COLLEGE POINT 3

FEASIBILITY STUDY REPORT

WORK ASSIGNMENT D007622-10.1A

COLLEGE POINT 3 SITE — SITE NO. 241122
COLLEGE POINT — QUEENS COUNTY, NY

Prepared for:
NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
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DIVISION OF ENVIRONMENTAL REMEDIATION
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CERTIFICATION

I Craig W. Pawlewski certify that I am currently a NYS registered professional engineer as defined in 6 NYCRR Part 375 and that this Feasibility Study Report was prepared in accordance with all applicable statutes and regulations and in substantial conformance with the DER Technical Guidance for Site Investigation and Remediation (DER-10) and that all activities were performed in full accordance with the DER-approved work plan and any DER-approved modifications.

FEASIBILITY STUDY REPORT

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SITE NO. 241122
COLLEGE POINT, QUEENS COUNTY, NEW YORK

Prepared for:

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
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ABBREVIATIONS

amsl	above mean sea level
bgs	below ground surface
DO	dissolved oxygen
ERH	electrical resistance heating
FFS	Focused Feasibility Study
ft	feet
gpm	gallons per minute
GWET	groundwater extraction and treatment
NYCDEP	New York City Department of Environmental Protection
NYCRR	New York State Code, Rules, and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OM&M	operation, maintenance and monitoring
ORP	oxidation/reduction potential
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
PCE	tetrachloroethene
PID	photoionization detector
ppb	parts per billion (micrograms per liter [ug/L])
RAOs	remedial action objectives
RI	Remedial Investigation
ROD	Record of Decision
SCGs	standards, criteria, and guidance
SVE	soil vapor extraction
TMV	toxicity, mobility or volume
TOGS	Technical and Operational Guidance Series
UIC	Underground and Injection Control
URS	URS Corporation – New York
USEPA	United States Environmental Protection Agency
VOCs	volatile organic compounds

1.0 INTRODUCTION AND BACKGROUND

1.1 General

URS Corporation (URS) has prepared this *Feasibility Study* (FS) for the New York State Department of Environmental Conservation (NYSDEC) for the College Point 3 Site (No. 241122). The work for this FS report is being performed for the NYSDEC under Work Assignment (WA) No. D007622-10.1.

1.2 Site History and Description

The Site is located on land that was reclaimed from the East River via unregulated landfilling prior to 1970. Sand, silt, and clay are mixed with varying amounts of construction and demolition (C&D) debris as well as industrial waste. Investigations on the College Point Properties Voluntary Clean-up Program (VCP) site V00254, located to the west of the Site, identified the presence of Light Non-Aqueous Phase Liquid (LNAPL) along its eastern site boundary, which is shared with the Site. The LNAPL was found to contain polychlorinated biphenyls (PCBs). As part of the VCP remediation at the College Point Properties VCP site, a subsurface barrier wall was installed during winter/spring 2007 to prevent any migration of LNAPL. The NYSDEC assigned an Immediate Response Work Assignment (IRWA) to URS in 2007 to determine if the PCB containing LNAPL was present beneath the College Point 3 Site/Riverview Condominiums.

The Site is located in an urban/residential area of the College Point section of Queens adjacent to the East River (Figure 1-1). The Site initially consisted of a 0.24-acre grassy parcel of land within the Riverview Condominium complex between several condominiums. The investigation area was expanded to include the Riverview Condominium properties bounded by the East River to the north, Capstan Court/121st Street to the east, Ketch Court to the south, and the College Point Properties VCP site to the west, as delineated on Figure 1-2.

For the purposes of this report, the area of the remedial investigation boundary as shown on Figure 1-2 will be henceforth referred to as the "Site". The Site is a mix of 2 to 3 story condominium buildings, pavement and grassy areas. Grassy areas are found between the condominium buildings (i.e., between Riviera Court, Capstan Court and Cove Court and Cove

Court, 121st Street and Ketch Court) and between the condominium buildings located on Rivera Court and the East River.

1.3 Investigations Prior to the Remedial Investigation

Eight on-site investigations were performed prior to the Remedial Investigation (RI). Investigations by Earth Tech Northeast Inc. (Earth Tech) in March 2008 and May 2009 included collection of air samples at private residences. Based on the results of the sampling, the New York State Department of Health (NYSDOH) determined that no further action was required at the residences sampled. AECOM performed site inspections from April 2009 through June 2010 that included water level measurements, LNAPL measurements, and re-installation of absorbent socks in on-site wells. A total of 7.39 gallons of LNAPL was removed during the site investigations.

Prior to the RI fieldwork, URS conducted five phases of site characterization fieldwork at the Site and surrounding areas. These investigations included sampling of surface soil, subsurface soil, groundwater, surface water, and soil vapor. The results from these investigations were similar to those from the RI. Results from all the investigations are discussed in the following section.

1.4 Remedial Investigation

The objective of the RI was to define the horizontal and vertical extent of contamination related to the Site in surface and subsurface soil, overburden groundwater, surface water, seep, sediment and soil vapor. The results of this investigation, together with data from previous investigations as part of the area-wide site characterization, will be used to develop remedial action objectives and support the selection of an appropriate remedial action to address contamination related to the site. The RI results are summarized below.

1.4.1 Geology and Hydrogeology

The following textural units have been found in the upper glacial aquifer from the surface downward: an urban fill unit and stratified mixtures of sands, silts and clays. The urban fill unit thickness on-site varies from approximately 12 feet to greater than 32 feet thick and consists of a heterogeneous mixture of sand, silt, clay and varying amounts of C&D debris (i.e., bricks, concrete, coal, slag, asphalt, metal, wire, foam, wood, etc.) and has been found at all boring locations. Industrial wastes (e.g., plastic containers, melted plastic) were also found at test trenches excavated during previous investigations. Petroleum, in the form of a sheen, oil blobs, and/or LNAPL, was detected in 44 of the 54 soil borings advanced on the site. Tar-like substances were found in 4 boring locations (SB-11, DEC-017, DEC-36, and DEC-44). Native soils, consisting of stratified mixtures of sand, silts and clays were encountered at 4 of the 54 boring locations advanced at the Site at depths ranging from 12 to 33 feet bgs.

The water table surface may be found between approximately 9 and 21 feet bgs depending on the well location and was primarily found in the urban fill unit. The groundwater flow in the shallow overburden is semi-radial from the center of Capstan Court/121st Street to the north, west and south. Horizontal hydraulic gradients range from 0.0006 to 0.0484 ft/ft. Horizontal hydraulic conductivity values range from 2.55×10^{-3} to 9.43×10^{-2} cm/sec.

Based on the results of the tidal influence study, the influence of tide-induced elevation changes in site wells indicated no changes in wells 120 feet from the shoreline. Tide-induced changes were measured only in the well located 50 feet from the shoreline. Based upon the tidal influence study, a majority of the site and all monitoring wells containing LNAPL are not influenced by tidal fluctuations.

1.4.2 Surface Soil

Surface soil sample results were compared to unrestricted use, residential, restricted residential and protection of groundwater criteria. SVOCs and PCBs were the primary contaminants in the surface soils.

One or more SVOCs, mostly PAHs, exceeded unrestricted criteria at 19 of 33 locations sampled and protection of groundwater criteria at 17 of 33 locations sampled. One or more PAHs exceeded both residential use and restricted residential use criteria at 19 of 33 locations sampled.

Total PCBs exceeded unrestricted use criteria at 25 of 33 locations sampled and exceeded protection of groundwater criteria at one location. Total PCBs exceeded residential use and restricted residential use criteria at four locations.

The following metals exceeded unrestricted, residential, restricted residential use and protection of groundwater criteria at one or more locations: arsenic and lead. Copper exceeded unrestricted, residential and restricted residential use criteria at one or more locations. Chromium and iron exceeded unrestricted and residential use criteria at one or more locations. Selenium exceeded unrestricted use and protection of groundwater criteria at one or more locations. Aluminum, beryllium, calcium, mercury, vanadium and zinc only exceeded unrestricted use criteria at one or more locations.

1.4.3 Subsurface Soil

Subsurface soil sample results were compared to unrestricted use, residential, restricted residential and protection of groundwater criteria. VOCs, SVOCs, PCBs, and metals were the primary contaminants in subsurface soils.

One or more VOC exceeded unrestricted use criteria and exceeded protection of groundwater criteria at the same locations at one or more depth interval at 36 of 56 sample locations. One or more of the BTEX compounds exceeded residential use criteria at six locations. PCE and 1,2,4-trimethylbenzene were each detected above residential criteria at one location. One or more of the BTEX compounds exceeded restricted residential use criteria at five locations and 1,2,4-trimethylbenzene was detected above the restricted residential criterion at one location.

One or more SVOC, mostly PAHs, exceeded unrestricted use criteria at all locations sampled except DEC-24, DEC-49, SA-03 and ST-01. One or more SVOC, mostly PAHs, exceeded protection of groundwater criteria at all locations sampled except DEC-24, DEC-49 and ST-02. For the SVOCs, the compounds and locations that exceeded unrestricted use criteria also exceeded residential use and restricted residential use criteria.

Pesticides exceeded unrestricted criteria at one or more depth interval at 5 of the 56 sample locations. One pesticide (endrin) exceeded protection of groundwater criteria at one or more depth interval at 3 of the 56 sample locations. The pesticides alpha and gamma chlordane exceeded residential use criteria at one or more depth interval at 1 of the 56 sample locations. No pesticides exceeded restricted residential use criteria.

Total PCBs exceeded unrestricted use criteria at one or more depth interval at 46 of the 56 sample locations. Total PCBs exceeded protection of groundwater criteria at one or more depth interval at 19 of the 56 sample locations. Total PCBs exceeded residential use and restricted residential use criteria at 36 of the 56 sample locations.

The following metals exceeded unrestricted, residential, restricted residential use and protection of groundwater criteria at one or more location and at one or more depth interval: arsenic, barium, cadmium, copper, lead, mercury, nickel and zinc. Selenium exceeded unrestricted, residential use and protection of groundwater criteria at one or more location and at one or more depth interval. Chromium, cobalt, iron and vanadium exceeded unrestricted and residential use criteria at one or more location and at one or more depth interval. Silver exceeded unrestricted use and protection of groundwater criteria at one or more location and at one or more depth interval. Aluminum, antimony and calcium only exceeded unrestricted use criteria at one or more location and at one or more depth interval.

1.4.4 Groundwater

Based on the RI Phase II groundwater sample analytical data, results exceeding NYS TOGS 1.1.1 Class GA groundwater standards and guidance values are as follows:

VOCs (i.e., benzene, toluene, ethylbenzene, and xylenes (BTEX), 1,2-dibromoethane, 1,2-dichlorobenzene, 1,4-dichlorobenzene, acetone, chlorobenzene, chloroethane, isopropylbenzene and styrene) were detected at concentrations exceeding TOGS 1.1.1 Class GA groundwater criteria in 15 of 25 monitoring wells sampled.

Another VOC, 1,4-Dioxane was detected in 9 of 29 samples and its average concentration was the highest among all the VOCs. However, there is no groundwater standard or guidance value for 1,4-Dioxane at this time.

SVOCs (i.e., PAHs, o-,m- and p-cresol, atrazine, bis(2-ethylhexyl)phthalate and phenol), were detected at concentrations exceeding TOGS 1.1.1 Class GA groundwater criteria in 9 of 25 monitoring wells sampled.

PCBs were not detected in any of the RI Phase II groundwater samples (i.e., samples collected in January 2012 or later). Historically, PCBs were detected in only two groundwater samples: SB-07/MW-07 [1.74 micrograms per liter (µg/L)]; and SB-14/MW-14 (16.7 µg/L), both collected on August 1, 2007. These samples were collected prior to the discovery of LNAPL at these locations. Most likely the samples contained trace amounts of LNAPL which resulted in the PCB detections. Subsequent groundwater samples from these monitoring wells were non-detect for PCBs.

One or more metals exceeded TOGS 1.1.1 Class GA groundwater criteria in every sample collected during the RI Phase II groundwater sampling. The most frequent exceedances were for iron, magnesium, manganese and sodium.

1.4.5 Seep and Surface Water

No VOCs were detected in the seep or surface water samples collected. The SVOC exceeding TOGS 1.1.1 Class I surface water SCGs was benzo(a) pyrene (a PAH) in Seep-04 and Seep-05. No PCBs were detected in the seep or surface water samples collected. The following metals exceeded TOGS 1.1.1 Class I surface water SCGs in one or more seep or surface water samples: arsenic, copper, lead, mercury, nickel and zinc.

1.4.6 Sediment

The East River, where sediment was sampled, is a major waterway with multiple sources of potential contamination. There are health restrictions on consumption of fish from the East River and water contact advisories posted along various public access locations because of the ubiquitous extent of contamination. On the Site, there is a fence along the northern edge of the property, restricting access to East River sediment and surface water. It is difficult to link the contaminants found in the sediment samples taken along the Site's shoreline directly to the Site. The East River is a tidal strait and usually reverses flow four times per day. Known for its swift current, sediment bearing contamination in the water can travel long distances. Therefore, although potential exposure pathways for surface water and sediment were identified in the RI, engineering controls (fencing) and site topography limit access to surface water and sediment. Remediation of surface water and sediment contaminants will not be included in the feasibility study.

1.4.7 Soil Vapor

Soil vapor samples were collected in March/April 2007 for the IWWA, but no samples were collected during the RI based on the NYSDOH determination that no further action was required with regard to soil vapor intrusion at the Site. However, the NYSDEC and NYSDOH decided to perform additional soil vapor sampling in 2015 and 2016. This sampling is discussed in Section 1.5.

1.4.8 Non-Aqueous Phase Liquid

LNAPL has been detected in 13 on-site monitoring wells. The locations where LNAPL has been detected and the range of thicknesses measured at these locations are shown in Figure 1-3. The estimated extent of the LNAPL is discussed in Section 2.2.3.

The primary contaminants of concern in LNAPL are PCBs. VOCs and SVOCs, primarily PAHs, have also been detected in LNAPL samples.

The results of sampling for LNAPL parameters showed much of the LNAPL was similar to #2 fuel oil (diesel) or #6 fuel oil. The LNAPL similar #6 fuel oil is very viscous, meaning it does not flow easily in the formation.

1.4.9 Qualitative Human Health Exposure Assessment

Under the current and future use scenarios, completed pathways are present for:

- Surface soil for residents;
- Subsurface soil, soil vapor and groundwater for construction/utility workers during intrusive activities; and
- Surface water, sediments and fish consumption for recreational users of the East River section adjacent to the Site was identified as a potential pathway; however, contaminants found in the surface water and sediment are ubiquitous to East River. The access to the East River directly from the Site is limited by fencing and shoreline topography, therefore sediment and surface water is an unlikely pathway.

Under the current and future use scenarios, incomplete pathways are present for:

- Soil vapor/indoor air for residents since the NYSDOH determined that no further action was required with regard to soil vapor intrusion; and

- Groundwater for residents since they are connected to a public water supply.

1.4.10 Fish and Wildlife Impact Analysis

Plant communities in the project area include mowed lawn and trees, and vacant lot species. These communities are associated with residential, commercial and industrial areas in the project area. The Site is located on a mowed lawn in a residential condominium complex. The results of the Fish and Wildlife Resources Impact Analysis (FWRIA) Step I analysis indicate that there is limited potential for wildlife at the Site. Because of its location in an urbanized area, the Site provides very limited suitable habitat for wildlife. The Site provides current value to humans as a nature recreation area through a walkway along the East River.

The East River provides opportunities for fishing, boating and passive recreation. Shoreline access to the public is limited, due to private property. Herman M. MacNeil Park, located west of the Site, does not provide public shoreline access. It should be noted that the shoreline is fenced off from Herman M. MacNeil Park through the Powell Cove Estates property east of the Site, and topography also limits access into the East River itself.

1.4.11 Source Characterization

The LNAPL detected at the Site will act as a continuing source of contamination to subsurface soils and groundwater. At this time, there appear to be five areas impacted by the presence of PCB containing LNAPL (See Section 2.2.3). Due to the heterogeneous nature of the fill material and the lack of tidal influence, the five LNAPL areas have not coalesced. The LNAPL consists of typical petroleum-related constituents and PCBs. Other contaminants (e.g., PCE, chlorobenzenes) are also dissolved in the LNAPL. Contaminants in the LNAPL or the solid-phase material may subsequently be dissolved into groundwater that is in contact with these materials. A residual LNAPL "smear zone" exists due to the rise and fall of the water table which resulted in LNAPL being retained in the soil pores.

1.5 Soil Vapor Intrusion (SVI) Sampling

After the RI, at the direction of the NYSDEC, soil vapor intrusion sampling was conducted at 19 condominium units from February 16, 2015 to February 27, 2015 following the procedures described in the NYSDOH *Guidance for Evaluating Soil Vapor Intrusion in the State of New York, Final*. Sampling for each unit investigated included an indoor air sample from the lowest level and a subslab soil vapor sample. An outdoor air sample was collected at the rate of one per sampling day. The samples were analyzed for VOCs and methane. The results are discussed in the *Soil Vapor Intrusion Data Summary Report* issued by URS in June 2015 and are summarized below.

NYSDOH decision matrices were used to evaluate the following compounds:

- Matrix 1 – TCE, carbon tetrachloride and vinyl chloride; and
- Matrix 2 – 1,1,1-trichloroethane (1,1,1-TCA), cis-1,2-dichloroethene, PCE and 1,1-dichloroethene.

Using NYSDOH Decision Matrix 1 and 2 for the compounds listed by the NYSDOH, no further action was recommended except as follows:

- The concentration of 1,1,1-TCA in the subslab soil vapor at one location (H-15) resulted in a "Monitor" recommendation.
- The concentration of TCE in the indoor air and subslab soil vapor at one location (H-12) resulted in a "Take reasonable and practical actions to identify source(s) and reduce exposures" recommendation
- Carbon tetrachloride concentrations in indoor air and subslab soil vapor resulted in a "Take reasonable and practical actions to identify source(s) and reduce exposures" recommendation. However indoor air and subslab soil vapor concentrations were similar to the outdoor air concentrations. It may be concluded that soil vapor is not a source of carbon tetrachloride in indoor air, and therefore the recommendation "No further action" may be applicable.

Methane was not detected in any of the indoor air, subslab soil vapor or outdoor air samples.

Based on the "Monitoring" recommendation from the 2015 sampling results, location H-15 was re-sampled on January 20, 2016. The results from 2016 showed that "no further action" was required for this location. Consequently, the SVI issue at the site is now considered closed for all locations.

1.6 Methane Sampling

After the RI was completed, soil gas sampling was also conducted to investigate and evaluate methane on the site. The results of sampling are discussed in the *Soil Gas Summary Report* (URS, February 2016) and are summarized in the remainder of this section.

Soil gas was sampled at 63 locations between March 2007 and April 2015. Methane concentrations were measured by field instruments in April, September and October 2014 and April 2015. Samples were collected and methane concentrations were measured in the laboratory in March and April 2007 and November 2014. Methane was detected at concentrations above the Lower Explosive Limit (LEL) and/or the Upper Explosive Limit (UEL) at eight locations between March 2007 and November 2014. However, methane concentrations decreased over the period, and methane was not detected above the LEL at any location in April 2015 (the most recent sampling event). The report recommended that methane sampling be considered in the development of the Site Management Plan.

1.7 Standards, Criteria and Guidance Values

Standards, Criteria, and Guidance Values (SCGs) were identified for each of the media sampled in the RI. They are presented below.

1.7.1 Soil

Two sources of soil SCGs are considered appropriate for this site: 6NYCRR Part 375, Environmental Remediation Programs, Subpart 375-6, Remedial Program Soil Cleanup Objectives, effective December 14, 2006; and NYSDEC Commissioner Policy (CP), CP-51/Soil

Cleanup Guidance, effective October 21, 2010. Hereafter, mention of Part 375 includes incorporation of CP-51 criteria values.

The zoning classification for the location of soil samples is a consideration in the determination of the appropriate soil SCGs. Soil samples were obtained from surface soil and soil borings on properties zoned residential (R4) by the NYC Department of City Planning. Therefore, Part 375 residential land use soil cleanup criteria are appropriate for the site. In addition, criteria for the Protection of Groundwater are considered as SCGs for contaminants which exceed groundwater SCGs.

1.7.2 **<u>Groundwater</u>**

The SCGs for groundwater are the Class GA standards and guidance values presented in NYSDEC TOGS 1.1.1 *Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations*, June 1998 (including subsequent revisions).

1.7.3 **<u>Seep and Surface Water</u>**

The SCGs for seep and surface water are the Class I standards and guidance values presented in NYSDEC TOGS 1.1.1 *Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations*, June 1998 (including subsequent revisions). The portion of the East River bordering the site (i.e., located between 12.3 and 14.4 miles above the mouth) is identified as a Class I body of water, as per 6NYCRR Part 935.6, Table 1.

1.7.4 **<u>Sediments</u>**

The sediments samples were collected along the East River shoreline, which is a saltwater body. The SCGs for marine and estuarine sediments are saltwater (SW) values presented in NYSDEC *Technical Guidance for Screening Contaminated Sediments*, January 1999 (including subsequent revisions). For the organic compounds, the criteria are low toxic effects or Effects Range-Low (ERL) and median toxic effects or Effects Range-Median (ERM) values listed in *Appendix 4*, *Table 4* of the document. For the non-polar organic compounds (i.e., those not listed in *Appendix 4, Table 4* of the document) the most stringent of the SW limits in *Table 1* of the document for: Human Health Bioaccumulation; Benthic Aquatic Life Acute Toxicity, Benthic Aquatic Life Chronic Toxicity; or Wildlife Bioaccumulation are applicable. For metals, the criteria are the ERL and ERM values listed in *Appendix 4, Table 4* of the document.

1.7.5 Soil Vapor

The NYSDEC has not published SCGs for soil vapor. However, the NYSDOH has guidance for SCGs related to soil vapor intrusion (NYSDOH, 2006).

2.0 REMEDIAL GOAL AND OBJECTIVES

2.1 Goal and Objectives

The remedial goal for the site is to eliminate or reduce to the maximum extent practicable, significant threats to human health and/or the environment due to former site activities. In order to meet this goal, remedial action objectives (RAOs) have been established. These RAOs provide the basis for selecting appropriate remediation technologies and developing remedial alternatives for the site. RAOs were established based on contaminated media, identified contaminants of concern, SCGs, and results of the QHHEA and FWIA as presented in the RI.

Media	RAO for	Remedial Action Objectives
Soil	Public Health Protection	o Prevent ingestion or direct contact with contaminated soil. o Prevent inhalation exposure to contaminants volatilizing from soil.
Soil	Environmental Protection	o Prevent migration of contaminants that would result in groundwater, surface water or sediment contamination. o Prevent impacts to biota from ingestion or direct contact with soil causing toxicity or impacts from bioaccumulation through the terrestrial food chain.
LNAPL/Groundwater	Public Health Protection	o Prevent ingestion of groundwater with contaminant levels exceeding drinking water standards. o Prevent contact with, or inhalation of volatiles, from contaminated groundwater.
LNAPL/Groundwater	Environmental Protection	o Restore groundwater aquifer to pre-disposal/pre-release conditions, to the extent practicable. o Prevent the discharge of contaminants to surface water or sediments. o Remove the source of groundwater contamination.

2.2 Remediation Areas and Volumes

The extent of surface soil, subsurface soil, LNAPL (free phase LNAPL and LNAPL-contaminated soil) and groundwater contamination is discussed below. These areas and volumes have been developed based on the characterization information provided in the RI report and will serve as the basis for development and evaluation of alternatives in this FS.

2.2.1 Surface Soil

Surface soil contamination was detected in the grassy area in the northern most portion of the site, and the grassy area between Riviera Court and Cove Court. The estimated extent of contamination is shown on Figure 2-1. The estimated area of contamination in the northern portion of the site is 54,000 square feet and the estimated area in the grassy area between Riviera Court and Cove Court is 25,000 square feet.

2.2.2 Subsurface Soil

Subsurface contamination has been detected above SCOs at nearly every location sampled on site. On this basis, subsurface contamination is assumed to extend from the southern boundary to the northern boundary of the investigation area (an estimated area of 324,000 square feet) as shown on Figure 2-2. Contaminants exceeding criteria were found at all locations and all depths sampled. In addition, boring logs show that petroleum odors and/or visible evidence of petroleum was detected at multiple boring locations at multiple depths. In general, borings extended to about 20 to 30 feet below ground surface (bgs). Contamination was often detected at the bottom of these borings, so the precise depth of contamination in some areas is unknown. It is conservatively estimated that contamination throughout the impacted area extends to a depth of 30 feet bgs. On this basis, the estimated volume of contaminated subsurface soil is 360,000 cubic yards.

Settling of fill has been observed to occur in onsite roads where utilities are located. Consequently, utilities need to be repaired and there is potential exposure to contamination when utility workers perform the repair activities. Therefore, the FS identifies a subset of subsurface soil known as the utility corridor soil. The extent of the utility corridor soil is shown on Figure 2-3. The estimated extent of the utility corridor soil is 27,000 square feet. A maximum depth of 8 feet is assumed for the excavation of utilities. On this basis, an estimated volume of 8,000 cubic yards is estimated for the utility corridor.

2.2.3 LNAPL

LNAPL was detected in five general areas located between Cove Court and Riviera Court during the RI. The estimated extent of LNAPL is shown on Figure 2-4. The approximate total area of LNAPL is 8,500 square feet. During the RI, the thickness of LNAPL detected in wells ranged from about ¼ inch to almost 8 feet as shown on Figure 1-3. In recent sampling conducted in May 2016, the average LNAPL thickness in wells shown on Figure 2-4 was about 0.6 feet. On this basis, the average thickness in the wells is estimated at 1 foot. However, the LNAPL thickness in monitoring wells is known to exceed the thickness in the formation by a factor of between 2 and 10. Assuming an average LNAPL correction factor of 6, the LNAPL thickness in the formation is estimated at 2 inches (0.167 feet). Assuming an average soil porosity of 0.3, the estimated quantity of LNAPL at the site is 425 cubic feet or about 3,200 gallons. The ratio of LNAPL that can be recovered to LNAPL that remains trapped in the soil decreases with time. Since the LNAPL detected at the site has been present at the site for a long time, it is assumed that only about one third, i.e. about 1,000 gallons of LNAPL is recoverable at the site under natural conditions. If methods are used to enhance the recovery of LNAPL (e.g. heat or surfactants), then more LNAPL would be recovered. For enhanced recovery, it is assumed that about two thirds, i.e. about 2,000 gallons of the LNAPL, is recoverable.

2.2.4 LNAPL-Contaminated Soil

As discussed in the section above, LNAPL has been detected as a free phase in a number of wells. Soil borings indicated that residual LNAPL is also present in soil pores in areas where free product is not present. This LNAPL-contaminated soil and the free phase LNAPL are considered the major sources of contamination at the site. The areal extent of LNAPL-contaminated soil correlates closely with the extent of free phase LNAPL as shown on Figure 2-5. The estimated area of LNAPL-contaminated soil is 31,000 square feet. The LNAPL-contaminated soil is assumed to extend vertically from the seasonal high water table to the seasonal low water table. The vertical extent is estimated at 5 feet. On this basis, the estimated volume of LNAPL-contaminated soil is 5,700 cubic yards. It is estimated that the average depth to the lowest extent of LNAPL-contaminated soil is 15 feet. Therefore, approximately a total of 17,000 cubic yards of soil would need to be excavated to remove the LNAPL-contaminated soil.

2.2.5 Groundwater

As indicated in the RI report, groundwater flow is in a radial pattern from the source areas. Figure 2-6 shows the locations where contaminants exceeded groundwater criteria. In general, the most significant exceedances were for VOCs. For the FS, it is assumed that the extent of groundwater contamination is the same as the subsurface soil, i.e. approximately 324,000 square feet.

3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

Remedial technology identification and screening presented in this section consists of: identification of general response actions to satisfy the site-specific RAOs; identification of potentially applicable remedial technologies that fall within the general response categories; and screening of those technologies with respect to their relative effectiveness, technical implementability and cost in meeting the site RAOs. Technologies identified for this site have been selected from the host of technologies considered potentially effective, and primarily include those technologies that have been previously implemented successfully at other similar sites. The most promising technologies are retained and carried forward into the development of alternatives.

3.1 General Response Actions

General response actions are broad categories of remediation approaches capable of satisfying the RAOs for a site. Some response actions may be sufficiently broad to be able to satisfy all RAOs for the site as a whole. Other response actions must be combined to satisfy RAOs for impacted media: soil (surface and subsurface soil) and LNAPL/groundwater. Remedial technologies have been identified which correspond to the general response actions of no action, containment, source removal, and in-situ treatment. A brief description of each of the general response actions follows:

No Action - The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) requires that a no action alternative be evaluated as part of the Feasibility Study process. This alternative will be used as the baseline for comparison of remedial alternatives.

Containment - Containment measures are those remedial actions for which the purpose is to contain and/or isolate contaminants. These measures provide protection to human health and the environment by reducing exposure or migration of contaminants, but they do not treat or remove the contamination.

Removal - Excavation of soil is a remedial action for which the purpose is to remove contaminants from the site and vicinity. Combined with on-site treatment or off-site treatment and/or disposal, source removal provides protection to human health and the environment by reducing exposure to or migration of contaminants. LNAPL collection, LNAPL recovery technologies, or removing residual in LNAPL-contaminated soil provides protection to human health and the environment by removing LNAPL and reducing contaminant mass in the subsurface.

In-situ Treatment – Treatment measures include technologies for which the purpose is to reduce the toxicity, mobility, or volume of contaminants by directly altering, isolating, or destroying those contaminants. Soil that is not excavated and groundwater may be treated in place (in-situ). In-situ treatment could potentially utilize biological, chemical/physical, solidification, or thermal processes.

3.2 Identification and Screening of Technologies for Soil

This section identifies and provides an initial screening of remedial technologies for contaminated soil at the site. Contaminated soil includes contaminated surface soil, contaminated subsurface soil, and LNAPL-contaminated soil as described in Section 2.0 Potentially applicable remedial technologies within each general response action which could meet the remedial action objectives are identified and, identified technologies are screened with respect to their effectiveness, technical implementability and relative cost. This evaluation is based on the site characterization, which includes the types and concentrations of contaminants, and the geology and hydrogeology of the area. Table 3-1 provides a summary of the general response actions and the results of the remedial technology identification and screening.

3.2.1 Site Management Plan

A Site Management Plan (SMP) would include institutional controls and engineering controls (ICs/ECs) to achieve the following:

- Manage potential exposure to residual contaminated soil, including procedures for soil characterization, soil excavation and handling, and the health and safety of workers and the community,

- Sample, analyze and evaluate soil vapor in future on-site buildings or existing buildings that have been modified, and institute soil vapor intrusion mitigation, only if necessary, in accordance with NYSDOH guidance.

- Provide for disposal/reuse of excavated soil in accordance with applicable NYSDEC regulations and procedures;

- Restrict the use of the property to specified categories (the site is currently zoned residential); and

- Restrict groundwater use.

Effectiveness: An SMP would be effective in identifying residuals and controls required for those residuals at the site.

Implementability: An SMP for the site would not be difficult to implement.

Cost: The cost for an SMP would be relatively low.

Conclusion: An SMP is retained for use at the site.

3.2.2 Containment

A soil cover, a low permeability cap, and vertical subsurface barriers are potential containment technologies for the site.

3.2.2.1 Soil Cover

A soil cover would be constructed over all areas of surface soil contamination. The soil cover would consist of 18 inches of clean fill soil, 6 inches of topsoil and vegetation in areas defined as “restricted-residential use” per 6 NYCRR Part 375-1.8(g)(2)(ii) and consist of 6 inches of clean fill and 6 inches of topsoil and vegetation in areas defined as “commercial use” per 6 NYCRR Part 375-1.8(g)(2)(iii).

Effectiveness: A soil cover would prevent local residents from being exposed to surface soil contamination.

Implementability: The soil cover would require that contaminated soil be excavated to a depth of 1 to 2 feet prior to installation of the clean fill. Installing the soil cover over the existing grassy areas without excavation is not considered feasible because existing topography would need to be kept to tie into existing structures (including patios) to maintain proper drainage and aesthetics.

Cost: The cost of the soil cover is expected to be relatively low.

Conclusion: The soil cover will be retained for the development of alternatives for the site.

3.2.2.2 Capping

A low permeability cap with geomembrane could be constructed over areas of the site not already covered by a structure or pavement to limit infiltration. The low permeability cap would be constructed by first excavating two feet of soil from the impacted areas. The geomembrane would be placed on 6 inches of sand overlying the cleared and grubbed ground surface. Topsoil, 12 inches of clean soil and a drainage layer would be placed over the geomembrane to promote drainage and provide geomembrane protection.

Effectiveness: A geomembrane cap would reduce infiltration and reduce contaminant leaching and subsequent migration. However, groundwater would continue to flow through the site and contamination would continue to migrate in groundwater.

Implementability: The cap would be difficult to construct around existing structures.

Cost: The cost of a geomembrane cap over the site is considered to be moderate.

Conclusion: A geomembrane cap is not retained for consideration for the site.

3.2.2.3 Vertical Barriers

Vertical barriers considered potentially applicable for the site are sheet piling, soil cement walls, and jet grouting.

- Sheet piling- Sheet pile cutoff walls are constructed by driving interlocking steel or HDPE into the ground. The joints between individual sheets are typically plugged with grout (when using steel sheets) or an expanding gasket (when using HDPE). Sheet piling may be used for structural support and soil and groundwater containment applications.

- Soil Cement Wall – A soil cement wall consists of a mixture of cement and native materials. The cement is introduced into the subsurface by an excavator or by augering through the overburden to the top of bedrock or low permeability clay layer. A soil cement wall may be designed for structural excavation support and soil and groundwater containment applications.

- Jet (pressure) Grouting – Jet grouting injects cementitious reagents under pressure into the ground. Under high pressure, the injected grout is blended with the soil and solidifies, reducing the hydraulic conductivity of the formation.

Effectiveness: Vertical barriers require the barrier to be keyed into an impervious layer to effectively cut off flow. An impervious layer beneath the site was not identified during the boring program. If there is no impermeable layer, groundwater can flow underneath the barrier limiting the effectiveness of the barrier.

Implementability: The vertical barriers would be difficult to construct because the site consists of fill that is very heterogeneous and contains significant amounts of C&D debris.

Cost: The relative cost of vertical cutoff walls is considered to be high and would depend on the depth and location.

Conclusion: Vertical barriers are not retained for consideration in the development of alternatives.

3.2.3 Excavation and Off-Site Disposal/Treatment

Excavation and off-site disposal is included with the construction of a soil cover as discussed in Section 3.2.2.1. Excavation could also be used to remove all the contaminated soil on site, contaminated soil in the utility corridor or to remove the major source of contamination which is the LNAPL-contaminated soil.

Effectiveness: Excavation of contaminated soil and off-site disposal/treatment would be effective in removing the source of contamination and meeting the RAOs for soil.

Implementability: This technology is practical and implementable for construction of a soil cover, excavation in the utility corridor or for the removal of LNAPL-contaminated soil, but would be extremely difficult to implement for all contaminated soil on site. Implementation of excavation for the large quantity (approximately 340,000 cubic yards) of contaminated soil for the entire site would require removal and reconstruction of the entire residential area including onsite buildings. Dewatering the excavation near the East River would be extremely difficult.

Cost: The cost of excavating soil for the soil cover would be low, the cost for excavating in the utility corridor or LNAPL-contaminated soil would be moderate, but the cost of excavating contaminated soil for the entire site would be extremely high.

Conclusion: Excavation and off-site disposal/treatment of contaminated soil is retained for the development of alternatives.

3.2.4 Excavation and On-Site Ex-Situ Treatment

Utilizing this method, contaminated soil is excavated by conventional equipment, treated on-site above ground, and then replaced on the site.

Effectiveness: Contaminants in soil include PAHs, PCBs, and metals. There is not one effective technology, other than possibly solidification, that would treat all these contaminants. Multiple technologies might be required to treat all the contaminants.

Implementability: The site is in a residential area so there is not much area available for ex-situ processing and treatment. There would be significant health and safety concerns for local residents if contaminated soil were treated on site.

Cost: The cost of excavating and processing contaminated soil using proper health and safety measures and the use of multiple technologies for treatment would render this technology relatively high in cost.

Conclusion: Excavation and on-site treatment of contaminated soil with replacement on-site is considered to be difficult to implement and relatively higher in cost than other technologies. Excavation and on-site treatment will not be retained.

3.2.5 In-Situ Treatment

In-situ soil treatment technologies include: chemical and thermal processes designed to destroy or increase the mobility of contaminants prior to removal, in-situ solidification processes that reduce the mobility of the contaminants, or biological processes designed to destroy the contaminants.

3.2.5.1 Biological Treatment

Naturally occurring microorganisms in the soil promote the breakdown and detoxification of organic contaminants. In-situ biological treatment such as bioremediation may enhance that process in soil and groundwater. Water enhanced with nutrients, oxygen, and other amendments is delivered to contaminated soil to enhance biological degradation of target contaminants. An infiltration gallery could be used for the unsaturated zone and injection wells for the saturated zone.

Establishing a healthy microbial community able to actively degrade contaminant species at this site (PAHs and PCBs) will likely require biostimulation and/or bioaugmentation. Biostimulation is the addition of an amendment (i.e., a food source) and/or nutrients needed to create an environment supporting microbial growth. Bioaugmentation is the introduction of laboratory-grown microbes to introduce specific bacteria with the ability to degrade target contaminants or to strengthen an existing microbial community to speed up biodegradation. Contaminants present can be degraded via multiple pathways, aerobically (in the presence of oxygen), anaerobically (in the absence of oxygen), or co-metabolically (combination of aerobic in anaerobic conditions).

As with other in-situ applications, subsurface distribution is a key component in the potential success of bioremediation. In general, microbial communities are fixed to the soil matrix. Once suitable aquifer conditions are established, microbes can spread in all directions, which can increase subsurface distribution where surface access is limited or unavailable (i.e., below structures, utilities, etc.).

Effectiveness: This technology has had limited success on PAHs, PCBs and metals, and would not be effective on LNAPL. Given the volume of soil source material, the presence of LNAPL, and the concentrations of contaminants present, bioremediation would require a long time period and significant amendment materials to remediate site soil. This technology would have limited effectiveness in remediating contaminated soil in the unsaturated zone.

Implementability: An infiltration gallery and injection wells for delivery of materials to establish aquifer conditions conducive to biodegradation would have to be located on the upgradient edge of the site which would be difficult because of the semi-radial groundwater flow pattern. Adequate subsurface distribution is required for contaminant treatment. Effective delivery of materials in the overburden may be difficult to implement due to the presence of fill creating heterogeneous conditions. Unsaturated conditions are present throughout the site and the majority of impacted soil is found at depth which would complicate the delivery system. Bench-scale laboratory analysis can be used to evaluate aquifer conditions and the amendments and/or additional microbial culture are needed.

Cost: The cost is considered to be moderate to high depending on the operating period and quantities of amendment materials required.

Conclusion: Biological treatment is not retained for use at the site.

3.2.5.2 Chemical Treatment

Treatment using in-situ chemical oxidation (ISCO) involves the delivery of a chemical oxidant to contaminated media to destroy target contaminants and convert them to non-toxic compounds. The rate and extent of degradation of organics using chemical oxidation are dictated by the properties of the contaminants and their susceptibility to oxidation. In addition, soil and groundwater matrix conditions (e.g., pH, temperature), and the concentration of other oxidant-consuming substances, such as natural organic matter and reduced minerals, affect the transport and reactions of both the oxidant and the target contaminants. Chemical oxidation reactions occur only with dissolved-phase contaminant materials and require contact between the oxidant and the contaminant. It is not effective on NAPL. ISCO is heavily dependent upon subsurface distribution and contact with target contaminant mass. For the unsaturated zone, an infiltration gallery would be used.

Effectiveness: ISCO use on sites with significant LNAPL is limited. While ISCO can enhance LNAPL recovery efforts, the high oxidant demand and multiple applications required limit its effectiveness over large areas. This technology would have limited effectiveness in remediating contaminated soil in the unsaturated zone.

Implementability: ISCO reactions are aqueous in nature and adequate subsurface distribution is required for contaminant treatment. Surface access is required to allow adequate delivery of materials. Surface access is limited by onsite buildings and infrastructure. Based upon this limited access and heterogeneity of the subsurface, this technology would be limited in effectiveness.

Cost: The relative costs of all ISCO processes are assumed to be moderate to high due to large quantities of oxidant materials required and the potential large number of injections required.

Conclusion: ISCO will not be retained for site-wide use.

3.2.5.3 Solidification

In-situ solidification (ISS) is the process of mechanical injection of a solidification mixture into contaminated subsurface soil in order to immobilize and contain the contaminants in a low permeability monolith. The solidification mixture is typically a combination of Portland cement and ground-granulated blast furnace slag with other additives to enhance chemical binding, improve mixture distribution, auger lubrication, or cohesive soil shearing as needed. Contaminants are immobilized primarily by incorporating contaminated soil into a low permeability mass, reducing groundwater flow through the soil, and binding the contaminants in a soil-cement matrix. While the overall mass of contaminants is not reduced, the mobility and the dissolution of contaminants to groundwater are largely eliminated. ISS also eliminates the LNAPL phase by binding the LNAPL with surrounding soil.

On relatively deep sites (i.e., greater than 20 feet), solidification reagents would be introduced through a drilling auger. A batch plant is constructed on-site where the grout is formulated from dry reagents and water. Permeabilities of treated soils are typically less than 10^{-6} cm/sec, thereby achieving several orders of magnitude reduction in permeability as compared to surrounding soil. Solidified soil strengths are typically between 50 and 250 pounds per square inch (psi) unconfined compressive strength, which is capable of supporting a wide variety of post-remediation development construction, yet such soil can be excavated or drilled into for the purpose of utility installation or support pile installation.

Effectiveness: This technology would be effective in reducing source and exposure pathways and the mobility of all site-related contaminants in soil in a relatively short time frame. ISS improves the soil bearing capacity. This technology has been applied to numerous sites nationwide. Bench-scale testing and pilot-scale testing are necessary to develop a site-specific mix design.

Implementability: Dewatering and/or groundwater control would not be required. An increase in the volume of the soil mixture may occur requiring appropriate site grading and off-site disposal of swell material. VOCs, which may be present in the subsurface, may be released to the atmosphere during treatment; however, this can be managed with an air monitoring program and engineering controls. Augering through fill such as found at the site would be extremely difficult and could significantly reduce the effectiveness of the technology. This technology is practical and implementable for solidification of LNAPL-contaminated soil, but is not practical and implementable for all contaminated soil on site. For LNAPL-contaminated soil, solidification near buildings would likely require the installation of sheet pile or comparable materials to protect building foundations during the solidification process. Implementation of ISS for the large quantity (approximately 340,000 cubic yards) of contaminated soil for the entire site would require removal and reconstruction of the entire residential area including onsite buildings.

Cost: The cost is considered to be high.

Conclusion: Solidification for LNAPL-contaminated soil is carried forward to the development of alternatives. However, solidification of other soil on site (e.g. surface soil) is not carried forward in the development of alternatives.

3.2.5.4 <u>In-Situ Thermal Treatment</u>

In-situ thermal treatment methods employ heat to increase the mobilization of contaminants via volatilization for recovery or for thermal destruction of contaminants. Heat added to the subsurface, through steam injection, electrical resistance heating, radiofrequency heating, or thermal desorption, induces remedial processes that, depending on the level of heating, soil and groundwater conditions, and the nature of the wastes, can partially or fully remediate the wastes. Among other processes, it can break down or volatilize the organic compounds, and reduce the viscosity of remaining source material to allow it to be more easily captured. Vacuum extraction wells would be installed within the heating wells to collect steam or contaminant vapors generated during heating. For optimal effectiveness, groundwater inflow should be minimized within the treatment area.

Effectiveness: Under favorable conditions, thermal treatment can remediate sites to cleanup criteria. The presence of groundwater at this site, and surface water adjacent to the site, however, will limit the effectiveness of the technology at and below the water table without groundwater containment since heat will be carried away by the groundwater. In addition, thermal treatment may not be as effective in treating less volatile organic compounds such as PCBs and PAHs.

Implementability: Groundwater containment would be required to increase the effectiveness of thermal treatment. During thermal treatment, VOCs would have to be captured through an aboveground vacuum extraction system. Air emissions would be a major concern in this residential area. The treatment is likely to be uneven because of the varying permeabilities throughout the site subsurface.

Cost: The cost is estimated to be high due to power requirements and system construction costs.

Conclusion: In-situ thermal treatment is not retained for use at the site.

3.3 Identification and Screening of Technologies for LNAPL/Groundwater

This section identifies and provides a screening of remedial technologies for LNAPL and groundwater. Table 3-1 includes a summary of the remedial technology identification and screening process for LNAPL/groundwater.

3.3.1 Site Management with Monitoring

The SMP for LNAPL/groundwater would include the institutional controls and engineering controls discussed in Section 3.2.1 and long-term monitoring. Monitoring would assess the degree to which natural processes were reducing contaminant concentrations in groundwater.

Natural processes which would be expected to occur include physical processes such as hydrodynamic dispersion and dilution by infiltration, and microbial degradation, which transforms the contaminants into typically less toxic daughter products and, ultimately, to carbon dioxide and water. Given sufficient time, a plume will stabilize after reaching a size where all of the mass delivered by the source is either diluted to very low concentration or destroyed. Further, if the source is removed or isolated from the aquifer through remediation, natural processes will cause the remaining plume to collapse with time, as the contaminant mass residing within the plume is diluted and destroyed, assuming no new mass is introduced.

Groundwater on-site and in the vicinity of the site is not utilized for potable purposes. An SMP, which maintains use restrictions regarding groundwater and a monitoring plan to assess future groundwater conditions, would be in line with current practices and be protective of human health. Monitoring would consist of periodic sampling of select existing monitoring wells, and analysis for VOCs, SVOCs and natural attenuation indicator parameters (i.e., such as dissolved oxygen and oxidation reduction potential).

Effectiveness: An SMP would be effective in identifying residuals and controls required for those residuals at the site. Monitoring will indicate whether contaminant levels are being reduced over time.

Implementability: An SMP with monitoring would not be difficult to implement.

Cost: The annual cost for the SMP and sampling, analysis, and reporting would be relatively low.

Conclusion: An SMP with monitoring is retained for use at the site.

3.3.2 <u>Interceptor Trench</u>

An interceptor trench would consist of the following components:

- a permeable trench within the overburden installed on the downgradient edge of the LNAPL plumes; and

- LNAPL sumps or recovery wells to collect LNAPL.

Effectiveness: An interceptor trench would collect and remove some LNAPL; thereby, reducing its impact on groundwater. However, because of the heterogeneity of the subsurface fill and the high viscosity, and therefore low mobility, of the LNAPL, the quantity of LNAPL removed by the trench would be expected to be small.

Implementability: An interceptor trench is an established technology; however, constructing a trench to the depth required to intercept LNAPL (about 15 feet bgs) would be difficult near buildings and because of the heterogeneity and unknown nature of the subsurface fill.

Cost: The cost of an interceptor trench would be moderate.

Conclusion: An interceptor trench will not be retained for LNAPL recovery.

3.3.3 Vertical Barriers

Vertical barriers considered potentially applicable for LNAPL/groundwater to produce hydraulic control are similar to those considered for soil and include sheet piling, soil cement walls, and jet grouting as discussed in Section 3.2.2.3. Since these vertical barriers cannot be keyed into an impermeable layer, would be difficult to construct through fill, and would have a high relative cost, they are not retained for use in the development of alternatives.

3.3.4 Horizontal Barriers

Horizontal barriers (capping) were discussed in Section 3.2.2.2, and for the reasons previously presented, are not retained for the development of alternatives.

3.3.5 Groundwater Extraction Wells

Groundwater extraction could provide hydraulic control that would curtail off-site migration of contamination. Groundwater extraction could be accomplished through extraction wells. Individual extraction wells can be located as needed within the remediation area and installed to the required depths in the overburden.

It is estimated that in order to provide adequate hydraulic control approximately 10 extraction wells would be required. The estimated groundwater extraction rate from the overburden is 60 gpm.

Effectiveness: An effective groundwater extraction system utilizing extraction wells could be installed within the overburden at the site; however, extracted groundwater would have to be treated.

Implementability: Extraction wells within the overburden could be readily installed.

Cost: The cost for groundwater extraction wells is estimated to be low; however, the cost of groundwater treatment could be moderate to high.

Conclusion: Groundwater extraction wells (with subsequent treatment) are retained for the FS.

3.3.6 LNAPL Recovery Wells

A technology that would meet the RAOs related to LNAPL and is considered implementable at this site is the use of LNAPL recovery wells. Existing monitoring wells or newly constructed recovery wells could be used to recover the LNAPL. If there is a small amount of LNAPL in a well, bailers or absorbent socks could be used to recover the LNAPL. If there is a significant quantity of recoverable LNAPL in an area, a recovery well could be constructed. The recovery well could be outfitted with a skimmer to remove the LNAPL or LNAPL could be removed manually. Collected LNAPL would be disposed off-site.

Effectiveness: LNAPL has been recovered from existing monitoring wells using absorbent socks. Continued monitoring and recovery efforts would be effective in removing small quantities of LNAPL from the subsurface. Recovery wells can be an effective method for removal. Two eighteen inch diameter recovery wells were installed near monitoring wells DEC-32 and DEC-35 in 2015; however, at first there was insufficient LNAPL in the wells to perform a pilot test with a skimmer. Subsequently, when LNAPL was present in one of the wells, it appeared to be too viscous to effectively remove with a skimmer. Therefore, the applicability and effectiveness of the skimmer is questionable. For the FS, it is assumed that manual methods will be used to remove LNAPL.

Implementability: Existing monitoring wells could be used for LNAPL recovery and construction of new LNAPL recovery wells would also be feasible.

Cost: The cost of LNAPL recovery wells would be expected to be moderate.

Conclusion: LNAPL recovery wells will be retained for the development of alternatives.

3.3.7 Enhanced LNAPL Recovery

Bailing and/or skimming alone may not be effective in recovering LNAPL as a result of its high viscosity, and the large capillary forces that can reduce the mobility of the non-aqueous phase. LNAPL recovery may require enhancements to increase recovery effectiveness. Enhanced LNAPL recovery may be implemented using chemical, thermal, biological or physical (dual-phase extraction) methods.

3.3.7.1 Chemical-Enhanced LNAPL Recovery

Surfactants can be used to lower interfacial tensions between water and LNAPL, increasing solubility and thus the mobility of the LNAPL.

Effectiveness: The injection of site-specific surfactants could be effective in increasing the solubility and mobility of LNAPL within the radius of influence where they were applied to the subsurface. However, because some of the LNAPL at the site is very viscous, a pilot test would likely be required to determine the effectiveness of this technology.

Implementability: An adequate subsurface distribution system would be required. Loss of hydraulic control following surfactant addition could result in increased mobility of LNAPL. Chemical-enhanced LNAPL recovery could be implemented in a localized area.

Cost: The cost of an effective surfactant-enhanced LNAPL recovery system is considered to be relatively moderate, given the size of the area, the amount of materials, and time frame required.

Conclusion: Chemical-enhanced LNAPL recovery is retained for site use under the enhanced LNAPL recovery category.

3.3.7.2 Thermal-Enhanced LNAPL Recovery

Similar to in-situ thermal treatment methods for soil, thermal-enhanced LNAPL recovery would employ heat within individual LNAPL recovery wells to increase the mobilization of LNAPL.

Effectiveness: The addition of heat would be effective in increasing the mobility and recovery of LNAPL within the radius of influence of the wells. Groundwater containment with recovery would be required. However, more-mobile LNAPL could migrate beyond the recovery wells.

Implementability: An adequate groundwater recovery well system would have to be developed to collect the more-mobile LNAPL in the subsurface. Implementation of this system would be difficult at this site due the quantity of LNAPL, size, and anticipated large number of wells. In addition, vapor control could be required to prevent the release of vapors into nearby buildings.

Cost: The cost of an effective thermal-enhanced NAPL recovery system is considered to be relatively high due to groundwater containment/collection needed and depending on the amount of power and time frame required.

Conclusion: Thermal-enhanced LNAPL recovery is not retained for use at the site under the enhanced LNAPL recovery category.

3.3.7.3 Biologically-Enhanced LNAPL Recovery

Biological agents can be used to degrade LNAPL, increasing solubility and thus the mobility of the LNAPL.

Effectiveness: Localized bioaugmentation could be effective in increasing the solubility and mobility of LNAPL within the radius of influence where they were applied to the subsurface, although they may not be totally effective on the degree of LNAPL present at this site. Biological treatment may degrade the LNAPL present, increase its mobility, and increase the effectiveness of LNAPL recovery efforts. However, because some of the LNAPL at the site is very viscous, a pilot test would likely be required to determine the effectiveness of this technology.

Implementability: An adequate subsurface distribution system would be required. Loss of hydraulic control following reagent addition could result in increased mobility of LNAPL. Biologically-enhanced LNAPL recovery could be implemented in a localized area.

Cost: The cost of an effective biologically-enhanced LNAPL recovery system is considered to be relatively moderate, given the size of the area, the amount of materials, and time frame required.

Conclusion: Biologically-enhanced LNAPL recovery is retained for site use under the enhanced LNAPL recovery category.

3.3.7.4 Dual-Phase Extraction

Dual-phase extraction, also known as multi-phase extraction, vacuum-enhanced extraction, or bioslurping, is an in-situ technology that uses pumps to remove contaminated groundwater, LNAPL and hydrocarbon vapor from the subsurface. This technology also stimulates biodegradation of petroleum contaminants in the unsaturated zone by increasing the supply of oxygen.

Effectiveness: Dual-phase extraction is a proven technology that has been used for remediation on many sites. Its effectiveness would be limited at best for more viscous petroleum products found at the site.

Implementability: Engineering controls and permits are required for the discharge of contaminants to water and the atmosphere.

Cost: Both the construction and operating costs for dual-phase extraction are considered to be moderate to high.

Conclusion: Dual-phase extraction is not retained for site use under the enhanced LNAPL recovery category.

3.3.8 Excavation and Off-Site Disposal/Treatment

Excavation of LNAPL-contaminated soil was discussed in Section 3.2.3. As stated, this technology will be carried forward for the development of alternatives.

3.3.9 Groundwater Treatment

Groundwater collected by extraction wells would be treated in an above-ground facility with subsequent discharge to either groundwater, surface water, or a publicly owned treatment works (POTW).

- Groundwater Treatment On-site; Discharge to Groundwater – An on-site water treatment facility could be constructed to treat collected groundwater. A site-specific process train would have to be developed to remove LNAPL and contaminants to appropriate standards and meet discharge permit requirements for effluent to be re-injected into the groundwater system (Class GA).

- Groundwater Treatment On-site; Discharge to Surface Water – An on-site water treatment facility could be constructed to treat collected groundwater. A site-specific process train would have to be developed to remove LNAPL and contaminants to appropriate standards and meet permit requirements for effluent to be discharged to the East River, a Class I water body.

- Groundwater Pretreatment On-site; Discharge to POTW – Collected groundwater could be separated from the collected LNAPL and pre-treated on-site to meet influent standards and either conveyed via tanker trucks or pumping to existing sanitary sewer lines to the POTW.

Effectiveness: Groundwater treatment could be provided to meet the appropriate requirements for re-injection, discharge to the East River or discharge to the POTW.

Implementability: Groundwater treatment is a conventional technology that can easily be implemented. However, groundwater treatment systems require significant operation, maintenance and monitoring activities that require greater attention over time; thereby, reducing the reliability of the treatment system.

Cost: On-site treatment to meet NYSDEC groundwater (GA) standards for re-injection to the aquifer would be the most expensive. On-site treatment to meet NYSDEC Class I standards and discharge to the adjacent East River would likely be somewhat less expensive, and discharging pretreated water to a POTW would likely be the least costly.

Conclusion: On-site pretreatment and discharge to the POTW will be retained for the development of alternatives.

3.4 Summary of Technologies Surviving Screening

Technologies retained for consideration in the development of alternatives include the following:

Soil

- Site Management Plan
- Soil Cover including excavation of one to two feet of contaminated soil before installing cover
- Excavation of Contaminated Soil
- Solidification of LNAPL-Contaminated Soil

Groundwater/LNAPL

- Site Management Plan with Monitoring
- Groundwater Extraction Wells
- LNAPL Recovery Wells
- Enhanced LNAPL Recovery
- Groundwater Pre-Treatment and Discharge to POTW

4.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

This section combines the remedial technologies considered feasible for each media into a list of remedial alternatives that best meet the remedial goal and RAOs for the site as a whole. The alternatives are described in this section with regards to: size and configuration, time for remediation, spatial requirements, options for disposal, permitting requirements, limitations, and ecological impacts. The alternatives that are developed and described in this section are subsequently screened with regard to their effectiveness, implementability and cost so that only the most feasible alternatives are carried forward for detailed analysis.

4.1 Development of Alternatives

Alternatives have been developed to address the general response actions identified for the site including: no action, containment, removal and in-situ treatment. The No Action alternative serves as a baseline of comparison and includes implementing an SMP. Remedial alternatives other than No Action include combinations of remedial technologies for soil and LNAPL/groundwater.

An SMP is considered a basic requirement for all alternatives except for Remediation to Pre-Disposal Conditions. The soil cover is considered a basic remediation component for all alternatives except No Action and Remediation to Pre-Disposal Conditions because it provides the greatest level of public health protection.

LNAPL is the major source of contamination at the site. Feasible technologies that have been carried forward into the development of alternatives that address this source of contamination include the following: recovery wells, enhanced LNAPL recovery, excavation of LNAPL-contaminated soil, and solidification of LNAPL contaminated soil. These technologies vary in effectiveness in addressing the LNAPL source of contamination. Recovery wells are used to recover free phase LNAPL (free product). Enhanced LNAPL recovery removes more LNAPL by using methods to remove residual LNAPL that is not in the free phase form. Excavation of LNAPL-contaminated soil would nominally remove the entire LNAPL source. Solidification of LNAPL-contaminated soil would prevent the LNAPL source from impacting groundwater quality. Each of these technologies is employed in development of alternatives to offer a breadth of alternatives for addressing the source of contamination.

Excavation of contaminated soil in the utility corridor has also been included in the development of alternatives. A significant amount of subsurface repair work is required in the utility corridors because the settling of fill in the area causes damage to the underground utilities. This excavation would greatly reduce potential exposure to contamination by workers repairing damaged underground utilities. The excavation would also greatly reduce the cost of future maintenance in the utility corridor because disposal of contaminated soil would not be required and because workers would not be required to have OSHA training for work in hazardous areas to perform work in the utility corridor.

For the FS, it is assumed that recovery wells will be used for remediation. Pilot tests may be performed to test the relative effectiveness of this technology. The nature and behavior of LNAPL encountered in an initial pilot test conducted in 2015 showed that active recovery of LNAPL by skimmers or similar equipment may not be feasible. Consequently, it is assumed that passive LNAPL recovery will be employed for remediation in this FS although further pilot tests may be performed to further evaluate active LNAPL recovery.

As discussed in Section 3, both chemical and biological methods are feasible for enhanced LNAPL recovery. A pilot test would be required to evaluate and select the best method for enhanced LNAPL recovery. This pilot study would be performed as a pre-design work element. For this FS, chemical-enhanced LNAPL recovery with surfactants is used for the development and evaluation of alternatives. Surfactants increase desorption rates of LNAPL bound to saturated soil and make it more available for efficient and rapid recovery of LNAPL.

Groundwater extraction and treatment (commonly referred to as pump and treat), although passing the initial screening of technologies, is not included in the development of alternatives. Based on their experience at other sites, the NYSDEC does not believe this technology would be effective at the College Point 3 site. Containment of groundwater flow at this site is problematic because of the high variability of fill that forms the site and the presence of significant underground utilities that would interfere with the normal flow patterns of extraction wells. Further difficulty in containing groundwater flow would result because the buildings and underground utilities at the site would likely prevent the extraction wells from being placed in the best location for containment. In addition, pump and treat systems require a significant operation and maintenance effort and cost that is not justified based on the expected inability of an extraction well network to effectively contain groundwater contamination.

DER-10 guidance requires that the FS include an alternative that restores the site to pre-disposal or unrestricted use conditions. This alternative would require the demolition of onsite structures and removal of all contaminated fill.

Based on the technologies considered feasible for remediation listed in Section 3.4 and the discussion above, six alternatives have been developed for the site as follows:

- Alternative 1 – No Action, SMP
- Alternative 2 – SMP, Soil Cover and Passive LNAPL Recovery
- Alternative 3 – SMP, Soil Cover and Enhanced LNAPL Recovery Using Surfactants
- Alternative 4 – SMP, Soil Cover, Excavation of LNAPL-Contaminated Soil and Excavation of the Utility Corridor
- Alternative 5 – SMP, Soil Cover and Solidification of LNAPL-Contaminated Soil Alternative 6 – Remediation to Pre-Disposal Conditions

A summary of the remedial alternatives including their components is presented in Table 4-1.

4.2 Description of Alternatives

4.2.1 Alternative 1 – No Action, SMP

Alternative 1 is the No Action alternative that includes no active remediation and maintains exposure controls through an SMP and includes monitoring.

Size and Configuration

- An SMP would be developed to include institutional controls to manage residual contaminated media and potential on-site worker or community exposures to contaminated media; evaluate potential vapor intrusion as required per NYSDOH guidance for future on-site buildings or modifications to existing buildings; and maintain use restrictions regarding site development and groundwater use.
- Annual sampling and analysis for VOCs and SVOCs, as well as routine water quality indicator parameters, (e.g., oxidation-reduction potential, pH, temperature and conductivity) would be performed in approximately 20 select existing groundwater

monitoring wells. The list of parameters, number of monitoring wells, and sampling frequency could be modified following data review of monitoring results.

- An annual report and Five-Year Review would evaluate site conditions and monitoring activities and recommend any changes necessary to the existing program.

Time for Remediation

- For the purpose of this report, a 30-year period is assumed for monitoring.

Spatial Requirements

- There are no spatial requirements for this alternative.

Options for Disposal

- No significant off-site disposal will be required for this alternative.

Permit Requirements

- No permits will be required for this alternative other than NYSDEC approval.

Limitations

- There are no limitations associated with this alternative.

Ecological Impacts

- There would be no change from existing conditions.

4.2.2 Alternative 2 –SMP, Soil Cover and Passive LNAPL Recovery

Alternative 2 includes a soil cover to prevent human contact with contaminated surface soil and LNAPL (which is the major source of contamination at the site) recovery and removal using new recovery wells or monitoring wells as required. The alternative also includes an SMP. A conceptual layout of this alternative is presented on Figure 4-1.

Size and Configuration

- An SMP would be developed to include institutional and engineering controls to manage residual contaminated media and potential on-site worker or community exposures to contaminated media; evaluate potential vapor intrusion as required per

NYSDOH guidance for future on-site buildings or modifications to existing buildings; and maintain use restrictions regarding site development and groundwater use.

- Conceptually, nineteen recovery wells would be installed as shown on Figure 4-1. Existing monitoring wells could also be used for LNAPL recovery. LNAPL would be removed by hand operated pumps or by a vacuum truck.

- Off-site disposal of approximately 1,000 gallons of LNAPL.

- Excavation and disposal of the top one foot of contaminated surface soil in areas defined as commercial use or the top two feet of contaminated surface soil in areas defined as restricted-residential use prior to soil cover installation.

- Depending on the land use, a one or two-foot thick soil cover, consisting of 6-18 inches of clean soil fill and 6 inches of topsoil and a vegetation layer would be installed in the area of the surface soil contamination. The estimated area of the one-foot thick cover is 54,000 square feet and the estimated area of the two-foot thick cover is 25,000 square feet.

- Quarterly sampling and analysis for VOCs and SVOCs, as well as routine water quality indicator parameters, would be performed in approximately 15 selected groundwater monitoring wells for the first five years of remediation during LNAPL recovery.

- Annual sampling and analysis for VOCs and SVOCs, as well as routine water quality indicator parameters, would be performed in approximately 20 selected existing groundwater monitoring wells after the first five years.

- An annual report and Five-Year review would evaluate site conditions, OM&M activities and recommend any changes necessary to the OM&M program.

Time for Remediation

- For the purposes of this report, a 30-year period is assumed for monitoring and a 5-year period for LNAPL collection.

- Construction would require less than one year.

Spatial Requirements

- On-site space would be required for stockpiling excavated soil and for storing soil cover materials during construction.

Options for Disposal

- LNAPL would be disposed of off-site.

- Excavated soil for the soil cover and drill cuttings from the recovery well installation would be disposed of off-site.

Permit Requirements

- A permit from the New York City Building Department would be required for excavation on the site.

Limitations

- Construction activities would have impacts on property owners and roadways and may require access agreements.

Ecological Impacts

- Remediation activities would have no ecological impacts.

4.2.3 Alternative 3 – SMP, Soil Cover and Enhanced LNAPL Recovery Using Surfactants

Alternative 3 includes a soil cover to prevent human contact with contaminated surface soil and enhanced LNAPL (which is the major source of contamination at the site) recovery using surfactants. The alternative also includes an SMP. A conceptual layout of this alternative is presented on Figure 4-2.

Size and Configuration

- An SMP would be developed to include institutional and engineering controls to manage residual contaminated media and potential on-site worker or community exposures to contaminated media; evaluate potential vapor intrusion as required per NYSDOH guidance for future on-site buildings or modifications to existing buildings; and maintain use restrictions regarding site development and groundwater use.

- Thirty-eight direct push borings would be installed to inject surfactants as shown on Figure 4-2. It is assumed that two injection events would be required.

- Conceptually nineteen recovery wells would be installed as shown on Figure 4-2. Existing monitoring wells could also be used for LNAPL recovery. LNAPL would be removed by hand operated pumps or by a vacuum truck.

- Off-site disposal of approximately 2,000 gallons of LNAPL.

- Excavation and disposal of the top one foot of contaminated surface soil in areas defined as commercial use or the top two feet of contaminated surface soil in areas defined as restricted-residential use prior to soil cover installation.

- Depending on the land use, a one or two-foot thick soil cover, consisting of 6-18 inches of clean soil fill and 6 inches of topsoil and a vegetation layer would be installed in the area of the surface soil contamination. The estimated area of the one-foot thick cover is 54,000 square feet and the estimated area of the two-foot thick cover is 25,000 square feet.Quarterly sampling and analysis for VOCs and SVOCs, as well as routine water quality indicator parameters, would be performed in approximately 15 selected groundwater monitoring wells for the first three years of remediation during enhanced LNAPL recovery.

- Annual sampling and analysis for VOCs and SVOCs, as well as routine water quality indicator parameters, would be performed in approximately 20 selected existing groundwater monitoring wells after the first three years.

- An annual report and Five-Year review would evaluate site conditions, OM&M activities and recommend any changes necessary to the OM&M program.

Time for Remediation

- For the purposes of this report, a 3-year period is assumed for LNAPL collection and a 30-year period for monitoring.
- Construction would require less than one year.

Spatial Requirements

- On-site space would be required for stockpiling excavated soil and for storing soil cover materials during construction.

Options for Disposal

- LNAPL would be disposed of off-site.
- Excavated soil for the soil cover and drill cuttings from the recovery well installation would be disposed of off-site.

Permit Requirements

- A permit from the New York City Building Department would be required for excavation on the site.

Limitations

- Construction activities would have impacts on property owners and roadways and may require access agreements.

Ecological Impacts

- Remediation activities would have no ecological impacts.

4.2.4 Alternative 4 – SMP, Soil Cover, Excavation of LNAPL-Contaminated Soil and Excavation of the Utility Corridor

Alternative 4 includes a soil cover to prevent human contact with contaminated surface soil and excavation of LNAPL contaminated soil (which is the major source of contamination at the site) and soil in the utility corridor. The alternative also includes an SMP. A conceptual layout of this alternative is presented on Figure 4-3.

Size and Configuration

- An SMP would be developed to include institutional and engineering controls to manage residual contaminated media and potential on-site worker or community exposures to contaminated media; evaluate potential vapor intrusion as required per NYSDOH guidance for future on-site buildings and modifications to existing buildings; and maintain use restrictions regarding site development and groundwater use.

- An estimated 17,000 cubic yards of soil would be excavated in the LNAPL-contaminated areas. Approximately 5,700 cubic yards of LNAPL-contaminated soil would be disposed of off-site. It is assumed that the remaining 11,300 cubic yards of excavated soil could be backfilled into the excavated areas. In addition, 5,700 cubic yards of clean fill that meets the Subpart 375 soil cleanup objectives for residential use would be imported on-site and used as backfill.

- An additional estimated 8,000 cubic yards of soil would be excavated in the utility corridor. The excavated soil would be replaced with clean fill.

- Excavation and disposal of the top one foot of contaminated surface soil in areas defined as commercial use or the top two feet of contaminated surface soil in areas defined as restricted-residential use not coincidental with the excavation of LNAPL contaminated soil prior to soil cover installation.

- Depending on the land use, a one or two-foot thick soil cover, consisting of 6-18 inches of clean soil fill and 6 inches of topsoil and a vegetation layer would be installed in the area of the surface soil contamination. The estimated area of the one-foot thick cover is 54,000 square feet and the estimated area of the two-foot thick cover is 25,000 square feet.

- Annual sampling and analysis for VOCs and SVOCs, as well as routine water quality indicator parameters, would be performed in approximately 20 selected existing groundwater monitoring wells.

- An annual report and Five-Year review would evaluate site conditions, OM&M activities and recommend any changes necessary to the OM&M program.

Time for Remediation

- For the purposes of this report, a 30-year period is assumed for monitoring.

- Construction, including excavation and disposal of contaminated soil, would require less than one year.

Spatial Requirements

- On-site space would be required for stockpiling excavated soil and for storing clean backfill materials during construction.

- On-site space would be required for equipment required to excavate contaminated soil and backfill the excavation.

- Space is very limited in this residential area so space would become a major issue with the significant amount of excavation required under this alternative.

Options for Disposal

- LNAPL-contaminated soil would be disposed of off-site.

- Excavated soil from the utility corridor would be disposed of off-site.

Permit Requirements

- A permit from the New York City Building Department would be required for excavation on the site.

Limitations

- Excavation areas and depths for removal of LNAPL-contaminated soil would be limited because of building foundations in the areas of excavation. The excavation perimeter would have to be off-set from the building foundation. Vibration monitoring would be required during the installation of shoring. There would be a significant risk of structural damage to residences under this alternative. Installation of shoring in the fill could be difficult.

- Due to the close proximity of nearby residences, the construction activities identified above will have impacts on nearby property owners and roadways. Extensive air monitoring and dust control would be required during excavation activities.

Ecological Impacts

- Remediation activities would have no ecological impacts.

4.2.5 Alternative 5 – SMP, Soil Cover and Solidification of LNAPL-Contaminated Soil

Alternative 5 includes a soil cover to prevent human contact with contaminated surface soil and solidification of LNAPL contaminated soil (which is the major source of contamination at the site). The alternative also includes an SMP. A conceptual layout of this alternative is presented on Figure 4-4.

Size and Configuration

- An SMP would be developed to include institutional and engineering controls to manage residual contaminated media and potential on-site worker or community exposures to contaminated media; evaluate potential vapor intrusion as required per NYSDOH guidance for future on-site buildings and modifications to existing buildings; and maintain use restrictions regarding site development and groundwater use.

- An estimated 5,700 cubic yards of LNAPL-contaminated soil would be solidified.

- Swelled soil after solidification and soil excavated in preparation for ISS would be disposed of off-site.

- Excavation and disposal of the top one foot of contaminated surface soil in areas defined as commercial use or the top two feet of contaminated surface soil in areas defined as restricted-residential use prior to soil cover installation.

- Depending on the land use, a one or two-foot thick soil cover, consisting of 6-18 inches of clean soil fill and 6 inches of topsoil and a vegetation layer would be installed in the area of the surface soil contamination. The estimated area of the one-foot thick cover is 54,000 square feet and the estimated area of the two-foot thick cover is 25,000 square feet.

- Annual sampling and analysis for VOCs and SVOCs, as well as routine water quality indicator parameters, would be performed in approximately 20 selected existing groundwater monitoring wells.

- An annual report and Five-Year review would evaluate site conditions, OM&M activities and recommend any changes necessary to the OM&M program.

<u>Time for Remediation</u>

- For the purposes of this report, a 30-year period is assumed for monitoring.

- Construction, including solidification of contaminated soil, would require less than one year.

<u>Spatial Requirements</u>

- On-site space would be required for equipment required to solidify contaminated soil. Space is very limited in this residential area.

- ISS may not be possible close to on-site buildings.

Options for Disposal

- Soil excavated for the soil cover and excess soil from in-situ solidification would be disposed of off-site.

Permit Requirements

- A permit from the New York City Building Department would be required for excavation on the site.

Limitations

- The perimeter of the solidification areas would have to be off-set from the building to protect the foundations. Vibration monitoring would be required during the solidification process. Sheet pile or a comparable technology would have to be employed to protect building foundations.

- Due to the close proximity of nearby residences, the construction activities identified above will have impacts on nearby property owners and roadways.

Ecological Impacts

- Remediation activities would have no ecological impacts.

4.2.6 Alternative 6 – Remediation to Pre-Disposal Conditions

Alternative 6 includes purchasing existing on-site condominiums from current owners, the demolition of all on-site residences and utilities and excavation of all on-site contaminated soil.

Size and Configuration

- All existing condominiums would be purchased from the current owners.

- An estimated 360,000 cubic yards of contaminated soil would be excavated and disposed of off-site.

- An estimated 360,000 cubic yards clean imported soil would be used to backfill the excavated area.

- All on-site structures and utilities would be demolished and removed from the site prior to excavation.

- It is assumed that if all contaminated soil is removed then groundwater will not be impacted by on-site contamination. However, groundwater could still be impacted be off-site sources that are adjacent to the site. Although groundwater could be contaminated by off-site contamination, it is assumed that no groundwater treatment will be required under this alternative.

Time for Remediation

- Construction, including demolition, excavation and backfill is estimated at 3 years.

Spatial Requirements

- Since all structures would be demolished prior to excavation, space would not be an issue.

Options for Disposal

- All excavated soil would be disposed of off-site.

Permit Requirements

- A permit for work on the shore of the East River would be required from the Army Corps of Engineers.

- A permit from the New York City Building Department would be required for excavation on the site.

Limitations

- Residents would be permanently relocated.

Ecological Impacts

- Remediation activities would likely have a positive impact on the ecology of the East River.

4.3 Screening of Alternatives

The College Point 3 site is a unique site because it is land reclaimed from the East River by unregulated landfilling and because it is highly developed site that currently is the location of the Riverview Condominium complex. The unique and complex geology and the significant development and population at the site greatly increase the complexity of remediation and thus the feasibility of remedial alternatives. Therefore, URS in collaboration with the NYSDEC has evaluated the six proposed alternatives and has eliminated two of the alternatives from consideration before proceeding with the detailed analysis of the alternatives. The two rejected alternatives are discussed below.

- Alternative 3 – SMP, Soil Cover and Enhanced LNAPL Recovery Using Surfactants

The Department's experience with surfactants has shown that surfactants are not likely to be effective with the very viscous LNAPL present at the College Point 3 site. In addition, the complex geology of the site will make it extremely difficult to effectively distribute the surfactant in the subsurface, i.e. it may not be possible to effectively inject surfactant in the areas where LNAPL is known to be present. There is the added risk that if LNAPL is mobilized that it could migrate under residences or to the East River, thereby, posing a greater risk to human health and/or the environment. Taking all these factors into account, enhanced LNAPL recovery included in Alternative 3 does not offer a significant advantage over passive LNAPL recovery included in Alternative 2. Consequently, Alternative 3 will not be carried forward to the detailed analysis of alternatives.

- Alternative 4 – SMP, Soil Cover, Excavation of LNAPL-contaminated Soil and Excavation of the Utility Corridor

Alternative 4 includes excavation to depth of approximately 15 feet in around several condominiums. These excavations represent a significant threat to the structural integrity of the condominiums. Settling and subsidence has been observed in roadways located on the site. The fill material underlying the site is conducive to the settling and subsidence that has been observed. Excavations near the condominiums is likely to intensify the conditions for settling and subsidence, and thereby, could likely result in damage to the condominiums. Steel sheet pile would likely be used to protect against subsidence during excavation; however, the sheet piling could be a threat to the integrity of the condominiums because driving sheet pile causes significant vibration that could damage buildings. In addition, excavating and replacing soil in the utility corridor will likely temporarily eliminate subsidence that causes damage to the utilities; however, over time the fill beneath the replaced soil in the utility corridor will subside and problems will once again occur there. Based on the above, Alternative 4 will not be carried forward to the detailed analysis of alternatives.

On the basis of the above evaluation, four alternatives (Alternatives 1, 2, 5 and 6) will be carried forward to the detailed analysis of alternatives. For clarity and convenience, Alternative 5 will hereinafter be referred to as Alternative 3 and Alternative 6 will be referred to as Alternative 4. Therefore, the alternatives included in the detailed analysis will include the following:

- Alternative 1 – No Action, SMP
- Alternative 2 – SMP, Soil Cover and Passive LNAPL Recovery
- Alternative 3 – SMP, Soil Cover and Solidification of LNAPL-Contaminated Soil
- Alternative 4 – Remediation to Pre-Disposal Conditions

5.0 DETAILED ANALYSIS OF ALTERNATIVES

5.1 Description of Evaluation Criteria

Each of the alternatives is subjected to a detailed evaluation with respect to the criteria outlined in 6 NYCRR Part 375. A description of each of the evaluation criteria is provided below. This evaluation aids in the selection process for remedial actions in New York State.

5.1.1 Overall Protection of Public Health and the Environment

This criterion is an assessment of whether the alternative meets requirements that are protective of human health and the environment. The overall assessment is based on a composite of factors assessed under other evaluation criteria, particularly long-term effectiveness and permanence, short-term effectiveness, and compliance with standards, criteria, and guidance (SCGs). This evaluation focuses on how a specific alternative achieves protection over time and how potential site risks are reduced. The analysis includes how the contamination is to be eliminated, reduced, or controlled.

5.1.2 Compliance with Standards, Criteria, and Guidance

This criterion determines whether or not each alternative and the proposed remedial technologies comply with applicable environmental laws and SCGs pertaining to the contaminants detected and the location of the site.

5.1.3 Long-term Effectiveness and Permanence

This criterion addresses the performance of a remedial action in terms of its permanence and the quantity/nature of waste or residuals remaining at the site after implementation. An evaluation is made on the extent and effectiveness of controls required to manage residuals remaining at the site and the operation and maintenance systems necessary for the remedy to remain effective. The factors that are evaluated include permanence of the remedial alternative, magnitude of the remaining risk, adequacy of controls used to manage residual contamination, and the reliability of controls used to manage residual contamination.

5.1.4 Reduction of Toxicity, Mobility or Volume with Treatment

This criterion assesses the remedial alternative's use of technologies that permanently and significantly reduce toxicity, mobility, or volume (TMV) of the contamination as their principal element. Preference is given to remedies that permanently and significantly reduce the toxicity, mobility, or volume of contamination at the site.

5.1.5 Short-term Effectiveness

This criterion assesses the effects of the alternative during the construction and implementation phase with respect to the effect on human health and the environment. The factors that are assessed include protection of the workers and the community during remedial action, environmental impacts that result from the remedial action, and the time required until the remedial action objectives are achieved.

5.1.6 Implementability

This criterion addresses the technical and administrative feasibility of implementing the alternative and the availability of various services and materials required during implementation. The evaluation includes the feasibility of construction and operation, the reliability of the technology, the ease of undertaking additional remedial action, monitoring considerations, activities needed to coordinate with regulatory agencies, availability of adequate equipment, services and materials, off-site treatment, and storage and disposal services.

5.1.7 Cost

Capital costs and operation, maintenance, and monitoring costs (OM&M) are provided for each alternative and presented as present worth using a 5% discount rate.

5.1.8 Community and State Acceptance

Concerns of the State and the Community will be addressed separately in accordance with the public participation program developed for this site.

5.1.9 Land Use

This criterion addresses the current, intended, and reasonably anticipated future land use in the area as impacted by the remediation.

5.2 Alternative 1 – No Action, SMP

5.2.1 Overall Protection of Public Health and the Environment

This alternative does not meet the RAOs for the site and is not effective in the long-term because the LNAPL and LNAPL-contaminated soil are not remediated. Implementing institutional controls as specified in the SMP would provide limited protection to human health and the environment as compared to current conditions.

5.2.2 Compliance with SCGs

Since no remediation is proposed, contamination would remain in-place at the site. This alternative would not meet the SCGs for media at the site.

5.2.3 Long-term Effectiveness and Permanence

Contaminant migration and potential exposure to contaminants would continue due to residual contamination. The potential risks to human health caused by contaminated subsurface soil and groundwater could be addressed by an SMP with use restrictions, soil excavation protocols and groundwater use restrictions. This alternative is not effective or permanent in reducing long-term risks.

5.2.4 Reduction of Toxicity, Mobility and Volume with Treatment

Reduction of the toxicity, mobility and volume (TMV) would occur very slowly through natural processes. No treatment is included to reduce TMV.

5.2.5 Short-term Effectiveness

There is no construction associated with this alternative, so there are no potential impacts to workers or residents. RAOs would not be met.

5.2.6 Implementability

Deed restrictions are routinely implemented at contaminated sites. However, implementation of an SMP would require coordination with condominium owners and local residents.

5.2.7 Cost

Estimated capital and OM&M costs for Alternative 1 are presented on Table 5-1. The capital cost is $28,900, present worth of OM&M costs is $276,000 and the total present worth of Alternative 1 is $304,900.

5.2.8 Land Use

The site is expected to remain a multi-unit residential area for the foreseeable future. Alternative 1 will restrict land use through deed restrictions.

5.3 Alternative 2- SMP, Soil Cover and Passive LNAPL Recovery

5.3.1 Overall Protection of Public Health and the Environment

A combination of deed restrictions, a soil cover and LNAPL removal is protective of human health and would meet the RAOs for public health protection. However, this alternative would not meet the RAOs for environmental protection. This alternative would leave a significant quantity of residual LNAPL contamination in the subsurface that will impact groundwater quality. However, groundwater is not used as a potable supply source.

5.3.2 Compliance with SCGs

SCGs for soil would be met in area where the soil cover is installed. Subsurface soil and groundwater quality would be improved, but SCGs for these media would not be achieved.

5.3.3 Long-term Effectiveness and Permanence

This alternative addresses the major source of contamination at the site, i.e. LNAPL. Deed restrictions and engineering controls would adequately address the remaining residual contamination at the site.

5.3.4 Reduction of Toxicity, Mobility and Volume with Treatment

Alternative 2 includes LNAPL removal which would significantly reduce the volume of contamination at the site and surface soil removal which would also reduce the volume of on-site contamination.

5.3.5 Short-term Effectiveness

Construction of a soil cover would produce noise, disrupt daily traffic patterns, and present short-term risks to workers and local residents that would need to be addressed through engineering controls and air monitoring. Dust control would be required. The time of construction would be less than one year. Air emissions would also be a concern during the LNAPL recovery phase of remediation. Engineering controls would also be required to address these concerns.

5.3.6 Implementability

The technologies employed for remediation are conventional technologies for addressing the types of contamination at the site. Considerable coordination with the site owners and residents would be required during the construction of the remedial components.

5.3.7 Cost

Estimated capital and OM&M costs for Alternative 2 are presented on Table 5-1. The capital cost is $1,886,700, present worth of OM&M costs is $427,000, and the total present worth of Alternative 2 is $2,313,700.

5.3.8 Land Use

The site is expected to remain a multi-unit residential area for the foreseeable future. Alternative 2 will restrict land use through deed restrictions. In addition, land use in the area of the recovery wells would be limited.

5.4 Alternative 3 – SMP, Soil Cover and Solidification of LNAPL-Contaminated Soil

5.4.1 Overall Protection of Public Health and the Environment

A combination of deed restrictions, a soil cover and solidification of LNAPL-contaminated soil is protective of human health. However, this alternative would not meet the RAOs for environmental protection. This alternative would prevent the migration of LNAPL. Groundwater quality would be improved slowly over time.

5.4.2 Compliance with SCGs

SCGs for soil would be met in area where the soil cover is installed. Subsurface soil and groundwater quality would be improved, but SCGs for these media would not be achieved.

5.4.3 Long-term Effectiveness and Permanence

This alternative addresses the major source of contamination at the site, i.e. LNAPL. Deed restrictions and engineering controls would adequately address the remaining residual contamination at the site.

5.4.4 Reduction of Toxicity, Mobility and Volume with Treatment

Alternative 3 includes LNAPL and residual LNAPL solidification which would significantly reduce the mobility of contamination at the site. Surface soil removal would also reduce the volume of on-site contamination.

5.4.5 Short-term Effectiveness

Construction of a soil cover and soil solidification would produce noise, disrupt daily traffic patterns and present short-term risks to workers and local residents that would need to be addressed through engineering controls and air monitoring. Dust control would be required. The time of construction would be less than one year.

5.4.6 Implementability

The technologies employed for remediation are conventional technologies for addressing the types of contamination at the site. Considerable coordination with the site owners and residents would be required during the construction of the remedial components.

Solidification areas and depths for removal of LNAPL-contaminated soil would be limited because of building foundations in the areas of excavation. The solidification perimeter would have to be off-set from the building foundation. Sheet pile or a comparable technology would be installed to protect building foundations during solidification activities. Vibration monitoring would be required during the solidification activities. The indefinite nature of the fill at the site would make soil mixing difficult to implement and solidification possibly ineffective.

5.4.7 Cost

Estimated capital and OM&M costs for Alternative 5 are presented on Table 5-1. The capital cost is $4,586,520 present worth of OM&M costs is $276,000 and the total present worth of Alternative 3 is $4,862,520.

5.4.8 Land Use

The site is expected to remain a multi-unit residential area for the foreseeable future. Alternative 3 will restrict land use through deed restrictions. In addition, land use in the areas of solidification would be limited.

5.5 Alternative 4 – Remediation to Pre-Disposal Conditions

5.5.1 Overall Protection of Public Health and the Environment

This alternative includes complete removal of contaminated soil and would meet all the RAOs for both public health and the environment.

5.5.2 Compliance with SCGs

SCGs for all media would be achieved.

5.5.3 <u>Long-term Effectiveness and Permanence</u>

This alternative is an effective and permanent remedy. No residuals would remain after implementation of this alternative.

5.5.4 <u>Reduction of Toxicity, Mobility and Volume with Treatment</u>

This alternative would remove all contamination at the site.

5.5.5 <u>Short-term Effectiveness</u>

Construction would produce noise, disrupt daily traffic patterns of nearby communities and present short-term risks to workers and local residents that would need to be addressed through engineering controls and air monitoring. Dust control would be required. The time of construction is estimated to be three years.

5.5.6 <u>Implementability</u>

This alternative would be difficult to implement. Potential pitfalls associated with this alternative include the following:

1. Significant time and coordination efforts would be required to purchase residences and relocate the residents.

2. Work along the East River would be difficult and require significant coordination with the Army Corp of Engineers and the City of New York.

3. Construction would significantly impact residents and commercial enterprises near the site and would require significant coordination with New York City Planning and local community groups.

4. Multiple facilities would likely be required to dispose of this volume of waste. Some could be located a significant distance from the site.

5.5.7 Cost

Estimated capital and OM&M costs for Alternative 4 are presented on Table 5-1. The capital cost is $205,151,700 present worth of OM&M costs is $0, and the total present worth of Alternative 3 is $205,151,700.

5.5.8 Land Use

The site would be considered an unrestricted use site.

5.6 Comparative Analysis of Alternatives

A comparison of the alternatives in light of the evaluation criteria follows.

5.6.1 Overall Protection of Public Health and the Environment

Alternative 1 is not protective of public health and the environment. Alternatives 2 and 3 meet RAOs for human health, but do not meet the environmental RAOs. Alternative 4 meets all the RAOs (assuming all contamination can be removed and the groundwater is not recontaminated from off-site sources) and is protective of human health and the environment. Alternatives 2 and 3 address the LNAPL source of contamination to varying degrees. Alternative 3 includes measures to stabilize and immobilize the source of contamination, but does not actually reduce the volume of LNAPL. Alternative 2 includes measures to reduce the volume of LNAPL. Even with source removal or abatement, SCGs for groundwater would not be achieved throughout the entire site with either Alternative 2 or Alternative 3. However, there is currently no groundwater use in the area, and deed restrictions could be easily put in place to prevent groundwater use.

5.6.2 Compliance with SCGs

Alternative 1 does not comply with the SCGs. Alternatives 2 and 3 have a soil cover that would meet the SCGs for surface soil. SCGs for subsurface soil and groundwater would not be met with these alternatives. Alternative 2 with LNAPL removal and Alternative 3 with LNAPL solidification would improve groundwater and subsurface soil quality over time. Alternative 4 meets all the SCGs.

5.6.3 Long-term Effectiveness and Permanence

Long-term effectiveness and permanence is directly related to the quantity of residuals remaining on the site. Alternative 4 would result in no residual contamination. Alternative 2 includes removal of LNAPL and would result in less residual contamination than Alternative 3. Alternative 3 would not reduce residuals, but does immobilize them. Alternative 1 does not address the source of contamination and is the least effective.

For all alternatives except Alternative 4 (which would not need to address residual contamination), monitoring and deed restrictions implemented through an SMP would be an effective means of managing residual contamination.

5.6.4 Reduction of Toxicity, Mobility and Volume with Treatment

The greatest reduction in contamination volume would be achieved by Alternative 4. Alternative 2 includes reduction of the LNAPL source. Alternative 3 does not reduce the volume of contamination, but it does decrease the mobility of the LNAPL source. Alternatives 2 and 3 are comparable with respect to TMV. Alternative 1 does not reduce TMV.

5.6.5 Short-term Effectiveness

Alternative 1 does not include any active remediation, and therefore, poses no risk to human health or the environment during construction. However, this alternative would not achieve the remedial action objectives for public health. Alternative 2 has the least intrusive activities during remediation, and therefore, would pose the smallest short-term risks. Alternatives 3 includes significant intrusive activities that would require significant air monitoring to protect residents, dust monitoring and control, and would represent more of a short-term risk to local residents. Alternatives 2 and 3 could all be constructed in less than a year, but Alternative 2 would include 5 years of O&M that would continue pose a risk to local residents. Alternative 4 includes the greatest short-term risks and would extend those risks over the greatest length of time (3 years).

5.6.6 Implementability

Since there is no construction, there is no implementation issue associated with Alternative 1. The technologies employed for Alternative 2 and are conventional and reliable technologies for remediation. Alternatives 3 would be more difficult to implement than Alternative 2. This alternative includes drilling near existing condominiums. Sheet pile or a comparable technology would be installed to protect nearby buildings. Vibration monitoring would need to be employed during intrusive activities to protect existing structures. This alternative would be more disruptive to the local residents and would require more coordination with site owners and residents. Alternative 4 would be the most difficult alternative to implement. It would require the purchase of all existing residences and relocation of all the current on-site residents. Extensive excavation would be required along the East River which would be difficult to implement and would require coordination with the Army Corp of Engineers and the City of New York. The extensive excavation would be very disruptive to nearby residences and businesses, and the transportation of the great volume of waste would impact a much larger community.

5.6.7 Cost

Capital costs and operation, maintenance, and monitoring costs (OM&M) are provided for each alternative and presented as present worth using a 5% discount rate. Cost estimates for each alternative are provided in Appendix A and are summarized on Table 5-1.

5.6.8 Land Use

The site is expected to remain a multi-unit residential area for the foreseeable future. Deed restrictions would be required under Alternatives 1, 2 and 3 that would restrict activities at the site. Deed restrictions would not be required for Alternative 4 and the site would not be restricted with regard to its use.

6.0 RECOMMENDED REMEDIAL ALTERNATIVE

Alternatives were developed, screened and evaluated for the remediation of the College Point 3 site. The evaluation of alternatives focused on remedial action objectives that were designed to provide source reduction, eliminate exposure pathways and attain SCGs to the extent practicable. Remediation areas and volumes were calculated for contaminated media identified for the site. Costs were developed for each alternative. The overall approach used to select the recommended alternative considered protection of human health and the environment during construction and after completion of remediation, the potential difficulties associated with implementing the alternative and the cost-effectiveness of the alternative. The recommendation is presented below.

6.1 <u>Basis for Recommendations</u>

Alternative 1 is not protective of human health and the environment and is rejected as a viable alternative for remediation. Alternatives 2 and 3 are protective of human health, but do not meet all the RAOs for protection of the environment. Alternative 4 includes measures to restore the site to pre-disposal conditions and is protective of human health and the environment. However, Alternative 4 would be extremely difficult to implement, would require the relocation of all current residents, would produce significant short-term risks to remediation workers and residents during construction and is very costly. Therefore, Alternative 4 is also rejected as a viable alternative for remediation. The two feasible remedial alternatives, Alternatives 2 and 3, are discussed below.

Alternative 2 is equal to or superior to Alternative 3 in almost every evaluation criteria and is recommended over Alternative 3 based on the following;

- Overall Protection of Public Health and the Environment: Alternative 2 includes measures to reduce the major source of contamination (LNAPL) while Alternative 3 includes measures to immobilize, but not reduce the source of contamination. Both alternatives are protective of public health, but limited in their protection of the environment.

- Compliance with Standards, Criteria and Guidance: Both Alternatives 2 and 3 include a soil cover that would meet the SCGs for surface soil. Both alternatives include measures to improve the quality of contaminated media but neither would achieve SCGs for the media. Alternatives 2 and 3 are comparable with regard to SCGs.

- Long-Term Effectiveness and Permanence: Long-term effectiveness and permanence is directly related to the quantity of residual contamination remaining on the site after remediation. Alternative 2 includes reduction of LNAPL which would reduce the amount of contamination left on-site (i.e. residual contamination) while Alternative 3 immobilizes the contamination, but the contamination remains on-site. Alternatives 2 and 3 are comparable with respect to long-term effectiveness and permanence.

- Reduction of Toxicity, Mobility with Treatment: Alternative 3 includes treatment to reduce the mobility of the contamination source. Alternative 2 does not include treatment, but does reduce the volume of contamination through LNAPL removal. Alternatives 2 and 3 are comparable with respect to this criterion.

- Short-Term Effectiveness: Alternative 3 includes significant short-term risks to the nearby residents because drilling during solidification could result in significant generation of dust, vapors and odors. Alternative 2 includes significantly less intrusive activities and is superior to Alternative 3 in terms of short-term effectiveness.

- Implementability: Alternative 3 includes extensive drilling near condominiums that would greatly complicate implementation of this alternative, especially considering the indefinite nature of the fill at the site. Comparatively, Alternative 2 would be easier to construct.

- Cost: The estimated cost of Alternative 2 is approximately $2.5 million less than Alternative 3.

- Land Use: The site is expected to remain a multi-unit residential area for the foreseeable future. Remediation will not significantly impact the use of the site although deed restrictions will impact activities on the site.

6.2 Components of Remediation

A conceptual layout for Alternative 2 is shown on Figure 4-1. The major components of the alternative are a soil cover and passive LNAPL collection which are described below.

Soil Cover: The soil cover will consist of 6-18 inches of clean fill and 6 inches of topsoil and vegetative cover depending on the land use designation. Conceptually, the waterfront area north of the condo buildings will be defined as “commercial use” per 6 NYCRR Part 375-1.8(g)(iii) because it meets the definition of a passive recreational use area. The grassy area surrounded by condo buildings will be defined as “restricted-residential use” per 6 NYCRR Part 375-1.8(g)(2)(ii). The cover materials and thickness will be evaluated during the design phase. The soil cover will cover contaminated surface soil. The estimated area the “commercial use” cover is 54,000 square feet, and the estimated area of the “restricted-residential” cover is 25,000 square feet.. The final size will be determined after inspection and survey is completed and possibly additional soil sampling.

Passive LNAPL Recovery: Conceptually, passive LNAPL recovery will utilize nineteen extraction wells to recover LNAPL. The actual types and numbers of components utilized for passive LNAPL recovery will be determined during design. An initial pilot test showed that skimmers may not be useful for LNAPL recovery. Further pilot tests and boring or well installation may be conducted during the design phase. It is possible that passive LNAPL recovery could best be accomplished using only existing monitoring wells or existing monitoring wells and some newly installed monitoring wells.

REFERENCES

NYSDOH, October 2016, *Guidance for Evaluating Soil Vapor Intrusion in the State of New York*.

URS Corporation, June 2013. *Remedial Investigation Report* prepared for the NYSDEC.

URS Corporation, June 2015. *Soil Vapor Intrusion Data Summary Report* prepared for the NYSDEC.

URS Corporation, February 2016. *Soil Gas Summary Report* prepared for the NYSDEC.

TABLES

TABLE 3-1
SUMMARY OF REMEDIAL TECHNOLOGY SCREENING

General Response Actions	Remedial Technologies for Soil	Description	Screening Comments
No Action	Site Management Plan	SMP would include IC/EC to manage residual contamination.	Retained for site use.
Containment	Soil Cover	Soil cover to prevent direct contact with soil contamination.	Retained for site use.
	Geomembrane Cap	Geomembrane cap to limit infiltration.	Not retained for site use.
	Vertical Barriers	No impervious layer to key into and difficult to construct in hetergeneous fill.	Not retained for site use.
Removal	Excavation and Off-Site Disposal and/or Treatment	Excavation of contaminated soil and off-site disposal/treatment.	Retained for site use.
	Excavation and On-Site Ex-Situ Treatment	Excavate contaminated soil and treat it on-site.	Not retained for site use.
In-Situ Treatment	Biological Treatment	Microorganisms, oxygen, and/or nutrients added to the subsurface to reduce volume of soil contamination.	Not retained for site use.
	Chemical Treatment	With ISCO, chemical oxidants are injected into the subsurface to convert toxic compounds into non-toxic compounds.	Not retained for site use.
	Solidification (ISS)	Solidification materials are mixed with soil using excavator buckets or injected into the subsurface and mixed with augers.	Retained for site use.
	Thermal Treatment	Various processes are used to heat the soil which produces off-gases that must be collected and treated. Groundwater control may be needed to retain heat in the target zone and control contaminant migration.	Not retained for site use.

TABLE 3-1
SUMMARY OF REMEDIAL TECHNOLOGY SCREENING

General Response Actions	Remedial Technologies for LNAPL/Groundwater	Description	Screening Comments
No Action	Site Management Plan with Monitoring	SMP would include IC/EC to manage residual contamination. Monitoring would indicate the rate of contaminant reduction.	Retained for site use.
Containment	Interceptor Trench	A permeable trench installled within the overburden on the downgradient edges of the LNAPL plumes.	Not retained for site use.
	Vertical Barriers	Barriers to produce hydraulic conctrol of LNAPL/groundwater.	Not retained for site use.
	Horizontal Barriers (Capping)	Cap to limit infiltration.	Not retained for site use.
	Groundwater Extraction Wells	Wells will provide hydraulic control and prevent contaminat migration.	Retained for site use.
Removal	LNAPL Recovery Wells	Use existing monitoring wells or install new recovery wells to remove LNAPL.	Retained for site use.
	Enhanced LNAPL Recovery	Chemical-Enhanced: Surfactants injected to increase LNAPL mobility.	Retained for site use.
		Thermal-Enhanced: Heat added to increase LNAPL mobility.	Not retained for site use.
		Biologically-Enhanced: Biological agents injected to increase LNAPL mobility.	Retained for site use.
		Dual-Phase Extraction: Vacuum used to remove groundwater, LNAPL and vapor.	Not retained for site use.
	Excavation and Off-site Disposal	Excavate and remove LNAPL-contaminated soil.	Retained for site use.
Treatment	Groundwater Treatment On-Site	Discharge to on-site groundwater.	Not retained for site use.
		Discharge to East River.	Not retained for site use.
	Groundwater Pretreatment On-Site	Discharge to local POTW.	Retained for site use.

TABLE 4-1

SUMMARY OF INITIAL REMEDIAL ALTERNATIVE COMPONENTS

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Description	No Action, SMP	SMP, Soil Cover and Passive LNAPL Recovery	SMP, Soil Cover and Enhanced LNAPL Recovery Using Surfactants	SMP, Soil Cover, Excavation of LNAPL-Contaminated Soil and Excavation of the Utility Corridor	SMP, Soil Cover and Solidification of LNAPL-Contaminated Soil	Remediation to Pre-Disposal Conditions
Source Control	None	Free-phase LNAPL removal	Free-phase and residual LNAPL removal	Complete LNAPL removal	Immobilize LNAPL and prevent migration of contamination from the source	Remove all sources of contamination
Remedial Actions for Surface Soil	None	Soil Cover	Soil Cover	Soil Cover	Soil Cover	Remove all surface soil
Remedial Actions for Subsurface Soil	Deed restrictions to prevent exposure	Deed restrictions to prevent exposure	Deed restrictions to prevent exposure	Deed restrictions to prevent exposure and removal of LNAPL-contaminated soil	Deed restrictions to prevent exposure and solidification of LNAPL-contaminated soil	Remove all subsurface soil
Remedial Actions for Groundwater	Deed restrictions to prevent exposure	Deed restrictions to prevent exposure	Deed restrictions to prevent exposure	Deed restrictions to prevent exposure	Deed restrictions to prevent exposure	Remove all contaminated soil

TABLE 5-1
SUMMARY OF FINAL REMEDIAL ALTERNATIVE COSTS

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
	No Action, SMP	SMP, Soil Cover and Passive LNAPL Recovery	SMP, Soil Cover and Solidification of LNAPL-Contaminated Soil	Remediation to Pre-Disposal Conditions
CAPITAL COSTS				
Site Management Plan	$20,100	$20,100	$20,100	
Mobilization/Demobilization&Site Services		$151,500	$160,500	$986,000
Soil Cover		$767,700	$767,700	
LNAPL Recovery		$380,000		
Solidification of LNAPL-Contaminated Soil			$2,259,000	
Condo Procurement				$72,000,000
Demolition Buildings/Infrastructure				$4,251,100
Excavation and Backfill				$66,225,600
Overhead and Profit	$2,100	$132,000	$320,800	$14,346,300
Contingency	$6,700	$435,400	$1,058,500	$47,342,700
TOTAL CAPITAL COST	$28,900	$1,886,700	$4,586,520	$205,151,700
OM&M COSTS				
Present Worth Monitoring-30 years	$46,000	$46,000	$46,000	
Present Worth Annual Report and 5-Year Reviews-30years	$230,000	$230,000	$230,000	
Present Worth LNAPL Recovery OM&M-5 Years		$151,000		
TOTAL OM&M COST	$276,000	$427,000	$276,000	
TOTAL COST	$304,900	$2,313,700	$4,862,520	$205,151,700

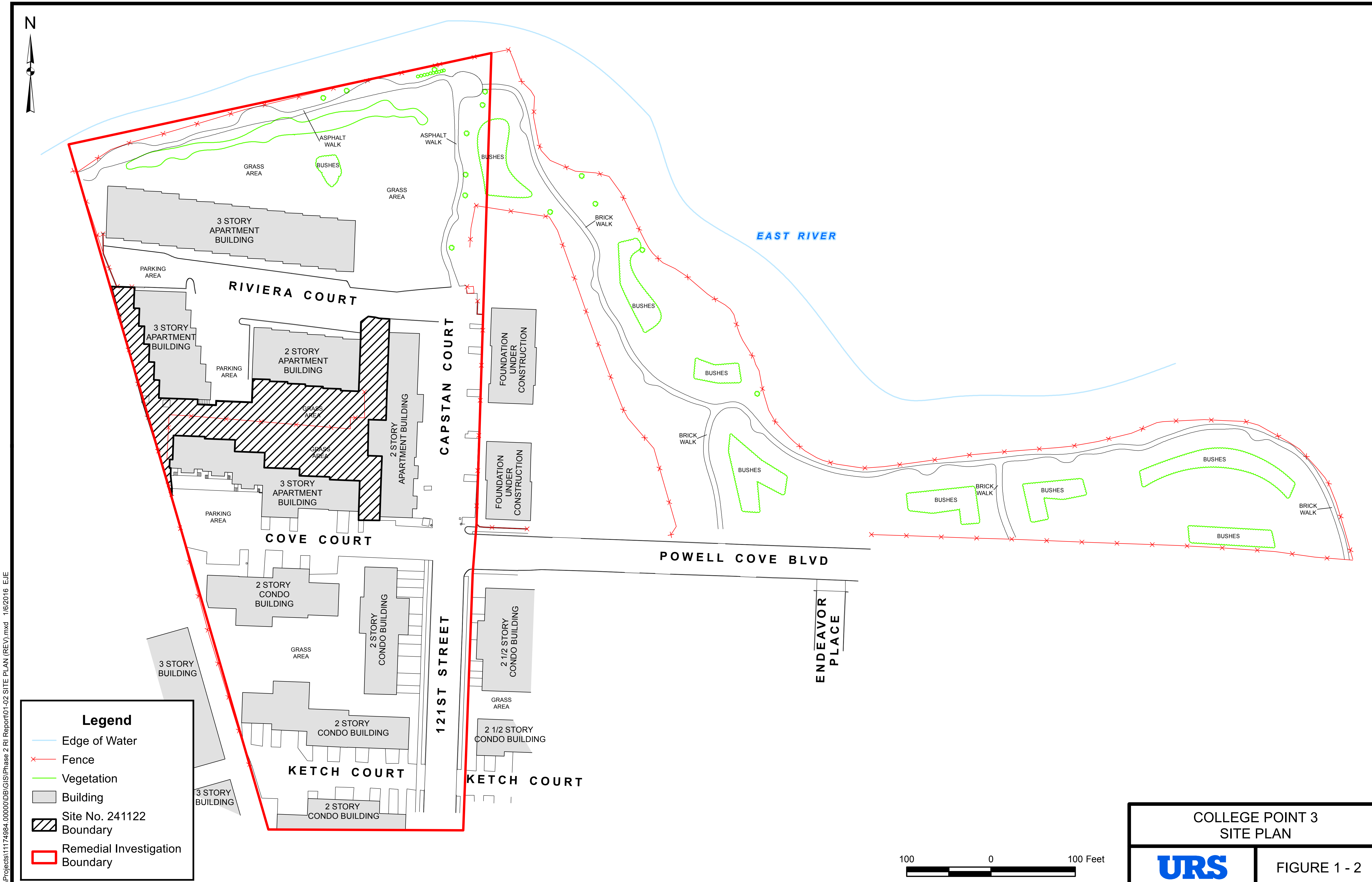
FIGURES

Source: ESRI World Street Map, 2012

COLLEGE POINT 3
SITE LOCATION

FIGURE 1-1

J:\Projects\11174984.00000\DB\GIS\Phase 2 RI Report\01-01 SITE LOCATION.mxd 1/6/2016 EJE



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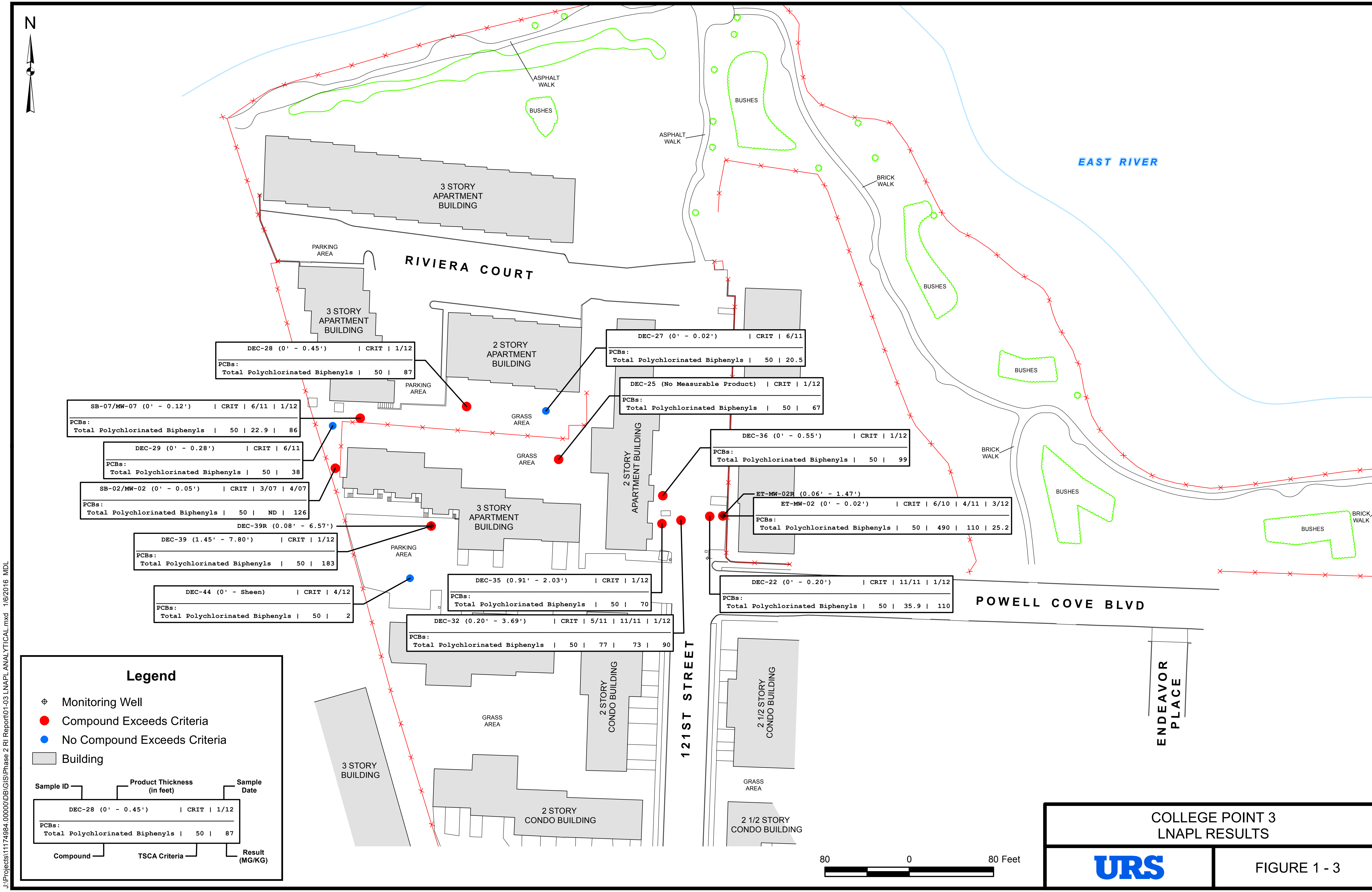
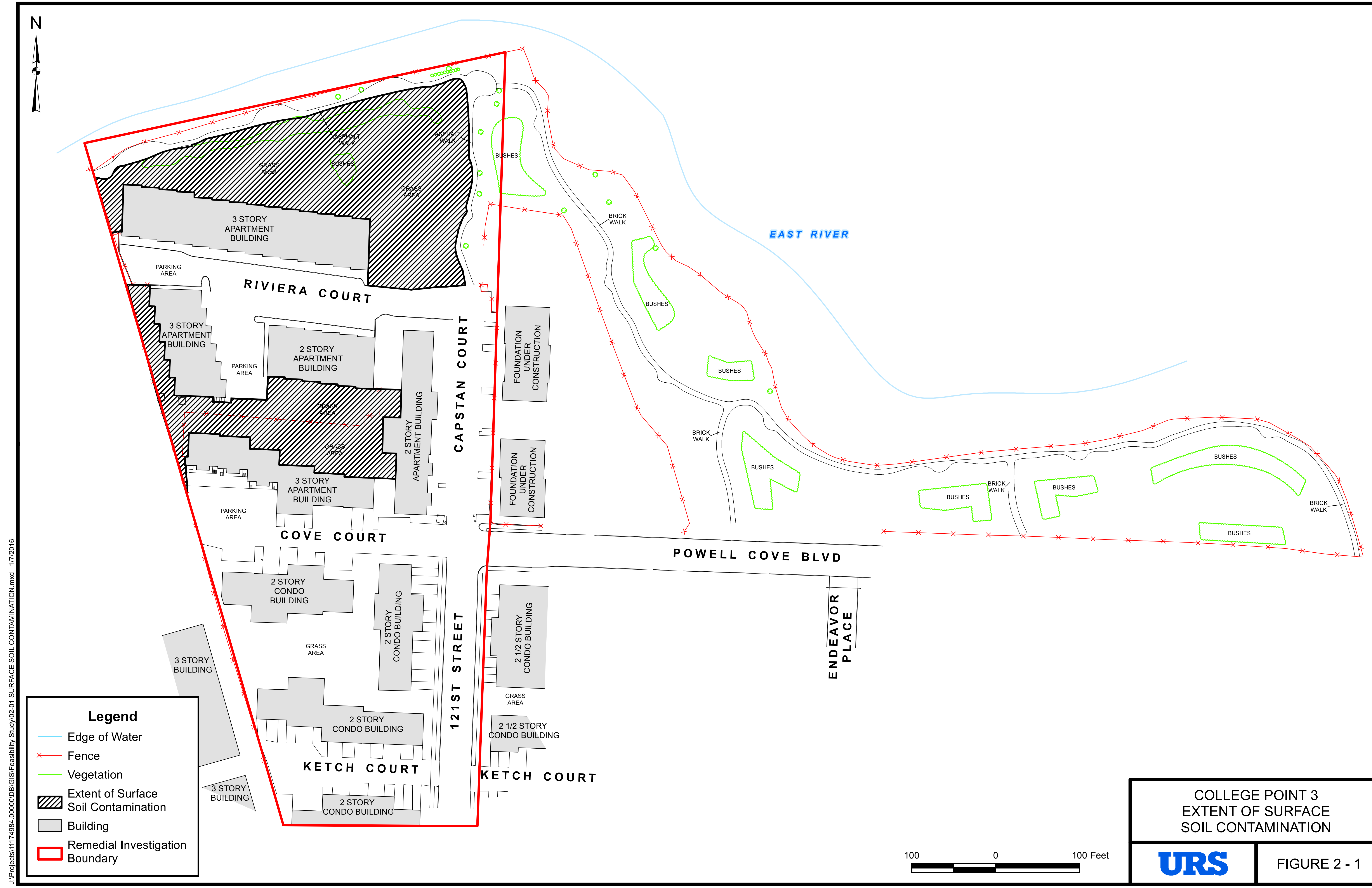


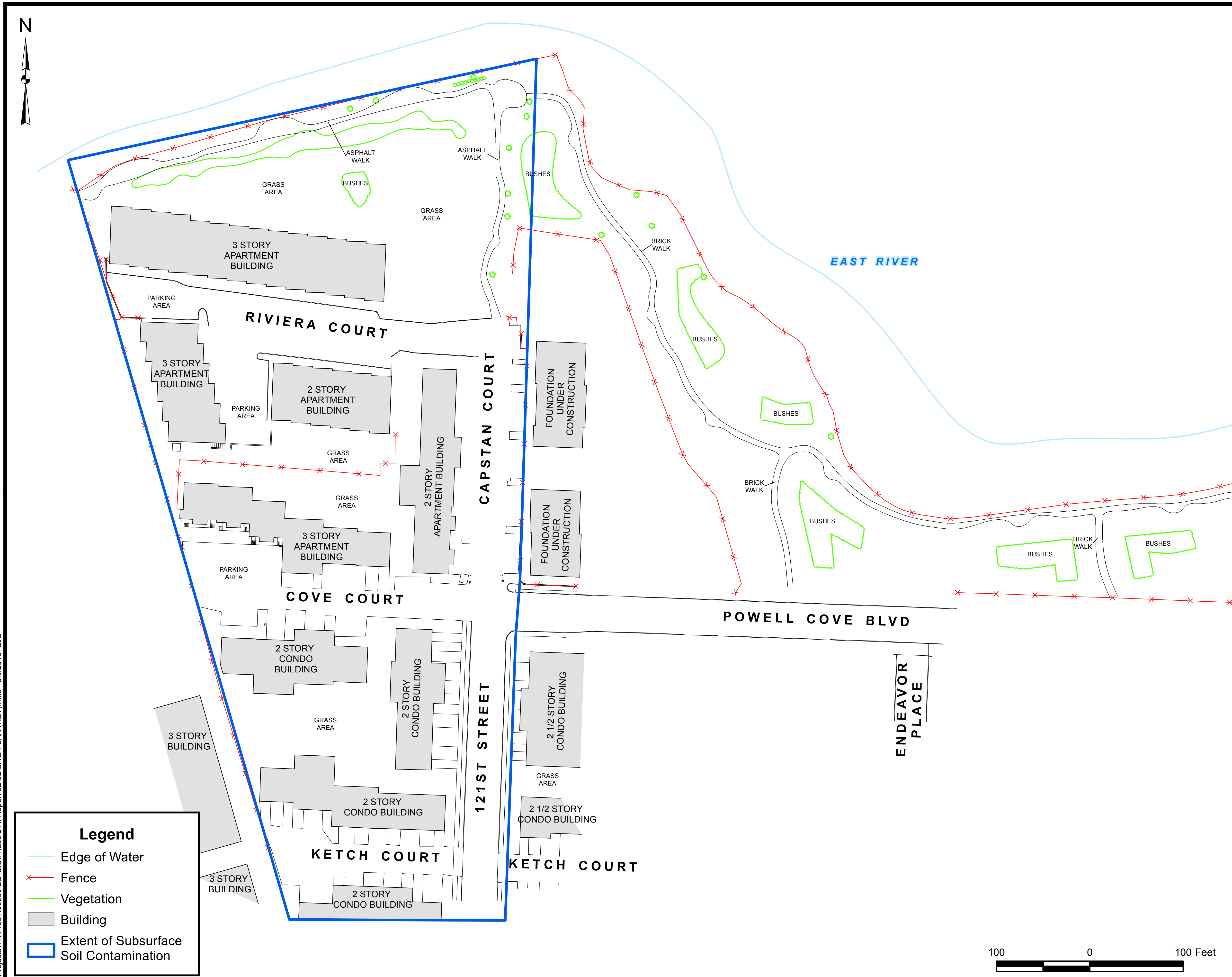
J:\Projects\11174984.00000\DB\GIS\Phase 2 RI Report\01-03 LNAPL ANALYTICAL.mxd 1/6/2016 MDL



COLLEGE POINT 3
EXTENT OF SURFACE SOIL CONTAMINATION

URS

FIGURE 2 - 1



COLLEGE POINT 3
EXTENT OF SUBSURFACE SOIL CONTAMINATION

URS

FIGURE 2 - 2

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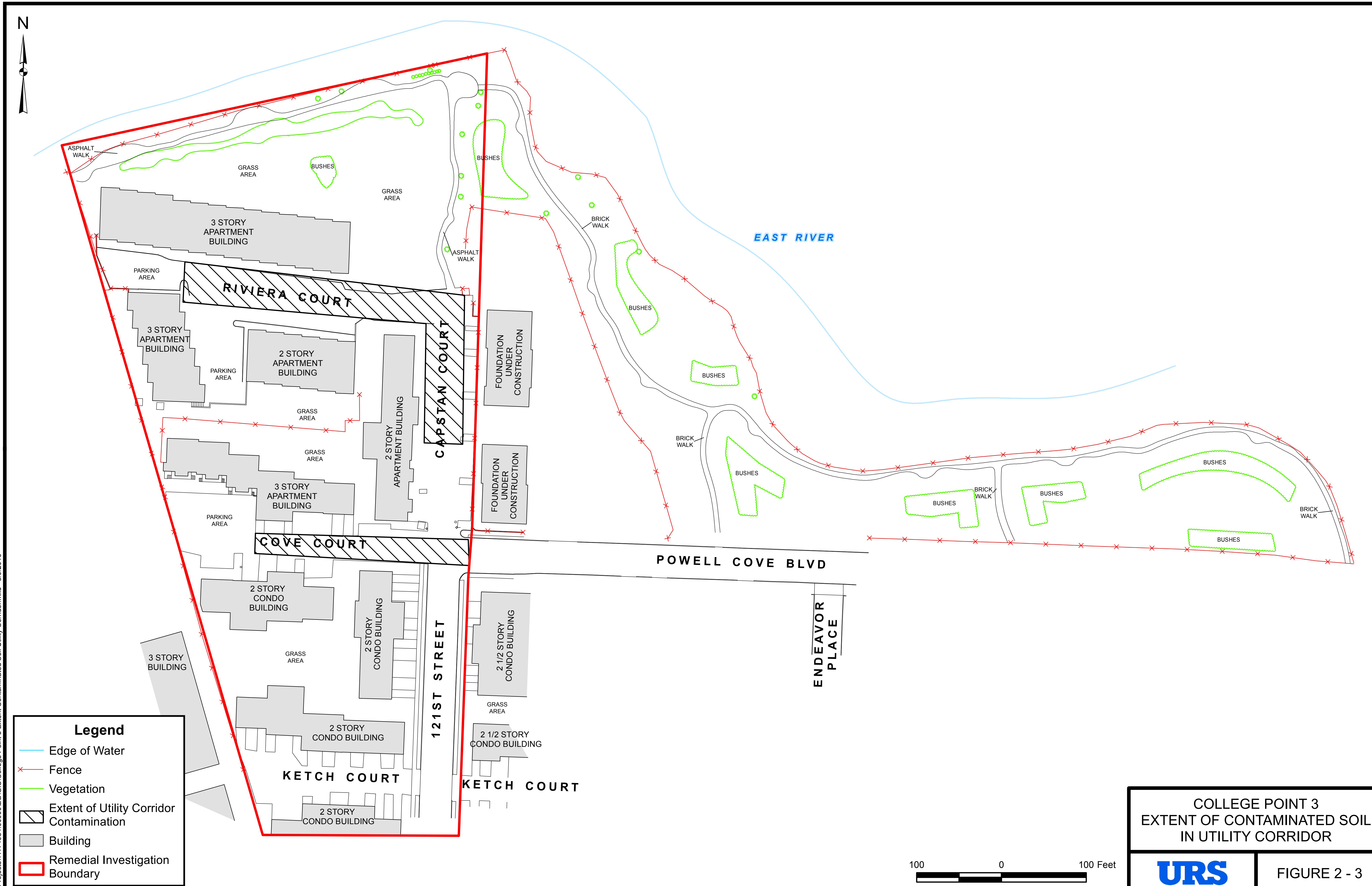
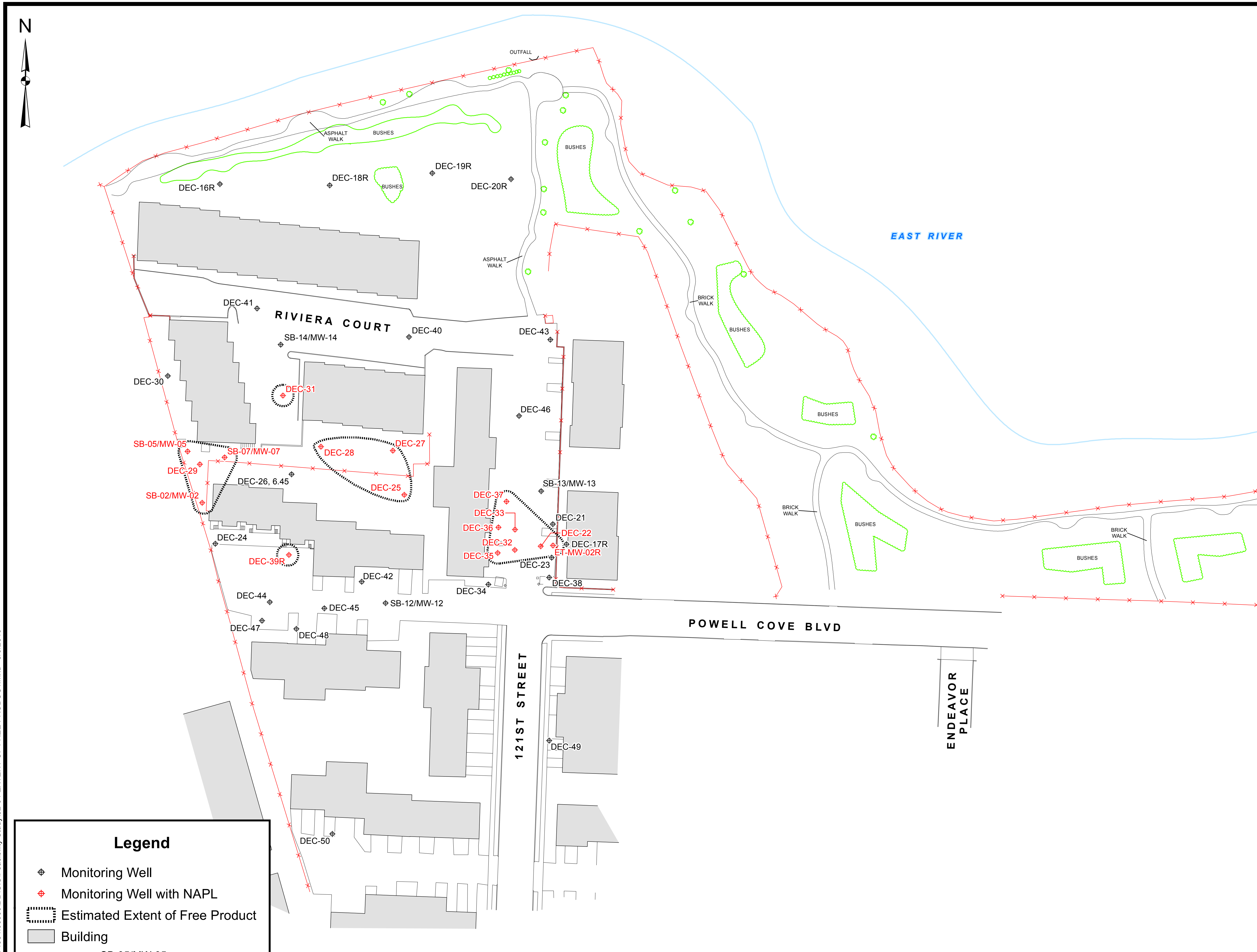


COLLEGE POINT 3
EXTENT OF CONTAMINATED SOIL
IN UTILITY CORRIDOR

URS

FIGURE 2 - 3

J:\Projects\11174984.00000\DB\GIS\College Point 3 Extent Contaminated Soil Utility Corridor.mxd 3/9/2016



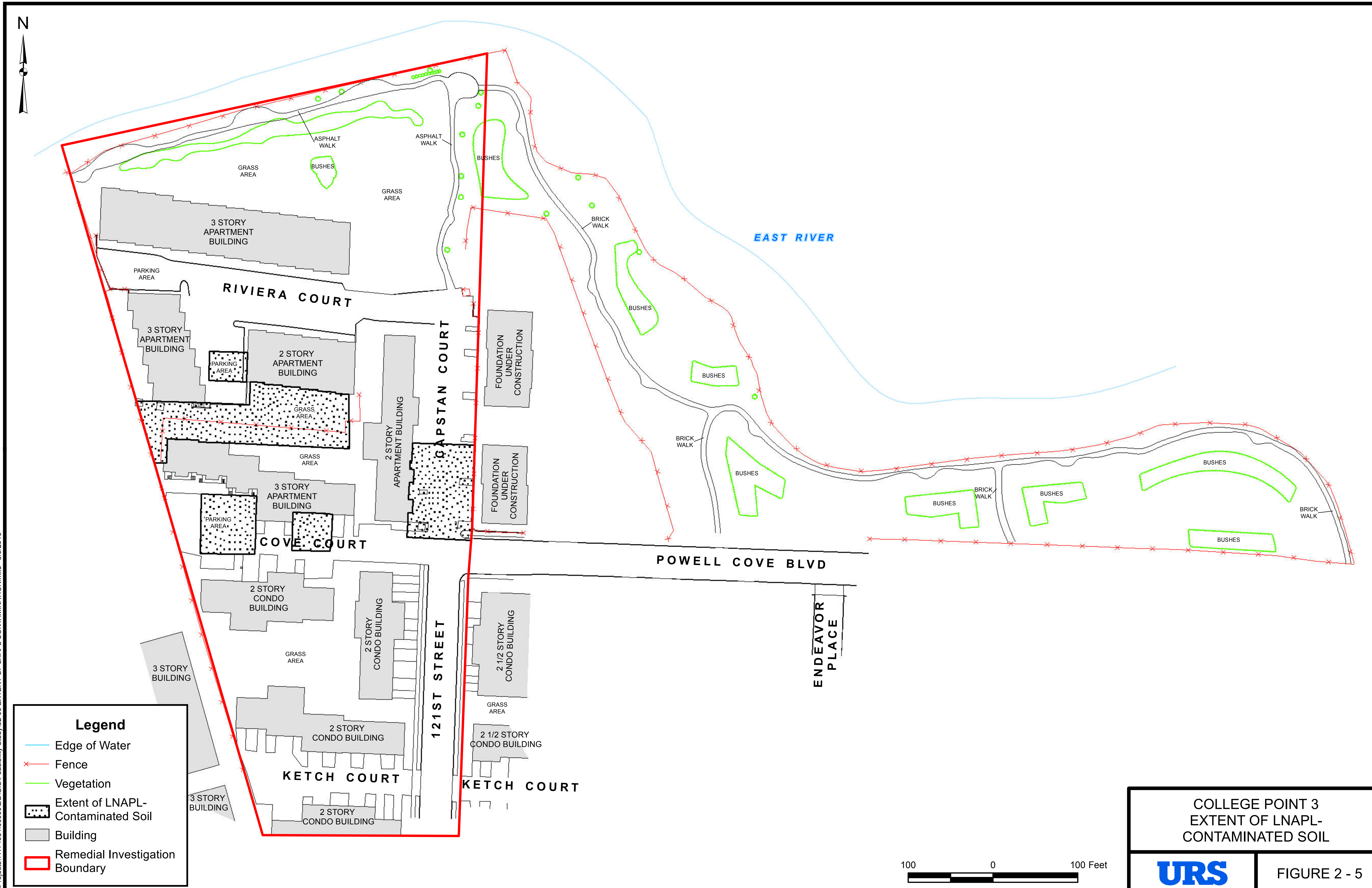
NOTE:
DEC-28, DEC-32, DEC-35, DEC-39, and ET-MW-02 were not included in the generation of the potentiometric surface due to the presence of free product

COLLEGE POINT 3
EXTENT OF FREE PRODUCT

URS

FIGURE 2 - 4

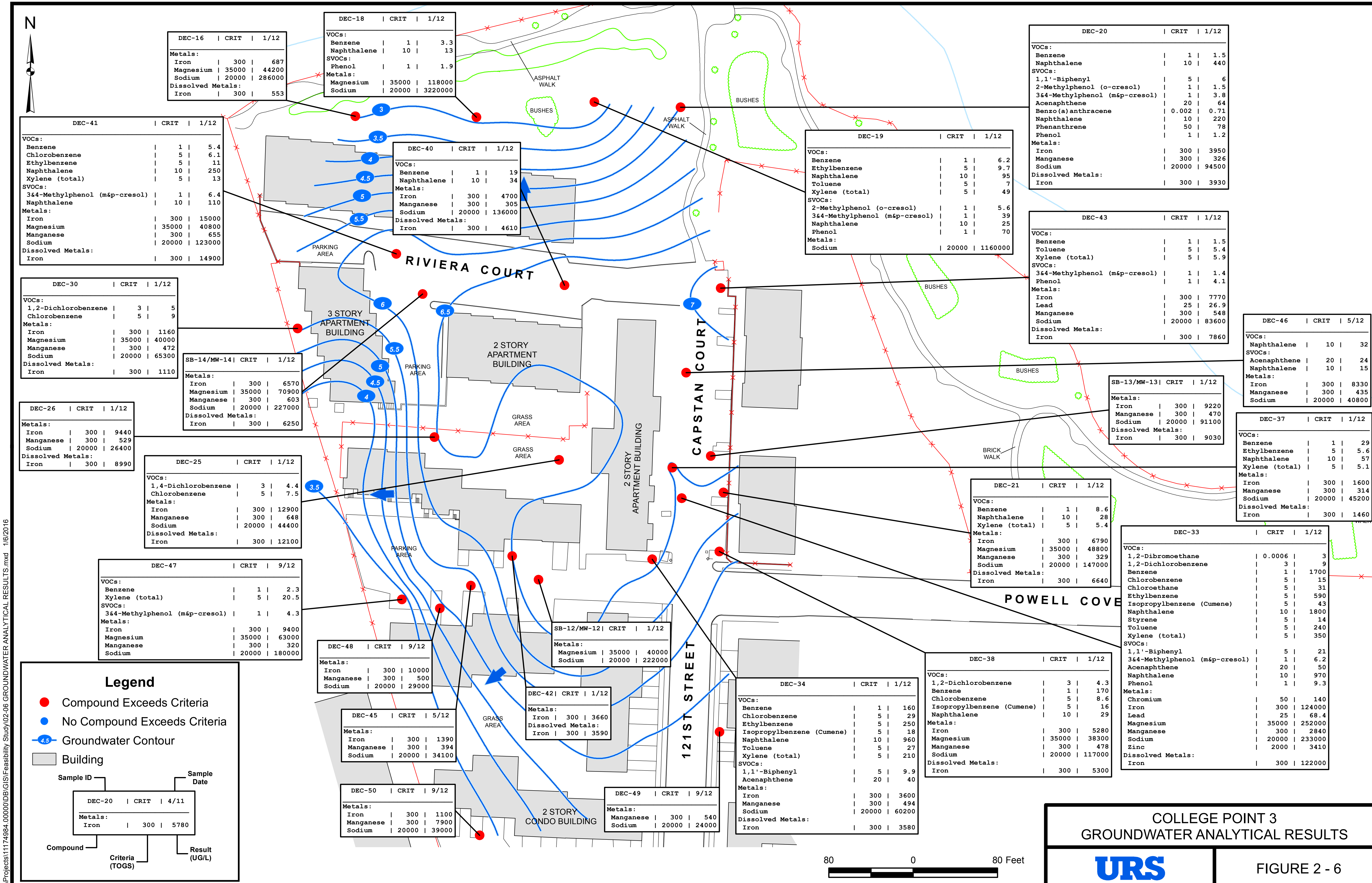
J:\Projects\11174984.00000\DB\GIS\Feasibility Study\02-04 EXTENT OF FREE PRODUCT.mxd 3/9/2016



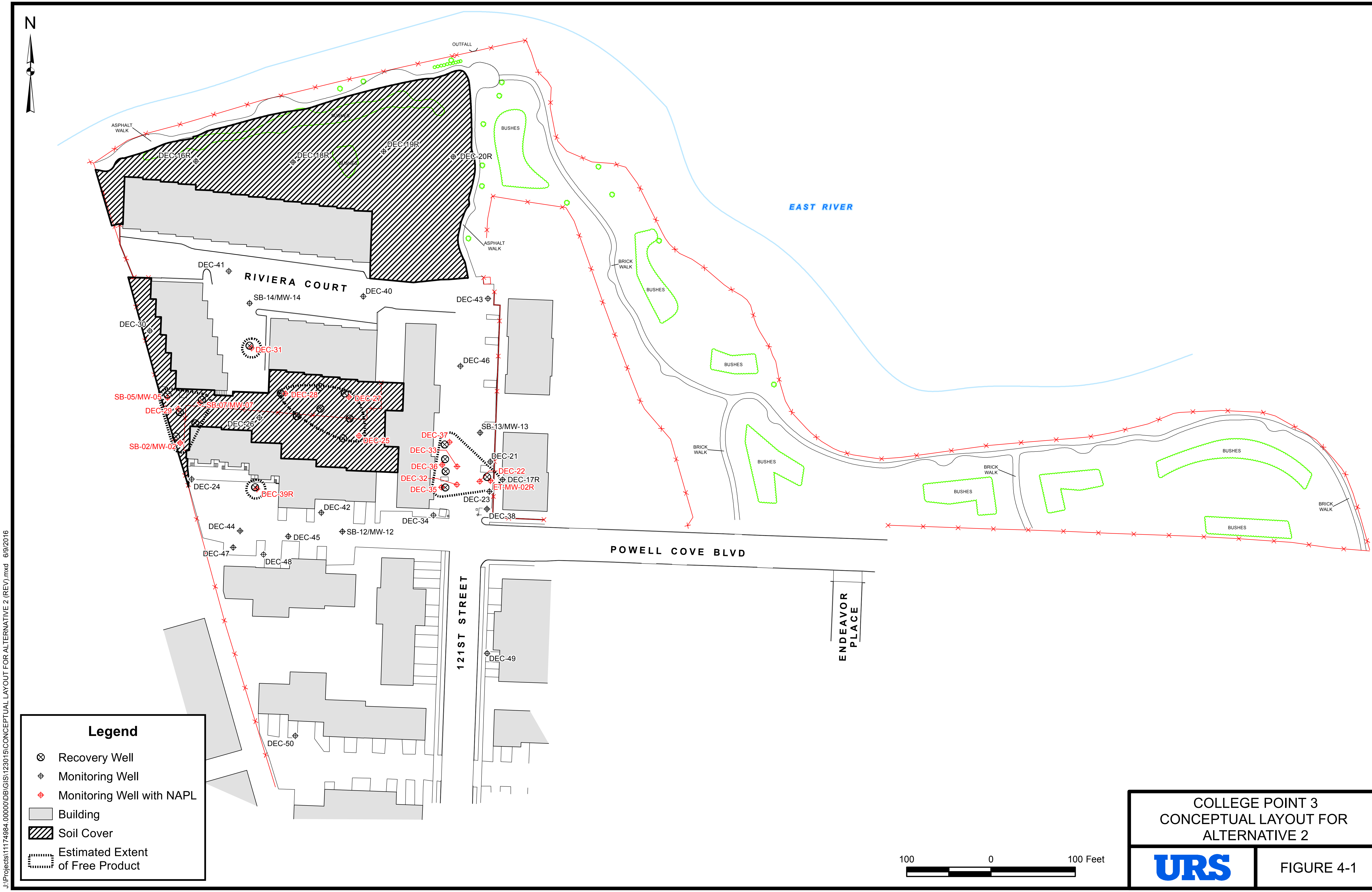
COLLEGE POINT 3
EXTENT OF LNAPL-CONTAMINATED SOIL

FIGURE 2 - 5

J:\Projects\11174984.00000\DB\GIS\Feasibility Study\02-05 EXTENT OF LNAPL CONTAMINATION.mxd 3/9/2016



N
DEC-16 | CRIT | 1/12
Metals:
Iron | 300 | 687
Magnesium | 35000 | 44200
Sodium | 20000 | 286000
Dissolved Metals:
Iron | 300 | 553
DEC-18 | CRIT | 1/12
VOCs:
Benzene | 1 | 3.3
Naphthalene | 10 | 13
SVOCs:
Phenol | 1 | 1.9
Metals:
Magnesium | 35000 | 118000
Sodium | 20000 | 3220000
DEC-41 | CRIT | 1/12
VOCs:
Benzene | 1 | 5.4
Chlorobenzene | 5 | 6.1
Ethylbenzene | 5 | 11
Naphthalene | 10 | 250
Xylene (total) | 5 | 13
SVOCs:
3&4-Methylphenol (m&p-cresol) | 1 | 6.4
Naphthalene | 10 | 110
Metals:
Iron | 300 | 15000
Magnesium | 35000 | 40800
Manganese | 300 | 655
Sodium | 20000 | 123000
Dissolved Metals:
Iron | 300 | 14900
DEC-40 | CRIT | 1/12
VOCs:
Benzene | 1 | 19
Naphthalene | 10 | 34
Metals:
Iron | 300 | 4700
Manganese | 300 | 305
Sodium | 20000 | 136000
Dissolved Metals:
Iron | 300 | 4610
DEC-20 | CRIT | 1/12
VOCs:
Benzene | 1 | 1.5
Naphthalene | 10 | 440
SVOCs:
1,1'-Biphenyl | 5 | 6
2-Methylphenol (o-cresol) | 1 | 1.5
3&4-Methylphenol (m&p-cresol) | 1 | 3.8
Acenaphthene | 20 | 64
Benzo(a)anthracene | 0.002 | 0.71
Naphthalene | 10 | 220
Phenanthrene | 50 | 78
Phenol | 1 | 1.2
Metals:
Iron | 300 | 3950
Manganese | 300 | 326
Sodium | 20000 | 94500
Dissolved Metals:
Iron | 300 | 3930
DEC-19 | CRIT | 1/12
VOCs:
Benzene | 1 | 6.2
Ethylbenzene | 5 | 9.7
Naphthalene | 10 | 95
Toluene | 5 | 7
Xylene (total) | 5 | 49
SVOCs:
2-Methylphenol (o-cresol) | 1 | 5.6
3&4-Methylphenol (m&p-cresol) | 1 | 39
Naphthalene | 10 | 25
Phenol | 1 | 70
Metals:
Sodium | 20000 | 1160000
DEC-43 | CRIT | 1/12
VOCs:
Benzene | 1 | 1.5
Toluene | 5 | 5.4
Xylene (total) | 5 | 5.9
SVOCs:
3&4-Methylphenol (m&p-cresol) | 1 | 1.4
Phenol | 1 | 4.1
Metals:
Iron | 300 | 7770
Lead | 25 | 26.9
Manganese | 300 | 548
Sodium | 20000 | 83600
Dissolved Metals:
Iron | 300 | 7860
DEC-30 | CRIT | 1/12
VOCs:
1,2-Dichlorobenzene | 3 | 5
Chlorobenzene | 5 | 9
Metals:
Iron | 300 | 1160
Magnesium | 35000 | 40000
Manganese | 300 | 472
Sodium | 20000 | 65300
Dissolved Metals:
Iron | 300 | 1110
SB-14/MW-14 | CRIT | 1/12
Metals:
Iron | 300 | 6570
Magnesium | 35000 | 70900
Manganese | 300 | 603
Sodium | 20000 | 227000
Dissolved Metals:
Iron | 300 | 6250
DEC-46 | CRIT | 5/12
VOCs:
Naphthalene | 10 | 32
SVOCs:
Acenaphthene | 20 | 24
Naphthalene | 10 | 15
Metals:
Iron | 300 | 8330
Manganese | 300 | 435
Sodium | 20000 | 40800
SB-13/MW-13 | CRIT | 1/12
Metals:
Iron | 300 | 9220
Manganese | 300 | 470
Sodium | 20000 | 91100
Dissolved Metals:
Iron | 300 | 9030
DEC-37 | CRIT | 1/12
VOCs:
Benzene | 1 | 29
Ethylbenzene | 5 | 5.6
Naphthalene | 10 | 57
Xylene (total) | 5 | 5.1
Metals:
Iron | 300 | 1600
Manganese | 300 | 314
Sodium | 20000 | 45200
Dissolved Metals:
Iron | 300 | 1460
DEC-26 | CRIT | 1/12
Metals:
Iron | 300 | 9440
Manganese | 300 | 529
Sodium | 20000 | 26400
Dissolved Metals:
Iron | 300 | 8990
DEC-25 | CRIT | 1/12
VOCs:
1,4-Dichlorobenzene | 3 | 4.4
Chlorobenzene | 5 | 7.5
Metals:
Iron | 300 | 12900
Manganese | 300 | 648
Sodium | 20000 | 44400
Dissolved Metals:
Iron | 300 | 12100
DEC-21 | CRIT | 1/12
VOCs:
Benzene | 1 | 8.6
Naphthalene | 10 | 28
Xylene (total) | 5 | 5.4
Metals:
Iron | 300 | 6790
Magnesium | 35000 | 48800
Manganese | 300 | 329
Sodium | 20000 | 147000
Dissolved Metals:
Iron | 300 | 6640
DEC-33 | CRIT | 1/12
VOCs:
1,2-Dibromoethane | 0.0006 | 3
1,2-Dichlorobenzene | 3 | 9
Benzene | 1 | 1700
Chlorobenzene | 5 | 15
Chloroethane | 5 | 31
Ethylbenzene | 5 | 590
Isopropylbenzene (Cumene) | 5 | 43
Naphthalene | 10 | 1800
Styrene | 5 | 14
Toluene | 5 | 240
Xylene (total) | 5 | 350
SVOCs:
1,1'-Biphenyl | 5 | 21
3&4-Methylphenol (m&p-cresol) | 1 | 6.2
Acenaphthene | 20 | 50
Naphthalene | 10 | 970
Phenol | 1 | 9.3
Metals:
Chromium | 50 | 140
Iron | 300 | 124000
Lead | 25 | 68.4
Magnesium | 35000 | 252000
Manganese | 300 | 2840
Sodium | 20000 | 233000
Zinc | 2000 | 3410
Dissolved Metals:
Iron | 300 | 122000
DEC-47 | CRIT | 9/12
VOCs:
Benzene | 1 | 2.3
Xylene (total) | 5 | 20.5
SVOCs:
3&4-Methylphenol (m&p-cresol) | 1 | 4.3
Metals:
Iron | 300 | 9400
Magnesium | 35000 | 63000
Manganese | 300 | 320
Sodium | 20000 | 180000
SB-12/MW-12 | CRIT | 1/12
Metals:
Magnesium | 35000 | 40000
Sodium | 20000 | 222000
DEC-48 | CRIT | 9/12
Metals:
Iron | 300 | 10000
Manganese | 300 | 500
Sodium | 20000 | 29000
DEC-38 | CRIT | 1/12
VOCs:
1,2-Dichlorobenzene | 3 | 4.3
Benzene | 1 | 170
Chlorobenzene | 5 | 8.6
Isopropylbenzene (Cumene) | 5 | 16
Naphthalene | 10 | 29
Metals:
Iron | 300 | 5280
Magnesium | 35000 | 38300
Manganese | 300 | 478
Sodium | 20000 | 117000
Dissolved Metals:
Iron | 300 | 5300
DEC-45 | CRIT | 5/12
Metals:
Iron | 300 | 1390
Manganese | 300 | 394
Sodium | 20000 | 34100
DEC-42 | CRIT | 1/12
Metals:
Iron | 300 | 3660
Dissolved Metals:
Iron | 300 | 3590
DEC-34 | CRIT | 1/12
VOCs:
Benzene | 1 | 160
Chlorobenzene | 5 | 29
Ethylbenzene | 5 | 250
Isopropylbenzene (Cumene) | 5 | 18
Naphthalene | 10 | 960
Toluene | 5 | 27
Xylene (total) | 5 | 210
SVOCs:
1,1'-Biphenyl | 5 | 9.9
Acenaphthene | 20 | 40
Metals:
Iron | 300 | 3600
Manganese | 300 | 494
Sodium | 20000 | 60200
Dissolved Metals:
Iron | 300 | 3580
DEC-50 | CRIT | 9/12
Metals:
Iron | 300 | 1100
Manganese | 300 | 7900
Sodium | 20000 | 39000
DEC-49 | CRIT | 9/12
Metals:
Manganese | 300 | 540
Sodium | 20000 | 24000
RIVIERA COURT
CAPSTAN COURT
POWELL COVE
121ST STREET
3 STORY APARTMENT BUILDING
2 STORY APARTMENT BUILDING
2 STORY APARTMENT BUILDING
2 STORY CONDO BUILDING
PARKING AREA
GRASS AREA
BUSHES
ASPHALT WALK
BRICK WALK
3
3.5
4
4.5
5
5.5
6
6.5
7
Legend
Compound Exceeds Criteria
No Compound Exceeds Criteria
Groundwater Contour
Building
Sample ID
Sample Date
DEC-20 | CRIT | 4/11
Metals:
Iron | 300 | 5780
Compound
Criteria (TOGS)
Result (UG/L)
80 0 80 Feet
COLLEGE POINT 3
GROUNDWATER ANALYTICAL RESULTS
URS
FIGURE 2 - 6
J:\Projects\11174984.00000\DB\GIS\Feasibility Study\02-06 GROUNDWATER ANALYTICAL RESULTS.mxd 1/6/2016


COLLEGE POINT 3
CONCEPTUAL LAYOUT FOR
ALTERNATIVE 2
URS
FIGURE 4-1
Legend
Recovery Well
Monitoring Well
Monitoring Well with NAPL
Building
Soil Cover
Estimated Extent
of Free Product
100
0
100 Feet
N
EAST RIVER
RIVIERA COURT
POWELL COVE BLVD
121ST STREET
ENDEAVOR
PLACE
OUTFALL
ASPHALT
WALK
BRICK
WALK
BUSHES
DEC-16R
DEC-18R
DEC-19R
DEC-20R
DEC-41
DEC-40
DEC-43
SB-14/MW-14
DEC-30
DEC-31
DEC-46
SB-05/MW-05
DEC-28
DEC-27
DEC-29
SB-07/MW-07
DEC-26
DEC-25
SB-02/MW-02
DEC-37
DEC-33
DEC-36
DEC-32
DEC-35
SB-13/MW-13
DEC-21
DEC-22
DEC-17R
ET-MW-02R
DEC-23
DEC-24
DEC-39R
DEC-42
DEC-34
DEC-38
DEC-44
DEC-45
SB-12/MW-12
DEC-47
DEC-48
DEC-49
DEC-50
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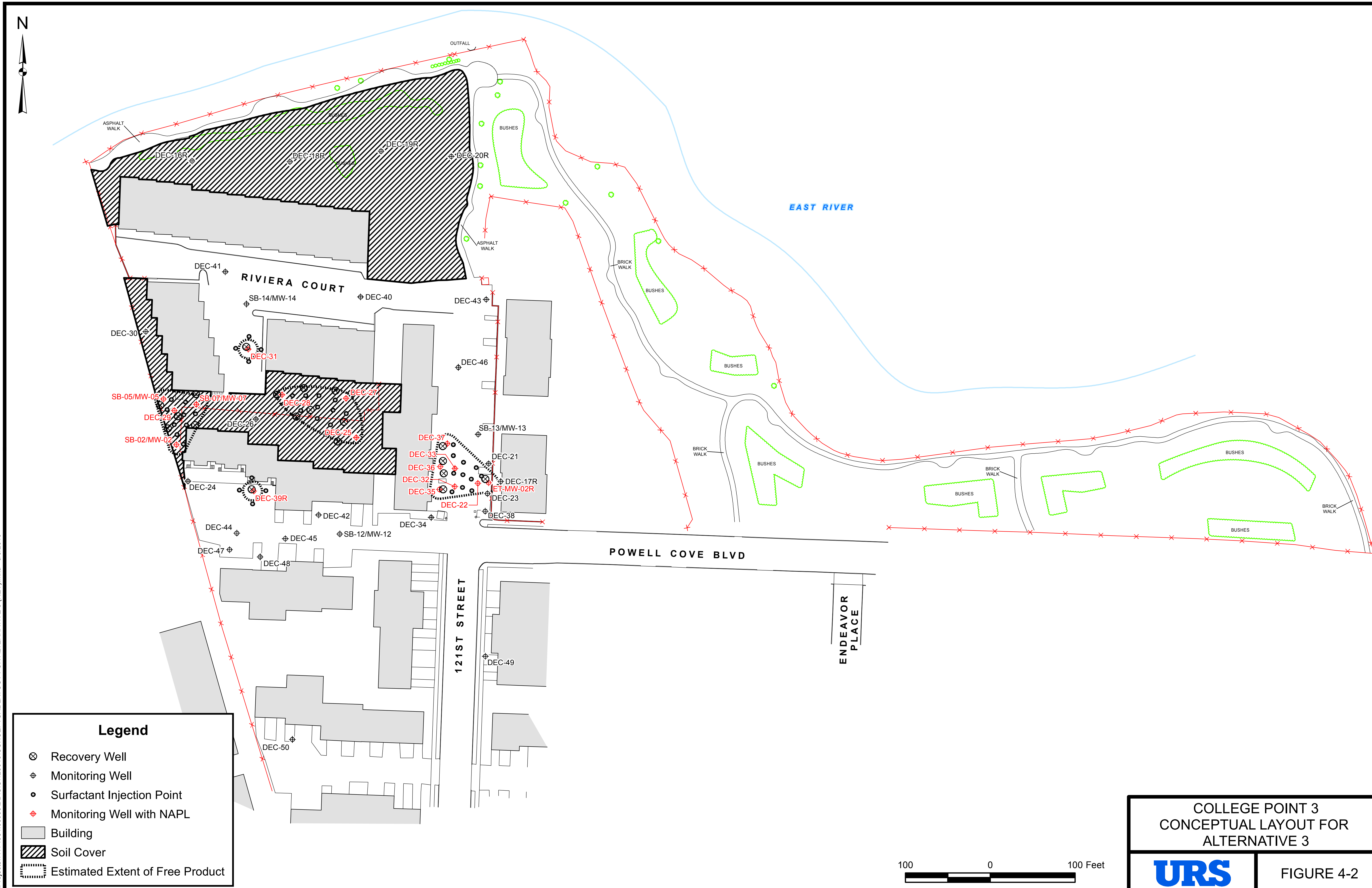

COLLEGE POINT 3
CONCEPTUAL LAYOUT FOR
ALTERNATIVE 3

FIGURE 4-2

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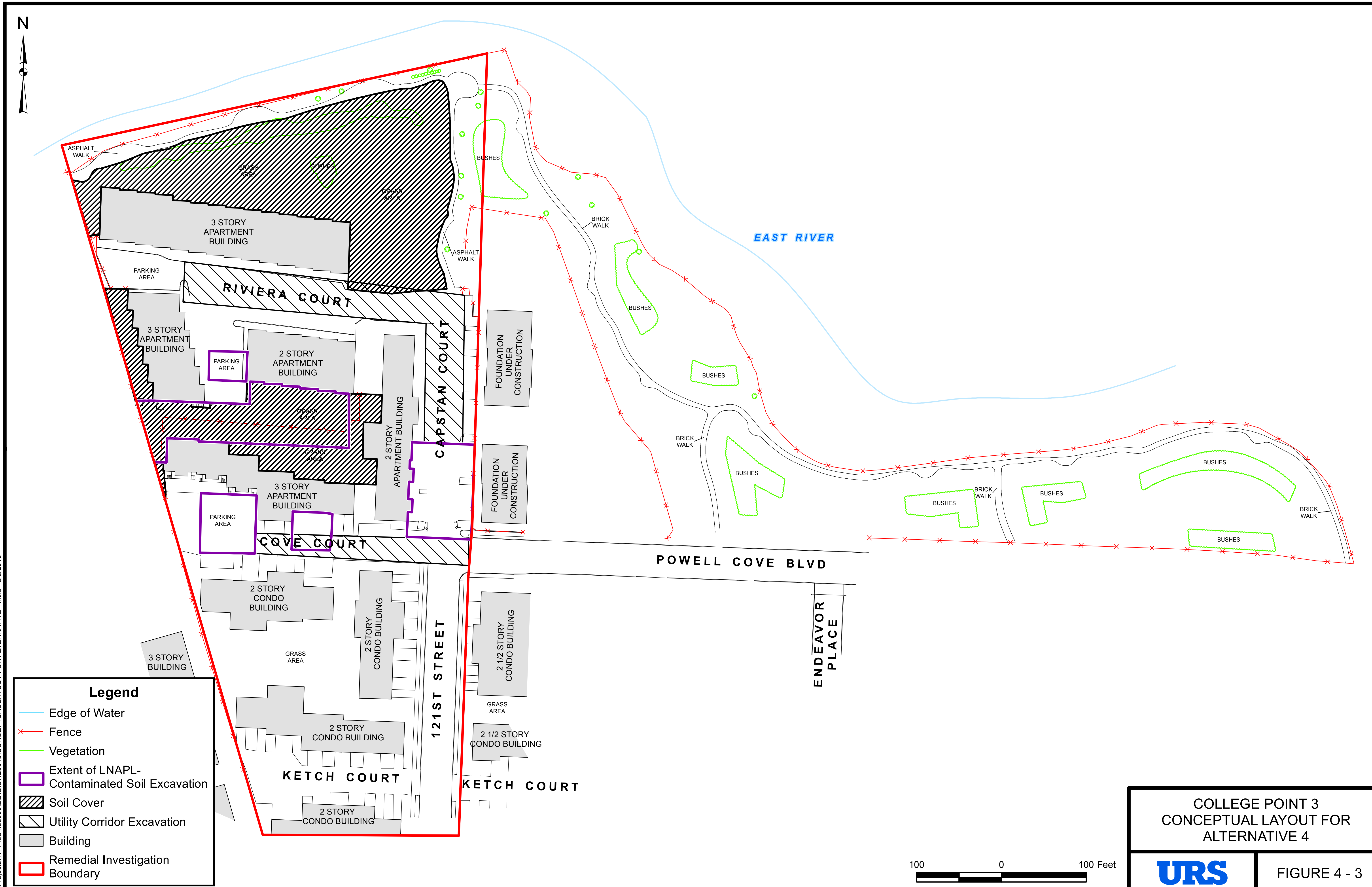

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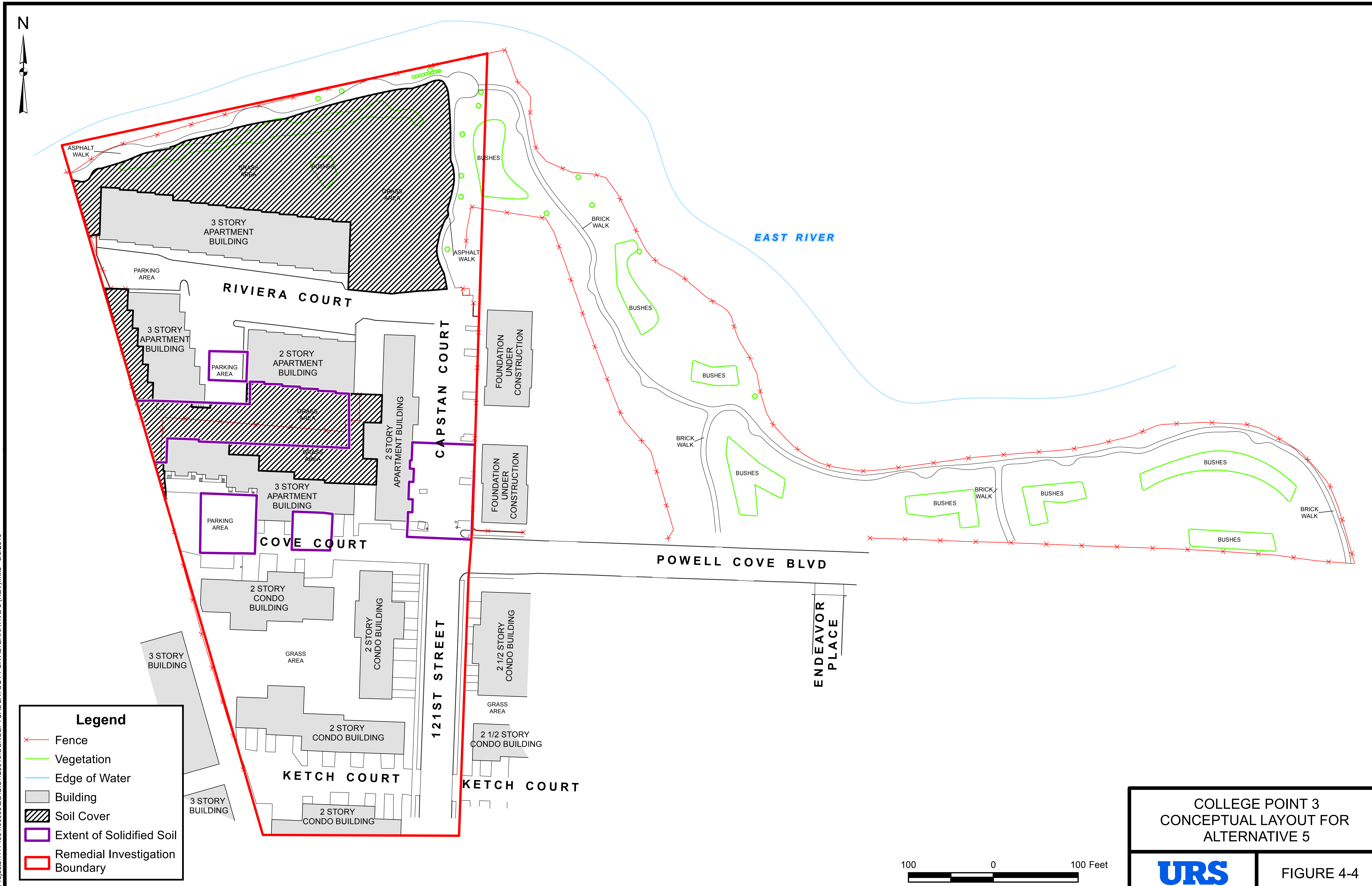

COLLEGE POINT 3
CONCEPTUAL LAYOUT FOR
ALTERNATIVE 5

FIGURE 4-4

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APPENDIX A

COST ESTIMATES

NYSDEC
College Point 3 Site
Feasibility Study

Client:	NYSDEC	Project Number:	11176715		
Project:	College Point 3 FS	Calculated By:	CWP	Date:	26-Oct-15
Description:	**ALTERNATIVE 1-No Action, SMP**	Checked By:	DMc	Date:	9-Mar-16

Construction Cost Estimate Summary

DESCRIPTION	ESTIMATED COST
SITE MANAGEMENT PLAN	**$20,100**
(CONSTRUCTION) SUBTOTAL 1	**$20,100**

SUPPLEMENTAL PROJECT COSTS

Overhead and Profit (10% of Subtotal 1)	**$2,100**
(CONSTRUCTION) SUBTOTAL 2	**$22,200**
Contingency (30% of Subtotal 2)	**$6,700**
TOTAL CONSTRUCTION COSTS	**$28,900**
Total Capital Costs	**$28,900**
Present Worth Monitoring - 30 Years	**$46,000**
Present Worth Annual Report&5-Year Review - 30 Years	**$230,000**
TOTAL COST	**$304,900**

NYSDEC
College Point 3 Site
Feasibility Study
Cost Estimate

Client:	NYSDEC	Project Number:	11176731		
Project:	College Point 3 FS	Calculated By:	CWP	Date:	26-Oct-15
Title:	**ALTERNATIVE 1-No Action, SMP**	Checked By:	DMc	Date:	3-Mar-16

ITEM	DESCRIPTION	QTY.	UNITS	UNIT COST	TOTAL COST
	SITE MANAGEMENT PLAN				
1	Labor	250	MH	$80	$20,000
2	Direct Costs	1	LS	$100	$100
	TOTAL COST				**$20,100**

NYSDEC
College Point 3 Site
Feasibility Study
Cost Estimate

Client:	NYSDEC	Project Number:	11176731		
Project:	College Point 3 FS	Calculated By:	CWP	Date:	26-Oct-15
Title:	**ALTERNATIVE 1-No Action, SMP**	Checked By:	DMc	Date:	9-Mar-16

ITEM	DESCRIPTION	QTY.	UNITS	UNIT COST	TOTAL COST
	MONITORING - 30 YEARS				
	ANNUAL COSTS				
1	Groundwater Analysis - VOCs	20	Each	$70	$1,400
2	Sampling Labor	16	Hour	$50	$800
3	Supplies	1	LS	$100	$100
	SUBTOTAL 1				**$2,300**
	30% Contingency				**$690**
	SUBTOTAL 2				**$2,990**
	Present Worth of Subtotal 1 (30 years @ 5% discount rate)	mult. by	15.3725		**$46,000**
	TOTAL COST				**$46,000**

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NYSDEC
College Point 3 Site
Feasibility Study
Cost Estimate

Client:	NYSDEC	Project Number:	11176731		
Project:	College Point 3 FS	Calculated By:	CWP	Date:	26-Oct-15
Title:	**ALTERNATIVE 1-No Action, SMP**	Checked By:	DMc	Date:	9-Mar-16

ITEM	DESCRIPTION	QTY.	UNITS	UNIT COST	TOTAL COST
	ANNUAL REPORT AND 5-YEAR REVIEW				
1	Labor Annual Report	120	Hour	$80	$9,600
2	Direct Cost Annual Report	1	LS	$200	$200
3	Labor 5-Year Review (on annual basis)	20	Hour	$80	$1,600
4	Direct Cost 5-Year Review (on annual basis)	1	LS	$100	$100
	SUBTOTAL 1				**$11,500**
	30% Contingency				**$3,450**
	SUBTOTAL 2				**$14,950**
	Present Worth of Subtotal 1 (30 years @ 5% discount rate)	mult. by	15.3725		**$230,000**
	TOTAL COST				**$230,000**

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NYSDEC
College Point 3 Site
Feasibility Study

Client:	NYSDEC	Project Number:	11176731		
Project:	College Point 3 FS	Calculated By:	CWP	Date:	12-May-16
Description:	**Alternative 2-SMP, Soil Cover with Passive LNAPL Recovery**	Checked By:	DMc	Date:	

Construction Cost Estimate Summary

DESCRIPTION	ESTIMATED COST
SITE MANAGEMENT PLAN	**$20,100**
MOB/DEMOB & SITE SERVICES	**$151,500**
LNAPL RECOVERY	**$380,000**
SOIL COVER	**$767,700**
(CONSTRUCTION) SUBTOTAL 1	**$1,319,300**

SUPPLEMENTAL PROJECT COSTS

Overhead and Profit (10% of Subtotal 1)	**$132,000**
(CONSTRUCTION) SUBTOTAL 2	**$1,451,300**
Contingency (30% of Subtotal 2)	**$435,400**
TOTAL CONSTRUCTION COSTS	**$1,886,700**
Total Capital Costs	**$1,886,700**
Present Worth Monitoring - 30 Years	**$46,000**
Present Worth Annual Report&5-Year Review - 30 Years	**$230,000**
Pesssent Worth LNAPL Recovery & OM&M-5 Years	**$151,000**
TOTAL COST	**$2,313,700**

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NYSDEC
College Point 3 Site
Feasibility Study
Cost Estimate

Client:	NYSDEC	Project Number:	11176731		
Project:	College Point 3 FS	Calculated By:	CWP	Date:	12-May-16
Title:	**Alternative 2-SMP, Soil Cover with Passive LNAPL Recovery**	Checked By:	DMc	Date:	

ITEM	DESCRIPTION	QTY.	UNITS	UNIT COST	TOTAL COST
	SITE MANAGEMENT PLAN				
1	Labor	250	MH	$80	$20,000
2	Direct Costs	1	LS	$100	$100
	TOTAL COST				**$20,100**

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NYSDEC
College Point 3 Site
Feasibility Study
Cost Estimate

Client:	NYSDEC	Project Number:	11176731		
Project:	College Point 3 FS	Calculated By:	CWP	Date:	12-May-16
Title:	**Alternative 2-SMP, Soil Cover with Passive LNAPL Recovery**	Checked By:	DMc	Date:	

ITEM	DESCRIPTION	QTY.	UNITS	UNIT COST	TOTAL COST
	MONITORING - 30 YEARS				
	ANNUAL COSTS				
1	Groundwater Analysis - VOCs	20	Each	$70	$1,400
2	Sampling Labor	16	Hour	$50	$800
3	Supplies	1	LS	$100	$100
	SUBTOTAL 1				**$2,300**
	30% Contingency				**$690**
	SUBTOTAL 2				**$2,990**
	Present Worth of Subtotal 1 (30 years @ 5% discount rate)	mult. by	15.3725		**$46,000**
	TOTAL COST				**$46,000**

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NYSDEC
College Point 3 Site
Feasibility Study
Cost Estimate

Client:	NYSDEC	Project Number:	11176731		
Project:	College Point 3 FS	Calculated By:	CWP	Date:	12-May-16
Title:	**Alternative 2-SMP, Soil Cover with Passive LNAPL Recovery**	Checked By:	DMc	Date:	

ITEM	DESCRIPTION	QTY.	UNITS	UNIT COST	TOTAL COST
	ANNUAL REPORT AND 5-YEAR REVIEW				
1	Labor Annual Report	120	Hour	$80	$9,600
2	Direct Cost Annual Report	1	LS	$200	$200
3	Labor 5-Year Review (on annual basis)	20	Hour	$80	$1,600
4	Direct Cost 5-Year Review (on annual basis)	1	LS	$100	$100
	SUBTOTAL 1				**$11,500**
	30% Contingency				**$3,450**
	SUBTOTAL 2				**$14,950**
	Present Worth of Subtotal 1 (30 years @ 5% discount rate)	mult. by	15.3725		**$230,000**
	TOTAL COST				**$230,000**

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NYSDEC
College Point 3 Site
Feasibility Study
Cost Estimate

Client:	NYSDEC	Project Number:	11176731		
Project:	College Point 3 FS	Calculated By:	CWP	Date:	12-May-16
Title:	**Alternative 2-SMP, Soil Cover with Passive LNAPL Recovery**	Checked By:	DMc	Date:	

ITEM	DESCRIPTION	QTY.	UNITS	UNIT COST	TOTAL COST
	MOBILIZATION/DEMOBILIZATION AND SITE SERVICES				
1	Submittals	1	LS	$5,000	$5,000
2	Health and Safety	160	Day	$700	$112,000
3	Project Sign	1	Each	$1,000	$1,000
4	Erosion and Sediment Control	1	LS	$2,000	$2,000
5	Decon Pad	1	LS	$2,500	$2,500
6	Temporary Fencing	1	LS	$2,000	$2,000
7	Air Monitoring	1	LS	$15,000	$15,000
8	Survey	1	LS	$2,500	$2,500
9	Utilities	1	LS	$2,500	$2,500
10	Mobilize Equipment	1	LS	$4,000	$4,000
11	Demobilize Equipment	1	LS	$2,000	$2,000
12	Office Trailer	1	LS	$1,000	$1,000
	TOTAL COST				**$151,500**

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NYSDEC
College Point 3 Site
Feasibility Study
Cost Estimate

Client:	NYSDEC	Project Number:	11176731		
Project:	College Point 3 FS	Calculated By:	CWP	Date:	12-May-16
Title:	**Alternative 2-SMP, Soil Cover with Passive LNAPL Recovery**	Checked By:	DMc	Date:	

ITEM	DESCRIPTION	QTY.	UNITS	UNIT COST	TOTAL COST
	LNAPL RECOVERY				
1	Recovery Wells	19	Each	$20,000	$380,000
	TOTAL COST				**$380,000**

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NYSDEC
College Point 3 Site
Feasibility Study
Cost Estimate

Client:	NYSDEC	Project Number:	11176731		
Project:	College Point 3 FS	Calculated By:	CWP	Date:	12-May-16
Title:	**Alternative 2-SMP, Soil Cover with Passive LNAPL Recovery**	Checked By:	DMc	Date:	

ITEM	DESCRIPTION	QTY.	UNITS	UNIT COST	TOTAL COST
	SOIL COVER				
1	Excavate Soil	4930	CY	$10	$49,300
2	Transport and Dispose Soil	4930	CY	$105	$517,700
3	Backfill and Compact with Imported Fill	3440	CY	$33	$113,600
4	Top Soil	1450	CY	$54	$78,300
5	Hydroseed	8,800	SY	$1	$8,800
	TOTAL COST				**$767,700**

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NYSDEC
College Point 3 Site
Feasibility Study
Cost Estimate

Client:	NYSDEC	Project Number:	11176731		
Project:	College Point 3 FS	Calculated By:	CWP	Date:	12-May-16
Title:	**Alternative 2-SMP, Soil Cover with Passive LNAPL Recovery**	Checked By:	DMc	Date:	

ITEM	DESCRIPTION	QTY.	UNITS	UNIT COST	TOTAL COST
	LNAPL RECOVERY & OM&M				
1	Groundwater Analysis - VOCs	60	Each	$70	$4,200
2	Sampling Labor	64	Hour	$50	$3,200
3	Supplies	1	LS	$400	$400
4	LNAPL Recovery Labor	260	Hour	$50	$13,000
5	LNAPL Recovery Equipment	1	LS	$2,000	$2,000
6	LNAPL Disposal	200	Gal	$20	$4,000
	SUBTOTAL 1				**$26,800**
	30% Contingency				**$8,040**
	SUBTOTAL 2				**$34,840**
	Present Worth of Subtotal 1 (5 years @ 5% discount rate)	mult. by	4.3295		
	TOTAL COST				**$151,000**

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NYSDEC
College Point 3 Site
Feasibility Study

Client:	NYSDEC	Project Number:	11176731		
Project:	College Point 3 FS	Calculated By:	CWP	Date:	8-May-16
Description:	**Alternative 3-SMP, Soil Cover with Solidification of LNAPL-Contaminated Soil**	Checked By:	DMc	Date:	

Construction Cost Estimate Summary

DESCRIPTION	ESTIMATED COST
SITE MANAGEMENT PLAN	**$20,100**
MOB/DEMOB & SITE SERVICES	**$160,500**
SOLIDIFICATION OF LNAPL-CONTAMINATED SOIL	**$2,259,000**
SOIL COVER	**$767,620**
(CONSTRUCTION) SUBTOTAL 1	**$3,207,220**

SUPPLEMENTAL PROJECT COSTS

Overhead and Profit (10% of Subtotal 1)	**$320,800**
(CONSTRUCTION) SUBTOTAL 2	**$3,528,020**
Contingency (30% of Subtotal 2)	**$1,058,500**
TOTAL CONSTRUCTION COSTS	**$4,586,520**
Total Capital Costs	**$4,586,520**
Present Worth Monitoring - 30 Years	**$46,000**
Present Worth Annual Report&5-Year Review - 30 Years	**$230,000**
TOTAL COST	**$4,862,520**

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NYSDEC
College Point 3 Site
Feasibility Study
Cost Estimate

Client:	NYSDEC	Project Number:	11176731		
Project:	College Point 3 FS	Calculated By:	CWP	Date:	8-May-16
Title:	**Alternative 3-SMP, Soil Cover with Solidification of LNAPL-Contaminated Soil**	Checked By:	DMc	Date:	

ITEM	DESCRIPTION	QTY.	UNITS	UNIT COST	TOTAL COST
	SITE MANAGEMENT PLAN				
1	Labor	250	MH	$80	$20,000
2	Direct Costs	1	LS	$100	$100
	TOTAL COST				**$20,100**

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NYSDEC
College Point 3 Site
Feasibility Study
Cost Estimate

Client:	NYSDEC	Project Number:	11176731		
Project:	College Point 3 FS	Calculated By:	CWP	Date:	8-May-16
Title:	**Alternative 3-SMP, Soil Cover with Solidification of LNAPL-Contaminated Soil**	Checked By:	DMc	Date:	

ITEM	DESCRIPTION	QTY.	UNITS	UNIT COST	TOTAL COST
	MONITORING - 30 YEARS				
	ANNUAL COSTS				
1	Groundwater Analysis - VOCs	20	Each	$70	$1,400
2	Sampling Labor	16	Hour	$50	$800
3	Supplies	1	LS	$100	$100
	SUBTOTAL 1				**$2,300**
	30% Contingency				**$690**
	SUBTOTAL 2				**$2,990**
	Present Worth of Subtotal 1 (30 years @ 5% discount rate)	mult. by	15.3725		**$46,000**
	TOTAL COST				**$46,000**

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NYSDEC
College Point 3 Site
Feasibility Study
Cost Estimate

Client:	NYSDEC	Project Number:	11176731		
Project:	College Point 3 FS	Calculated By:	CWP	Date:	8-May-16
Title:	**Alternative 3-SMP, Soil Cover with Solidification of LNAPL-Contaminated Soil**	Checked By:	DMc	Date:	

ITEM	DESCRIPTION	QTY.	UNITS	UNIT COST	TOTAL COST
	ANNUAL REPORT AND 5-YEAR REVIEW				
1	Labor Annual Report	120	Hour	$80	$9,600
2	Direct Cost Annual Report	1	LS	$200	$200
3	Labor 5-Year Review (on annual basis)	20	Hour	$80	$1,600
4	Direct Cost 5-Year Review (on annual basis)	1	LS	$100	$100
	SUBTOTAL 1				**$11,500**
	30% Contingency				**$3,450**
	SUBTOTAL 2				**$14,950**
	Present Worth of Subtotal 1 (30 years @ 5% discount rate)	mult. by	15.3725		**$230,000**
	TOTAL COST				**$230,000**

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NYSDEC
College Point 3 Site
Feasibility Study
Cost Estimate

Client: NYSDEC	Project Number: 11176731		
Project: College Point 3 FS	Calculated By: CWP	Date:	8-May-16
Title: **Alternative 3-SMP, Soil Cover with Solidification of LNAPL-Contaminated Soil**	Checked By: DMc	Date:	

ITEM	DESCRIPTION	QTY.	UNITS	UNIT COST	TOTAL COST
	MOBILIZATION/DEMOBILIZATION AND SITE SERVICES				
1	Submittals	1	LS	$5,000	$5,000
2	Health and Safety	160	Day	$700	$112,000
3	Project Sign	1	Each	$1,000	$1,000
4	Erosion and Sediment Control	1	LS	$2,000	$2,000
5	Decon Pad	1	LS	$2,500	$2,500
6	Temporary Fencing	1	LS	$2,000	$2,000
7	Air Monitoring	1	LS	$15,000	$15,000
8	Survey	1	LS	$2,500	$2,500
9	Utilities	1	LS	$2,500	$2,500
10	Mobilize Equipment	1	LS	$10,000	$10,000
11	Demobilize Equipment	1	LS	$5,000	$5,000
12	Office Trailer	1	LS	$1,000	$1,000
	TOTAL COST				**$160,500**

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NYSDEC
College Point 3 Site
Feasibility Study
Cost Estimate

Client:	NYSDEC	Project Number:	11176731		
Project:	College Point 3 FS	Calculated By:	CWP	Date:	8-May-16
Title:	**Alternative 3-SMP, Soil Cover with Solidification of LNAPL-Contaminated Soil**	Checked By:	DMc	Date:	

ITEM	DESCRIPTION	QTY.	UNITS	UNIT COST	TOTAL COST
	SOLIDIFICATION OF LNAPL-CONTAMINATED SOIL				
1	Soil Solidification	5700	CY	$125	$712,500
2	Excavate Swelled Soil	1100	CY	$10	$11,000
3	Transport and Dispose Swelled Soil	1100	CY	$105	$115,500
4	Steel Sheet Pile	1100	Ton	$1,200	$1,320,000
5	Pilot Test	1	LS	$100,000	$100,000
	TOTAL COST				**$2,259,000**

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NYSDEC
College Point 3 Site
Feasibility Study
Cost Estimate

Client:	NYSDEC	Project Number:	11176731		
Project:	College Point 3 FS	Calculated By:	CWP	Date:	8-May-16
Title:	**Alternative 3-SMP, Soil Cover with Solidification of LNAPL-Contaminated Soil**	Checked By:	DMc	Date:	

ITEM	DESCRIPTION	QTY.	UNITS	UNIT COST	TOTAL COST
	SOIL COVER				
1	Excavate Soil	4930	CY	$10	$49,300
2	Transport and Dispose Soil	4930	CY	$105	$517,700
3	Backfill and Compact with Imported Fill	3440	CY	$33	$113,520
4	Top Soil	1450	CY	$54	$78,300
5	Hydroseed	8,800	SY	$1	$8,800
	TOTAL COST				**$767,620**

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NYSDEC
College Point 3 Site
Feasibility Study

Client:	NYSDEC	Project Number:	11176731		
Project:	College Point 3 FS	Calculated By:	CWP	Date:	18-May-16
Description:	**Alternative 4 - Remediation to Pre-Disposal Conditions**	Checked By:	DMc	Date:	

Construction Cost Estimate Summary

DESCRIPTION	ESTIMATED COST
MOB/DEMOB & SITE SERVICES	**$986,000**
CONDO PROCUREMENT	**$72,000,000**
DEMOLITION OF BUILDINGS/INFRASTRUCTURE	**$4,251,100**
EXCAVATION AND BACKFILL	**$66,225,600**
(CONSTRUCTION) SUBTOTAL 1	**$143,462,700**

SUPPLEMENTAL PROJECT COSTS

Overhead and Profit (10% of Subtotal 1)	**$14,346,300**
(CONSTRUCTION) SUBTOTAL 2	**$157,809,000**
Contingency (30% of Subtotal 2)	**$47,342,700**
TOTAL CONSTRUCTION COSTS	**$205,151,700**
Total Capital Costs	**$205,151,700**
TOTAL COST	**$205,151,700**

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NYSDEC
College Point 3 Site
Feasibility Study
Cost Estimate

Client: NYSDEC	Project Number: 11176731		
Project: College Point 3 FS	Calculated By: CWP	Date:	18-May-16
Title: **Alternative 4 - Remediation to Pre-Disposal Conditions**	Checked By: DMc	Date:	

ITEM	DESCRIPTION	QTY.	UNITS	UNIT COST	TOTAL COST
	MOBILIZATION/DEMOBILIZATION AND SITE SERVICES				
1	Submittals	1	LS	$20,000	$20,000
2	Health and Safety	1000	Day	$700	$700,000
3	Project Sign	1	Each	$1,000	$1,000
4	Erosion and Sediment Control	1	LS	$100,000	$100,000
5	Decon Pad	1	LS	$10,000	$10,000
6	Temporary Fencing	1	LS	$10,000	$10,000
7	Air Monitoring	1	LS	$50,000	$50,000
8	Survey	1	LS	$25,000	$25,000
9	Utilities	1	LS	$15,000	$15,000
10	Mobilize Equipment	1	LS	$25,000	$25,000
11	Demobilize Equipment	1	LS	$25,000	$25,000
12	Office Trailer	1	LS	$5,000	$5,000
	TOTAL COST				**$986,000**

NYSDEC
College Point 3 Site
Feasibility Study
Cost Estimate

Client:	NYSDEC	Project Number:	11176731		
Project:	College Point 3 FS	Calculated By:	CWP	Date:	18-May-16
Title:	**Alternative 4 - Remediation to Pre-Disposal Conditions**	Checked By:	DMc	Date:	

ITEM	DESCRIPTION	QTY.	UNITS	UNIT COST	TOTAL COST
	CONDO PROCUREMENT				
1	Purchase Condo Units	144	Each	$500,000	$72,000,000
	TOTAL COST				**$72,000,000**

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NYSDEC
College Point 3 Site
Feasibility Study
Cost Estimate

Client:	NYSDEC	Project Number:	11176731		
Project:	College Point 3 FS	Calculated By:	CWP	Date:	18-May-16
Title:	**Alternative 4 - Remediation to Pre-Disposal Conditions**	Checked By:	DMc	Date:	

ITEM	DESCRIPTION	QTY.	UNITS	UNIT COST	TOTAL COST
	DEMOLITION OF BUILDINGS AND INFRASTRUCTURE				
1	Asbestos Abatement	79,500	SF	$25.00	$1,987,500
2	Demolish 2-Story Buildings	884,000	CF	$0.47	$415,500
3	Demolish 3-Story Buildings	1,059,000	CF	$0.47	$497,800
4	Demolish Concrete Slab	79,500	SF	$1.03	$81,900
5	Demolish Footers	4,120	LF	$23.68	$97,600
6	Concrete Disposal	1,500	CY	$20.00	$30,000
7	Building Debris Disposal	23,800	CY	$16.16	$384,700
7	Demolish and Remove Asphalt	11,100	SY	$19.57	$217,300
8	Asphalt Disposal	1,850	CY	$20.00	$37,000
9	Remove Sewer Pipe 12"	1,800	LF	$13.97	$25,200
10	Haul Sewer Pipe 12"	1	LS	$20,000	$20,000
11	Remove Sewer Pipe 4"	1,000	LF	$15.31	$15,400
12	Haul Sewer Pipe 4"	1	LS	$10,000	$10,000
13	Remove Water Pipe 4"	1,800	LF	$15.31	$27,600
14	Remove Wate Pipe 2"	1,000	LF	$20.00	$20,000
15	Haul Water Pipe	1	LS	$20,000	$20,000
16	Remove Gas Pipe 5"	1,800	LF	$10.52	$19,000
17	Haul 5" Gas Pipe	1	LS	$15,000	$15,000
18	Remove 1-4' Gas Pipe	1,000	LF	$2.75	$2,800
19	Haul 1-4" Gas Pipe	1	LS	$10,000	$10,000
20	Remove Underground Electrical 3-6"	1,800	LF	$4	$7,400
21	Haul 3-6" Electrical	1	LS	$5,000	$5,000
22	Remove 1/2-2" Electrical	1,000	LF	$1.37	$1,400
23	Haul 1/2-2" Elecrical	1	LS	$3,000	$3,000
24	Miscellaneous-Remove Lights, Curbs, Underground Valves etc.	**1**	LS	$300,000.00	$300,000
	TOTAL COST				**$4,251,100**

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NYSDEC
College Point 3 Site
Feasibility Study
Cost Estimate

Client:	NYSDEC	Project Number:	11176731		
Project:	College Point 3 FS	Calculated By:	CWP	Date:	18-May-16
Title:	**Alternative 4 - Remediation to Pre-Disposal Conditions**	Checked By:	DMc	Date:	

ITEM	DESCRIPTION	QTY.	UNITS	UNIT COST	TOTAL COST
	EXCAVATION AND BACKFILL				
	Assume excavation completed in 100'x100' areas				
	For One Area				
1	Excavated contaminated soil	11,100	CY	$12	$133,200
2	Backfill and Compact with Imported Fill	11,100	CY	$35	$388,500
3	Dewatering with Well Points	880	LFHdr	$100	$88,000
4	Treatment Sytem Rental	1	Month	$1,000	$1,000
5	Treatment Sytem Operator	160	Hr	$60	$9,600
6	Discharge Sampling	4	Each	$200	$800
7	Soil Characterization Sampling	11	Each	$200	$2,200
8	Transport and Dispose of Excavated Soil	11,100	CY	$115	$1,276,500
	Subtotal 100'x100' Area				**$1,899,800**
	Total area of Excavation is 324,000; therefore multiply subtotal				
	for 100'x100' area by 32				
	Total for Entire Area	32	Area	$1,899,800	$60,793,600
	Additional materials and labor required to excavate along the				
	East River	1	LS	$5,000,000	$5,000,000
	Additional material and labor required to excavated along property	1	LS	$3,000,000	$3,000,000
	boundaries near buildings				
	Topsoil/Seed/Mulch	36,000	SY	$12	$432,000
	TOTAL COST				**$66,225,600**

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