REMEDIAL ACTION/ENVIRONMENTAL REDEVELOPMENT STRATEGY REPORT AND SUPPLEMENTAL SAMPLING PLAN

SOUTH WATERFRONT – RIVER PLAIN PARK

Prepared For:

THE CITY OF KNOXVILLE

Knoxville, Tennessee

Prepared By:

MACTEC ENGINEERING AND CONSULTING, INC.

9725 Cogdill Road
Knoxville, Tennessee 37932

November 25, 2009

MACTEC Project 3043-08-1018

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November 25, 2009

Mr. Dan Hawkins
Tennessee Division of Remediation
Knoxville Environmental Field Office
3711 Middlebrook Pike
Knoxville, TN 37921

Subject: **Final Report, "Remedial Action/Environmental Redevelopment Strategy Report and Supplemental Sampling Plan, South Waterfront-River Plain Park"**
MACTEC Project 3043081018

Dear Mr. Hawkins:

MACTEC Engineering and Consulting Inc. is please to provide, on behalf of the City of Knoxville, the final version of the referenced report. This report will become an attachment to the Brownfield Voluntary Agreement, South Waterfront Development Park and Road Redevelopment Project, Site Number ID 47-584.

We appreciate the opportunity to have worked with you in a cooperative fashion to make this phase of the redevelopment a success.

Sincerely,

MACTEC Engineering and Consulting, Inc.

W. Paul Teichert
Senior Principal

Jerry A. Archer, P.G.
Vice President

cc: Susanna Bass, City of Knoxville
David Hill, City of Knoxville

Enclosure

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ABBREVIATIONS

µg/L	microgram per liter
AOC	areas of concern
AST	above ground storage tank
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, xylenes
cm^2	square centimeters
COC	contaminant of concern
DOE	Department of Energy
DUST	Division of Underground Storage Tanks
E-DOT	Enhanced Dissolved Oxygen Treatment
EPH	extractable petroleum hydrocarbon
ESA	Environmental Site Assessment
ISL	Initial Screening Level
LNAPL	light non-aqueous phase liquid
MACTEC	MACTEC Engineering and Consulting, Inc.
MassDEP	Massachusetts Department of Environmental Protection
MCL	Maximum Contaminant Level
mg/cm^2	milligrams per square centimeter
mg/day	milligrams per day
mg/kg/day	milligrams per kilogram per day
msl	mean sea level
MTBE	methyl tert-butyl ether
NPDES	National Pollutant Discharge Elimination System
PAH	polyaromatic hydrocarbon
PCB	polychlorinated biphenyl
PEC	Professional Environmental Consulting, Inc.
PRG	Preliminary Remediation Goal
RAGS	*Risk Assessment Guidance for Superfund* (USEPA)
RBSL	Risk-Based Screening Level
RCRA	Resource Conservation and Recovery Act
REC	recognized environmental condition
RfD	dose-response value
RSL	Risk Screening Level
SAIC	Science Applications International Corporation
SVOC	semivolatile organic compound

TDEC	Tennessee Department of Environment and Conservation
TN	Tennessee
USEPA	United States Environmental Protection Agency
UST	underground storage tank
VOC	volatile organic compound

EXECUTIVE SUMMARY

This report has been prepared by MACTEC Engineering and Consulting, Inc., (MACTEC) on behalf of the City of Knoxville to present findings regarding potential contamination at the Redevelopment Site, including a summary of previous investigations, a work plan specifying the additional sampling required, and potential remedial assessment measures required in support of the City's application to the Tennessee Department of Environment and Conservation (TDEC) for a Brownfield Voluntary Agreement for the Redevelopment Site. The location of the Knoxville River Plain Park consists of portions of five parcels of land along the southern bank of the Tennessee River (Fort Loudon Lake) in Knoxville, Tennessee. This report discusses the environmental conditions on the Redevelopment Site.

MACTEC prepared this report and sampling plan relying on data provided by the City of Knoxville (2008 PEC Phase I and Phase II of the subject properties) and figures (River Plain Park design figures, and cut and fill maps) provided by their subcontracted design firms, Hargreaves Associates, Inc. and Vaughn & Milton, Inc., as well as various reports by SAIC (2003 and 2004 Quarterly Groundwater Reports) and Pangean Solutions (2003 Exposure Assessment) for site closure activities at the former Star Enterprises/Chevron Bulk Storage Facility at 701 Langford Avenue. The only information collected directly by MACTEC is in the form of site notes and photographs collected during two separate site walks: one on November 5, 2008 for 701 and 901 Langford Avenue; and one on March 3, 2009 for 939 Langford, 1015 Phillips, and 1101 Phillips Avenue. MACTEC used the data collected from the site walks to augment the data collected during previous assessments.

701 Langford Avenue was formerly a bulk fuel storage facility operated by Star Enterprises from 1947 to 1978 and as Chevron Facility #211997 as a bulk fuel facility from 1978 to 2004. Petroleum hydrocarbons, including benzene, toluene, ethylbenzene, xylenes (BTEX), and methyl tert-butyl ether (MTBE) as well as light non-aqueous phase liquids (LNAPLs) of a petroleum origin were identified in groundwater at 701 Langford Avenue during a site investigation conducted in 1989.

In March 2003, an Exposure Assessment was completed by Pangean Solutions for the Chevron Bulk Fuels Storage facility (Pangean Exposure Assessment) at the 701 Langford Avenue (Figure 7) and was used to determine site-specific clean-up standards for identified contaminants of concern (COCs) BTEX, MTBE, and Resource Conservation and Recovery Act (RCRA) metals for soils and

groundwater in the western two-thirds of the property that formerly contained petroleum above ground storage tanks (ASTs) and underground storage tanks (USTs) and associated equipment. Assumptions used in preparation of the Pangean Exposure Assessment included commercial and construction worker receptors. Current or future residential/park patron receptors at the site were not included in the Pangean Exposure Assessment.

The Pangean Exposure Assessment determined that neither soil nor groundwater Risk-Based Screening Levels (RBSLs) were exceeded for either of the two pathways evaluated. As a result of the Pangean Exposure Assessment and three additional quarters of groundwater sampling, including the collection of one confirmation soil sample, TDEC issued a "Contamination Case Closure" letter to Chevron on August 27, 2004. The "Contamination Case Closure" letter was based on site-specific soil and groundwater standards determined approved by TDEC on July 15, 2003. The closure letter noted that if land use of the property was to change from industrial to residential that the site-specific closure levels may not continue to be applicable. An area of groundwater contamination above Maximum Contaminant Levels (MCLs) was identified in semi-annual groundwater monitoring reports (SAIC, 2004).

In March 2008, PEC conducted a Phase II assessment at the direction of the City of Knoxville, based on RECs identified by the PEC Phase I Environmental Site Assessment (ESA). The Phase II ESA sampling included 15 direct-push subsurface soil borings (B-1 to B-15) at various locations in the vicinity of the future River Plain Park. Subsurface soil samples were collected for all borings except B-4 and B-5. No surface soil samples were collected during the PEC Phase II Assessment. Groundwater grab samples were collected from all 15 borings. All soil and groundwater samples were analyzed for volatile organic compounds (VOCs) and polyaromatic hydrocarbons (PAHs). Soil and groundwater samples from B-6, B-7, and B-15 were also analyzed for RCRA metals. The results were screened against TDEC Division of Underground Storage Tanks (DUST) Initial Screening Levels (ISLs) and United States Environmental Protection Agency (USEPA) Region IX Preliminary Remediation Goals (PRGs) for residential and industrial soils and against the USEPA Drinking Water Maximum Contaminant Levels (MCLs). DUST ISLs and EPA PRGs for soil and MCLs were not exceeded except for arsenic in soils at 701 Langford and soils and unfiltered groundwater at 939 Langford. Arsenic concentrations in soils at both properties were below averages identified by DOE for soil horizons underlain by the Knox Geologic Group. Arsenic concentrations in filtered groundwater at 939 Langford were below the MCLs.

On November 5, 2008, MACTEC conducted a site reconnaissance of 701 and 901 Langford Avenue and on March 3, 2009 of 939 Langford Avenue and 1015 and 1101 Philips Avenue. MACTEC's site reconnaissance included a physical walk of the properties, as well as walking along the river bank to look for discharge pipes and outfalls. In addition to the RECs identified in the PEC Phase I, MACTEC identified additional areas of concern as follows:

- Former Diesel Head Manufacturing building (floor drains) at 701 Langford Avenue
- Residual fill area at 901 Langford Avenue
- Railroad spur that crosses the north end of 701, 901, and 939 Langford Avenue
- Current operations at 939 Langford Avenue: auto repair, AST tank overfill and equipment storage (PEC Phase I REC)
- Sediments in the Tennessee River in the vicinity of a proposed boat dock at 1015 and 1101 Phillips Avenue
- Park redevelopment cut and fill areas that have not been previously assessed

MACTEC conducted an Exposure Assessment of the data collected during previous assessments by SAIC, Pangean and PEC. Figure 11 presents an Exposure Pathway Assessment for the River Plain Park that summarizes the potential sources of contamination, exposure pathways, and potential receptors. Surface soils in the subject area may be contaminated from releases of petroleum products or other substances used by historic or current industrial and commercial activities. During development of the park, construction workers may be exposed to contamination in surface soils by dermal contact, inhalation of soil particles that become airborne due to disturbance or incidental ingestion. After development of the park, future recreational users may be exposed to contamination in surface soils by dermal contact or incidental ingestion.

In addition, subsurface soils in the subject area may also be contaminated from releases of petroleum products or hazardous substances used by historic or current industrial and commercial activities. During development of the park, construction workers may be exposed to contamination in subsurface soils by dermal contact, inhalation of soil particles that become airborne due to disturbance, or incidental ingestion. After development of the park, future recreational users may be exposed to contamination in subsurface soils by dermal contact or incidental ingestion at locations where excavation for development has uncovered those soils. During construction of the dock at the site, there is limited potential for construction workers to be exposed to contaminants

present in surface water and river sediments. Exposure to groundwater at the site is unlikely for either construction workers or future recreational receptors.

Results of the exposure assessment of previous assessment data indicates, various data gaps have been identified. Previous assessments by PEC (2008) and SAIC (2004), and site walks and data reviews conducted by MACTEC (2008-2009) of the subject properties identified areas of concern that may potentially be contaminated with one or more compounds. The sampling efforts completed during the PEC Phase II assessment were collected to determine if there was potential for releases from RECs identified in the PEC Phase I Assessment. Groundwater sampling conducted by SAIC in the vicinity of the former Star Enterprises Bulk Storage Facility (701 Langford) indicated the presence of benzene and MTBE above the DUST ISL. The SAIC groundwater sampling events, the PEC Phase II samples, and the data review/site walks by MACTEC were used as indicators for potential releases and for the selection of sample locations most likely to be contaminated.

The environmental sampling program includes the collection of surface and subsurface soil samples from direct-push sampler, as well as, sediment samples from the Tennessee River. The sampling effort will also generate data to satisfy applicable regulatory evaluations and limit data gaps.

MACTEC has prepared this sampling plan based on the City of Knoxville's property redevelopment schedule. In addition to assessment of groundwater and in order to mitigate groundwater use risk, a groundwater use deed restriction will be implemented for the site. TDEC-DUST land use deed restrictions for 701 Langford Avenue will also be revised as necessary to incorporate land use as a public park by revisiting and modifying the values for recreational use receptors as required by TDEC in its "Contamination Case Closure" letter issued on August, 27, 2004. Upon completing the proposed site assessment and exposure assessment updates, TDEC, MACTEC, and the City of Knoxville will discuss the need for a Soil Management Plan for the River Plain Park development. Additional work for the project will be conducted in accordance with the Brownfields Voluntary Agreement between the City of Knoxville and TDEC Division of Remediation.

1.0 INTRODUCTION

The City of Knoxville plans to redevelop various former waterfront industrial and residential properties along the Tennessee River in Knoxville (Figure 1) to create a public use park (the Redevelopment Site) for the citizens of Knoxville, Tennessee, as shown on Figure 2. Existing buildings and railroad spur will be removed and the properties regarded, cut, and filled to create public multi-purpose use areas and walking paths.

This report has been prepared by MACTEC Engineering and Consulting, Inc., (MACTEC) on behalf of the City of Knoxville to present findings regarding potential contamination at the Redevelopment Site, including a summary of previous investigations, a work plan specifying the additional sampling required, and potential remedial assessment measures required in support of the City's application to the Tennessee Department of Environment and Conservation (TDEC) for a Brownfield Voluntary Agreement for the Redevelopment Site. This report discusses the environmental conditions present across the entire parcels for the purpose of providing a more complete evaluation of potential impacts. However, it should be noted that the Redevelopment Site only consists of the northern portions of these properties (Figure 3).

MACTEC prepared this report and sampling plan relying on data provided by the City of Knoxville (2008 PEC Phase I and Phase II of the subject properties), and figures (River Plain Park design figures, and cut and fill maps) provided by their subcontracted design firms, Hargreaves Associates and Vaughn & Milton, Inc., as well as various reports by Science Applications International Corporation (SAIC) (2003 and 2004 Quarterly Groundwater Reports) and Pangean Solutions (2003 Exposure Assessment) for site closure activities at the former Star Enterprises/Chevron Bulk Storage Facility at 701 Langford Avenue.

2.0 SITE DESCRIPTION AND BACKGROUND

The location of the future City of Knoxville River Plain Park consists of portions of five parcels of land along the southern bank of the Tennessee River (Fort Loudon Lake) in Knoxville, Tennessee (Figure 3). The properties addressed in this report are listed in Table 1.

2.1 LOCAL GEOLOGY

According to the geologic map of the Knoxville Quadrangle, Tennessee, the site is underlain by the lower Ordovician Newala Formation (On) (Figure 4). The Newala is a light gray to gray fine-grained limestone/dolomite with relatively abundant rounded nodules of chert (Cattermole, 1958). Due to the nature and southward dipping beds of this formation, the potential exist for strike-trending karst features. Geologic strike of the bedrock is approximately parallel to the river at this location and dips toward the south.

Bedrock is overlain by residuum and alluvial soils consisting of reddish brown silty clay with very fine sands. The thickness of the soils at the site range from 25 feet near the river to approximately 49 feet along the southern end of the site (MACTEC, 2008).

2.2 LOCAL HYDROGEOLOGY

The site lies along the southern bank of the Tennessee River and is within the 500-year flood plain. Site surface water drains to Tennessee River via overland surface drainage and at National Pollutant Discharge Elimination System (NPDES) discharge points along the northern edge of 701 Langford Avenue (Figure 3). A wetland area of 0.14 acre was identified by MACTEC (2008) in the western portion of 701 Langford Avenue and indicated on Figure 3.

Groundwater in the vicinity of the site is reported to range between approximately 4 feet and 19.5 feet below ground surface (bgs) (SAIC, 2004). Groundwater flow in the residuum is generally toward the Tennessee River (Fort Loudon Lake) to the north. Groundwater flow in bedrock is likely influenced by fractures and strike-trending karst features given the geology of the area as shown in the Site Conceptual Cross Section (Figure 5).

2.3 701 LANGFORD AVENUE

2.3.1 Site Description

701 Langford Avenue is located on the far eastern edge of the proposed River Plain Park (Figure 6). A vacant one-story commercial/industrial facility (former Diesel Head Manufacturing) is situated on the northeast portion of the property. Paved parking areas are located to the south and southeast of the facility. A former fuel dispensing terminal is located to the south of the facility. A storage shed and small storage building that housed a groundwater remediation system is located to the southwest of the facility. The groundwater remediation system and associated wells are no longer in service (Professional Environmental Consulting, Inc. [PEC], 2008).

2.3.2 Previous Assessments

701 Langford Avenue, as shown on Figure 6, was formerly a bulk fuel storage facility operated by Star Enterprises from 1947 to 1978 and as Chevron Facility #211997 as a bulk fuel facility from 1978 to 2004. Petroleum hydrocarbons, including benzene, toluene, ethylbenzene, xylenes (BTEX), and methyl tert-butyl ether (MTBE) as well as light non-aqueous phase liquids (LNAPLs) of a petroleum origin were identified in groundwater at 701 Langford Avenue during a site investigation conducted in 1989. A pump and treat corrective action plan was submitted to TDEC in November 1990 with revisions submitted in 1991 and 1992. The pump and treat corrective action and quarterly groundwater monitoring program was implemented in 1991. Five USTs were removed from the property in September 1994 and a permanent closure report was submitted to TDEC in January 1996. None of these reports were present in TDEC files or archives. A number of ASTs and associated piping and dikes were removed from the property in May of 1995 (Pangean, 2003). The corrective action plan was again revised in October 2001 to include Enhanced Dissolved Oxygen Treatment (E-DOT) to remove LNAPL from the vicinity of MW-8A. The pump and treat system was shut down in June 2002, followed by the deactivation of the E-DOT system in August 2002.

In March 2003, an Exposure Assessment was completed by Pangean Solutions for the Chevron Bulk Fuels Storage facility (Pangean Exposure Assessment) at the 701 Langford Avenue (Figure 6) and was used to determine site-specific clean-up standards for identified contaminants of concern (COCs) BTEX, MTBE, and Resource Conservation and Recovery Act (RCRA) metals for soils and

groundwater in the western 2/3 of the property that formerly contained petroleum above ground storage tanks (ASTs) and underground storage tanks (USTs) and associated equipment. Assumptions used in preparation of the Pangean Exposure Assessment included commercial and construction worker receptors. Current or future residential/park patron receptors at the site were not included in the Pangean Exposure Assessment.

The Pangean Exposure Assessment determined that neither soil nor groundwater Risk-Based Screening Levels (RBSLs) were exceeded for either of the two pathways evaluated. As a result of the Pangean Exposure Assessment and three additional quarters of groundwater sampling, including the collection of one confirmation soil sample, TDEC issued a "Contamination Case Closure" letter to Chevron on August 27, 2004. The "Contamination Case Closure" letter was based on site-specific soil and groundwater standards determined approved by TDEC on July 15, 2003. The closure letter noted that if land use of the property was to change from industrial to residential that the site-specific closure levels may not continue to be applicable. An area of groundwater contamination above Maximum Contaminant Levels (MCLs) was identified in semi-annual groundwater monitoring reports (SAIC, 2004) and show on Figure 6.

In March 2008, PEC conducted a Phase II assessment at the direction of the City of Knoxville, to investigate recognized environmental conditions (RECs) identified by the PEC Phase I Environmental Site Assessment (ESA). Two subsurface soil borings, B-6 and B-7, were installed by PEC during the Phase II ESA conducted in March 2008 as shown on Figure 6. Boring B-6 was installed in a location down gradient of the footprint of the Former Phoenix Dye Works and within the River Plain Park boundary. Boring B-7 was installed west of the former Phoenix Dye Works as shown on Figure 6 and is outside the River Plain Park boundary. Soil and groundwater samples were collected and sent to a laboratory analysis of volatile organic compounds (VOCs), polyaromatic hydrocarbons (PAHs) for soil, and RCRA metals for groundwater. Laboratory data provided in the PEC Phase II ESA indicated that only arsenic concentrations in subsurface soil exceed the United States Environmental Protection Agency (USEPA) Region IX residential and industrial Preliminary Remediation Goals (PRGs) at 12 to 14 feet bgs in B-6, as indicated in Table 2. No Division of Underground Storage Tanks (DUST) Initial Screening Levels (ISLs) or USEPA PRGs were exceeded in soil samples collected from B-7 (Table 2). No surface soil samples were collected for this property. Laboratory data indicated that groundwater samples collected from each of these two borings were below the USEPA Drinking Water MCLs (Table 3). Groundwater in the former bulk fuels storage area of this property was not assessed during the PEC Phase II assessment.

2.3.3 MACTEC Site Reconnaissance

On November 5, 2008, MACTEC conducted a site reconnaissance of 701 Langford Avenue (Figure 6). MACTEC's site reconnaissance included a physical walk of the property, as well as walking along the riverbank to look for discharge pipes and outfalls. In addition to the RECs identified in the PEC Phase I, MACTEC identified additional concerns related to property development as a public park. The additional concerns identified in the vicinity of the future park are indicated on Figure 6 and include:

- Former Diesel Head Manufacturing building floor drains may have been an avenue for the release of VOCs and semivolatile organic compounds (SVOCs) to subsurface soils and groundwater.
- Railroad spur that crosses the north end of 701 Langford Avenue and may have been subject to releases of PAH compounds to surface soils, as are commonly found near railroad tracks.
- Proposed park excavation areas have not been assessed for surface or subsurface contamination. Given the site history these areas require additional assessment prior to park construction in order to determine requirements for management of potentially contaminated soils.

2.3.4 Previous Assessment Summary – 701 Langford Avenue

The following is a summary of sample screening conducted at 701 Langford Avenue for each assessed media: surface soil, subsurface soil and groundwater.

2.3.4.1 Surface Soil

Surface soils were not assessed during the SAIC nor PEC assessment activities and represent a data gap for potential exposure to contaminated media by recreational users in the immediate area of the railroad spur as well as the proposed park development cut areas.

2.3.4.2 Subsurface Soils

The Pangean Exposure Assessment indicated that RBSLs were not exceeded for either the commercial and construction worker for subsurface soils for BTEX, MTBE, PAHs, and RCRA metals in the vicinity of the former bulk fuels storage area.

Laboratory data provided in the PEC Phase II ESA indicated that only arsenic concentrations in subsurface soil exceed the USEPA Region IX residential and industrial PRGs as indicated in Table 2. However, these results are within the normal ranges commonly detected in background soils derived from the Knox Group (Department of Energy [DOE], 1993).

2.3.4.3 Groundwater

Groundwater samples collected in 2004 by SAIC for the closure of the bulk storage area of the property did not exceed the Pangean Exposure Assessment RBSLs for either the commercial or construction worker pathways evaluated for the site-specific COCs (BTEX, MTBE, PAHs, and RCRA Metals) (Table 4).

With the exception of an unfiltered sample for arsenic, PEC Phase II Laboratory data indicated that groundwater samples collected from each of the two on-site borings were below the USEPA Drinking Water MCLs (Table 3).

2.3.5 Areas of Concern – 701 Langford Avenue

Various data gaps remain for the proposed redevelopment of this property and are as follows:

- Former Diesel Head Manufacturing building floor drains may have been an avenue for the release of VOC and SVOC compounds to subsurface soils and groundwater. No assessment of the former Diesel Head manufacturing facility has been conducted for soils.

- Railroad spur that crosses the north end of the property and may have been subject to releases of PAH compounds to surface soils, as are commonly found near railroad tracks. No surface samples have been collected at this property.

Proposed park excavation areas have not been assessed for surface soil (current/final) impacts. Given the site history and lack of surface soil samples, these areas require additional assessment prior to park construction in order to determine requirements for management of potentially contaminated soils. The areas of concerns (AOCs) for this property are as indicated on Figure 7.

2.4 901 LANGFORD AVENUE

2.4.1 Site Description

901 Langford Avenue is located immediately east of 701 Langford Avenue and bordered by the Tennessee River to the north and Langford Avenue to the south (Figure 8). A commercial warehouse, formerly Dixie Laundry, is currently occupied by Value Textiles, Inc. and located in the southwestern corner of the property. The area to the north and east is undeveloped. A railroad easement extends across the northern portion of the facility (PEC, 2008).

2.4.2 Previous Assessments

In March 2008, PEC conducted a Phase II assessment at the direction of the City of Knoxville, to investigate RECs identified by the PEC Phase I ESA. Two subsurface soil borings, B-8 and B-9, were installed by PEC during the Phase II ESA conducted in March 2008 (Figure 8). Boring B-8 was installed north and downgradient of the current Value Textile facility, and Boring B-9 was installed adjacent to the east side of the facility near a former UST location as shown on Figure 8. Samples were collected and sent for VOC and PAH analysis for soil and RCRA metals analysis for groundwater, as indicated above.

2.4.3 MACTEC Site Reconnaissance

On November 5, 2008, MACTEC conducted a site reconnaissance of 901 Langford Avenue (Figure 8). MACTEC's site reconnaissance included a physical walk of the property, as well as walking along the riverbank to look for discharge pipes and outfalls. In addition to the RECs identified in the PEC Phase I, MACTEC identified additional concerns related to property development as a public park. The additional concerns identified in the vicinity of the future park are indicated on Figure 8 and include:

- Residual fill area in the south central portion of the property. The origin of the soils is unknown and has the potential to be contaminated.
- Railroad spur that crosses the north end of the property and may have been subject to releases of PAH compounds to surface soils, as are commonly found near railroad tracks.

- Proposed park excavation areas have not been assessed for surface soil (current/final) contamination. Given the site history and lack of surface soil samples, these areas require additional assessment prior to park construction in order to determine requirements for management of potentially contaminated soils.

2.4.4 Previous Assessment Summary – 901 Langford Avenue

The following is a summary of sample screening conducted at 901 Langford Avenue for each assessed media: surface soil, subsurface soil and groundwater.

2.4.4.1 Surface Soils

Surface soils were not assessed during the PEC Phase II assessment activities and represent a data gap for potential exposure to contaminated media by recreational users in the immediate area of the railroad spur and residual fill area, as well as, the proposed cut areas identified by Hargreaves for park development.

2.4.4.2 Subsurface Soils

Laboratory data provided in the PEC Phase II ESA indicated that none of subsurface soil exceeds the USEPA Region IX residential and industrial PRGs as indicated in Table 2.

2.4.4.3 Groundwater

PEC Phase II Laboratory data indicated that groundwater samples collected from each of the two borings located near the proposed park redevelopment area were below the USEPA Drinking Water MCLs (Table 3) for VOCs and PAHs.

2.4.5 Areas of Concern – 901 Langford Avenue

Various data gaps remain for the proposed redevelopment of this property and are as follows:

- Railroad spur that crosses the north end of the property and may have been subject to releases of PAH compounds to surface soils, as are commonly found near railroad tracks. No surface samples have been collected at this property.

- Proposed park excavation areas have not been assessed for surface soil (current/final) contamination. Given the presence of residual fill area and the lack of surface soil samples, this area requires assessment prior to park construction in order to determine if potentially contaminated soils are present.

The AOCs for this property are as indicated on Figure 7.

2.5 939 LANGFORD AVENUE

2.5.1 Property Description

The subject property is located immediately east of 901 Langford Avenue (Figure 9). The property is currently comprised of a one-story commercial building located on the east central portion of the property with various out buildings along the edges of the property that are used primarily for storage and maintenance of various construction equipment. The central portion of the property is grass covered and is used as a storage yard for construction equipment and materials. A former railroad spur extends across the northwest portion of the property. A boat ramp and dock also extends into the Tennessee River from this property toward the north (PEC, 2008).

2.5.2 Previous Assessments

In March 2008, PEC conducted a Phase II assessment at the direction of the City of Knoxville, to investigate RECs identified by the PEC Phase I ESA. Subsurface soil borings B-10 through B-15 were installed by PEC during the Phase II ESA conducted in March 2008 (Figure 9). Soil and groundwater samples were collected and sent for analysis of VOCs, PAHs. B-15 was also analyzed for RCRA Metals. Laboratory data provided in the PEC Phase II ESA indicated that none of the subsurface soils or groundwater samples collected from B-10 through B-15 exceeded the USEPA Region IX residential and industrial PRGs or USEPA MCLs (Tables 2 and 3). No surface soil samples were collected during the Phase II assessment of this property.

2.5.3 MACTEC Site Reconnaissance

On March 3, 2009, MACTEC conducted a site reconnaissance of 939 Langford Avenue (Figure 9). MACTEC's site reconnaissance included a physical walk of the property, as well as walking along the riverbank to look for discharge pipes and outfalls. In addition to the RECs identified in the PEC Phase I, MACTEC identified additional concerns related to property development as a public

park. The additional concerns identified in the vicinity of the future park are indicated on Figure 7 and include:

- Proposed park excavation areas have not been assessed for surface soil (current/final) contamination. Given the current activities and site history as well as the lack of surface soil samples, these areas require additional assessment prior to park construction in order to determine requirements for management of potentially contaminated soils.

- Two underground pipes are visible on the river bank and the potential for an underground tank are present at the site and most likely remain from the molasses terminal; whereas sampling during the PEC Phase II did not indicate these areas are contaminated, these structures should be removed under the oversight of an experienced professional.

2.5.4 Previous Assessment Summary – 939 Langford Avenue

The following is a summary of sample screening conducted at 939 Langford Avenue for each assessed media: surface soil, subsurface soil, and groundwater.

2.5.4.1 Surface Soils

Surface soils were not assessed during the PEC Phase II assessment activities and represent a data gap for potential exposure to contaminated media by recreational users, as well as, the proposed cut areas identified by Hargreaves for park development.

2.5.4.2 Subsurface Soils

Laboratory data provided in the PEC Phase II ESA indicated that none of subsurface soil exceed the USEPA Region IX residential and industrial PRGs as indicated in Table 2.

2.5.4.3 Groundwater

PEC Phase II Laboratory data indicated that groundwater samples collected from each of the borings were below the USEPA Drinking Water MCLs (Table 3) for VOCs, PAHs, and RCRA metals.

2.5.5 Areas of Concern – 939 Langford Avenue

A data gap remains for the proposed redevelopment of this property and is as follows:

- Proposed park excavation areas have not been assessed for surface soil (current/final) contamination. Given the presence of residual surface impacts due to current activities at the site and the lack of surface soil samples, these areas require additional assessment prior to park construction in order to determine requirements for management of potentially contaminated soils.

The AOC for this property is as indicated on Figure 7.

2.6 1015 PHILLIPS AVENUE

2.6.1 Property Description

The subject property is located between 939 Langford Avenue and 1101 Phillips Avenue and is bounded on the north by the Tennessee River (Figure 3). Access to the property is via a narrow gravel driveway that crosses the southwest corner of 1101 Phillips Avenue. A single-family two-story house occupies the center of the property. Two single-story storage buildings are located in the northwest corner of the property and used to house various tools and lawn maintenance equipment (PEC, 2008). No RECs were identified for this property during the PEC Phase I.

2.6.2 Previous Assessment Summary

No previous assessments have been conducted at 1015 Phillips Avenue.

2.6.3 MACTEC Site Reconnaissance

On March 3, 2009, MACTEC conducted a site reconnaissance of 1015 Phillips Avenue (Figure 10). MACTEC's site reconnaissance included a physical walk of the property, as well as walking along the riverbank to look for discharge pipes and outfalls. MACTEC identified additional concerns related to property development as a public park. The additional concerns identified in the vicinity of the future park are indicated on Figure 7 and include:

- Sediments of the Tennessee River are known to be potentially contaminated with polychlorinated biphenyls (PCBs) and metals and have not been previously assessed for this property. Given that this area is proposed for the

construction of a boat dock and public use area, construction workers and park patrons may be exposed to contaminated sediments.

2.6.4 Previous Assessment Summary – 1015 Phillips Avenue

No assessment of this property was conducted during the PEC Phase II assessment.

2.6.5 Areas of Concern – 1015 Phillips Avenue

Data gaps remain for the proposed redevelopment of this property and are as follows:

- Sediments of the Tennessee River are known to be potentially contaminated with PCBs and metals and have not been previously assessed for this property. Given that this area is proposed for the construction of a boat dock and public use area, construction workers and park patrons may be exposed to contaminated sediments.

The AOC for this property is as indicated on Figure 7.

2.7 1101 PHILLIPS AVENUE

2.7.1 Site Description

The subject property is an irregular-shaped undeveloped property bounded to the north by the Tennessee River and to the southwest and south by Phillips Avenue (Figure 3). Dixie Printers is located immediately to the west of the property (PEC, 2008).

2.7.2 Previous Assessments

The PEC Phase I identified an adjacent off-site property, Union Printers, as a REC. Boring B-4 was installed by PEC during the Phase II ESA conducted in March 2008 to assess the off-site REC (Figure 10). Boring B-4 was installed north of Union Printers western facility. One groundwater sample was collected and sent for analysis VOCs and PAHs. No surface or subsurface soil samples were collected from B-4. Laboratory data provided in the PEC Phase II ESA indicated that the groundwater sample collected from B-4 did not exceed the USEPA MCLs (Table 3).

2.7.3 MACTEC Site Reconnaissance

On March 3, 2009, MACTEC conducted a site reconnaissance of 1101 Phillips Avenue (Figure 10). MACTEC's site reconnaissance included a physical walk of the property, as well as walking along the riverbank to look for discharge pipes and outfalls. MACTEC identified additional concerns related to property development as a public park. The additional concerns identified in the vicinity of the future park are indicated on Figure 7 and include:

- Sediments of the Tennessee River are known to be potentially contaminated with PCBs and metals and have not been previously assessed for this property. Given that this area is proposed for the construction of a boat dock and public use area, construction workers and park patrons may be exposed to contaminated sediments.

2.7.4 Previous Assessment Summary – 1101 Phillips Avenue

The following is a summary of sample screening conducted at 1101 Phillips Avenue for each assessed media: surface soil, subsurface soil, and groundwater.

2.7.4.1 Surface Soils

Surface soils were not assessed during the PEC Phase II assessment activities.

2.7.4.2 Subsurface Soils

Subsurface soils were not assessed during the PEC Phase II assessment activities and represent a data gap for potential exposure to contaminated media by recreational users, as well as, in the proposed cut areas identified by Hargreaves for park development.

2.7.4.3 Groundwater

PEC Phase II Laboratory data indicated that the groundwater sample collected was below the USEPA Drinking Water MCLs (Table 3) for VOCs, PAHs.

2.7.5 Areas of Concern - 1101 Phillips Avenue

Data gaps remain for the proposed redevelopment of this property and are as follows:

- Sediments of the Tennessee River are known to be potentially contaminated with PCBs and metals and have not been previously assessed for this property. Given that this area is proposed for the construction of a boat dock and public use area, construction workers and park patrons may be exposed to contaminated sediments.

The AOC for this property is as indicated on Figure 7.

3.0 SITE CONCEPTUAL MODEL AND EXPOSURE PATHWAY EVALUATION

In order to visualize the various relationships between potential AOCs and future property use, a site conceptual cross-section model of the site has been created. Figure 3 shows various potential contamination sources, including:

- Former USTs and ASTs at 701 and 901 Langford Avenue;
- Unauthorized discharge pipes at 701 Langford Avenue;
- Railroad spur at 701, 901, and 939 Langford Avenues;
- Current and former industrial buildings at all properties;
- Floor drains and piping discharges from the former Diesel Head Manufacturing Facility;
- Fill areas at 901 Langford Avenue;
- Contaminated soil and groundwater in the vicinity of the former bulk storage facility at 701 Langford Avenue; and
- Potentially contaminated riverbed sediments at 1015 and 1101 Phillips Avenues.

Contamination that may result from former or current sources impacts various environmental media at the site such as surface soils, subsurface soils, groundwater, surface water, and river sediments. Potentially contaminated environmental media may impact re-development plans if construction workers or future park users become exposed to the contamination and that exposure presents unacceptable risks. Construction workers and future park users are referred to as the potentially exposed population. Potential routes by which individuals may be exposed are referred to as exposure pathways and generally include dermal contact with contaminated media and inhalation or incidental ingestion of the contaminated media. The presence of potentially contaminated media at a site does not necessarily translate to unacceptable risks. For unacceptable risks to occur, the pathway of exposure from the contaminated media to the receptor must be complete. In order to conduct an exposure assessment, the potential pathways for contaminants to reach potential receptors are evaluated to determine if those exposure scenarios are likely or complete. Where the exposure pathways are considered likely to be complete, data from the contaminated media are screened against criteria for the specific medium and pathway of exposure to determine the potential for unacceptable risks. These criteria, referred to as Risk Screening Levels (RSL), are presented in the next section.

3.1 EXPOSURE PATHWAY EVALUATION

Figure 11 presents an Exposure Pathway Assessment for the River Plain Park that summarizes the potential sources of contamination, exposure pathways, and potential receptors. Surface soils in the subject area may be contaminated from releases of petroleum products or other substances used by historic or current industrial and commercial activities. During development of the park, construction workers may be exposed to contamination in surface soils by dermal contact, inhalation of soil particles that become airborne due to disturbance or incidental ingestion. After development of the park, future recreational users may be exposed to contamination in surface soils by dermal contact or incidental ingestion. For the purpose of exposure evaluation, surface soils are considered to be soils from ground surface to a depth of 0 to 6 inches and 6 inches to 2 feet.

Subsurface soils in the subject area may also be contaminated from releases of petroleum products or hazardous substances used by historic or current industrial and commercial activities. During development of the park, construction workers may be exposed to contamination in subsurface soils by dermal contact, inhalation of soil particles that become airborne due to disturbance, or incidental ingestion. After development of the park, future recreational users may be exposed to contamination in subsurface soils by dermal contact or incidental ingestion at locations where excavation for development has uncovered those soils.

During construction of the dock at the site, there is limited potential for construction workers to be exposed to contaminants present in surface water and river sediments. Any construction worker exposures resulting from dock construction would be of very limited duration. Recreational users at the future park could potentially be exposed to contaminants that are present in river sediments and surface water by incidental ingestion and dermal contact as a result of wading, kayaking, and similar activities. Aquatic receptors such as benthic organisms, fish, and certain avian species may also be exposed to contaminants present in the sediments and surface water.

In general, exposure to groundwater at the site is unlikely for either construction workers or future recreational receptors. Current development plans include construction of a wetland and pool in the vicinity of the former Chevron bulk storage terminal. Excavation for construction of the pool and wetland is to a depth of 3 feet mean sea level (msl) (818 feet). Based on 10 years of groundwater elevation data at the site from December 1993 to April 2004, the highest observed water table elevation was 816.72 feet msl. Although the highest observed water table elevation is

1.28 feet below the currently planned excavation depth, mounding in this area that could occur if these features have permeable bottoms could result in mingling of groundwater and surface water at this location.

3.2 RISK SCREENING LEVELS

3.2.1 Risk Screening Levels for Soils

RSLs are published by USEPA in the Regional Screening Level Tables (USEPA, 2008). USEPA publishes RSLs for both residential and commercial/industrial land use exposures to soil. The commercial/industrial RSLs are based on an assumption that an adult is exposed to soil by dermal contact and incidental ingestion 250 days per year for 25 years; the screening levels are protective for those exposures at an excess lifetime cancer risk of 1 in 1-million and a non-cancer hazard index of 1.

In the Phase II ESA, subsurface soil data from the borings were compared with RSLs (also referred to as PRGs) for industrial and commercial receptors such as construction workers. These criteria are presented in Table 2.

Residential RSLs are based on an assumption that children and adults are exposed to soil by dermal contact and incidental ingestion 350 days per year for 30 years; the screening levels are protective for those exposures at an excess lifetime cancer risk of 1 in 1-million and a non-cancer hazard index of 1. The residential RSLs are intended to be used to evaluate (and be protective for) potential exposures to chemicals in soil in a residential back yard.

The specific exposure assumptions used to derive the residential RSLs are:

- Soil ingestion rate: 100 milligrams per day (mg/day) (adult); 200 mg/day (child)
- Dermal surface area: 5,700 square centimeters (cm^2) (adult); 2,800 cm^2 (child)
- Soil adherence factor: 0.07 milligram per square centimeter (mg/cm^2) (adult); 0.2 mg/cm^2 (child)
- Exposure frequency: 350 days per year
- Exposure duration: 24 years (adult); 6 years (child); 30 years (total)

In the Phase II ESA, subsurface soil data from the borings were compared with RSLs (also referred to as PRGs) for industrial and commercial receptors such as construction workers. These criteria are presented in Table 2.

As a public park, children, adolescents, and adults would be expected to visit the park for various recreational purposes, including play by children, recreational athletic activities (e.g., ball throwing), and passive leisure activities such as reading and walking. In addition, adult maintenance workers/grounds keepers would be expected to access the park for maintenance and grounds keeping and landscaping activities.

Neither USEPA nor the State publish RBSLs that are specifically applicable for evaluation of recreational land uses. Generally, recreational land uses would be associated with soil exposures that are similar to those that might be associated with exposures to soil in a residential back yard, as both involve children and adults and exposures by the same exposure pathways listed above. The principal difference between recreational and residential exposures is that recreational exposures to soil would not be expected every day of the year and would not be expected to occur for more than a few hours each day, whereas residential exposures would be expected each day of the year, and for as much as several hours per day.

However, the residential RSLs can be modified for use as screening levels for recreational land uses by adjusting the exposure frequency to reflect an exposure frequency that is more realistic for the potential exposure conditions at a recreational park.

Young children are likely to visit a park more frequently than adults. A young child might visit a park as much as 5 days per week, or 250 days per year. It is unlikely that visitation would occur at a higher frequency than this because measureable precipitation (based on the Knoxville area) occurs approximately 110 days per year, and it is unlikely that young children would visit a park on days when precipitation occurs. An adult is assumed to visit a park less frequently than a young child; it is assumed that an adult visits a park 3 days per week, or 156 days per year.

To modify the residential RSLs, the RSLs were multiplied by the ratio of residential exposure frequency used to derive the RSLs (350 days per year) to the site-specific recreational exposure frequency, as follows:

- RSLs based on non-cancer risks were derived by USEPA based on exposures to young children. Therefore, recreational screening levels for chemicals that

have RSLs based on non-cancer effects were developed by multiplying the RSL by a factor of 1.4 (equal to 350 days/year divided by 250 days per year).

- RSLs based on cancer risks were derived by USEPA based on combined child and adult exposures over a 30-year period, where 6 years is allocated to exposures as young children and 24 years is allocated to exposures as adults. Applying the recreational exposure frequencies of 250 days per year for children and 156 days per year for adults yields an age-averaged exposure frequency of 175 days per year. Recreational screening levels for chemicals that have RSLs based on cancer effects were developed by multiplying the RSL by a factor of 2.0 (equal to 350 days/year divided by 175 days per year).

Table 5 presents the derivation of the recreational risk-based screening levels for soil. The recreational RBSLs for soil are protective for young children and adults who are assumed to visit the park frequently (nearly daily for young children and nearly every other day for adults) and be exposed to chemicals in soil by incidental ingestion, dermal contact, and dust and vapor inhalation exposure routes at the same contact intensity that is assumed for residential exposures to soil over a 30-year period, at an excess lifetime cancer risk of 1 in 1 million and a non-cancer hazard index of 1.

3.2.2 Risk Screening Levels for Groundwater and Surface Water

In the Phase II ESA, groundwater data from the borings were compared with MCLs. The MCLs are drinking water standards that apply at the tap or point of distribution of potable water. Where MCLs have not been promulgated for contaminants in the groundwater, the Phase II ESA screened the groundwater data against PRGs. These criteria are contaminant levels that are considered protective of drinking water uses. These criteria are presented in Table 3.

The most likely potential pathway for exposure to contaminated groundwater for the proposed redevelopment use, involves wading or similar play activities at any location where groundwater may discharge to the surface. RBSLs that are protective for groundwater that may discharge to wetlands were derived by calculating a risk-based concentration that is protective for human recreational exposures to surface water, then multiplying those values by a dilution factor to account for the dilution of chemical concentrations in groundwater that would occur upon discharge to surface water in a wetland.

RBSLs for surface water were calculated using standard USEPA risk assessment approaches as described in USEPA *Risk Assessment Guidance for Superfund (RAGS)* guidance document series.

Specifically, RBSLs were derived assuming that young children and adults access wetlands at the site for play or exploration an average of two days per week over the months of June, July, August, and September, or 34 days per year. As with the derivation of recreational screening values for soil, the surface water screening values assume that recreational exposures occur over a 30-year period. Since the wetland areas are not deep enough to permit swimming, exposures to wetland surface water are based on wading exposures. Wading exposures assume that the feet, legs, forearms, and hands get wet, as opposed to the entire body and that incidental ingestion of surface water occurs at half the rate that is assumed for swimming exposures. Parameter values and algorithms used to quantify exposures are presented in Table 6.

RBSLs for surface water were derived by calculating risk associated with exposure to a concentration of 1 microgram per liter (µg/L) of each chemical, then back-calculating the surface water concentration of each chemical that would correspond to a target cancer risk of 1 in 1 million or a target hazard index of 1. Tables 7 and 8 present the calculation of cancer and non-cancer risks for child and adult recreational visitors who are assumed to be exposed to 1 µg/L of each chemical in surface water. Calculations were performed using the exposure parameters and algorithms presented in Table 6 with cancer slope factor and reference dose values selected from USEPA-approved sources in accordance the USEPA-specified hierarchy of sources for obtaining dose-response data (USEPA, 2003). Calculations also incorporated USEPA guidance on Assessing Susceptibility from Early-Life Exposure to Carcinogens (USEPA, 2005) by incorporating age-specific potency factors in the calculation of risks for carcinogens with mutagenic potential (i.e., carcinogenic polyaromatic hydrocarbons).

Table 9 presents calculation of risk-based concentrations for surface water and the derivation of risk-based screening values for groundwater that may discharge to surface water. As noted in Table 9, RBSLs based on non-cancer effects were calculated based on the young child receptor, and RBSLs based on cancer effects were calculated based on the combined child and adult receptor risks (to account for a cumulative 30-year exposure). Screening levels for groundwater were derived by multiplying the risk-based values for surface water by a dilution factor of 10. This factor accounts for the dilution of chemical concentration in groundwater that would occur when the groundwater discharges to and mixes with surface water. A site-specific dilution and attenuation factor would likely be much higher than a value of 10 because it could account for adsorption of chemicals in groundwater prior to discharge, as well as dilution based on actual groundwater plume dimensions and surface water flow.

In summary, the risk-based screening levels for groundwater are protective for groundwater that discharges to surface water in wetlands where young children and adults are assumed to wade in the surface water and be exposed to chemicals in the water by incidental ingestion and dermal contact over a 30-year period, at an excess lifetime cancer risk of 1 in 1 million and a non-cancer hazard index of 1.

3.3 SUMMARY OF RISK SCREENING AND IDENTIFICATION OF DATA REQUIREMENTS

The final step in the exposure assessment involves summarization of previous risk screening results and screening of historic data against the risk screening criteria developed for the recreational receptor. The following sections present this evaluation on a media specific basis. Additional data that needs to be collected to complete the evaluation are also identified.

3.3.1 Surface soils

As noted in Section 2, data concerning the potential for contamination in surface soils has never been obtained for the proposed site. Therefore, surface soils data must be acquired to assess whether potentially unacceptable risks to receptors (construction workers and future recreational users) may exist. Once these data are obtained, it will be evaluated against the relevant RSLs for these two potentially exposed receptor populations.

Where the pathway from the contaminated media to the receptor is incomplete, the potential for unacceptable risks are abated. Therefore, in areas of the site where 2 feet or more of clean fill material will be placed as part of development, the pathway for exposure to potentially contaminated surface soils for future park recreational users has been mitigated. Therefore, in areas where 2 feet or more of clean fill will be placed, there is not any need to evaluate surface soil contamination.

3.3.2 Subsurface soils

Subsurface soil data from the PEC Phase II ESA were previously screened against RSLs for the construction worker receptor and determined to not present unacceptable risks except for arsenic.

However, arsenic concentrations are within the normal ranges commonly detected in background soils derived from the Knox Group (Department of Energy [DOE], 1993).

The PEC Phase II ESA did not evaluate risks to the recreational receptor. For this evaluation, data from the PEC Phase II ESA were screened against the RSLs developed for the recreational receptor's exposure to soil (See Table 10). Sub-surface soil data from closure of the former UST site at 701 Langford Avenue were also screened against the recreational receptor RSLs. This evaluation determined that subsurface soils in the redevelopment site do not present unacceptable risks to recreational receptors.

Although evaluation of the historic data indicate that subsurface soils do not present unacceptable risks to construction workers during development or to future recreational users, MACTEC's assessment found that the potential for contamination had not been previously evaluated at the former Diesel Head manufacturing facility and that subsurface data had not been obtained in the vicinity of the former Chevron bulk storage facility. Data for subsurface soils needs to be obtained from these locations to verify that there are not any unacceptable risks to construction worker receptors.

3.3.3 Surface Water and River Sediments

The *2008 305(b) Report, The Status of Water Quality in Tennessee*, April 2008, indicates that the Fort Loudon Reservoir does not have bacteriological contamination that would restrict swimming or wading. Fish tissue advisories do exist limiting the consumption of some species of fish based upon the presence of PCBs and mercury. During construction of the dock at the site, there is limited potential for construction workers to be exposed to contaminants present in surface water and river sediments. Any construction worker exposures resulting from dock construction would be of very limited duration. Although certain contaminants bound to soils may be transported to surface water during construction, any impacts from these activities are transient in nature.

Ambient water quality criteria are not developed for sediments and prior assessments did not sample river sediments along the proposed redevelopment river stretch. The potential for contamination of river sediments is known to exist along the Tennessee River. However, any exposure of the construction worker to sediments would be of extremely limited duration and therefore further evaluation of this pathway is not recommended.

It should be noted that if there is potential for contaminated sediments to be disturbed during construction, measures to control contaminant migration and potential impacts will need to be addressed under a Clean Water Act Section 404 permit with the Corps of Engineers and Aquatic Resource Alteration Permit (ARAP) with TDEC. Therefore it is recommended that sampling of river sediments in the proposed dock area be conducted.

Post development risks associated with recreational receptor exposure to sediments would not be expected to differ from the current baseline except where sediments may be disturbed. Ambient water quality criteria are not developed for sediments and prior assessments did not sample river sediments along the proposed redevelopment river stretch. The potential for contamination of river sediments is known to exist along the Tennessee River. Therefore, it is recommended that data be obtained to complete evaluation of this exposure pathway.

Aquatic receptors such as benthic organisms, fish, and certain avian species may also be exposed to contaminants present in the sediments and surface water. This exposure assessment did not evaluate ecological risks because TDEC has not indicated exceedance of Water Quality Criteria for these species along this river segment. Any alteration of risks to aquatic receptors from sediment disturbance would be transient in nature but sampling of sediments in the proposed dock area may be needed to support the Clean Water Act 404 and Aquatic Resource Alteration Permit process.

3.3.4 Groundwater

As indicated, recreational receptor exposure to groundwater is unlikely except at the proposed pool and wetland in the 701 Langford Avenue parcel. At this location, localized mounding may create a limited potential for groundwater recharge into these features. Accordingly, historic data (SAIC, 2003 and 2004) and groundwater results from the PEC Phase II assessment (PEC, 2008) for groundwater were screened against recreational user criteria developed as described in Section 4.2. The results of this evaluation are presented in Tables 11 and 12 and indicate that there are not any unacceptable risks for park patrons by this exposure scenario.

4.0 PROPOSED SAMPLING ACTIVITIES

This section presents the proposed sampling activities for each subject property and the rationale supporting the sampling efforts. The environmental sampling program includes the collection of surface and subsurface/future surface soil samples from a direct-push sampler, and sediment samples from the Tennessee River. All soil samples will be collected in accordance with USEPA Region IV standard operating procedures and submitted to an accredited laboratory for analysis. Soil and sediment sample locations are shown on Figure 12. Table 13 presents the surface and subsurface/future surface soil and sediment sample numbers and analysis required for each.

4.1 701 LANGFORD AVENUE SAMPLING ACTIVITIES

Based on the identification of AOCs in Section 2 and the Exposure Assessment in Section 3, MACTEC recommends surface soil samples be collected along the railroad spur that crosses the northern portion of the property, inside the Former Diesel Head Manufacturing Facility, and in the vicinity of the area to be excavated for wetland construction, as show on Figure 12. Soil samples will be collected at the current soil surface and at a depth that corresponds to the proposed soil surface following excavation activities. Soil sample locations will require soil samples to be collected at multiple depths to assess the current surface soils as well as subsurface/future surface soils. To collect the required data, the following fieldwork will be completed at 701 Langford Avenue:

- Collection and analysis of two composite soil samples from the railroad spur that crosses three of the redevelopment properties (i.e. two surface samples comprised of two surface locations at 701 Langford to be composited into one sample, and one surface sample collected from each property (901 and 939 Langford) to be composited for a second sample).

- Collection and analysis of soil samples below a floor drain inside the former Diesel Head Manufacturing Facility Building (one subsurface), and in excavation areas as identified by Hargreaves Associates (two current and two future surface).

Rationale for Surface and Subsurface Soil Sample Collection at 701 Langford Avenue

No soil samples were collected during previous site assessments for surface soils at 701 Langford Avenue and therefore constitutes a surface soil data gap for the property. Given that site was a former bulk storage facility for petroleum products and releases have been indicated in the past, as

well as its subsequent use as an industrial manufacturing operation, it is reasonable to assess both surface and subsurface soils on this subject property.

Proposed soil sample locations are illustrated on Figure 12 and labeled RP-1 through RP-5. Soil borings will be advanced to the depths as indicated in Table 13. All soil samples will be collected in accordance with USEPA region IV standard operating procedures and submitted to an accredited laboratory to be analyzed for the following parameters:

- VOCs – 8260B
- PAHs – 8270C
- RCRA Metals – 6020B
- Herbicides and Pesticides – Method 8151 and 8081A, respectively, for railroad spur samples only

No groundwater samples will be collected from this property.

4.2 901 LANGFORD AVENUE SAMPLING ACTIVITIES

Based on the identification of AOCs in Section 2 and the Exposure Assessment in Section 3, MACTEC recommends surface soil samples be collected along the railroad spur that crosses the northern portion of the property, and surface and subsurface soil samples be collected in the area of residual site fill along the southeastern portion of the proposed park boundary as indicated on Figure 12. Soil samples will be collected at the current soil surface and at a depth that corresponds to the proposed soil surface following excavation activities for the park development. Soil sample locations will require soil samples to be collected at multiple depths to assess the current surface soils as well as future surface soils. To collect the required data, the following fieldwork will be completed at 901 Langford Avenue:

- Collection and analysis of soil samples from the railroad spur (one surface sample for composite)
- Collection and analysis of soil samples in excavation areas within the residual fill area as identified by Hargreaves Associates (one current and one subsurface/future surface)

Rationale for Surface and Subsurface Soil Sample Collection at 901 Langford Avenue

No soil samples were collected during previous site assessments for surface soils at 901 Langford Avenue and therefore constitutes a surface soil data gap for the property. Given that the site was used in an industrial laundry operation, it is reasonable to assess both surface and subsurface soils on this subject property.

Proposed soil sample locations are illustrated on Figure 12 and labeled RP-6 and RP-7. Soil borings will be advanced to the depths as indicated in Table 13. All soil samples will be analyzed for the following parameters:

- VOCs – 8260B
- PAHs – 8270C
- RCRA Metals – 6020B
- Herbicides and Pesticides – Method 8151 and 8081A, respectively, for railroad spur samples only

No groundwater samples will be collected from this property.

4.3 939 LANGFORD AVENUE SAMPLING ACTIVITIES

Based on the identification of AOCs in Section 2 and the Exposure Assessment in Section 3, MACTEC recommends surface soil samples be collected along the railroad spur that crosses the northern portion of the property, and surface and subsurface soil samples be collected in areas identified as cut areas on Figure 12. Soil samples will be collected at the current soil surface and at a depth that corresponds to the proposed soil surface following excavation activities for the park development. Soil sample locations will require soil samples to be collected at multiple depths to assess the current surface soils as well as future surface soils. To collect the required data, the following fieldwork will be completed at 939 Langford Avenue:

- Collection and analysis of soil samples from the railroad spur (one surface sample for composite)
- Collection and analysis of soil samples and in the excavation area as identified by Hargreaves Associates (two current and two subsurface/future surface).

Rationale for Surface and Subsurface Soil Sample Collection at 939 Langford Avenue

No soil samples were collected during previous site assessments for surface soils as they relate to risk exposure at 939 Langford Avenue and therefore constitutes a surface soil data gap for the property. Given that the entire site was used in an industrial/commercial operations (PEC REC), it is reasonable to assess both surface and subsurface soils on this subject property.

Proposed soil sample locations are illustrated on Figure 12 and labeled RP-8 through RP-10. Soil borings will be advanced to the depths as indicated in Table 13. All soil samples will be analyzed for the following parameters:

- VOCs – 8260B
- PAHs – 8270C
- RCRA Metals – 6020B
- Herbicides and Pesticides – Method 8151 and 8081A, respectively, for railroad spur samples only

No groundwater samples will be collected from this property.

4.4 1015 AND 1101 PHILLIPS AVENUE SAMPLING ACTIVITIES

Based on the identification of AOCs in Section 2 and the Exposure Assessment in Section 3, MACTEC recommends that one sediment sample be collected at the bottom of the Tennessee River in the vicinity of the proposed dock as indicated on Figure 12. A single groundwater sample will be collected from the 1015 Phillips property. To collect the required data, the following fieldwork will be completed at 1015 and 1101 Phillips Avenue:

- Collection and analysis of one sediment sample from the bottom of the Tennessee River
- Collection and analysis of one groundwater sample from the 1015 Phillips property

Rationale for Sediment Sample Collection at 1015 and 1101 Phillips Avenue

No sediment samples were collected during previous site assessments at 1015 and 1101 Phillips Avenue and therefore constitutes a gap for the properties. Given that sediments in the Tennessee River are known to be contaminated, it is reasonable to assess sediments on these subject properties. TDEC requested that a groundwater sample be collected from the 1015 Phillips property since there were no previous groundwater samples from that property.

The proposed sample locations for the sediment and groundwater samples are illustrated on Figure 12 and labeled RP-11 and TW-1, respectively. The sediment sample will be analyzed for the following parameters:

- PCBs – 8082
- RCRA Metals – 6020B

The groundwater sample will be analyzed for the following parameters:

- VOCs – 8260B
- PAHs – 8270C
- RCRA Metals – 6020B

Following receipt of the analytical data for soil and sediment samples collected as outlined above, it will be reviewed for completeness and quality. The data will then be screening against a set of recreational use risk values for groundwater (Table 10) and against residential PRGs modified for recreational use for soils (Table 5). A short summary report will be written that details the sampling activities and subsequent data screening with a list of recommendations based on the data analysis and screening results.

5.0 CONCLUSIONS AND RECOMMENDATIONS

MACTEC recommends the execution of a the sampling plan as outlined in Section 4 and based on the City of Knoxville's property redevelopment schedule. In addition to assessment of groundwater and in order to mitigate groundwater use risk, a groundwater use deed restriction should be implemented for the site. TDEC-DUST land use deed restrictions for 701 Langford Avenue should also be revised as necessary to incorporate land use as a public park by revisiting and modifying the values for recreational use receptors as required by TDEC in its "Contamination Case Closure" letter issued on August 27, 2004. Upon completing the proposed site assessment and exposure assessment updates, TDEC, MACTEC, and the City of Knoxville will discuss the need for a Soil Management Plan for the River Plain Park development. Additional work for the project will be conducted in accordance with the Brownfields Voluntary Agreement between the City of Knoxville and TDEC Division of Remediation.

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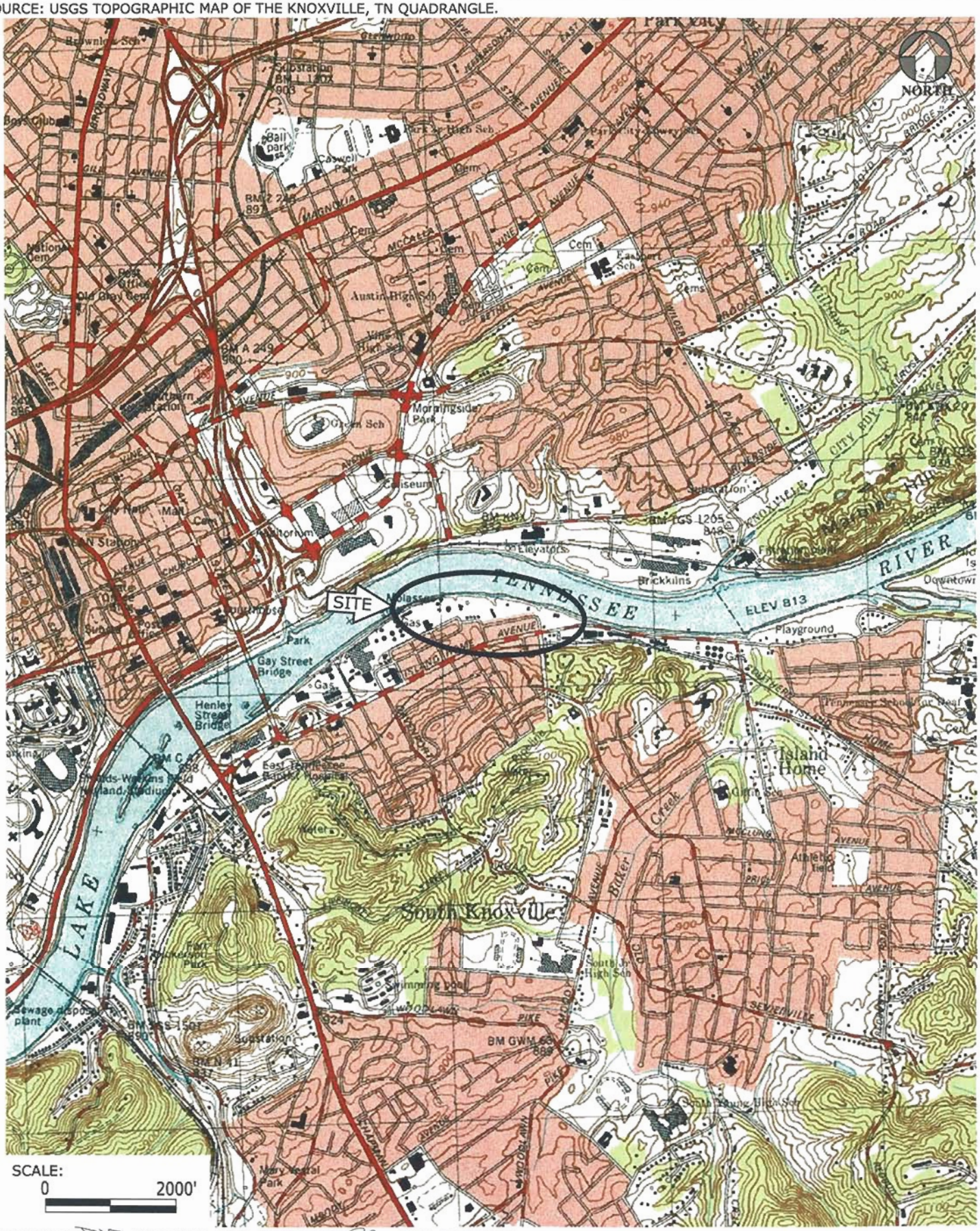
FIGURES

SOURCE: USGS TOPOGRAPHIC MAP OF THE KNOXVILLE, TN QUADRANGLE.



PREPARED BY: RSS DATE: 18 Nov 2009 CHECKED BY: GB DATE: 18 Nov 2009

CITY OF KNOXVILLE
SOUTH WATERFRONT
DEVELOPMENT DEPARTMENT
CITY-COUNTY BUILDING, 400 MAIN STREET
KNOXVILLE, TENNESSEE

MACTEC

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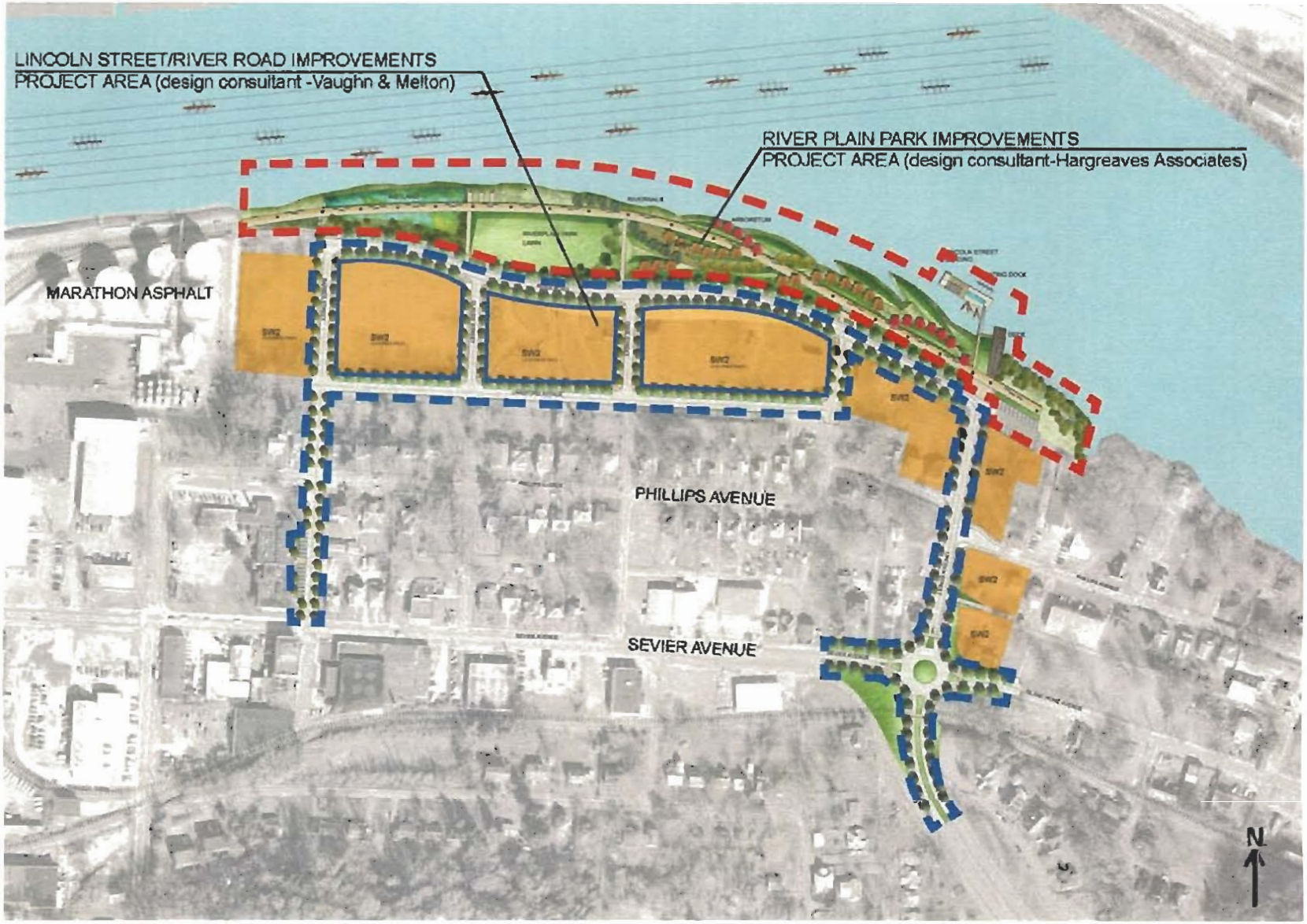
Phone: 865-588-8544 Fax: 865-588-8026

SITE LOCATION MAP
KNOXVILLE SOUTH
WATERFRONT PROPERTIES
KNOXVILLE, TENNESSEE

PROJECT NO. 3043-08-1018-08 FIGURE 1

Source: This drawing was adapted from a plan view provided by Hargreaves Associates.



PLAN A
RIVER PLAIN PARK AND LINCOLN STREET/RIVER ROAD PUBLIC IMPROVEMENT PROJECTS

Not to Scale
30 MAY 08

CITY OF KNOXVILLE
SOUTH WATERFRONT
DEVELOPMENT DEPARTMENT
CITY-COUNTY BUILDING, 400 MAIN STREET
KNOXVILLE, TENNESSEE

PREPARED BY: RES DATE: 17 Nov 2009 CHECKED BY: DATE: 17 Nov 2009

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Knoxville, TN 37932
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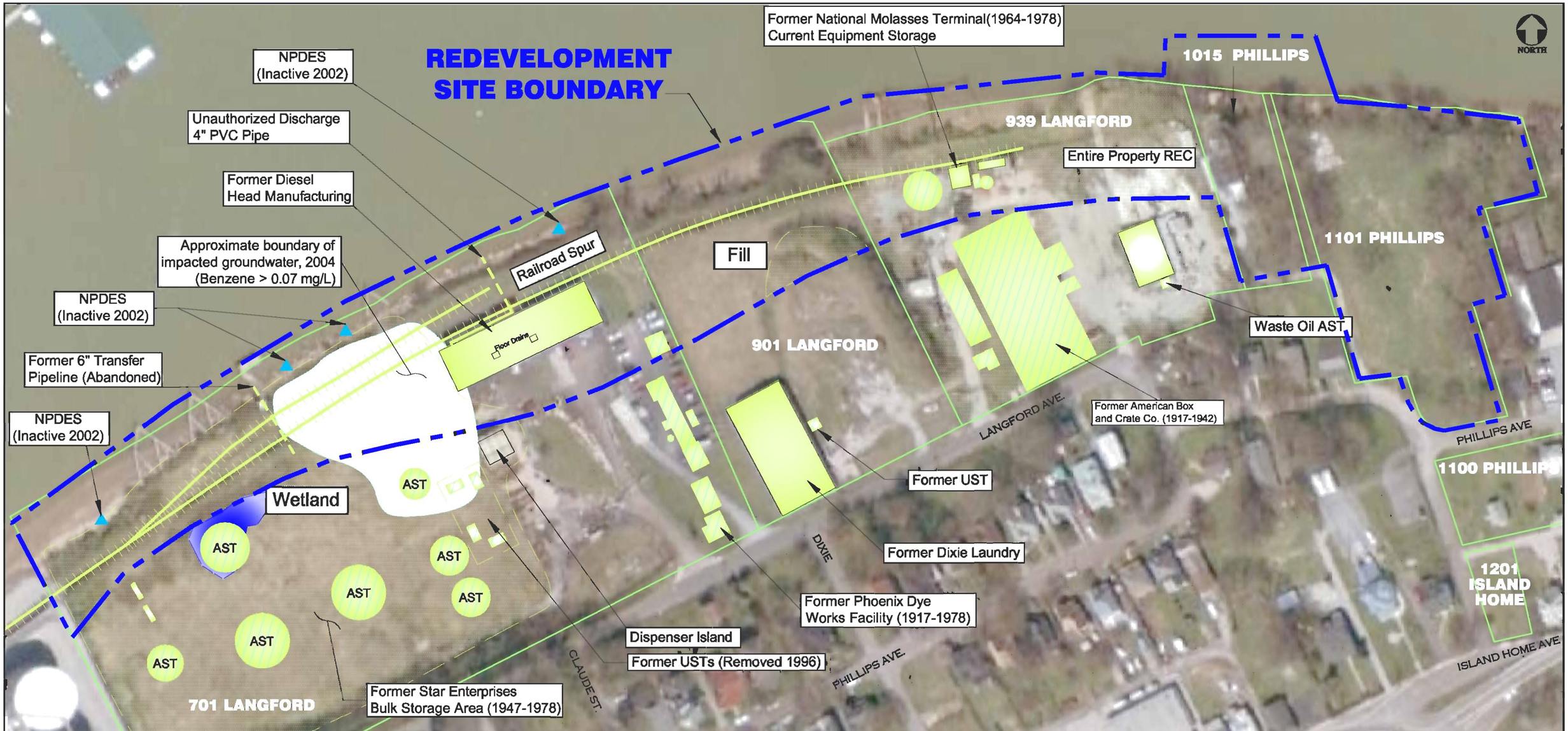
SOUTH KNOXVILLE RIVER PLAIN PARK
REDEVELOPMENT MAP
KNOXVILLE, TENNESSEE

PROJECT NO.: 3043-08-1018

FIGURE 2



LEGEND

- FORMER STRUCTURE

04 Dec 2009

04 Dec 2009

CITY OF KNOXVILLE
SOUTH WATERFRONT
DEVELOPMENT DEPARTMENT
CITY-COUNTY BUILDING, 400 MAIN STREET
KNOXVILLE, TENNESSEE

MACTEC

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865-588-8544

CURRENT AND FORMER LAND USE MAP
KNOXVILLE SOUTH
WATERFRONT PROPERTIES
KNOXVILLE, TENNESSEE

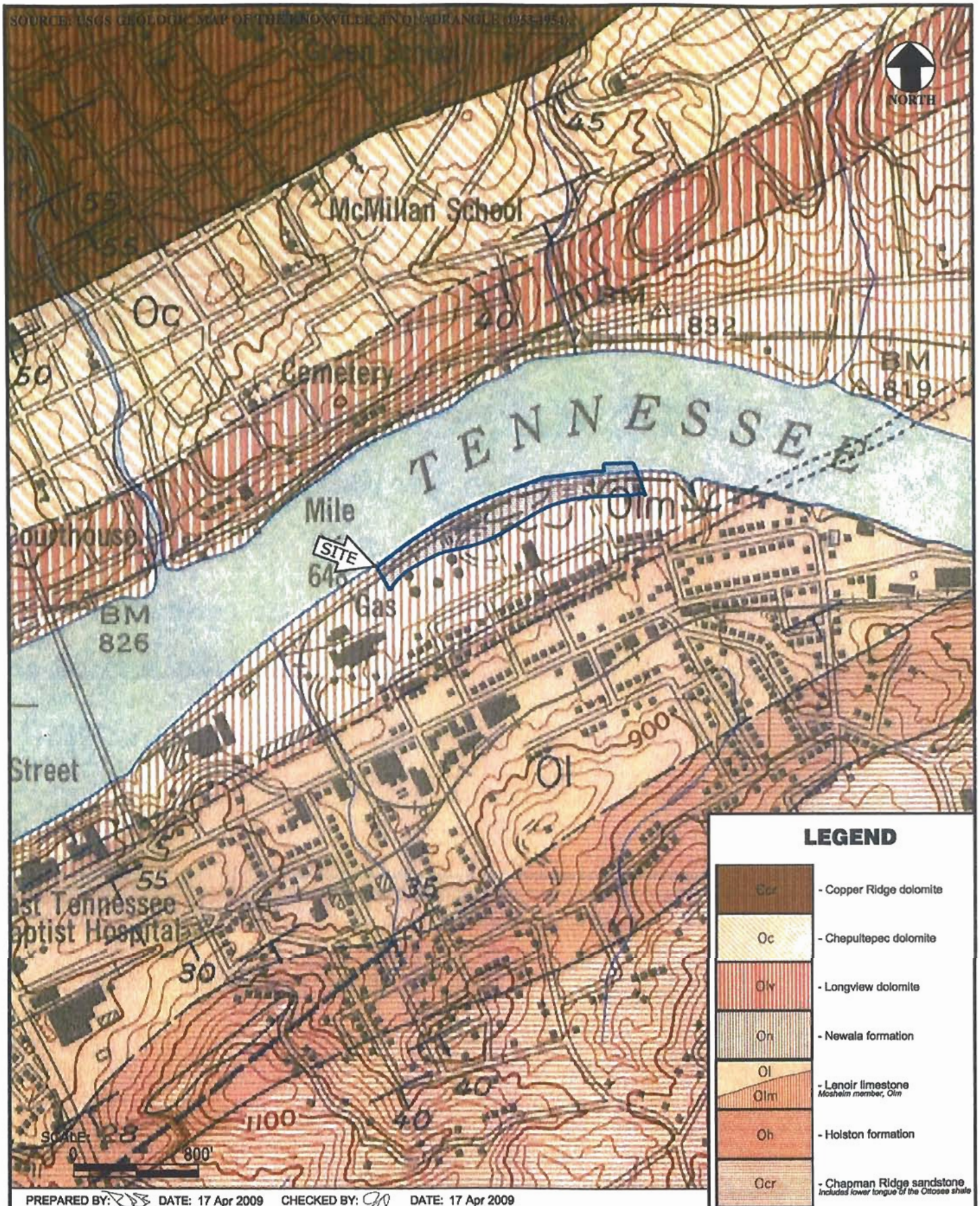
SCALE 0 100'

PROJECT NUMBER 3043-08-1018

FIGURE 3

CADD FILE

PLOT DATE Fri, 04 Dec 2009



PREPARED BY: RSE DATE: 17 Apr 2009 CHECKED BY: JB DATE: 17 Apr 2009

CITY OF KNOXVILLE
SOUTH WATERFRONT
DEVELOPMENT DEPARTMENT
CITY-COUNTY BUILDING, 400 MAIN STREET
KNOXVILLE, TENNESSEE

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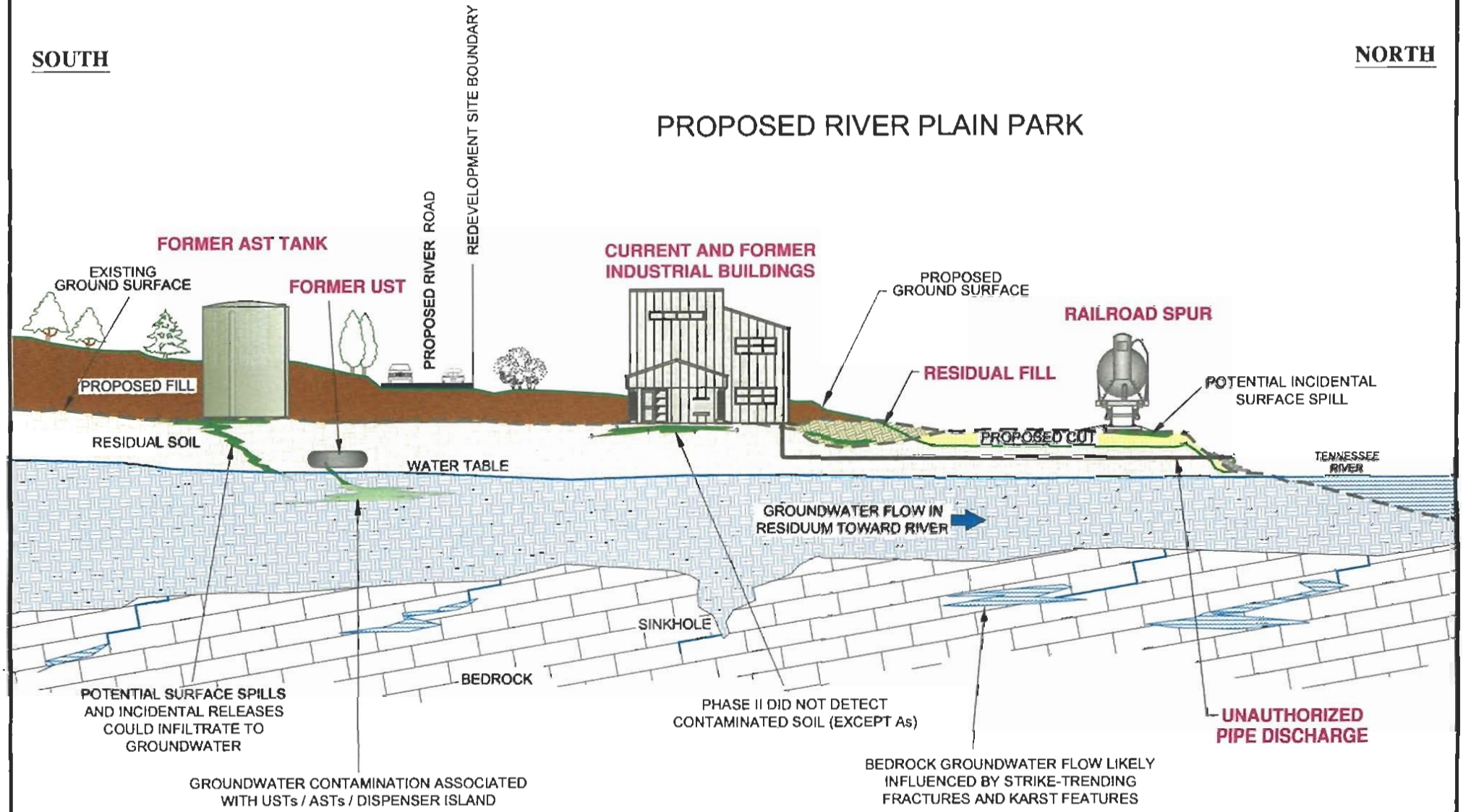
SITE GEOLOGY
SOUTH WATERFRONT - RIVER PLAIN PARK
KNOXVILLE, TENNESSEE

PROJECT NO. 3043-08-1018 FIGURE 4



CITY OF KNOXVILLE
SOUTH WATERFRONT
DEVELOPMENT DEPARTMENT
CITY-COUNTY BUILDING, 400 MAIN STREET
KNOXVILLE, TENNESSEE

PREPARED BY: DATE: 18 Nov 2009 CHECKED BY: DATE: 18 Nov 2009

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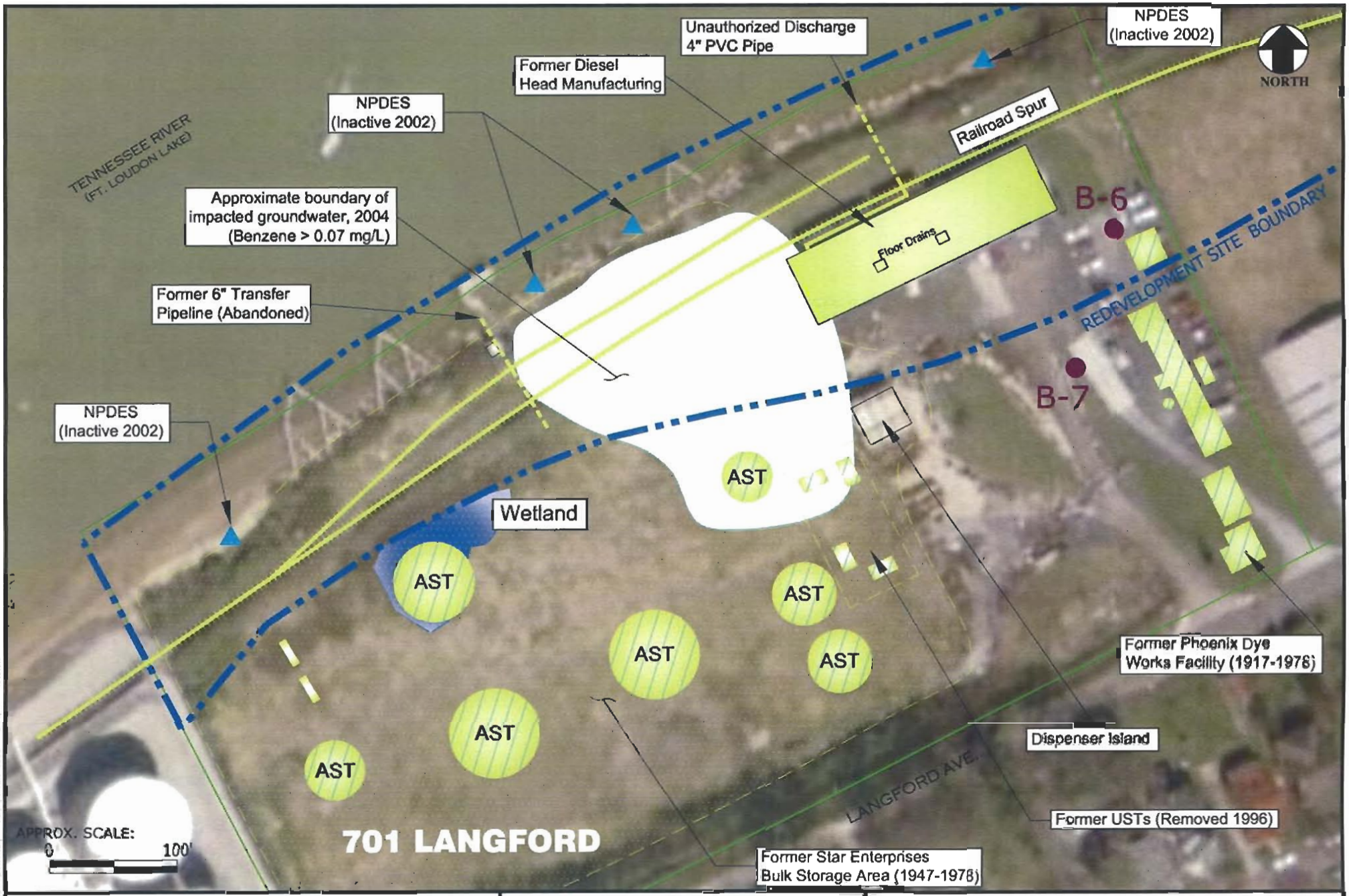
Knoxville, TN 37932
Phone: 865-588-8544 Fax: 865-588-8028

SITE CONCEPTUAL CROSS SECTION
SOUTH WATERFRONT - RIVER PLAIN PARK
KNOXVILLE, TENNESSEE

PROJECT NO.: 3043-08-1018

FIGURE 5



CITY OF KNOXVILLE
SOUTH WATERFRONT
DEVELOPMENT DEPARTMENT
CITY-COUNTY BUILDING, 400 MAIN STREET
KNOXVILLE, TENNESSEE

PREPARED BY: DATE: 24 Nov 2009 CHECKED BY: DATE: 24 Nov 2009

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701 LANGFORD AVENUE SITE MAP
SOUTH WATERFRONT - RIVER PLAIN PARK
KNOXVILLE, TENNESSEE

PROJECT NO.: 3043-08-1018

FIGURE 6

LEGEND

>1 FOOT CUT CONTOUR

DRAFTING BY & DATE: 04 Dec 2009

CHECKED BY & DATE: 04 Dec 2009

CITY OF KNOXVILLE
SOUTH WATERFRONT
DEVELOPMENT DEPARTMENT
CITY-COUNTY BUILDING, 400 MAIN STREET
KNOXVILLE, TENNESSEE

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Knoxville, Tennessee 37932
865-588-8544

AREAS OF CONCERN MAP
SOUTH WATERFRONT - RIVER PLAIN PARK
KNOXVILLE, TENNESSEE

SCALE: 0 100'

PROJECT NUMBER: 3043-08-1018

FIGURE: 7

CADD FILE:

PLOT DATE: Fr, 04 Dec 2009

CITY OF KNOXVILLE
SOUTH WATERFRONT
DEVELOPMENT DEPARTMENT
CITY-COUNTY BUILDING, 400 MAIN STREET
KNOXVILLE, TENNESSEE

PREPARED BY: DATE: 18 Nov 2009 CHECKED BY: DATE: 18 Nov 2009

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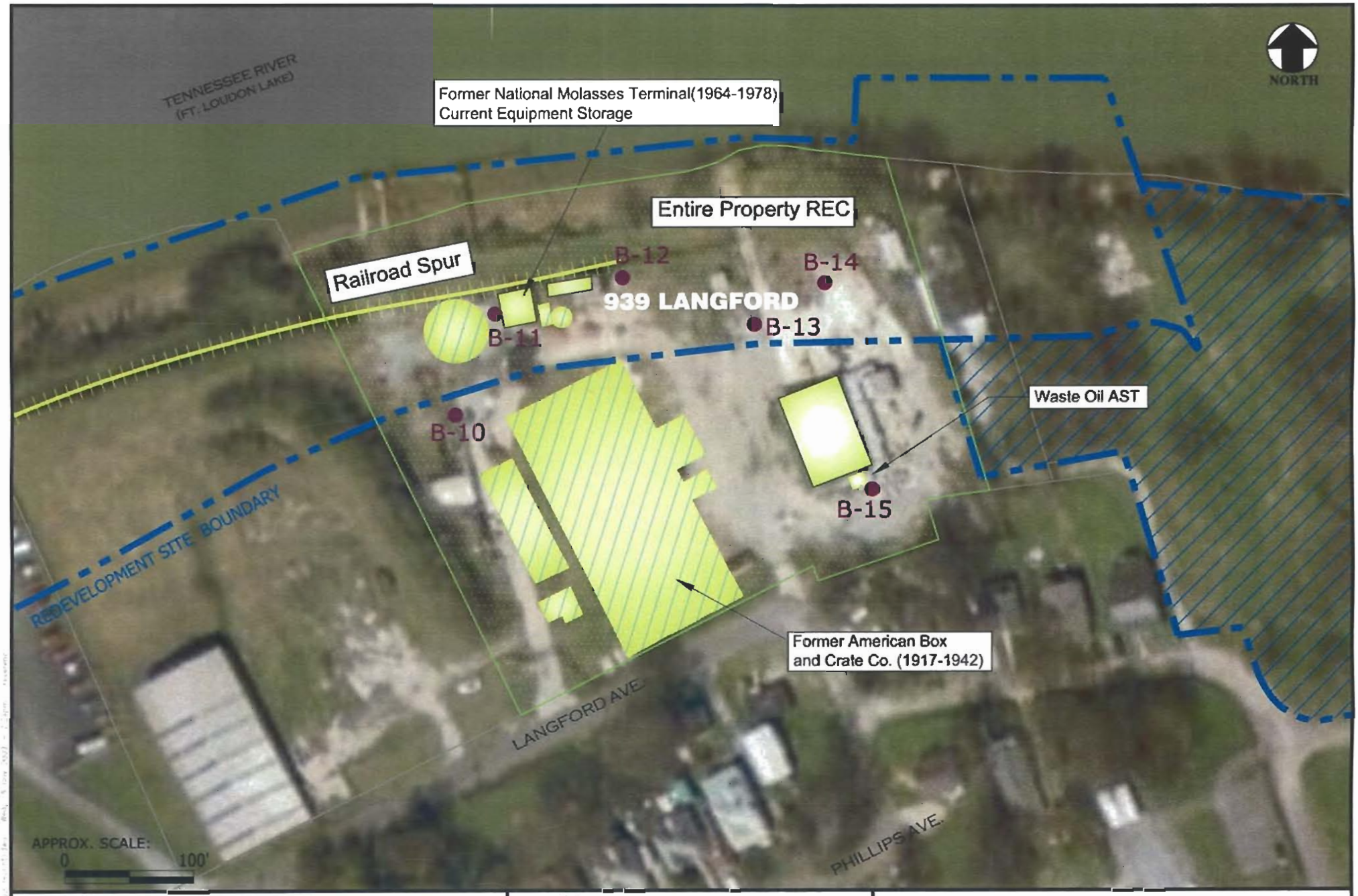
901 LANGFORD AVENUE SITE MAP
SOUTH WATERFRONT - RIVER PLAIN PARK
KNOXVILLE, TENNESSEE

PROJECT NO.: 3043-08-1018

FIGURE 8



CITY OF KNOXVILLE
SOUTH WATERFRONT
DEVELOPMENT DEPARTMENT
CITY-COUNTY BUILDING, 400 MAIN STREET
KNOXVILLE, TENNESSEE

PREPARED BY: DATE: 18 Nov 2009 CHECKED BY: DATE: 18 Nov 2009

MACTEC
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Phone: 865-588-8544 Fax: 865-588-8026

939 LANGFORD AVENUE SITE MAP
SOUTH WATERFRONT - RIVER PLAIN PARK
KNOXVILLE, TENNESSEE

PROJECT NO.: 3043-08-1018

FIGURE 9

CITY OF KNOXVILLE
SOUTH WATERFRONT
DEVELOPMENT DEPARTMENT
CITY-COUNTY BUILDING, 400 MAIN STREET
KNOXVILLE, TENNESSEE

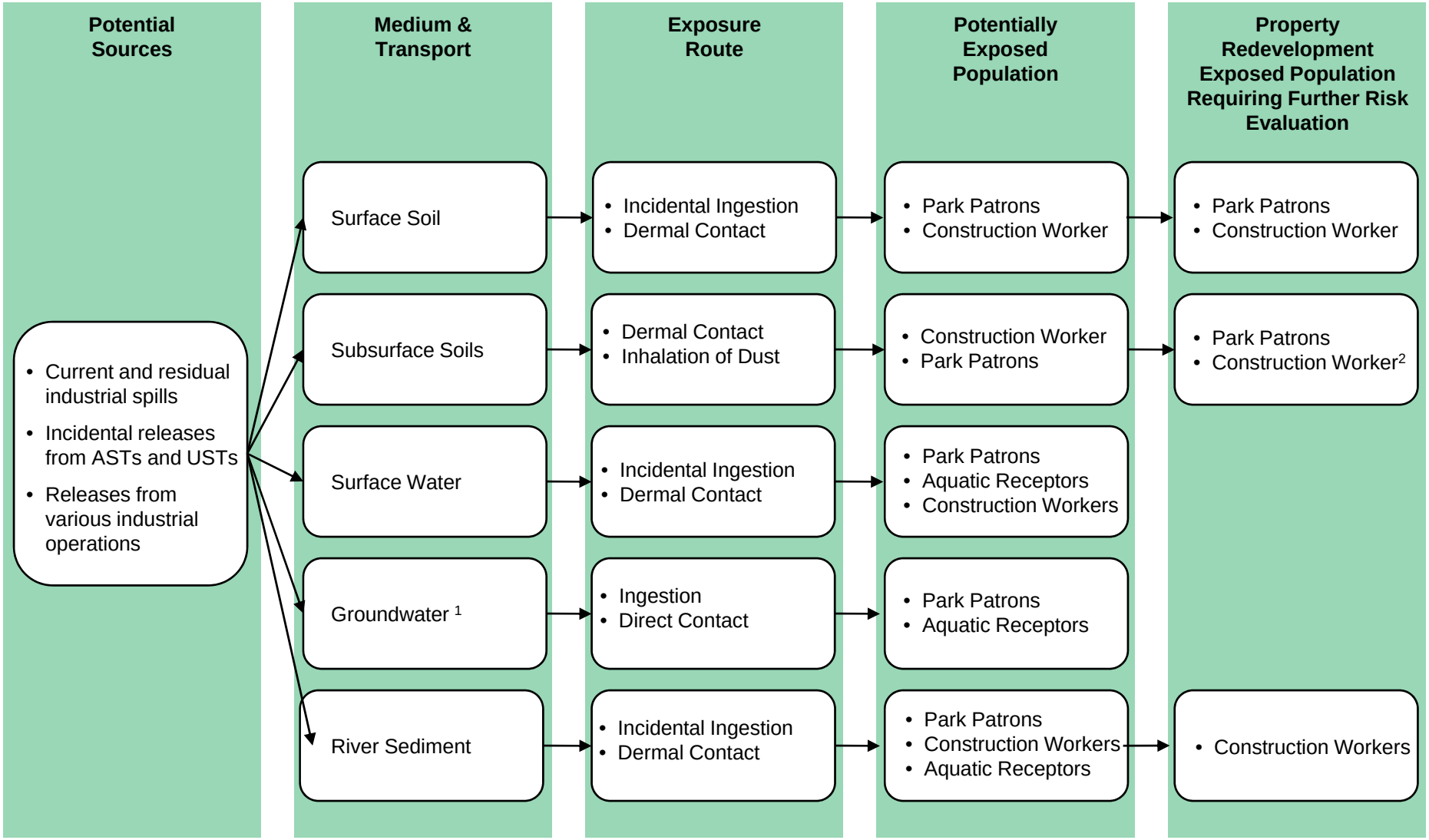
PREPARED BY: RJS DATE: 24 Nov 2009 CHECKED BY: RJS DATE: 24 Nov 2009

MACTEC
9725 Cogdill Road
Knoxville, TN 37932
Phone: 865-588-8544 Fax: 865-588-8026

1101 AND 1105 PHILLIPS AVENUE SITE MAP
SOUTH WATERFRONT - RIVER PLAIN PARK
KNOXVILLE, TENNESSEE

PROJECT NO.: 3043-08-1018

FIGURE 10



[1] Groundwater will not be used and will be deed restricted. Groundwater contamination potentially exists. The city will not be responsible for existing groundwater contamination.

[2] Ecological Risk Assessment for aquatic receptors is not applicable to proposed park development and will not be conducted.

CITY OF KNOXVILLE
SOUTH WATERFRONT
DEVELOPMENT DEPARTMENT
CITY-COUNTY BUILDING, 400 MAIN STREET
KNOXVILLE, TENNESSEE

PREPARED BY: DATE: 13 Apr 2009 CHECKED BY: DATE: 13 Apr 2009

MACTEC
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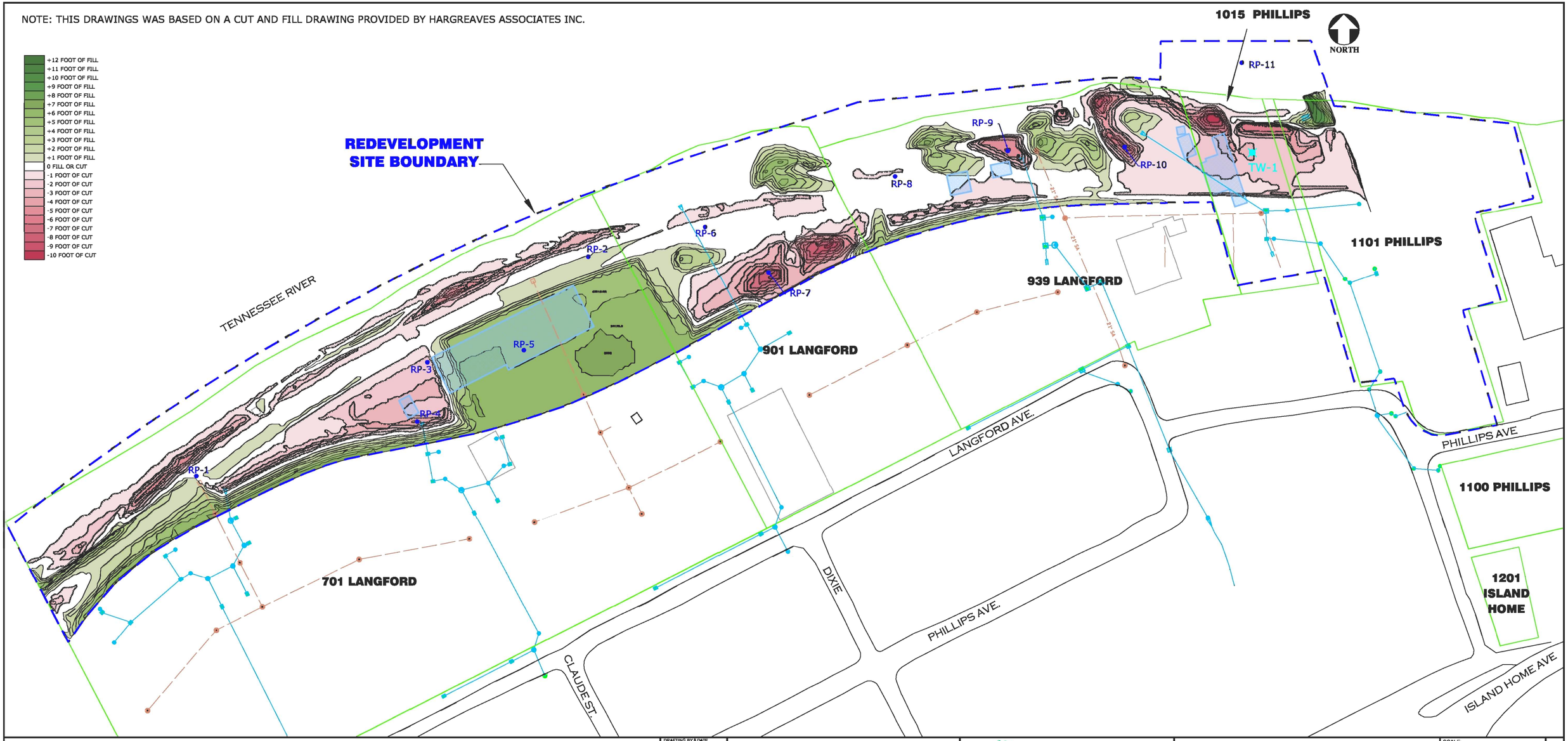
EXPOSURE PATHWAY EVALUATION
RIVER PLAIN PARK
WATERFRONT PROPERTIES
KNOXVILLE, TENNESSEE

PROJECT NO.: 3043-08-1018

FIGURE 11

NOTE: THIS DRAWINGS WAS BASED ON A CUT AND FILL DRAWING PROVIDED BY HARGREAVES ASSOCIATES INC.



LEGEND

- FILL 1' INTERVALS
- CUT 1' INTERVALS
- CURRENT STRUCTURES
- RP-10 - SAMPLE LOCATIONS
- TW-1 - APPROXIMATE TEMPORARY WELL LOCATION

DRAFTING BY & DATE: 04 Dec 2009

CHECKED BY & DATE: 04 Dec 2009

CITY OF KNOXVILLE
SOUTH WATERFRONT
DEVELOPMENT DEPARTMENT
CITY-COUNTY BUILDING, 400 MAIN STREET
KNOXVILLE, TENNESSEE

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SUPPLEMENTAL SAMPLING LOCATION MAP
SOUTH WATERFRONT - RIVER PLAIN PARK
WATERFRONT PROPERTIES
KNOXVILLE, TENNESSEE

SCALE: 0 100'

PROJECT NUMBER: 3043-08-1018

FIGURE: 12

CADD FILE: 3043081018_fig12 (11-24-09 reprv6).dwg

PLOT DATE: Fri, 04 Dec 2009

TABLES

Table 1: Future River Plain Park Property Summary

Address	Acreage	Parcel ID
701 Langford Avenue	8.86	095OB030
901 Langford Avenue	2.9	095OB028
939 Langford Avenue	3.49	095OB027
1015 Phillips Avenue	0.3	095OB019
1101 Philips Avenue	2.88	095OB016

Prepared by/Date: 4/16/09

Checked by/Date: 4/17/09

Table 2: PEC Phase II Soil Analytical Detection Results[1]

Constituents	Sample Locations (screen level in feet)													DUST Residential ISL (mg/kg)	DUST Commercial ISL (mg/kg)
	B-1 (16-18)	B-2 (22-24)	B-3 (22-24)	B-6 (12-14)	B-7 (12-14)	B-8 (12-14)	B-9 14-16)	B-10 (8-10)	B-11 (8-10)	B-12 (8-10)	B-13 (8-10)	B-14 (8-10)	B-15 (6-8)		
Ethylbenzene	BDL	BDL	BDL	BDL	BDL	BDL	0.19	BDL	BDL	BDL	BDL	BDL	BDL	143	1,310
Naphthalene	BDL	BDL	BDL	BDL	BDL	BDL	0.54	BDL	BDL	0.56	BDL	BDL	BDL	135	403
Other Constituents														**EPA Region IX Residential PRG**	**EPA Region IX Industrial PRG**
n-Butylbenzene	BDL	BDL	BDL	BDL	BDL	BDL	0.74	BDL	BDL	0.14	BDL	BDL	BDL	240	240
sec-Butylbenzene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.14	BDL	BDL	BDL	220	220
Isopropylbenzene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.052	BDL	BDL	BDL	570	2,000
2-Butanone (MEK)	BDL	BDL	BDL	BDL	BDL	BDL	3.8	BDL	BDL	3.4	BDL	BDL	BDL	22,000	110,000
n-Propylbenzene	BDL	BDL	BDL	BDL	BDL	BDL	0.52	BDL	BDL	0.10	BDL	BDL	BDL	240	240
1,2,3-Trimethylbenzene	BDL	BDL	BDL	BDL	BDL	BDL	0.64	BDL	BDL	BDL	BDL	BDL	BDL	NA	NA
Phenanthrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.063	BDL	BDL	BDL	NA	NA
Arsenic	NA	NA	NA	**4.7**	**4.2**	NA	NA	NA	NA	NA	NA	NA	**4.8**	0.39	1.6
Barium	NA	NA	NA	150	89	NA	NA	NA	NA	NA	NA	NA	110	5,400	67,000
Cadmium	NA	NA	NA	3.5	2.8	NA	NA	NA	NA	NA	NA	NA	3.2	37	450
Chromium	NA	NA	NA	19	14	NA	NA	NA	NA	NA	NA	NA	18	210	450
Lead	NA	NA	NA	17	12	NA	NA	NA	NA	NA	NA	NA	14	400	800
Mercury	NA	NA	NA	0.035	BDL	NA	NA	NA	NA	NA	NA	NA	0.025	23	310
Silver	NA	NA	NA	0.58	BDL	NA	NA	NA	NA	NA	NA	NA	0.54	390	5,100

[1] Professional Environmental Consulting, Inc., 2008. *Report of Limited Phase II Environmental Site Assessment, Knoxville South Waterfront Properties, Knoxville, Tennessee*. Prepared for Knoxville's Community Development Corporation (March 31).

Prepared by/Date: 4/16/09

Checked by/Date: 4/17/09

Samples B-1 through B-7 were sampled March 18, 2008, and samples B-8 through B-15 were sampled March 19, 2008.

Bold type indicates constituent detected above applicable regulatory level.

Notes: BDL = below detection limit
DUST = Division of Underground Storage Tank
EPA = Environmental Protection Agency
ISL = Initial Screening Level
mg/kg = milligrams per kilogram
NA = not applicable
PRG = Preliminary Remediation Goal (EPA Region IX)

Table 3: PEC Phase II Groundwater Analytical Detection Results[1]

Constituents	Sample Locations																DUST Drinking Water ISL	DUST Non-drinking Water ISL
	B-1	B-2	B-3	B-4	B-5	B-6	B-7	B-8	B-9	B-10	B-11	B-12	B-13	B-14	B-15	B-15 Filtered		
MTBE	BDL	BDL	BDL	BDL	BDL	BDL	0.039	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NA	0.02	175
Acenaphthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.0003	BDL	BDL	BDL	NA	0.939	NA
Anthracene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.000098	BDL	BDL	BDL	NA	0.0434	NA
Naphthalene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.00063	BDL	BDL	0.0018	BDL	BDL	BDL	NA	0.02	9.81
Phenanthrene	BDL	BDL	BDL	BDL	BDL	BDL	0.0018	BDL	BDL	BDL	BDL	0.00079	BDL	BDL	BDL	NA	0.469	NA
Pyrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.00027	BDL	BDL	BDL	NA	0.135	NA
Other Constituents																	**EPA MCL**	**EPA Region IX PRG**
Acetone	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.084	BDL	NA	NA	5.5
1-Methylnaphthalene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.0041	BDL	BDL	BDL	NA	NA	NA
2-Methylnaphthalene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.0005	BDL	BDL	0.0044	BDL	BDL	BDL	NA	NA	NA
Barium	NA	NA	NA	NA	NA	0.42	0.25	NA	NA	NA	NA	NA	NA	NA	0.11	0.062	2.0	NA
Lead	NA	NA	NA	NA	NA	0.0066	A	NA	NA	NA	NA	NA	NA	NA	**0.026**	BDL	0.015	NA

[1] Professional Environmental Consulting, Inc., 2008. *Report of Limited Phase II Environmental Site Assessment, Knoxville South Waterfront Properties, Knoxville, Tennessee.* Prepared for Knoxville's Community Development Corporation (March 31).

Prepared by/Date: 4/16/09

Checked by/Date: 4/17/09

Samples B-1 through B-5 were sampled March 18, 2008, and samples B-6 through B-15 were sampled March 19, 2008.

Results are reported in milligrams per liter.

Bold type indicates constituent detected above applicable regulatory level.

Notes: BDL = below detection limit
DUST = Division of Underground Storage Tank
EPA = Environmental Protection Agency
ISL = Initial Screening Level
MCL = Maximum Contaminant Levels
MTBE = methyl tert-butyl ether
NA = not applicable
PRG = Preliminary Remediation Goal (EPA Region IX)

Table 4: SAIC Groundwater Analytical Detection Results[1]
2004

	Groundwater Monitoring and Recovery Well Sample Locations																DUST Drinking Water ISL
Constituents	**MW-1A**	**MW-2**	**MW-3**	**MW-4**	**MW-5**	**MW-8**	**MW-9**	**MW-10A**	**MW-11**	**MW-12**	**MW-13**	**RW-1**	**RW-2**	**RW-3**	**RW-4**	**RW-5**	**RW-6**	**mg/L**
Benzene	**0.374**	<0.001	<0.001	<0.001	**0.148**	**0.029**	0.0022	**0.0270**	<0.001	**0.3**	<0.001	**0.012**	<0.001	**0.0869**	**0.2680**	**0.521**	<0.001	0.005
Toluene	0.002	<0.001	<0.001	<0.001	0.0024	<0.001	0.0016	<0.001	<0.001	**0.003**	<0.001	<0.001	<0.001	0.0109	0.0265	0.0098	<0.001	1.0
Ethlybenzene	0.003	<0.001	<0.001	<0.001	0.0046	0.0019	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0072	0.0082	0.0018	<0.001	0.70
Xylenes	0.004	<0.001	<0.001	<0.001	0.0014	0.0015	<0.001	<0.001	<0.001	**0.002**	<0.001	<0.001	<0.001	0.0552	0.0357	0.0023	<0.001	10
MTBE	**0.0434**	<0.001	<0.001	<0.001	**0.1570**	**1.84**	<0.001	**0.0337**	<0.001	**0.0263**	**0.004**	<0.001	<0.001	**0.0229**	0.0074	**0.0468**	0.0165	0.02

[1] SAIC, 2004. *Third Quarterly Closure Monitoring Report, Former Chevron Facility 211997, 701 Langford Avenue, Knoxville, Tennessee, TN Facility I.D., #2-470668* (February 25).

SAIC, 2004. *Fourth (Final) Quarterly Closure Monitoring Report, Former Chevron Facility 211997, 701 Langford Avenue, Knoxville, Tennessee, TN Facility I.D., #2-470668* (May 26).

Prepared by/Date: mi 4/16/09

Checked by/Date: MA 4/17/09

Results are reported in milligrams per liter.

Bold type indicates constituent detected above applicable regulatory level.

Notes: BDL = below detection limit
DUST = Division of Underground Storage Tank
ISL = Initial Screening Level
mg/L = milligrams per liter
MTBE = methyl tert-butyl ether

Table 5: Derivation of Risk-Based Screening Levels – Recreational Exposure to Soil

Chemical	Residential Soil RSL (mg/kg)		Recreational Screening Value[1] (mg/kg)
Volatile Organic Compounds (mg/kg)			
Benzene	1.1	c	2.2
Ethylbenzene	5.7	c	11
Toluene	5,000	n	7,000
Xylene	600	n	840
MTBE	39	c	78
Polyaromatic Hydrocarbons (mg/kg)			
Benzo(a)anthracene	0.15	c	0.30
Benzo(a)pyrene	0.015	c	0.030
Benzo(b)fluoranthene	0.15	c	0.30
Benzo(k)fluoranthene	1.5	c	3.0
Chrysene	15	c	30
Dibenz(a,h)anthracene	0.015	c	0.030
Indeno(1,2,3-cd)pyrene	0.15	c	0.30
Naphthalene	3.9	c	7.8
Inorganics (mg/kg)			
PCBs	0.22	c	0.44
Inorganics (mg/kg)			
Aluminum	77,000	n	107,800
Antimony	31	n	43
Arsenic	0.39	c	0.78
Barium	15,000	n	21,000
Beryllium	160	n	224
Cadmium	70	n	98
Chromium	280	c	560
Cobalt	23	n	32
Copper	3,100	n	4,340
Lead	400	n	560
Manganese	1,800	n	2,520
Mercury	6.7	n	9.4
Nickel	1,600	n	2,240

Table 5: Derivation of Risk-Based Screening Levels – Recreational Exposure to Soil (Continued)

Chemical	Residential Soil RSL (mg/kg)		Recreational Screening Value[1] (mg/kg)
Selenium	390	n	546
Silver	390	n	546
Thallium	5.1	n	7.1
Vanadium	550	n	770
Zinc	23,000	n	32,200
Petroleum Hydrocarbons (mg/kg)			
EPH[2]	1,700		2,380

[1] Screening value is the USEPA Residential Regional Screening Level (RSL) multiplied by a factor of 1.4 for non-carcinogens and a factor of 1.98 for carcinogens. This modification results in a risk-based screening value that assumes children and adults are exposed to soil in a park at the intensity that is assumed for backyard soil at a residence, but at a frequency and adults are exposed to soil in a park at the intensity that is assumed for backyard soil at a residence, but at a frequency and adults are exposed to soil in a park at the intensity that is assumed for backyard soil at a residence, but at a frequency and adults are exposed to soil in a park at the intensity that is assumed for backyard soil at a residence, but at a frequency that is less than 350 days per year, which is the frequency that is used by USEPA in the derivation of the RSLs. Specifically, it is assumed that young children would be exposed to soil at the park 5 days per week (250 days per year) and older children and adults would be exposed to soil at the park 3 days per week (156 days per year). Since RSLs based on non-cancer risks are derived for young children, a factor of 1.4 (350/250) is applied for values based non-cancer risks. Since RSLs based on cancer risks are derived for young children (6 year duration) and adults (24 year duration), an age-averaged factor of 1.98 is applied for values based cancer risks (5 days/week x 6 years + 3 days/week x 24 years)/30 years = avg of 3.4 days per week exposure over a 30 year duration, or 177 days/year (350/175 = 2.0).

[2] Pyrene value used as a surrogate for EPH.

Notes: c = Regional Screening Levels is based on an excess lifetime cancer risk of 1 in 1 million.
EPH = Extractable Petroleum Hydrocarbons
mg/kg = milligrams per kilogram
n = Regional Screening Level is based on a non-cancer hazard quotient of 1.0

Prepared by: JHP
Checked by: MH

Table 6: Values Used For Daily Intake Calculations – Recreational Exposure to Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Points	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation / Model Name
Ingestion	Recreational Visitor	Adult	Wetland	CW-c	Chemical Concentration in Water		mg/L		CHEMICAL INTAKE-INGESTION (mg/kg-day)=
				IR-W	Ingestion Rate of Water	0.025	L/hr	BPJ	CW-c x IR-W x FI x ET x EF x ED x 1/BW x 1/AT
				ET	Exposure Time	1	hr/event	USEPA, 1997	
				FI	Fraction Ingested	1	unitless	BPJ	
				EF	Exposure Frequency - Wading	34	event/yr	BPJ[1]	
				ED	Exposure Duration	24	yr	USEPA, 1991	
				BW	Body Weight	70	kg	USEPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	day	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	8,760	day	USEPA, 1989/equal to ED	
		Child (ages 1-6)	Wetland	CW-c	Chemical Concentration in Water		mg/L		CHEMICAL INTAKE-INGESTION (mg/kg-day)=
				IR-W	Ingestion Rate of Water	0.025	L/hr	USEPA, 1988	CW-c x IR-W x FI x ET x EF x ED x 1/BW x 1/AT
				ET	Exposure Time	1	hr/event	USEPA, 1997	
				FI	Fraction Ingested	1	unitless	BPJ	
				EF	Exposure Frequency - Wading	34	event/yr	BPJ [1, 2]	
				ED	Exposure Duration	6	yr	USEPA, 1991	
				BW	Body Weight	15	kg	USEPA, 1991	
				AT-C	Averaging Time (Cancer)	25,550	day	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,190	day	USEPA, 1989/equal to ED	
Dermal	Recreational Visitor	Adult	Wetland	CW	Chemical Concentration in Water		mg/L		INTAKE-DERMAL (mg/kg-day)=
				DAevent	Permeability Constant Per Event	chemical-specific	mg/cm^2-event	USEPA, 2004	DAevent x SA x EF x ED x EV x 1/BW x 1/AT
				SA	Skin Surface Area Available for Contact - Wading	9,540	cm^2	USEPA, 1997[3]	DAevent = CW x CF x PCevent
				tevent	Exposure Time	1	hr/event	USEPA, 1997	where:
				EF	Exposure Frequency - Wading	34	event/yr	BPJ[1]	PCevent is tevent multiplied by chemical-specific parameters
				ED	Exposure Duration	24	yr	USEPA, 1991	B, t*, Tevent, and Kp, using the algorithm that is appropriate
				EV	Event Frequency	1	event/day	USEPA, 2004	for the relationship between tevent and t*, per USEPA (2004)
				BW	Body Weight	70	kg	USEPA, 1991	and as described in the risk assessment text.
				AT-C	Averaging Time (Cancer)	25,550	day	USEPA, 1989	Calculations are documented in the risk calculations appendix.
				AT-N	Averaging Time (Non-Cancer)	8,760	day	USEPA, 1989/equal to ED	
				CF	Conversion Factor	0.001	L/cm^3		
		Child (ages 1-6)	Wetland	CW	Chemical Concentration in Water		mg/L		INTAKE-DERMAL (mg/kg-day)=
				DAevent	Permeability Constant Per Event	chemical-specific	mg/cm^2-event	USEPA, 2004	DAevent x SA x EF x ED x EV x 1/BW x 1/AT
				SA	Skin Surface Area Available for Contact - Wading	3,050	cm^2	USEPA, 1997[3]	DAevent = CW x CF x PCevent
				tevent	Exposure Time	1	hr/event	USEPA, 1997	where:
				EF	Exposure Frequency - Wading	34	event/yr	BPJ[1, 2]	PCevent is tevent multiplied by chemical-specific parameters
				ED	Exposure Duration	6	yr	USEPA, 1991	B, t*, Tevent, and Kp, using the algorithm that is appropriate
				EV	Event Frequency	1	event/day	USEPA, 2004	for the relationship between tevent and t*, per USEPA (2004)
				BW	Body Weight	15	kg	USEPA, 1991	and as described in the risk assessment text.
				AT-C	Averaging Time (Cancer)	25,550	day	USEPA, 1989	Calculations are documented in the risk calculations appendix.
				AT-N	Averaging Time (Non-Cancer)	2,190	day	USEPA, 1989/equal to ED	
				CF	Conversion Factor	0.001	L/cm^3		

USEPA, 1989. "Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A)"; Office of Emergency and Remedial Response; EPA-540/1-89/002 (interim final); Washington, D.C., December.
USEPA, 1991. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Supplemental Guidance, Standard Default Exposure Factors"; OSWER Directive 9285.6-03 (interim final); Washington, D.C
USEPA, 1997. "Exposure Factors Handbook, Volume 1"; Office of Research and Development; EPA-600/P-95/002Fa; Washington, D.C.; August.
USEPA, 2004. "Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.

[1] Assumes two events per week during June, July, August, and Sept.

[2] Assumes the same exposure frequency as adults. This is conservative for young children who are unlikely to wade in the Site surface water bodies. However, use of this exposure frequency for both the young child and adult ensures that risks for older children (who are more likely to wade at this frequency) are not under estimated.

[3] Surface area for legs (thighs and lower legs), feet, forearms, and hands, calculated as average areas for males and females, for ages 1 through 6 and older than 18 (used for adults).

Notes: cm^2 = square centimeters
cm^3 = cubic centimeters
hr = hour
kg = kilograms
L = liter
mg = milligrams
yr = year

Prepared by: JHP

Checked by: MH

Table 7: Calculation of Chemical Cancer Risks and Non-cancer Hazards – Future Recreational Visitor – Child

SCENARIO TIMEFRAME: FUTURE
RECEPTOR POPULATION: RECREATIONAL VISITOR
RECEPTOR AGE: CHILD

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical	EPC		CANCER RISK CALCULATIONS					NON-CANCER HAZARD CALCULATIONS				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC[1]		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water	Surface Water	Wetland	Ingestion	MTBE	0.001	mg/L	1.3E-08	mg/kg/day	1.8E-03	mg/kg/day	2.E-11	1.6E-07	mg/kg/day	ND		
				Naphthalene	0.001	mg/L	NC		NC			1.6E-07	mg/kg/day	2.0E-02	mg/kg/day	8.E-06
				Benzene	0.001	mg/L	1.3E-08	mg/kg/day	5.5E-02	mg/kg/day	7.E-10	1.6E-07	mg/kg/day	4.0E-03	mg/kg/day	4.E-05
				Ethylbenzene	0.001	mg/L	NC		NC			1.6E-07	mg/kg/day	1.0E-01	mg/kg/day	2.E-06
				Toluene	0.001	mg/L	NC		NC			1.6E-07	mg/kg/day	8.0E-02	mg/kg/day	2.E-06
				Xylene	0.001	mg/L	NC		NC			1.6E-07	mg/kg/day	2.0E-01	mg/kg/day	8.E-07
				Vinyl chloride	0.001	mg/L	1.3E-08	mg/kg/day	1.4E+00	mg/kg/day	2.E-08	1.6E-07	mg/kg/day	3.0E-03	mg/kg/day	5.E-05
				Trichloroethene	0.001	mg/L	1.3E-08	mg/kg/day	1.3E-02	mg/kg/day	2.E-10	1.6E-07	mg/kg/day	3.0E-04	mg/kg/day	5.E-04
				Benzo(a)anthracene	0.001	mg/L	7.1E-08	mg/kg/day	7.3E-01	mg/kg/day	5.E-08	1.6E-07	mg/kg/day	3.0E-02	mg/kg/day	5.E-06
				Benzo(a)pyrene	0.001	mg/L	7.1E-08	mg/kg/day	7.3E+00	mg/kg/day	5.E-07	1.6E-07	mg/kg/day	3.0E-02	mg/kg/day	5.E-06
				Benzo(b)fluoranthene	0.001	mg/L	7.1E-08	mg/kg/day	7.3E-01	mg/kg/day	5.E-08	1.6E-07	mg/kg/day	3.0E-02	mg/kg/day	5.E-06
				Benzo(k)fluoranthene	0.001	mg/L	7.1E-08	mg/kg/day	7.3E-02	mg/kg/day	5.E-09	1.6E-07	mg/kg/day	3.0E-02	mg/kg/day	5.E-06
				Chrysene	0.001	mg/L	7.1E-08	mg/kg/day	7.3E-03	mg/kg/day	5.E-10	1.6E-07	mg/kg/day	3.0E-02	mg/kg/day	5.E-06
				Dibenz(a,h)anthracene	0.001	mg/L	7.1E-08	mg/kg/day	7.3E+00	mg/kg/day	5.E-07	1.6E-07	mg/kg/day	3.0E-02	mg/kg/day	5.E-06
				Indeno(1,2,3-cd)pyrene	0.001	mg/L	7.1E-08	mg/kg/day	7.3E-01	mg/kg/day	5.E-08	1.6E-07	mg/kg/day	3.0E-02	mg/kg/day	5.E-06
			Exposure Route Total								1.E-06					7.E-04
			Dermal	MTBE	0.001	mg/L	--		1.8E-03	mg/kg/day		--		ND		
				Naphthalene	0.001	mg/L	NC		NC			1.8E-06	mg/kg/day	2.0E-02	mg/kg/day	9.E-05
				Benzene	0.001	mg/L	3.8E-08	mg/kg/day	5.5E-02	mg/kg/day	2.E-09	4.4E-07	mg/kg/day	4.0E-03	mg/kg/day	1.E-04
				Ethylbenzene	0.001	mg/L	NC		NC			1.7E-06	mg/kg/day	1.0E-01	mg/kg/day	2.E-05
				Toluene	0.001	mg/L	NC		NC			9.9E-07	mg/kg/day	8.0E-02	mg/kg/day	1.E-05
				Xylene	0.001	mg/L	NC		NC			--		2.0E-01	mg/kg/day	
				Vinyl chloride	0.001	mg/L	1.3E-08	mg/kg/day	1.4E+00	mg/kg/day	2.E-08	1.6E-07	mg/kg/day	3.0E-03	mg/kg/day	5.E-05
				Trichloroethene	0.001	mg/L	--		1.3E-02	mg/kg/day		--		3.0E-04	mg/kg/day	
				Benzo(a)anthracene	0.001	mg/L	1.6E-05	mg/kg/day	7.3E-01	mg/kg/day	1.E-05	3.5E-05	mg/kg/day	3.0E-02	mg/kg/day	1.E-03
				Benzo(a)pyrene	0.001	mg/L	2.7E-05	mg/kg/day	7.3E+00	mg/kg/day	2.E-04	6.0E-05	mg/kg/day	3.0E-02	mg/kg/day	2.E-03
				Benzo(b)fluoranthene	0.001	mg/L	2.8E-05	mg/kg/day	7.3E-01	mg/kg/day	2.E-05	6.1E-05	mg/kg/day	3.0E-02	mg/kg/day	2.E-03
				Benzo(k)fluoranthene	0.001	mg/L	2.8E-05	mg/kg/day	7.3E-02	mg/kg/day	2.E-06	6.1E-05	mg/kg/day	3.0E-02	mg/kg/day	2.E-03
				Chrysene	0.001	mg/L	1.6E-05	mg/kg/day	7.3E-03	mg/kg/day	1.E-07	3.5E-05	mg/kg/day	3.0E-02	mg/kg/day	1.E-03
				Dibenz(a,h)anthracene	0.001	mg/L	4.2E-05	mg/kg/day	7.3E+00	mg/kg/day	3.E-04	9.3E-05	mg/kg/day	3.0E-02	mg/kg/day	3.E-03
				Indeno(1,2,3-cd)pyrene	0.001	mg/L	2.9E-05	mg/kg/day	7.3E-01	mg/kg/day	2.E-05	6.4E-05	mg/kg/day	3.0E-02	mg/kg/day	2.E-03
			Exposure Route Total								6.E-04					1.E-02
		Exposure Point Total									6.E-04					1.E-02
	Exposure Medium Total										6.E-04					1.E-02
Total Receptor Risk Across All Media											**6.E-04**	**Total Receptor Hazard Across All Media**				**1.E-02**

[1] Blank cells indicate that an RfD or RfC is not available from the sources used to obtain dose-response data for this risk assessment.

Notes: -- = Not calculated; dose-response data and/or dermal absorption values are not available.
NA = Not applicable; exposure route not applicable for this chemical/exposure medium.
NC = Not carcinogenic by this exposure route.
NV = Not volatile; exposure route not complete for this chemical.

Prepared by: JHP

Checked by: MH

Table 8: Calculation of Chemical Cancer Risks and Non-cancer Hazards – Future Recreational Visitor – Adult

SCENARIO TIMEFRAME: FUTURE
RECEPTOR POPULATION: RECREATIONAL VISITOR
RECEPTOR AGE: ADULT

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical	EPC		Cancer Risk Calculations					Non-cancer Hazard Calculations				
							Intake/Exposure Concentration		CSF/Unit Risk			Intake/Exposure Concentration		RfD/RfC[1]		HAZARD QUOTIENT
					Value	Units	Value	Units	Value	Units	Cancer Risk	Value	Units	Value	UNITS	
Surface Water	Surface Water	Wetland	Ingestion	MTBE	0.001	mg/L	1.1E-08	mg/kg/day	1.8E-03	mg/kg/day	2.E-11	3.3E-08	mg/kg/day	ND		
				Naphthalene	0.001	mg/L	NC		NC			3.3E-08	mg/kg/day	2.0E-02	mg/kg/day	2.E-06
				Benzene	0.001	mg/L	1.1E-08	mg/kg/day	5.5E-02	mg/kg/day	6.E-10	3.3E-08	mg/kg/day	4.0E-03	mg/kg/day	8.E-06
				Ethylbenzene	0.001	mg/L	NC		NC			3.3E-08	mg/kg/day	1.0E-01	mg/kg/day	3.E-07
				Toluene	0.001	mg/L	NC		NC			3.3E-08	mg/kg/day	8.0E-02	mg/kg/day	4.E-07
				Xylene	0.001	mg/L	NC		NC			3.3E-08	mg/kg/day	2.0E-01	mg/kg/day	2.E-07
				Vinyl chloride	0.001	mg/L	1.1E-08	mg/kg/day	1.4E+00	mg/kg/day	2.E-08	3.3E-08	mg/kg/day	3.0E-03	mg/kg/day	1.E-05
				Trichloroethene	0.001	mg/L	1.1E-08	mg/kg/day	1.3E-02	mg/kg/day	1.E-10	3.3E-08	mg/kg/day	3.0E-04	mg/kg/day	1.E-04
				Benzo(a)anthracene	0.001	mg/L	2.1E-08	mg/kg/day	7.3E-01	mg/kg/day	1.E-08	3.3E-08	mg/kg/day	3.0E-02	mg/kg/day	1.E-06
				Benzo(a)pyrene	0.001	mg/L	2.1E-08	mg/kg/day	7.3E+00	mg/kg/day	1.E-07	3.3E-08	mg/kg/day	3.0E-02	mg/kg/day	1.E-06
				Benzo(b)fluoranthene	0.001	mg/L	2.1E-08	mg/kg/day	7.3E-01	mg/kg/day	1.E-08	3.3E-08	mg/kg/day	3.0E-02	mg/kg/day	1.E-06
				Benzo(k)fluoranthene	0.001	mg/L	2.1E-08	mg/kg/day	7.3E-02	mg/kg/day	1.E-09	3.3E-08	mg/kg/day	3.0E-02	mg/kg/day	1.E-06
				Chrysene	0.001	mg/L	2.1E-08	mg/kg/day	7.3E-03	mg/kg/day	1.E-10	3.3E-08	mg/kg/day	3.0E-02	mg/kg/day	1.E-06
				Dibenz(a,h)anthracene	0.001	mg/L	2.1E-08	mg/kg/day	7.3E+00	mg/kg/day	1.E-07	3.3E-08	mg/kg/day	3.0E-02	mg/kg/day	1.E-06
				Indeno(1,2,3-cd)pyrene	0.001	mg/L	2.1E-08	mg/kg/day	7.3E-01	mg/kg/day	1.E-08	3.3E-08	mg/kg/day	3.0E-02	mg/kg/day	1.E-06
			Exposure Route Total								4.E-07					1.E-04
			DERMAL	MTBE	0.001	mg/L	--		1.8E-03	mg/kg/day		--		ND		
				Naphthalene	0.001	mg/L	NC		NC			1.2E-06	mg/kg/day	2.0E-02	mg/kg/day	6.E-05
				Benzene	0.001	mg/L	1.0E-07	mg/kg/day	5.5E-02	mg/kg/day	6.E-09	3.0E-07	mg/kg/day	4.0E-03	mg/kg/day	7.E-05
				Ethylbenzene	0.001	mg/L	NC		NC			1.1E-06	mg/kg/day	1.0E-01	mg/kg/day	1.E-05
				Toluene	0.001	mg/L	NC		NC			6.6E-07	mg/kg/day	8.0E-02	mg/kg/day	8.E-06
				Xylene	0.001	mg/L	NC		NC			--		2.0E-01	mg/kg/day	
				Vinyl chloride	0.001	mg/L	3.6E-08	mg/kg/day	1.4E+00	mg/kg/day	5.E-08	1.0E-07	mg/kg/day	3.0E-03	mg/kg/day	3.E-05
				Trichloroethene	0.001	mg/L	--		1.3E-02	mg/kg/day		--		3.0E-04	mg/kg/day	
				Benzo(a)anthracene	0.001	mg/L	1.5E-05	mg/kg/day	7.3E-01	mg/kg/day	1.E-05	2.4E-05	mg/kg/day	3.0E-02	mg/kg/day	8.E-04
				Benzo(a)pyrene	0.001	mg/L	2.5E-05	mg/kg/day	7.3E+00	mg/kg/day	2.E-04	4.0E-05	mg/kg/day	3.0E-02	mg/kg/day	1.E-03
				Benzo(b)fluoranthene	0.001	mg/L	2.5E-05	mg/kg/day	7.3E-01	mg/kg/day	2.E-05	4.1E-05	mg/kg/day	3.0E-02	mg/kg/day	1.E-03
				Benzo(k)fluoranthene	0.001	mg/L	2.5E-05	mg/kg/day	7.3E-02	mg/kg/day	2.E-06	4.1E-05	mg/kg/day	3.0E-02	mg/kg/day	1.E-03
				Chrysene	0.001	mg/L	1.5E-05	mg/kg/day	7.3E-03	mg/kg/day	1.E-07	2.4E-05	mg/kg/day	3.0E-02	mg/kg/day	8.E-04
				Dibenz(a,h)anthracene	0.001	mg/L	3.9E-05	mg/kg/day	7.3E+00	mg/kg/day	3.E-04	6.3E-05	mg/kg/day	3.0E-02	mg/kg/day	2.E-03
				Indeno(1,2,3-cd)pyrene	0.001	mg/L	2.6E-05	mg/kg/day	7.3E-01	mg/kg/day	2.E-05	4.3E-05	mg/kg/day	3.0E-02	mg/kg/day	1.E-03
			Exposure Route Total								5.E-04					8.E-03
		Exposure Point Total									5.E-04					8.E-03
	Exposure Medium Total										5.E-04					8.E-03
TOTAL RECEPTOR RISK ACROSS ALL MEDIA											**5.E-04**	**TOTAL RECEPTOR HAZARD ACROSS ALL MEDIA**				**8.E-03**

[1] Blank cells indicate that an RfD or RfC is not available from the sources used to obtain dose-response data for this risk assessment.

NOTES: -- = Not calculated; dose-response data and/or dermal absorption values are not available.
NA = Not applicable; exposure route not applicable for this chemical/exposure medium.
NC = Not carcinogenic by this exposure route.
NV = Not volatile; exposure route not complete for this chemical.

Prepared by: JHP

Checked by: MH

Table 9: Derivation of Risk-Based Screening Levels – Recreational Exposure to Groundwater that Discharges to Surface Water

Chemical	Risk @ Exposure to 1 µg/L in Surface Water[1]				Surface Water Screening Level (µg/L) [2]		Groundwater Screening Level (µg/L) [3]
	Adult-cancer	Child-cancer	Total-cancer	Child-non cancer	Cancer risk = 1E-06	HI = 1	
MTBE	2.1E-11	2.4E-11	4.4E-11	See note 4	22,480	See note 4	224,799
Naphthalene		Not carcinogenic		0.00010	Not carcinogenic	10,111	101,110
Benzene	6.2E-09	2.8E-09	9.0E-09	0.00015	111	6,712	1,110
Ethylbenzene		Not carcinogenic		0.000018	Not carcinogenic	54,780	547,798
Toluene		Not carcinogenic		0.000014	Not carcinogenic	70,071	700,707
Xylene		Not carcinogenic		0.00000078	Not carcinogenic	1,288,235	12,882,353
Vinyl chloride	6.6E-08	3.7E-08	1.0E-07	0.00010	9.7	9,647	96.7
Trichloroethene	1.5E-10	1.7E-10	3.2E-10	0.00052	3,113	1,932	19,324
Benzo(a)anthracene	1.1E-05	1.2E-05	2.2E-05	0.0012	0.045	845	0.45
Benzo(a)pyrene	1.8E-04	2.0E-04	3.8E-04	0.0020	0.0026	497	0.026
Benzo(b)fluoranthene	1.8E-05	2.0E-05	3.9E-05	0.0020	0.026	489	0.26
Benzo(k)fluoranthene	1.8E-06	2.0E-06	3.8E-06	0.0020	0.26	489	2.6
Chrysene	1.1E-07	1.2E-07	2.2E-07	0.0012	4.5	845	44.5
Dibenz(a,h)anthracene	2.8E-04	3.1E-04	5.9E-04	0.0031	0.0017	321	0.017
Indeno(1,2,3-cd)pyrene	1.9E-05	2.1E-05	4.0E-05	0.0021	0.025	471	0.25

[1] Risks are calculated in Tables 7 and 8, and represent the sum of risks for the ingestion and dermal pathways.
[2] Calculated as (target risk for screening level)/(risk calculated for exposure to 1 µg/L).
[3] Calculated as the lower of the cancer or non-cancer based surface water screening level, multiplied by a dilution factor of 10.
[4] A non-cancer reference dose for MTBE has not been published. Therefore, screening levels are based on cancer risks only.

Prepared by: JHP
Checked by: MH

Table 10: PEC Phase II Soil Analytical Detection Results Compared to Risk Based Screening Levels for Recreational Exposure to Soil

Constituents	Sample Locations (screen level in feet)													Recreational Screening Value (mg/kg)
	B-1 (16-18)	B-2 (22-24)	B-3 (22-24)	B-6 (12-14)	B-7 (12-14)	B-8 (12-14)	B-9 14-16)	B-10 (8-10)	B-11 (8-10)	B-12 (8-10)	B-13 (8-10)	B-14 (8-10)	B-15 (6-8)	
Ethylbenzene	BDL	BDL	BDL	BDL	BDL	BDL	0.19	BDL	BDL	BDL	BDL	BDL	BDL	11
Naphthalene	BDL	BDL	BDL	BDL	BDL	BDL	0.54	BDL	BDL	0.56	BDL	BDL	BDL	7.8
n-Butylbenzene	BDL	BDL	BDL	BDL	BDL	BDL	0.74	BDL	BDL	0.14	BDL	BDL	BDL	NC
sec-Butylbenzene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.14	BDL	BDL	BDL	NC
Isopropylbenzene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.052	BDL	BDL	BDL	NC
2-Butanone (MEK)	BDL	BDL	BDL	BDL	BDL	BDL	3.8	BDL	BDL	3.4	BDL	BDL	BDL	NC
n-Propylbenzene	BDL	BDL	BDL	BDL	BDL	BDL	0.52	BDL	BDL	0.10	BDL	BDL	BDL	NC
1,2,3-Trimethylbenzene	BDL	BDL	BDL	BDL	BDL	BDL	0.64	BDL	BDL	BDL	BDL	BDL	BDL	NC
Phenanthrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.063	BDL	BDL	BDL	NC
Arsenic	NA	NA	NA	**4.7**	**4.2**	NA	NA	NA	NA	NA	NA	NA	**4.8**	0.78
Barium	NA	NA	NA	150	89	NA	NA	NA	NA	NA	NA	NA	110	21,000
Cadmium	NA	NA	NA	3.5	2.8	NA	NA	NA	NA	NA	NA	NA	3.2	98
Chromium	NA	NA	NA	19	14	NA	NA	NA	NA	NA	NA	NA	18	560
Lead	NA	NA	NA	17	12	NA	NA	NA	NA	NA	NA	NA	14	560
Mercury	NA	NA	NA	0.035	BDL	NA	NA	NA	NA	NA	NA	NA	0.025	9.4
Silver	NA	NA	NA	0.58	BDL	NA	NA	NA	NA	NA	NA	NA	0.54	546

Arsenic results are within the normal ranges commonly detected in background soils of East Tennessee (Boerngen, J.G. and Hansford, T.S., 1981. *Chemical Analysis of Soils and Other Surface Materials of the Coterminous United States*. USGS Open File Report 81-197).

Prepared by/Date: 4/16/09

Checked by/Date: 4/17/09

Samples B-1 through B-7 were sampled March 18, 2008, and samples B-8 through B-15 were sampled March 19, 2008.

Bold type indicates constituent detected above recreational screening value.

Notes: BDL = below detection limit
mg/kg = milligrams per kilogram
NA = not applicable
NC = not calculated

Table 11: SAIC Groundwater Analytical Detection Results Compared to Risk Based Screening Levels for Recreational Exposure to Groundwater
2004

Constituents	Groundwater Monitoring and Recovery Well Sample Locations																Recreational Screening Value (mg/L)
	MW-1A	MW-2	MW-3	MW-4	MW-5	MW-8	MW-9	MW-10A	MW-11	MW-12	MW-13	RW-1	RW-2	RW-3	RW-4	RW-5	RW-6	
Benzene	0.374	<0.001	<0.001	<0.001	0.148	0.029	0.0022	0.0270	<0.001	**0.3**	<0.001	**0.012**	<0.001	0.0869	0.2680	0.521	<0.001	1
Toluene	0.002	<0.001	<0.001	<0.001	0.0024	<0.001	0.0016	<0.001	<0.001	**0.003**	<0.001	<0.001	<0.001	0.0109	0.0265	0.0098	<0.001	701
Ethlybenzene	0.003	<0.001	<0.001	<0.001	0.0046	0.0019	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0072	0.0082	0.0018	<0.001	548
Xylenes	0.004	<0.001	<0.001	<0.001	0.0014	0.0015	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	0.0552	0.0357	0.0023	<0.001	12,882
MTBE	0.0434	<0.001	<0.001	<0.001	0.1570	1.84	<0.001	0.0337	<0.001	0.0263	**0.004**	<0.001	<0.001	0.0229	0.0074	0.0468	0.0165	225

Prepared by/Date: [illegible] 4/17/09

Checked by/Date: [illegible] 4/17/09

Results are reported in milligrams per liter.

Bold type indicates constituent detected above applicable regulatory level.

Notes: BDL = below detection limit
mg/L = milligrams per liter
MTBE = methyl tert-butyl ether

Table 12: PEC Phase II Groundwater Analytical Detection Results Compared to Risk Based Screening Levels for Recreational Exposure to Groundwater

Constituents	Sample Locations																Recreational Screening Value (mg/L)
	B-1	B-2	B-3	B-4	B-5	B-6	B-7	B-8	B-9	B-10	B-11	B-12	B-13	B-14	B-15	B-15 Filtered	
MTBE	BDL	BDL	BDL	BDL	BDL	BDL	0.039	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NA	225
Acenaphthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.0003	BDL	BDL	BDL	NA	NC
Anthracene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.000098	BDL	BDL	BDL	NA	NC
Naphthalene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.00063	BDL	BDL	0.0018	BDL	BDL	BDL	NA	101
Phenanthrene	BDL	BDL	BDL	BDL	BDL	BDL	0.0018	BDL	BDL	BDL	BDL	0.00079	BDL	BDL	BDL	NA	NC
Pyrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.00027	BDL	BDL	BDL	NA	NC
Acetone	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.084	BDL	NA	NC
1-Methylnaphthalene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.0041	BDL	BDL	BDL	NA	NC
2-Methylnaphthalene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.0005	BDL	BDL	0.0044	BDL	BDL	BDL	NA	NC
Barium	NA	NA	NA	NA	NA	0.42	0.25	NA	NA	NA	NA	NA	NA	NA	0.11	0.062	NC
Lead	NA	NA	NA	NA	NA	0.0066	A	NA	NA	NA	NA	NA	NA	NA	**0.026**	BDL	NC

Samples B-1 through B-5 were sampled March 18, 2008, and samples B-6 through B-15 were sampled March 19, 2008.

Prepared by/Date: 4/16/09

Results are reported in milligrams per liter.

Checked by/Date: 4/17/09

Bold type indicates constituent detected above recreational screening value.

Notes: BDL = below detection limit
MTBE = methyl tert-butyl ether
NA = not applicable
NC = not calculated

Table 13: Proposed Sample Summary Table

Property	Sample ID	Sample Depth (feet)	Media Type	Analysis
701 Langford Avenue	RP-1	0-2'*, 3'-5'	Soil	VOCs, PAHs, Metals, Herbicides, Pesticides
	RP-2	0-2'	Soil	PAHs, Metals, Herbicides, Pesticides
	RP-3	0-2' and 3'-4'	Soil	VOCs, PAHs, SVOCs, Metals, Herbicides, Pesticides
	RP-4	0-2' and 5'-6'	Soil	VOCs, PAHs, SVOCs, Metals
	RP-5 Drain	0-2'	Soil	VOCs, SVOCs, Metals
901 Langford Avenue	RP-6	0-2'	Soil	PAHs, Metals, Herbicides, Pesticides
	RP-7	0-2' and 9'-10'	Soil	VOCs, PAHs, Metals
939 Langford Avenue	RP-8	0-2'	Soil	PAHs, Metals, Herbicides, Pesticides
	RP-9	0-2'	Soil	VOCs, PAHs, Metals
	RP-10	0-2'	Soil	VOCs, PAHs, Metals
1015 and 1101 Phillips Avenue	RP-11	0-2'	River Sediment	PCBs, Metals
1015 Phillips Avenue	TW-1	Water Table	Groundwater	VOCs, PAHs, Metals

* Composite each sample from 0 to 2 feet for all surface samples.

Notes: PAH = polynuclear aromatic hydrocarbon
PCB = polychlorinated biphenyl
SVOC = semivolatile organic compound
VOC = volatile organic compound

Prepared by/Date: 4/17/09

Checked by/Date: 8/31/09