review (Section 2.6.1) and comparison of data to screening values (Section 2.6.2). Analytical data are provided in laboratory reports (O'Brien & Gere Laboratories 2001a-m, 2002a-k; Columbia Analytical Service, Inc. 2001a-e; Ecology & Environment, Inc. 2001a-c, 202a-f, 2003a-d).

2.6.1. Data Quality Review

Review of the data quality indicated that the RI data are acceptable for the intended uses. Laboratory data quality was evaluated according to New York State requirements for data usability summary reports (DUSR). The data quality review resulted in some of the data being qualified as estimates (J). Consistent with data validation guidance, the qualification of data as estimated does not affect the end uses of the data. Results of the DUSR were incorporated into data summary tables. Copies of the DUSRs completed for the Phase I RI and Phase II RI were presented separately (Potak 2001, 2003a-e).

From review of the DUSRs completed for this RI, the data quality is acceptable for intended uses. Minor laboratory problems resulted in some data being qualified. Data qualified as estimates (J) are acceptable for intended uses. The data quality issues identified are summarized below:

- Acetone and methylene chloride were laboratory contaminants detected in some of the VOC blank samples. Acetone was detected in both Phase I and Phase II RI samples. Methylene chloride was detected in samples collected during the Phase II RI (Potak 2001, 2003). The presence of laboratory contaminants complicates the interpretation of these compounds.

- Evaluation of hexavalent chromium concentrations is complicated by matrix interferences. For several samples, the recoveries of matrix spike/matrix spike duplicates for hexavalent chromium were lower than expected. However, results of laboratory control spikes indicated that the laboratory analytical performance was within acceptable ranges providing evidence that the soil matrices were responsible for these anomalies. The laboratory noted that low matrix spike/matrix spike duplicate recoveries may be due to reduction of hexavalent chromium in the soil matrix. If such rapid reduction occurs in in-situ sediment, this suggests that hexavalent chromium would be absent. Nonetheless, these interferences result in some uncertainty associated with the interpretation of undetected hexavalent chromium in affected samples. Total chromium data provide additional data to evaluate the potential levels of hexavalent chromium in the soil. It is not unusual for evaluation of soil and sediment matrices to be complicated by such factors.

A complete review of data quality is provided in the DUSRs (Potak 2001, 2003a-e).

2.6.2. Interpretation of Analytical Data

Site data were compared to screening values according to provisions of the work plan and addendum (O'Brien & Gere 2001, 2002). Interpretation of data trends was aided by generalization of analytical testing results:

- Interpretation of VOC data included calculation of total VOC and total BTEX concentrations and the identification of principle components. The presence of BTEX compounds can be associated with hydrocarbon sources. Chlorinated VOCs are another class of VOCs that may be indicative of industrial solvents. An understanding of the environmental chemistry of VOCs (Section 1.3.1) was applied to further evaluate potential sources.

- Interpretation of SVOC data included calculation of total SVOC concentration. SVOCs that are commonly associated with combustion occur as mixtures of PAHs consisting of sixteen analytical compounds (Table 2-5). Total PAH concentrations were also calculated to support the evaluation of the concentrations of PAHs in site media.

- Evaluation of inorganic data focused on inorganics that are not common geologic elements. Common geologic elements (consisting of aluminum, beryllium, calcium, iron, manganese, magnesium, potassium, and sodium) occur naturally in wide concentration ranges, and other inorganics are more suitable for evaluation of potential site impacts. As such, the common geological elements were not evaluated beyond tabulation of results. The other inorganics consist of arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver (elements with usage controlled by the Resource Conservation and Recovery Act (RCRA)), and antimony, cobalt, copper, nickel, thallium, vanadium, and zinc. The nature and extent of cyanide was also

included. An understanding of the environmental chemistry of inorganic constituents (Section 1.3.3) was applied to further evaluate potential sources.

Concentrations of SVOCs, in particular PAHs, and inorganics are ubiquitous in the environment, and comparison of site data with background data (off-site) can be used to evaluate potential incremental concentrations due to past site activities. Statistical evaluation of background data was completed to identify maximum background concentrations for reference (NYSDEC 2002). This statistical evaluation is documented in Appendix D.

2.6.3. Media-Specific Screening Values

The RI data were compared to screening values according to media-specific data quality objectives outlined in the Quality Assurance Project Plan (QAPP) (O'Brien & Gere 2001):

- Surface water and ground water data were evaluated using ambient water quality standards and guidance provided in the *Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations, Division of Water Technical and Operational Guidance Series 1.1.1* (NYSDEC 1998). For ground water, Class GA screening values were applied as benchmarks for ground water quality although ground water use for this purpose is prohibited by the Village of Wappingers Falls. For surface water, Class C screening values were applied consistent with the water quality designation of Wappingers Creek. These evaluations were intended to represent conservative screening values, although they may not represent the intended uses for these waters on the Three Star Site.

- Soil data were compared to soil clean-up guidance provided in the *Part 375-6 Remedial Program Soil Cleanup Objectives* (NYSDEC 2006). Screening values for unrestricted uses and commercial uses were applied in the evaluation of the soil data. Local background concentrations of soil samples collected in the village of Wappingers Falls were also used as reference values to support the evaluation of potential incremental concentrations on the Three Star Site that may be related to site activities. New York State provides soil cleanup goals, referred to as Part 375 screening values in this report, for both organic compounds and inorganics (NYSDEC 2006).

- Sediment was compared to screening guidance provided in the *Technical Guidance for Screening Contaminated Sediments* (NYSDEC 1999). For organic compounds in sediment, a screening concentration was developed using sample TOC concentration to adjust each constituent concentration according to the sediment guidance. This approach assumes that equilibrium partitioning occurs in sediment. Elevated concentrations of TOC above 12 percent detected in certain samples were evaluated using the NYS screening values based 12% TOC. Concentrations of inorganics in sediment were compared to reference values for typical background concentrations, as provided in the screening guidance.

Results of these interpretive efforts are reported in subsequent sections of this report. Additional screening values were used to evaluate data for the FWIA component of the RI (Appendix E). For the FWIA, ecological screening values were obtained from Friday (1998) and additional screening values for surface soil were obtained from NYSDEC (1994b).

2.6.4. Source Identification Approach

Initially, ground water data was used to identify overall spatial patterns of constituents and select areas for in-depth evaluation of site soil. These data provide further detail to support the evaluation

of potential source areas that may be contributing to the ground water conditions that were observed. Source identification was aided by an interpretation of possible relationships between organic compounds and their fate in the environment (Section 1.3). Evaluation of the vertical extent of constituents in soils and ground water flow direction were used to support the inferences of source migration pathways drawn from the data.

3. Site Drainage, Geology and Hydrogeology

3.1. Site Drainage

The overall topography the Three Star Site is level with a typical elevation of approximately 7 to 8 ft above mean sea level (msl). The Three Star Site generally drains toward the west and north in the direction of the tidal creek (Figure 3-1). In portions of the Three Star Site the elevation ranges from approximately 4 to 16 ft above msl. The elevation was lower behind the Main Site Buildings 15,16, and 17 where an elevation of approximately 3.5 above msl was obtained (MW-7). The former raceway, which forms the south and west boundaries of the Main Site, drains toward the west. The former raceway contains elevations ranging from approximately 16 ft above msl at the east end (MW-13) to approximately 7 ft above msl toward the west end (MW-11). Based on elevations, stormwater runoff would tend to pool behind Buildings 15, 16, and 17 because the elevation of the former raceway and other portions of the Three Star Site are higher in comparison. In other areas of the Main Site, the drainage is generally toward the Three Star lagoon. The east portion of the Three Star Site near the tidal creek, with an elevation of approximately 10 ft above msl (MW-8), drains toward the former Axton-Cross Building where elevations are lower, between 6 and 7 ft above msl. The surface water elevation of the Three Star lagoon was not obtained, but based on observations, the elevation is presumed to be approximately equivalent to the elevation of the tidal creek or slightly higher.

The elevation of the MGP Site is approximately 9 to 14 ft above msl, with a typical elevation of approximately 11 ft. Therefore, the elevation of the MGP Site is approximately 3 to 4 ft higher than the Main Site. The area of highest elevation on the MGP Site is located at the south border of the site (SS-MGP-5). The area around the former gas holders contained elevations of 13 ft above msl. The northeast portion of MGP Site, with an elevation of approximately 9 ft above msl (SS-MGP-7), drains toward the tidal creek to the north. The remainder of the MGP Site drains toward the northwest.

The tidal creek is located to the north of the Main Site and to the northwest of the MGP Site. The elevation of the water surface in the tidal creek is approximately at msl, with water depths in the tidal creek varying by approximately 4 ft over the tidal cycle. Maximum water depths in the tidal creek are approximately 10 ft in the vicinity of the Three Star Site.

Off-site areas are generally higher in elevation compared to the Three Star Site. On the opposite shore of the tidal creek to the north is another portion of the Market Street Industrial Park and a steep embankment that is not developed. The embankment on the north shore of the tidal creek has elevations over 140 ft above msl. The village borders the Main Site to the south on top of an embankment approximately 40 ft to 70 ft above msl.

3.2. Geology

Subsurface material encountered at the site consisted of fill material, naturally deposited alluvium, glacial till, and bedrock. The fill material was of variable thickness and commonly consisted of reworked native material with variable amounts of cinders, concrete, and brick fragments. In portions of the site, the fill material was underlain by a layer of thin, dark, gray/black organic clay matter. Native alluvium consisted of various mixtures of silt, sand and gravel. A thin layer of till was found above bedrock in several locations. Bedrock observed at the Three Star Site consisted of shale and shaley limestone. Bedrock depths were variable across the Three Star Site. Soil boring logs are

provided in Appendix A. Two geologic cross-sections were constructed from the boring logs. The locations of the cross-sections are identified on Figure 3-2. An east-west trending cross-section is included as Figure 3-3. A north-south trending cross-section is included as Figure 3-4.

On the Main Site, fill that was sampled consisted predominantly of silt, sand and gravel with various amounts of cinders, slag, coke and brick fragments. Fill thickness varied from 4 ft at MW-1 near the southwest margin of the Main Site to 14 ft in BMW-3 to the northeast. The fill material in the northeast portion of the site is composed predominantly of brick fragments. The fill in the former raceway is very similar to the other fill on the site and ranges from 5 ft in BMW-2 to 18 ft in MW-13.

A dense organic clay was noted to be present within the upper 5 ft of the native material on the south and west portions of the Main Site. The organic clay layer ranged from 0.4 ft thick at the MW-1 location to 2.1 ft at the MW-6 location. The organic clay unit was absent in MW-8, MW-10, SB-9, SB-16 and MW-13 located along the north and east portions of the site. The organic clay layer was not observed on the MGP Site.

The fill material present on portions of the MGP Site consisted predominantly of cinders with occasional brick and concrete fragments, and scrap metal. Little to no fill material was encountered near the middle of the MGP Site in test pits TP-1, TP-2, and TP-3 and borings MW-2, MW-3 and SB-2. Fill material was encountered in test pits TP-5 and TP-11, and in borings MW-4, MW-5 and BMW-1. This material typically extended from grade to a depth of approximately 10 to 12 ft below grade. Fill related to the former gas-holders was also encountered in soil borings SB-3-01 and SB-4-01.

The native alluvium on the Three Star Site consists of various amounts of silt, sand and gravel. The composition of the alluvium was highly variable, but could be split into three generalized layers.

- A 5 to 10 ft thick layer of brownish fine to coarse-grained sand with little gravel was present on the majority of the site, except along the northeastern portion of the Main Site. On the MGP Site, this layer is at the surface in the areas where no fill is present.

- The aforementioned layer grades downward into a coarser layer of grayish medium to coarse-grained sand and gravel. This 10 to 20 ft thick layer is present on the Main Site but is absent from the majority of the MGP Site due to the elevated bedrock surface (discussed below). The layer is however, present on the northwestern part of the MGP Site adjacent to the tidal creek (MW-4, MW-5 and BMW-1) where the top of bedrock is lower.

- The above layer grades into a finer grained layer of brown/gray fine to medium grained sand and silt with little fine gravel. This layer, approximately 15 to 30 ft thick, appears to be somewhat finer along the eastern side of the Main Site.

Depth to bedrock across the Three Star Site ranged from approximately 66 ft below grade on the Main Site to approximately 1 ft below grade on the MGP Site as shown in a contour map of bedrock elevation data collected from the Three Star Site (Figure 3-5). The map was completed based on the soil borings and test pits that encountered bedrock. There were limited borings advanced to bedrock, particularly on the Main Site. Observations at several of the locations indicate that the bedrock was overlain by reworked glacial till and/or weathered bedrock. On the Main Site, 2 inches and 1.3 ft of till was encountered in deep borings BMW-3 and BMW-2, respectively. In BMW-3, the thin layer of

till was above approximately 9 ft of weathered bedrock. On the MGP Site, 1.5 ft of till was encountered only in MW-3 above approximately 2 ft of weathered bedrock.

From the limited bedrock elevation data collected from the Main Site, it appears that bedrock elevations are deepest along the east portion of the site, up to approximately 66 ft below grade, and they become shallower toward the west, at approximately 20 ft below grade. Finely laminated limey shale bedrock was encountered on the Main Site in borings from BMW-2 and BMW-3 at depths of 66.25 and 52.5 ft below ground surface, respectively. Bedrock elevations of the west portion of the Main Site are inferred from data collected from the MGP Site.

On the MGP Site, bedrock elevations ranged from 1 ft below grade (TP-2) to 49 ft below grade (BMW-1, Figure 3-5). Bedrock was encountered in test pits TP-2, TP-3, and TP-4 at depths of approximately 1, 8, and 2 ft below grade, respectively. Bedrock was also encountered in soil borings SB-2 (8 ft), SB-3-01 (27 ft), SB-4-01 (9 ft) and deep monitoring well BMW-1 (49 ft). Shallow bedrock encountered in TP-4 dipped to the north towards BMW-1. Although bedrock was initially encountered at a depth of less than 1 foot below grade in TP-2, the test pit was extended to the southeast and the bedrock surface was found to dip downward to the southeast. These observations, as presented in both cross-section maps (Figures 3-3 and 3-4) and the top of bedrock contour map (Figure 3-5), suggest that a bedrock ridge or knob, trending northeast to southwest, is present in the central area of the MGP Site. From the ridge, bedrock appears to dip away steeply northwest towards the tidal creek and to the southeast towards the Main Site.

3.3. Hydrogeology

The Three Star Site is located inside an oxbow of the tidal creek that borders the site to the north and west. In addition much of the Three Star Site is located on filled-in areas of the creek. Other surface water features on the site include the Three Star lagoon located between the Main Site and the MGP Site. This lagoon was at one time connected to the former raceway located along the south border of the Main Site. The raceway is now filled in. Village storm water formerly drained to the Three Star lagoon via a pipe located along the former raceway (Section 1.1). In April 2005, storm water was observed discharging to the ground surface through a break in the pipe and draining toward the low area behind former Buildings 15 and 16 (Section 1.1).

The majority of the runoff on the Three Star Site flows to the tidal creek or the Three Star lagoon, or collects in several low areas associated with the former raceway and near MW-7 (Figures 2-2 and 3-1). Due to the proximity of the Three Star Site to the tidal creek there is likely interaction between surface water and ground water on the Three Star Site.

Ground water occurs within the fill and alluvium at depths ranging from 3 to 14 ft across the site. Thirteen monitoring wells were constructed screening the ground water table to evaluate shallow ground water. Three deep monitoring wells were constructed on top of bedrock in order to evaluate the deep ground water on the site. Site hydrogeology related to tidal influences, shallow ground water, and deep ground water are discussed in separate subsections below.

3.3.1. Tidal Influences

Wappingers Creek discharges to the Hudson River approximately 1.5 miles downstream and is subject to the tidal influences of the river. The tidal cycle in the Hudson is approximately 6 hours between high and low tides. Fluctuations in the tide influence ground water levels beneath the site.

Although a complete tidal monitoring program was not performed, water levels (lagoon, tidal creek and ground water) were collected twice in 2002. The water levels obtained represent a period of high tide on the afternoon of December 7th and low tide on the morning of December 9th. These data are presented on Table 3-1. Elevation measurements were collected within 1 hour of each other and provide a snapshot of ground water flow beneath the site. Recorded tidal changes in the Hudson River of approximately 3 ft (www.HarborTides.com) corresponded to measured changes in Wappingers Creek of approximately 4 ft.

The results of the tidal monitoring are as follows:

- Lagoon levels did not fluctuate significantly between high and low tide measurements.

- The elevations of shallow ground water fluctuated with tidal changes in the creek. Fluctuations measured in the shallow monitoring wells ranged between 0.18 to 3.39 ft, with wells in close proximity to the tidal creek (MW-4, MW-5 and MW-8) showing the greatest change in elevations.

- The elevations of deep ground water also fluctuated with the tides. In wells located near the tidal creek (BMW-1 and BMW-3), fluctuations of 3.02 and 3.45 ft were measured. In contrast, ground water levels in BMW-2, located in the former raceway, fluctuated 1.45 ft. Unlike the other deep monitoring wells, levels in BMW-2 were higher when the tidal creek levels were lower. This is most likely a temporal effect due to lag caused by difference in material and distance from the tidal creek.

Further evaluations of tidal influences on ground water flow are included in the discussion of shallow and deep ground water below.

3.3.2. Shallow Ground Water

Tidal changes in Wappingers Creek clearly affect shallow ground water levels on the site (Section 3.3.1) suggesting that there is a connection between the two media (Table 3-1). Wells located adjacent to the tidal creek (MW-4, MW-5 and MW-8) are more readily influenced by the fluctuating water levels in the tidal creek. This results in localized and temporary variations in flow direction of shallow ground water.

Two shallow ground water flow maps representing high tide on December 7, 2002 and low tide on December 9, 2002 were developed based on water levels collected on those dates, and are presented on Figures 3-6 and 3-7, respectively. In both figures, ground water flow is generally towards the tidal creek. However, there is a component of flow towards the former raceway. On the MGP Site, a shallow bedrock ridge that trends approximately northeast to southwest will likely influence the flow of shallow ground water. The bedrock ridge likely results in influencing a large component of shallow ground water flow toward the northeast and southwest, parallel to the ridge.

Ground water in shallow wells adjacent to the Three Star lagoon fluctuated 1 to 2 ft between high and low tide measurements while the levels of surface water in the Three Star lagoon only fluctuated 0.05 ft during that time period (Tables 3-1 and 3-2). This suggests that the Three Star lagoon may only have a limited hydraulic connection to the shallow ground water and the tidal creek. The Three Star lagoon is more likely a surface water feature where surface runoff and storm water collects.

Shallow ground water likely interacts with the deep ground water on the site. A downward hydraulic gradient is exhibited at each of the deep wells. This gradient is also likely affected by fluctuating water levels in the tidal creek.

3.3.3. Deep Ground Water

Much like the shallow ground water, tidal changes in the creek discussed above clearly affect deep ground water levels on the site (Table 3.1). This suggests a connection between the tidal creek and deep ground water on the site. There were only three deep monitoring points, and as discussed above, well BMW-2, unlike the other two wells, actually showed lower water levels when the tidal creek levels were higher. The variations in well BMW-2, located further from the tidal creek than the other deep monitoring wells, created distinctly different flow patterns based on the high and low tide measurements.

Two deep ground water flow maps (presented as Figures 3-8 and 3-9) represent high tide on December 7, 2002 and low tide on December 9, 2002, respectively. The maps were based on water levels measured during those periods. Ground water flow direction during the high tide period (Figure 3-8), is generally south, but appeared to reverse during the measurements collected during the low tide (Figure 3-9). This suggests that the variation in flow direction is temporal and likely a function of lag created by differences in the influence of the creek's tidal fluctuations on the surrounding ground water. Further evaluation of deep ground water flow characteristics is not possible due to the limited data points.

4. Off-Site Soil Investigation Results

4.1. Overview

Off-site soil samples were collected from background locations in the village of Wappingers Falls (Section 4.2) and at Off-Site Location 1 (Section 4.3) located adjacent to the tidal creek (Figure 2-1). The samples collected in the village provide local background data for comparison with soil data collected at Off-Site Location 1, the Main Site, and the MGP Site. The local background data are used to evaluate potential incremental concentrations in site soil that may be related to site activities. The samples collected at Off-Site Location 1 were intended to evaluate residential soil that reportedly contains fill material that may have originated from the site.

Results of laboratory analyses are presented in tables that include comparison of detected concentrations of SVOCs and inorganics to Part 375 screening values for unrestricted uses. Complete results for off-site sample analyses are presented in Appendix F.

4.2. Background

Ten background locations were sampled to provide reference data to support the evaluation of the Three Star Site.

Samples of background soil contained inorganics above Part 375 screening values for unrestricted uses whereas SVOC concentrations were below Part 375 screening values for unrestricted uses (Tables 4-1 and 4-2, respectively). The occurrence of inorganics included occasional detections of arsenic, cadmium, and lead above Part 375 screening values for residential and restricted residential uses. These inorganics exceeded the Part 375 screening values for restricted residential uses at 3, 1, and 2 locations, respectively, of the 10 locations sampled. The detection of inorganics above Part 375 screening values for unrestricted was more frequent and included copper, mercury, and zinc, in addition to the inorganics cited above. Ubiquitous levels of lead, mercury, and zinc were generally above Part 375 screening values for unrestricted uses.

The soil that was investigated generally did not contain unusual visual appearance or odors, except in the sample collected from Temple Park at location SS-BK2 (Figure 2-1). At that location, odors and a PID level of 1 ppm were observed. The presence of odors and detected PID readings in the soil samples collected at background location SS-BK2 were not quantified from SVOC analyses, suggesting the presence of other constituents that were not analyzed. Possibly VOCs are present in that soil. During the investigation, a resident at 106 Market Street noted that a spill of oil may have occurred nearby. Therefore, VOCs from that spill represent a source unrelated to the Three Star Site which may impact the soil at that location.

In general, local background soil concentrations of SVOCs and inorganics were within ranges expected in an urban environment, although levels of some inorganics were above Part 375 screening values for unrestricted or residential uses (Appendix G). The SVOCs detected in the soil were primarily made up of PAHs at concentrations below Part 375 screening values for unrestricted uses.

4.3. Off-Site Location 1

Soil samples were also collected from two locations at Off-Site Location 1 to evaluate the soil for evidence of potentially contaminated fill material on this property.

Similar to results of background soil samples, inorganics were detected above Part 375 screening values for unrestricted uses and SVOCs were below Part 375 screening values for unrestricted uses (Tables 4-1 and 4-2). The detection of inorganics included cadmium and mercury at concentrations above background levels and Part 375 screening values for restricted residential uses. The detection of copper exceeded Part 375 screening values for unrestricted uses, ranging from 61 to 204 mg/Kg, with three of the four samples also exceeding the maximum background level of 79 mg/Kg. The maximum concentration of zinc also exceeded background levels. Otherwise, the levels of inorganics were similar to background, with ubiquitous levels of lead, mercury, and zinc above Part 375 screening values for unrestricted uses and lead occasionally exceeding Part 375 screening values for residential uses. Therefore, the soil data indicate that Off-Site Location 1 may be impacted by heavy metals.

SVOC TICs were also reported in laboratory reports.

5. Main Site – Investigation Results

5.1. Overview

The features of the Main Site and the sample locations are identified on the site map (Figure 2-1). Individual areas within the Main Site were evaluated as previously described in Section 1.6. Results of the investigation of the Main Site are presented in the four sections listed below:

- Surface soil and shallow soil data are presented in Section 5.2.
- Subsurface soil data are presented in Section 5.3.
- Ground water data are presented in Section 5.4.
- Three Star lagoon data are presented in Section 5.5.

The presentation of analytical results for each of the media is based on comparison to NYSDEC screening values. Each of the data results sections (Sections 5.2 through 5.5) presents the analytical results analyses for VOCs, SVOCs, inorganics, and associated supplementary parameters. In Section 5.6, the results of qualitative human health and ecological exposure assessments are presented. A discussion of the data is provided in Section 5.7.

Pesticides and PCBs were also analyzed in a subset of samples of ground water, soil, and lagoon sediment (Appendix F). The concentrations of these compounds in soil were generally below screening values, except for the detection of DDT and related compounds (DDE and DDD), and one detection of PCBs (Aroclor 1260) above the screening values for unrestricted uses (Table 5-1, Appendix F). The PCBs were detected at 0.2 mg/Kg in one surface soil collected from the lower raceway (SS-01). The detection of pesticides and PCBs in soil was below the Part 375 screening values for commercial uses. PCB/pesticides were not detected in ground water (Appendix F). Results were similar for the MGP Site (Section 6.1). The detection of these constituents in soil did not suggest that the Three Star Site was a source for these compounds and subsequent evaluation was focused on site related constituents.

5.2. Surface and Shallow Soil

Surface soil samples were collected to represent the 0- to 2-inch interval and, at some of the locations, shallow soil samples were also collected, generally from the 0- to 2-ft interval. Analytical data for surface soil are provided in Tables 5-2 through 5-4. Detected concentrations of VOCs, SVOCs, and inorganics in surface soil are compared to Part 375 screening values in Figure 5-1. TOC and percent solids data are presented in each of the tables summarizing the other constituents analyzed. TOC levels in surface and shallow soil ranged from non-detectable to 12 percent. Solids ranged from 47 to 96 percent. A brief summary of the constituents detected in surface soil is provided below.

Samples from most of the sixteen locations on the Main Site contained constituents in surface soil above Part 375 screening values for unrestricted uses consisting primarily of inorganics and occasional detections of PAHs and VOCs (Figure 5-1). In addition, localized areas contained constituents above Part 375 screening values for commercial uses as summarized below:

- The lower raceway (SS-01) contained the some of the highest levels of inorganics detected. Chromium, copper lead, nickel, and cyanide were detected at 6,260; 2,140; 1,100; 603; and 94 mg/Kg, respectively.
- Adjacent to Buildings 16 and 17, constituents were detected above Part 375 screening values for commercial uses at MW-1, SS-06, and MW-07. At MW-1, PAHs consisting of benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenzo(a,h)anthracene were detected at 15, 12, 18, and 1.4 mg/Kg. At SS-06 (surface) and MW-07 (0 to 0.5 ft), copper was detected at 611 and 483 mg/Kg, respectively. At SS-06 (surface), cadmium was also detected at 36 mg/Kg.
- In the drywell area south of the Axton-Cross Building (SS-10, 1 to 1.2 ft), mercury was detected at 31 mg/Kg.
- Behind the Axton-Cross Building near the suspected drain holes (SS-11, surface), nickel was detected at 2,310 mg/Kg.
- In shallow soil, concentrations of cadmium and PAHs were detected at concentrations slightly above Part 375 screening values for commercial uses adjacent to Building 16 (SS-04) and adjacent to Building 12 (SS-17), respectively.

Visual inspection of the soil in the field revealed that the shallow soil generally consisted of coarse to fine sand with various amounts of medium to fine gravel, silt, and fill material including brick, cinder, and glass fragments. Observations of staining or odors were observed at three of the locations. A slight petroleum odor was observed in surface soil samples that were collected in the vicinity of ASTs adjacent to Buildings 21 and 22 (SS-07 and SS-08), and the sample located near the UST in the Building 12 Area (SS-17). The ground surface and a concrete retaining wall were stained with petroleum in the vicinity of one of the ASTs (SS-08). Shallow soil at the remaining surface soil sampling locations did not exhibit visual evidence of contamination or odors.

Additional details of the analytical data for surface soil are provided below:

Volatile Organic Compounds

In general, total VOC concentrations ranged from less than 0.01 to 0.5 mg/Kg in surface and shallow soil (Table 5-2) and were below Part 375 screening values for unrestricted uses. However, the total VOC concentration in shallow soil samples collected from behind the Axton-Cross Building (SS-11, 0 to 2 ft) and adjacent to Building 17 (MW-1, 0.5 to 2.5 ft) were exceptions, with PCE and TCE detected slightly above Part 375 screening values for unrestricted uses (Figure 5-1).

Samples collected from the other areas (Building 21/22, former raceway, and Building 12) of the Main Site were below Part 375 screening values. VOC TICs were also identified in laboratory reports.

Semivolatile Organic Compounds

SVOCs detected in surface soil generally consisted of primarily PAHs at levels below Part 375 screening values with a few exceptions (Table 5-3). Total PAH concentrations in surface soils were typically within background levels and ranged from 0.5 to approximately 7 mg/Kg. However, in addition to the PAHs detected adjacent to Building 17 (MW-1), as noted above, PAHs were also detected a concentrations similar to Part 375 screening values for commercial uses adjacent to Building 12 (SS-17) where 1.3 mg/Kg of benzo(a)pyrene was detected (Table 5-4). PAHs were also detected above Part 375 screening values for unrestricted uses behind Building 16 (MW-7) and in the drywell area adjacent to the Axton-Cross Building (SS-10). SVOC TICs were also identified in laboratory reports likely attributable to cinders and ashes observed in the fill.

Inorganics
In addition to the specific areas with concentrations of inorganics detected above Part 375 screening values for commercial uses, the detection of inorganics above Part 375 screening values for unrestricted uses was widespread (Table 5-5, Figure 5-1). Eight inorganics consisting of cadmium, chromium, copper, lead, mercury, nickel, zinc, and cyanide were detected above Part 375 screening values for unrestricted uses. Antimony was detected above background and reference values.

5.3. Subsurface Soil

Subsurface soil investigations consisting of soil borings/wells and test pit excavations are discussed in separate sections below (Sections 5.3.1 and 5.3.2, respectively). Analytical results for subsurface soil are presented in Section 5.3.3. Deep monitoring wells BMW-2 and BMW-3 were completed on the Main Site to the top of bedrock.

5.3.1. Borings and Wells

During drilling for monitoring wells and soil borings on the Main Site, soil samples were visually logged and screened in the field using a handheld PID. Observations obtained during soil boring activities are presented in Table 5-6. In general, PID measurements indicative of VOCs in soil were above background from each area of the Three Star site, except the Building 12 Area (Table 5-6). Other observations are listed below:

- The highest concentration was detected in the vicinity of the Axton-Cross Building where readings up to 1,200 ppm (MW-9), a heavy sheen, and BTEX odors were observed.
- In the former raceway, black stained soils with coal tar odors were observed in the west portion of the former raceway (MW-11, and BMW-2). Observations of soil from those borings included brick and asphalt fragments (MW-11), tarry silt and clay (BMW-2, 6 ft bgs). Soil with a slight "ammonia" odor was observed in the upper raceway (MW-13).
- A moderate petroleum odor was observed in the loading dock of Building 21 near ASTs (MW-10).

Deeper soil encountered in the former raceway (BMW-2) and adjacent to the tidal creek (BMW-3) showed no signs of contamination.

5.3.2. Test Pits

The four shallow test pits completed in the Main Site (Test Pits TP-7, TP-8, TP-9, and TP-10 on Figure 2-2) helped characterize the spatial distribution of fill material and the general overburden characteristics. As illustrated on Figure 2-2, the four test pits were completed along the north side of the facility (south side of the tidal creek).

Test pits TP-7 and TP-8 were completed near the former Axton-Cross building. In particular, TP-7 was located in a grassy area approximately 20 ft east-northeast of an UST identified adjacent to the northeast corner of the Axton-Cross building. Fill material, overlain by a thin layer of topsoil, was encountered in both TP-7 and TP-8 from grade to a depth of approximately 6.5 to 7.0 ft below grade.

Shallow test pits TP-9 and TP-10 were completed in paved areas of the site and encountered considerable amounts of fill material from grade to approximately 5 and 10 ft below grade, respectively. The fill material contained an abundance of brick and concrete fragments. Both TP-9

and TP-10 were bordered to one side by brick walls that may be ruins of buildings that were formerly located there. Saturated conditions were not reached in TP-9, but were encountered in TP-10 at a depth of approximately 10.5 ft below grade. Saturated soil and ground water encountered in TP-10 was black. A sheen and a petroleum odor were also noted. Field screening using a hand held PID did not detect VOCs in the air headspace above soil samples collected from test pits completed in the Main Site.

A total of six composite soil samples collected from test pits completed in the Main Site were submitted for laboratory analysis. Samples for laboratory analysis were selected based on test pit stratigraphy, evidence of possible contamination, and degree of saturation.

5.3.3. Analytical Results

Subsurface soil data are presented in Tables 5-7 through 5-9. Detected concentrations of VOCs, SVOCs, and inorganics in subsurface soil above Part 375 screening values for unrestricted uses are presented in Figure 5-2. TOC concentrations in subsurface soil ranged from less than 0.1 to 25%. TOC data are presented in each of the tables summarizing the other constituents analyzed.

The occurrence of constituents in subsurface soil above Part 375 screening values for unrestricted uses was common, consisting primarily of inorganics with occasional detection of VOCs and PAHs. Inorganics were also detected at concentrations that were above Part 375 screening values for commercial uses primarily in the lower raceway and adjacent to the Axton-Cross Building, although across the Main Site arsenic was detected sporadically:

- The lower raceway (MW-11) contained arsenic, mercury, and PAHs above Part 375 screening values for commercial uses. Mercury was detected at 41 and 16 mg/Kg in the 16 to 18 ft and 20 to 22 ft depth intervals, respectively. Arsenic was detected in the 16 to 18 ft interval at 55 mg/Kg. Total PAHs were detected at 181 mg/Kg including benzo(a)pyrene at 1.7 mg/Kg, slightly above the Part 375 screening value for commercial uses.
- Adjacent to the Axton Cross Building (SB-3-02, 10 to 12 ft), arsenic, copper, lead and PAHs were detected above Part 375 screening values for commercial uses (Table 5-4). Arsenic, copper, and lead were detected at 17, 653 and 2,860 mg/Kg, respectively. Total PAHs were detected at 81 mg/Kg including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenzo(a,h)anthracene above Part 375 screening values for commercial uses.
- In addition, arsenic was detected above Part 375 screening values for commercial uses at MW-8 (2 to 4 ft and 8 to 10 ft) and SB-16 (8 to 10 ft), TP-10 (4 to 6 ft and 7 to 9 ft), and BMW-2 (10 to 12 ft). At those locations, arsenic concentrations ranged from 27 to 52 mg/Kg.

In subsurface soil samples collected for the SRI, nickel and arsenic were detected at concentrations above Part 375 screening values for commercial uses between Buildings 16 and 15 (MW-15, 10 to 12 ft), at 1,510 and 20 mg/Kg, respectively (Figure 5-2). Further discussion of the SRI results is presented in the SRI Report (O'Brien & Gere 2007).

Additional details of the analytical data for subsurface soil are provided below:

Volatile Organic Compounds

Most of the VOC concentrations were below Part 375 screening values for unrestricted uses, with total VOCs generally less than 1.5 mg/Kg (Table 5-7). However, the detection of total VOCs at 280 mg/Kg in the drywell area of the Axton-Cross Building (MW-9, 10 to 12 ft) is noteworthy. At that location, the detected VOCs consisted primarily of PCE, TCE, and xylene at 140, 49, and 64 mg/Kg,

respectively. Elsewhere on the Main Site, acetone was the most common VOC detected above Part 375 screening values for unrestricted uses with concentrations ranging from 0.007 to 0.32 mg/Kg at three locations consisting of MW-6, MW-7, and MW-10. Other VOCs detected at concentrations slightly above Part 375 screening values for unrestricted uses consisted of vinyl chloride (MW-6, SB-16) and cDCE (SB-16).

Semi-Volatile Organic Compounds

The SVOCs in subsurface soil primarily consisted of PAHs with concentrations ranging from less than 0.1 to 6.2 mg/Kg, which is similar to background levels in surface soil (Table 5-8). The concentrations of PAHs were generally below Part 375 screening values for unrestricted uses, except as discussed above.

Inorganics

In addition to the specific areas with concentrations of inorganics detected above Part 375 screening values for commercial uses, the detection of inorganics in subsurface soil above Part 375 screening values for unrestricted uses was widespread (Table 5-9, Figure 5-2).

Similar to the surface soil results, eight inorganics consisting of cadmium, chromium, copper, lead, mercury, nickel, zinc, and cyanide were detected above Part 375 screening values for unrestricted uses. In addition, arsenic was also detected above Part 375 screening values for unrestricted uses. Mercury, chromium, and nickel were the most prevalent inorganics detected above Part 375 screening levels for unrestricted uses. Soil obtained within the saturated overburden layer below the ground water table from the upper raceway (MW-11, 16 to 18 ft) contained the highest concentrations detected in subsurface soil from the Main Site of antimony, arsenic, mercury, and zinc. The concentrations of these inorganics were 377, 55, 41, and 671 mg/Kg, respectively.

5.4. Ground Water

Field observations are summarized in Section 5.4.1. Analytical data are presented in Sections 5.4.2 through 5.4.4. Detected concentrations in ground water compared to TOGS screening values are presented in Tables 5-10 through 5-16. A summary of constituents detected above TOGS screening values is also presented (Figure 5-3). The analytical results for ground water include separate discussions of shallow and deep ground water data.

5.4.1. Field Observations

During ground water sampling on the Main Site, field observations including color and odor were noted. While purging each well, pH, temperature, conductivity, and turbidity were measured. Temperatures ranged from approximately 8 (December 2002) to approximately 12 (May 2001) degrees Celsius. Field measurements for pH ranged from 6.5 to 7.5 except at MW-12. At that location, the pH was approximately 12.5 and a distinct ammonia-like odor was noted in the soil, which may be the reason for the elevated pH. Conductivity measurements ranged from approximately 0.35 to 2.5 mS/cm with the highest readings detected in BMW-3 and MW-13. In the majority of the wells the turbidity of the ground water remained high during sampling due to the fine-grained material within the soil. Field measurements of DO, salinity, and ORP collected in May 2001 are reported on the field logs (Appendix B).

Field data collected from the monitoring wells is summarized below.

Field Data Collected from Monitoring Wells

Monitoring well	Appearance	Odor	Turbidity (NTU)
MW-6	sheen	sweet odor	>1000
MW-7	sheen	---	---
MW-9	heavy sheen	strong "oil like" odor	>1000
MW-10	---	slight fuel odor	---
MW-11	black	minor oily odor	---
MW-12	---	---	---
MW-13	---	---	---

Notes:
DL = detection limit; ppm = parts per million; --- = no data.

Field data for the investigation of ground water are provided in Appendix B.

5.4.2. Volatile Organic Compounds

Shallow and deep ground water contained VOCs at concentrations above screening values with total VOC concentrations generally ranging from 5 µg/L to 56 µg/L in shallow ground water (Table 5-10) and 5 to 90 µg/L in deep ground water (Table 5-11). However, concentrations of VOCs exceeded these ranges in the vicinity of the Axton-Cross Building and the Building 15/16/17 Area, as summarized below:

- Within the former drywell area south of the Axton-Cross Building (MW-9), the total VOCs were 20,609 µg/L and the primary compounds detected were chlorinated VOCs and BTEX at 10,800 and 8,400 µg/L, respectively. The chlorinated VOCs consisted of primarily PCE and TCE at 7,900, and 2,900 µg/L, respectively. The prominent BTEX compounds were xylene and ethylbenzene
- Next to Building 17 (MW-1), total VOCs were 157 µg/L consisting primarily of chlorinated VOCs.

VOCs were below screening values in shallow ground water collected from the upper raceway (MW-11) and next to the creek in the Building 12 Area (MW-8) (Table 5-10).

The VOC concentrations in deep ground water were variable (Table 5-11). In the former raceway (BMW-2), the total VOCs primarily consisted of BTEX compounds at concentrations below screening values. In deep ground water collected next to the creek (BMW-3), the total VOCs were 90 µg/L and the principle compounds detected were CB and benzene at 34 and 4 µg/L, respectively. In addition, deep ground water sampled on the MGP Site (BMW-1) contained total VOCs at 44 µg/L with chlorinated VOCs at 36 µg/L including cis-1,2-DCE as the principle compound at 26 µg/L. In addition, benzene was present in that well at approximately 3 µg/L (Section 6.4).

VOC TICs were also detected in ground water, as identified in the laboratory reports.

5.4.3. Semivolatile Organic Compounds

Shallow ground water beneath the Main Site contains SVOCs above water quality standards (Table 5-12), but deep ground water was within the standards (Table 5-13).

Shallow Ground Water

In general, total SVOCs in shallow ground water ranged from less than 5 µg/L to 12 µg/L (Table 5-12). However, two wells, one in the vicinity of the Axton-Cross Building (MW-9) and the other in the lower raceway (MW-11), contained total SVOCs over 150 µg/L. Semivolatile organic compounds were detected at concentrations above screening values in five of the wells:

- Axton-Cross Area. In the drywell area south of the Axton-Cross Building (MW-9), the total SVOCs were present in shallow ground at 192 µg/L with the principle compound detected as 1,2-dichlorobenzene (1,2-DCB) at 170 µg/L. Other compounds above screening values consisted of 1,4-DCB and 2,4-dimethylphenol at estimated concentrations of 13 µg/L and 6 µg/L, respectively.

- Former Raceway. In the upper raceway (MW-13) total phenol was detected in shallow ground water at 11 µg/L. In the lower raceway (MW-11), naphthalene was present at 160 µg/L compared to the screening value of 10 µg/L for this compound.

- Building 15/16/17 Area. Next to Building 17 (MW-1), the concentration of 1,2-DCB was 4 µg/L and exceeded the screening value of 3 µg/L in 2001. In 2002, phenol was also detected at 2 µg/L, a concentration twice the 1 µg/L ground water standard for that compound.

- Building 21/22 Area. In shallow ground water next to Building 21 (MW-6), SVOCs were below ground water standards in 2001. In 2002, total PAHs were detected at 12 µg/L. Concentrations of individual PAH compounds ranged from 1 to 3 µg/L. Three PAH compounds exceeded their respective guidance value of 0.002 µg/L.

TICs for SVOCs were identified in laboratory reports.

Deep Ground Water

Deep ground water beneath the former raceway (BMW-2) contained naphthalene at 9 µg/L (Table 5-13). Naphthalene was also present in deep ground water beneath the MGP Site (BMW-1) at 77 µg/L (Section 6.4) compared to the screening value of 10 µg/L. Other SVOCs were not present above screening values in deep ground water.

5.4.4. Inorganics

Inorganic concentrations are summarized in Tables 5-14 and 5-15. Concentrations that exceeded screening values are discussed below. Iron, manganese, and sodium in ground water above water quality standards often occurs naturally due to local geology. Therefore, the occurrence of these elements above ground water standards is not discussed further.

During ground water sampling events completed in 2001 and 2002 for the Site RI, inorganics detected in ground water were generally within water quality standards (Tables 5-14 and 5-15), except for specific areas that are summarized below.

- Axton-Cross Area. Inorganics in the Axton-Cross Area were within the water quality standards (Figure 5-3, Tables 5-14 and 5-15).

- Building 21/22 Area. Arsenic, chromium, and lead were above water quality standards in shallow ground water the loading dock area of Building 21 (MW-10) at concentrations of approximately 2, 3, and 10 times the standards, respectively (Figure 5-3, Tables 5-14 and 5-15).

- Former Raceway. Shallow ground water in each of the wells within the former raceway contained up to 13 metals and cyanide above water quality standards (Figure 5-3, Tables 5-14 and 5-15). The widest range of constituents and highest concentrations were detected in the shallow ground water under the upper raceway (MW-11) including concentrations of antimony, lead, and mercury at over 200 times the standards. The deeper ground water in this area (BMW-2) contained seven inorganics above water quality standards including antimony and mercury concentrations over 25 times the standards.

- Building 15/l6/17 Area. Shallow ground water from between Buildings 15 and 16 (MW-12) contained antimony, arsenic, chromium, and lead concentrations approximately 1.2, 1.2, 1.4, and 3 times the standards, respectively (Figure 5-3, Tables 5-14 and 5-15).

- Building 12 Area. In deep ground water adjacent to the creek (BMW-3), ten inorganics were at concentrations above standards (Figure 5-3, Tables 5-14 and 5-15). Some of the highest concentrations of inorganics were detected, with arsenic, lead, and thallium at concentrations that were over 20 times the water quality standards.

In ground water sampling events completed in 2006 for the SRI, elevated concentrations of inorganics were detected in ground water in the vicinity of the vats (Figure 5-3). The SRI data is discussed further in the SRI Report (O'Brien & Gere 2007c).

Turbidity can influence the concentrations of inorganics detected in ground water. In ground water, higher levels of turbidity tend to be associated with elevated levels of suspended solids and inorganics.

5.5. Lagoon Investigation

Physical features of the lagoon were observed during field reconnaissance activities. The surface area of the lagoon was measured to be approximately 200 ft by 40 ft. A black sediment layer was identified along the mid-section of the Three Star lagoon ranging from approximately 4 to 11.5 ft thick (Figure 5-4) with a consistency like pudding. Water depth along the midsection of the Three Star lagoon ranged from approximately 4 to 7.5 ft. During field activities, inflow and outflow pathways were dry, suggesting the water observed in the Three Star lagoon may be accumulated from intermittent storm water sources. Ground water interaction may also contribute, although water level monitoring of the surface water of the Three Star lagoon indicated only minor fluctuations associated with tide cycling (Section 3.3.1). Field observations of the Three Star lagoon are presented in Appendix C. Tables presenting analytical results of VOC, SVOC, and inorganics analyses of surface

water and sediment samples collected from the Three Star lagoon are presented in Appendix F. Concentrations of constituents detected in surface water and sediment are discussed in separate sections below.

5.5.1. Surface Water

Surface water sampling was completed in the center of the lagoon.
Field and laboratory analytical data are summarized below. Field data were within expected ranges:

Results of field analyses of surface water

Parameter	*Units*	*Result*
pH		6.9
Conductivity	μsem/cm	0.36
Temperature	Deg C	5.8
Dissolved oxygen	mg/L	7.4
Salinity	mg/L	0.1

Source: O'Brien & Gere Engineers, Inc.

Field logs present raw data collected for the surface water investigation of the lagoon (Appendix C).

Laboratory data for the analysis of surface water is discussed below. Surface water concentrations detected in the lagoon were compared to TOGS screening values for Class C waters (Section 2.6.2). The comparison of the surface water data from the lagoon to TOGS screening values intended for the protection of surface water bodies is a conservative approach and does not represent the anticipated uses of the Three Star lagoon.

The concentrations of inorganics detected in surface water of the Three Star lagoon were similar to background levels detected in Wappingers Creek. Aluminum, iron, and silver comprised the inorganics detected at concentrations above the TOGS screening values for surface water quality (Table 5-16). Aluminum and iron were only slightly above the TOGS screening values with aluminum and iron concentrations of 194 and 318 μg/L, respectively, compared to the TOGS screening values for propagation of fish of 100 and 300 μg/L, respectively (Table 5-16). Silver was detected at 1.6 μg/L. The concentration of total silver detected in the surface water of the Three Star lagoon exceeded the TOGS screening value of 0.1 μg/L for propagation of fish exposed to ionic silver. There is uncertainty in the application of the screening value for ionic silver, which is a component of silver concentrations measured analytically as total silver. The concentrations of aluminum, iron, and silver detected in the surface water of the Three Star lagoon were below the maximum background levels detected in Wappingers Lake during a storm event (O'Brien & Gere 2007).

Other constituents were within TOGS screening values or within levels indicative of acceptable water quality:

- Concentrations of VOCs in the surface water of the lagoon were not detected above TOGS screening values (Table 5-16). TCE, at 0.6 μg/L, was the only VOC detected in surface water; this level of TCE is below the TOGS screening value of 5 μg/L for human consumption of surface water.

- SVOCs were not detected in the surface water of the lagoon (Table 5-16).

- Dissolved organic carbon and total suspended solids concentrations were <4.4 and <5.0 mg/L, respectively. Hardness and total alkalinity concentrations were 140 and 110 mg/L, respectively.

5.5.2. Sediment

Detected concentrations in lagoon sediment compared to sediment screening values are presented in Tables 5-17 through 5-19. Comparison of lagoon sediment data to ecological screening values for protection of fish may not be appropriate as the Three Star lagoon does not provide an environment suitable for this use because of its frequent hydraulic isolation from the tidal creek. However, the comparison does provide a benchmark to judge the potential impacts of sediment migration from the Three Star lagoon, should it occur.

Sediment data were evaluated using NYS screening approach with total concentrations of organic compounds adjusted for TOC (Section 2.6.3). TOC data are presented with the summaries of the detected concentrations in sediment (Tables 5-17 through 5-19). Tables presenting sediment data from the lagoon are provided in Appendix F. A brief summary of the detected concentrations in sediment of the lagoon is provided below:

Volatile Organic Compounds

The total VOC concentrations ranged from 0.9 to 273 mg/Kg. Total BTEX concentrations ranged from 0.2 to 143 mg/Kg (Table 5-17). Chlorinated VOCs ranged from 0.5 to 130 mg/Kg. CB, ethylbenzene, xylene, methylene chloride, acetone, and cDCE were detected above the NYSDEC screening values for sediment.

The primary VOCs present consist of xylene and CB with concentrations identified up to 140 and 130 mg/Kg, respectively (Table 5-17). Samples LG-4L (3 to 6 ft interval) and LG-7M (2 to 3 ft interval) contained the highest VOC concentrations, with total VOC concentrations of 240 and 270 mg/Kg, respectively. At LG-7L (3 to 3.5 ft interval), in the northern end of the lagoon, the highest number of VOCs was detected; but the total VOC concentration at that location, 0.9 mg/Kg, was among the lowest detected in the sediment of the Three Star lagoon. VOC TICs were also detected in lagoon sediment, as identified in laboratory reports.

Semivolatile Organic Compounds

The total SVOC and total PAH concentrations ranged from 36 to 227 mg/Kg, and 3 to 88 mg/Kg, respectively (Table 5-18). The maximum concentrations for both total SVOCs and total PAHs were detected at location LG03UP. The primary SVOC detected consists of 1,4-DCB which was detected in each of the seven samples collected above the NYSDEC screening value for sediment. Location LG-4U (0 to 3 ft interval) contained the maximum 1,4-DCB concentration of 51 mg/Kg. Location LG-7L (3 to 3.5 ft interval) contained the largest number of SVOCs detected in excess of sediment screening values. At that location, total SVOC and total PAH concentrations of 71 and 65 mg/Kg, respectively were detected. Several individual PAHs exceeded sediment screening values (Table 5-18). BEHP was also detected above its sediment screening value in four of the seven sediment sampled collected from the Three Star lagoon. Other SVOCs detected above sediment less frequently than the SVOCs discussed above consisted of 1,2-DCB, 1,3-DCB, 2-4-dimethylphenol, and phenol. SVOC TICs were also detected in lagoon sediment, as identified in laboratory reports.

Inorganics

Inorganic concentrations above the severe effect level (SEL) screening value for sediment (Table 5-19) consisted of cadmium, chromium, copper, iron, lead, mercury, nickel, silver, and zinc. Cyanide

was also detected above the screening value of Eisler (1991). The maximum concentrations of these constituents compared to the respective screening values are summarized below:

Maximum concentrations of inorganics compared to screening values .for sediment (mg/Kg).

Inorganic Analyte	***Screening Value***	***Max. Conc***
Cadmium	9.0 S	122
Chromium	110 S	26,300
Copper	110 S	10,600
Iron	4%	4.6%
Lead	110 S	9,650
Mercury	1.3 S	54
Nickel	50 S	3,890
Silver	2.2	2.9
Zinc	270 S	3,710
Cyanide	0.1 E	69

References:
S = Severe effect level (Long & Morgan 1990; Persuad 1992)
E = Eisler (1991)

Source: O'Brien & Gere Engineers, Inc.

Pesticides/PCBs

Pesticides were detected in one of two samples analyzed for pesticides/PCBs. The levels of DDT, Endosulfan II, Heptachlor epoxide, and chlordane were above sediment screening values (Table 5-20). PCBs were not detected in either of the two samples (Appendix F).

TCLP

Results of TCLP analysis of a lagoon sediment sample LG03 MID (1.5 to 3.0 ft interval, Table 5-21) did not identify concentrations above those that would characterize the sediment as hazardous waste as defined by 6 NYCRR Part 371 and 40 CFR Part 261.

Particle Size Distribution and Bulk Density

The sediment collected from the Three Star lagoon consists of primarily sand making up approximately 50 to 60% of the sediment by weight (Appendix C). The upper layer of sediment also contained silt and gravel consisting of approximately 40% and 10% of the sediment, respectively. The lower layer of sediment contained roughly equal portions of silt and gravel. The dry and wet bulk densities in upper sediment were approximately 20% and 70%, respectively (Appendix C).

5.6. Exposure Assessment

Risk assessment activities completed for the RI consisted of an Exposure Pathway Analysis describing potential human contact with site media (Section 5.6.1, Appendix H) and a Fish and Wildlife Impact Analysis describing potential wildlife contact with site media (Section 5.6.2, Appendix E).

5.6.1. Exposure Pathway Analysis

A qualitative exposure pathway analysis was performed to evaluate the potential for human contact with site constituents (Appendix H). Surface soil contact and inhalation of ambient and indoor air are the most likely exposure routes.

For the most part, contact with surface soils or inhalation of ambient air is expected to be similar to background levels which represent a low level risk. Most of the Main Site is occupied by buildings, ruins of buildings, or covered by pavement or gravel parking areas preventing contact with surface soil. In general, the concentrations of constituents in surface soil were similar to local background levels, except in specific areas of the site. Those specific areas, such as the former raceway, represent areas of higher potential for exposures, if they are accessed. The debris left from the fire of May 2004 may increase the potential exposure to contaminated surface materials.

The highest potential for exposure to site constituents present in subsurface media is through inhalation of indoor air that contains VOCs. VOCs can be pulled into buildings by the buildings ventilation system. Long-term exposures to VOCs in indoor air may be a health concern for workers or possible future residents of buildings on the site. The Three Star Site is downgradient from other areas of the village and is therefore not expected to affect off-site properties. Interior surfaces of existing buildings may also contain industrial residuals, if they have not been properly cleaned. Cleaning of interior surfaces can reduce that potential pathway. Subsurface excavations can provide a pathway for construction/utility workers to contact site constituents. Protective measures (*e.g.* protective clothing and gloves) can be used to reduce potential contact of these workers.

The primary pathways for potential exposure to site constituents in the Three Star lagoon and the tidal creek are from ingestion of or dermal contact with sediment. Sediment of the lagoon and the tidal creek contain elevated levels of PAHs and inorganics. Surface water was similar to background levels detected in Wappingers Lake, upstream of the Three Star Site.

5.6.2. Fish and Wildlife Impact Analysis

The FWIA was completed through Step IIC which is a screening level ecological risk assessment (Appendix E). The screening level risk assessment evaluates potential exposure to surface soil, and lagoon sediment and surface water using ecological screening values. Ecological screening considers representative wildlife species that may be present compared to conservative screening values. Representative wildlife species considered in the ecological assessment consisted of the American robin and the short tailed shrew to evaluate soil contact and the great blue heron and the mink to evaluate contact with the lagoon. The results of the ecological screening indicate that inorganics represent the most common constituent of potential ecological concern (COPEC) among the representative wildlife species (Appendix E). PAHs and PCBs (Aroclor 1260) were also indicated as COPEC, however the occurrence of those constituents on the Main Site is limited (Appendix E). For the most part, the Main Site consists of buildings and paved parking areas and represents poor quality habitat that is not expected to be particularly attractive to wildlife.

5.7. Discussion

The discussion provided below focuses on the isolation and characterization of the source areas at the site. Initially, ground water data was used to identify overall spatial patterns of constituents and locate areas for in-depth evaluation of site soil and lagoon sediment data. These data provide further

detail to support the evaluation of potential source areas that may be contributing to the ground water conditions that were observed. Source identification was aided by an interpretation of possible relationships between organic compounds and their fate in the environment. Evaluation of the vertical extent of constituents in soils and ground water flow direction were used to support the inferences of source migration pathways drawn from the data.

The data suggests that there are at least four different classes of organic compounds in site subsurface media consisting of PCE, TCA, DCB and BTEX. These four unrelated compounds or classes of compounds that were identified as constituents in ground water and site soils represent different sources (Section 1.3.1). The discussion of potential source areas that follows focuses the evaluation of VOC sources by interpreting spatial trends of parent compounds as compound groups.

In general, the analytical data suggest that the drywell and former drum storage area south of the Axton-Cross Building is the primary source for organic compounds and that the former raceway appears to be the primary source area for inorganics. In addition, several other relatively minor sources of organic compounds were also detected on the Three Star Site. The Axton-Cross Area and former raceway are discussed below as the primary source areas. Following their discussion, the other VOC sources detected at the Three Star Site are discussed.

Axton-Cross Area

The data indicates that potential sources consist of the dry well and former drum storage area located south of the building, and the suspected drain holes on the west side of the building. Specifically, VOCs associated with PCE, DCB, and BTEX were found to be present in both the ground water and the soil in the vicinity of the dry well. Elevated concentrations of chromium, copper and mercury were present in shallow soil in this area as well. The vertical extent of the impacts appear to be limited to a maximum of between 12 and 16 ft below grade as the sample of soil collected from the 16 to 18 ft interval did not contain concentrations that were significantly elevated.

Although ground water samples were not collected from the west side of the building in the vicinity of suspected drain holes, soil data indicate the presence of elevated concentrations of chlorinated VOCs (predominantly PCE) within the shallow soil in this area as well as nickel, chromium, copper and mercury. Lead was also found to be elevated at depth (10 to 12 ft) within the soil on this side of the building. The proximity of this area to the lagoon suggests the potential for migration of these constituents via surface runoff and ground water to this surface water body.

Former Raceway

In general, VOCs were not detected at significant concentrations within the ground water and soil within the raceway, with the exception of naphthalene. Naphthalene was detected at 160 μg/L in shallow ground water at MW-11 located in the upper raceway. Several PAHs and naphthalene were detected in the soil from this area as well. Naphthalene was not detected in significant concentrations in ground water in other areas of the Main Site, which suggests that there may have been some discharge of these materials to the former raceway.

Inorganics were detected to be at significant concentrations in the shallow and deep ground water beneath the former raceway. A total of 13 metals and cyanide were analyzed for during the program. Each of these constituents were identified at concentrations above the water quality standard in the shallow ground water at well MW-11 and nine were detected in ground water at MW-13 located on the upper raceway. In addition, seven of these constituents were identified in the deep ground water. This suggests that there was discharge of inorganics to the subsurface soil.

In soil samples analyzed from the deep soil boring located in the former raceway (BMW-2) concentrations of inorganics were not significantly elevated at depths of 22 ft and below that were sampled. However, surface soil sample SS-1 collected from the lower raceway contained a number of elevated concentrations of inorganics, particularly cadmium, chromium, copper, lead, mercury, nickel and zinc. Subsurface soils collected between 4 and 22 ft (MW-11 and BMW-2) also contained elevated levels of inorganics. These data indicate that inorganics were discharged to the raceway area. It is not clear, however, whether the material was discharged in soluble form or if a layer of sludge or other material is present within the former raceway that continues to be a source to ground water.

It should be noted that the deep ground water from well BMW-3 located along the creek to the northeast of BMW-2 also contained elevated concentrations of arsenic, chromium, copper, lead, nickel and thallium. It is not clear from the data whether the presence of these constituents are directly related to those detected beneath the former raceway, or, as discussed in the SRI Report (O'Brien & Gere 20007c), the vats. However, metals were not detected in any significant concentration in shallow groundwater in other areas of the Main Site. Therefore, another potential source has not been identified. The mechanism for the vertical migration of inorganics to the deep ground water is not known and it may not be currently active.

Building 15/16/17 Area.

The SRI (O'Brien & Gere 2007) identified the vats as a potential source of metals (primarily zinc, copper, and chromium) and phthalates as contaminants associated with vat liquids and sludge. The detection of elevated levels of metals in ground water downgradient of the vats after the vats were exposed to the environment following the fire of 2004 suggests that the vats have leaked. However, the elevated metals were generally associated with turbidity and particulate matter which may limit their potential for migration. Although metals may be concentrated in soil under the vats, soil under the vats was not sampled due to complicated access. Other inorganics, total phenol, and acetone were detected in vat liquids at lower concentrations relative to the primary constituents cited above (O'Brien & Gere 2007).

In addition, the Building 15/16/17 Area may contain two sources of VOCs in ground water that appear to be approximately one to two orders of magnitude lower in concentration compared to the source identified in the Axton-Cross Area. One source appears to be located in front of Building 17 where relatively low concentrations of PCE and related compounds were detected. The VOC with the highest concentrations in ground water from this location was TCE. The soil at this location also contained TCE at 1.6 mg/Kg. This suggests that a source of material may be present in the area, although the ground water data does not suggest that it is concentrated.

The other potential VOC source in this area (which contained PCE, TCE, and TCA) was detected in shallow ground water located between Buildings 15 and 16. In soils, the highest concentrations of TCA and DCA were found in surface and shallow soil up to depths of 6 ft. The TCA and DCA concentrations were not observed to be substantial in other areas of the site suggesting the presence of a separate source in this area. The concentrations detected in soil did not provide evidence of a concentrated source area. Past discharge of facility wastes to surface soils reportedly occurred in this area.

For both of these locations in the Building 15/16/17 Area, the waste management practices of the facility are not known and in addition to surface discharges, concentrated source areas such as a drywell may be present that may have impacted ground water.

Other Areas of the Three Star Site

In the Building 12 Area, no constituents were identified at concentrations that would be suggestive of a separate source of contaminants in this area of the site.

In the Building 21/22 Area. VOCs were detected in the ground water of wells in front of Buildings 21 and 22 at concentrations that were relatively low compared to those detected in other areas of the Three Star Site. This suggests that a concentrated source is not present in the immediate area of these wells. Xylene was the only elevated constituent (40 μg/L) detected in MW-10 located at the loading dock on the northwest corner of Building 21. This presence of this compound differs from patterns of occurrence detected in the ground water elsewhere on site and therefore, the data suggest that there may have been a source of xylene such as the AST located in the loading dock, although the source does not appear to be significant.

6. MGP Site Investigation Results

6.1. Overview

A description of physical features observed on the MGP Site and the associated samples collected for the RI are presented in Table 2-4. The locations of samples collected from the MGP Site are identified on the site maps (Figures 2-1 and 2-2). The primary features of the MGP Site that were observed during field activities are summarized below, along with the associated sample locations shown in parentheses:

- Soil was evaluated in the vicinity of two former MGP gas holders located on the site (SB-3-01 and SB-4-01).
- Soil was evaluated in the vicinity of debris and fill material observed between the gas holders and the tidal creek (TP-3, TP-4, SS-MGP3, and SS-MGP4).
- Soil and ground water were evaluated in a filled area adjacent to the tidal creek (MW-4, MW-5, and BMW-1), north of the former gas holders.
- Soil and ground water were evaluated in the area between the gas holders and the lagoon (TP-1, TP-2, and MW-3).
- During subsurface soil investigation, a 2-inch diameter pipe was observed between the former MGP gas holder (near SB-3-01) and the lagoon.

The Three Star lagoon and its drainage channel to the tidal creek border the MGP Site to the east, and the tidal creek borders the MGP Site to the north and west. Residential properties border the MGP Site to the south.

Results of the investigation of the MGP Site are presented in three sections:

- Surface and shallow soil data are presented in Section 6.2.
- Subsurface soil data are presented in Section 6.3.
- Ground water data are presented in Section 6.4.

The discussions of results of analyses for VOCs, SVOCs, inorganics and supplemental parameters for each of the media presented in Sections 6.2 through 6.4 are based on comparison to screening values, as discussed previously in Section 2.6. Screening level exposure assessments completed for the MGP Site are summarized in Section 6.5. A discussion of site data of the RI for the MGP Site is provided in Section 6.6.

In addition to the analyses cited above, pesticides and PCBs were analyzed in a subset of ground water and soil samples (Table 5-4). DDT was detected above Part 375 screening values for unrestricted uses (SS-13 and SS-14), up to 0.02 mg/Kg, in both surface soil samples that were analyzed. The concentrations of other pesticides and PCBs in soil were generally below screening values with occasional detections of pesticides (other DDT compounds, Dieldrin, and Endrin) and one detection of PCBs (Aroclor 1260) above the screening values for unrestricted uses (Table 5-4). The PCBs were detected at 0.2 mg/Kg in surface soil collected from the area adjacent to the creek (SS-13). The detection of pesticides and PCBs in soil was below the Part 375 screening values for commercial uses. Neither pesticides nor PCBs were detected in ground water samples collected from

the MGP Site (Appendix F). The occurrence of these constituents was similar to that of the Main Site (Section 5.1) and did not suggest that the Three Star Site was a source for these compounds. Subsequent evaluation was focused on constituents that were identified to be related to the MGP Site.

6.2. Surface and Shallow Soil

Nine surface soil locations were sampled from the MGP Site (Figure 2-1). At each location, soil from the 0- to 2-ft interval below grade was observed and geological descriptions were recorded in field logs (Appendix A). Samples SS-13 and SS-14 were collected from the 0- to 2-inch interval near monitoring wells MW-4 and MW-5 where visual contamination was identified in subsurface soil (Section 6.3). The surface soil samples with the prefix "SS-MGP-" were collected from the 0- to 2-inch and 0- to 24-inch depth intervals. Shallow soil samples were also collected from two test pits TP-4 (0.5- to 2.5- foot interval) and TP-12 (0- to 2-foot interval). The shallow soil generally consisted of brown, coarse to fine sand, with variable amounts of medium to fine gravel and silt, and trace amounts of brick and cinder fragments.

In general, analytical data indicated that PAHs were the primary constituents detected in surface soil and inorganics were also detected. The PAH concentrations were frequently above Part 375 screening values for commercial uses. Inorganics were detected at concentrations generally below Part 375 screening values for commercial uses, although concentrations were frequently above Part 375 screening values for unrestricted uses. The highest concentrations of both PAHs and inorganics were located adjacent to the creek.

The discussion of surface soil data includes results of shallow soil sampling in the test pits. In addition, test pit results are presented in Section 6.3.2. As noted above, results of analyses for pesticides and PCBs that were screened out as site constituents are presented in Appendix F. The detections of VOCs, PAHs and inorganics are discussed further below.

Volatile Organic Compounds

Trace levels of VOCs detected in surface soil samples, consisting of benzene, PCE, toluene, methylene chloride, were below Part 375 screening values and were screened out from further evaluation (Appendix F).

Semivolatile Organic Compounds

The SVOCs detected in surface soil above Part 375 screening values consisted of PAHs (Figure 5-1, Table 6-1). The detections of PAHs included five compounds above Part 375 screening values for commercial uses:

PAH Compound	*Range (mg/Kg)*
Benzo(a)anthracene	0.060 J - 79
Benzo(a)pyrene	0.056 J - 87
Benzo(b)fluoranthene	0.19 J – 100
Dibenzo(a,h)anthracene	0.069 J - 18
Indeno(1,2,3-cd)pyrene	0.049 J - 53

SVOC TICs were also detected as identified in laboratory reports.

Inorganics

Inorganics were present above Part 375 screening values for unrestricted uses in each of the areas sampled from the MGP Site (Table 6-2, Figure 5-1). However, the highest concentrations were generally located along the west portion of the site (SS-MGP-1 and SS-MGP-2) and adjacent to the tidal creek (SS-13, SS-14, and SS-MGP-7). Samples from two locations contained inorganics above Part 375 screening values for commercial uses (Figure 5-1):

- At SS-MGP1, lead was detected at 1160 mg/Kg in surface soil and arsenic was detected at 37 mg/Kg in shallow soil (0 to 2 ft).

- At SS-14, copper was detected at 441 mg/Kg in surface soil.

6.3. Subsurface Soil

6.31. Soil Borings and Wells

During the installation of monitoring wells and soil borings on the MGP Site, soil samples were visually inspected, logged, and screened in the field using a handheld PID (Appendix A). Details of the soil encountered are presented in Table 6-3. To summarize the observations, odors characteristic of naphthalene were present in the soil borings completed on the MGP Site, except in those located between the gas holders and the lagoon (MW-2 and MW-3). Soil encountered in that area did not exhibit evidence of fill material or contamination.

The soil borings that exhibited naphthalene odor were completed in the former gas holders and the filled area adjacent to the tidal creek. Headspace screening of soil from each of the borings advanced in these areas resulted in PID readings above background. The bottom of the gas holders (SB-3-01 and SB-4-01) were encountered at approximate depths of 6.5 ft and 9.2 ft below grade based on the appearance of native material at those levels. Gas holders typically had concrete bottoms or used the top of the water table as the base to retain the gas. It appears that these gas holders were constructed using the latter approach. No coal tar sludge was observed at the apparent bottoms of the gas holders although PID readings up to 27 ppm were obtained from SB-4-01 in the 8 to 10 ft depth interval. The borings adjacent to the tidal creek (MW-4 and BMW-1) contained globules of free product in subsurface soil. PID readings up to 108 ppm were detected in soil from MW-4 in the 14 to 16 ft interval. The subsurface materials in that area (MW-4) consisted of soil with bricks and glass observed at approximately 8 ft bgs suggesting that soil in the area was filled.

6.3.2. Test Pits

A total of eight shallow test pits were completed in the MGP Site (Figure 2-2). Four of the test pits, identified as TP-1, TP-2, TP-3, and TP-4 were completed in the general vicinity of the former gas holders. The remaining four test pits, TP-5, TP-6, TP-11, and TP-12 were completed northwest of the gas holders to characterize the spatial distribution of fill material in this area. Test pits TP-11 and TP-12 were completed in an area where several empty five-gallon drums are exposed at the ground surface.

In general, test pits completed in the MGP Site did not demonstrate evidence of contamination. No atypical odors were noted and no measurable readings were by the PID. Soil samples were selected for laboratory analysis based field observation in the head space, on the overburden stratigraphy encountered at each test pit location, and the degree of saturation. A total of nine soil samples were collected and submitted for laboratory analysis from test pits completed in the MGP Site. In addition, one sample of cinders was collected for analysis from test pit TP-04.

6.3.3. Subsurface Soil Analytical Data

Subsurface soil data for the MGP Site are provided in Tables 6-4 through 6-6. Data for the deep soil boring on the MGP Site (BMW-1) are presented in Tables 5-7c, 5-8c, and 5-9c. Detected concentrations in subsurface soil above Part 375 screening values for unrestricted uses are presented in Figure 5-2. TOC concentrations in MGP Site subsurface soil ranged from less than 0.1 to 11%. TOC data are presented in each of the tables summarizing the other constituents analyzed.

In six of thirteen locations sampled, constituents were below Part 375 screening values for unrestricted uses, except the detection of zinc in TP-02 at a concentration similar to the Part 375 screening value. In soil collected from another six locations sampled, PAHs were detected above Part 375 screening values for commercial uses. In general, the highest levels and widest range of contaminants in subsurface soil were detected in five locations sampled from two areas:

- In the south gas holder (SB-04-01, 6 to 8 ft deep), the analytical results included PAHs and lead detected at concentrations above Part 375 screening values for commercial uses. In that depth interval, the concentration of total PAHs and lead were 2,261 and 1,750 mg/Kg, respectively.
- In the area adjacent to the creek (MW-4, MW-5, BMW-1, TP-05), PAHs were detected at concentrations above Part 375 screening values for commercial uses, with concentrations of total PAHs up to 1,448 mg/Kg detected (MW-5, 2 to 4 ft). In addition, mercury, arsenic, and cadmium were detected at MW-4 (14 to 16 ft) above Part 375 screening values for commercial uses, at 249, 39, and 18 mg/Kg, respectively. The detection of mercury at MW-4 included 6.7 and 16 mg/Kg detected above (12 to 14 ft) and below (18 to 20 ft) that depth interval, respectively. In addition, at MW-5 (12 to 14 ft), mercury was also detected at 3.7 mg/Kg, above the Part 375 screening value for commercial uses

As expected, PAHs were associated with fill containing cinders. In a sample of the cinders (TP-04, cinders), total PAHs were detected at 1,670 mg/Kg and PAHs exceeded Part 375 screening values for commercial uses.

Additional details of the analytical results for subsurface soil are provided below. Most of constituents detected above Part 375 screening values were associated with the features discussed above.

Volatile Organic Compounds

VOCs were not detected above Part 375 screening values for unrestricted uses, except in soil collected from the south gas holder and the area adjacent to the creek (Figure 5-2, Table 6-4):

- In the south gas holder (SB-4-01, 10 to 12 ft), benzene, xylene, and acetone were detected at 0.16, 0.37, and 0.11 mg/Kg, respectively.
- Adjacent to the creek (BMW-1, MW-4), benzene was detected at concentrations up to 0.27 mg/Kg (BMW-1, 28 to 30 ft). In addition, xylene was detected at 3.1 mg/Kg (BMW-1, 28 to 30 ft) and acetone was detected at 0.094 mg/Kg (MW-5, 14 to 16 ft). VOCs were below Part 375 screening values for unrestricted uses in a deep sample of soil collected from the 38 to 40 ft interval at BMW-1.

VOC TICs were also detected, as identified in laboratory reports.

Semivolatile Organic Compounds
As discussed above, detected SVOCs, primarily PAHs, were generally associated with the south gas holder and area adjacent to the creek, including concentrations detected above Part 375 screening values for commercial uses. In addition, phenol and dibenzofuran were also associated with the south gas holder and area adjacent to the creek, with concentrations detected above Part 375 screening values for unrestricted uses (Figure 5-2, Table 6-5):

- In the south former gas holder (SB-4-01), DBF up to 15 mg/Kg (6 to 8 ft) and phenol up to 0.9 mg/Kg ((10 to 12 ft) were detected.
- Adjacent to the creek, DBF up to 54 mg/Kg (MW-4, 14 to 16 ft) was detected. The PAHs detected in that sample included the maximum concentration of naphthalene, 290 mg/Kg, detected on the MGP Site.

SVOC TICs were also detected, as identified in laboratory reports.

Inorganics
Inorganics were generally associated with the south gas holder and the area adjacent to the creek where the highest concentrations and widest range of inorganics were detected on the MGP Site (Figure 5-2 and Table 6-6). In addition to the detection of mercury, arsenic, cadmium, and lead above Part 375 screening values for commercial uses discussed above, these metals and chromium, copper, nickel, and zinc were detected above Part 375 screening values for unrestricted uses. Antimony was also detected above its reference value.

Non-Aqueous Phase Liquid
Non-Aqueous Phase Liquid (NAPL) was observed in the deep boring adjacent to the tidal creek (BMW-1) at depths of 26 to 36 ft.

6.4. Ground Water

Tables presenting ground water data are provided in Appendix F. Detected concentrations in shallow ground water compared to TOGS screening values are presented in Tables 6-7 through 6-9. Detected concentrations in deep ground water at BMW-1 compared to TOGS screening values are presented in Tables 5-11, 5-13, and 5-15. Concentrations detected in ground water above TOGS screening values are presented in Figure 5-3. A brief summary of the detected concentrations in ground water is provided below.

6.4.1. Field Observations
During ground water sampling on the MGP Site, field observations including color and odor were noted. While purging each well, pH, temperature, conductivity and turbidity were measured. Temperatures ranged from approximately 8 (December 2002) to approximately 12 degrees (May 2001) Celsius. Field measurements for pH ranged from 7 to 7.5. Conductivity measurements ranged from approximately 0.5 to 0.75 mS/cm with the highest readings in BMW-1. In each of the wells the turbidity of the ground water remained high during sampling due to the fine-grained nature of the soil. Field measurements of DO, salinity, and ORP collected in May 2001 are reported on the field logs (Appendix B).

Purge water from MW-4 and MW-5 appeared grayish brown to black. During the first round of sampling, a sheen and a mothball (naphthalene) odor was noticeable. During the second round of

sampling no sheen or odor was noted. No noticeable odors or contamination were noted for the other wells on the MGP Site.

6.4.2. Volatile Organic Compound Data

Shallow ground water

Total VOC concentrations in shallow ground water ranged from 1 to 160 μg/L (Table 6-7). VOCs detected in ground water above TOGS screening values consisted of benzene, TCE, cis-1,2-DCE, and vinyl chloride (Table 6-7):

- Benzene was detected in shallow ground water adjacent to the tidal creek (MW-4), at up to 3 μg/L.
- TCE was detected in shallow ground water from the south portion of the site (MW-2) at up to 17 μg/L.
- Cis-1,2-DCE was detected in shallow water from the south portion of the site (MW-2) and adjacent to the lagoon (MW-3) at up to 110 and 16 u/L, respectively.
- Vinyl chloride was also detected in shallow ground water from MW-2, MW-3 and MW-4 at concentrations of up to 24, 8 and 8 μg/L, respectively.

Methylene chloride in ground water samples, detected below the TOGS screening value, may be related to laboratory contamination (Potak 2001, 2003), although anthropogenic sources can not be ruled out. Other than methylene chloride, no other VOCs were detected in MW-5.

VOCs TICs were also detected, as identified in laboratory reports.

Deep Ground Water

VOC concentrations were below TOGS screening values in deep ground water adjacent to the tidal creek (BMW-1), except for benzene which was detected at 3 μg/L and cis-1,2-DCE, which was detected at 26 μg/L (Table 5-11).

Wells were not screened in the NAPL zone.

6.4.3. Semivolatile Organic Compound Data

Shallow Ground Water

SVOCs were not detected in shallow ground water samples collected from two of the four wells (MW-2 and MW-3) on the MGP Site (Table 6-8). PAHs were detected in shallow ground water sampled adjacent to the tidal creek (MW-4 and MW-5) at concentrations above TOGS guidance values with total PAH concentrations up to 188 μg/L detected (Table 6-8). Levels of other SVOCs detected in ground water at MW-4 and MW-5 were below TOGS screening values.

Deep Ground Water

In deep ground water adjacent to the tidal creek (BMW-1), naphthalene was detected at 77 μg/L (Table 5-13), above the TOGS screening value of 10 μg/L.

TICs for SVOCs were detected in ground water, as identified in laboratory reports.

6.4.4. Inorganics Data

Shallow Ground Water
Inorganics detected above TOGS screening values generally consisted of elements that are commonly related to local geologic conditions (iron, magnesium, manganese, and sodium), except antimony (Table 6-9). Antimony was detected in shallow ground water from a single monitoring well located adjacent to the tidal creek (MW-4), at a concentration approximately five times the TOGS screening value.

Deep Ground Water
In deep ground water adjacent to the tidal creek (BMW-1), several inorganics were above TOGS screening values (Table 5-15):

- Thallium and lead were detected at approximately eight times higher than the TOGS screening values.
- Arsenic and chromium were detected at approximately four times the TOGS screening values.
- Beryllium, copper, and nickel were approximately three, three, and two times their respective TOGS screening values.
- Mercury was slightly above its TOGS screening value.

Concentrations of iron, manganese, magnesium, and sodium were also above TOGS screening values, but the presence of these elements may be attributed to local geologic conditions. Therefore, these constituents were not evaluated further.

Turbidity can influence the concentrations of inorganics detected in ground water. In ground water, higher levels of turbidity tend to be associated with elevated levels of suspended solids and inorganics.

6.5. Exposure Assessment

6.5.1. Exposure Pathway Analysis
A qualitative exposure pathway analysis was performed to evaluate the potential for human contact with site constituents (Appendix H).

The MGP Site is currently undeveloped which limits expected uses of the area by humans. Anticipated current uses that were evaluated consist of trespassers and site workers (although the MGP Site did not appear to be maintained). The potentially complete exposure pathways for current uses are summarized below:

- Ingestion and dermal contact of surface soil by adult, adolescent, and child trespassers, and adult site workers.
- Inhalation of ambient air by adult, adolescent, and child trespassers and adult site workers.
- Ingestion and dermal contact of subsurface soil by adult site worker.
- Inhalation of outdoor air by adult site worker during trenching/excavation activities.

Future development of the site could result in additional human uses of the MGP Site such as commercial site workers, recreators, or residents. The potentially complete exposure pathways for these potential future uses are summarized below:

- Ingestion and dermal contact of surface soil by adult, adolescent, and child trespasser; adult site worker; adult commercial worker; adult, adolescent, and child recreator; and adult, adolescent, and child residents.
- Inhalation of ambient air by adult, adolescent, and child trespasser; adult site worker; adult commercial worker; and adult, adolescent, and child recreator; and adult, adolescent, and child residents.
- Ingestion and dermal contact of subsurface soil by adult site worker.
- Inhalation of outdoor air (trenches/excavations) by adult site worker.
- Inhalation of indoor air (vapor intrusion) by adult site worker, adult commercial worker, and adult, adolescent, and child residents.
- Ingestion, dermal contact, and air inhalation related to the interior space of new/existing buildings for future uses by adult site worker; adult, adolescent, and child recreator; and adult, adolescent, and child resident.

6.5.2. Fish and Wildlife Impact Analysis

The FWIA was completed through Step IIC which is a screening level ecological risk assessment (Appendix E). The screening level risk assessment evaluates potential exposure to surface soil on the MGP Site using ecological screening values. Ecological screening considers representative wildlife species that may be present compared to conservative screening values. For the most part, the MGP Site consists of vegetated areas with trees, shrubs, and grasses that may be suitable for wildlife habitat. Ruins of gas holders are also present along with an area with various debris (Section 1.1.2). Results of the screening level risk assessment indicate that the area provides a limited area for wildlife habitat. The results of the ecological screening indicate that inorganics and PAHs represent the most common COPEC among the representative wildlife species (Appendix E). In addition, PCBs (Aroclor 1260) were also indicated as COPEC, however the occurrence of PCBs appears limited (Appendix E). Pesticides were also identified as COPEC.

6.6. Discussion

Similar to findings for the Main Site (Section 5), concentrations detected on the MGP Site do not suggest widespread contamination. In general, areas within the MGP Site contain ground water with VOCs consisting of benzene, TCE, cDCE, and vinyl chloride above screening values. While benzene is commonly associated with MGP operations, it is noteworthy that chlorinated organic compounds such as TCE and vinyl chloride are not. The presence of these compounds in ground water may be associated with fill materials placed on the MGP Site or migration from contamination from the Main Site (MW-9).

VOCs have migrated to the deeper portion below the site, with benzene at 3 µg/L detected in deep ground water adjacent to the creek (BMW-1), above the water quality screening concentration. This migration is also reflected by the observation of separate phase globules in deeper borings in that area associated with MW-4, MW-5, and BMW-1. The area in the vicinity of these wells appeared to be filled. The elevated levels of PAHs and separate phase material suggest the presence of MGP wastes in this area. It is unclear whether NAPL is mobile as a free-phase liquid.

Inorganic concentrations in ground water included iron, magnesium, manganese, and sodium above background reference values. The occurrence of these inorganic concentrations may be natural. Antimony was detected above the TOGS screening value in shallow ground water collected from adjacent to the creek (MW-4). Otherwise, inorganics that were detected in shallow ground water under the Main Site were not detected in shallow ground water under the MGP Site. However, inorganics were detected in deep ground water under the MGP Site (BMW-1), similar to results for the Main Site. As discussed previously (Section 5.7), the mechanism for the vertical migration of metals to deep ground water is not known.

Localized areas of impacted soil were identified. Evaluation of the site soils is complicated by the past filling and the possible use of the MGP Site as a disposal area for industrial wastes from operations that occurred on the Main Site. The PAH levels detected in soil on the MGP Site were frequently above the Part 375 screening values for commercial uses. At MW-2 and MW-3, neither PAHs nor inorganics were detected in shallow ground water above screening levels. These wells are generally up-gradient of the MGP Site, but down-gradient of areas on the Main Site.

Over the years, random dumping has occurred on the MGP Site, west of the former MGP gas holders (Figure 2-1). Observations during the field program indicated the presence of rusted containers, drums, and other debris. These types of materials may result in a release.

7. Summary

A Remedial Investigation of the Three Star Anodizing Site (Three Star Site, Site #314058) was completed by O'Brien & Gere Engineers, Inc. (O'Brien & Gere) on behalf of the New York State Department of Environmental Conservation (NYSDEC). The "Site RI" identified historic operations on the Three Star Site that is located on the south portion of the Market Street Industrial Park on McKinley Street in the Village of Wappingers Falls. During the original site development activities approximately 9 to 11 ft of material that included coal cinders were used to fill the Three Star Site. The area occupied by the Market Street Industrial Park has been the site of industrial/commercial operations since the 1830s.

The Three Star Site was originally developed as a cloth dye manufacturing facility called the Dutchess Bleachery. During the operation of the Dutchess Bleachery, the facility also manufactured ammunition, leather products, and felt hats. Other activities included plastic mold injection. A portion of the Three Star Site was used for the operation of a manufactured gas plant (MGP) over the period of the 1830s to approximately 1913. The Three Star Anodizing Company also operated a metal plating facility at the Three Star Site from the late 1950s to 1995. During operation of the Dutchess Bleachery, hydropower was used at the facility. An inactive raceway borders the property to the south (former raceway) and drains from east to toward a former industrial lagoon (Three Star lagoon). The Three Star lagoon then drains north toward Wappingers Creek bordering the Three Star Site to the north and west.

Current uses of the Three Star Site include a warehouse and an area used for storage of tractor trailers. A fire in May 2004 destroyed three of the buildings at the Three Star Site. The area affected by the fire contains ruins of three buildings and debris associated with the fire. Twenty-three former metal plating vats that were contained in one of the buildings are exposed to the environment. Five buildings presently occupy the Three Star Site.

For the *Site RI*, the Three Star Site was conceptually subdivided into two areas, the *Main Site* and *MGP Site* that are separated by the Three Star lagoon. The Main Site is located on the east portion of the Three Star Site and contains buildings formerly associated with industrial activities and includes the Three Star lagoon. The MGP Site is located on the west portion of the Three Star Site and contains the ruins of gas holders that were associated with the MGP operations and undeveloped areas that include miscellaneous debris and fill. Wappingers Creek is located adjacent to the Three Star Site to the north. The potential impacts of the Three Star Site to Wappingers Creek were evaluated separately from the Three Star Site in the *Creek RI Report* (O'Brien & Gere 2007b). Contaminant sources, potential migration pathways, potential exposure pathways identified on the Three Star Site are summarized below.

7.1. Contaminant Sources and Extent

The results of the Site RI indicated that concentrations of VOCs, PAHs, and inorganics detected in site media do not suggest wide-spread contamination that would potentially impact the surrounding community. However, the Site RI identified four focused source areas associated with specific features of the Main Site and consisting of the lower raceway, the Three Star lagoon, media in the vicinity of a drywell and former drum storage area, and exposed soil along the creek bank. A Supplemental Remedial Investigation (SRI) of the vats on the Main Site also identified the exposed former metal plating vats (the vats) as a newly exposed potential source. The results of the SRI are

reported separately in the *SRI Report* (O'Brien & Gere 2007). These five primary sources identified at the Three Star Site are discussed below. Four other comparatively minor sources that were identified are also summarized subsequently.

- The lower raceway is a source of mercury, naphthalene, and a wide range of other inorganics. The levels of mercury, naphthalene, and cyanide in ground water distinguish this source from other sources detected on the Three Star Site. Surface soil from this area also contains a wide range of inorganics at elevated levels including the highest concentrations of mercury and cyanide detected at the Three Star Site. Elevated concentrations of inorganics detected in surface and subsurface soil, and shallow and deep ground water suggest that this structure is a pathway for potential off-site migration. In addition, the surface soil concentrations may represent an exposure pathway for small animals.

- The Three Star lagoon has been impacted by an unknown CB source. The presence of TCE in the surface water of the Three Star lagoon and the sediment at the confluence of the Three Star lagoon with Wappingers Creek provides evidence that off-site migration of chlorinated VOCs from site source(s) may be occurring. The sediment in the Three Star lagoon contains elevated levels of VOCs, PAHs, and metals.

- The dry well and former drum storage area located south of the Axton-Cross Building contains a concentrated source of chlorinated VOCs (PCE, TCE, DCB) and xylene to ground water. The highest levels of VOCs detected in soil and ground water from the Three Star Site are associated with this area. The VOC plume likely extends under the Axton-Cross Building.

- The SRI (O'Brien & Gere 2007c) identified liquid and sludge in the vats as potential sources of zinc, chromium, copper, and other constituents to subsurface media. The detection of elevated levels of metals in ground water downgradient of the vats suggests that the vats have leaked. However, the elevated metals were generally associated with turbidity and particulate matter which may limit their potential for migration. Although metals may be concentrated in soil under the vats, soil under the vats was not sampled due to complicated access. Phthalates were also associated with vat liquids and sludge. Other inorganics, total phenol, and acetone were detected in vat liquids at lower concentrations relative to the primary constituents cited above (O'Brien & Gere 2007c).

- The area of the MGP Site bordering the creek contains benzene, PAHs, and separate phase globules that suggest the presence of MGP wastes. In addition, the detection of inorganics and chlorinated VOCs in that area suggests that the MGP wastes may be mixed with industrial residues.

The four other comparatively minor sources identified at the Three Star Site are summarized below.

- Fill material is a source of PAHs and inorganics, mostly at levels within 1 order of magnitude of background. The fill material is widespread and extends to approximately 10 ft below grade. Soil samples collected at the MGP Site generally contained higher levels of PAHs compared to concentrations detected at the Main Site suggesting contribution of by products from the MGP.

- TCA was detected in ground water in the vicinity of Buildings 15 and 16. The source of the TCA, however, was not identified.

- As would be expected, the surface soil at the MGP Site contained PAH levels that distinguish it from other portions of the Three Star Site. In addition, the surface soil at the MGP Site also contains inorganics.

- The soil adjacent to the west side of the Axton-Cross Building contained elevated levels of nickel in surface soil and lead in subsurface soil relative to other areas of the Three Star Site. PCE was also detected in shallow soil above levels detected elsewhere on the Three Star Site. Drain holes on that side of the Axton-Cross Building are a potential contaminant pathway from the interior of the building.

Other sporadic detections of constituents in soil at levels above screening values for commercial uses were also detected at the Three Star Site. The detection of PCBs and pesticides in soil and pesticides in lagoon sediment did not identify a source of PCBs or pesticides specific to the Three Star Site.

7.2. Potential Migration Pathways

Sources of VOCs were identified in shallow ground water beneath the Main Site, as discussed above. There are several areas where chemical signatures in the ground water suggest that multiple sources are present. However, the concentrations detected in the soil did not identify specific source areas. Inorganics were also detected in shallow ground water within the former raceway and deep ground water under the Main Site. Although the source of these constituents may be concentrated in the lower raceway or another unidentified source, the mechanism for vertical migration of inorganics to deep ground water is has not been established. Furthermore, transport of inorganics to deep ground water may not be currently active.

The presence of elevated concentrations of inorganics in deep ground water adjacent to the creek suggests that the creek channel may provide a migration pathway with the potential for ground water to migrate downgradient within the sediment of Wappingers Creek. The volume of ground water seepage to the creek or river may be small in comparison to creek and river flows reducing the ability to observe these interactions.

Erosion of site soil could occur along the unprotected banks that could contribute to the migration of PAHs and inorganics to the creek. The stone block retaining wall located upstream of the west bridge located on the Three Star Site protects that portion of the Three Star Site from scouring along the creek bank. Adjacent to the Axton-Cross Building and the MGP Site, the exposed soil may be subject to erosion.

7.3. Potential Exposure Pathways

Future uses of the site are expected to be consistent with its current use, which is commercial. Current potential human exposure pathways are primarily associated with the inhalation of indoor air by workers inside the Axton-Cross Building due to the VOC plume located in the vicinity of it and indoor air of other buildings on the Three Star Site. Additional pathways include potential human contact with surface soil and fugitive dust at the Three Star Site, and surface water and sediment of the Three Star lagoon. The size of the exposed soil area and uses of the Three Star Site limit the potential contact with surface soil on the Main Site. Surface water and sediment of the Three Star lagoon are potential exposure routes for trespassers, site workers, or recreational visitors. Exposure to subsurface materials is a potential pathway for construction workers. Due to the availability of a

public water supply, the village prohibits the use of ground water from private wells for potable water. Therefore, contact to ground water will be limited. Other potential uses of the Three Star Site are recreational uses primarily associated with the proximity to the creek, and future residential uses, if they were permitted. Exposure to surface soil is a pathway for both of these potential receptors. Potential exposures for residences would also include breathing indoor air.

The Three Star Site contains limited ecological habitat. Most of the Main Site is occupied by buildings, ruins of buildings, and paved parking areas that represent poor quality ecological habitat. However, wildlife that may be present on the Main Site may be exposed to metals, PAHs, and VOCs that were detected in surface soil above ecological screening values. The Three Star lagoon provides limited aquatic habitat on the Three Star Site. Aquatic receptors that visit the Three Star lagoon may be exposed to metals, PAHs, and CB concentrations that were detected in surface water or sediment above ecological screening values. The MGP Site consists primarily of vegetated areas with grasses, trees, and shrubs that may be suitable habitat for wildlife. Wildlife that may be present on the MGP Site may be exposed to PAHs and metals concentrations that were detected above ecological screening values in surface soil.

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