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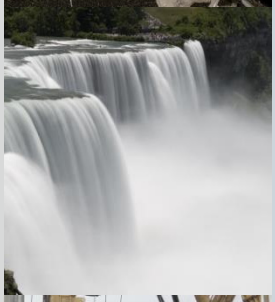
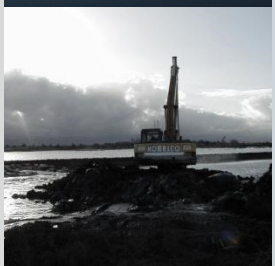
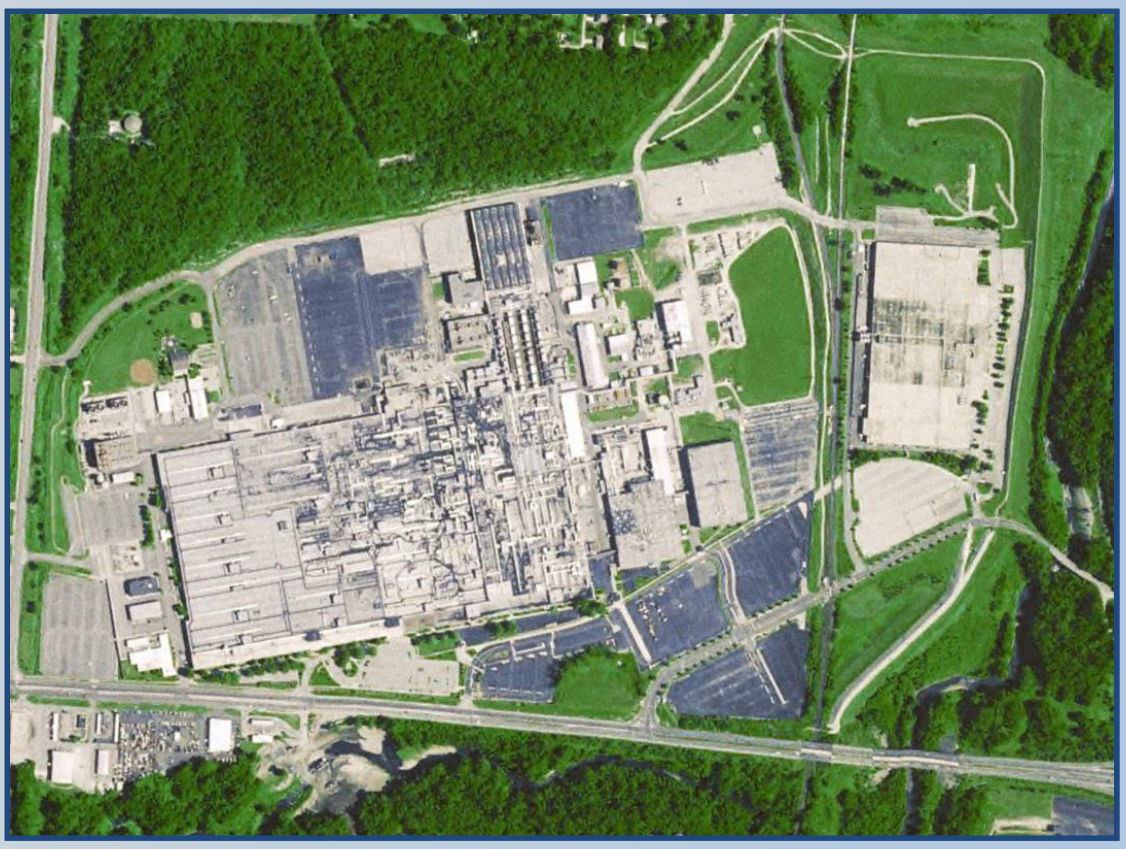




Corrective Measures Report

Bannister Federal Complex
Kansas City, MO

Draft Final
April, 2017



S.S. Papadopulos & Associates, Inc.

S.S. PAPADOPULOS & ASSOCIATES, INC.

ENVIRONMENTAL & WATER-RESOURCE CONSULTANTS

April 20, 2017

Rich Nussbaum, P.E.
Section Chief, Permits Section
Missouri Department of Natural Resources
Hazardous Waste Program
P.O. Box 176
Jefferson City, MO 65102-0176

Subject: Bannister Federal Complex –
Draft Final Corrective Measures Report

Dear Rich:

On behalf of CenterPoint, I am pleased to submit with this letter, the Draft Final Corrective Measures Report (CMR) for the Bannister Federal Complex (BFC). The report provides a summary of the corrective measures proposed for the BFC, should a property transfer occur. This report has been revised on the basis of comments from MDNR dated March 2017, as well as minor editorial comments provided by Don Dicks via email later that month. A Response to Comments matrix is provided as Appendix E to the report.

We have tried to efficiently summarize voluminous information in figures, tables, text and appendices. Nonetheless, if there is additional information you would like to assist in your review, please let me know, and we can provide additional backup.

As always, if you or your staff have any questions, feel free to phone or email.

Sincerely,

S. S. PAPADOPULOS & ASSOCIATES, INC.

Harvey Cohen, PhD, RG
Principal

cc: Electronic Distribution List via FTP

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Corrective Measures Report

Bannister Federal Complex
Kansas City, MO

Prepared for:

CenterPoint Properties Trust

Prepared by:

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S.S. PAPADOPULOS & ASSOCIATES, INC.
Environmental & Water-Resource Consultants

Draft Final
April, 2017

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List of Acronyms

BFC	Bannister Federal Complex
BGS	Below Ground Surface
BMP	Best Management Practice(s)
BRA	Baseline Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability
CMS	Corrective Measures Study
CMR	Corrective Measures Report
COC	Contaminant of Concern
COPEC	Chemical of Potential Environmental Concern
COPC	Chemical of Potential Concern
CVOC	Chlorinated Volatile Organic Compound
DCCR	Description of Current Conditions Report
DCE	Dichloroethylene (Dichloroethene)
DDI	Due Diligence Investigation
DHSS	Missouri Department of Health and Senior Services
DOE	Department of Energy
FEMA	Federal Emergency Management Agency
GSA	General Services Administration
GWTF	Groundwater Treatment Facility
IC	Institutional Controls
KCMO	City of Kansas City, Missouri
LNAPL	Light Non-Aqueous Phase Liquid
MDNR	Missouri Department of Natural Resources
MHWMF	Missouri Hazardous Waste Management Facility
MoECA	Missouri Environmental Covenants Act
MSOP	Missouri State Operating Permit
NAPL	Non-Aqueous Phase Liquid
NNSA	National Nuclear Security Administration
NPV	Net Present Value
PCB	Polychlorinated Biphenyls
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SAP	Sampling and Analysis Plan
SLRA	Screening Level Risk Assessment

SOB	Statement of Basis
SSCL	Site-Specific Cleanup Level
SSP&A	S.S. Papadopulos & Associates
SWMU	Solid Waste Management Unit
SWPPP	Stormwater Pollution Prevention Plan
1,1,1-TCA	1,1,1 Trichloroethane
TCE	Trichloroethylene (Trichloroethene)
TPH	Total Petroleum Hydrocarbons
TSCA	Toxic Substances Control Act
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
WTSA	Waste Transfer Spill Area

Selected Definitions

Clean Fill The MDNR defines "Clean Fill" as "uncontaminated soil, rock, sand, gravel, concrete, asphaltic concrete, cinder blocks, brick, minimal amounts of wood and metal and inert solids, for fill, reclamation or other beneficial use" [§260.200(4), RSMo]. Excavated material containing a minimal amount of wood, metal or other solid wastes, and thereby clean fill by definition is not regulated and may be reburied in the same location or elsewhere on the property from where it was excavated. Concrete containing wire mesh or rebar is considered clean fill provided exposed rebar is first removed to the maximum extent possible in order to prevent a public nuisance or health and safety hazard. Roofing shingles, sheet rock, lumber or other construction and demolition (C&D) wastes are not clean fill.

Fill As used in this document, the term "fill" refers primarily to natural materials (rock, soil, clay) used to modify the site grade and provide structural support for future buildings. The primary source of this material is likely to be quarries and/or borrow pits to be identified at the time of corrective measures implementation, and could also be referred to as "clean imported fill." It may also include materials derived on-site and meeting MDNR's definition of "clean fill" (see above). The large volume of fill required in these corrective measures, however, ensures that most will be clean imported fill.

On-Site For the purposes of this report, the term "On-Site" refers to the current extent of the ~300 acre Bannister Federal Complex. Roughly, this corresponds to property between Santa Fe Trail, Boone Creek, Blue River, Troost Avenue and Bannister Road.

Off-Site For the purposes of this report, the term "Off-Site" refers to land and/or waterways outside of the current boundaries of the ~300 acre Bannister Federal Complex. Generally, this refers to property beyond Santa Fe Trail, Boone Creek, Blue River Troost Avenue and Bannister Road. This includes waters of the Blue River, Indian Creek, and Boone Creek.

Property to be Transferred (or Transfer Property)

For the purposes of this report, the "Property to be Transferred" refers to the ~230 acres of the Bannister Federal Complex situated west of the Union Pacific Railroad Right-of-Way, and the 2.3-acre Tower Site, which is located north of the BFC, off of Troost Avenue.

Proposed Cleanup Levels or Proposed Site-Specific Cleanup Levels (SSCLs)

For the purposes of this report, "Proposed Cleanup Levels" is used interchangeably with Proposed Site-Specific Cleanup Levels (SSCLs). These are the "Final Proposed Cleanup Goals" developed by ToxStrategies (2017) based upon a 1 x 10^{-5} excess cancer risk and a hazard index of 0.1 for carcinogenic and non-carcinogenic chemicals, respectively. The future site users were assumed to include an outdoor worker, a construction worker, and a trench/utility worker. These SSCLs

have not yet been approved as cleanup levels by the Missouri Department of Natural Resources (MDNR).

Solid Waste Management Unit (SWMU)

For the purpose of this report, SWMU refers only to the SWMUs previously identified, delineated, and described in the MHWMF Part 1 Permit for the Bannister Federal Complex

Executive Summary

Under the authority of the National Defense Authorization Act of 2014 and an agreement between the National Nuclear Security Administration (NNSA) and CenterPoint Properties Trust (CenterPoint), Contract No. DE-NA0002662, CenterPoint is currently evaluating the potential for transferring portions of the Bannister Federal Complex (BFC), located at 1500 East Bannister Road in Kansas City, Missouri, to a new property owner. The portions of the BFC being considered for transfer is generally the area west of the existing Union Pacific railroad tracks (Figure ES-1). Anticipated re-use of the transferred property will be commercial/industrial only - residential land use will be prohibited. It is anticipated that following transfer, all buildings except for the groundwater treatment facility and an existing electrical sub-station will be demolished, existing utility infrastructure will be substantially removed or abandoned in-place, and the property will be re-graded and prepared for redevelopment. This Corrective Measures Report (CMR) proposes corrective measures for soil, groundwater, surface water, and sediment to be implemented during and after demolition and re-grading, in order to protect human health and the environment. Implementation of the proposed corrective measures is contingent on the actual transfer of the property to CenterPoint. If the transfer does not occur, the current corrective measures under the Missouri Hazardous Waste Management Facility (MHWMF) Part I Permit will remain in place. Any corrective measures implemented by the current or future owners will be completed under the authority of the MHWMF Part 1 Permit. Demolition of buildings and disposition of asbestos, lead paint, general waste and/or other building materials will be addressed separately in a demolition plan.

Soil, groundwater, and building materials at the BFC are known to be contaminated with chlorinated solvents, polychlorinated biphenyls (PCBs), and other chemicals originating from industrial activities at the site. Environmental management issues at the BFC are primarily governed by a MHWMF Part 1 Permit. There are 45 Solid Waste Management Units (SWMUs) at the BFC. Among these are 11 SWMUs for which "no further action" is required, 4 SWMUs for which "remediation [is] not required at this time," and 3 closed SWMUs under post-closure care. The remaining SWMUs are under corrective action.

Corrective measures outlined in this report are based upon data collected during the past 30 years of environmental investigation, as well as CenterPoint's due diligence investigation completed by S.S. Papadopulos & Associates and Evans Consulting in 2016. In addition, CenterPoint oversaw completion of a Technical Memorandum for Development of Proposed Cleanup Levels (ToxStrategies, 2017) for the portions of the BFC considered for transfer. This CMR relies on the Proposed Site-Specific Cleanup Levels (SSCLs) developed by ToxStrategies (2017); these SSCLs are based upon a 10^{-5} excess cancer risk and a hazard index of 0.1. These SSCLs have not yet been approved as cleanup levels by the Missouri Department of Natural Resources (MDNR). In evaluating risk pathways, the future site users were assumed to include an indoor worker, an outdoor worker, a construction worker, and a trench/utility worker. The indoor worker risk pathway was considered in establishing corrective measures for potential vapor inhalation.

Analysis of the soil data indicates that the majority of SSCL exceedances in soil are PCBs. These form a contiguous area in and near Department 26 (SWMU 31), and in the adjacent outdoor SWMUs. Additional contaminants exceeding the SSCLs are chlorinated solvents (TCE, PCE, dichlorobenzenes) and hexavalent chromium.

The proposed corrective measures are integrated with a building demolition and site re-grading plan. To improve site drainage, future surface elevations will be higher than the current ground surface on most of the property to be transferred. Corrective measures for contaminated soils at the BFC will include:

- excavation and disposal of soils exceeding SSCLs to 12 feet below future surface grades (2 to 8 feet below current grades);
- excavation of utilities to 6 to 12 feet below future surface grades (2 to 10 feet below current grades) where they may interfere with development, and in-place abandonment of other utilities;
- excavation and disposal of impacted soils with a strong odor or other apparent contamination that might impact site re-use when encountered during demolition and utility removal activities;
- emplacement of barriers (e.g. engineered caps, buildings, concrete, or asphalt pavement) where the presence of residual subsurface contamination at known SWMUs requires ongoing engineering controls to limit contact and infiltration;
- raising grades with clean fill across most of the property to be transferred – the proposed fill thickness will vary up to a maximum of 10 feet above the current grade;
- implementation of institutional controls including access restrictions and soil contingency plans as part of the long-term risk management process – these will be memorialized in a Missouri Environmental Covenants Act (MoECA) compliant environmental covenant; and
- obtaining MDNR approval of "corrective action complete - without controls" status for selected SWMUs with no contamination requiring risk management.

Groundwater at the BFC is also contaminated with VOCs and PCBs and existing deed restrictions prevent the use of groundwater. The current groundwater remedy requires containment of contaminated groundwater via pumping of extraction wells, building sumps, and building footing tile drains and treatment in the on-site groundwater treatment facility. The proposed groundwater corrective measures consist of

- groundwater extraction and treatment for plume containment (expected total extraction rates averaging ~ 34 gpm); the groundwater collection system will utilize extraction wells, and two linear collection trenches to maintain groundwater conditions as close as possible to their current configuration;

- construction of low-permeability barrier walls around two areas in the former manufacturing areas, to minimize new mass transfer of contaminants to groundwater while also removing mass by pumping within the barriers;
- construction of a low-permeability barrier wall to reduce migration of contaminants beyond the proposed transfer property in the northeast area while also removing mass by pumping and on-site treatment of groundwater extracted upgradient of the barrier;
- removal and replacement of existing subsurface leaking water mains that have an unpredictable and unreliable influence on plume migration;
- abandoning in place of storm and sanitary sewers, including unregulated Outfalls B, C and F, by filling with grout and plugging the ends of existing tile drains where they connect to building sumps;
- installation of new utilities along pathways that avoid known contamination to the greatest extent possible;
- continuation of institutional controls banning on-site groundwater use, thereby eliminating the tapwater risk pathways; and
- executing an environmental covenant requiring vapor mitigation for all new buildings to be built on-the transfer property, unless it can be demonstrated for MDNR's approval that no vapor barrier is required.

Demolition and reconstruction at the transfer property may impact groundwater levels and potentially contaminant concentrations. It will also require abandonment and replacement of large sections of the groundwater monitoring and extraction network. Consequently, the proposed corrective measures for groundwater include two configurations:

- demolition phase, and
- post-re-grading phase.

The corrective measures efforts will include development of a comprehensive plan for phased abandonment/replacement of extraction and monitoring wells. Once site conditions have stabilized after demolition and re-grading, the groundwater control system will be optimized, with final design dependent, in part, on the redevelopment plan.

Four existing surface water outfalls are currently regulated through a Missouri State Operating Permit (MSOP); monitoring of discharges and off-site impacts is required under both the MSOP and MHWMF permits. The regulated outfalls will be abandoned, thereby eliminating their surface water discharges of PCBs to Indian Creek and Boone Creek. During the demolition phase, stormwater will be controlled through four temporary basins with a capacity for the 2-year, 24-hour storm event, and will be treated prior to discharge. After demolition, new outfalls will be installed that will discharge stormwater collected in permanent detention basins to be constructed

on the transfer property. These will retain runoff from the 100-year storm event, capture most of the sediment, and substantially reduce peak discharge. Surface water remedies will also include:

- abandonment and plugging of existing stormwater conveyance systems including removal, or plugging of Outfalls 001, 002, 003, and B, C, and F and re-purposing of Outfall 004 (a portion of the Outfall 004 structure under the floodwall will be re-purposed as a sleeve for a new Indian Creek outfall);
- re-routing stormwater outfall D so that it is no longer directed across GSA property;
- placement of fill between the embankments near Outfall 001 and Outfall 002;
- installation of a new stormwater system including detention basins, and new outfalls; and
- continued monitoring of regulated stormwater discharges.
- Off-site PCB contamination in Indian Creek and the Blue river will be addressed via:
  - continued monitoring and reporting of groundwater, surface water, and sediment quality, as per the MHWMF permit and cleanup goals established for the 95th Terrace SWMU; and
  - continued sampling of fish tissue at 5-year intervals as per the recommendations of the recently completed PCB Fate and Transport Study.

REPORT

Section 1
Introduction

Under the authority of the National Defense Authorization Act of 2014 and an agreement between the National Nuclear Security Administration (NNSA) and CenterPoint Properties Trust (CenterPoint), Contract No. DE-NA0002662, CenterPoint is currently evaluating the potential for transferring portions of the Bannister Federal Complex (BFC), located at 1500 East Bannister Road in Kansas City, Missouri (Figure 1), to a new property owner. Portions of the BFC being considered for transfer are generally those areas west of the existing Union Pacific railroad tracks (Figure 2). The planned re-use of the transfer property will be commercial/industrial only. Residential land use will be prohibited.

Soil, groundwater, and building materials at the BFC are known to be contaminated with chlorinated solvents, polychlorinated biphenyls (PCBs), and other chemicals originating from industrial activities at the BFC. Management of these environmental issues is regulated through a Missouri Hazardous Waste Management Facility (MHWMF) Part 1 Permit (MDNR, 2012a), as administered by the Missouri Department of Natural Resources (MDNR). In addition, surface water discharges from four surface water outfalls are regulated by a Missouri State Operating Permit (MDNR, 2012b). It is anticipated that the corrective measures proposed in this report will be incorporated into a Statement of Basis that will subsequently be used to support the modification of permits for the facility.

S.S. Papadopulos & Associates (SSP&A) has prepared this Corrective Measures Report (CMR) on behalf of CenterPoint to describe the measures proposed for the BFC and their basis. It is anticipated that following the property transfer, all buildings, except Building 98, which houses the Industrial Waste Pretreatment and Groundwater Treatment Facility (GWTF), and the electrical sub-station located in the southwest corner of the BFC, will be demolished. It is also anticipated that the existing utility infrastructure will be substantially removed or abandoned, and the property will be regraded and prepared for redevelopment.

Section 120(h) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) imposes requirements on all transfers of federal property to non-federal entities to ensure continued protection of human health and the environment after the transfer. Section 120(h) allows an agency to transfer the property before remediation is complete as long as safeguards are in place to protect human health and the environment. One purpose of this CMR is to satisfy these requirements for an acceptable corrective measures plan under new ownership. Implementation of the proposed corrective measures is contingent on the actual transfer of the property to CenterPoint. If the transfer does not occur, the current corrective measures under the MHWMF Part I Permit will remain in place. Any corrective measures implemented by the current or future owners will be completed under the authority of the MHWMF Part 1 Permit. In addition, the General Services Administration (GSA) portions of the BFC not intended for transfer (i.e. areas east of the Union Pacific Railroad right-of-way) will be addressed by GSA in accordance with the MHWMF Part I Permit requirements.

Section 2
Background

Environmental investigations for soil and groundwater contamination at the BFC have been ongoing since the 1980s. Monitoring of groundwater, surface water, and off-site surface water bodies continues to this day. In addition, a number of corrective measures have been undertaken by the current BFC owners, including excavation of contaminated soils, containment and treatment of groundwater contamination, and replacement and lining of contaminated utility lines. An extensive summary of these activities and the current conditions of the BFC are provided in the Description of Current Conditions Report (DCCR; DOE & GSA, 2016).

In 2014, CenterPoint initiated a due diligence investigation to confirm site conditions prior to the proposed property transfer. SSP&A and Evans Consulting were the primary environmental consultants completing this work. The due diligence investigation included substantial environmental investigation, including collection and analysis of over 2,000 soil samples, about 80 groundwater samples, and limited sampling of groundwater seeps, surface water, and sediments. This work has been documented in a series of work plans and data reports (SSP&A 2016a-b, 2017; SSP&A et al., 2015, 2017; SSP&A and Evans Consulting, 2015a-j, 2016). Interpretation of these results is presented in the Due Diligence Summary Report (SSP&A, and Evans Consulting, 2017). This section provides a brief summary of background information including a site description, current ownership and use, anticipated ownership and use, geology, hydrogeology, and the nature and extent of contamination. Additional detail can be found in the documents referenced above.

2.1 Site Description

The BFC is located approximately 12 miles south of downtown Kansas City at 1500 Bannister Road in Kansas City, MO (Figure 1) and is situated on relatively flat land surrounded by hills and bedrock bluffs. The site elevation is about 800 feet above Mean Sea Level (MSL; Figure 3). The BFC comprises approximately 300 acres of industrial, office, and warehouse space. Approximately 230 acres of the property are slated for potential transfer (Figure 1).

The BFC is located within the Blue River watershed. The Blue River, which is situated directly east of the BFC, flows to the north. Indian Creek, a tributary to the Blue River, borders the BFC south of Bannister Road, and discharges into the Blue River just southeast of the BFC. Another tributary, "Boone Creek," joins the Blue River northeast of the facility (Figure 2).

The BFC is historically located within the 100-year flood plain of the Blue River. Extensive flooding occurred at the BFC until approximately 1970. Flood protection features including levees and floodwalls were constructed in the 1990s (Figures 1 and 3). These features were designed for the FEMA-designated 500-year flood level at that time. (New FEMA floodplain maps became effective in January, 2017). Following demolition and redevelopment, the existing levees and flood walls will largely remain although some gates will no longer be operational. It is anticipated that future buildings within the property transfer area of the BFC will be located above the new FEMA-designated 100-year floodplain. It is possible, however, that under these

conditions, some lower-lying areas of the transfer property may be subject to inundation at the 100-year flood level.

2.2 Current Ownership and Use

The BFC is owned by the US Government. Two federal agencies have jurisdiction and control over the property, the General Services Administration (GSA) and the NNSA, a semi-autonomous administration within the U.S. Department of Energy. The NNSA controls approximately 122 acres and the GSA controls the remaining area, approximately 178 acres. In addition, portions of the BFC have been leased between GSA, NNSA and third parties. The National Oceanic and Atmospheric Administration, United States Marine Corps (USMC) and the Internal Revenue Service (IRS) have occupied portions of the GSA owned property. The Bannister Complex buildings west of the UPRR tracks are now largely vacant.

2.3 Anticipated Future Ownership and Use

Should the portions of the BFC be transferred to CenterPoint as the new owner, the intention would be to redevelop the transfer property as an Urban Redevelopment District. Although no development plans have been finalized, the following assumptions can be made regarding future utilization of the former BFC property prior to its redevelopment.

- all buildings except Building 98, which houses the Industrial Waste Pretreatment and Groundwater Treatment Facility (GWTF), and the electrical sub-station will be demolished;
- utilities (storm sewer, sanitary sewer, power, gas, etc.) will be removed or abandoned to the depth necessary for redevelopment, and new utilities will be installed; and
- the redevelopment will be limited to commercial and industrial uses – residential use will be prohibited.[1]

2.4 Geology and Hydrogeology

The BFC facility is situated on alluvial deposits of the Blue River basin. These generally consist of silty clays approximately 30 to 45 feet thick. A basal layer of clayey gravel is present beneath the silty clays across the BFC, ranging in thickness from several inches to eight feet. The average horizontal hydraulic conductivity of the fine alluvium and interbedded silty/sandy layers is estimated to be around 0.5 feet/day (SSP&A, 2016b). Higher conductivities are associated with the basal material. Bedrock is present beneath the basal layer consisting of shale and sandstones.

[1] Appendix D contains a list of acceptable land uses proposed for the Bannister Federal Complex after transfer of the property to a private owner. These "acceptable" and "prohibited" land uses have not yet been approved by the Kansas City, MO Department of Planning.

Previous testing of aquifer properties by DOE has determined the bedrock to be largely impermeable (DOE & GSA, March, 2013).

Groundwater is present in the alluvium at a depth of approximately 10-15 feet below ground surface (bgs), corresponding to elevations of approximately 786-790 feet MSL in the center of the property to be transferred (Figure 4). Under natural conditions, groundwater at BFC flows either to 1) Blue River, or 2) Indian Creek. Previous BFC investigators have therefore designated the Blue River Groundwater Flow System and the Indian Creek Groundwater Flow System.

The primary sources of recharge to the groundwater system are on-site precipitation and leakage from utilities (Laase, 2010; SSP&A, 2016b). The primary known discharge locations for groundwater are the bounding streams, as well as footing tile drains, building sumps, and groundwater extraction wells that intercept groundwater (Figure 4). The largest and most significant depression in groundwater elevation is under the Main Manufacturing Building (MMB) with other important depressions under the West Boiler House (Building 5) and Building 91 (Figure 4). The impact of groundwater extraction from remedial recovery wells is also apparent in the groundwater elevations (see 2002-2012 average water levels in Figure 4). Recently, pumping from some of these wells has been discontinued in response to favorable contamination trends in monitoring wells. Under current conditions, the groundwater gradients are generally downward at the site periphery, and are upward in the vicinity of the footing tile drains. The magnitude of these downward gradients increases near extraction wells at two locations: the southeast parking lot and in the northeast area.

2.5 Regulatory Status

Environmental management issues at the BFC are primarily governed by the MHWMF Permit (MDNR, 2012a). Under Missouri's authorized RCRA-equivalent hazardous waste program, areas of environmental concern are managed as Solid Waste Management Units (SWMUs). There are currently 45 Solid Waste Management Units (SWMUs) at the BFC (Figure 5 and Table 1).[2] Among these are 11 SWMUs for which investigations have been completed and "no further action" is required, 4 SWMUs for which "remediation [is] not required at this time," and 3 closed SWMUs (the North and South Lagoons, and the former Underground Tank Farm) that are currently under post-closure care. The remaining SWMUs are under corrective action, for groundwater and soil contaminants. Figure 5 shows the current status, per the MHWMF permit, of the 45 SWMUs.

The BFC is authorized through its Missouri State Operating Permit (MSOP) to discharge stormwater through four permitted outfalls (Figure 3). The operating permit requires comprehensive monitoring including sampling water at the four regulated sewer outfalls, as well at a downstream sampling point at the confluence of the Blue River and Boone Creek at Prospect Bridge. Additional surface water monitoring is also required under the MHWMF permit.

[2] As of March, 2017, additional areas of the BFC are under consideration by MDNR for designation as Areas of Concern (AOCs) and inclusion as such in future versions of the MWHMF Permit. These are, however, located outside of the property to be transferred.

2.6 Nature and Extent of Contamination

The collection of samples for the environmental assessment of the BFC and adjacent off-site areas has been ongoing for the last 30 years. Section 5 of the DCCR (DOE and GSA, 2016) presents an extensive summary of the nature and extent of contamination in both soil and groundwater. CenterPoint's 2015-2016 due diligence investigation (SSP&A and Evans, 2017) provided additional confirmation data and review of existing conditions. It concluded that the contaminants of potential concern (COPC) identified in soils at the BFC, and their overall distribution are largely consistent with previous investigations by the currents owner. With regards to groundwater, the due diligence investigation concluded that in general, the compounds detected and concentrations are similar to those documented previously.

The contaminants of potential concern identified at the BFC primarily consist of:

- volatile organic compounds (VOCs), especially chlorinated solvents including TCE, cis-1,2-DCE, vinyl chloride and dichlorobenzenes;
- components of petroleum such as the BTEX compounds (benzene, toluene, ethylbenzene, and xylenes);
- semi-volatile organic compounds (SVOCs) such as the polyaromatic hydrocarbon benzo(a)pyrene);
- polychlorinated biphenyls (PCBs); and
- hexavalent Chromium

Other contaminants of potential concern include petroleum mixtures such as jet fuel, and "total petroleum hydrocarbons" (TPH). Areas of fuel contamination in soil or groundwater can cause risks to human health and the environment, as well as nuisance due to odor or the presence of non-aqueous product that can interfere with site use. In practice, and as per MDNR recommendations, risks associated with fuels are most precisely measured based on individual fuel components, such as benzene. Following the quantitative approach of the BRA, the corrective measures described in this report are targeted first at areas where proposed cleanup levels for specific compounds have been exceeded. Secondarily, additional corrective measures are targeted for areas of potential fuel contamination where odors and/or fuel product might also interfere with future development.

During CenterPoint's due diligence investigation, samples of both soil and groundwater were analyzed for hexavalent chromium, whereas previous studies had only looked at total chromium results. The detections of hexavalent chromium in groundwater were negligible (maximum value of 0.013 J[3] ug/L). In soil, limited detections were found, with the highest results (up to 72.8 J mg/kg) found in association with elevated total chromium in former waste management areas of SWMU 6. Therefore, hexavalent chromium was retained through the

[3] Laboratory values with "J" flags indicate the positive detection of an analyte with a concentration that is estimated due to quantitation confidence below specific criteria.

screening process for contaminants of potential concern (ToxStrategies, 2017).[4] Ultimately hexavalent chromium is not likely to be a driver of corrective measures as the limited exceedances of proposed cleanup levels co-occur with volatile organic compounds that are also targeted for corrective measures. (see Sections 4 and 5). Nonetheless, during demolition and remedial activities, soils will be observed for staining, and this may lead to additional corrective measures beyond those described here.

Other metals, including arsenic, manganese and lead were also identified as contaminants of potential concern in the Baseline Risk Assessment completed by URS (2015). There is no clear link between isolated occurrences of these elevated metals concentrations at the BFC and historical activities or releases (see ToxStrategies, 2017). Elevated levels of arsenic, for example are naturally occurring in soils of Jackson County and most manganese values also appear naturally elevated at the BFC (Dickerson et al., 1995; Fleischhauer, 1998; Tidball, 1983). Consequently, no corrective measures are planned specifically to address contamination with these metals. Nonetheless, some metals exceedances will be addressed through excavation of VOC-and PCB-contaminated soils, institutional and engineering controls, and soil contingency plans with requirements for construction worker health and safety.

2.6.1 Soil

Figure 6 shows the extent of known soil contamination, as illustrated in the DCCR (DOE and GSA, 2016). As can be seen from this figure, the key areas of soil contamination include:

- VOCs associated with the former TCE Still Area (SWMU 2) on the east side of the main manufacturing building (MMB);
- PCBs and VOCs used in manufacturing operations in the vicinity of Department 26 (SWMUS 9-12 and 31) on the east side of the MMB;
- PCBs released to historical outfall areas near Indian creek (SWMU 42); and
- Several areas of petroleum hydrocarbon (TPH) associated with SWMUs and non-SWMU areas in the northeast portion of the property to be transferred.

The due diligence investigation also found several other contamination issues not previously documented. These included:

- Common observations of low-level PCBs and polyaromatic hydrocarbons (PAH) in shallow soils (0-2 feet depth), likely related to asphaltic paving materials and past industrial activities;

[4] Only some of the due diligence Cr-VI data was available to URS during completion of the BRA. The complete data set, including the maximum value referenced here was available to ToxStrategies (2017), and resulted in identification of hexavalent chromium as a contaminant of concern.

- previously undocumented soil contamination with TCE under Building 15 (Figure 2)[5];
- shallow chlorobenzenes in two adjacent borings (CP-322 and CP-322R) outside of any SWMUs in the footprint of former "pools" of surface water in the northeast area – subsequent investigation in June 2016 identified additional chlorobenzenes, TCE and other VOCs in in nearby borings such as CP-5010[6]; and
- hexavalent chromium and TCE detections found in the "Old Ponds" SWMU (SWMU 6) at depths of 5 to 10 feet bgs (boring CP-2219 in the western "old pond").

2.6.2 Groundwater

Groundwater contaminants of concern previously identified for the BFC are organic compounds including chlorinated solvents and PCBs that are only slightly soluble in water. They were released into the subsurface as components of non-aqueous organic liquids (solvents, fuels, thermal transfer fluids) that are not miscible with water. The distribution of contaminants observed in groundwater suggests that dense non-aqueous liquids (DNAPLs) have migrated vertically to the bedrock / alluvium interface. Previous investigations have confirmed the presence of organic liquids (NAPL and residual product) in the subsurface (DOE & GSA, 2013). Product was directly observed in groundwater extraction wells near the former plating building (Wells 86 and 87) and in the source area of the northeast plume (well KC01-273). Concentrations indicative of the presence of NAPL and therefore the presence of continuing source material, have also been observed in the area of the former plating building degreaser just east of the Main Manufacturing Building, in the well KC85-37 area (northeast plume), and in the Building 50 area (Figure 2).

The primary solvent released in these areas was TCE. Today, TCE's degradation daughter products, cis-1,2-DCE, and vinyl chloride are also present at high concentrations in the groundwater. Similarly, 1,1,1-trichloroethane (1,1,1-TCA) was apparently released into groundwater and its hydrolysis byproduct, 1,1-DCE, is widely observed in association with the 1,1,1-TCA. 1,4-Dioxane, a solvent as well as a stabilizer commonly mixed with 1,1,1-TCA is also present in groundwater. Other VOCs detected in BFC groundwater include acetone, benzene, chloroform, tetrachloroethene, chlorobenzenes, dichloroethanes, toluene, and xylenes.

In the Department 26 area, PCBs are intermixed with the chlorinated solvents due to the release of Therminol heat transfer liquids and with total petroleum hydrocarbons (TPH) from releases of waste oils (DOE, 1990).

A general depiction of groundwater contamination areas in both the upper and lower alluvium intervals is shown on Figure 6. Additional detail on the groundwater conditions is provided in subsequent sections of this report.

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[5] Building 15 originally served as the pump house for the Underground Tank Farm (SWMU #1) and pumps serving the tank farm were located in the basement. According to NNSA comments on the draft due diligence report, TCE at this location may be attributable to releases associated with TCE pumped through Building 15.

[6] The Stage III Supplemental investigation was completed by SSP&A on behalf of CenterPoint in June, 2016, and a final report issued to MDNR in March, 2017.

2.6.3 Stormwater Discharge

Stormwater runoff from the BFC currently discharges to Indian Creek, Boone Creek and the Blue River through both unregulated and regulated outfalls (Figure 3). There are six unregulated outfalls (A through F) and four regulated surface water outfalls, identified as 001 through 004. Outfalls 002, 003, and 004 discharge water directly into Indian Creek, whereas Outfall 001 discharges water into Boone Creek. Both Indian and Boone Creeks ultimately discharge into the Blue River.

Discharges at the numbered outfalls are regulated by the Missouri State Operating Permit (MSOP). This permit requires comprehensive monitoring, and includes numeric discharge limits and notification levels. Additional monitoring of surface water discharges, stream sediments, and stream flows in Indian Creek, Boone Creek, and the Blue River is required by the MHWMF Part 1 permit. Historically, VOCs have periodically been discharged to Indian Creek and the Blue River at concentrations below MSOP notification levels, and below Missouri-established risk levels based upon human health criteria (DOE & GSA, 2013; NNSA, 2014, 2015).

PCB discharges have also been observed historically from the regulated outfalls. In recent years, discharge of PCBs from these outfalls has been substantially mitigated by remedial actions, including diversion of surface water runoff, lining of the storm sewer system, and excavation of contaminated soils. The MHWMF Permit and MSOP set 0.000045 ug/L as the relevant Missouri Water Quality Standard concentration for PCBs. Measured PCB Aroclor values greater than or equal to the minimum quantification level of 0.5 ug/L, however, are considered an exceedance of the permit limit. An exceedance of the 0.5 ug/L permit level will trigger corrective actions in the site's Best Management Practices as detailed in special condition #7 of the MSOP.

As recently as 2013, PCBs have been detected at the Outfall 002 “flap gate” location above the current Aroclor analytical quantitation limit (0.5 ug/L).[7] Data collected by Anchor QEA as part of the PCB Fate and Transport Study (Anchor QEA, 2016) confirmed PCB congeners at concentrations less than 0.5 ug/L during storm events in 2014 at both the Outfall 001 and Outfall 002 MSOP compliance points.

In addition, PCBs have been detected in sediment samples collected in Indian Creek, the Blue River and Boone Creek. Other media sampled for PCBs have included receiving surface waters, and fish tissue. As part of the MHWMF Permit requirements, fish tissue samples have been periodically collected from Boone Creek, the Blue River and Indian Creek. The recent work by Anchor QEA (2016) provided estimates of the mass loading of these surface water bodies, based upon 2013-2014 sampling data, and analytical modeling. Outfalls 001 and 002 are discussed in more detail in Section 2.7 below.

2.6.4 Building Contamination

The DCCR (DOE & GSA, 2016) notes a number of potential contamination issues associated with the interior of buildings at the BFC. These include beryllium dust, lead paint,

[7] The flap gate is a compliance point for the MHWMF Permit, not for the MSOP.

asbestos-containing materials, PCBs and other contaminants associated either with building materials or manufacturing processes.

Remediation and demolition of building materials are outside the scope of this corrective measures document. These issues will be addressed in CenterPoint's demolition plan.

2.6.5 Radionuclides

The historical use of depleted uranium as a manufacturing material has been documented at the BFC. In recent years, additional research has documented the handling and milling of natural uranium in the 1950s and thorium compounds from the 1950s to the 1970s. (ORAUT, 2006, 2014; NIOSH, 2011). Prior to the due diligence investigation, there has been only limited investigations that specifically addressed the potential for radionuclide contamination of soil and groundwater.

The revised Section 7 of the DCCR (DOE & GSA, 2017) addresses the BFC's history of working with depleted uranium as a manufacturing material. Measurable levels of fixed radioactivity in sumps, floor drains, piping, floor expansion joints, and other surface areas were reportedly remediated by DOE's contractor (Rockwell) in phases through 1986 (DOE & GSA, 2017). More recently, additional investigative and remedial work by ANTECH (2016a-c, 2017) has addressed residual radioactivity above background levels in concrete and subsurface piping within Department 20, Department 49X, and Building 96.

On behalf of CenterPoint, independent investigations of radionuclides and building materials were conducted by Brandenburg Industrial Services Company and Auxier & Associates as part of the due diligence investigation. Reports detailing the investigations and results were provided by each firm (Brandenburg, 2016; Auxier, 2016).

CenterPoint's due diligence investigation (Stage III and Stage III supplemental investigations) addressed the potential for radiological parameters and specific isotopes in soil and groundwater. The Stage III supplemental investigation in June of 2016 did identify a single boring, east of Building 59 where elevated radioactivity levels were found to be associated with depleted uranium (DU) in shallow soil (ANTECH, 2016c, 2017). DU levels in the material removed by ANTECH exceeded Authorized Limits for DU in soil (Oak Ridge Institute for Science and Education, 2016). To date, no additional areas requiring remediation of radionuclides in soil or groundwater have been identified, and no corrective measures in this report address DU.[8]

2.7 Additional Areas

This section describes four additional areas relevant to either the MHWMF Part 1 Permit or CenterPoint's due diligence investigation. Although these are "off-site" locations, beyond the boundaries of the BFC property, should a property transfer occur, CenterPoint, as a new permittee,

[8] Because of the potential for additional DU contamination in building materials and soils at the BFC, demolition and excavation plans for the BFC will include a rigorous program for screening waste material for radioactive materials. Plans for these activities are currently being developed by CenterPoint in coordination with MDNR, DOE and the demolition contractor.

may retain responsibility for environmental management at these locations. Appropriate corrective measures are therefore presented herein for completeness, and to better align this document with the MHWMF Part 1 Permit.

2.7.1 Outfall 001 (SWMU No. 8)

Outfall 001 currently drains the northeastern manufacturing areas of the BFC to Boone Creek (Figure 3). Portions of the outfall are located on property owned by the Union Pacific Railroad – property that will not be transferred to a new owner (Figure 1). Historically, surface water discharges from Outfall 001 have included both PCBs and chlorinated solvents, although in recent years monitoring results have generally remained below laboratory reporting limits.

A portion of the Outfall 001 pathway, the Outfall 001 raceway, is designated as SWMU 8 (Figure 5). In the 1990s, the raceway was installed a part of a corrective action to remove contaminated soil and capture shallow contaminated groundwater for treatment prior to surface water discharge. Currently water collected from a french drain under the raceway is treated at the groundwater treatment facility prior to discharge. Outfall 001 daylights in a triangular basin situated between spurs of the Union Pacific Railroad tracks, on land owned by the railroad. In 2015, CenterPoint due diligence sampling in this area confirmed the presence of chlorinated solvents in shallow groundwater and seeps, and PCBs in soils.

2.7.2 Outfall 002 (SWMU 15) and SWMUs 14 and 42

Outfall 002, designated as SWMU 15 (Figure 5), drains the south-central manufacturing areas of the BFC. The outfall drains into Indian Creek, south of Bannister Road, via a flap gate and concrete raceway. Prior to the late 1960s or early 1970s an old meander of Indian Creek, ran north of the current Outfall 002 location. This meander was subsequently filled in for construction of the new Bannister Road and 95th Terrace. Prior to that, however, stormwater was discharged into the meander at a location referred to as the Abandoned Indian Creek Outfall (AICO). The AICO was the location of surface PCB releases that followed the Indian Creek meander, resulting in soil contamination. Despite remedial excavation, PCB contamination associated with the AICO remains at depths greater than 30 feet bgs in the area of SWMU 42 (the 95th Terrace; DOE & GSA, 2013).

Substantial remedial work has been undertaken by the current BFC owner to line the storm drain piping, reroute process cooling and condensate water to the industrial waste lines, and to install a low-flow bypass system in order to minimize additional PCB loading to Indian Creek via the current Outfall 002 pathway. Nonetheless, exceedances of the PCB reporting limits do sometimes occur at this outfall (NNSA, 2014, 2015).

2.7.3 Off-Site PCB Contamination in Indian Creek and Blue River

Due to historic discharges of contaminated stormwater to the Blue River system, the MHWMF Part 1 Permit requires ongoing sampling of surface water, sediment, and fish tissue in Indian Creek and the Blue River. Special Condition III (Surface Water Monitoring Program) of

the current MHWMF Part 1 permit delineates the requirements, including reference to the Sampling and Analysis Plan (Appendix B) of the Corrective Measures Study for the 95th Terrace SWMU (URS Group, 2004) and subsequent updates (2013 and 2016). In particular, the MHWMF Permit requires continuation of the ongoing:

- semi-monthly/monthly sampling for sediment and surface water at the Outfall 002 sluice gate;
- semi-annual surface water sampling at four regulated sewer outfall and six surface water sampling locations;
- quarterly sediment sampling from 3 locations in Indian Creek; and
- bioaccumulation studies for PCBs in fish tissue to be conducted every five years.

The current MHWMF Part 1 Permit also requires the completion of, a one-time PCB Fate and Transport Study to holistically evaluate the sources, loading, fate, and transport of PCBs in the Blue River System. This work was completed by Anchor QEA (2016), and recommended that periodic bioaccumulation studies continue at a 5-year intervals (such that a minimum of three additional studies are performed) to evaluate that the observed downward trend in the historical fish data continues into the future. As detailed in the PCB Fate and Transport Report, the first round of sampling will be in 2017 to act as a background prior to site demolition and implementation of the revised corrective measures. The second round will be performed 1-year post demolition. The third sampling will be conducted 5 years after the second round. After the third sampling event, the continued sampling of fish tissue will be reevaluated and a request to suspend future sampling may be submitted to the agencies for review.

2.7.4 Tower Site

The Tower Site is a non-contiguous property, approximately 2.3 acres in size, located north of the BFC and east of Troost Ave (Figure 2). The Tower Site is not subject to either the MSOP or the MHWMF Permit. As part of the environmental due diligence for the BFC, SSP&A conducted a site reconnaissance in November, 2015 to identify any recognized environmental conditions (REC). No apparent RECs were found during the reconnaissance, and soil samples that were collected from 10 locations across the property did not indicate any contamination above USEPA regional screening levels (RSLs; SSP&A and Evans Consulting, 2017). No corrective measures are planned for this location.

2.8 Data Gaps and Limitations

The remedial measures described in this report were developed in conjunction with a number of ongoing reports and analyses. For example, the Technical Memorandum on Proposed Cleanup Levels (ToxStrategies, 2017) has not been approved by MDNR. Consequently, it is possible that finalization of these studies may impact the conclusions and proposed corrective measures outlined in this CMR.

As noted in the draft due diligence investigation report, SSP&A has relied, in part, upon extensive documents and data provided by GSA, NNSA, DOE, and other parties. Many of these documents were prepared with the review/approval and oversight of MDNR and EPA. The authors of this Corrective Measures Report are not responsible for any inaccurate or incomplete information provided by other parties.

Additionally, the extent of soil and groundwater contamination from the Former Landfill (SWMU 44) and the parking lot east of the former IRS building have not yet been determined by the responsible parties, GSA and the U.S. Army Corps of Engineers (USACE). As these areas are part of the BFC but are not part of the property to be transferred, CenterPoint did not collect any data in these areas during the Due Diligence sampling and did not conduct any analysis of these areas as they will remain the responsibility of GSA/USACE under the proposed modified MHWMF Part I Permit.

Section 3
Existing Corrective Measures

Remedial requirements of the current MHWMF Permit are summarized in Tables 2 and 3. Briefly, these requirements can be summarized as:

- containment of groundwater with contaminant concentrations above the groundwater protection standards (Table 4) via pumping and collection in building sumps, with on-site treatment before discharge;
- monitoring of groundwater conditions, via regular sampling and analysis, with emphasis on point of compliance, effectiveness, and perimeter wells, which are designated in regularly updated Sampling and Analysis Plans (SAPs);
- monitoring of surface water, stream sediments and fish tissue specifically to address off-site migration of PCBs and other contaminants (Table 5);
- regular reporting of permitted activities on annual, semi-annual, biennial, and as-needed schedules;
- post-closure care of three closed SWMUs (north lagoon, south lagoon, and tank farm);
- institutional and engineering controls to prevent human contact with contaminated soils;
  - use of existing buildings, parking lots, etc., as barriers to contact;
  - requirements for safe management of soil during invasive activities (e.g. utility repair), and use of clean fill after repairs;
  - placement and maintenance of warning signage in the vicinity of Outfall 002 on Indian Creek;
- periodic evaluation of "innovative" remedial technologies for application to the BFC contamination; and
- a number of one-time requirements to address data gaps and other issues, including:
  - completion of a Baseline Risk Assessment [approved by MDNR, in coordination with USEPA, in July, 2016];
  - completion of a study of PCB fate and transport from the BFC to Indian Creek and the Blue River [approved by MDNR, in coordination with USEPA, in March, 2016];
  - completion of the Description of Current Conditions Report (DCCR) [approved by MDNR in 2016 & 2017]; and
  - completion of data gap studies, such as the Building 4 Investigation [Approved by MDNR in December 2016] and Abandoned Fuel Lines investigation [Approved by MDNR in March 2017].

The current MHWMF groundwater monitoring and recovery network, consisting of more than 200 wells, is shown on Figure 7. In addition, collection of contaminated groundwater in

building drains and sumps is a primary control of groundwater contaminants, preventing off-site migration of contaminants. These are illustrated in Figure 4.

Section 4
Risk Assessment, Proposed Cleanup Levels and Other Regulatory Limits

This section describes the development and application of proposed site-specific cleanup levels for contaminated media at the BFC. After contaminants released to the environment during historical facility operations are identified on a property, corrective measures are designed to address locations where the human health risk or ecological risk exceed acceptable levels. This first requires application of a screening process utilizing conservative screening levels such as USEPA Regional Screening Levels (RSLs) to identify Contaminants of Potential Concern (COPCs). Subsequently, the COPCs are further evaluated by considering individual exposure pathways (e.g. ingestion of drinking water, dermal contact, inhalation of vapors), to determine what concentrations of each of COPC corresponds to acceptable risk levels. These are then used as the basis for determining potential cleanup levels, or the minimum contaminant concentrations that pose unacceptable risks.[9] Finally, Contaminants of Concern (COC) are identified through this process of identifying complete risk pathways for each COPC.

At the BFC, prior corrective actions have resulted in definition of cleanup levels for about 30 COCs, inclusive of the VOCs and PCBs described above (USEPA, 1998). Because of the extensive environmental investigations completed since that time, and changes to toxicology values and methods used for calculating risk, however, revised cleanup levels were required before corrective measures could be proposed.

As noted above, the BFC Baseline Risk Assessment (BRA; URS Corporation, 2015), was approved by the MDNR, in coordination with USEPA, in July of 2016. The BRA addressed both on-site soils and groundwater, as well as off-site environmental concerns in Indian Creek and the Blue River. Using soil, groundwater and surface water data collected through 2014, the BRA identified chemicals of potential concern (COPCs) and chemicals of potential environmental concern (COPEC) in these media. In addition, the BRA calculated baseline human health and environmental risk values for designated exposure areas in soil, groundwater, and off-site streams.

Building on the data, methods and conclusions of the BRA, CenterPoint developed a Technical Memorandum: Proposed Cleanup Levels for On-Site Areas of the Bannister Federal Complex (ToxStrategies, 2017). The purpose of this document was twofold:

1. to develop proposed cleanup levels for portions of the BFC property proposed for transfer, and
2. to delineate sub-areas of the BFC for which corrective measures are recommended and other areas that can be used for commercial/industrial purposes without restriction.

[9] The Risk Assessment process typically considers risks from both carcinogens and non-carcinogens. For the sake of simplicity, the term "risk", as used here, is intended in encompass both exceedances of acceptable cancer- and non-cancer risk levels.

ToxStrategies (2017) was also able to incorporate into their analysis 2015-2016 due diligence data not available while the BRA was being completed. The primary impact of these data was the addition of further detail to contaminant distributions, and the addition of several COPCs. The ToxStrategies report primarily addressed soil and groundwater contaminants within the property boundaries of the BFC. BRA conclusions regarding off-site environmental concerns (e.g. PCBs in Indian Creek and Blue River) were incorporated directly into the "Cleanup Levels Technical Memorandum."

The following sections provide a focused summary of the nature and extent of soil, groundwater, and surface water contamination. This discussion is limited to contamination determined to require corrective measures. That includes:

- specific areas of the property to be transferred where contamination in soil exceeds the proposed cleanup levels;
- areas of the BFC where groundwater contamination exceeds the groundwater protection standards in the MHWMF Part 1 Permit;
- additional areas on the property to be transferred where sampling data indicates that petroleum and volatile organic contaminants are present in soil at levels potentially associated with non-aqueous liquids, even if cleanup standards are not specifically exceeded; and
- off-site areas (Indian Creek and Blue River) in which contamination of surface water, sediment, and fish have previously been documented by numerous investigations.

4.1 Proposed Site-Specific Cleanup Levels

CenterPoint's due diligence investigation report (SSP&A and Evans Consulting, 2017) provides detailed maps illustrating the extents of key contaminant groups, with a comparison to the most recent USEPA screening levels. These screening levels are USEPA RSLs, based upon a $1x10^{-6}$ excess cancer risk, and a hazard index of 0.1 for carcinogenic and non-carcinogenic effects, respectively. The RSLs are conservative values, designed for identification of COPCs. For the purposes of corrective measures, however, the proposed cleanup levels were initially based on targets of $1x10^{-5}$ for excess cancer risk, and 1 for the hazard index. These are the same risk criteria approved for the 95th Terrace Corrective Measures (URGS Group, 2004). Ultimately, to address the potential for cumulative risk across media and where multiple contaminants are present, we selected more stringent proposed cleanup levels based on criteria of $1x10^{-5}$ excess cancer risk and a hazard index of 0.1.

The proposed site-specific cleanup levels (SSCLs) developed by ToxStrategies (2017) are presented in Table 6. The future site users were assumed to include an indoor worker, an outdoor worker, a construction worker, and a trench/utility worker. The commercial/industrial indoor worker scenario was primarily used to evaluate indoor vapor inhalation risk in future buildings. The soil SSCLs provided in Table 6 are the lowest value from any of these pathways within the relevant depth interval. These SSCLs have not yet been approved as cleanup levels by the MDNR.

4.1.1 Soil

The proposed SSCLs were calculated for two depth intervals, based upon the following exposure scenarios:

- 0-2 feet bgs (outdoor worker risk scenario)[10], and
- 2-12 feet bgs (utility worker and construction worker risk scenarios[11])

Figure 8 illustrates the locations where soil data exceeded the proposed SSCLs for either the outdoor worker or the utility and construction worker scenario risks. As can be seen from Figure 8, many SSCL exceedances are PCBs. These form a contiguous area in and near Department 26 (SWMU 31), and in the adjacent outdoor SWMUs. Additional COPCs exceeding the SSCLs are chlorinated solvents (TCE, PCE, chlorobenzenes) and hexavalent chromium.

The majority of metals exceedances calculated from the BFC data are associated with arsenic (As), an element that is naturally elevated in soils of Jackson County. Manganese (Mn) and Aluminum (Al) results also exceed target risk levels in isolated locations.[12] While most of these exceedances are likely attributable to natural background, some elevated values do appear to exceed the site-specific background ranges (ToxStrategies, 2017). Nonetheless, there is no historical information or geographic pattern of exceedances to suggest that these metals results are related to historical BFC activities. Consequently, no metals other than hexavalent chromium were identified as COCs by ToxStrategies (2017).

Similarly, the semi-volatile compound benzo(a)pyrene was identified as a COPC on the basis of RSL exceedances, primarily in shallow soil (ToxStrategies, 2017). A review of the data indicated that these results reflect the impact of paving materials, not chemical releases from past historical activities. Consequently, benzo(a)pyrene was not identified as a COC (ToxStrategies, 2017).

Additional detail on the exceedances associated with specific risk scenarios and compounds can be found in Appendix A.

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[10] Soil samples were considered as potentially "shallow" if at least part of the sampling interval was within the 0-2 ft bgs zone. For example, surficial samples from the Outfall 008 area were collected from a depth interval of 0- 3 feet bgs, but were compared to the shallow soil criteria.

[11] The maximum depth of construction on the property to be transferred is anticipated to be 12 feet below final grade.

[12] Some thallium results reported by NNSA/DOE exceeded the target risk levels, but these thallium results were likely an artifact of the analytical method used (ICP method 6010), and were not confirmed by due diligence data analyzed using ICP/MS (method 6020; ToxStrategies, 2017). Three soil sample locations in the northeast area exhibited lead concentrations above the proposed SSCL. While no corrective measures are specifically targeted to these locations, all will be addressed through the implementation of corrective measures addressing other compounds.

4.1.2 Groundwater

ToxStrategies (2017) used the same approach as described above for soils to develop proposed cleanup levels for COCs in groundwater (Table 6). They are based on a target cancer risk of 1 x 10^{-5} and a hazard index of 0.1. These levels are used to determine when corrective measures are complete.

Depictions of the current groundwater conditions for the upper and lower alluvium can be found in Figures 9 and 10. These figures illustrate the general extents of the groundwater plumes, and the documented exceedances of the MHWMF Part 1 Permit groundwater protection standards (GPS) at individual well locations. The MHWMF Permit groundwater protection standards are implemented, in part, to protect groundwater and surface water beyond the permitted facility property boundaries.

At the current time, no modifications to the existing groundwater protection standards are being proposed as part of this CMR.[13] We anticipate that demolition and reconstruction at the transfer property will impact groundwater levels and contaminant concentrations, requiring post-demolition review and optimization of the groundwater containment and monitoring systems. Once these conditions have stabilized, the MHWMF groundwater protection standards may be re-evaluated, with the potential for modification to updated risk-based standards, via a permit modification. Until then, the current groundwater protection standards in the MHWMF Part I Permit will remain in place. The groundwater protection standards at the point of compliance wells must still be achieved during demolition and construction phase of redevelopment. Any updated risk-based standards must not only meet on-site requirements, but also off-site requirements for water that could migrate to the adjacent streams.

The Baseline Risk Assessment (URS, 2015) also identified vapor intrusion risks based upon the potential for VOC volatilization from groundwater. The resulting risk characterization is highly conservative and does not take into account much of the geographic variation in groundwater contamination. Figure 11 illustrates the geographic variability of indoor vapor inhalation risks as calculated from data collected from individual groundwater wells (ToxStrategies, 2017). No cleanup levels based on the vapor intrusion pathway are presented here, as vapor barrier requirements are assumed for all future construction, as per the Baseline Risk Assessment.

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[13] In a letter dated April 28, 2016, the Missouri Department of Natural Resources approved a Class I permit modification that added two additional constituents, 1,4-dioxane and Total Petroleum Hydrocarbons Gasoline Range Organics (TPH-GRO), to the groundwater monitoring requirements for selected wells. This letter also lays out provisions for adding the USEPA's RSL screening level for 1,4-dioxane to Tables I and IA of the permit as a new Groundwater Protection Standard should it be detected in selected wells. Detections of 1,4-dioxane in the shallow and deep alluvium were confirmed in 2016 (see the Groundwater Corrective Action Report for Calendar Year 2016, March 2017) and the Groundwater Protection Standards are updated in Table 4 of this report.

4.2 Other Relevant Quantitative Limits

4.2.1 Stormwater

Sampling requirements for the stormwater outfalls are currently addressed under both the MSOP and MHWMF permit for the BFC. Acceptable discharge levels, however, are solely provided in the MSOP, as shown in Table 5.

Redevelopment plans for the BFC include complete reconfiguration of the regulated outfalls (see Section 5.7). Stormwater monitoring consistent with current requirements will be maintained for the legacy outfalls while they remain in service. No additional surface water discharge goals are established in this report. An MSOP permit modification will be required to incorporate any proposed stormwater management system changes and to define requirements for continued monitoring of discharges from the new outfalls after development.

4.2.2 Off-Site Surface Water and Sediment

Recommended PCB cleanup levels for off-site surface water and stream sediments are summarized in the 95th Terrace Corrective Measures Study (URS Group, Inc., 2004). These are not modified by ToxStrategies (2017), nor this Corrective Measures report. The relevant PCB cleanup goals are tabulated below.

Media	Cleanup Goal
Surface Water	0.26 ug/L
Sediments	4.9 mg/kg

Section 5
Proposed Corrective Measures

This section describes the proposed corrective measures to be established for the BFC after the "transfer property" has been acquired by a new owner. Should a transfer not occur, conditions of the current MHWMF Part 1 Permit remain in effect. The overall goals of the proposed measures are to protect human health and the environment, to reduce the mass and mobility of contaminants, to reduce the long-term requirements for active management of contaminated media, and to make the transfer property suitable for future redevelopment and reuse for commercial and industrial purposes. The corrective measures described below utilize a number of strategies including mass removal (e.g. excavation of soil), reductions in contaminant mobility (e.g. replacement of contaminated stormwater outfalls) and risk management to eliminate risk pathways (e.g. prohibitions on groundwater use).

Prior to development of the corrective measures outlined below, a number of potential corrective measures were screened. The screening evaluation is presented in Appendix B. Corrective measures that were retained through the screening process and that are proposed for the BFC include:

- Soil Corrective Measures
  - excavation and disposal of soils;
  - emplacement of barriers to reduce human contact and infiltration (e.g. engineered caps, buildings, concrete, or asphalt pavement); and
  - raising grades across most of the transfer property.
- Groundwater Corrective Measures
  - continued groundwater monitoring and reporting;
  - groundwater extraction and treatment for containment of contamination;
  - construction of low-permeability barrier walls;
  - removal and replacement of existing subsurface leaking water mains;
  - abandonment and plugging of storm and sanitary sewers that currently may be acting as conduits for contaminant migration; and
  - installation of new utilities along routes to avoid known contamination to the greatest extent possible.
- Surface Water Corrective Measures
  - removal and plugging of regulated outfalls;
  - placement of fill between the embankments near Outfall 001 and Outfall 002;
  - installation of a new stormwater system including detention basins, pre-discharge stormwater treatment (for demolition phase), and four new discharge outfalls;
  - re-grading of the transfer property with up to 10 feet of additional fill above current grades;
  - periodic collection of surface water, sediment and fish tissue samples and analysis for PCBs, as required through 2013 under the current MHWMF Part 1 Permit and for

additional sampling events, as recommended in the approved Indian Creek/Blue River Fate and Transport Study Final Report; and
  - maintenance of warning signs at stormwater outfalls.
- Institutional Controls Memorialized in a MoECA compliant Environmental Covenant
  - access restrictions and soil contingency plans;
  - continuation of deed restrictions preventing use of groundwater; and
  - requirements for vapor mitigation measures to be installed in all new buildings.

The proposed measures assume that all buildings on the transfer property, except Building 98, which houses the Industrial Waste Pretreatment and GWTF, will be demolished, that most of the utilities will be demolished/abandoned, and the surface will be regraded. In addition, the electrical sub-station located in the southwest corner of the BFC will be retained.

Demolition plans and costs, including aspects related to contaminated building materials are being addressed separately and are not included in this Corrective Measures Report.

Upon preliminary approval by MDNR (in coordination with EPA) of the measures described herein, a department-initiated MHWMF Part I permit modification will be developed pursuant to 10 CSR 25-7.270(1) incorporating 40 CFR 270.41 to facilitate public review and comment on the proposed measures. Upon successful completion of this department-initiated modification and later approval of a Class 1 permit modification with prior Director's approval to transfer the property/permit to the new owner, the modified MHWMF Part I Permit will memorialize the updated requirements for the BFC regarding ownership/operation, SWMU status, revised corrective measures, financial assurance and long-term operation, inspection, maintenance and monitoring.

5.1 Soil Excavation

Soil areas are targeted for excavation based on both historical data collected by the current permittees (1984 to 2015) and due diligence data collected by CenterPoint in 2015-2016. The same data sets were used by ToxStrategies, Inc. in developing the proposed SSCLs. A number of assumptions were made in defining the soil excavation areas:

- Exceedances of proposed SSCLs are based upon the outdoor worker risk pathway (for soils from 0 to 2 feet bgs), and construction worker and utility worker risk scenarios (for soils from 2 to 12 feet bgs);
- The SSCL for PCBs for construction worker risk scenario was determined to be 75 mg/kg (Table 6). However, soils exceeding the Toxic Substances Control Act (TSCA) regulatory level of 50 mg/kg are also targeted for excavation;
- Shallow soils on the eastern part of the property to be transferred (at a depth of 2 feet or less) contain exceedances of polyaromatic hydrocarbons such as benzo[a]pyrene that are likely associated with paving materials; these locations are not targeted for remediation unless other COCs are also present above cleanup goals;

- Some metals (e.g. arsenic and manganese) are known to exceed risk-based screening levels at the BFC, solely on the basis of natural background values (see Section 4.1.1 and Appendix A). These isolated occurrences are not targeted for remediation, as they are not associated with identifiable historical activities. Post-demolition re-grading of the transfer property, site-specific institutional controls and risk management measures, such as soil management plans for soil excavation, will address these issues.
- The analytical parameter TPH has historically represented differing fractions of petroleum compounds, depending upon specific laboratories and methods applied. The current MDNR-recommended TPH methods are based upon GC/MS techniques (USEPA method 8260 and 8270) that identify individual compounds with known toxicity values. Consequently, unless otherwise noted, exceedances of TPH screening levels are not targeted for excavation, unless specific compounds exceed their individual cleanup goals.

5.1.1 Risk-Based Soil Excavation

To minimize human health risk, selected soils in exceedance of the SSCLs are targeted for excavation to a depth of approximately 12 feet below future surface grades (approximately 794 feet MSL for most areas of excavation). The proposed soil excavation areas are shown on Figure 12. These are locations where soil borings indicate contiguous areas of elevated site-related contamination, and where historical information indicates that a significant release of these contaminants has occurred. Based on the maximum depths of the exceedances and the final surface grades, the depths of these risk-based excavations are estimated to be:

- Department 27 Area [Historic PCB releases to soil]
  - Planned Excavation Depth: 6 feet below current grade;
- Department 26 Area and Vicinity (SWMUs 9,10,11 and 31) [Historic PCB releases to soil]
  - Planned Excavation Depth: 6 to 8 feet below current grade;
- TCE Still Area (SWMU 2) [Historic releases of TCE to soil]
  - Planned Excavation Depth: 6 feet below current grade;
- Waste Transfer Spill Area (WTSA; SWMUs 3, 23, 27 and 37) [Historic releases of PCBs to soil]
  - Planned Excavation Depth: 3 feet below current grade;
- Building 15 Area [Historic location of pumps and piping connected to former underground tank farm]
  - Planned Excavation Depth: 8 feet below current grade;
- Former Western Pond (SWMU 6; borehole CP-2219 area) [Historic location for liquid waste management]

- o Planned Excavation Depth: 9 feet below current grade; [14]
- Former NEA Pools (vicinity of boreholes CP-322/CP-322R and CP-5010) [Historical location of pooled surface water]
  - o Planned Excavation Depth: 6 feet below current grade.

The excavation areas depicted on Figure 12 are based upon a combination of several approaches:

- indicator kriging, a geostatistical method for extrapolating between points of known values, was used to develop generalized areas where contiguous exceedances of SSCLs occurred, for example in the TCE Still, D26, and WTSA areas ("Areas where Proposed Cleanup Levels are Exceeded" on Figure 12).;
- prior information, such as the documented horizontal extent of PCBs under Department 27 (and new data from the due diligence sampling) was used in delineating the extent of contamination in that area;
- engineering calculations were used to determine the excavation areas necessary to safely excavate the targeted soils.

The actual lateral extent of excavations will be refined after demolition during pre-design sampling and analysis. The pre-design sampling will include closely spaced soil borings to clarify the extent of excavation, as well as to pre-characterize soils for determining waste disposal options. Details of this work and of post-excavation confirmation sampling will be delineated in a Corrective Measures Implementation (CMI) Work Plan to be submitted to MDNR for review and approval post-transfer of the property.

5.1.2 Additional Excavation Areas

Additional areas with soil requiring excavation and disposal are expected to be encountered during demolition and remediation activities. Although the TPH parameter is not being used directly as a criterion for delineation of soil excavation areas, in parts of the BFC, TPH components related to past fuel releases are still present in soil. Some of these soils exhibit odors or the presence of residual product. It is expected that this type of soil as well as additional soil exceeding SSCLs will be encountered during the removal of utilities, demolition of building slabs and foundations, and during preparation for the installation of groundwater collection trenches and subsurface barrier walls. Some percentage of the soils encountered during these activities will require excavation and off-site disposal.

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[14] Analysis of air photos indicates that the positions of the "Old Pond" SWMU 6, as registered with Jackson County (Figure 6) are offset eastward from their actual locations by about 100 feet. The location of boring CP-2219 (Figures 8, 12 and 13) is centered in the actual western pond area targeted for corrective measures (see SSP&A and Evans Consulting, 2017).

During demolition and utility excavation activities, soils will be monitored for evidence of contamination that may include the presence of staining and discoloration, presence of shiny and oily material, a noticeable solvent-like or hydrocarbon odor, or elevated levels of volatile organic compounds when screened with a portable Photoionization Detector. When observations or evidence of contamination is discovered, the following steps will be followed:

- soils of concern will be excavated and stockpiled; final disposition will be evaluated pending sampling, analysis, and receipt of laboratory results;
- if the reported concentrations in remaining in-situ soils are below SSCLs, no further action is required; or
- if the reported concentrations exceed SSCLs in remaining in-situ soils, MDNR will be notified, and the soils will be further characterized for risk-management and/or off-site disposal, if needed.

More detailed protocols will be defined in the Corrective Measures Implementation (CMI) Work Plan for excavation, to be developed post-transfer. In addition, the demolition contractors will follow OSHA requirements for HAZWOPER training for site workers. As per Section 10.3, "Hazardous and/or Environmentally Impacted Removal" of Brandenburg's Demolition Plan (Brandenburg, 2016), this work will be performed by workers and supervisors with the necessary OSHA Hazardous Waste Operations (HAZWOPER) training.

The specific areas of the transfer property where soils requiring off-site disposal are expected to be encountered in conjunction with demolition and utility removal activities include (Figure 13):

- some soils in the areas centered under Building 41, near the test cells, and the western terminus of the Abandoned Fuel Lines (SWMU 20) exhibit strong odors and visible petroleum product at shallow depths;[15]
- a substantial portion of the soil excavated during removal of utilities in the area of the Abandoned Fuel Lines (SWMU 20) will likely require off-site disposal;
- the area in and around SWMU 22 is not tied to a specific release. It is, however, associated with petroleum and chlorinated solvents at shallow depths (Figure 5).

5.2 Existing SWMUs – Long Term Risk Management

As previously discussed, 45 SWMUs have been identified at the BFC (Table 1), 42 of which are on the property to be transferred. The corrective measures proposed here are generally not limited by SWMU boundaries. Our intent is to implement corrective measures that are protective of human health and the environment, regardless of SWMU limits. Nonetheless,

[15] Elevated levels of methylcyclohexane, a component of jet fuel, are observed in analytical results in this area. While methylcyclohexane results do not exceed risk-based risk-management targets, analytical results are shown on Figure 13 as a marker for the possible presence of residual fuels in the subsurface.

SWMU boundaries are important in memorializing the extent of investigation and remediation areas. This section addresses SWMU-specific actions regarding soil contamination.

5.2.1 Moving Low Risk SWMUs to "Corrective Action Complete"

A number SWMUs at the BFC have achieved "No Further Action" designations. There are others that have not achieved that designation, but contain no soils that exceed the proposed SSCLs. The following actions will be taken to address individual SWMUs that do not require corrective measures:

- the new owner will develop an updated description of SWMU conditions, including relevant data from the 2015 due diligence investigation; and
- a letter describing these conditions will be submitted to MDNR together with a formal request that SWMU status be altered to "Corrective Action Complete without Controls".

5.2.2 Caps

During the demolition phase, SWMUs that have not been designated with the status of "No Further Action" or "Corrective Action Complete - No Controls" and have the presence of residual subsurface contamination that requires ongoing engineering controls, will be capped at or near current grade, and will be re-designated "Corrective Action Complete- Final Controls in Place." Where future building slabs and pavement overlap with active SWMU boundaries, these structures will serve as caps that reduce infiltration and potential human contact. These areas (Figure 14) will be monitored and maintained as part of the corrective measures.

Where future structures or pavement do not correspond with SWMU locations, an engineered cap will be installed. A schematic design is presented in Figure 15. This example presents a relatively impermeable multi-layered system used to drain subsurface flows to the cap periphery, and provide a visual demarcation of cap extents to warn potential future construction workers so that underlying capped soils are not disturbed unintentionally. The example soil cap design consists of:

- 1-foot (minimum) of compacted clay material, graded to drain;
- approximately 6-inches of compacted crushed stone placed on the clay layer to facilitate drainage;
- orange-colored geo-fabric placed on the crushed stone layer to act as a warning layer and as a separator fabric to prevent migration of fines from overlying general fill into the crushed stone layer; and
- the actual design of the caps will be completed at a later date.

Caps (engineered caps, buildings, concrete, asphalt pavement) will also be implemented across the extent of the enclosed barrier walls (see Section 5.4.2). The cap design calls for

extending the drainage layer 5 feet beyond the SWMU boundary or the extent of the enclosed barrier walls. Construction of the caps, will be coordinated with the placement of imported fill to be placed across the transfer property. The design, materials and plans for SWMU capping will be contained in a Corrective Measures Implementation (CMI) Work Plan to be submitted to MDNR for review and approval after transfer of the property

5.3 Institutional Controls

Currently, institutional controls at the BFC are maintained, in part, as deed restrictions filed with Jackson County. Details of the overall institutional control strategy are addressed in site-wide institutional controls plans that are periodically reviewed and updated, as per the MHWMF permit.

As part of the proposed corrective measures, a new site-wide institutional controls plan will be developed to address changes in access and security.

5.3.1 Environmental Covenant

In addition to the institutional control plan, a new environmental covenant between the site owner(s) and MDNR, and following MoECA requirements, will be developed prior to property transfer, and executed following the transfer, to memorialize the elements listed below. Details on these items can be found elsewhere in this CMR.

- Legal description of the property boundary and ownership;
- A brief description of site conditions and history, including maps of contaminated areas including SWMUs;
- Requirements to comply with the restrictions in the MHWMF Part 1 Permit;
- Activity Use Limitations
  - prohibition on residential land use, and list of allowable commercial/industrial uses [see Appendix D];
  - requirements for a soil management plan to address disturbance of potentially contaminated soils, their management if excavated, and construction worker health and safety in these areas [see Section 5.1.2];
  - requirements for future buildings to be constructed with engineered barriers to minimize vapor intrusion, unless it can be demonstrated to MDNR, with their written consent, that such a barrier is not needed for a specific building [see Section 5.5]; the efficacy of vapor mitigation measures will be confirmed via future monitoring, specification of minimum air exchange rates for any new buildings, or other methods approved by MDNR [16];

[16] Because the exact locations of new buildings, their layout, and construction is currently unknown the proposed corrective measure envisions vapor barriers on all future buildings. It is also proposed, however, that the

- language that these requirements shall be binding upon successor and/or transferee parties that own the land;
- Other requirements, including
  - a description of the physical location of the administrative record for BFC environmental response projects
  - enforcement mechanisms;
  - rights of access to regulatory agencies;
  - compliance reporting;
  - methods for amendment or termination, with the consent of MDNR and USEPA;
  - the obligations of the MDNR and other holders of interest;
  - how the covenant will be recorded and who will receive a copy; and
  - how the Missouri Hazardous Substance Site Locator database is structured.

5.4 Groundwater Control

As under current conditions, the containment and treatment of groundwater will be a substantial part of the overall proposed corrective measures. Currently, building footing tile drains and sumps provide a large part of the groundwater containment system. After demolition, these will no longer be operational. Consequently, new infrastructure for controlling groundwater will be installed prior to demolition.

In addition, leakage of water from ageing water mains, sewers, and distribution lines also impacts the current groundwater environment. Laase (2010) as well as S.S. Papadopulos & Associates (2016) independently estimated that leakage of water from utilities constituted about 70% of the site groundwater budget. Previous analyses by KCP and discussions with site personnel indicate that the leakage rates from individual lines have never been quantified and metering locations are insufficient to quantify those rates. Nonetheless, hydrogeologic analyses in the Long-Term Soil and Groundwater Plan (DOE, 2000) concluded that "the greatest source of recharge to the alluvial aquifer is leakage from the KCP fire protection and water supply lines and the 16" diameter water line located immediately south of the facility." The groundwater mound resulting from this leakage plays an important role in reducing the risk of off-site groundwater migration to Indian Creek. Plant personnel have informed CenterPoint that the water mains along the old 95th Street right-of-way have a long history of breaks and repairs. As recently as March, 2015, a water main south of the main manufacturing building ruptured, releasing water to the surface, and resulting in a precautionary water advisory to area residents.

A primary goal of the groundwater control program will be maintaining the groundwater levels and gradients as close to current conditions as possible during demolition and redevelopment so that plume migration is minimized. To accomplish this goal, a carefully phased program will be developed to install new groundwater extraction wells, extraction trenches and conveyance

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covenant language include a provision that waivers from this requirement be available if applicant can demonstrate to MDNR's satisfaction that such a barrier is not necessary in a particular building prior to construction.

piping prior to abandoning currently operating extraction wells and sumps. The new extraction wells and trenches will be pumped to maintain capture of contaminated areas during demolition, remediation and re-grading. In addition, most existing monitoring wells will be abandoned in a phased approach, some prior to demolition, and others when demolition and re-grading are completed.[17] Point of compliance wells will be maintained to the extent possible during demolition to confirm groundwater capture. The final configuration of the monitoring well network will include perimeter and point of compliance wells as required.

It is understood that groundwater conditions will change during and after demolition. Water levels will be affected by the loss of utilities that currently release significant volumes of water into the subsurface. In addition, the loss of buildings, parking lots, and other paved areas that currently control infiltration patterns will alter recharge. Consequently, models currently used to understand groundwater conditions have significant uncertainties with respect to prediction of post-demolition conditions. Therefore, after surface re-grading, and following a period of extraction system operation, monitoring, and updates to the groundwater model, the groundwater extraction and monitoring system will be further optimized to reflect the new site conditions.

In addition to these pumping-related activities, the corrective measures proposed for groundwater include:

- low-permeability barrier walls around two major source areas (Figure 16 and 17), which will reduce the mobility of high levels of contaminants outside the source areas and reduce long-term loading of contaminants to groundwater beyond the proposed transfer property; and
- a low-permeability barrier wall to cut-off migration of the northeast area plume across the Union Pacific railroad property and the GSA property, and toward the Blue River (Figure 16).

5.4.1 Groundwater Extraction and Treatment

Groundwater extraction and treatment will be implemented in two phases. The first phase will be designed to maintain hydraulic control of the groundwater plumes while facilitating demolition activities. The second phase will be designed to work with the planned redevelopment of the transfer property.

To maintain hydraulic control over the plumes of contaminated groundwater during demolition, several existing wells, new extraction wells, and two new groundwater collection trenches will be pumped at a total flow rate totaling approximately 34 gallons per minute, on average, and transmitted to the existing groundwater treatment system for treatment and discharge to the publicly owned treatment works (POTW).

An overview of the demolition-phase extraction system is illustrated on Figure 19. It shows the area of groundwater exceedances, together with the capture zones of the extraction system.

[17] A Missouri-licensed drilling contractor will properly abandon the boring following acceptable procedures as required by Missouri's Monitoring Well Construction Code (10 CSR 23 Chapter 4).

This phase of the groundwater control system will be comprised of the following extraction wells and continuous collection trenches:

- one new groundwater extraction trench southwest of Building 50, constructed to an elevation of approximately 775 feet MSL (about 25 feet below current ground surface), and approximately 650 feet long;
- one new groundwater extraction trench east of Building 50, constructed to an elevation of approximately 770 feet MSL (about 30 feet below current ground surface), and approximately 350 feet long;
- continued operation of the existing drain beneath the raceway at Outfall 001; and
- up to 10 new wells outside the demolition zone on the east and south side of the property[18].

Modifications to the existing treatment plant and equipment will be implemented as necessary to accommodate the new wells and optimize the treatment process. The modified treatment system will have a 100 gallons per minute design capacity (similar to the current treatment system), which is sufficient to handle the expected flow rates, as well as higher flows during precipitation events to maintain groundwater levels.

At the current time, extracted groundwater is treated through physical filtration, carbon adsorption for removal of organic contaminants, and water softening to improve system performance. Treated water is discharged to the POTW. There are no plans to modify this treatment train at this time.

New subsurface conveyance piping, communication lines and electrical power will be routed between the new wells, collection trenches and the treatment building. A new POTW connection will be constructed from the treatment plant location for discharge of treated groundwater to the new sanitary sewer main to be installed on the transfer property.

After demolition, soil excavation, barrier wall and engineered cap installation, property re-grading will commence. At that time, development plans for the transfer property will be further advanced and permanent extraction well locations and utility corridors for extraction piping will be established. Subsequently, the extraction wells and the conveyance piping and controls will be replaced. The total estimated flow rate is expected to be similar to be approximately 34 gallons per minute, on average.

The post-re-grading extraction system (Figure 20) will be comprised of the following extraction wells and continuous collection trenches:

- the two demolition-phase groundwater collection trenches described above, and;
- 1 new well to replace the existing drain near Outfall 001;

[18] Two wells are designated as contingent on Figure 19, representing areas where additional capture may or may not be needed, pending analysis of data from the recent Building 4 investigation and the due diligence investigation.

- up to 14 extraction wells (including a contingent well near Building 4); and
- 2 new wells within the two enclosed barrier walls.

The subsurface conveyance piping, communication lines and electrical power will be rerouted between the extraction wells, collection trenches and the treatment building. The previously installed sanitary sewer connection will continue to be used or modified as needed.

5.4.2 Barrier Walls Installation

To reduce the migration of VOCs in groundwater, two vertical, low-permeability soil-bentonite barrier walls are proposed to surround deep contaminated soils in the vicinity of the former Department 26 and TCE Still Area, and the former WTSA (Figures 16 and 17). These two walls will provide localized containment and control of high-concentration contaminated groundwater. Extraction wells will be installed within each containment wall to maintain inward hydraulic gradients and to remove mass by pumping of groundwater.

An additional soil-bentonite barrier wall is proposed for the northeast area of the transfer property (Figure 16). Unlike the other two barrier walls, this one is intended as a cut-off wall, rather than to provide enclosed containment. Combined with upgradient pumping wells, this wall will help limit further migration of dissolved contaminants beyond the proposed transfer property in the northeast area plume.

The barrier walls will be keyed into bedrock at approximately 40 to 45 feet bgs and extend to near the ground surface creating low permeability subsurface vertical barriers (Figure 17). It is anticipated that the walls will be installed using a one-pass trenching method (mixing bentonite slurry with existing soil in place). The permeability of the soil bentonite barrier walls is anticipated to be less than 1.0×10^{-6} cm/sec. Portland cement can be added to the barrier wall if additional strength is required, although this would increase the permeability of the final wall. The final wall design will be completed following pre-design geotechnical sampling and bench-scale tests. It will be presented in the Corrective Measures Implementation Plan.

5.4.3 Groundwater Monitoring

In conjunction with remedial and construction activities, the site-wide Sampling & Analysis Plan will be revised to account for monitoring wells to be abandoned and replaced, as needed. The revised monitoring program will be developed to determine compliance, evaluate remediation effectiveness, and delineate the contaminant plumes. It is currently estimated that approximately 200 existing monitoring wells on the property to be transferred will be abandoned, and replaced with a currently undetermined number of new wells (pending MDNR approval) that will adequately determine compliance, evaluate remediation effectiveness, and delineate the contaminant plumes. Half of these wells will be replaced during demolition, and the other half following re-grading. The additional costs and complications of attempting to preserve these wells during demolition and re-grading far outweighs the cost of replacing them after those activities are complete. Existing wells will continue to be sampled annually, with selected effectiveness and

perimeter wells sampled semi-annually. New monitoring wells will be sampled quarterly for the first year, and semi-annually thereafter.

5.5 Vapor Intrusion Management

In the Baseline Risk Assessment (URS, 2015), vapor intrusion risks from groundwater were developed on the basis of three large exposure areas, encompassing the western groundwater plume, central plume, and northern plume, respectively. These exposure areas ranged in size from 55 to 194 acres, and the risk for each was determined by the maximum concentrations of COCs from any well within those zones. The resulting risk characterization is highly conservative and does not take into account the fact that large portions of the property to be transferred are not underlain by any groundwater contamination, and the actual risk at any one location (Figure 11) may not be equivalent to the maximum risk for the exposure areas defined by URS.

Key factors in determining the actual vapor intrusion risk include soil and groundwater VOC concentrations, depth to groundwater, building location, and building construction. All of these factors are subject to change following redevelopment and re-grading of the site. Therefore, as a conservative, pre-emptive risk management measure, it is proposed that all future buildings be constructed with a passive vapor barrier system to eliminate the risk pathway. A schematic of possible systems is provided as Figure 18.

The requirement for vapor barriers in new buildings will be incorporated into the proposed environmental covenant for the property to be transferred. The covenant language will also include a provision that should an applicant demonstrate to MDNR's satisfaction that such a barrier is not necessary in a particular building prior to construction, the requirement can be waived upon MDNR's written approval.

5.6 Utility Removal/Plugging

CenterPoint plans to demolish buildings and remove all infrastructure and known utilities to a depth of approximately 12 feet below proposed future grades in areas west of the groundwater treatment system and to 6 feet below current grades in areas to the east (2 to 10 feet below current grades); (Figure 21). Pipelines deeper than these vertical extents will be abandoned in place. Abandoned storm or sanitary sewers that could act as preferential pathway for contaminated groundwater will be filled with grout and segments of each will be excavated/removed and backfilled with compacted clay or flowable fill. Building sumps will be abandoned in place and the connecting drain pipe ends filled with grout; it is not practical to remove or grout the existing drains below the basement slabs.

As noted in Section 5.1.2, many of these utilities cross known areas of soil contamination in exceedance of proposed cleanup levels or with petroleum product contamination, this removal will also address a significant volume of contaminated soil. Plans for excavation and removal of utilities are being developed as part of the design prepared by CenterPoint's civil engineering contractor, Olsson Associates.

5.7 Stormwater Outfalls

The corrective measures for stormwater include abandonment and plugging of the existing storm sewers and outfalls and installation of a new surface water conveyance system. This will eliminate stormwater contact with legacy contamination within the existing stormwater conveyance systems and also eliminate preferential pathways for further groundwater migration. Abandonment of these outfalls will also eliminate most PCB loading to surface water from the site.

This will include removal, re-purposing, or plugging of Outfalls 001, 002, 003, 004, and B, C and F. Unregulated Outfalls A and D[19] will remain.

5.7.1 Outfall Abandonment/Plugging

As part of the proposed corrective measure, the existing regulated outfalls 001 through 004 and unregulated Outfalls B, C and F will be abandoned in place, filled with grout, and segments will be excavated/removed and replaced with compacted clay or flowable fill to reduce the potential for preferential pathways. The existing segment of Outfall 004 beneath the floodwall, will be re-purposed as a sleeve for a new storm sewer pipe for the new Indian Creek regulated outfall. The re-engineering of this outfall will include cutting off this portion of the outfall structure upstream of the flood wall and sealing the void between the new storm sewer and existing Outfall 004 pipe sleeve with grout (Figure 21). This approach avoids the need for new construction beneath the existing BFC floodwall, and limits the risk for any future contaminant migration from the old Outfall 004 materials.

The existing raceways at Outfall 001 and 002 will be abandoned in place and filled. The corrective measures for Outfall 001 and Outfall 002 are described further below because they are interrelated with corrective measures for nearby SWMUs.

The proposed corrective measures for Outfall 001 and SWMU 8 are shown on Figure 22 and include the following:

- abandonment of the existing outfall, storm drain and raceway in place;
- plugging of the storm drain by installing a concrete bulkhead and filling the remaining storm drain with flowable fill;
- in select on-site locations along the abandoned storm drain, plugging of the pipe backfill with grout or excavating through the pipe and backfill and replacing the excavated material with a low permeability backfill plug;
- plugging the interceptor pipe below the raceway with grout;
- abandoning the gatewell and interceptor vault/pump in place;
- capping SWMU 8 with an engineered cap (e.g. clay fill);

[19] As currently planned, Outfall D will remain in place, but will no longer serve the property to be transferred; the connection between Outfall D and the southeast parking lot north of Bannister Road will be abandoned and stormwater from this portion of the proposed transfer property will be conveyed to a new outfall.

- filling the basin between the rail lines with approximately 56,000 cubic yards of clean fill to eliminate existing groundwater seeps and potential exposure to remaining contaminated soil; and
- installation of a new groundwater extraction well between the rail lines to control groundwater in this area (as part of the groundwater extraction system described in Section 5.4.3).

The proposed corrective measures for Outfall 002 are shown on Figure 23 and include the following:

- abandoning the existing outfall, box culvert, raceway, and gatewell in place;
- filling the raceway to match adjacent grades;
- plugging the box culvert with a concrete bulkhead and filling the remaining storm sewer and gatewell with flowable fill;
- in select on-site locations along the abandoned storm drain, plugging the pipe backfill with grout or excavate through the pipe and backfill and replacing the excavated material with a low permeability backfill plug;
- maintaining asphalt cap (95th Terrace roadway) at SWMU 42;
- use of the basin north of Bannister Road (SWMU 14) as a temporary, lined pond during demolition; and
- conversion of SWMU 29 and vicinity to a permanent stormwater detention pond (Figures 25 and 26).

5.7.2 Stormwater Monitoring

As noted above, the current MSOP permit include requirements for off-site monitoring of stormwater discharges (Table 5). These requirements will be continued, consistent with the current permits in effect, after property transfer until the outfalls are decommissioned. Requirements for monitoring of new surface water outfalls will be addressed in an updated MSOP.

5.8 Surface Re-Grading and New Outfalls

Prior to conducting demolition activities, temporary sediment control basins will be installed along the periphery of the property as shown on Figure 24. These basins will function to reduce run-off of sediment from the property during demolition activities and control stormwater flows. Water from the temporary basins will be treated using filtration and granular activated carbon treatment prior to discharge to the outfalls. The draft SWPPP (Lutjen, 2015) describes the proposed temporary basins and treatment system including the design capacity (2-year, 24-hour storm event).

Upon completion of demolition and remediation activities, the transfer property will be re-graded with surface elevations increasing up to 10 feet above current exterior grade across the property to be transferred (Figure 25). Materials suitable for general fill will be in compliance with the geotechnical engineer's recommendations as noted in the site geotechnical report and may consist of imported fill or on-site materials demonstrated to be "clean fill" as per §260.200(4), RSMo. General fill (soils and rock) will be imported from excavation sites determined to be previously undisturbed, or locations with no known history that could contribute to soil contamination associated with historical facility operations (see, for example, MDNR fact sheet on Using Painted Block and Brick as Clean Fill, January 31, 2003). These conditions will be verified through a Phase 1-type investigation of historical records. Coarser fill (e.g. gravel for sub-grade materials) will be imported from local quarries to be determined at the time of construction.

Should any questions arise about the quality of fill, based on observations of staining, odor, or man-made waste, some or all of the following laboratory analyses may be appropriate:

1. volatile organic compounds (VOCs) using EPA Method SW-846 8260C;
2. semi-volatile organic compounds (SVOCs) and polycyclic aromatic hydrocarbons (PAHs) using EPA Method SW-846 8270D; and
3. total petroleum hydrocarbons (TPH) using EPA Methods SW-846 8260C / SW-846 8270D.

The proposed permanent (post-demolition) stormwater detention basins (Figure 26) will be designed to meet local municipality requirements, retain runoff from the 100-year storm event, capture most of the sediment, and substantially reduce peak discharge from the new outfalls.

The proposed fill in the grading plan will also provide an additional barrier between site workers and contamination remaining, helping to eliminate risks via the outdoor worker risk pathway.

An additional impact of site re-grading will be the redirection of surface drainage to new stormwater conveyance systems and detention basins; four new and modified surface water outfalls. The proposed new outfalls are as shown on Figure 26 and include:

- Indian Creek Outfall – located in the southwest corner of the proposed transfer property near existing Outfall 003/004/F;
- Blue River Outfall – located in the southeast corner of the proposed transfer property and discharge downstream from the Bannister Road Bridge;
- Boone Creek Outfall – located in the northeast corner of the proposed transfer property and discharge to Boone Creek upstream from existing Outfall 001; and
- GSA Detention Basin Outfall – located in the detention area north of the existing GSA building and parking area. This Outfall will extend through the levee and discharge to Boone Creek downstream from the existing Outfall 001 location.

The re-grading will also minimize the potential surface water contact with contaminated soils currently at the surface or immediately beneath buildings and/or paved areas to be demolished.

5.9 Surface-Water Bodies Outside of the Property to be Transferred

As per the 95th Terrace Corrective Measures Study (URS Group, 2004), sampling requirements contained within the MHWMF Part 1 Permit address off-site stream sediment, surface water, and fish (see Section 2.7.3 and Table 5). No changes to these requirements are proposed while the existing outfalls remain operational. Future reductions in monitoring are anticipated as outfalls are abandoned and contaminant trends in these media continue downward.

5.9.1 Monitoring of Fish Tissue

The MHWMF Part 1 Permit requires monitoring the off-site impacts of PCBs in fish tissue with periodic sampling events as a means to gauge environmental improvements over time resulting from implementation of the 95th Terrace remedy. We propose following the recommendations of Anchor QEA (2016) that additional sampling of fish tissue at 5-year intervals will be required for at least 3 more events. With a new sampling round scheduled for 2017, a minimum of two additional fish tissue evaluations are planned subsequent to transfer. After the third sampling event, the continued sampling of fish tissue will be reevaluated and a request to suspend future sampling may be submitted to the agencies for review.

5.10 Summary of Proposed Corrective Measures

The proposed corrective measures for portions of the BFC to be transferred to a new property owner are summarized below. Should transfer of the BFC property occur, the detailed requirements for these will appear in a number of future documents, including a Corrective Measures Implementation Plan, updated Sampling and Analysis Plans, an Institutional Control Plan, an Environmental Covenant, and updated MSOP and MHWMF Permits. The corrective measures include:

- SWMU management
  - most SWMUs will be capped following demolition and prior to surface re-grading; this will memorialize their location, and minimize infiltration of precipitation; these SWMUs will be designated "Corrective Action Complete - Final Controls in Place";
  - SWMUs with limited or no contamination will be designated "Corrective Action Complete without Controls";
- Soil excavation
  - excavation to a depth of approximately 12 feet below future grade in areas that exceed proposed cleanup levels for the Outdoor Worker, Utility Worker and Construction Worker risk scenarios;

- o excavation of other contaminated, stained, and or odiferous soils, as needed when encountered during utility removal, building slab and foundation removal, and preparation for barrier wall installation;

- Groundwater control
  - o containment of groundwater contaminated with VOCs and PCBs via pumping of continuous collection trenches and extraction wells;
  - o treatment of extracted groundwater via physical filtration, carbon adsorption; water softening; and discharge to the sanitary sewer;
  - o continued monitoring of groundwater to confirm containment;
  - o due to changing groundwater conditions and grade, the groundwater control system will include 1) "demolition phase" and 2) "post -re-grading phase configurations;

- Control of groundwater source areas
  - o installation of low-permeability soil-bentonite barrier walls around the Department 26 / TCE Still areas and around the WTSA where high levels of VOCs serve as a continuing source to groundwater;
  - o installation of groundwater extraction wells within the proposed enclosed soil-bentonite barrier walls to control groundwater;
  - o installation of a soil-bentonite barrier wall west of the UPRR right-of-way to reduce migration of contaminated groundwater beyond the proposed transfer property and toward the Blue River;

- Vapor Intrusion Management
  - o installation of passive vapor mitigation systems in future buildings, unless MDNR approves a waiver of this requirement upon application for specific buildings;

- Elimination of sources to surface water
  - o abandonment of all regulated outfalls, and replacement with new stormwater discharge outfalls;
  - o removal of some of the existing Outfall 001 and Outfall 002 structures, filling the remaining outfall pipes with grout, and filling and re-grading the adjacent basin areas;
  - o installation of temporary stormwater detention basins, treatment, and conveyance systems for stormwater management during demolition activities; and
  - o post-demolition re-grading of the transfer property to facilitate future stormwater management. In addition re-grading with clean fill will provide an additional barrier between site workers and contamination remaining on site.

Estimated costs for these proposed corrective measures are summarized in Table 7 and Appendix C.

Section 6
Evaluation of the Proposed Corrective Measures

The proposed corrective measures were evaluated as per the EPA Guidance Document, "RCRA Corrective Action Plan" (EPA, 1994). This section provides a description of the criteria and an evaluation of the proposed corrective measures using the criteria.

6.1 Evaluation Criteria

Detailed evaluation criteria for the corrective measures are based on the EPA Guidance Document for RCRA corrective actions (USEPA 1994). The first four criteria are performance standards that must be satisfied for a remedy to be eligible for selection and the next 5 are balancing criteria used to evaluate the advantages and disadvantages of the remedies. The final two criteria are modifying criteria, "Community Acceptance", and "State Acceptance", which are typically considered after public comment is received on the statement of basis (SOB). The performance and balancing criteria are discussed below. The modifying criteria will be addressed after formal public and MDNR review of the proposed plan.

6.2 Performance Standards

The proposed corrective measures must meet these four performance standards:

1) Protection of Human Health and Environment: Corrective action remedies must be protective of human health and the environment. A remedy is protective if it adequately eliminates, reduces, or controls all current and potential risks posed through each pathway of exposure. In addition, implementation of a remedy cannot produce unacceptable short-term risks to human health and the environment. If, after remediation, hazardous substances remain at a site such that unrestricted use and unlimited exposure are not allowable, engineering controls (e.g., capping or fences); institutional controls (e.g., zoning or deed restrictions); or some combination of the two must be implemented to control exposure and thereby provide reliable protection over time.

The Proposed Corrective Measures would be protective of human health and the environment and would provide protection by:

- demolition of buildings and utilities to a depth of approximately 6 to 12 feet below future surface grade to remove materials that may be sources of potential contamination;
- excavation of soil to approximately 12 feet below future grade where contaminants released to the environment during historical facility operations are in excess of site-specific cleanup levels;
- capping contaminated soils that pose a threat via direct contact pathways;

- source containment with enclosed and linear barrier walls and corresponding extraction wells to minimize additional contaminant migration;
- utility plugging/removal to eliminate potential preferential pathways for contaminant migration;
- outfall abandonment/plugging to eliminate ongoing contaminant migration to surface water;
- containment of contaminated groundwater by extraction and treatment;
- re-grading of the property to reduce potential exposure to residual contamination;
- development of a new surface water conveyance system to eliminate stormwater contact with residual contamination within existing stormwater conveyance systems;
- sampling/analysis and assessment of contaminant concentrations in groundwater, surface water, stream sediment and fish tissue to verify compliance with the regulatory requirements;
- the MHWMF Part I Permit will continue to provide for protection of groundwater to drinking water standards and surface water to Missouri Water Quality Standards beyond the permitted facility property boundaries, and
- institutional controls to prevent contact with contaminated soils or groundwater by site workers, prohibit use of site groundwater, and eliminate risk of indoor vapor inhalation in future buildings.

2) Attain Media Cleanup Objectives: Corrective Measures will be required to attain media cleanup standards set by the implementing agency, which may be derived from a site specific risk assessment, existing state or federal regulations or other standards.

The Proposed Corrective Measures would meet media cleanup objectives by

- excavation of shallow soil to approximately 12 feet below future grade where contaminants released to the environment during historical facility operations are in excess of SSCLs, and excavation is practicable;
- source containment with enclosed and linear barrier walls to improve downgradient water quality;
- utility plugging/removal/upgrade to eliminate potential preferential pathways for contaminant migration;
- outfall abandonment/plugging to eliminate ongoing sources of contamination to surface water;
- containment, extraction and treatment of contaminated groundwater; and
- the use of passive vapor mitigation systems in new buildings to eliminate/reduce the indoor air risk pathway.

3) Control the Sources of Releases: A critical objective of any remedy must be to stop further risk to human health and the environment. Unless source control measures are taken, efforts to clean up releases may be ineffective or, at best, will essentially involve a perpetual cleanup.

The Proposed Corrective Measures would control the sources of releases by:

- demolition of buildings and utilities to a depth of approximately 6 to 12 feet below future grade to eliminate potential source material and allow access to the subsurface to implement source control measures;
- excavation of shallow soil to a depth of approximately 12 feet below future grade to remove soil with concentrations exceeding SSCLs.
- enclosing the remaining primary groundwater source areas with low permeability barrier walls to limit additional migration;
- impeding off-site groundwater flow with linear barrier walls at the Northeast Area; and
- eliminating the source to surface water by abandoning the outfalls and adding fill that meets MDNR requirements.

4) Comply with Applicable Standards for Management of Wastes: All corrective measures must comply with state or federal regulations.

The Proposed Corrective Measures would comply with applicable standards for management of wastes and would include demolition, waste characterization and management plans to ensure compliance with applicable federal and state regulations including the following examples:

- discharge collected/treated groundwater to the KCMO sanitary sewer system in accordance with applicable permits/requirements,
- discharge stormwater through permitted outfalls in accordance with MSOP requirements,
- manage/dispose of contaminated soils in accordance with applicable federal and state regulations and disposal facility requirements.

6.3 Balancing Criteria

The five balancing criteria are also used to evaluate the proposed corrective measures:

1) Long-term Reliability and Effectiveness: This criterion considers implementing remedies that provide protection of human health and the environment into the future as well as in the near term. This analysis includes consideration of the following: the effectiveness of the proposed corrective measures under similar site conditions; the degree of threat posed by any hazardous substances remaining at the site; estimates of the projected useful life of the proposed corrective measures; the operation and maintenance requirements of the remedy; the adequacy and reliability of any controls (e.g., engineering or institutional controls) used to manage the hazardous

substances remaining at the site; and the potential impacts on human health and the environment if the remedy fails, based on assumptions included in the exposure scenarios.

The Proposed Corrective Measures provide long-term reliability and effectiveness through continuation of the types of actions that have proven to be reliable/effective historically including groundwater extraction and treatment, soil capping, institutional and engineering controls, and sampling/analysis to assess contaminant concentrations and verify compliance with the regulatory requirements for groundwater, surface water, stream sediment, and fish tissue.

Additional proposed actions go beyond current actions and include installing subsurface low permeability barriers to provide more containment of VOC mass that is a source to groundwater contamination, excavating shallow soils to reduce direct contact risk pathways, more extensive soil capping, raising the surface grades, installing barriers to potential vapor intrusion in all new buildings, and constructing new surface water conveyance systems to replace the existing outfall system.

2) Reduction of Toxicity, Mobility, and Volume through Treatment: As a general goal remedies will be preferred that employ techniques, such as treatment technologies, that are capable of eliminating or substantially reducing the inherent potential for the wastes in SWMUs to cause further environmental releases or other risks to human health and the environment.

The Proposed Corrective Measures achieve reduction in toxicity, mobility, and volume of contaminants over the long-term by excavating soil, capping soils, and containment of groundwater with barrier walls and extraction and treatment. In addition, the proposed excavation/removal, plugging, and abandonment of utilities that could act as conduits for contaminant migration achieves reduction in mobility of contaminants.

3) Short-Term Effectiveness: This criterion includes the short-term impacts of the proposed corrective measures (i.e., impacts during implementation) on the neighboring community, workers, and the surrounding environment, including potential threats to human health and the environment associated with treatment, excavation, transportation and disposal of hazardous substances. The time required to achieve protectiveness is also considered.

The Proposed Corrective Measures will be effective in controlling risks during implementation through the use of temporary stormwater and groundwater extraction systems during the demolition phase of the work (final systems will be implemented in coordination with redevelopment.) Short-term effectiveness will be verified with sampling/analysis and assessment of contaminant concentrations in groundwater, measurements of water levels to confirm continued capture of contaminants, and continued sampling of surface water, stream sediment and fish tissue to verify compliance with the regulatory requirements. Noise, dust or other control measures during demolition are outside the scope of the CMR and will be addressed in the demolition plan.

4) Implementability: Considerations include the technical and administrative feasibility of the proposed corrective measures. This analysis includes consideration of the following: the administrative activities needed to implement the proposed corrective measures (e.g. permits, off-

site approvals) and the length of time these activities will take; the constructability, time for implementation, and time for beneficial results; any safety concerns associated with the remedy; the availability of adequate off-site treatment, storage capacity, disposal services, needed technical services and materials; and the availability of prospective technologies for the proposed corrective measures.

The Proposed Corrective Measures are implementable and rely on technologies that are proven and readily available. More specifically, groundwater extraction and treatment, soil excavation, soil capping, and utility excavation/plugging/abandonment are widely used technologies, have been implemented previously at the BFC, and can be readily designed and implemented. The groundwater collection trenches and barrier walls are also widely used technologies and a one-pass trenching contractor has been identified, reviewed the site conditions, and provided an estimated cost and schedule for implementing the work. Groundwater monitoring is performed routinely, and a monitoring well network already exists at the site. A monitoring well replacement phasing work plan will be developed to ensure ongoing routine groundwater monitoring during the proposed facility demolition.

5) Cost: Costs encompass all construction and all operation maintenance and monitoring costs incurred over the life of a project. The cost of a remedy may be an appropriate consideration where several different remedial alternatives offer equivalent protection. Often the Net Present Value is used to compare the cost of alternatives. In this Corrective Measures Report alternatives are not proposed, and the Net Present Value is not calculated. It should be noted that the general accuracy of this level of estimates are assumed to be within the range of +50% to -30% of the costs presented, a per USEPA guidance.

The Proposed Corrective Measures have an estimated capital cost of $98.2 million, and Operations, Maintenance and Monitoring costs averaging $1.5 million per year in years 1 to 30 for the proposed corrective measures. These costs include civil engineering components and some demolition components related to the corrective measures. However, facility demolition costs (including aspects related to contaminated building materials) are excluded from this estimate and are being addressed separately. The estimated costs for the proposed corrective measures are presented in Table 7, and detailed in Appendix C. In accordance with EPA guidance for Remedial Investigation/Feasibility Studies (EPA, 1988), Table 7 presents the costs within the +50% to -30% range of accuracy for the proposed corrective measures.

Section 7
References

Anchor QEA LLC. 2016. Indian Creek/Blue River Fate and Transport Study - Final Report: Prepared for U.S. Department of Energy. March.

ANTECH Corporation. 2016a. Radiological Assessment of Former Radiologic Areas at the DOE Kansas City Plant - Honeywell Federal Manufacturing & Technologies, LLC, Kansas City, MO 64147. March 29.

ANTECH Corporation. 2016b. Supplement to Radiological Assessment of Former Radiologic Areas at the DOE Kansas City Plant: Prepared for Honeywell Federal Manufacturing & Technologies LLC. September 26.

ANTECH Corporation. 2016c. Supplement II to Radiological Assessment of Former Radiologic Areas at the DOE Kansas City Plant Grassy Area Remediation - Version 2 - Honeywell Federal Manufacturing & Technologies LLC. December 22.

ANTECH Corporation. 2017. Final Report - Conversion of Existing Radiologic Data to Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIUM) Format: Prepared for Bannister Federal Complex, Kansas City, Missouri. February 28.

Auxier and Associates, Inc. 2016. Survey Report for Stage 3 Building Materials, Bannister Federal Complex, Kansas City MO. November.

Brandenburg Industrial Service Company. 2016. Bannister Federal Complex Demolition Plan - Revision 2. January.

Dickerson KS, Davidson JR, Korte NE. 1995. Updated background concentrations of selected elements in unconsolidated surficial materials at the U.S. Department of Energy Kansas City Facility. Prepared by Oak Ridge National Laboratory. May.

Fleischhauer, H.L. 1988. Background Concentrations of Selected Elements in Unconsolidated Surficial Materials at the U.S. Department of Energy Kansas City Facility. U.S. Department of Energy. February.

Laase, A. D., 2010. Construction, Calibration and Predictions of a Groundwater Flow and Transport Model for the United States Department of Energy Kansas City Plant, U.S. Department of Energy, Kansas City Plant, Kansas City, Missouri. Prepared by A. D. Laase Hydrologic Consulting.

Missouri Department of Natural Resources (MDNR). 2012a. Missouri Hazardous Waste Management Facility Permit Part 1. Permit Number: M09890010524.

Missouri Department of Natural Resources (MDNR). 2012b. Missouri State Operating Permit MO-0004863

National Nuclear Security Administration (NNSA). 2014. Bannister Federal Complex: Groundwater Corrective Action Report for Calendar Year 2013. March.

National Nuclear Security Administration (NNSA). 2015. Bannister Federal Complex: Groundwater Corrective Action Report for Calendar Year 2014. March.

National Institute for Occupational Safety and Health (NIOSH). 2011. Health Hazard Evaluation (Appendix H to 2013 BFC Community Involvement Plan), James Couch and Elena Page.

Oak Ridge Associated Universities Team. 2006 (ORAUT). Site Profile for the Kansas City Plant, NIOSH: 46.

Oak Ridge Associated Universities Team (ORAUT). 2014. Evaluation Report Summary; SEC-00210, Kansas City Plant. Kansas City, NIOSH: 70.

Oak Ridge Institute for Science and Education (ORISE). 2016. Authorized Limits for Soil at the Bannister Federal Complex at the Kansas City Plant in Kansas City, Missouri. Report No. DCN 5286-TR-01-2. April.

S.S. Papadopulos & Associates 2016a. Due Diligence Site Investigation, PCB Migration in Groundwater, Bannister Federal Complex, Kansas City, MO. April.

S.S. Papadopulos & Associates 2016b. Technical Memorandum: Groundwater Modeling at Bannister Federal Complex – Modeling Approach and Results. April 28.

S.S. Papadopulos & Associates, 2017. Due Diligence Site Investigation, Stage III Supplemental Investigation Report, Bannister Federal Complex, Kansas City, MO, March.

S.S. Papadopulos & Associates, Auxier and Associates, and Evans Consulting, 2015. Due Diligence Site Investigation Work Plan, Stage III – Radiological Sampling, Bannister Federal Complex, Kansas City, MO. August.

S.S. Papadopulos & Associates, Auxier and Associates, and Evans Consulting, 2017. Due Diligence Site Investigation, Stage III Data Report – Radiological Parameters for Soil and Groundwater, Bannister Federal Complex, Kansas City, MO, March.

S.S. Papadopulos & Associates and Evans Consulting, 2015a. Due Diligence Site Investigation Work Plan, Stage I – Soils, Bannister Federal Complex, Kansas City, MO. March.

S.S. Papadopulos & Associates and Evans Consulting, 2015b. Due Diligence Site Investigation Work Plan, Stage II – Soils, Bannister Federal Complex, Kansas City, MO. April (revised map, May).

S.S. Papadopulos & Associates and Evans Consulting, 2015c. Due Diligence Site Investigation Work Plan, Stage IV, Bannister Federal Complex, Kansas City, MO. October.

S.S. Papadopulos & Associates and Evans Consulting, 2015d. Due Diligence Site Investigation Work Plan, Outfall 001 / SWMU 8 Sampling, Bannister Federal Complex, Kansas City, MO. November.

S.S. Papadopulos & Associates and Evans Consulting, 2015e. Due Diligence Site Investigation Work Plan, Tower Property, Bannister Federal Complex, Kansas City, MO. November.

S.S. Papadopulos & Associates and Evans Consulting, 2015f. Due Diligence Site Investigation, Stage I Data Report, Bannister Federal Complex, Kansas City, MO. July.

S.S. Papadopulos & Associates and Evans Consulting, 2015g. Due Diligence Site Investigation, Stage II - Soils Data Report, Bannister Federal Complex, Kansas City, MO. September.

S.S. Papadopulos & Associates and Evans Consulting, 2015h. Due Diligence Site Investigation, Stage II - Groundwater Data Report, Bannister Federal Complex, Kansas City, MO. November.

S.S. Papadopulos & Associates and Evans Consulting, 2015i. Due Diligence Site Investigation, Stage II – Soil Vapor Data Report, Bannister Federal Complex, Kansas City, MO. November.

S.S. Papadopulos & Associates and Evans Consulting, 2015j. Due Diligence Site Investigation, Tower Site and Outfall 001 Areas Data Report, Bannister Federal Complex, Kansas City, MO. January.

S.S. Papadopulos & Associates and Evans Consulting, 2016. Due Diligence Site Investigation, Stage III and IV Data Report (non-Radiological Parameters), Bannister Federal Complex, Kansas City, MO. January.

S.S. Papadopulos & Associates and Evans Consulting, 2017. Due Diligence Site Investigation, Summary Report, Bannister Federal Complex, Kansas City, MO. April.

Tidball, R. 1984. Geochemical Survey of Missouri- Geography of Soil Geochemistry and Classification by Factor Analysis of Missouri Agricultural Soils. Geological Survey Professional Paper 954-H,I.

ToxStrategies, 2017. Technical Memorandum: Proposed Cleanup Levels for On-Site Areas of the Bannister Federal Complex, March.

URS Group Inc. 2004. Corrective Measures Study for the 95th Terrace Site National Nuclear Security Administration. Kansas City Plant. July 26.

URS Corporation. 2015. Final - Baseline Risk Assessment Bannister Federal Complex: Prepared for Honeywell Federal Manufacturing and Technologies, LLC. December.

U.S. Department of Energy. 1990. Summary and Analysis of Historical PCB Data for the Kansas City Plant, Revision 2. November.

U.S. Department of Energy (DOE) Albuquerque Operations Office. 1993. Northeast Area/001 Outfall RCRA Facility Investigation Report. Environmental Restoration Program - Kansas City Plant Draft. September.

United States Department of Energy (DOE). 2000. Kansas City Plant - Long Term Soil and Groundwater Plan Report No. KCPERA-278. April.

U.S. Department of Energy (DOE) and General Services Administration (GSA). 2013. Phase I RCRA Facility Investigation Report for Building 50, Solid Waste Management Unit 44 Bannister Federal Complex. December.

U.S. Department of Energy (DOE) and General Services Administration (GSA). 2013. Draft - Phase I RCRA Facility Investigation Report for Building 50 Solid Waste Management Unit 44 Bannister Federal Complex - Kansas City Missouri. December.

U.S. Department of Energy (DOE) and General Services Administration (GSA). 2016. Description of Current Conditions Report for the Bannister Federal Complex. July.

U.S. Department of Energy (DOE) and General Services Administration (GSA). Revised Section 7 - Presence of Uranium and Beryllium at the BFC and Current and Potential Future Impacts on the Environment. Description of Current Conditions for the Bannister Federal Complex.

U.S. Environmental Protection Agency (USEPA). 1994. RCRA Corrective Action Plan (Final), May, Office of Waste Programs Enforcement, Office of Solid Waste.

U.S. Environmental Protection Agency (USEPA). 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies, Interim Final, EPA/540/G-89/004.

U.S. Environmental Protection Agency (USEPA). 1998. Final Decision, Response to Comments, U.S. Department of Energy Kansas City Plant, Multiple Sites, Kansas City, Missouri. July 15.

U.S. Environmental Protection Agency (USEPA). 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, July, EPA 540\R-00-002.

U.S. Environmental Protection Agency (USEPA). 2011. Evaluation Report - Vapor Intrusion Health Risks at Bannister Federal Complex Not a Concern for Buildings 50 and 52, Unknown for Other Buildings. 11-P-0048. January 5.

FIGURES

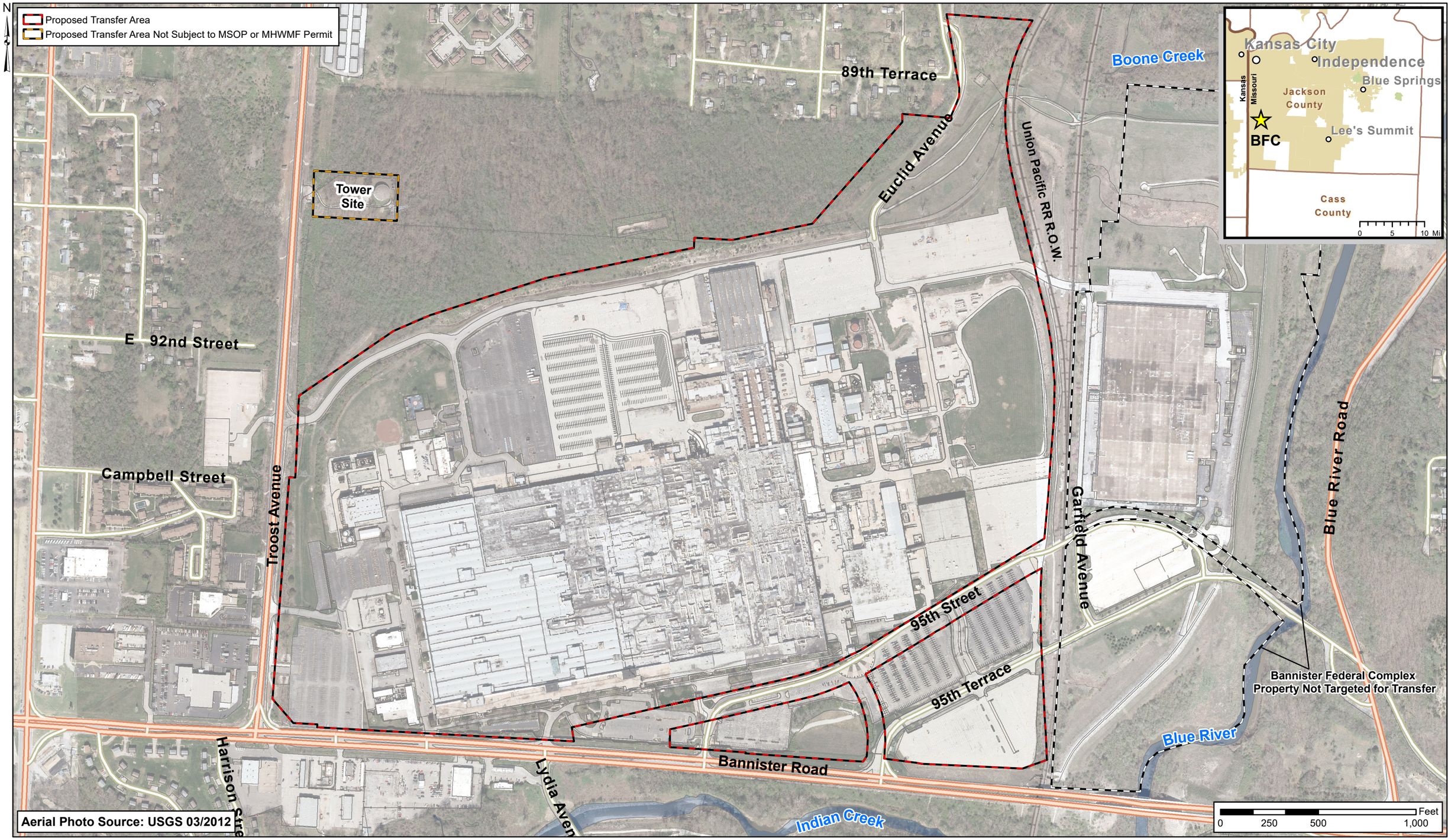

Figure 1 Location Map of the Bannister Federal Complex

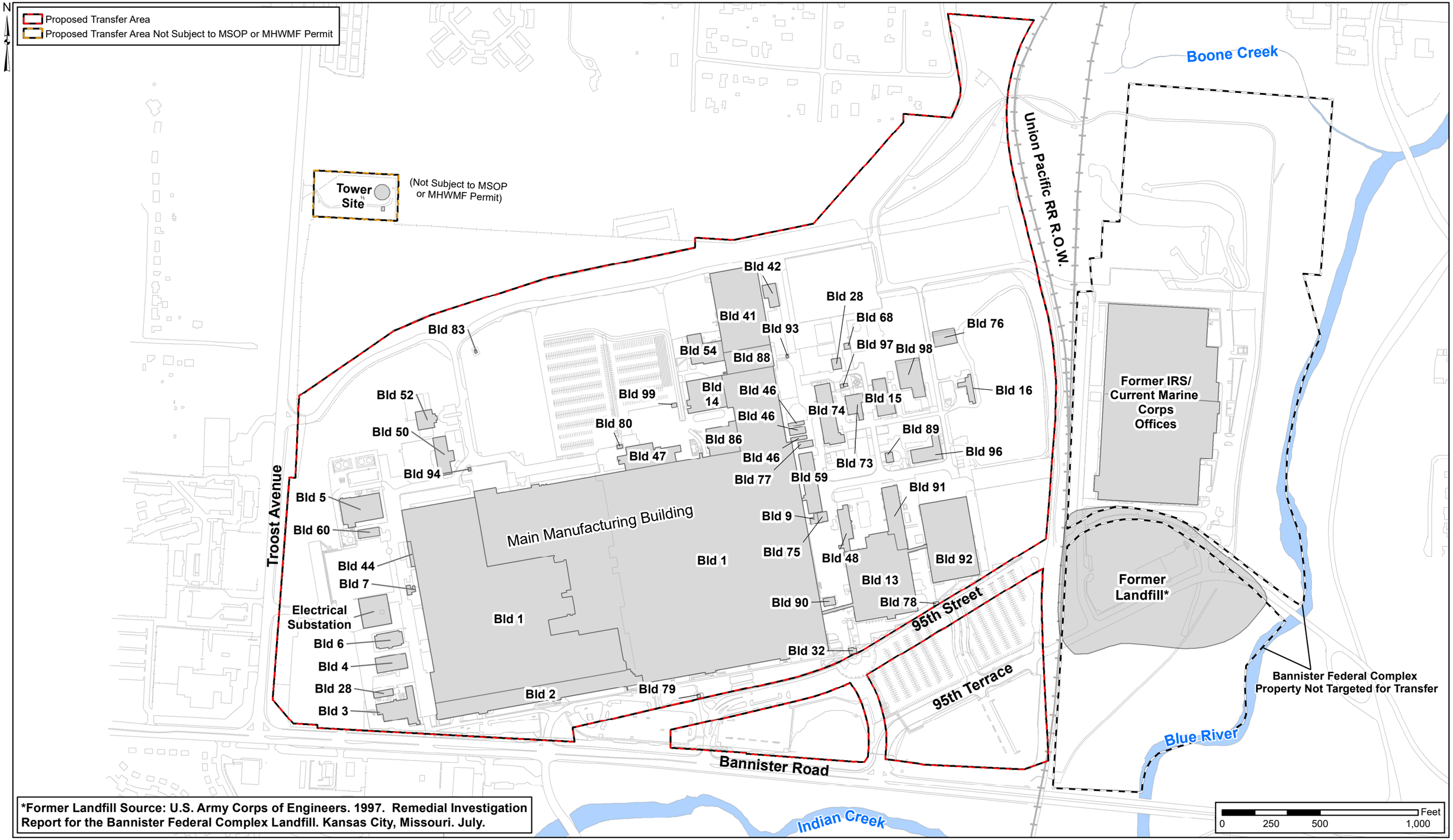

Figure 2 Proposed Transfer Area and Existing Buildings of the Bannister Federal Complex

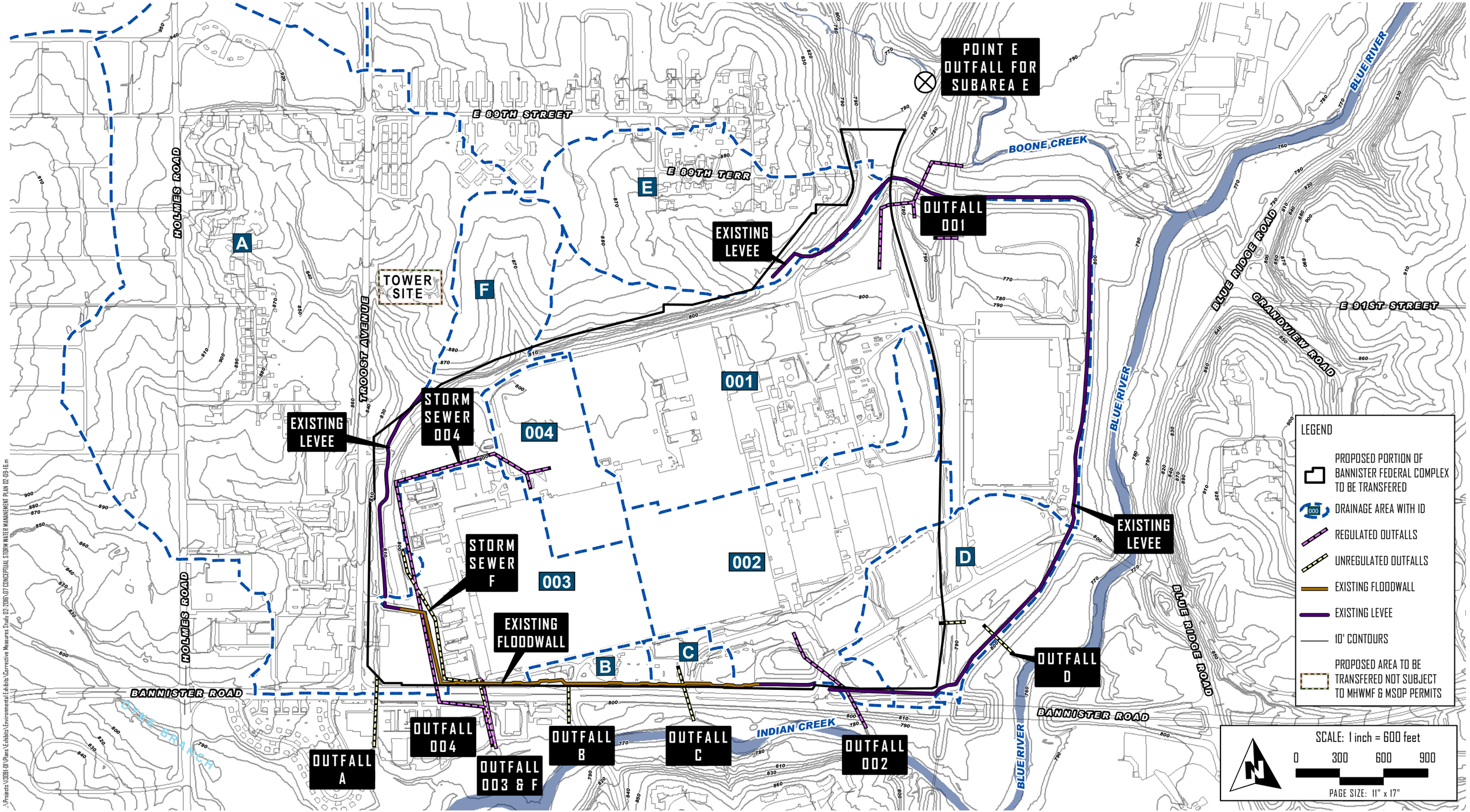

FIGURE 03 - CURRENT SITE DRAINAGE AREAS AND DISCHARGE LOCATIONS// DATE 2016-11-29

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BANNISTER FEDERAL COMPLEX
KANSAS CITY, JACKSON COUNTY, MISSOURI

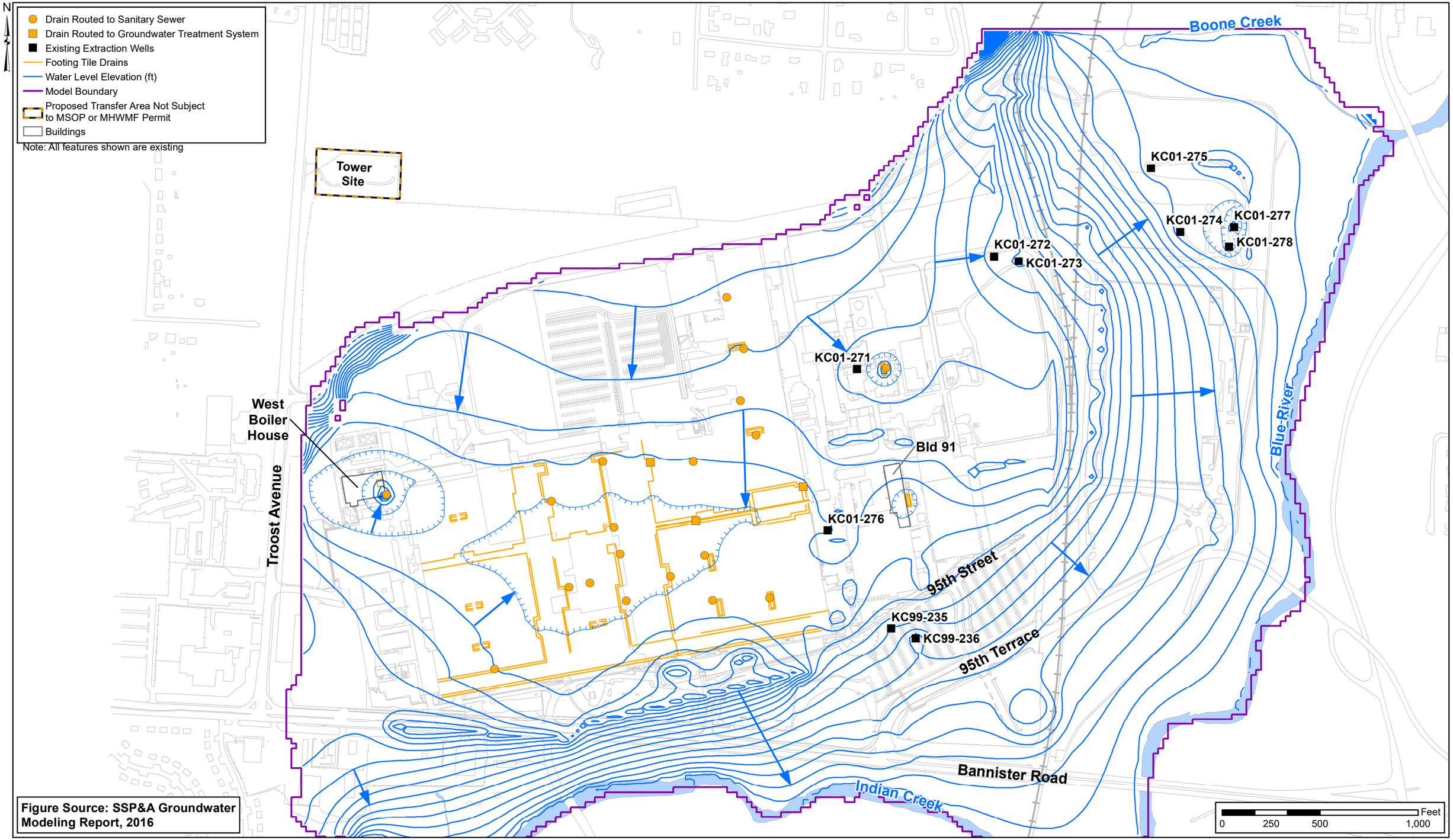
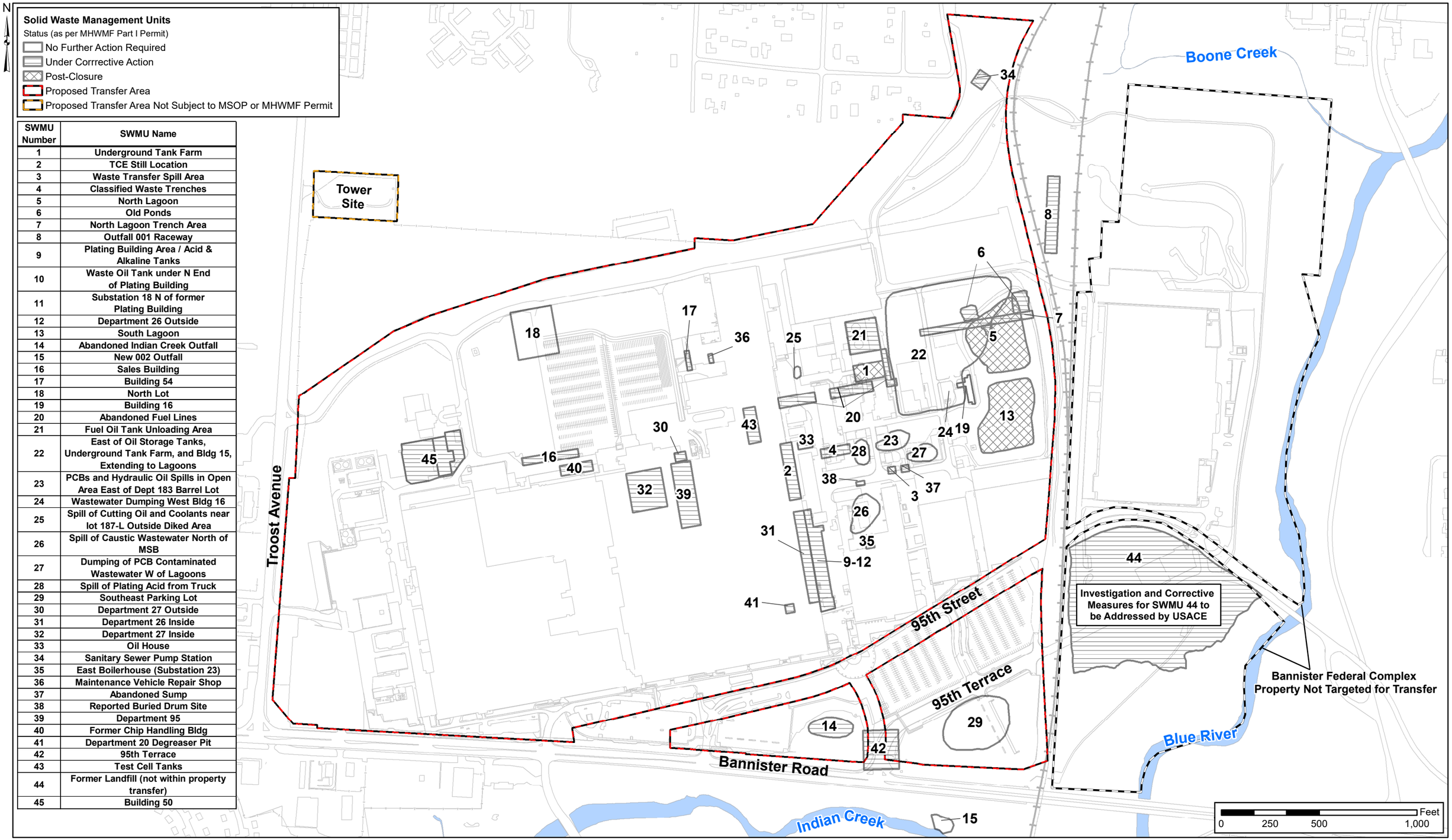


Figure 4 Conceptual Model of Groundwater Flow (Average Conditions, 2002-2012)



SWMU Number	SWMU Name
1	Underground Tank Farm
2	TCE Still Location
3	Waste Transfer Spill Area
4	Classified Waste Trenches
5	North Lagoon
6	Old Ponds
7	North Lagoon Trench Area
8	Outfall 001 Raceway
9	Plating Building Area / Acid & Alkaline Tanks
10	Waste Oil Tank under N End of Plating Building
11	Substation 18 N of former Plating Building
12	Department 26 Outside
13	South Lagoon
14	Abandoned Indian Creek Outfall
15	New 002 Outfall
16	Sales Building
17	Building 54
18	North Lot
19	Building 16
20	Abandoned Fuel Lines
21	Fuel Oil Tank Unloading Area
22	East of Oil Storage Tanks, Underground Tank Farm, and Bldg 15, Extending to Lagoons
23	PCBs and Hydraulic Oil Spills in Open Area East of Dept 183 Barrel Lot
24	Wastewater Dumping West Bldg 16
25	Spill of Cutting Oil and Coolants near lot 187-L Outside Diked Area
26	Spill of Caustic Wastewater North of MSB
27	Dumping of PCB Contaminated Wastewater W of Lagoons
28	Spill of Plating Acid from Truck
29	Southeast Parking Lot
30	Department 27 Outside
31	Department 26 Inside
32	Department 27 Inside
33	Oil House
34	Sanitary Sewer Pump Station
35	East Boilerhouse (Substation 23)
36	Maintenance Vehicle Repair Shop
37	Abandoned Sump
38	Reported Buried Drum Site
39	Department 95
40	Former Chip Handling Bldg
41	Department 20 Degreaser Pit
42	95th Terrace
43	Test Cell Tanks
44	Former Landfill (not within property transfer)
45	Building 50

Figure 5 Solid Waste Management Units (SWMUs) at the Bannister Federal Complex

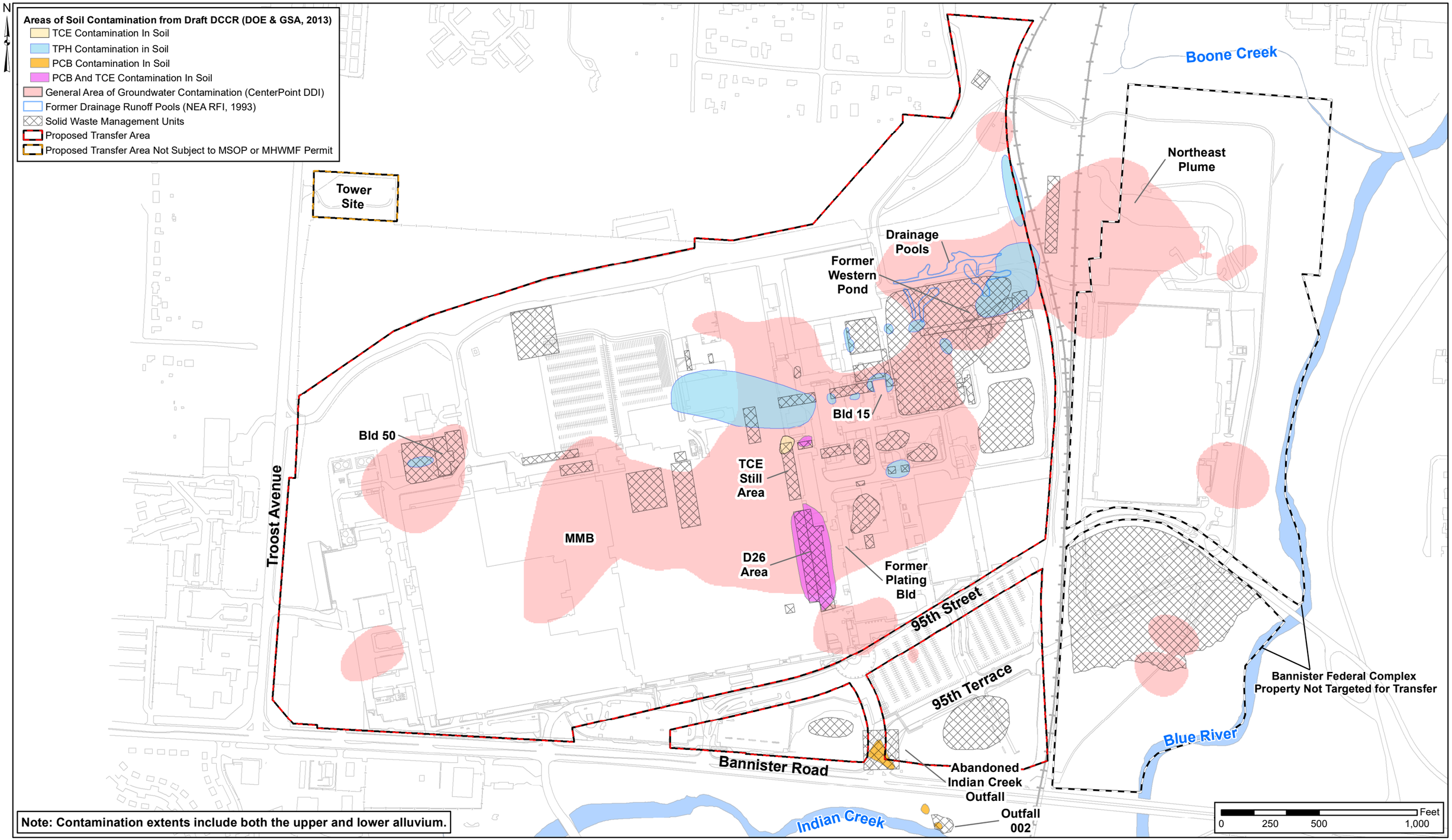


Figure 6 Generalized Extent of Soil and Groundwater Contamination

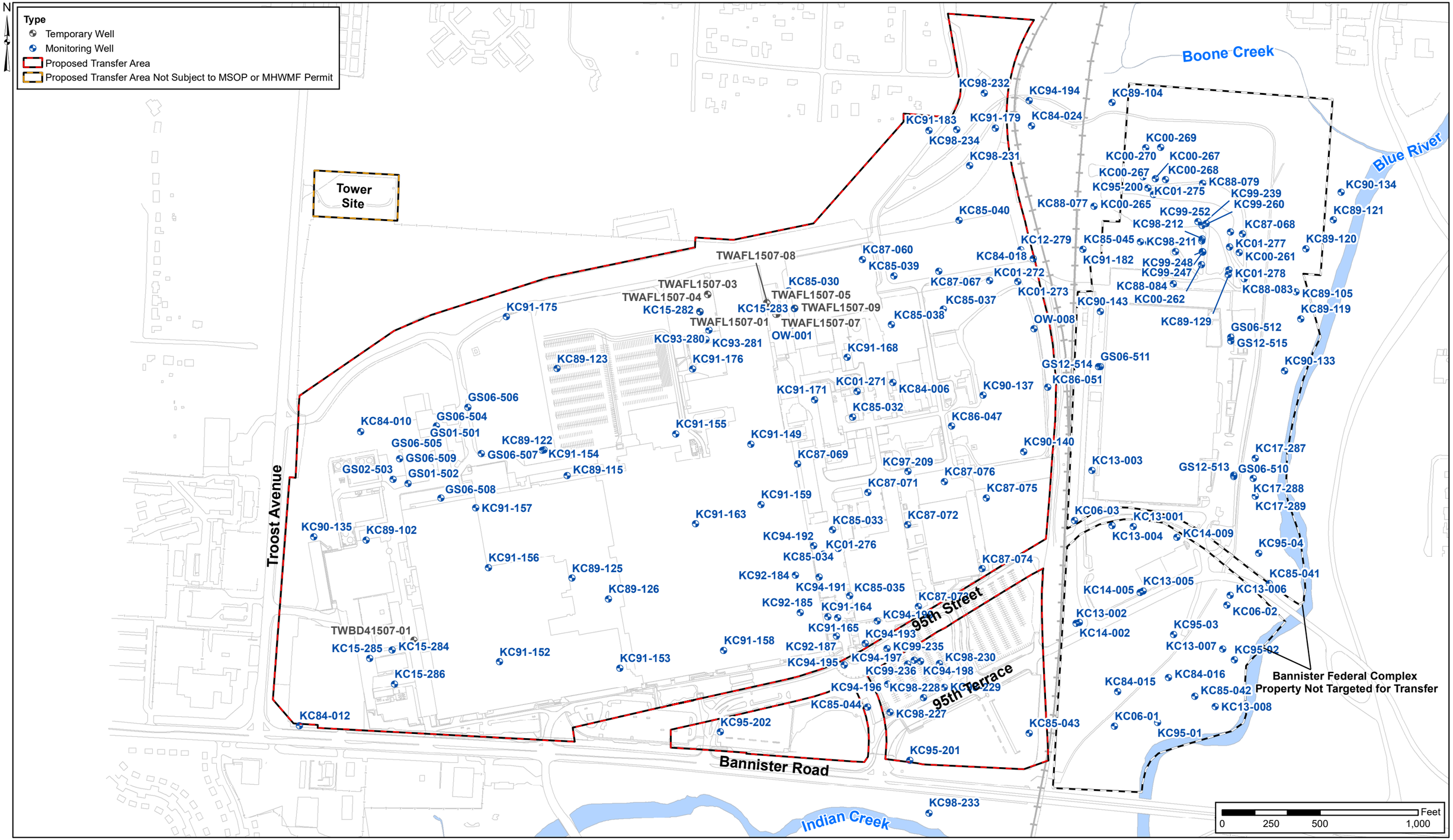


Figure 7 Existing MHWMF Groundwater Monitoring Well Network at the Bannister Federal Complex

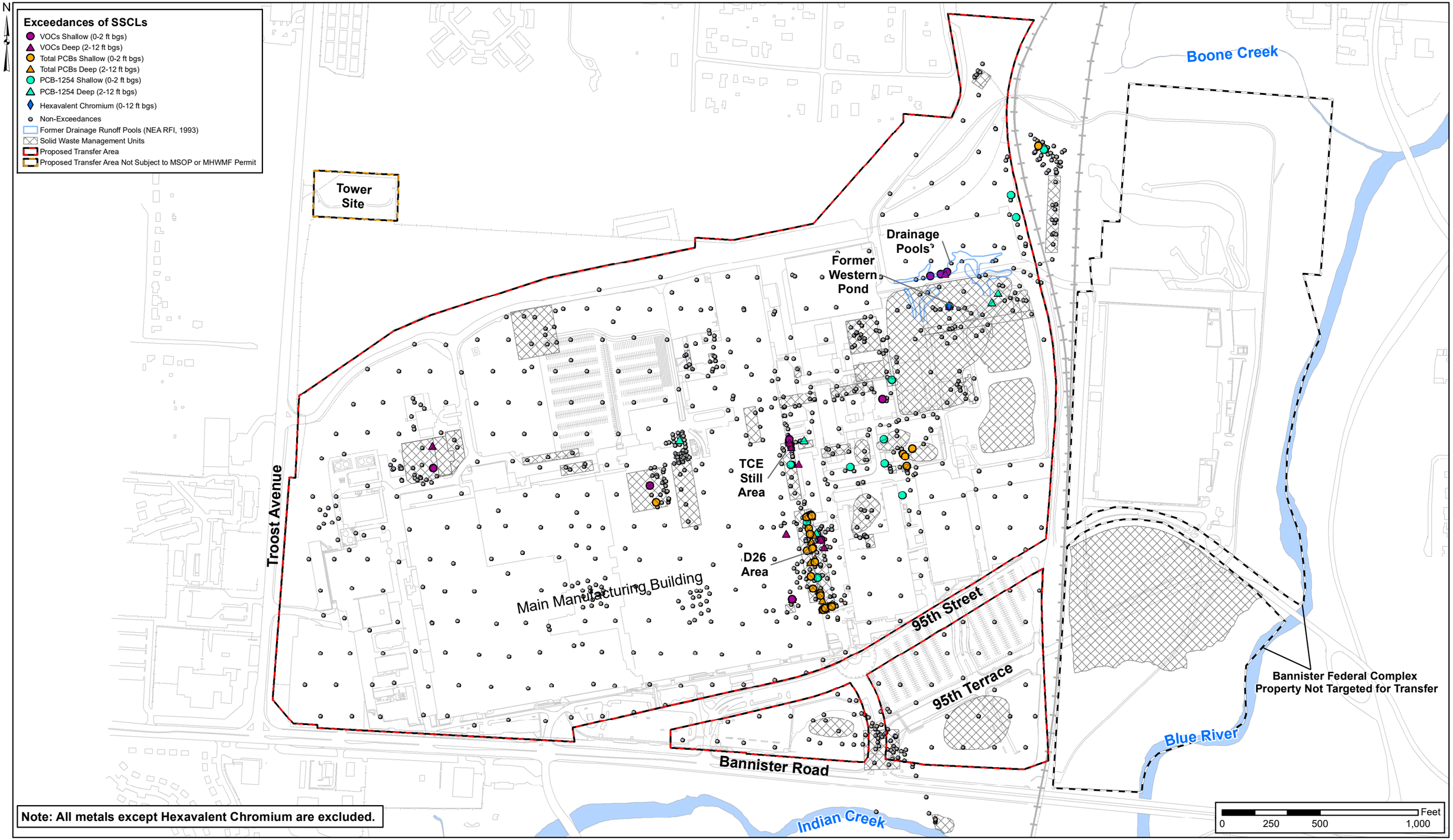


Figure 8 Exceedances of Proposed Site-Specific Cleanup Levels in Soil, 0-12 feet below Current Site Grade

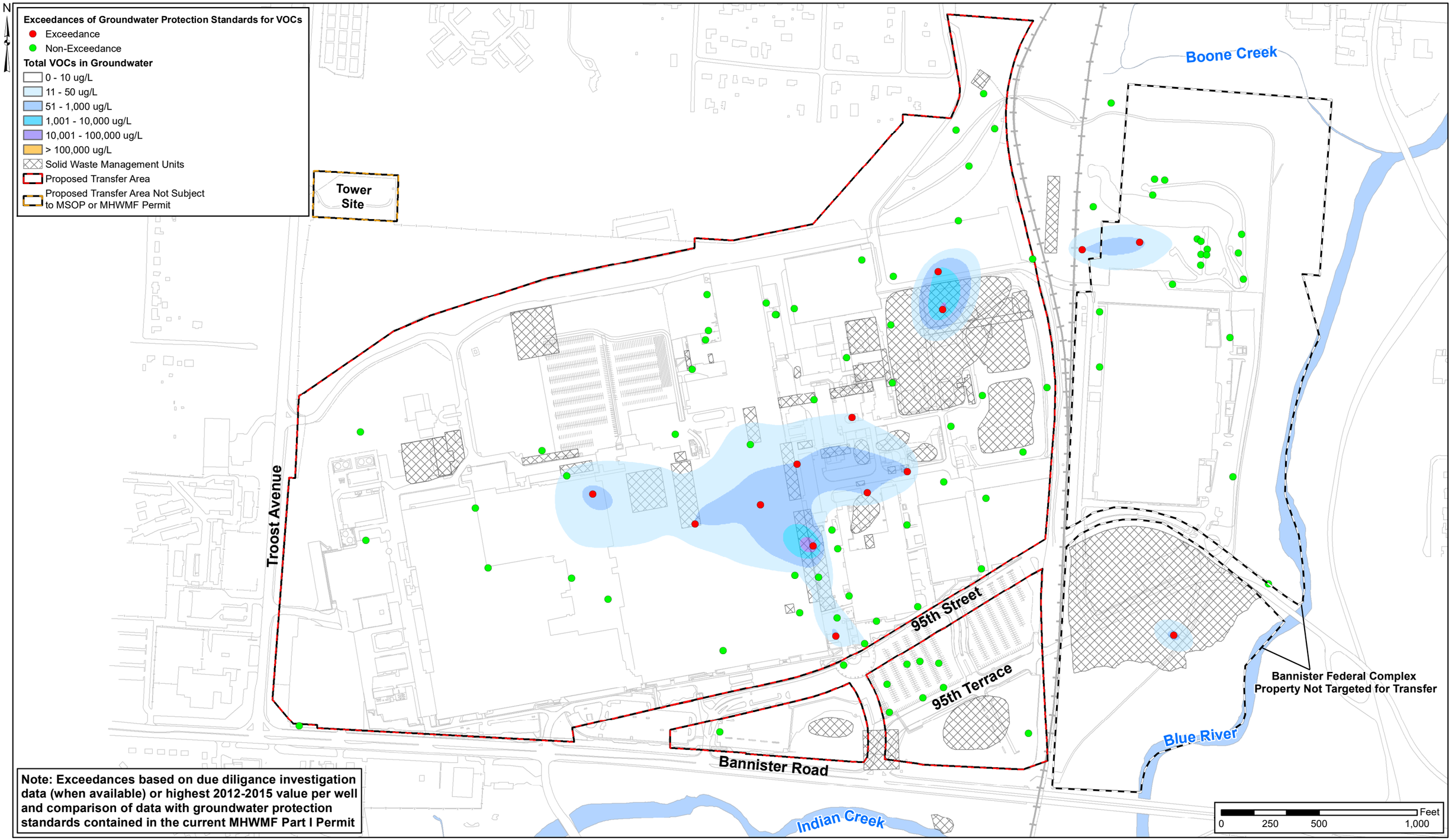


Figure 9 Exceedances of Groundwater Protection Standards for VOCs, and General Areas of Total VOC Contamination, Upper Interval

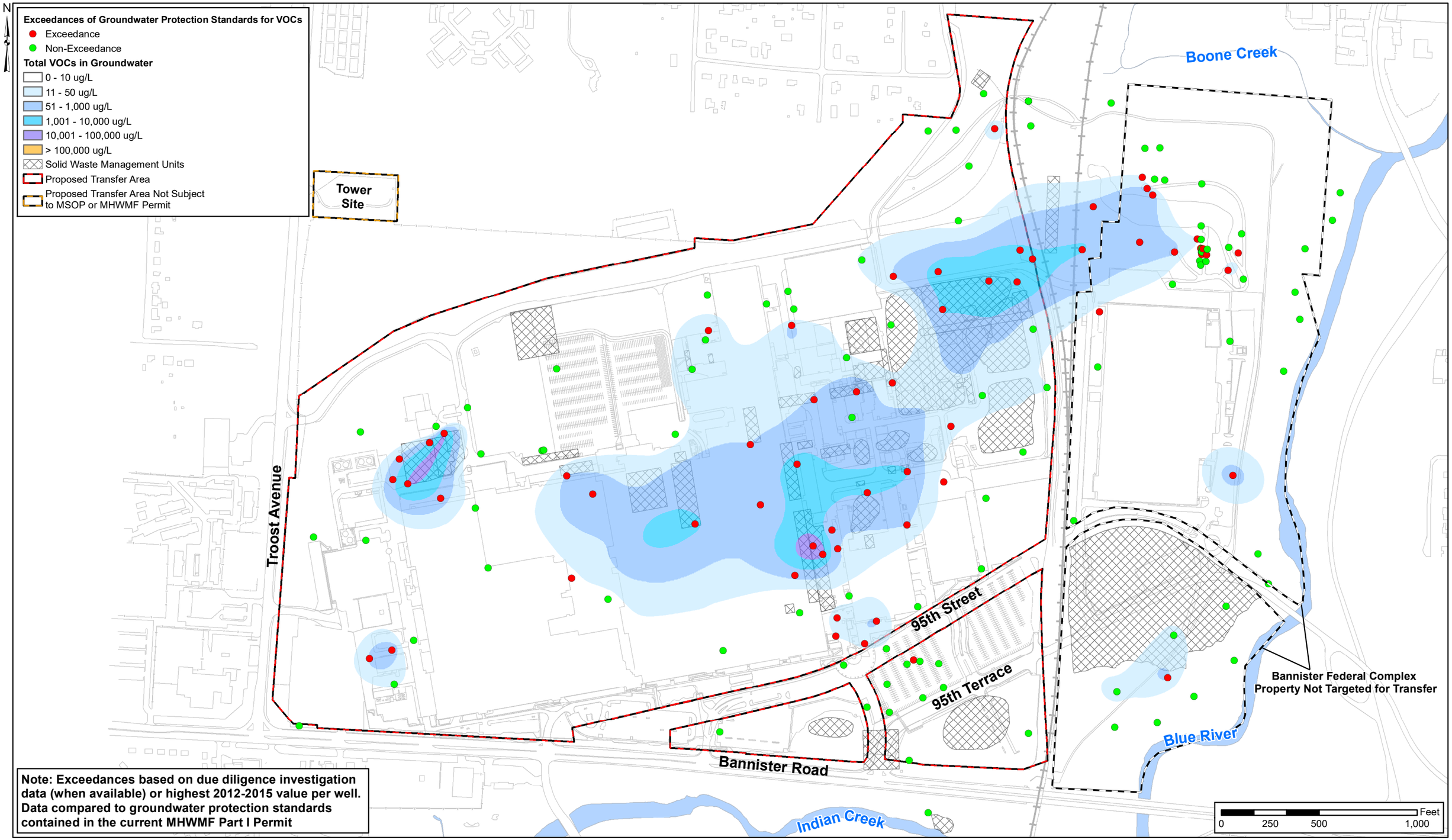


Figure 10 Exceedances of Groundwater Protection Standards for VOCs, and General Areas of Total VOC Contamination, Lower Interval

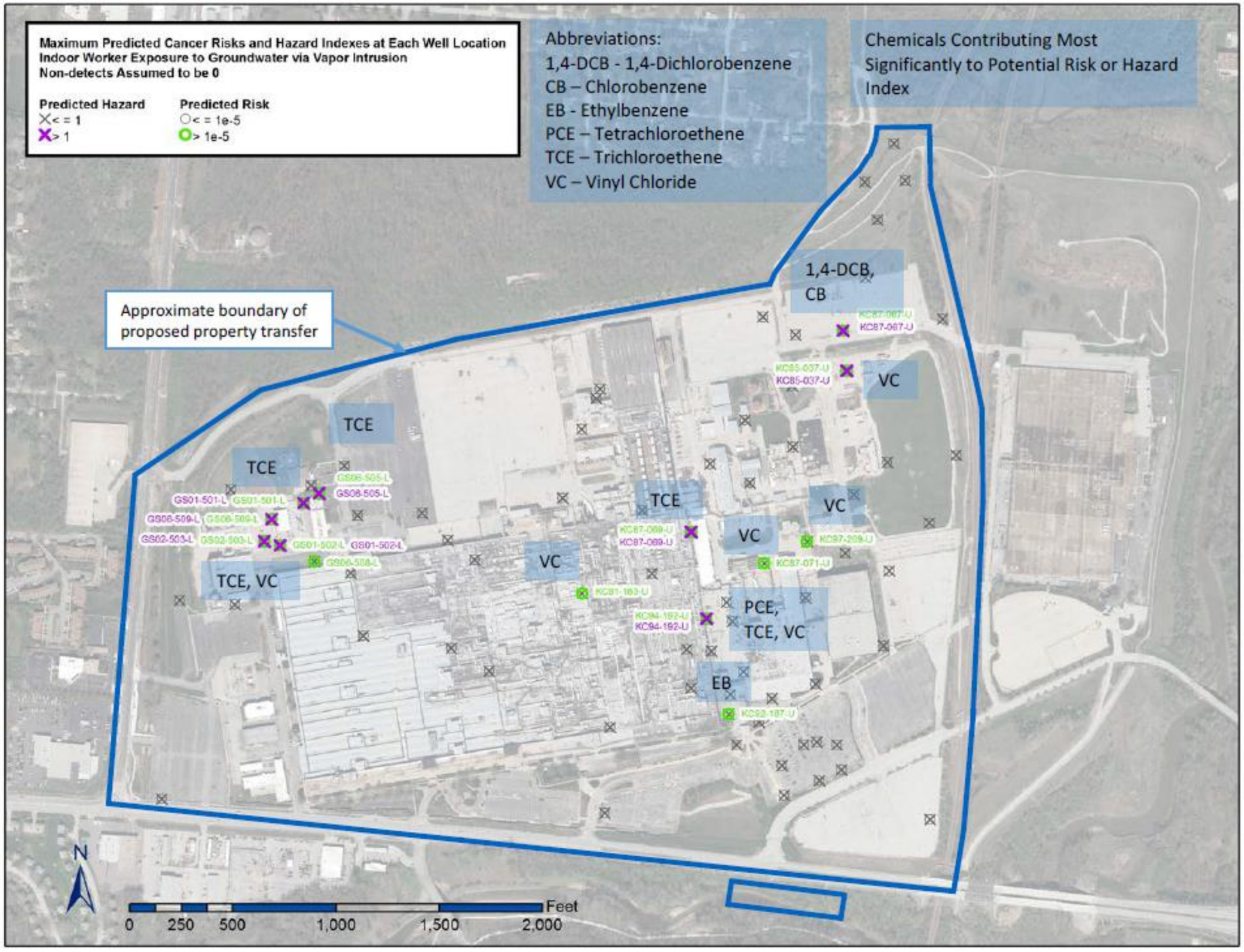


Figure 11 Exceedances of Proposed Site-Specific Vapor Intrusion Risk and Hazard Levels, based on 2012-2014 Groundwater Data (from ToxStrategies, 2017)

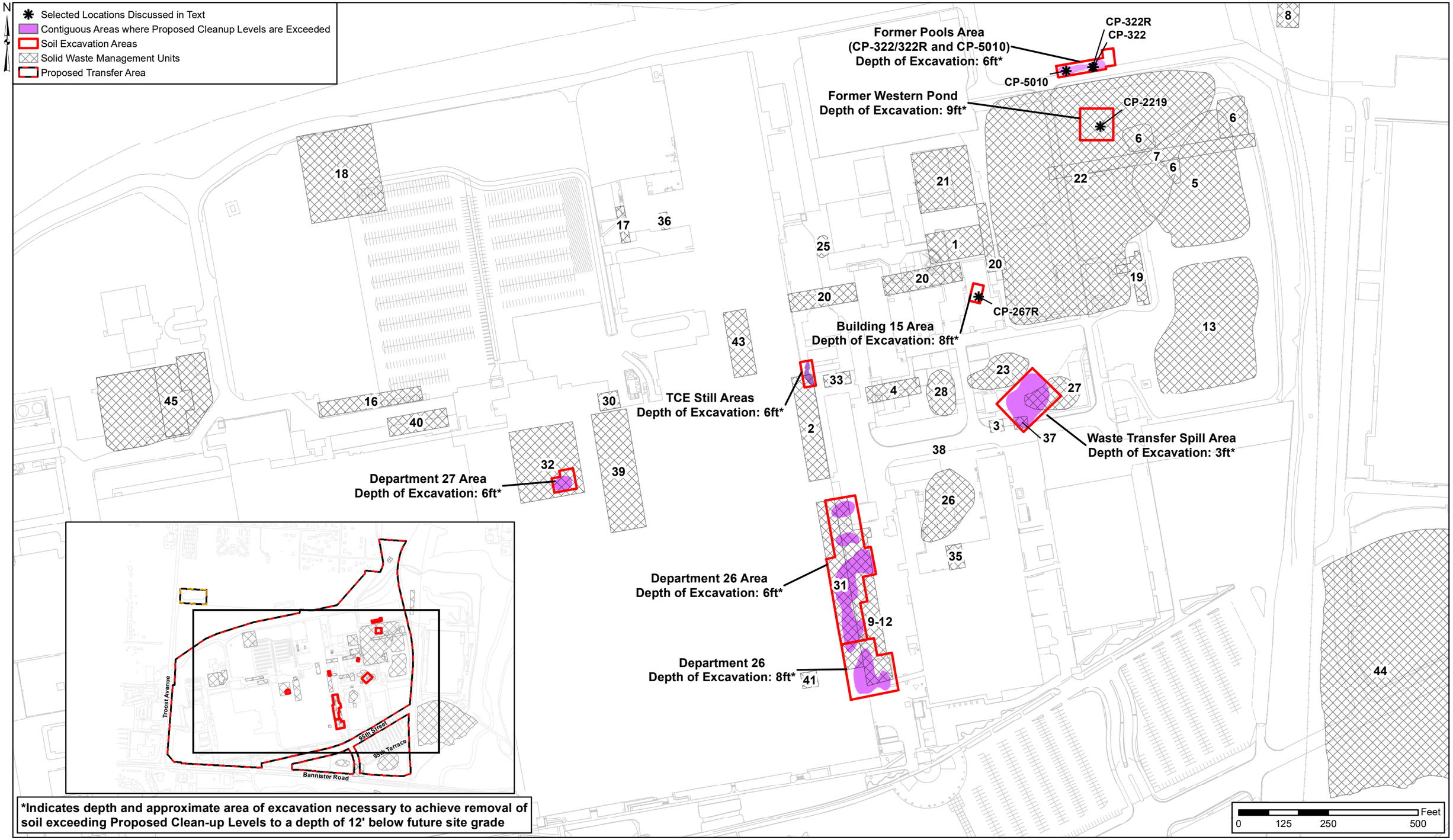
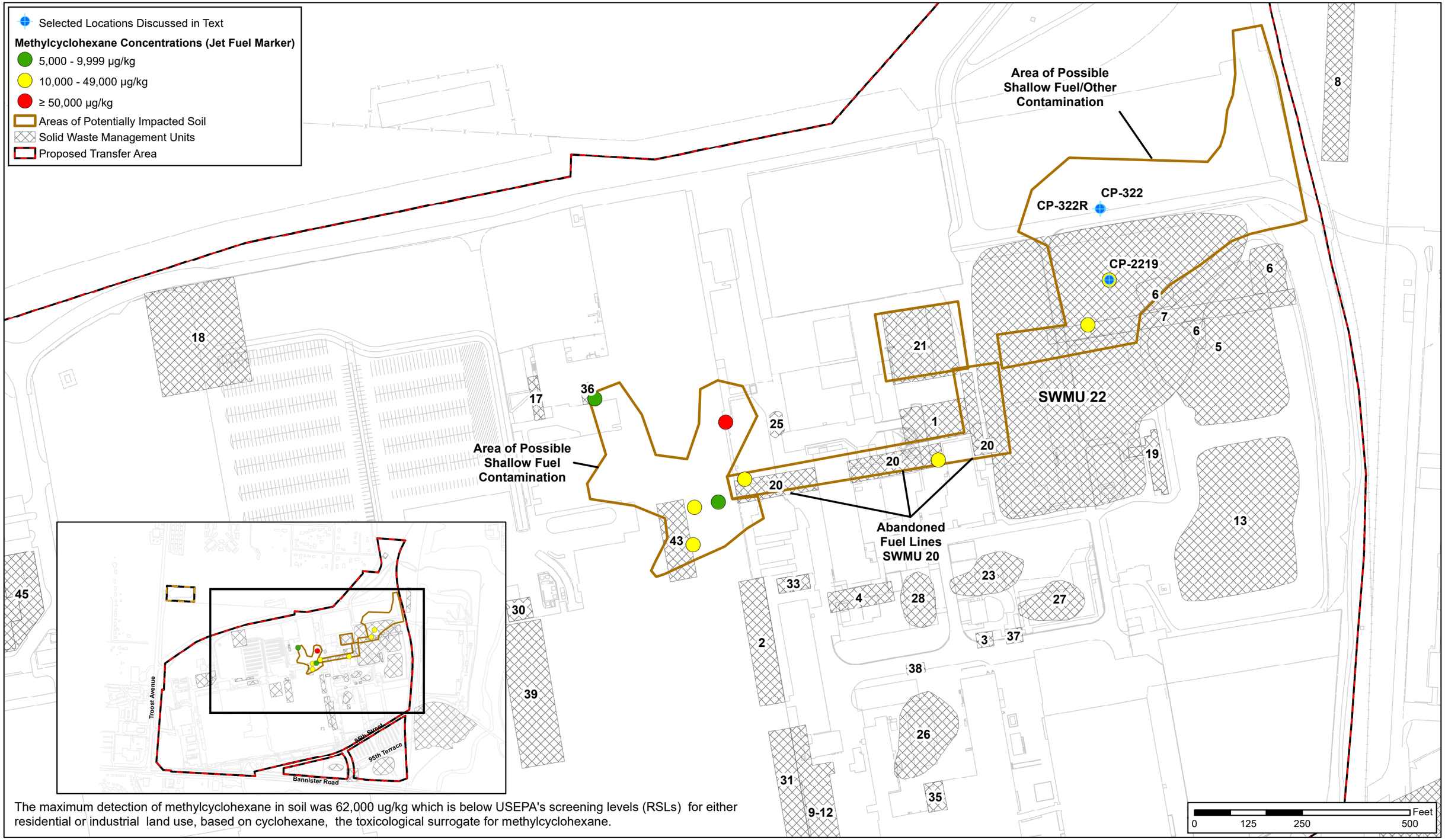


Figure 12 Proposed Soil Excavation Areas with Concentrations in Excess of Proposed Cleanup Levels



The maximum detection of methylcyclohexane in soil was 62,000 ug/kg which is below USEPA's screening levels (RSLs) for either residential or industrial land use, based on cyclohexane, the toxicological surrogate for methylcyclohexane.

Figure 13 Areas of Potential Petroleum Contamination, NAPL or Strong Odors in Soil

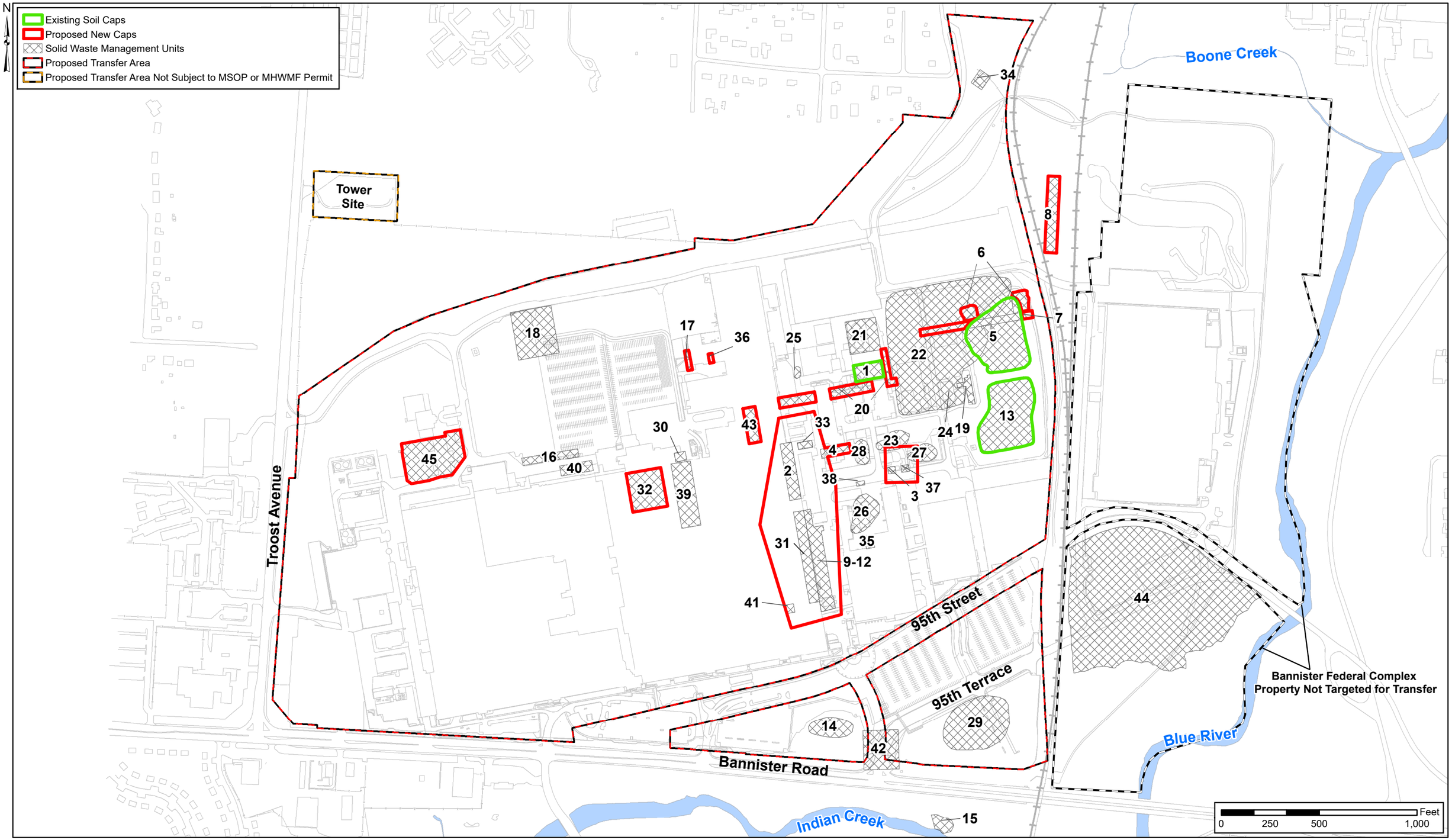


Figure 14 Caps for Solid Waste Management Units (SWMUs)

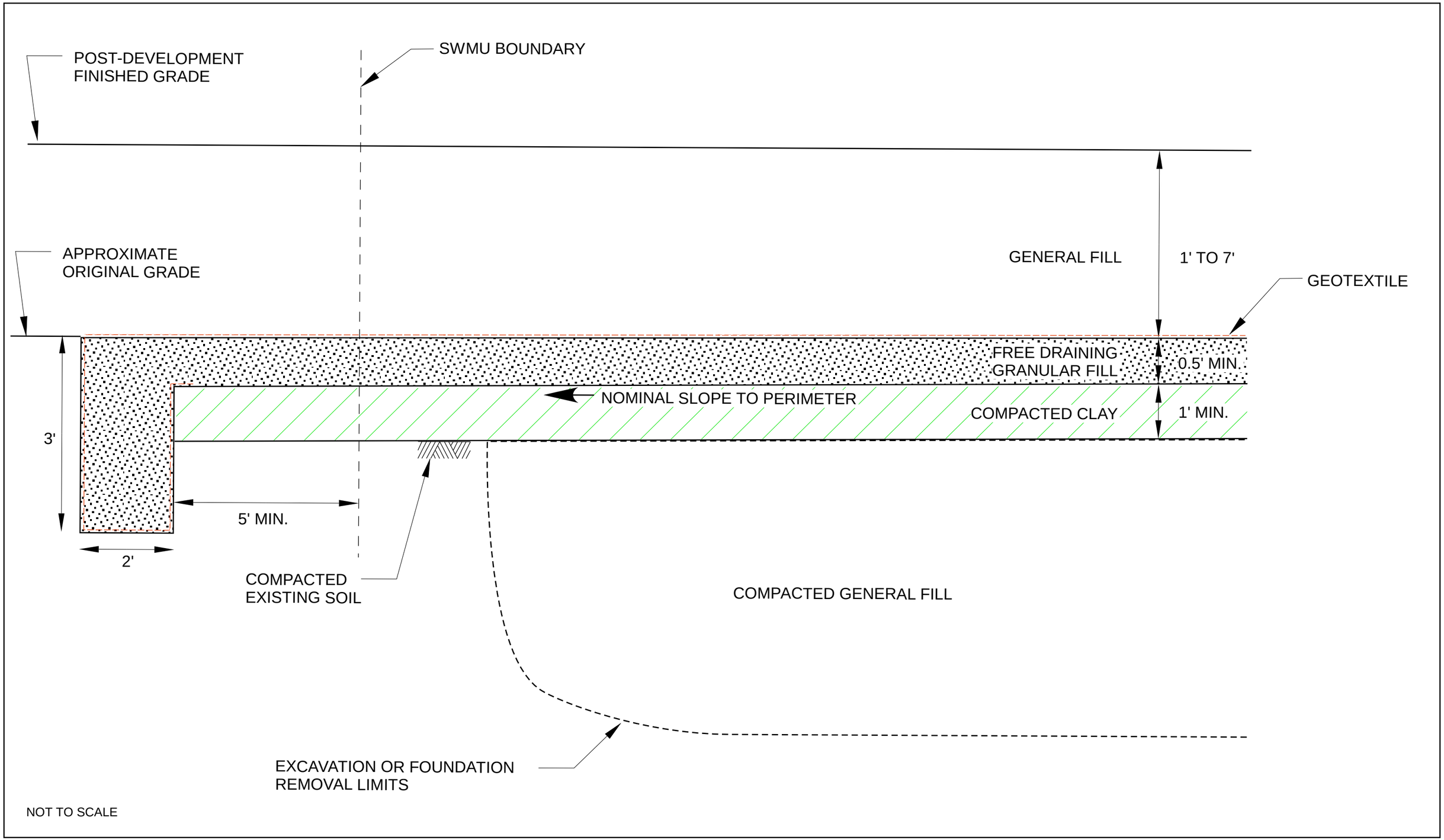


Figure 15 Schematic of Possible Engineered Caps for Solid Waste Management Units (SWMUs)

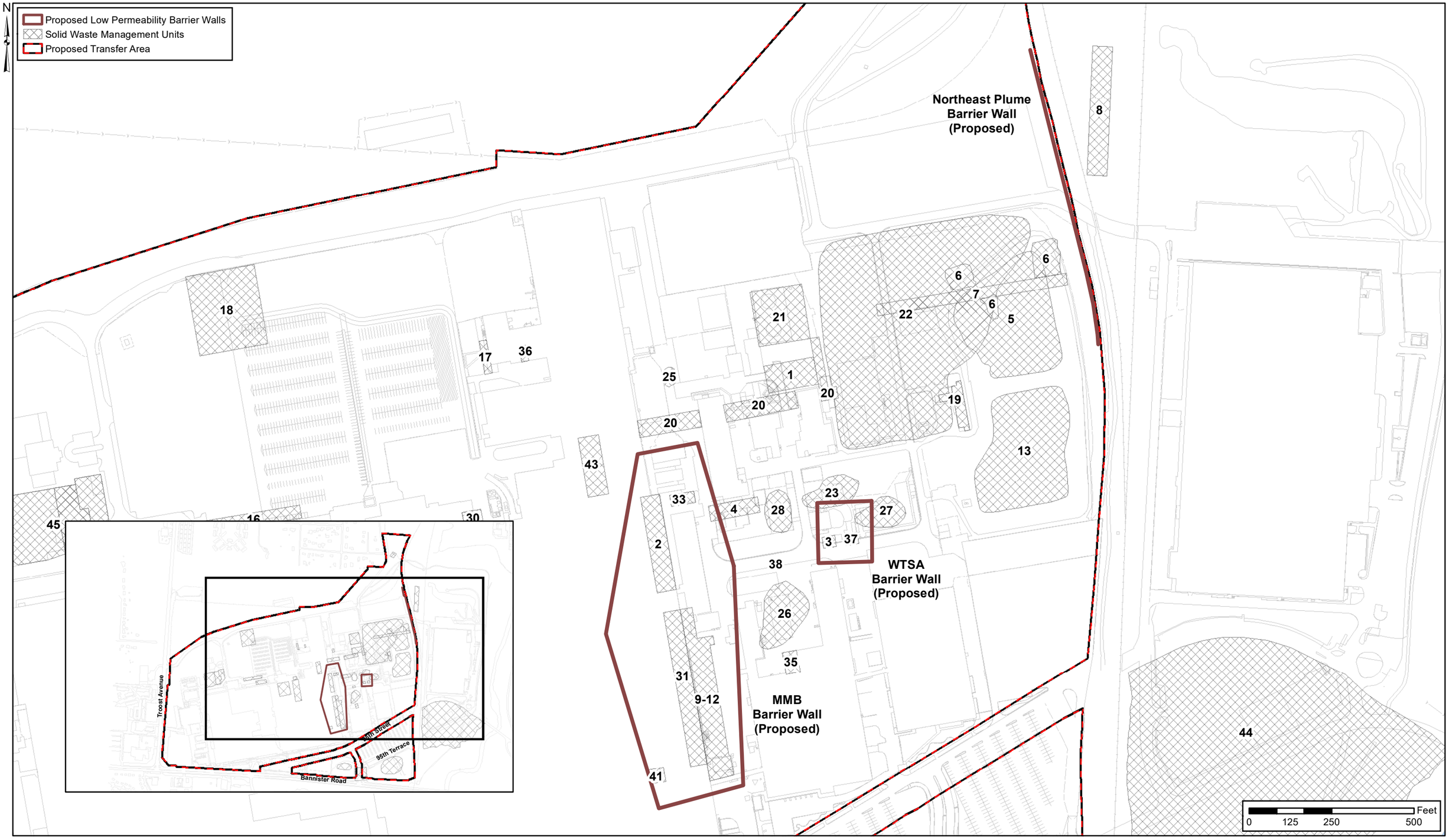


Figure 16 Proposed Low Permeability Barrier Walls

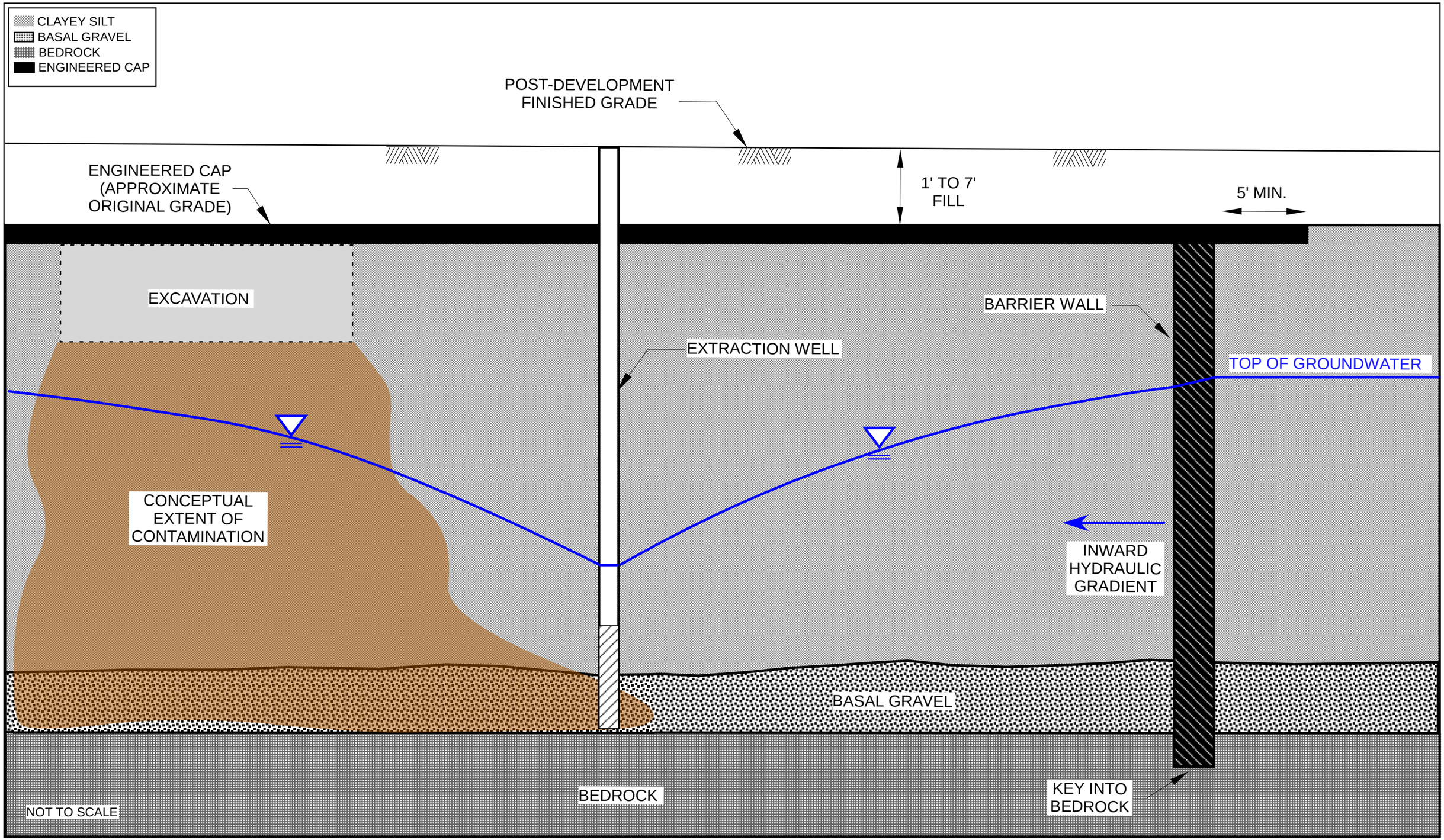
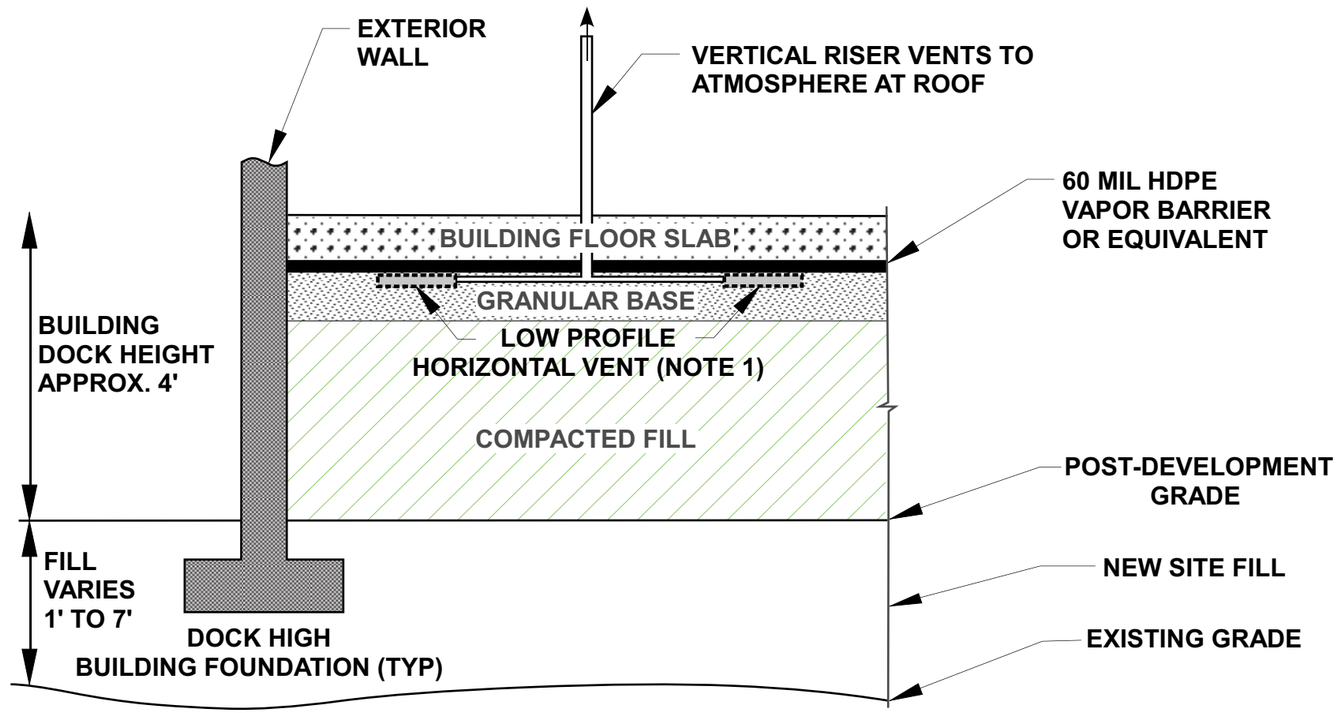


Figure 17 Schematic of Barrier Wall, Excavation, Engineered Cap, and Groundwater Extraction



CONCEPTUAL SCHEMATIC

NOT TO SCALE

NOTES:

1) THE CONCEPTUAL SCHEMATIC INCLUDES LOW PROFILE HORIZONTAL VENTS (GEOVENT BY CETCO, VAPOR-VENT BY LAND SCIENCE, OR EQUIVALENT) TO PASSIVELY VENT TO THE ATMOSPHERE AT THE ROOF. HORIZONTAL SLOTTED PVC PIPE MAY BE CONSIDERED AS AN EQUIVALENT TO THE LOW PROFILE HORIZONTAL VENTS.

Figure 18 Schematic of Vapor Barrier with Passive Venting

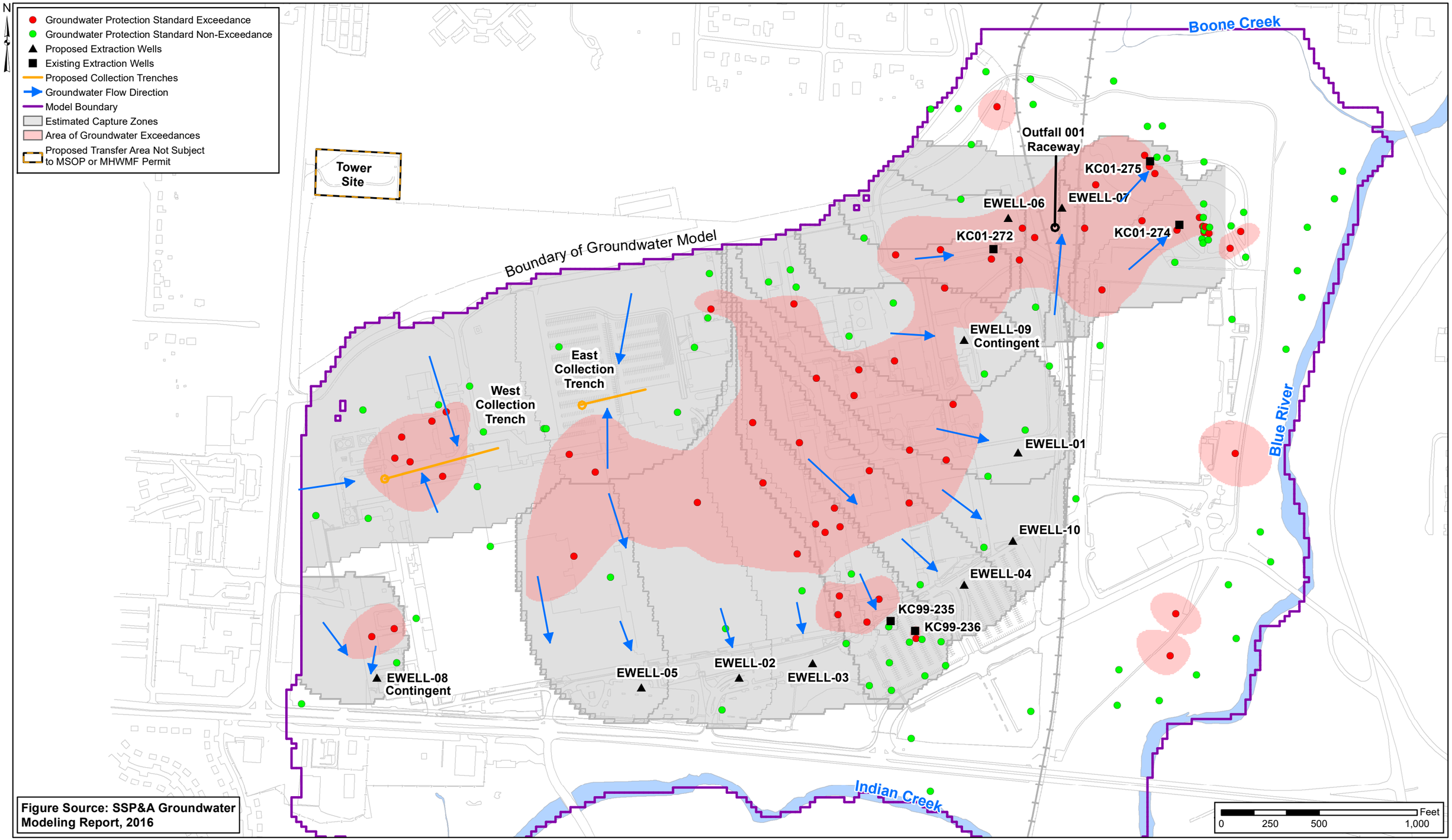


Figure 19 Overview of Proposed Groundwater Control System, Demolition-Phase

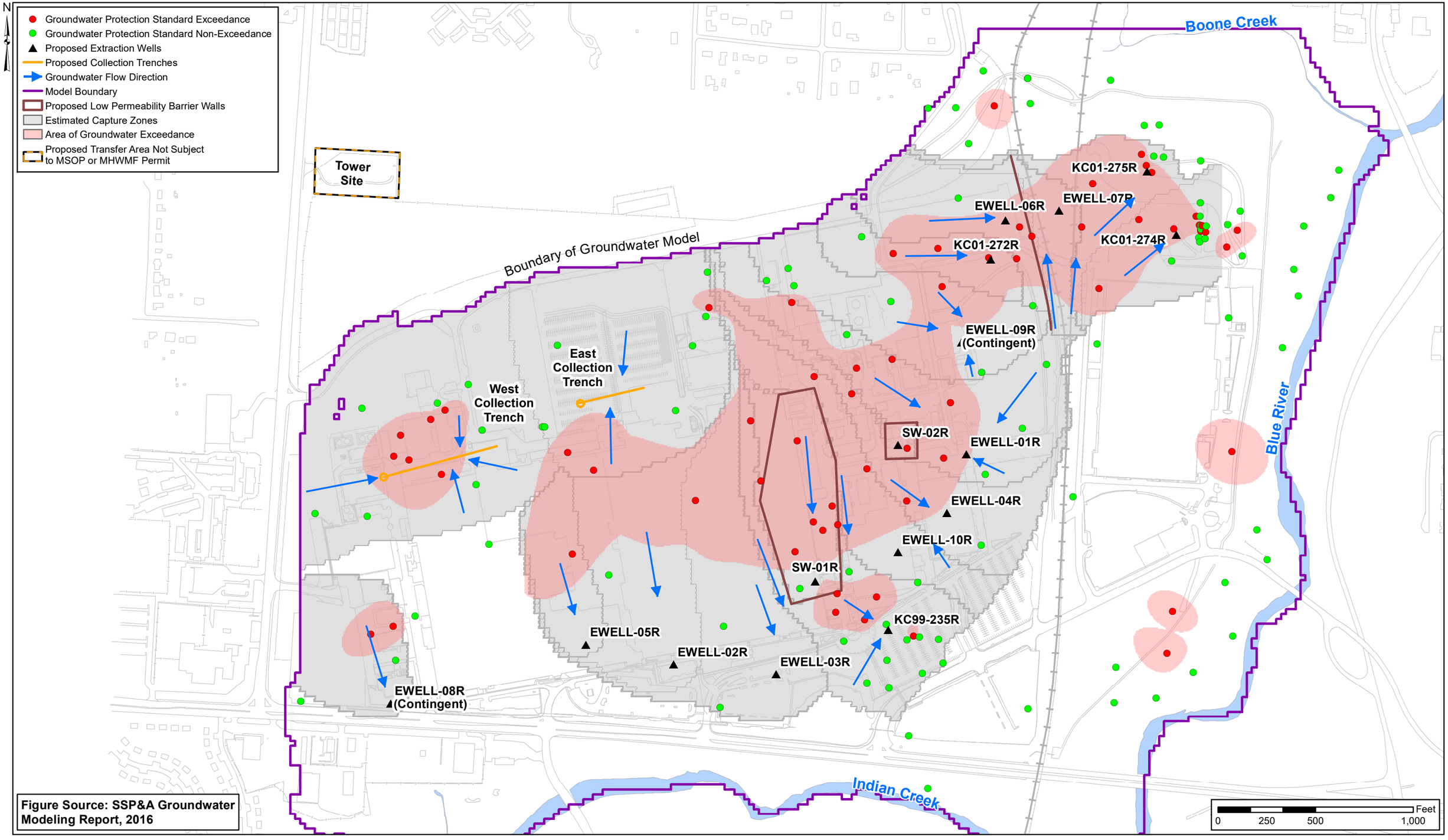


Figure 20 Overview of Proposed Groundwater Control System, after Re-Grading

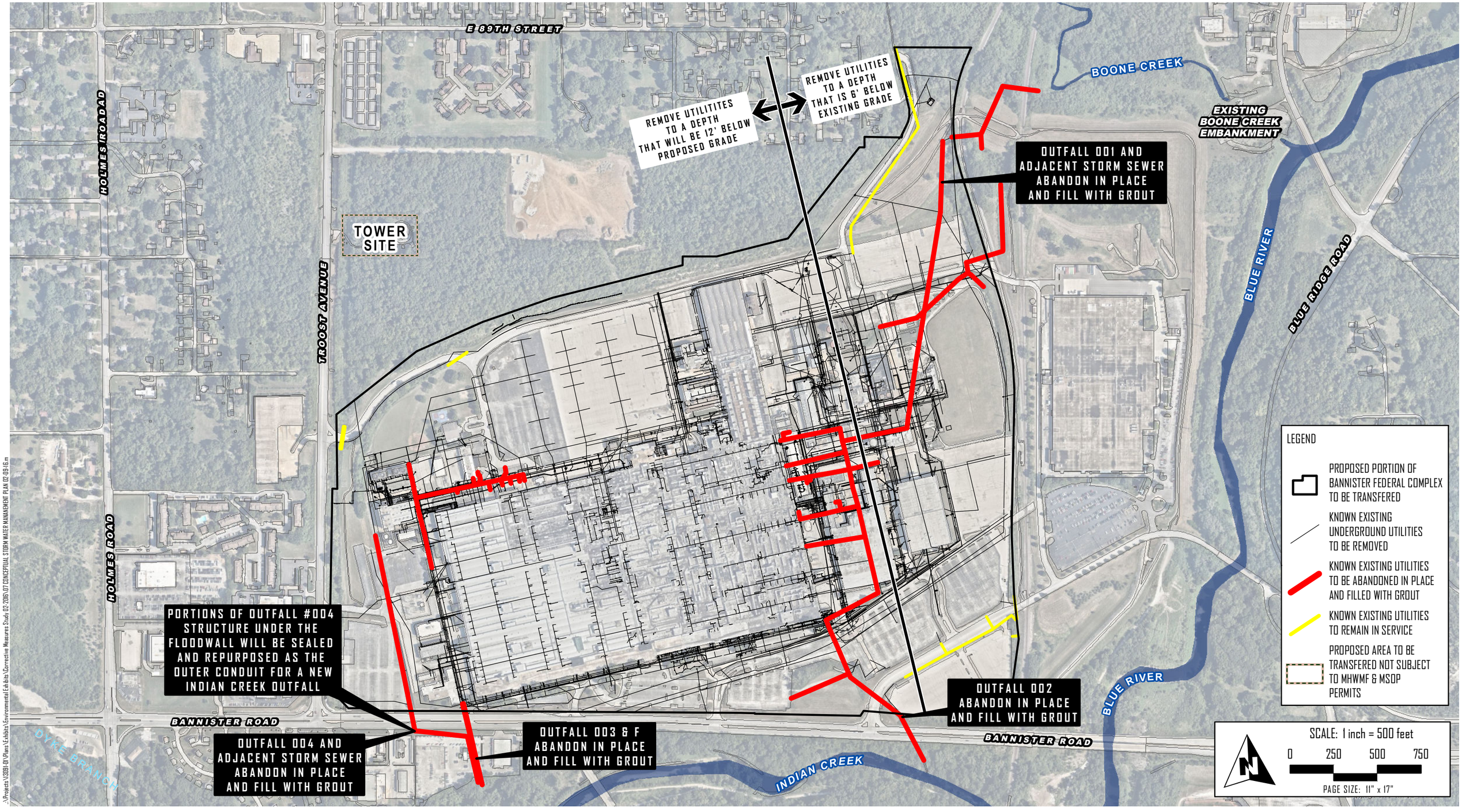


FIGURE 21 - UNDERGROUND UTILITY REMOVAL & ABANDONMENT PLAN// DATE 2017-03-16

CenterPoint Properties® OLSSON ASSOCIATES® S.S. PAPADOPULOS & ASSOCIATES, INC. ENVIRONMENTAL AND WATER RESOURCE CONSULTANTS GLOBAL PRAIRIE EVANS CONSULTING, PA

BANNISTER FEDERAL COMPLEX
KANSAS CITY, JACKSON COUNTY, MISSOURI

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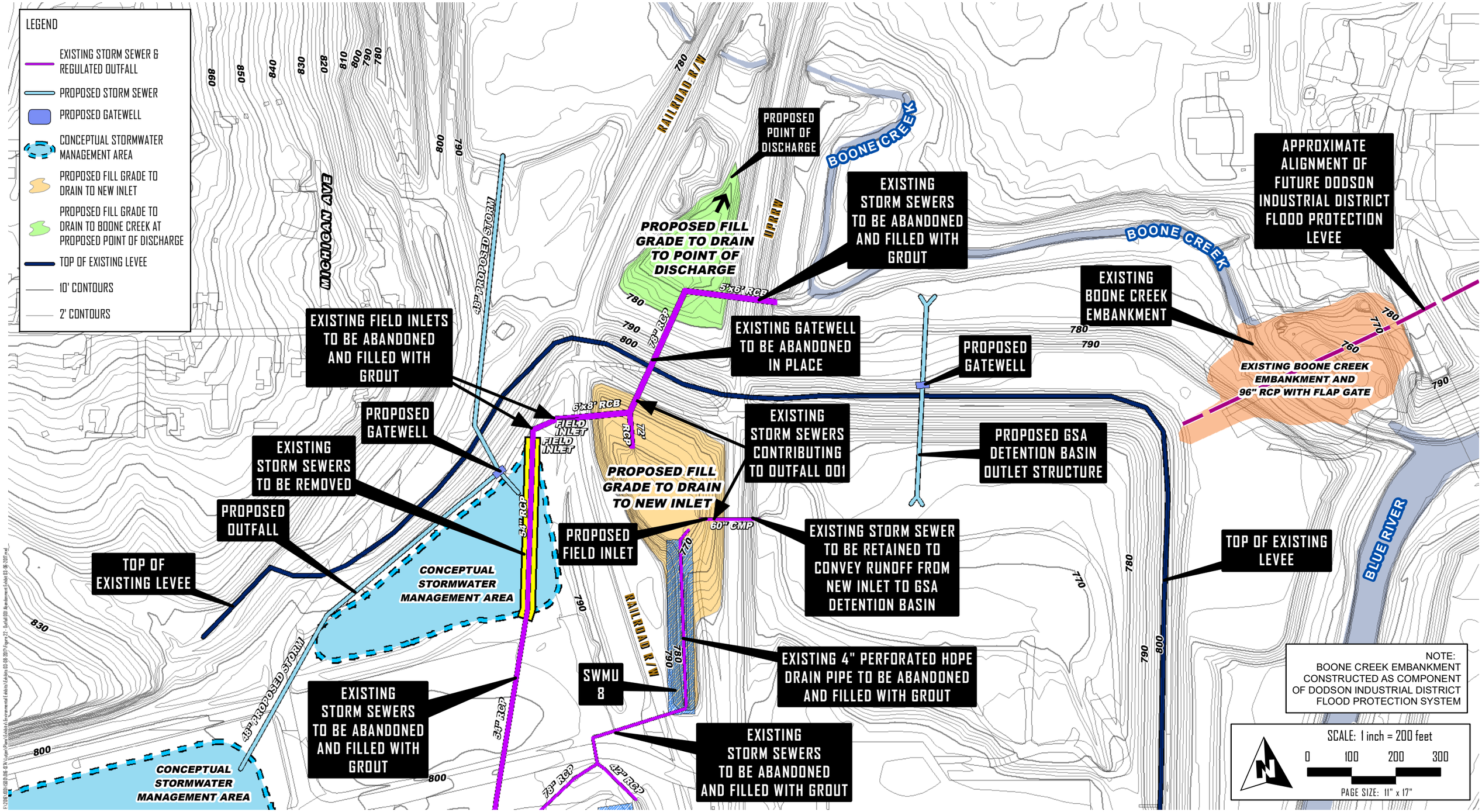

BANNISTER TRANSFORMATION & DEVELOPMENT LLC

FIGURE 22 - OUTFALL 001 ABANDONMENT PLAN// DATE 2017-03-07

CenterPoint Properties® OLSSON ASSOCIATES® S.S. PAPADOPULOS & ASSOCIATES, INC. ENVIRONMENTAL AND WATER RESOURCE CONSULTANTS GLOBAL PRAIRIE

BANNISTER FEDERAL COMPLEX
KANSAS CITY, JACKSON COUNTY, MISSOURI

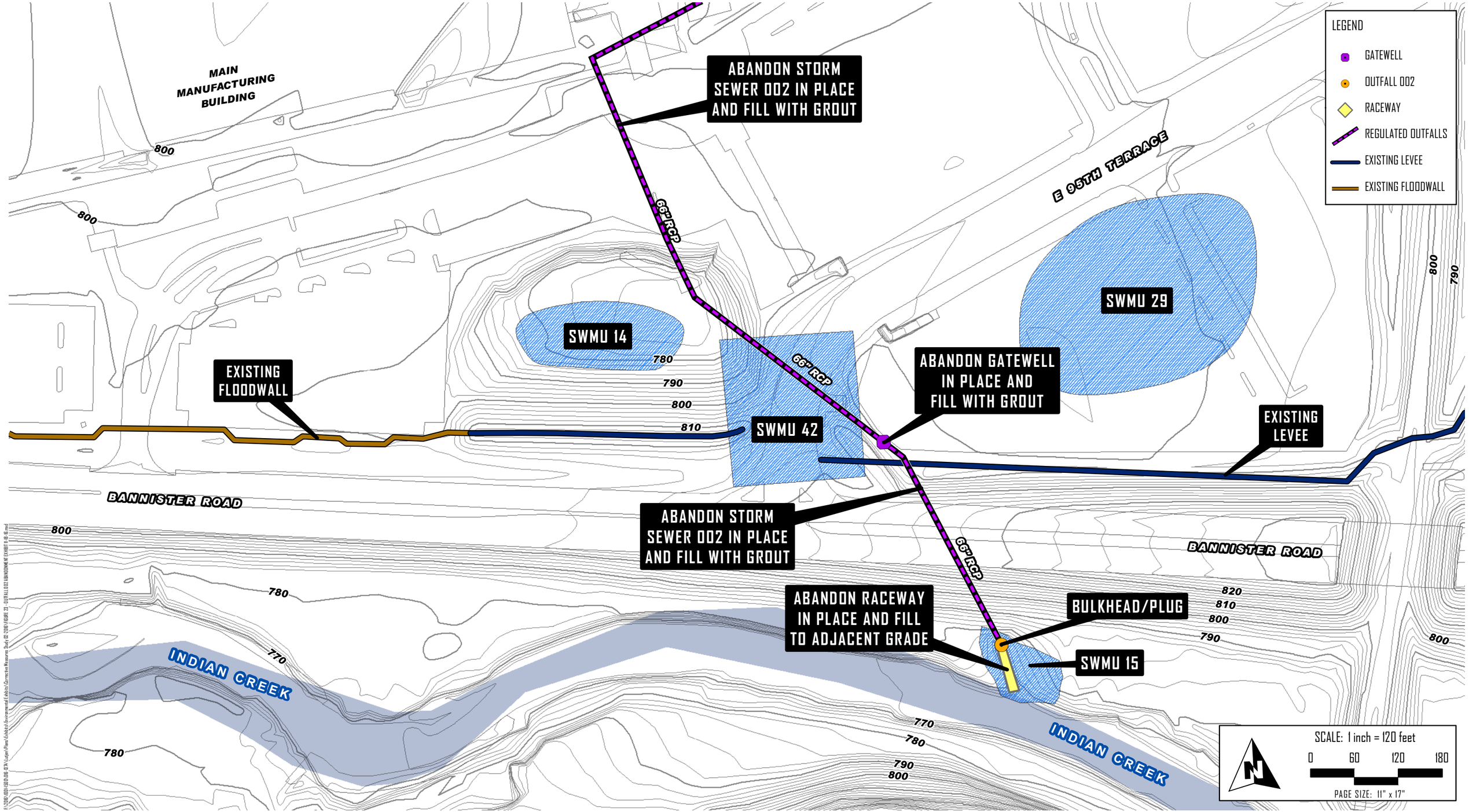

FIGURE 23 - OUTFALL 002 ABANDONMENT PLAN// DATE 2016-11-21

CenterPoint Properties® OLSSON ASSOCIATES LUTJEN S.S. PAPADOPULOS & ASSOCIATES, INC. ENVIRONMENTAL AND WATER RESOURCE CONSULTANTS GLOBAL PRAIRIE EVANS CONSULTING, PA

BANNISTER FEDERAL COMPLEX
KANSAS CITY, JACKSON COUNTY, MISSOURI

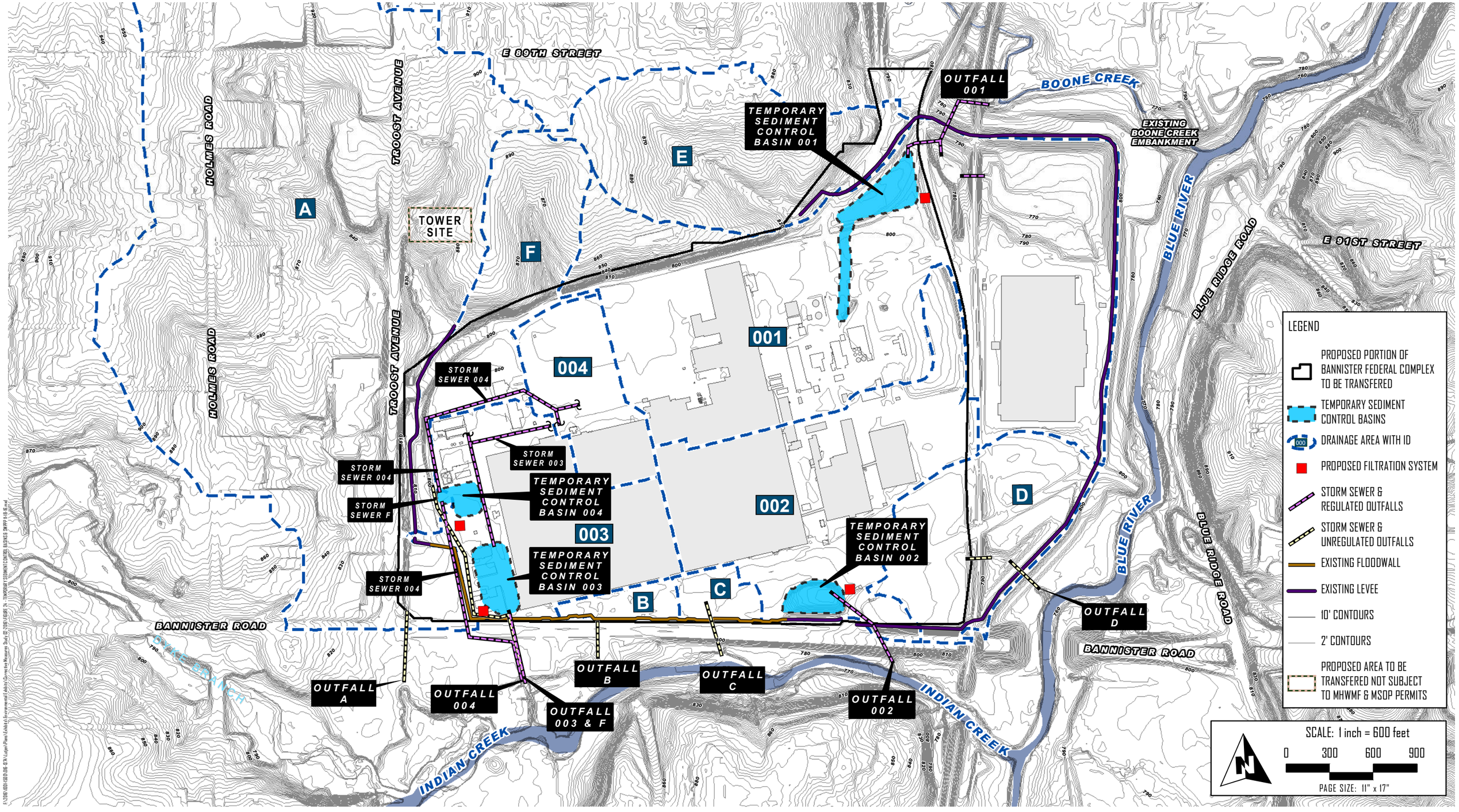

FIGURE 24 - TEMPORARY SEDIMENT CONTROL BASINS// DATE 2016-11-29

CenterPoint Properties® OLSSON ASSOCIATES LUTJEN S.S. PAPADOPULOS & ASSOCIATES, INC. ENVIRONMENTAL AND WATER RESOURCE CONSULTANTS GLOBAL PRAIRIE EVANS CONSULTING, PA

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KANSAS CITY, JACKSON COUNTY, MISSOURI

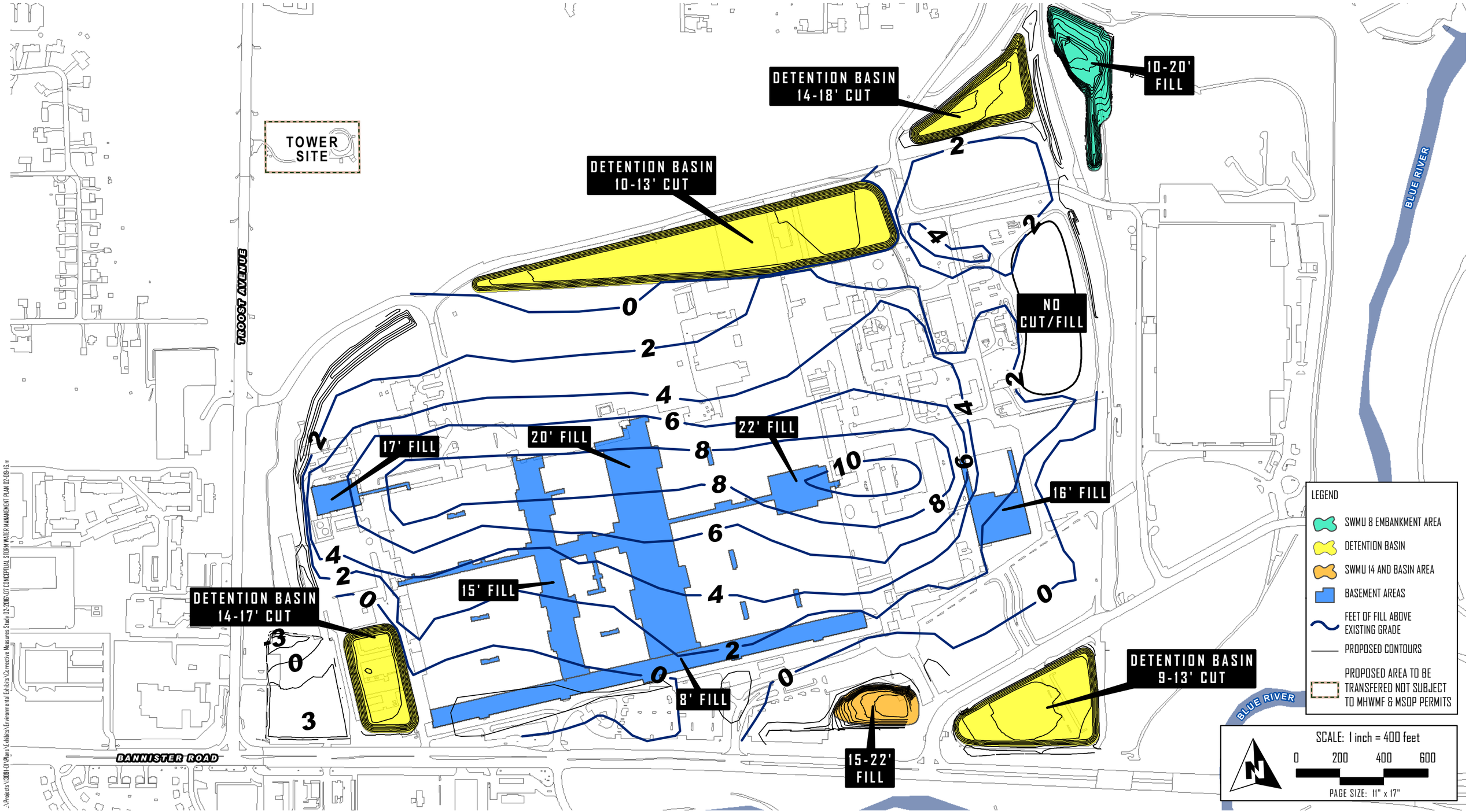
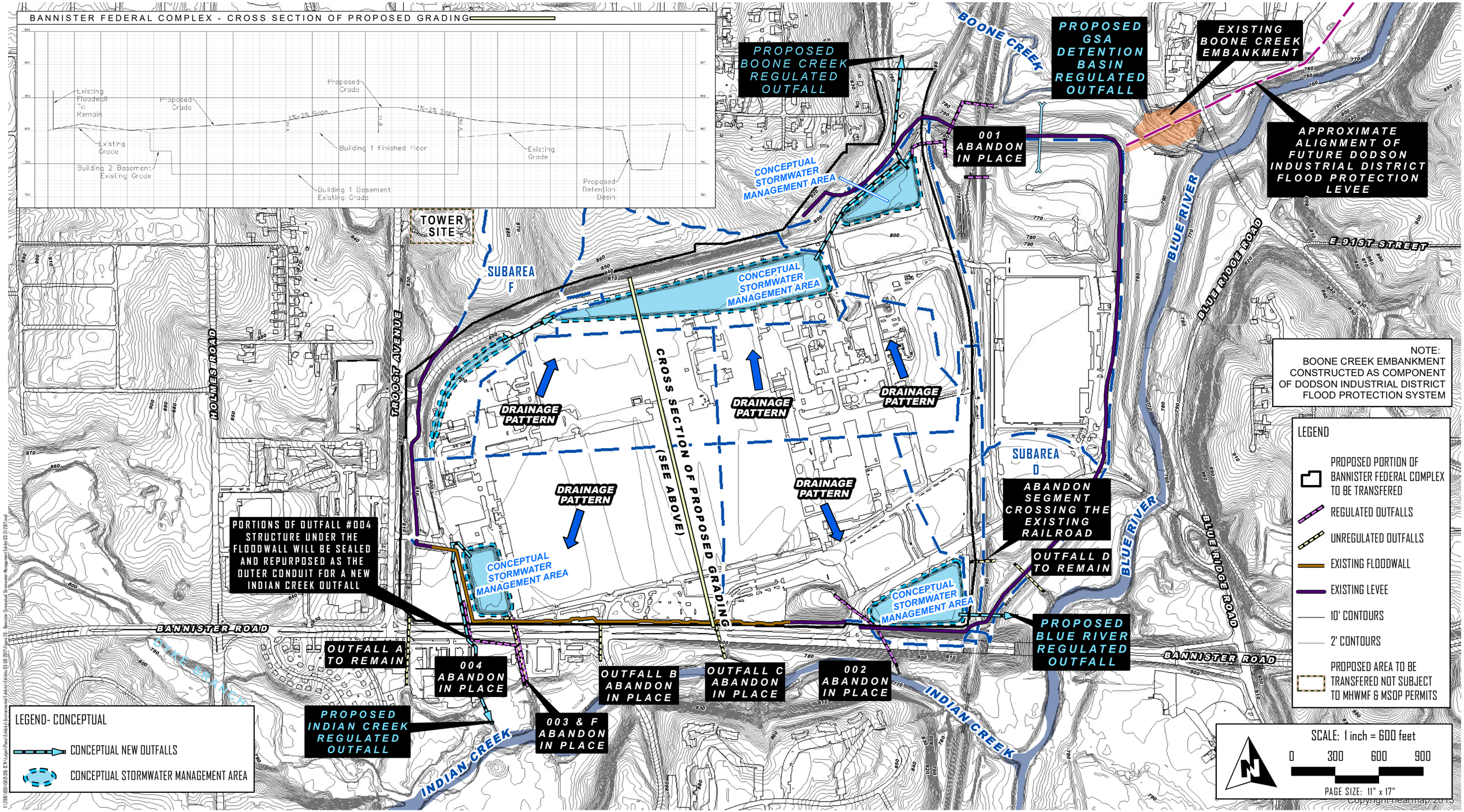


FIGURE 25 - SITE CUT/FILL PLAN// DATE 2016-11-21

BANNISTER FEDERAL COMPLEX
KANSAS CITY, JACKSON COUNTY, MISSOURI

CenterPoint Properties® OLSSON ASSOCIATES LUTJEN S.S. PAPADOPULOS & ASSOCIATES, INC. ENVIRONMENTAL AND WATER RESOURCE CONSULTANTS GLOBAL PRAIRIE EVANS CONSULTING, PA

J:\Projects\130911-01\Plans\Exhibits\Environmental Exhibits\Corrective Measures Study 02-2016\07 CONCEPTUAL STORM WATER MANAGEMENT PLAN 02-09-16.m



BANNISTER TRANSFORMATION & DEVELOPMENT LLC

CenterPoint Properties® OLSSON ASSOCIATES S.S. PAPADOPULOS & ASSOCIATES, INC. ENVIRONMENTAL AND WATER RESOURCE CONSULTANTS GLOBAL PRAIRIE

FIGURE 26 - CONCEPTUAL STORMWATER MANAGEMENT PLAN// DATE 2017-03-21

BANNISTER FEDERAL COMPLEX
KANSAS CITY, JACKSON COUNTY, MISSOURI

TABLES

TABLE 1
SWMUs and Regulatory Status

SWMU Number	SWMU Name	Current Regulatory Status[1]	Planned Soil Excavation	Cap to be Installed	Post-Remediation Status[2]
1	Underground Tank Farm	Post-Closure Care - Final Controls In Place	No	Already Capped	Corrective Action Complete - Final Controls In Place
2	TCE Still Location	Under Corrective Action	Yes[3]	Yes (Within TCE Still/D26 Barrier Wall Cap)	Corrective Action Complete - Final Controls In Place
3	Waste Transfer Spill Area	Under Corrective Action	No	Yes (Within WTSA Barrier Wall Cap)	Corrective Action Complete - Final Controls In Place
4	Classified Waste Trenches	Under Corrective Action	No	Yes (Portion Falls within TCE Still/D26 Barrier Wall Cap)	Corrective Action Complete - Final Controls In Place
5	North Lagoon	Post-Closure Care - Final Controls In Place	No	Already Capped	Corrective Action Complete - Final Controls In Place
6	Old Ponds	Under Corrective Action	Possible[4]	Yes	Corrective Action Complete - Final Controls In Place
7	North Lagoon Trench Area	Under Corrective Action	Possible[4]	Yes	Corrective Action Complete - Final Controls In Place
8	Outfall 001 Raceway	Under Corrective Action	No	Yes	Corrective Action Complete - Final Controls In Place
9	Plating Building Area / Acid & Alkaline Tanks	Under Corrective Action	Yes[3]	Yes (Within TCE Still/D26 Barrier Wall Cap)	Corrective Action Complete - Final Controls In Place
10	Waste Oil Tank under N End of Plating Building	Under Corrective Action	Yes[3]	Yes (Within TCE Still/D26 Barrier Wall Cap)	Corrective Action Complete - Final Controls In Place
11	Substation 18 N of former Plating Building	Under Corrective Action	Yes[3]	Yes (Within TCE Still/D26 Barrier Wall Cap)	Corrective Action Complete - Final Controls In Place
12	Department 26 Outside	Under Corrective Action	Yes[3]	Yes (Within TCE Still/D26 Barrier Wall Cap)	Corrective Action Complete - Final Controls In Place
13	South Lagoon	Post-Closure Care - Final Controls In Place	No	Already Capped	Corrective Action Complete - Final Controls In Place
14	Abandoned Indian Creek Outfall	Under Corrective Action[5]	No	No	Corrective Action Complete - Final Controls In Place
15	New 002 Outfall	No Further Action	No	No	No Further Action
16	Sales Building	Under Corrective Action	No	No	Corrective Action Complete - No Controls In Place
17	Building 54	Under Corrective Action	No	Yes	Corrective Action Complete - Final Controls In Place
18	North Lot	No Further Action	No	No	No Further Action
19	Building 16	No Further Action	No	No	No Further Action
20	Abandoned Fuel Lines	Under Corrective Action	Possible[4]	Yes	Corrective Action Complete - Final Controls In Place
21	Fuel Oil Tank Unloading Area	Under Corrective Action	Possible[4]	No	Corrective Action Complete - No Controls In Place
22	East of Oil Storage Tanks, Underground Tank Farm, and Bldg 15, Extending to Lagoons	No Further Action	Possible[4]	No	No Further Action
23	PCBs and Hydraulic Oil Spills in Open Area East of Dept 183 Barrel Lot	No Further Action	No	No	No Further Action
24	Wastewater Dumping West Bldg 16	No Further Action	No	No	No Further Action
25	Spill of Cutting Oil and Coolants near lot 187-L Outside Diked Area	No Further Action	No	No	No Further Action
26	Spill of Caustic Wastewater North of MSB	No Further Action	No	No	No Further Action

TABLE 1
SWMUs and Regulatory Status

SWMU Number	SWMU Name	Current Regulatory Status[1]	Planned Soil Excavation	Cap to be Installed	Post-Remediation Status[2]
27	Dumping of PCB Contaminated Wastewater W of Lagoons	No Further Action	No	No	No Further Action
28	Spill of Plating Acid from Truck	No Further Action	No	No	No Further Action
29	Southeast Parking Lot	No Further Action	No	No	No Further Action
30	Department 27 Outside	Under Corrective Action[6]	No	No	Corrective Action Complete - No Controls In Place
31	Department 26 Inside	Under Corrective Action	Yes[3]	Yes (Within TCE Still/D26 Barrier Wall Cap)	Corrective Action Complete - Final Controls In Place
32	Department 27 Inside	Under Corrective Action	Yes[3]	Yes	Corrective Action Complete - Final Controls In Place
33	Oil House	Under Corrective Action	No	Yes (Within TCE Still/D26 Barrier Wall Cap)	Corrective Action Complete - Final Controls In Place
34	Sanitary Sewer Pump Station	Under Corrective Action[6]	No	No	Corrective Action Complete - No Controls In Place
35	East Boilerhouse (Substation 23)	Under Corrective Action	No	No	Corrective Action Complete - No Controls In Place
36	Maintenance Vehicle Repair Shop	Under Corrective Action	No	Yes	Corrective Action Complete - Final Controls In Place
37	Abandoned Sump	Under Corrective Action	No	Yes (Within WTSA Barrier Wall Cap)	Corrective Action Complete - Final Controls In Place
38	Reported Buried Drum Site	Under Corrective Action[6]	No	No	Corrective Action Complete - No Controls In Place
39	Department 95	Under Corrective Action	No	No	Corrective Action Complete - No Controls In Place
40	Former Chip Handling Bldg	Under Corrective Action	No	No	Corrective Action Complete - No Controls In Place
41	Department 20 Degreaser Pit	Under Corrective Action	No	Yes (Within TCE Still/D26 Barrier Wall Cap)	Corrective Action Complete - Final Controls In Place
42	95th Terrace	Under Corrective Action	No	95th Terrace acts as Cap	Corrective Action Complete - Final Controls In Place
43	Test Cell Tanks	Under Corrective Action	Possible[4]	Yes	Corrective Action Complete - Final Controls In Place
44	Former Landfill (not within property transfer)	Under Corrective Action	N/A	N/A	Not Within Property Transfer
45	Building 50	Under Corrective Action	No	Yes	Corrective Action Complete - Final Controls In Place

Note: As of March, 2017, additional areas of the BFC are under consideration by MDNR for designation as Areas of Concern (AOCs) and inclusion as such in future versions of the MWHMF Permit. These are, however, located outside of the property to be transferred.

[1] Regulatory Status based on information in the Missouri Hazardous Waste Management Facility (MHWMF) Permit - Part I, MO9890010524 - Modified August 24, 2012

[2] It is anticipated that the entire property to be transferred will be deed-restricted.

[3] Excavation of soil above risk based levels in the top 12 feet below ground surface.

[4] Soil containing NAPL or strong odor is expected to be encountered in this SWMU during utility removal. This soil will be removed.

[5] The MHWMF Permit states "remediation not required at this time to protect HHE" in this SWMU.

[6] The Description of Current Conditions Report (DOE and GSA, 2016) lists this SWMU as No Further Action. The MHWMF Permit does not indicate No Further Action but states "remediation not required at this time to protect HHE" in this SWMU.

TABLE 2
Corrective Action Requirements, Source and Context

	Requirement	Context	Description & Purpose	Modification of Requirement	Source
GROUNDWATER MONITORING AND REMEDIATION	Groundwater Protection Standard (GPS)	Corrective Action Program (ICGFS and BRGFS)	Limits for hazardous constituents in groundwater at and beyond POC	1. MDNR reserves right to modify in response to changing analytical technology (II.A.4) 2. Permittee may propose Alternate Concentration Limits (ACLs) protective of HHE (II.A.5) 3. Addition of site-sourced hazardous constitutents identified during future sampling required (II.A.6; see II.E.6)	MHWMF Part I Permit, Special Permit Conditions Post-Closure, Section II.A Tables I and IA
	Point of Compliance (POC) Wells	Corrective Action Program (ICGFS)	Monitor groundwater passing the point of compliance for the ICGFS	Class 2 Permit Modification	MHWMF Part I Permit, Special Permit Conditions Post-Closure, Section II.B (list of POC wells in Section II.B)
		Corrective Action Program (BRGFS NE Area)	Monitor groundwater passing the point of compliance for the BRGFS	Class 2 Permit Modification	MHWMF Part I Permit, Special Permit Conditions Post-Closure, Section II.B (list of 3 POC wells in Section II.B for NE Area)
		Corrective Action Program (BRGFS Landfill Plume)	Monitor groundwater passing the point of compliance for the BRGFS	N/A	Additional BRGFS POC wells added via Section 3.5 of April 2013 SAP
	Perimeter Wells	GW Monitoring Program	Ensure adequate delineation of the horizontal and vertical extent of contamination	Changes in approved SAP require permit modification (annual changes acceptable)	Specific wells identified in SAP; MHWMF Part I Permit, Special Permit Conditions, Section II.E.2
	Effectiveness Wells	GW Monitoring Program	Assess effectiveness of corrective action program	Changes in approved SAP require permit modification (annual changes acceptable)	Specific wells identified in SAP; MHWMF Part I Permit, Special Permit Conditions, Section II.E.3
	Monitoring Wells	GW Monitoring Program	1) Detection/delineation of horizontal and vertical extent of contamination at and beyond the point of compliance 2) Determination of representative concentrations 3) Permittees ability to determine effectiveness of corrective action	1. Any changes in wells for Closed Regulated Units (lagoons and UST Farm) require Class 2 permit modification; annual changes acceptable 2. Other new monitoring wells to be proposed in Work Plans 3. MDNR requires 5 days advance notice prior to construction/modification of GW monitoring system	MHWMF Part I Permit, Special Permit Conditions, Section II.D Specific monitoring wells specified in SAP
	Well Inspection and Maintenance	GW Monitoring Program	Inspection and maintenance program to ensure integrity of wells	Notification of MDNR 5 days prior to any major work such as new wells, retrofitting or abandonment of wells is required Does not apply to minor repairs or maintenance	MHWMF Part I Permit, Special Permit Conditions, Section II.D.7
	Full Analytical Suite Sampling	GW Monitoring Program	Broad range of analytes at three historically contaminated wells every 5 years to detect new contamination		MHWMF Part I Permit, Special Permit Conditions, Section II.E.6
	Groundwater Sampling Schedule	GW Monitoring Program	Semi-annual / annual (see Table II in Permit)		Table II in MHWMF Part I Permit
	Pumping System Evaluation	GW Monitoring Program	Re-evaluation of pumping system every five years		MHWMF Part I Permit, Schedule of Compliance Section VII.A
	Monitoring Well Addition	GW Monitoring Program	Addition of wells to maintain permit compliance	Addition for monitoring at former lagoons and underground tank farm requires Class 2 permit modification. Addition for monitoring elsewhere requires approval from MDNR	MHWMF Part I Permit, Special Permit Conditions, Section II.D.2 (see also Section II.E.2.e)
	Monitoring Well Abandonment	GW Monitoring Program	Abandonment of wells	Class 2 permit modification for wells monitoring former lagoons and underground tank farm. Other monitoring wells require coordination with MDNR.	MHWMF Part I Permit, Special Permit Conditions, Section II.D.4
SURFACE WATER	General Monitoring	SW Monitoring Program	- Monitoring Program to be Incorporated into SAP - Methods to be consistent with Table II of MHWMF Part I Permit (see Table 4-5)	Changes may be proposed in future modifications of SAP; permittee may apply for SW monitoring exemption, approval would require a permit modification	MHWMF Part I Permit, Special Permit Conditions, Section III Appendix E of most recent Sampling and Analysis Plan
	Comprehensive Outfall 002 Monitoring	SW Monitoring Program	(See Table 4-5)		MHWMF Part I Permit, Special Permit Conditions, Section III Appendix E of most recent Sampling and Analysis Plan
REPORTING	Annual Corrective Action Report	Groundwater-Related Reporting Requirements	Raw data, analsyis, and narratives dsscribing all CA in past year		MHWMF Part I Permit, Special Permit Conditions Sections II.F
	Semi-Annual Progress Reports	MDNR Required Submission	Summarize all permitted CA activities in past 6 months		MHWMF Part I Permit, Special Permit Conditions, Section XIX
	SW Data Reporting as part of Annual GW CA Report	Surface Water Monitoring Program			See MHWMF Part I Permit, Special Permit Conditions, Section III
	Planned Activities	Recurring Reports and One-Time Reports			Table IV in Part I Permit
	Biennial Report	General Requirements	Covering facility activities by March 1 during even-numbered calendar years		MHWMF Part I Permit, General Permit Conditions, Section V
	Contingent Activities	Upon Discovery of New SWMUs and AOCs			Table V in Part I Permit
SWMUs AND INFRASTRUCTURE	No Further Corrective Action	SWMUs	SWMU 15, 18, 19, 22, 23, 24, 25, 26, 27, 28		MHWMF Part I Permit, Special Permit Conditions, Section IV.B
	No Remediation Currently Required to Protect Human Health and Environment (HHE)	SWMUs	SWMU 13, 14, 15, 18, 19, 30, 34, 38		MHWMF Part I Permit, Special Permit Conditions, Section IV.E
	Further Corrective Action Needed	SWMUs	SWMU 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 16, 17, 20, 21, 29, 31, 32, 33, 35, 36, 37, 39, 40, 41, 42, 43, 44, 45		MHWMF Part I Permit, Special Permit Conditions, Section IV.F
	Removal of Cover	SWMUs (Further CA Needed)	Infrastructure covering SWMUs cannot be removed	Must get MDNR approval for removal	MHWMF Part I Permit, Special Permit Conditions, Section IV.F
	Soil Contamination Management	SWMUs (Further CA Needed)	Soil above saturated zone left in place with institutional controls (IC) and land-use controls (LUC)		MHWMF Part I Permit, Special Permit Conditions, Section IV.F and Multiple Sites CMS (1989)
	Bannister Road Box Culvert Maintenance	Corrective Action	Maintenance and ICs; semi-annual inspections, possible sediment removal, effluent monitoring		MHWMF Part I Permit, Special Permit Conditions, Section IV.F; Sampling and Analysis Plan

TABLE 2
Corrective Action Requirements, Source and Context

	Requirement	Context	Description & Purpose	Modification of Requirement	Source
OTHER	Integrated CA Program	Corrective Action Program (Former Lagoons and Underground Tank Farm)	Integration of CA Program for closed regulated units and sitewide program: Inability to differentiate GW contamination related to closed lagoons, Closed UST Farm and other nearby SWMUs/AOCs		MHWMF Part I Permit, Special Permit Conditions Section II.E
	Compliance Period	Corrective Action Program (Former Lagoons and Underground Tank Farm)	Establishes compliance periods equal to active life of HWMUs - Closed UST Farm: 44 years - Closed Impoundments: 23 years	Class 3 Permit Modification to Reduce Post-Closure Care Period May be extended if Compliance Criteria not met at end of Compliance Period	MHWMF Part I Permit, Special Permit Conditions Post-Closure, Section II.C
	Post-Closure Care	Corrective Action Program	Post-closure care continues for at least 30 years	May submit request to shorten post-closure care period	MHWMF Part I Permit, Special Permit Conditions, Section I.A
CONDITIONAL REQUIREMENTS	Future SWMU Excavation or Construction Notification	MDNR Notification	Ensure necessary precautions taken when disturbing or exposing any contaminated environmental media. Permittee may be required to reevaluate the need for further CA if any information comes to light indicating that HHE may be adversely impacted		MHWMF Part I Permit, Special Permit Conditions, Section IV.F
	Notification of Newly Discovered SWMUs or AOCs	MDNR Notification	MDNR may require SWMU/AOC Assessment Work Plan and will subsequently require submission of Assessment Report		MHWMF Part I Permit, Special Permit Conditions, Section V
	Notification of Newly Identified Releases from Existing SWMUs	MDNR Notification	MDNR may require a Newly Identified Release Work Plan and will subsequently require submission of Newly Identified Release Report		MHWMF Part I Permit, Special Permit Conditions, Section VI
	Notification of Need for ISM	MDNR Notification	Interim/Stablization Measures (ISM) to limit or stop the spread of contaminants		MHWMF Part I Permit, Special Permit Conditions, Section VII
	Submit RFI Work Plan and Report	MDNR Required Submission	MDNR determines that further investigation is needed for new or existing SWMU/AOC; MDNR may require a new RFI Work Plan		MHWMF Part I Permit, Special Permit Conditions, Section VIII, IX
	Submit CMS Work Plan and Report Remedy Approval & Implementation	MDNR Required Submission	MDNR determines further Corrective Measures Study (CMS) is needed for new or existing SWMU/AOC; MDNR may require a new CMS Work Plan. MDNR will approve of a remedy that will be implemented in a Corrective Measures Implementation (CMI) Work Plan		MHWMF Part I Permit, Special Permit Conditions, Section X, XI, XIII
	Submit Corrective Measures Construction Completion Report (CCR)	MDNR Required Submission	Upon completion of activities detailed for existing CMS and remedies specified in the permit		MHWMF Part I Permit, Special Permit Conditions, Section XIV
	Submit Corrective Measures Completion Report (CMC)	MDNR Required Submission	Within 60 days of completion of corrective measures		MHWMF Part I Permit, Special Permit Conditions, Section XVI
OTHER	Maintain all supplemental data	Other Requirements	All raw data, reports, etc generated to be maintained by permittee		MHWMF Part I Permit, Special Permit Conditions, Section XX
	Excavated Soil Mgmt Procedures	Other Requirements	Allow for facilitate maintenance and repair of utilities in contaminated areas - pre-excavation sampling/analysis - MNDR approval required - minimum 4" of clean fill on top of contaminated backfill, if approved		MHWMF Part I Permit, Special Permit Conditions, Section XXI.B
	Revise LTOM&M Plan	MDNR Required Submission	Revise procedures in Long-Term Operation, Maintenance, and Monitoring (LTOM&M) Plan within 60 days of date of permit modificaion		MHWMF Part I Permit, Special Permit Conditions, Section XV
	Deed Notation and/or Deed Restriction Requirements	MDNR Required Submission	Defines the LUC explicity in Section XVII.D May require updating for new AOCs, SWMUs or at landfill		MHWMF Part I Permit, Special Permit Conditions, Section XVII
	Technology Investigation	MDNR Required Submission	Permitee must continue to test innovative technology to address soil contamination; must report on outcomes every third year		MHWMF Part I Permit, Special Permit Conditions, Section XVII.G
	Funding and Financial Assurance for Corrective Action	MDNR Required Submission	Must provide proof of financial ability to manage CA activities; annual funding reports		MHWMF Part I Permit, Special Permit Conditions, Section XVIII
	Semi-Annual Progress Reports	MDNR Required Submission	Summarize all permitted CA activities in past 6 months		MHWMF Part I Permit, Special Permit Conditions, Section XIX
	Risk Assessment (RA)	MDNR Required Submission	For areas identified as potentially requiring further corrective action. Must include analysis of risks and effects with and without any actions or controls. Used to assess current strategies and develop future plans.		MHWMF Part I Permit, Schedule of Compliance, Section IV
	CMS Report	MDNR Required Submission	CMS Action may be required based on outcome of Risk Assessment		MHWMF Part I Permit, Schedule of Compliance, Section V
	PCB Fate & Transport Study	MDNR Required Submission	Work Plan submitted within 90 days of current permit modification. Must evaluate media and transport mechanism contributing to presence of PCBs in environment near facility. Also must evaluate corrective actions that may be beneficially implemented.		MHWMF Part I Permit, Schedule of Compliance, Section IX
	RFI Work Plan(s) and Report(s)	MDNR Required Submission	May be required after review of DCCR; must address data gaps determined from DCCR		MHWMF Part I Permit, Schedule of Compliance, Section III
	Revised Community Action Plan	MDNR Required Submission	Must describe efforts to involve and inform the local community in cleanup efforts and about the future use of the site; within 60 days of permit modification		MHWMF Part I Permit, Schedule of Compliance, Section VI
	Revised Sampling and Analysis Plan	MDNR Required Submission	Must revise the Sampling and Analysis Plan to include certain new requirements and guidelines; within 60 days of permit modification		MHWMF Part I Permit, Schedule of Compliance, Section VIII
	Updated Spill Control Plan / Emergency Plan	MDNR Required Submission	Must include applicable provisions for the GSA portion of the site; submitted within 60 days of permit modification		MHWMF Part I Permit, Schedule of Compliance, Section I.E

TABLE 3
MHWMF Part I Permit: Additional Requirements
re: Institutional Controls and Corrective Action Context

	SWMU	Sub-Areas	Justification	Requirement
1	TCE Still Area	2,3,4,16,33,37,39,40,41 across central part of facility	Further CA for Soil Contamination below buildings or paved areas	Part 1 Permit Section XIII.A.1 - IC and Containment to limit access to contamianted soil - LU Restrictions - Any future maintenance-related excavation/alteration subject to Condition XXI.B - non-maintenance-related excavation/alterations will require a WP
2	Plating Buildings	9,10,11,12		Part 1 Permit Section XIII.A.2 - IC and Containment to limit access to contamianted soil - LU Restrictions - Any future maintenance-related excavation/alteration subject to Condition XXI.B - non-maintenance-related excavation/alterations will require a WP
3	Department 26, Inside	31		Part 1 Permit Section XIII.A.3 - IC and Containment to limit access to contamianted soil - LU Restrictions - Any future maintenance-related excavation/alteration subject to Condition XXI.B - non-maintenance-related excavation/alterations will require a WP
4	Department 27, Inside	32		Part 1 Permit Section XIII.A.4 - IC and Containment to limit access to contamianted soil - LU Restrictions - Any future maintenance-related excavation/alteration subject to Condition XXI.B - non-maintenance-related excavation/alterations will require a WP
5	Matinenance Vehicle Repair Shop	17, 36, 43		Part 1 Permit Section XIII.A.5 - IC and Containment to limit access to contamianted soil - LU Restrictions - Any future maintenance-related excavation/alteration subject to Condition XXI.B - non-maintenance-related excavation/alterations will require a WP
6	95th Street Terrace, SWMU 42		soil contaminated with PCBS, most of which is covered by 20-50 ft of clean soil and beneath a box culvert under Bannister	Part 1 Permit Section XIII.A.6 - DOE and MoDOT to work on Access and Deed Restrictions - 95th Street Remedy - Corrective Measures and Engineering controls in place - ongoing monitoring of effluent, sediment, water, fish - Continued use of IC (XIII.B)
7	Former Landfill, SWMU 44		CERCLA Investigation under FUDS	Part 1 Permit Section XIII.A.7 - if MDNR determines that additional CA is required over the FUDS program, Permittee shall be responsible
8	Northeast Area Recovery wells			Part 1 Permit Section XIII.D - Recovery wells in NE Area shall continue to operate to meet the GPS
9	Groundwater Recovery System			Part 1 Permit Section XIII.E - Permittee shall use the existing P&T system to contain contamination and remove hot spots within the plume. - shall continue to investigate innovate treatement technologies re: high conc. Areas - report on innovative treatment efforts every 3 years in Annual GW CA Report - If buildings are removed from ICGFS, requirementss of XVII.D.3 apply - to address uncovered soils

TABLE 4
Groundwater Protection Standards from Current MHWMF Part 1 Permit

Compound	Maximum Concentration Limit (ug/L)	Source[1]	Maximum Detection Limit (ug/L)	Flow System[2]
Acetone	5500.0	(c)	10.0	BRGFS
Benzene	5.0	(a), (b)	2.0	BRGFS and ICGFS
2-Butanone (MEK)	7000.0	(c)	5.0	BRGFS
Carbon Disulfide	1000.0	(c)	5.0	BRGFS
Chlorobenzene	100.0	(a), (b)	0.7	BRGFS and ICGFS
Chloroethene (Vinyl Chloride)	2.0	(a), (b)	1.8	BRGFS and ICGFS
Chloroform	5.7	(b)	0.5	BRGFS
1,2-Dichlorobenzene	600.0	(a)	1.0	BRGFS and ICGFS
1,1-Dichloroethane	810.0	(c)	0.7	BRGFS and ICGFS
1,2-Dichloroethane	5.0	(a), (b)	0.5	BRGFS and ICGFS
1,1-Dichloroethene	7.0	(a), (b)	1.3	BRGFS and ICGFS
1,2-Dichloroethene	70.0	(a)	0.5	BRGFS
1,2-Dichloroethene (Total)	70.0	(a)	0.5	ICGFS
Ethylbenzene	700.0	(a), (b)	2.0	ICGFS
4-Methyl-2-Pentanone (MIBK)	2000.0	(c)	5.0	BRGFS and ICGFS
Polychlorinated Biphenyls	0.5	(a), (d), (e)	0.5	ICGFS
Tetrachloroethene	0.8	(b)	0.5	BRGFS and ICGFS
Toluene	1000.0	(a), (b)	2.0	BRGFS and ICGFS
1,1,1-Trichloroethane	200.0	(a), (b)	0.5	BRGFS and ICGFS
1,1,2-Trichloroethane	5.0	(a), (b)	0.5	BRGFS
Trichloroethene	5.0	(a), (b)	1.2	BRGFS and ICGFS
1,1,2-Trichlo-1,2,2-Trifluoroethane	59000.0	(c)	5.0	ICGFS
Trichloroflouromethane (Freon 11)	1300.0	(c)	0.8	ICGFS
Xylenes (Total)	10000.0	(a), (b)	7.0	ICGFS
1,4-Dioxane[3]	see footnote 3	see footnote 3	---	BRGFS and ICGFS

[1] (a) = State (10 CSR 60 Chapter 4 - October 31, 2003) and Federal public drinking water regulations
(b) = Missouri Water Quality Standards (10 CSR 20-7.031 - November 30, 2005) for protection of groundwater
(c) = Preliminary Remediation Goals (PRGs) for tap water as contained on the EPA Region IX PRG Table, October 2004
(d) = The Department (MDNR) reserves the right, based on future advances in analytical technology, to modify this Permit to require the Permittee to achieve analytical detection limits for the hazardous constituents covered by Special Permit Condition II.A. which allows for adequate comparison with appropriate health- or environmental protection-based concentration limit(s.)
(e) = Health and/or environmental-based levels are lower than the ability of current analytical technology to routinely attain detection limits at or below such levels. These constituents and their health- and/or environmental-based criteria are listed below:

Constituent	MCL (ug/L)	Source
Polychlorinated Biphenyls	0.000045	(b)

[2] BRGFS = Blue River Groundwater Flow System; ICGFS = Indian Creek Groundwater Flow System

[3] In a letter dated April 28, 2016, the MDNR approved a Class I permit modification that identified USEPA's regional screening level (RSL), as a new Groundwater Protection Standard (GPS). The draft department-initiated permit modification being issued as part of the potential property transfer has proposed a GPS for 1,4-dioxane of 4.6 ug/L, which is based on a 1×10^{-5} excess cancer risk, to be consistent with the approved risk levels used in developing other site-specific cleanup goals.

TABLE 5
Current MSOP and MHWMF Part 1 Permit Stormwater Requirements

	Missouri Hazardous Waste Management Facility Permit Part 1 [1, 3]	Missouri State Operating Permit (MSOP) [2]
Permit Number	MO9890010524	MO-0004863
Sampling Locations	**1** Surface Water Locations Outfall 001 Outfall 002 Outfall 003 Outfall 004 ICU ICDA ICDB ICBR BRU BRD **2** Outfall 002 Locations Flap gate (stormwater) Sluice gate (sediment) **3** Indian Creek Sediment Locations Holmes Bridge (HOB, background) Outfall 002 - Immediately upstream - Immediately downstream - Across channel	Storm Sewer Outfalls 001 002 (sluice gate) 003 004 Downstream Sampling Point S1 - near BRD
Reporting Requirements	Annual Groundwater Corrective Action Report - All Data - Analytical data from weekly Outfall 002 sampling presented in table - Surface water EPA Method 1668 data presented in table	Monitoring reports submitted quarterly
Sampling Requirements	**1** Surface Water Locations Aluminum Arsenic Beryllium Chlorine, Total Residual Chromium, Total Copper Iron Mercury Nitrate/Nitrite Phosphorous/ Total Potassium Silver Sulfate Titanium TCE 1,2-DCE Ammonia Barium Boron Cobalt Cyanide Lead Nickel Oil & Grease Phenol Selenium Strontium Thallium Zinc Chloroethene (Vinyl Chloride) Settleable Solids **2** Outfall 002 Locations Stormwater: PCBs TCE 1,2-DCE Chloroethene (Vinyl Chloride) Sediment: PCBs **3** Indian Creek Sediment Locations PCBs (EPA Method 8082)	Storm Sewer Outfalls PCBs pH Settleable Solids Total Suspended Solids Oil & Grease Aluminum Chromium (IV) TCE 1,2-DCE Vinyl Chloride Downstream Sampling Point PCBs
Other Sampling Requirements	1 Surface Water Locations Total PCBs (EPA Method 1668, 24-Hour Composite Sample) Biochemical Oxygen Demand (BOD_5, 24-Hour Composite Sample) Chemical Oxygen Demand (COD, 24-Hour Composite Sample) Total Organic Carbon (TOC, 24-Hour Composite Sample) Settleable Solids (24-Hour Composite Sample) pH Temperature **3** Indian creek Sediment Locations Additional sampling as needed Calculation of Hazard Quotient	Storm Sewer Outfalls Flow Hardness Rainfall (as measured at USGS Gauging Station #06893400) Downstream sampling point Flow Hardness
Discharge Limits	None	Daily Maximum PCBs = 0.5 µg/L pH = 6.5-9.0 Settleable Solids = 1.5 mL/L Oil & Grease = 15 mg/L All other compounds have notification limit of 100 µg/L Monthly Average pH = 6.5-9.0 Settleable Solids = 1.0 mL/L Oil & Grease = 10 mg/L
Sampling Frequency	1 Surface Water Locations Semi-annually (complete analysis for first sampling event, PCBs only for second sampling event) **2** Outfall 002 Locations Stormwater: Semi-monthly Sediment: Monthly **3** Indian creek Sediment Locations Quarterly	Storm Sewer Outfalls Daily: Rainfall Weekly: Flow, PCBs, pH Monthly: Settleable Solids, Total Suspended Solids, Oil & Grease Quarterly: All other analytes Downstream Sampling Point All measurements monthly

Source:
[1] Missouri Hazardous Waste Management Facility Permit Part 1 (August 2012)
[2] Missouri State Operating Permit (October 2012)
[3] Sampling and Analysis Plan (Appendix E) (May 2013)
[4] Groundwater Corrective Action Report For Calendar Year 2012 Volume 1 (March 2013)
[5] Corrective Measures Study for the 95th Terrace Site (Appendix B) (July 2004)

Notes:
(A) Source 3, the most recent SAP, and source 5, the 2004 SAP, differ slightly. Information from source 5 is presented here
(B) When possible and when sample timing overlaps, the same PCB and VOC analytical data may be collected and reported to satisfy the requirements of both the MHWMF Part 1 Permit and the MSOI
(C) While no discharge limits are specified under the MSHMF Part 1 Permit for surface water, the analytical data are compared to the MO surface water standards in the Groundwater Corrective Action Report

TABLE 6
Proposed Site-Specific Cleanup Levels for the BFC, Industrial/Commercial Land Use (after ToxStrategies, 2017)

Chemicals of Concern	Soil 0 to 2 feet bgs (mg/kg)			Soil 2 to 12 feet bgs (mg/kg)			Groundwater (ug/L)		
	Proposed Cleanup Goal (Cancer Risk at 1 x 10^{-5})	**Proposed Default Cleanup Goal (Hazard Index at 0.1)**	**Final Proposed Cleanup Goal [1]**	**Proposed Cleanup Goal (Cancer Risk at 1 x 10^{-5})**	**Proposed Default Cleanup Goal (Hazard Index at 0.1)**	**Final Proposed Cleanup Goal[1]**	**Proposed Cleanup Goal (Cancer Risk at 1 x 10^{-5})**	**Proposed Default Cleanup Goal (Hazard Index at 0.1)**	**Final Proposed Cleanup Goal [1]**
1,1-Dichloroethene								7.6	7.6
1,2-Dichlorobenzene		1000	1000		2000	2000		200	200
1,2-Dichloroethene (Total)		260	260		680	680		73	73
1,4-Dichlorobenzene	127		127	640		640	80	130	80
Benzene								6.8	6.8
Chlorobenzene								48	48
Hexavalent Chromium	34		34	34		34			
PCBs[2]	10		10	75		75	2.4		2.4
PCB-1254		0.7	0.7		0.7	0.7			
Tetrachloroethene		8.7	8.7		8.7	8.7		4.8	4.8
Trichloroethene	340	0.4	0.4	340	0.4	0.4	200	0.22	0.22
Vinyl Chloride	100	6.4	6.4	100	6.4	6.4	110	5.8	5.8
Xylenes								40	40

Notes:

1. Final proposed cleanup goal is minimum of cleanup goals based on cancer risk and noncancer hazard index.

2. For soil from 2 to 12 feet bgs, this proposed cleanup goal is applicable to total PCB measurement or the sum of Aroclors. If dioxin-like PCBs are measured, use the target level 0.00024 mg/kg for the dioxin-like congeners in soil. If PCB -1221 or PCB-1232 is dected in soil, use 63 and 52 mg/kg, respectively.

Abbreviations:

mg/kg - milligram per kilogram

ug/L - microgram per liter

TABLE 7
Estimated Cost for Proposed Corrective Measures

Capital Costs	Cost Estimate
Soil Corrective Measures	
Soil Excavation	$ 11,900,000
Engineered Caps	$ 1,400,000
Groundwater Corrective Measures	
Abandon and Replace Monitoring Wells (Years 1 and 4)	$ 2,300,000
Modify Groundwater Extraction and Treatment System - Pre-Demolition	$ 5,000,000
Modify Groundwater Extraction System - Post Demolition (Year 4)	$ 2,600,000
Source Area Corrective Measure	
Barrier Wall Installation	$ 3,600,000
Stormwater Management, Utility Removal, Site Grading, and Utilities	
Temporary Sedimentation Basins, Stormwater Protection and Treatment	$ 10,400,000
Remove Utilities	$ 7,100,000
Close Outfalls 001-004, and F	$ 8,900,000
Grade Site and Install New Outfalls	$ 27,100,000
Install Public and Private Utilities	$ 5,500,000
Repair and Upgrade Groundwater Treatment Plant Building	$ 700,000
Vapor Intrusion Corrective Measure	
Install Vapor Barriers and Passive Venting for Future Buildings	$ 11,700,000
Capital Cost Subtotal	**$ 98,200,000**
Operation, Maintenance, Monitoring, and Reporting Costs - Years 1 to 30	
Groundwater Extraction and Treatment System O&M ($690,00 to $760,000 per year)	$ 21,000,000
Groundwater Monitoring and Reporting ($510,000 to $670,000 per year)	$ 16,000,000
MSOP Compliance, Monitoring, and Reporting ($180,000 per year)	$ 5,300,000
MHWMF Surface Water/Sediment/Outfall Compliance ($110,000 to $320,000 pear year)	$ 4,100,000
Future O, M and M Costs Subtotal	**$ 46,400,000**
TOTAL (2016 Dollars)	**$ 144,600,000**
ROUNDED TOTAL (2016 Dollars)	**$ 145,000,000**
TOTAL -30%	**$ 101,000,000**
TOTAL +50%	**$ 217,000,000**

APPENDICES

Appendix A

Risk Maps from “Technical Memorandum: Proposed Cleanup Levels for On-Site Areas of the Bannister Federal Complex” (ToxStrategies, 2017)

Figure 7A. Potential Carcinogenic Risks or Hazard Indexes Exceeding Target Levels for Chemicals in Shallow Soil (top 2 feet of soil) – Outdoor Worker

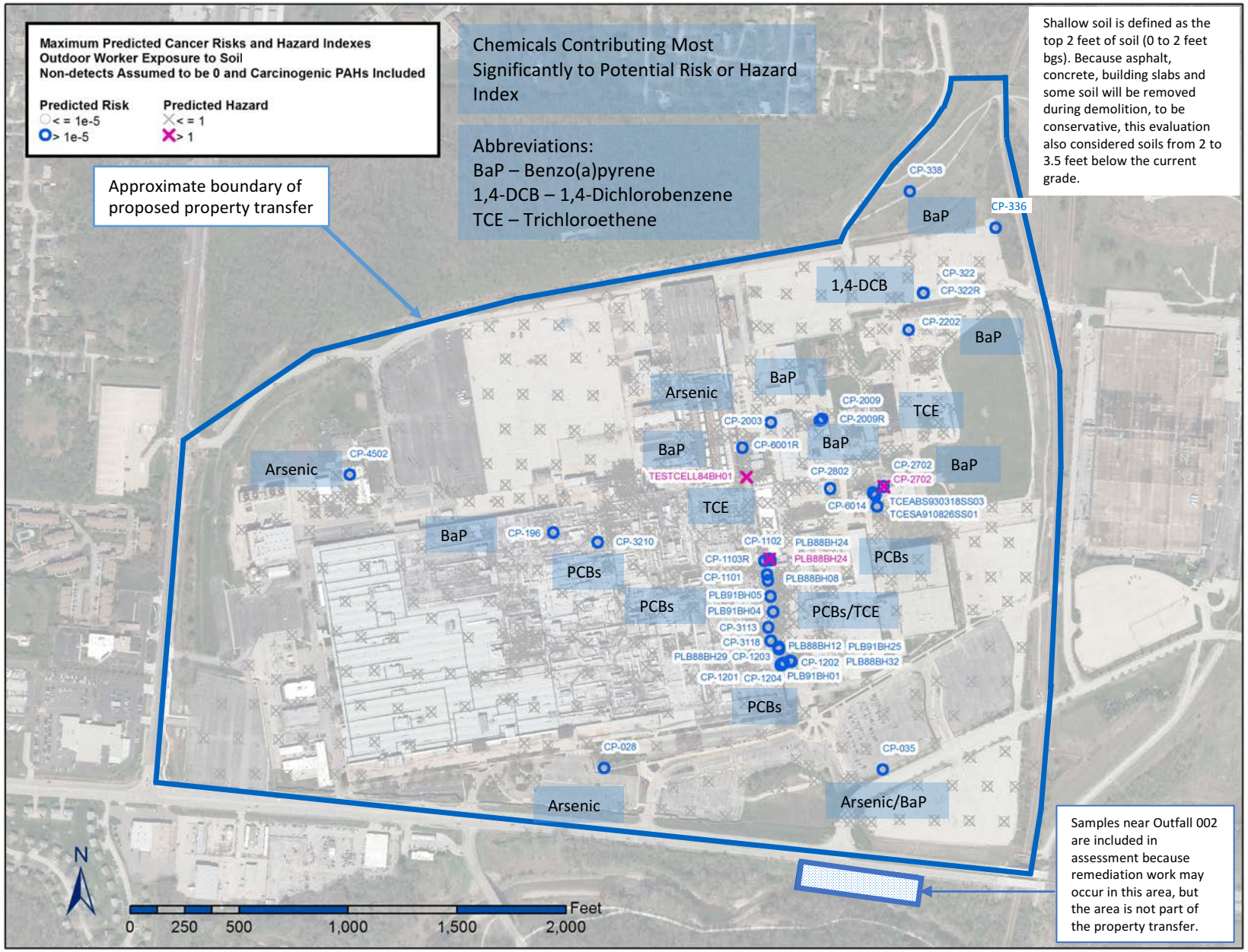


Figure 7B. Potential Carcinogenic Risks or Hazard Indexes Exceeding Target Levels for Chemicals in Shallow Soil (top 2 feet of soil) Excluding Carcinogenic PAHs – Outdoor Worker

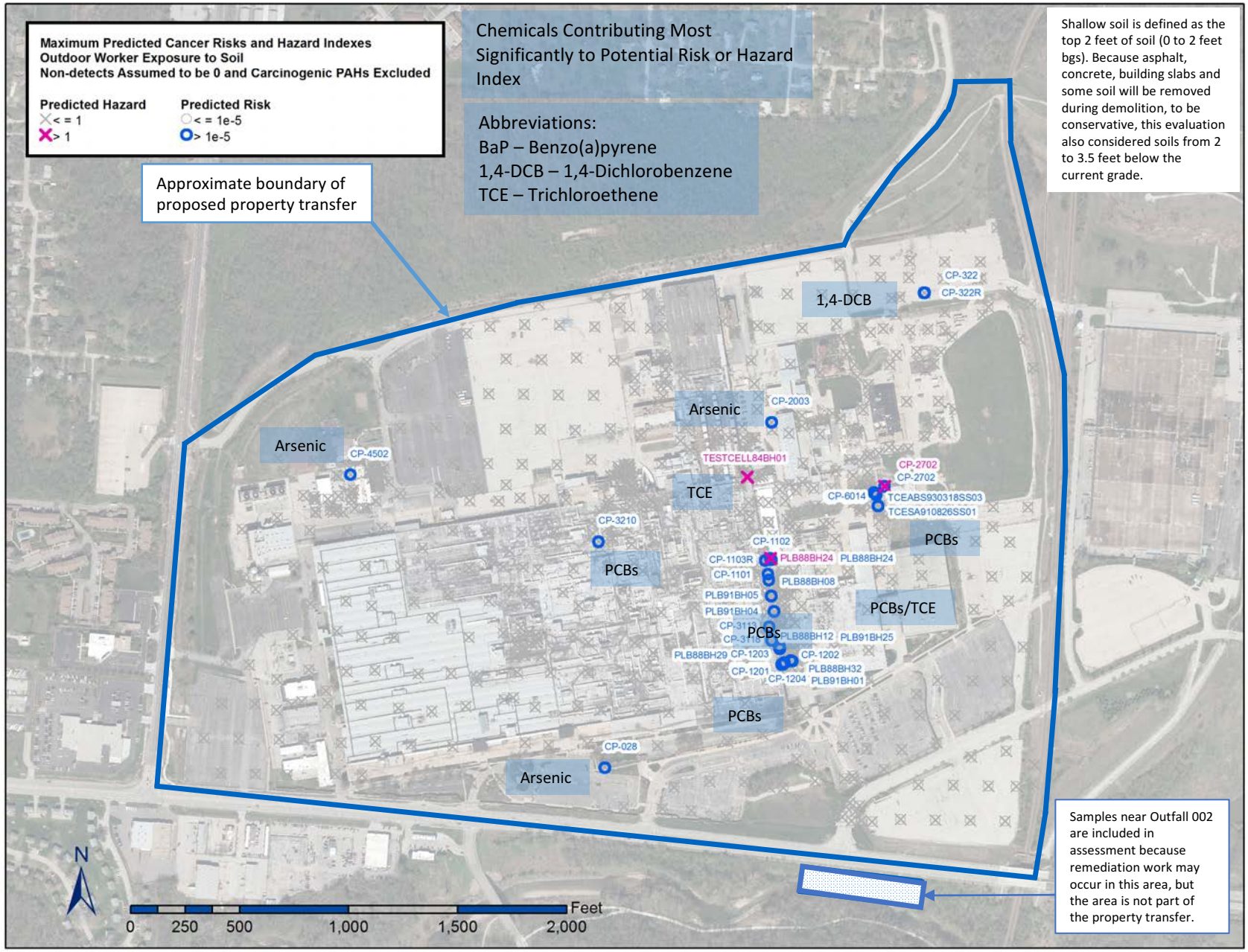


Figure 8. Potential Carcinogenic Risks or Hazard Indexes Exceeding Target Levels for Chemicals in Shallow Soil (top 2 feet of soil) – Construction Worker

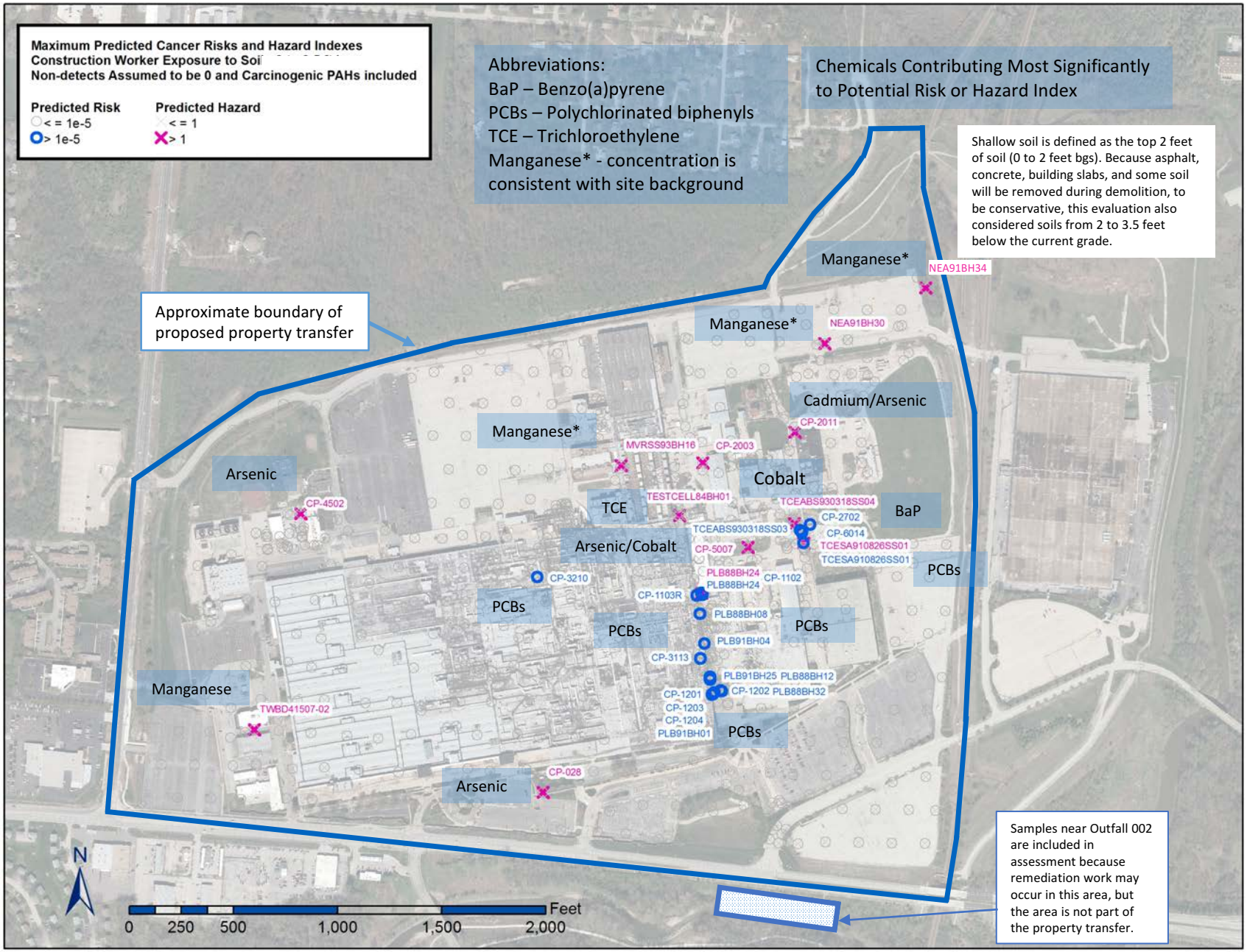


Figure 9. Potential Carcinogenic Risks or Hazard Indexes Exceeding Target Levels for Chemicals in Shallow Soil (top 2 feet of soil) – Trench Utility Worker

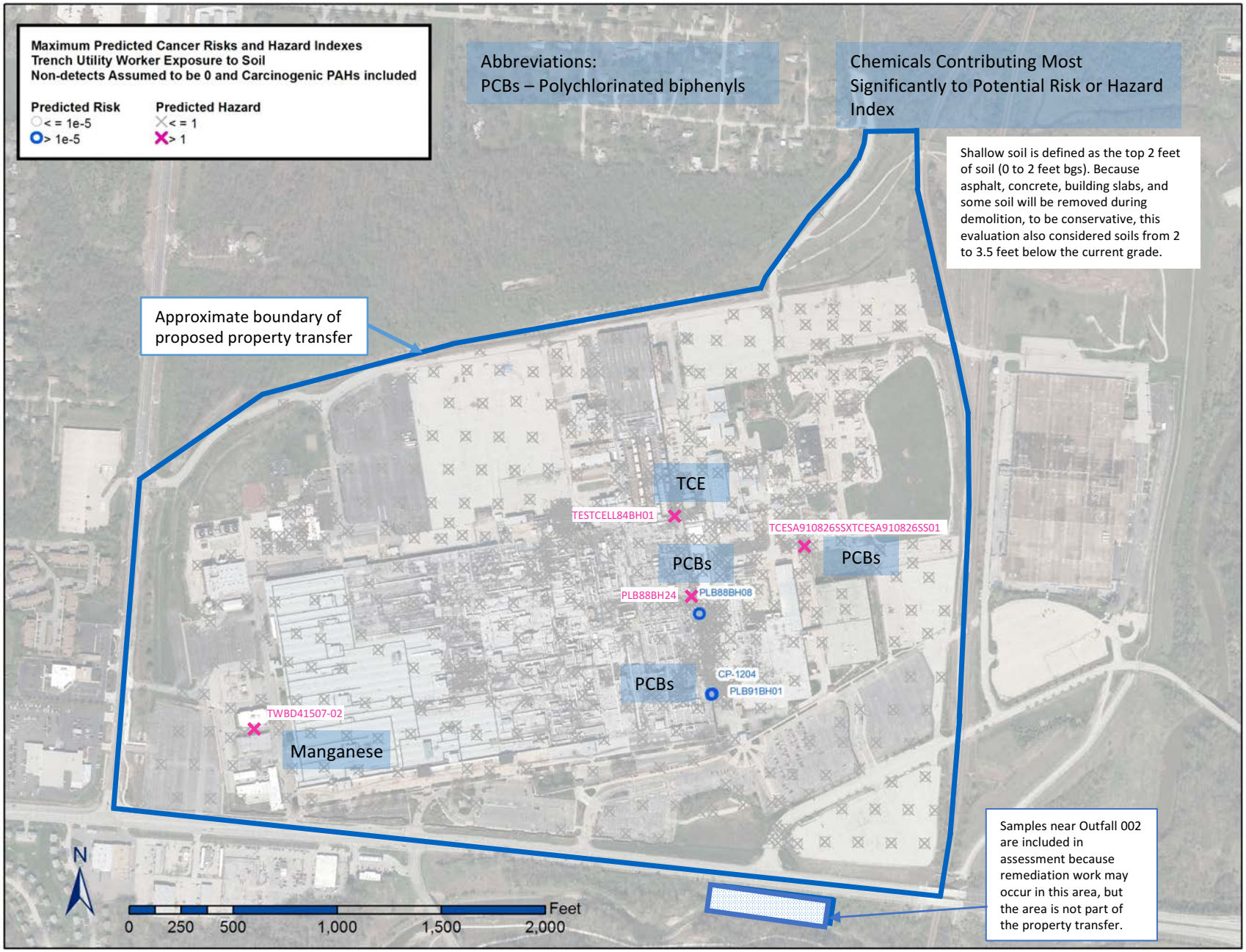


Figure 10. Potential Carcinogenic Risks or Hazard Indexes Exceeding Target Levels for Chemicals in Deeper Soil (2 to 12 feet below top of soil) – Construction Worker

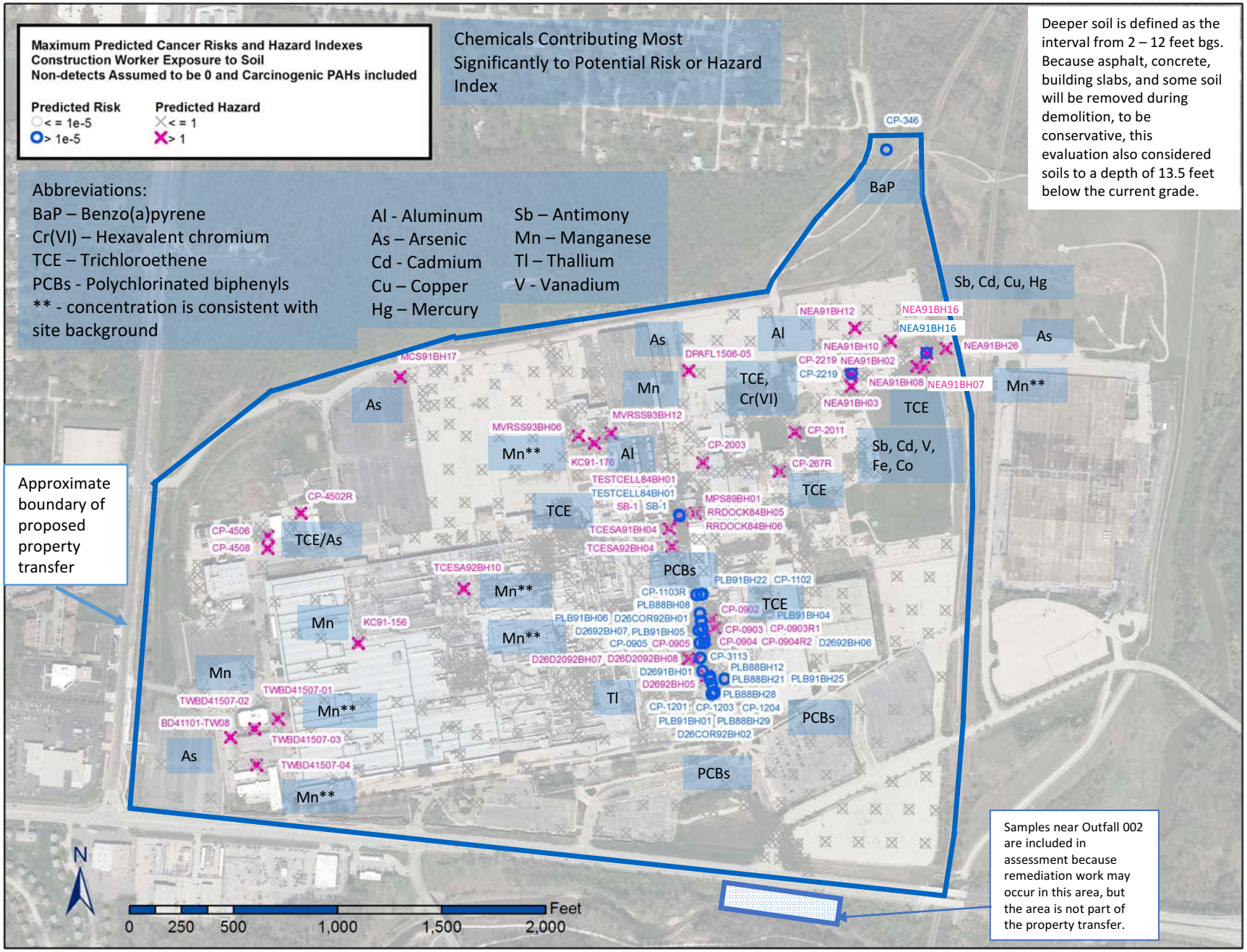


Figure 11. Potential Carcinogenic Risks or Hazard Indexes Exceeding Target Levels for Chemicals in Deeper Soil (2 and 12 feet below top of soil) – Trench Utility Worker

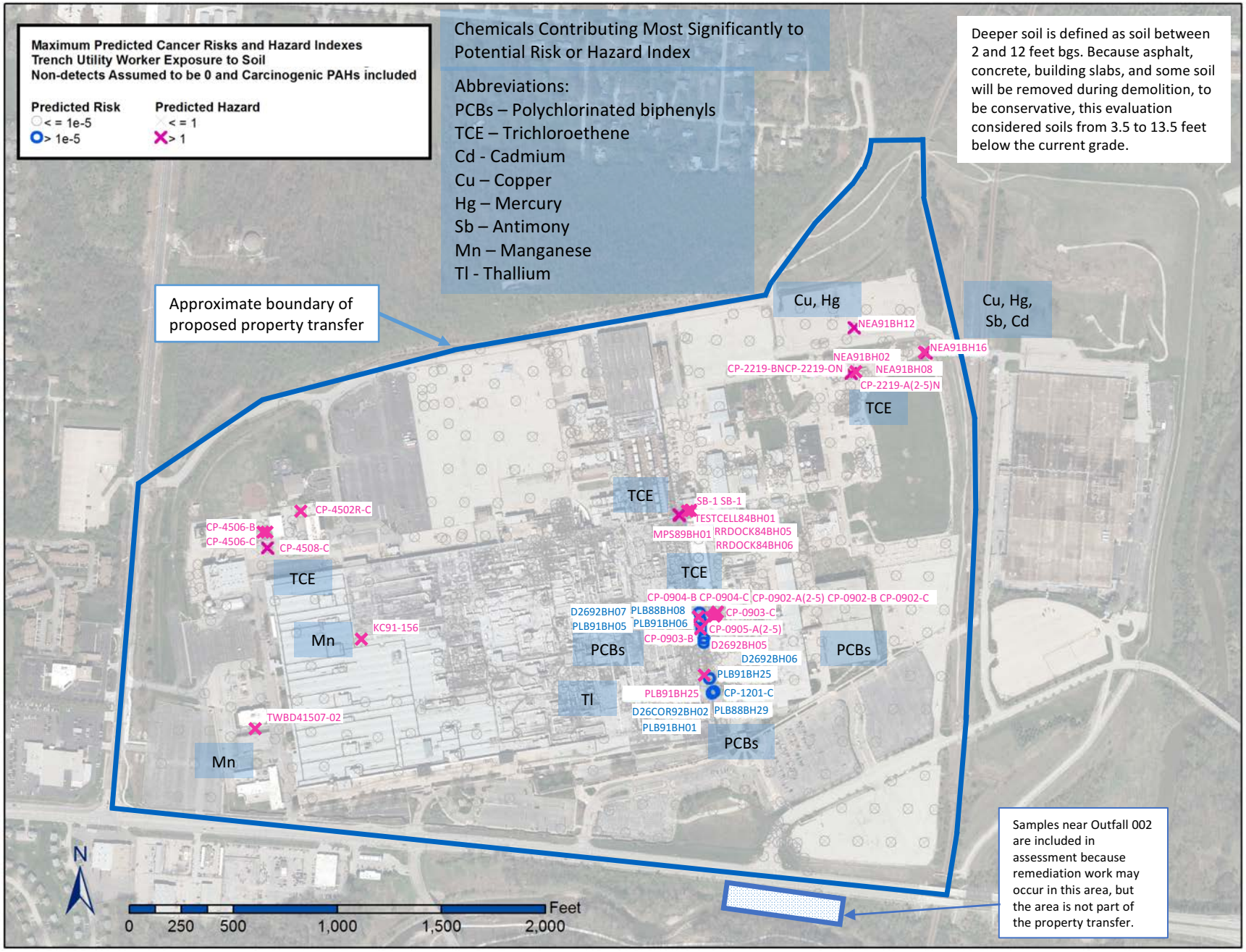


Figure 12. Lead Exceeding the Screening Level in Deeper Soil (2 to 12 feet below top of soil)

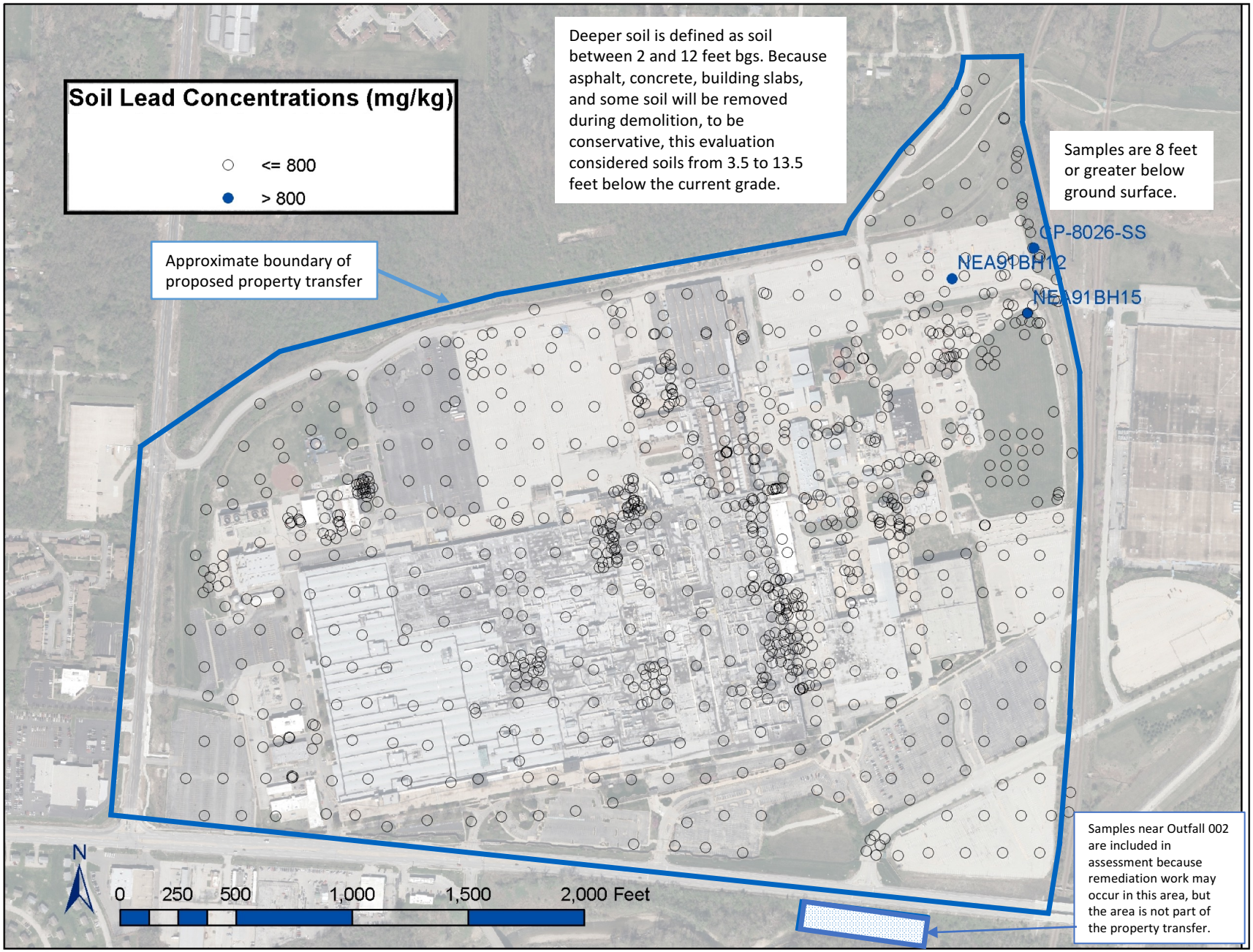


Figure 13. Potential Carcinogenic Risks or Hazard Indexes Exceeding Target Levels for Chemicals in Groundwater – Indoor Worker

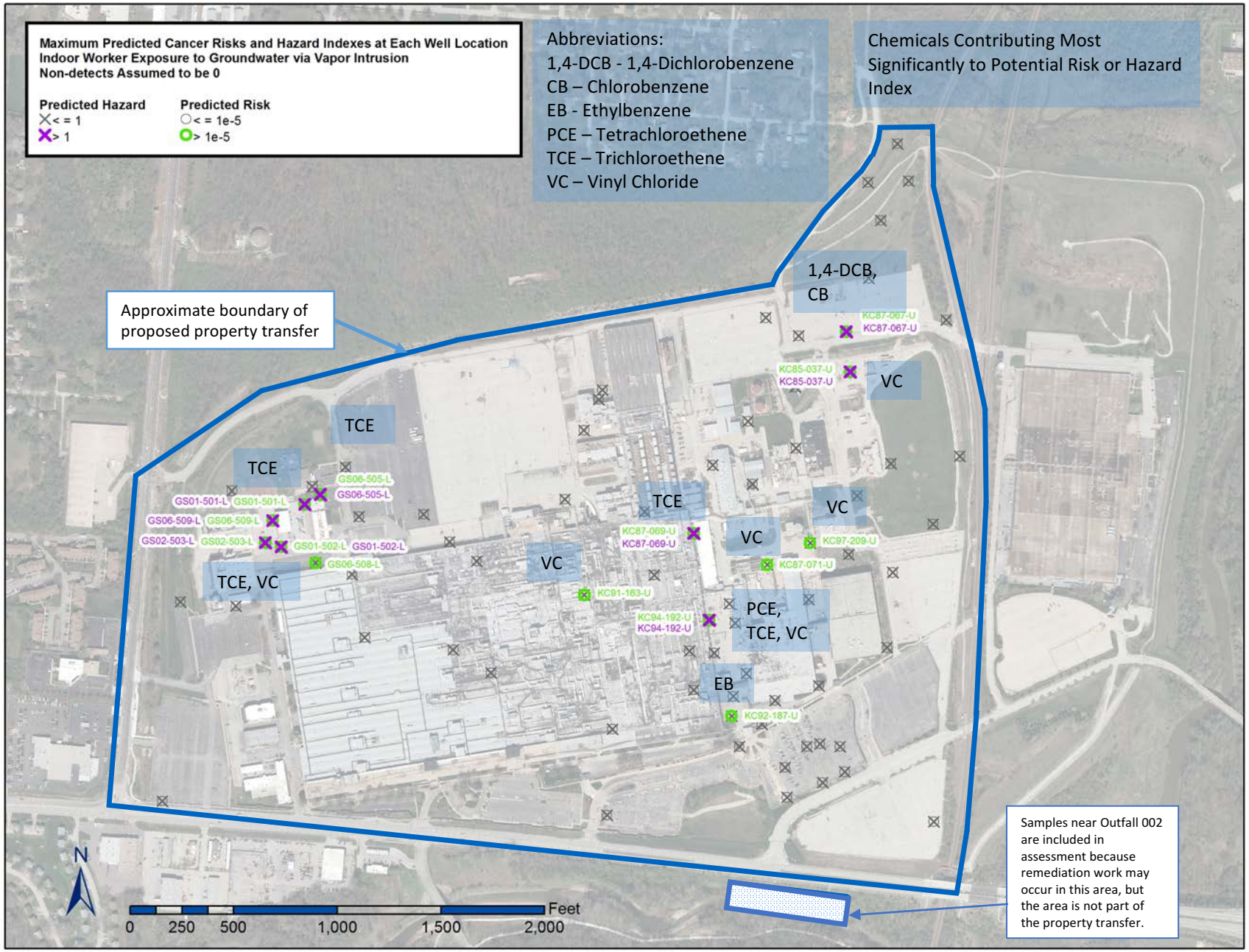


Figure 14. Potential Carcinogenic Risks or Hazard Indexes Exceeding Target Levels for Chemicals in Shallow Groundwater – Construction Worker

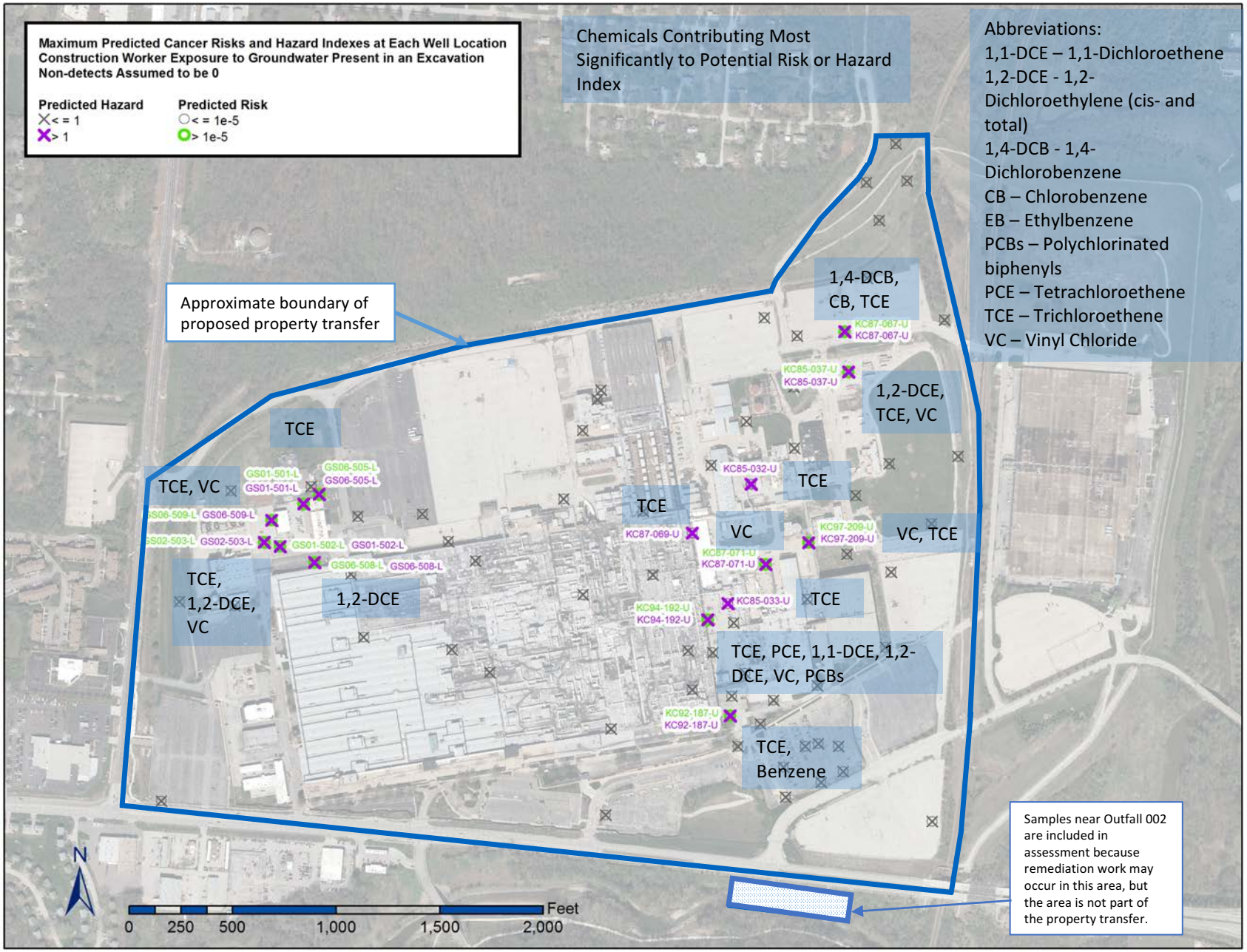


Figure 15. Potential Carcinogenic Risks or Hazard Indexes Exceeding Target Levels for Chemicals in Pooled Groundwater –Trench Utility Worker

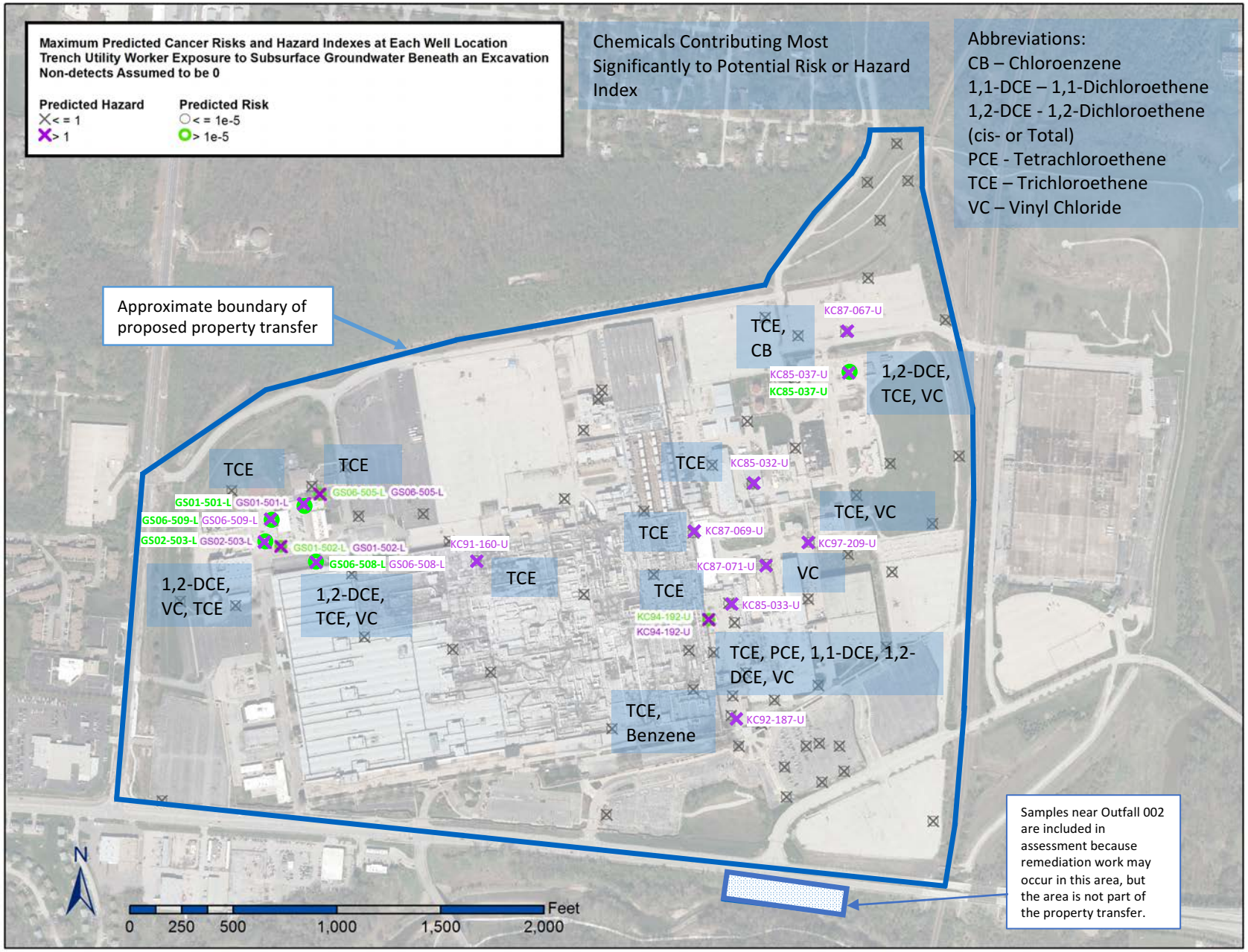
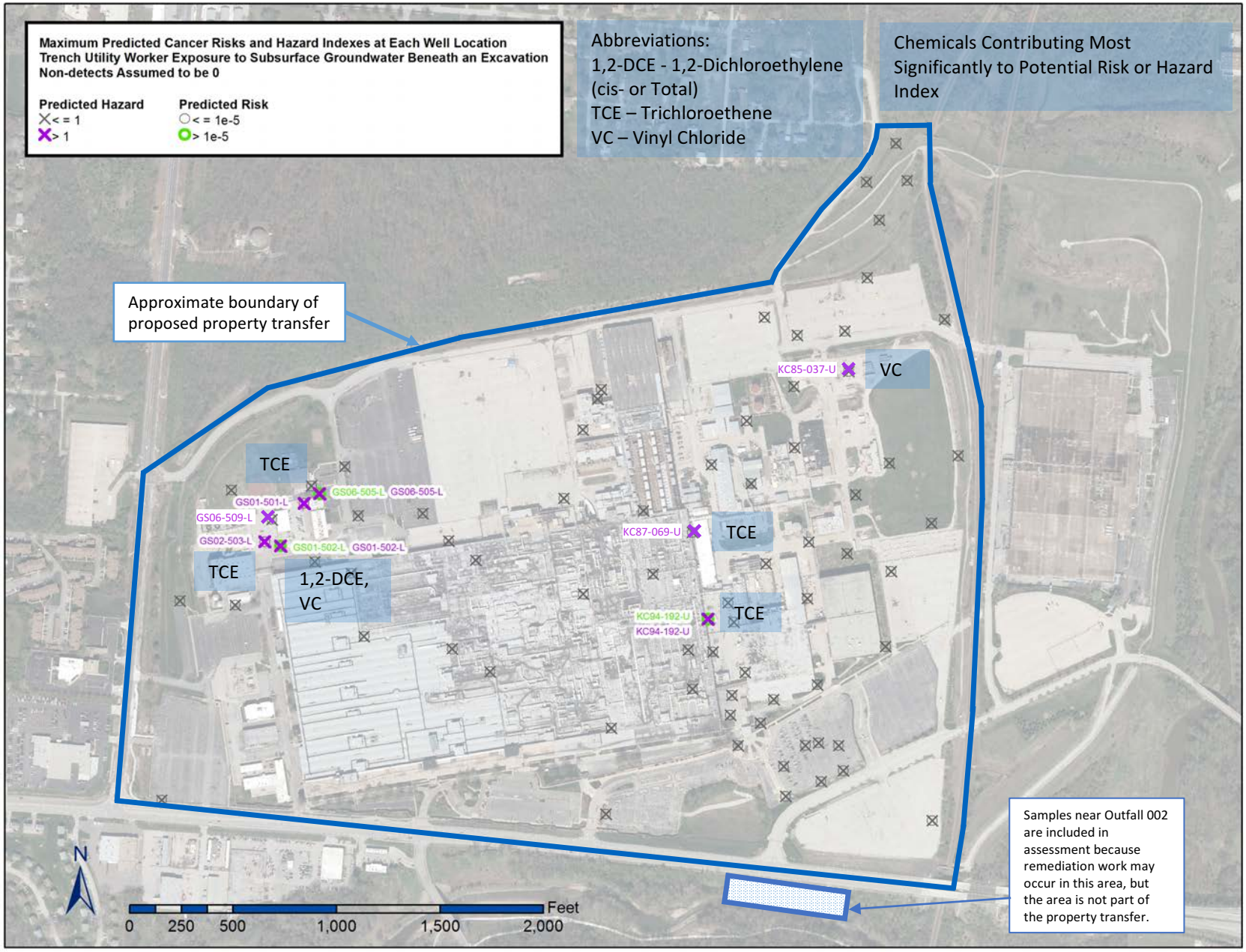


Figure 16. Potential Carcinogenic Risks or Hazard Indexes Exceeding Target Levels for Chemicals in Subsurface Groundwater – Trench Utility Worker



Appendix B

Screening of Corrective Measures

Appendix B
Screening of Corrective Measures

Various corrective measures were considered to address contaminants of concern at the Bannister Federal Complex. Corrective measures and the screening results are described below and presented in Table B.1 and Table B.2 by the impacted media – soil or groundwater. The corrective measures are generally organized by the location of application: in-situ or ex-situ. In-situ treatments are further categorized by the nature of the treatment: destruction, removal, or stabilization / immobilization. The screening considers applicability of corrective measures to target COCs and ability to achieve remediation goals, as well as site specific factors such as applicability of the corrective measures to the fine grained soils at the site and compatibility with anticipated site redevelopment.

The screening approach used in this appendix follows the format of the Federal Remediation Technologies Roundtable's "Treatment Technologies Screening Matrix", which USEPA references as a primary source for "Remediation Technologies for Contaminated Sites" (FTRT, 2002).

1.0 Soils

Corrective measures considered potentially applicable to contaminated soil included:

In Situ Destruction

- Enhanced Bioremediation
- Phytoremediation
- Bioventing
- Oxidation
- Reduction
- Thermal Conductive Heating

In Situ Removal

- Soil Flushing
- Soil Vapor Extraction
- Electrical Resistance Heating

In Situ Stabilization / Immobilization

- Capping
- Solidification/Stabilization

Ex Situ

- Excavation

Other

- Institutional Controls

The considered technologies are described below and the screening results presented in Table B.1.

1.1 Enhanced Bioremediation (via Injection or Soil Mixing)

In-situ bioremediation uses indigenous or applied bacteria to biodegrade organic compounds in groundwater and soil. The process requires the delivery of nutrients and, for aerobic degradation, an oxygen source to the subsurface.

Bioremediation via injection of bacteria was eliminated in the preliminary screening based on experience and engineering expertise concluding it would be difficult to achieve effective contact and delivery by injection in the fine grained clay soils at the site.

Bioremediation via deep soil mixing was considered in the preliminary screening analysis, but did not pass additional screening because of the uncertain ability of soil mixing to sustain bacteria populations and degradation conditions in the subsurface for sufficient time to achieve cleanup goals. In addition, soil mixing is not compatible with the anticipated site redevelopment because soil would have little compressive strength after soil mixing. Post-treatment soil improvement would be required in the treatment area to allow for future development, which would interfere with the project schedule and add significant costs.

1.2 Phytoremediation

Phytoremediation uses plants to contain, destroy, extract, or immobilize contaminants in soil and groundwater. The effective remediation depth is limited to the depth of tree roots. Phytoremediation is effective at low contaminant concentrations, but high concentrations may limit plant growth. Phytoremediation is effective for metals, VOCs, and TPH, and has limited effectiveness for PCBs.

Phytoremediation was considered unlikely to achieve site cleanup goals because it is limited to shallow soils and groundwater, would likely require a large surface area of land, seasonal conditions may inhibit plant growth, and high concentrations of hazardous materials can be toxic to plants (FTRT, 2002).

1.3 Bioventing

Bioventing uses a network of vadose-zone wells and blowers to inject nutrients and/or oxygen into the contaminated soil to enhance the biodegradation activity of indigenous bacteria.

Bioventing was eliminated because low permeability soils are difficult to treat with this technology (FTRT, 2002).

1.4 Oxidation (via Injection or Soil Mixing)

Chemical oxidation technology is based on the oxidative power of specific chemicals to destroy contaminants or make them less toxic. Various oxidants can be used including: permanganate (sodium and potassium), persulfate (sodium, potassium and ammonium), peroxide (with iron, Fenton's reagent), and ozone. Different oxidants have various relative strengths, stabilities and abilities to persist in situ as well as varying effectiveness on site contaminants. Most are effective for VOCs and light TPH but only some have been shown to have minimal effectiveness for PCBs and heavy TPH. Chemical oxidation is effective in saturated and unsaturated zones and results in the destruction of VOC mass present as non-aqueous phase liquid

(NAPL) and rapid reduction in concentrations in soil and groundwater. The treatment time frame for in situ oxidation depends upon the oxidant used in the reaction. For example, Fenton's reagent reacts within days, while the reaction/persistence time of permanganate is on the order of several months.

Injection of oxidants was eliminated in the preliminary screening based on engineering experience and expertise concluding it would be difficult to achieve effective contact and delivery by injection in the fine grained clay soils at the site.

Oxidation via deep soil mixing was eliminated in the preliminary screening primarily because the soil would have little compressive strength after soil mixing. Post-treatment soil improvement would be required in the treatment area to allow for future development, which would interfere with the project schedule and add significant costs. There is also a risk that oxidation via deep soil mixing could mobilize chromium in groundwater. This risk was not evaluated in detail since soil mixing was determined not to be compatible with anticipated site redevelopment.

1.5 Reduction (via Injection or Soil Mixing)

Chemical reduction technology uses an additive such as zero-valent iron (ZVI) applied via injection or soil mixing to facilitate reductive degradation of contaminants. This technology is applicable to unsaturated and saturated zones and has demonstrated effectiveness for halogenated VOCs in clay soil and no treatment of PCBs. The reductive treatment of VOCs would occur on the order of several months.

ZVI injection was eliminated in the preliminary screening based on engineering experience and expertise concluding it would be difficult to achieve effective contact and delivery by injection in the fine grained clay soils at the site.

Reduction via soil mixing was eliminated during additional screening because the soil would have little compressive strength after soil mixing. Post-treatment soil improvement would be required in the treatment area to allow for future development, which would interfere with the project schedule and add significant costs.

1.6 Thermal Conductive Heating

Thermal Conductive Heating (TCH) relies on heating the subsurface using electric or gas powered heater wells capable of generating very high temperatures (i.e., >1,000°F) causing contaminants to be vaporized or destroyed and allowing treatment of compounds like heavy TPH and PCBs. TCH requires an off-gas capture and treatment system. Heating elements can be powered by either gas or electricity depending on local utility costs. The system would have to be designed to limit or prevent groundwater influx.

TCH was eliminated during preliminary screening because the significant infrastructure and time for treatment would likely restrict significant portions of the site from redevelopment.

1.7 Soil Flushing

Soil flushing is an in-situ technology for the extraction of contaminants from the soil with water or other suitable aqueous solutions. Typically, water or water containing an additive (e.g., surfactant or solvent) to enhance contaminant solubility is applied to the soil or injected into the groundwater to raise the water table into the contaminated soil zone. Contaminants are leached into the groundwater, which is then extracted and treated or disposed.

Soil flushing was eliminated because low permeability soils are difficult to treat with soil flushing (FTRT, 2002).

1.8 Soil Vapor Extraction

Soil vapor extraction removes the more volatile, low molecular-weight components from soil in a manner that is similar to air stripping. This system works by applying a vacuum to either a horizontal or vertical extraction well(s) that are completed in the vadose zone. The volatile component is removed from the soil in both the unsaturated zone and capillary fringe. The produced gases that are stripped can then be treated by condensation, granular activated carbon (GAC), thermal destruction, or other means.

Soil vapor extraction was eliminated because they are less effective in tight (low-permeability) soils (FTRT, 2002)

1.9 Electrical Resistance Heating

Electrical resistance heating (ERH) is a thermal treatment option that uses heat generated by the resistance of the soil matrix to the flow of electrical current to raise subsurface temperatures up to the boiling point of water (212°F or 100°C). The electrodes can be controlled to direct electrical current into specific targeted subsurface depth intervals. During ERH, volatile compounds transition to the vapor phase and are captured by a vapor recovery system. ERH is implemented using three phase or six phase heating.

ERH passed the preliminary screening as the technology is feasible in the fine grained soils at the site. The technology was excluded from the additional screening because the significant infrastructure and time required for treatment using this technology that would restrict significant portions of the site from redevelopment.

1.10 Capping

Capping involves installing a layer of low permeability soil (e.g. clay), concrete, or asphalt on the ground surface over top of contaminated soil. Capping limits access to soil and migration of contaminants through surface water runoff and air. Capping the ground surface with asphalt or concrete may increase surface runoff, but the surface water would not be in contact with the contaminated soil. This is commonly used technology that can be implemented easily.

Capping is retained for development of alternatives.

1.11 In-situ Solidification/Stabilization via Deep Soil Mixing

In-situ solidification/stabilization (S/S) is a treatment technology that mixes inorganic cementitious/pozzolanic reagents into contaminated material to transform it into a durable, solid, low-hydraulic conductivity material that reduces the rate of contaminant migration through leaching. Large augers would be used to mix soil while injecting reagents. S/S does not destroy contaminants, but rather renders them immobile. As such, long term stewardship and monitoring of leachability are required with this remedy. S/S has been effective in immobilizing PCBs and TPH at other sites, but has very limited demonstrated effectiveness for halogenated VOCs.

S/S is excluded from development of alternatives because it is not a proven technology for chlorinated volatile organic compounds (CVOCs) and is unlikely to achieve cleanup goals.

1.12 Soil Excavation

Soil excavation involves the physical removal of contaminated soil and either onsite treatment and reuse, or offsite disposal. This action includes excavation with standard construction equipment, including shoring, dewatering pumps/equipment, and treatment of water that accumulates in the excavation. Large Diameter Augers (LDA) can also be used to excavate deep soils to eliminate shoring and minimize dewatering efforts. Deep excavation is a reliable method for complete source removal for all COCs within the excavation area, but is intrusive and increasingly cost prohibitive with increasing depth of excavation.

Soil excavation with onsite soil treatment was eliminated in the preliminary screening due to the large amount of land and equipment required to treat the soils that would likely conflict with site development.

Deep soil excavation with offsite disposal is retained for alternative development, as it would be effective at achieving cleanup goals for all contaminants.

1.13 Institutional Controls

Institutional controls restrict access to soil and groundwater underlying the site using land use covenants and management procedures for future intrusive work. Typically used in conjunction with other technologies, limiting access to the subsurface, providing long-term management procedures, and restricting land use are integral assumptions to the various alternatives; therefore, institutional controls are retained in the corrective measure alternatives.

2.0 Groundwater

Corrective measures considered potentially applicable to contaminated groundwater included:

In Situ Destruction

- Monitored Natural Attenuation
- Permeable Reactive Barrier
- Phytoremediation

- Bioslurping

In Situ Removal

- Air Sparging
- Dual Phase Extraction

In Situ Stabilization / Immobilization

- Utility Removal / Plugging / Upgrade
- Vertical Subsurface Barrier Walls

Ex Situ

- Extraction and Treatment

The considered technologies are described below and the screening results presented in Table B.2.

2.1 Monitored Natural Attenuation

Natural attenuation processes are commonly used for remediation of contaminated sites. A variety of natural processes occur without human intervention at varying rates and degrees of effectiveness to attenuate (i.e., decrease) the mass, toxicity, mobility, volume, or concentrations of organic and inorganic contaminants in soil, groundwater, and surface water systems. As defined in the U.S. Environmental Protection Agency (USEPA) policy for monitored natural attenuation as a remediation alternative, these in situ, natural attenuation processes include: biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants.

Monitored natural attenuation passed the preliminary screening process, but was eliminated during additional screening because active groundwater extraction and treatment have been required to control groundwater and achieve groundwater protection standards historically, and will be required into the future. Under current conditions, without active groundwater control, discharge of contaminated groundwater to off-site groundwater above permitted levels is a likely outcome. Under future conditions, when contaminant concentrations have been further reduced, monitored natural attenuation may become as suitable alternative worth evaluating in detail.

2.2 Permeable Reactive Barrier

A permeable reactive barrier (PRB) is a passive treatment system that creates a barrier to the target contaminant, but not to groundwater. The majority of installed PRBs use iron metal, Fe(0), as the reactive media for converting contaminants to nontoxic or immobile species. The funnel-and-gate design PRB uses impermeable walls (sheet pilings, slurry walls, etc.) as a "funnel" to direct the contaminant plume to a "gate" containing the reactive media, whereas a continuous PRB completely transects the plume flow path with reactive media. PRBs have been successful remediating CVOCs at other sites.

In 1997-1998, a reactive barrier wall was installed at the BFC to treat groundwater contamination in the northeast plume area. As noted by Allied Signal FM&T (1998), "the use of zero valent iron as a permeable reactive barrier for subsurface contaminant remediation is a relatively new innovative in-situ technology which has been actively supported by the U.S. EPA

through ongoing research at a number of it's [sic] facilities." Following installation, it was concluded that "the iron wall is degrading both the vinyl chloride and cis-l ,2-DCE to below both their respective MCL and detection limits." (URS Greiner Woodward Clyde Federal Services, 1999). Nonetheless, analysis of the plume following wall installation indicated bypassing of the reactive barrier by contaminated groundwater (URS Greiner Woodward Clyde Federal Services, 2000). Oak Ridge National Laboratory (2000) attributed this bypassing to vertical and horizontal flow paths that differed from those in the design concept, and a low-permeability smear layer along the leading edge of the wall created during construction.

For this evaluation, the PRB passed the preliminary screening, but was eliminated in the additional screening process. For the target installation areas, screening calculations indicated that an unreasonable wall thickness would be required to treat the observed concentrations of vinyl chloride and to achieve the groundwater cleanup goals. Additionally, the groundwater contamination at the site is widespread and would require a PRB or funnel and gate of significant length substantially increasing costs.

2.3 Phytoremediation

Phytoremediation (discussed previously) uses plants to contain, destroy, extract, or immobilize contaminants in soil and groundwater. Phytoremediation is effective at low contaminant concentrations, but high concentrations may limit plant growth. Phytoremediation is effective for metals, VOCs, and TPH, and has limited effectiveness for PCBs.

Phytoremediation was eliminated for further evaluation because its impact is limited to shallow soils groundwater, whereas the highest concentrations of contaminants at the site are in the deeper alluvium, because the volume of water requiring extraction for plume control would require sufficient plants to interfere with site development plans, and because experience suggests that phytoremediation would also require substantial maintenance and protection of plants from deer, disease, drought, etc. which was incompatible with site development plans.

2.4 Bioslurping

Bioslurping involves the simultaneous application of vacuum enhanced extraction/recovery, vapor extraction, and bioventing to address light non-aqueous phase liquids (LNAPL) contamination. Vacuum extraction/recovery is used to remove free product along with some groundwater, vapor extraction is used to remove high volatility vapors from the vadose zone, and bioventing is used to enhance aerobic biodegradation in the vadose zone and capillary fringe.

Bioslurping was eliminated because it is less effective in tight (low-permeability) soils (FRTR, 2002)

2.5 Air Sparging

Air sparging consists of the injection of air into the saturated zone of the contaminated aquifer, transfer of VOCs from the groundwater to the air as the air moves through the aquifer, and the subsequent collection and treatment of the resulting vapor in the unsaturated zone.

Air sparging was eliminated because it is less effective in tight (low-permeability) soils (FRTR, 2002)

2.6 Dual Phase Extraction

Dual phase extraction (DPE) uses a high-vacuum system to remove both contaminated groundwater and soil vapor. Fluid/vapor extraction systems depress the water table increasing flow to the extraction well by increasing the head. The lowered water table also exposes previously saturated soils and allows contaminates to be removed by vapor extraction. Once above ground, the extracted vapors, liquid-phase organics, and groundwater are separated and treated.

DPE was eliminated in the preliminary screening because soil that has a high percentage of fines and a high degree of saturation requires higher vacuums and/or hinders the operation of soil vapor extraction (FTRT, 2002) and these limitations also apply to DPE.

2.7 Utility Removal / Plugging / Upgrade

Pipe plugging and upgrade are mechanical technologies that can eliminate a pipe/conduit as a potential preferential pathway or reduce the potential for contaminants to enter the pipe/conduit, respectively. For pipe plugging, typically the utility would be backfilled with a material such as concrete designed to block or seal the pipe. For pipe upgrade, typically a section of the pipe would be excavated, cut and removed, sealed at the ends, and a section of new material (that is more stable, flexible and potentially does not have joints along the pipe‘s length) would be replaced. Pipe upgrade could also include installation of new utilities along new alignments.

Utility removal and plugging are retained for development of corrective measure development.

2.8 Vertical Subsurface Barrier Walls

Vertical subsurface barrier walls are low permeability walls that impede the horizontal migration of contaminants in soil and groundwater. Vertical barriers include cement-bentonite slurry walls, soil-bentonite slurry walls, soil-mix grout walls, and sheetpile walls. Installation or construction methods include one-pass trenching, traditional trenching and backfilling, augering and backfilling, injection, or driving sheetpiles. Subsurface barrier walls are a well-established technology that can implemented in a short time frame. The risk of transport of contaminants through vertical barrier walls can be reduced by including groundwater extraction and treatment within, or adjacent to, the walls to maintain inward hydraulic gradients. The barrier walls would be designed to key into the impermeable bedrock layer below the site. Keying in to the bedrock minimizes leakage potential. This technology can be can be used in conjunction with other corrective measures to provide additional source treatment or containment.

Vertical, low permeability barriers are retained for corrective measure development.

2.9 Groundwater Extraction and Treatment

Groundwater extraction and treatment (i.e., pump and treat) is a widely-used ground water treatment technology where groundwater is pumped to the surface and treated.

Groundwater extraction and treatment is the primary component of the existing corrective measure for the site and is retained for development of future corrective measures.

3.0 Summary of Technology Screening

Based on review of potential corrective measure technology alternatives for the site, the technologies retained for development of corrective measure development for soil are:

- Capping
- Excavation (offsite disposal)
- Institutional Controls

For groundwater:

- Groundwater Extraction and Treatment
- Utility Removal / Plugging / Upgrade
- Vertical Subsurface Barrier Walls

References

AlliedSignal FM&T. 1998. Iron Treatment Wall Implementation Report. Department of Energy Kansas City Plant. Northeast/Outfall 001 Area. July 16.

Federal Remediation Technologies Roundtable, 2002. Remediation Technologies Screening Matrix and Reference Guide, 4th Edition (only available online, at URLs below).

- Bio Venting Limitations retrieved from: https://frtr.gov/matrix2/section4/4_1.html
- Phytoremediation: https://frtr.gov/matrix2/section4/4-33.html
- Soil Flushing Limitations retrieved from: https://frtr.gov/matrix2/section4/4-6.html
- Soil Vapor Extraction Limitation retrieved from: https://frtr.gov/matrix2/section4/4-7.html
- Bioslurping Limitations retrieved from: https://frtr.gov/matrix2/section4/4-35.html
- Air Sparging Limitations retrieved from: https://frtr.gov/matrix2/section4/4-34.html

Oak Ridge National Laboratory. 2000. Lower Northeast Area Characterization and Iron Wall Evaluation Report for Environmental Restoration Program at the Kansas City Plant. U.S. Department of Energy. June.

URS Greiner Woodward Clyde Federal Services. 1999. Final Report. Iron Wall Demonstration Monitoring Report. Department of Energy Kansas City Plant. September.

URS Greiner Woodward Clyde Federal Services. 2000. Final Report. Iron Wall Demonstration Monitoring Report. Addendum No. 1. Department of Energy Kansas City Plant. March.

TABLE B-1
Soil Technology Screening Summary

Location	Method	Technology	PRELIMINARY SCREENING						ADDITIONAL SCREENING		
			Applicable to Target COCs				Applicable to Fine Grained Soils at Site	Considered for Additional Screening	Compatible with Anticipated Site Redevelopment	Achieve Remedial Action Goals	Component of Proposed Corrective Measures
			Metals	TPH	CVOCs	PCBs					
In Situ	Destruction	Bioremediation via Injection	No	Yes	Yes	No	No	No	--		
		Bioremediation via Soil Mixing	No	Yes	Yes	No	Yes	Yes	Yes	No	No
		Phytoremediation	Yes	Yes	Yes	Limited	Yes	Yes	Yes	No	No
		Bioventing	No	Yes	Yes	No	No	No	--		
		Oxidation via Deep Soil Mixing	No	Minimal	Yes	No	Yes	Yes	No- Soil improvements are required in areas where structures are planned.	There is a risk of mobilizing chromium in groundwater	No
		Oxidation via Injection	No	No	Yes	No	No	No	--		
		Reduction via Injection	No	No	Yes	No	No	No	--		
		Reduction via Deep Soil Mixing	No	No	Yes	No	Yes	Yes	No- Soil improvements are required in areas where structures are planned.	Yes	No
		Thermal Conductive Heating	No	Yes	Yes	Yes	Yes	Yes	No - Significant footprint/timeline	Yes	No

TABLE B-1
Soil Technology Screening Summary

Location	Method	Technology	PRELIMINARY SCREENING						ADDITIONAL SCREENING		
			Applicable to Target COCs				Applicable to Fine Grained Soils at Site	Considered for Additional Screening	Compatible with Anticipated Site Redevelopment	Achieve Remedial Action Goals	Component of Proposed Corrective Measures
			Metals	TPH	CVOCs	PCBs					
In Situ	Removal	Soil Flushing	Yes	Yes	Yes	Yes	No	No	--		
		Soil Vapor Extraction	No	Yes	Yes	No	No	No	--		
		Electrical Resistive Heating	No	Yes	Yes	No	Yes	Yes	No - Significant footprint/timeline	Yes	No
	Stabilization / Immobilization	Capping	Yes	Yes	Yes	Yes	Yes	Yes	Yes	In conjunction with other technologies	Yes
		Solidification/Stabilization via Deep Soil Mixing	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No
Other		Soil Excavation with Offsite Disposal	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
		Soil Excavation with Onsite Soil Treatment	Yes	Yes	Yes	Yes	Yes	Yes	No - Significant footprint/complications	Yes	No
		Institutional Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	In conjunction with other technologies	Yes

TABLE B-2
Groundwater Technology Screening Summary

Location	Method	Technology	PRELIMINARY SCREENING						ADDITIONAL SCREENING		
			Applicable to Target COCs				Applicable to Fine Grained Soils at Site	Considered for Additional Screening	Compatible with Anticipated Site Redevelopment	Achieve Clean Up Goals	Component of Proposed Corrective Measures
			Metals	TPH	CVOCs	PCBs					
In Situ	Destruction	Monitored Natural Attenuation	No	Yes	Yes	No	Yes	Yes	Yes	No	No
		Permeable Reactive Barriers	No	Yes	Yes	No	Yes	Yes	Yes	No. Cannot reasonably achieve groundwater cleanup goals for Vinyl Chloride.	No
		Phytoremediation	Yes	Yes	Yes	Limited	Yes	Yes	Yes	No	No
		Bioslurping	No	Yes	Yes	No	No	No	--		
	Removal	Air Sparging	No	Yes	Yes	No	No	No	--		
		Dual Phase Extraction	No	Yes	Yes	No	No	No	--		
	Stabilization / Immobilization	Utility Removal / Plugging / Upgrade	Yes	Yes	Yes	Yes	Yes	Yes	Yes	In conjuction with other technologies	Yes
		Vertical Subsurface Barrier Walls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other		Groundwater Extraction and Treatment	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Appendix C

Cost Estimate Details

TABLE C-1
Estimated Cost for Proposed Corrective Measures

Capital Costs	Cost Estimate	Backup Table Number
Soil Corrective Measures		
Soil Excavation	$ 11,900,000	C.2
Engineered Caps	$ 1,400,000	C.3
Groundwater Corrective Measures		
Abandon and Replace Monitoring Wells (Years 1 and 4)	$ 2,300,000	C.4
Modify Groundwater Extraction and Treatment System - Pre-Demolition	$ 5,000,000	C.5
Modify Groundwater Extraction System - Post Demolition (Year 4)	$ 2,600,000	C.6
Source Area Corrective Measure		
Barrier Wall Installation	$ 3,600,000	C.7
Stormwater Management, Utility Removal, Site Grading, and Utilities		
Temporary Sedimentation Basins, Stormwater Protection and Treatment	$ 10,400,000	C.8
Remove Utilities	$ 7,100,000	
Close Outfalls 001-004, and F	$ 8,900,000	C.9
Grade Site and Install New Outfalls	$ 27,100,000	
Install Public and Private Utilities	$ 5,500,000	
Repair and Upgrade Groundwater Treatment Plant Building	$ 700,000	
Vapor Intrusion Corrective Measure		
Install Vapor Barriers and Passive Venting at Future Buildings	$ 11,700,000	C.10
Capital Cost Subtotal	**$ 98,200,000**	
Operation, Maintenance, Monitoring, and Reporting Costs - Years 1 to 30		
Groundwater Extraction and Treatment System O&M ($690,00 to $760,000 per year)	$ 21,000,000	C.11
Groundwater Monitoring and Reporting ($510,000 to $670,000 per year)	$ 16,000,000	C.12
MSOP Compliance, Monitoring, and Reporting ($180,000 per year)	$ 5,300,000	C.13
MHWMF Surface Water/Sediment/Outfall Compliance ($110,000 to $320,000 pear year)	$ 4,100,000	C.14
Future O, M and M Costs Subtotal	**$ 46,400,000**	
TOTAL (2016 Dollars)	**$ 144,600,000**	
ROUNDED TOTAL (2016 Dollars)	**$ 145,000,000**	
TOTAL -30%	**$ 101,000,000**	
TOTAL +50%	**$ 217,000,000**	

TABLE C-2
Estimated Cost of Soil Excavation

Soil Excavation				
Description	**Quantity**	**Unit**	**Unit Cost**	**Cost**
Mob/Demob	1	LS	$ 375,000	$ 375,000
Excavation	42876	CY	$ 27.6	$ 1,183,378
Reuse Soil Onsite - Backfill/Compact	788	tons	$ 3.8	$ 2,994
T&D Non-Hazardous	33620	tons	$ 48.8	$ 1,640,656
T&D RCRA Hazardous	19825	tons	$ 165	$ 3,271,125
T&D RCRA Hazardous with Incineration	80	tons	$ 740	$ 59,200
T&D TSCA Hazardous	13448	tons	$ 165	$ 2,218,920
"Combo" - T&D RCRA Hazardous and TSCA	840	tons	$ 1,750	$ 1,470,000
Backfill/Compact Import Fill	76289	tons	$ 9.4	$ 717,117
			Subtotal	**$ 10,938,390**
Engineering/Consulting				
Pre-design Eval, Work Plan & Permiting	15%	%	$ 2,278,489	$ 341,773
Remedial Design & Project Management	16%	%	$ 2,278,489	$ 364,558
Construction Management	12%	%	$ 2,278,489	$ 273,419
			Engineering/Consulting Subtotal	**$ 979,750**
			TOTAL	**$ 11,918,140**
			ROUNDED TOTAL	**$ 11,900,000**

Note: The Engineering/Consulting costs are based on a percentage of the total soil excavation costs excluding Transport and Disposal (T&D).

TABLE C-3
Estimated Cost of Engineered Caps

Engineered Caps				
Description	**Qty**	**Unit**	**Unit Cost**	**Cost**
Mob/Demob	1	LS	$ 90,000	$ 90,000
SWMU Caps	114899	SF	$ 4.2	$ 482,576
D26 & TCE Still Barrier Wall Cap	115203	SF	$ 3.5	$ 403,211
WTSA Barrier Wall Cap	33600	SF	$ 3.9	$ 131,040
			Subtotal	**$ 1,106,827**
Engineering/Consulting				
Pre-design Evaluation, Work Plan & Permits	6%	%	$ 1,106,827	$ 66,410
Design & Project Management	15%	%	$ 1,106,827	$ 166,024
Construction Management	10%	%	$ 1,106,827	$ 110,683
	Engineering/Consulting Subtotal			**$ 343,117**
			TOTAL	**$ 1,449,944**
			ROUNDED TOTAL	**$ 1,400,000**

TABLE C-4
Estimated Cost of Well Abandonment and Replacement

Monitoring Well Abandonment and Replacement Costs Year 1				
Description	**Quan.**	**Unit**	**Unit Cost**	**Cost**
Mob/Demob	1	LS	$ 70,000	$ 70,000
Abandon Existing Monitoring Wells	100	Well	$ 1,700	$ 170,000
Replacement Monitoring Wells	100	Well	$ 6,150	$ 615,000
Work Plan for Phased Replacement of Monitoring Wells & MDNR review	1	LS	$ 50,000	$ 50,000
			Subtotal	**$ 905,000**
Design and Construction Oversight				
Planning and Permitting	8%	%	$ 905,000	$ 72,400
Design	10%	%	$ 905,000	$ 90,500
Construction and Project Management	12%	%	$ 905,000	$ 108,600
			Subtotal, Engineering/Consulting	**$ 271,500**
			TOTAL YEAR 1	**$ 1,176,500**
Monitoring Well Abandonment and Replacement Costs Year 4				
Description	**Quantity**	**Unit**	**Unit Cost**	**Cost**
Mob/Demob	1	LS	$ 70,000	$ 70,000
Abandon Monitoring Wells	100	Well	$ 1,700	$ 170,000
Install Replacement Monitoring Wells	100	Well	$ 6,150	$ 615,000
			Subtotal	**$ 855,000**
Design and Construction Oversight				
Planning and Permitting	8%	%	$ 855,000	$ 68,400
Design	10%	%	$ 855,000	$ 85,500
Construction and Project Management	12%	%	$ 855,000	$ 102,600
			Subtotal, Engineering/Consulting	**$ 256,500**
			TOTAL YEAR 4	**$ 1,111,500**
			TOTAL YEAR 1 and 4	**$ 2,288,000**
			ROUNDED TOTAL YEAR 1 and 4	**$ 2,300,000**

TABLE C-5
Estimated Cost to Modify Groundwater Extraction and Treatment System – Pre-Demolition

Modify Groundwater Extraction and Treatment System - Pre-Demolition				
Description	**Quan.**	**Unit**	**Unit Cost**	**Cost**
Mob/Demob	1	LS	$ 220,000	$ 220,000
Abandon Drain Sumps in Buildings	1	LS	$ 200,000	$ 200,000
Temp. Vertical Wells to 45' (ea), Survey, IDW	10	Well	$ 23,000	$ 230,000
Temporary Well Head Protection	18	EA	$ 2,500	$ 45,000
Traffic-rated Vault	17	EA	$ 4,000	$ 68,000
Wellhead Fittings/Piping/Instrumentation	13	EA	$ 5,000	$ 65,000
Modify Wellhead Piping/Instrumentation	5	EA	$ 2,500	$ 12,500
Install New Electric Submersible Pumps	18	EA	$ 1,500	$ 27,000
Collection Trenches	2134	LF	$ 528	$ 1,126,752
Non-hazardous Soil Disposal	3794	Tons	$ 48.8	$ 185,136
Conveyance Piping	10580	LF	$ 78	$ 825,240
Local Discharge Piping to Sanitary Sewer	20	LF	$ 48	$ 960
Electrical Conduit and Junction Vaults	10580	LF	$ 25	$ 264,500
Tie in Existing Treatment System Equipment	1	LS	$ 450,000	$ 450,000
			Subtotal	**$ 3,720,088**
Design and Construction Oversight				
Planning and Permitting	8%	%	$ 3,534,952	$ 282,796
Design	10%	%	$ 3,534,952	$ 353,495
Construction and Project Management	12%	%	$ 3,534,952	$ 424,194
Startup Testing, Sampling & Analysis, Update the SAP and IC Plans, Reporting and O&M Manual	1	LS	$ 240,000	$ 240,000
			Subtotal, Engineering/Consulting	**$ 1,300,485**
			TOTAL	**$ 5,020,573**
			ROUNDED TOTAL	**$ 5,000,000**

Note: The Engineering/Consulting costs are based on a percentage of the total cost to modify the groundwater extraction and treatment system (excluding Transport and Disposal (T&D) costs).

TABLE C-6
Estimated Cost to Modify Groundwater Extraction System – Post Demolition (Year 4)

Modify Groundwater Extraction System - Post Demolition (Year 4)				
Description	**Quan.**	**Unit**	**Unit Cost**	**Cost**
Mob/Demob	1	LS	$ 70,000	$ 70,000
Abandon Demo Phase Extraction Wells	10	Well	$ 5,000	$ 50,000
Vertical Wells to 45' (ea), Survey, IDW	16	Well	$ 23,000	$ 368,000
Traffic-rated Vault	18	EA	$ 4,000	$ 72,000
Wellhead Fittings/Piping/Instrumentation	18	EA	$ 5,000	$ 90,000
Install Electric Submersible Pumps	18	EA	$ 750	$ 13,500
Conveyance Piping	8985	LF	$ 80	$ 718,760
Electrical Conduit and Junction Vaults	8985	LF	$ 27	$ 242,582
			Subtotal	**$ 1,624,842**
Design and Construction Oversight				
Groundwater Capture Optimization Study	1	LS	$ 250,000	$ 250,000
Planning and Permitting	10%	%	$ 1,624,842	$ 162,484
Design	12%	%	$ 1,624,842	$ 194,981
Construction and Project Management	14%	%	$ 1,624,842	$ 227,478
Startup Testing, Sampling & Analysis, Reporting and O&M Manual	1	LS	$ 140,000	$ 140,000
			Subtotal Engineering/Consulting	**$ 974,943**
			TOTAL	**$ 2,599,785**
			ROUNDED TOTAL	**$ 2,600,000**

TABLE C-7
Estimated Cost of Barrier Wall Installation

Barrier Wall Installation				
Description	**Qty**	**Unit**	**Unit Cost**	**Cost**
Mob/Demob/Survey	1	LS	$ 130,000	$ 130,000
D26 & TCE Still Enclosed Barrier Wall Installation	117260	VSF	$ 13.6	$ 1,594,736
WTSA Enclosed Barrier Wall Installation	33110	VSF	$ 13.7	$ 453,607
NEA Linear Barrier Wall Installation	45540	VSF	$ 15.1	$ 687,654
			Subtotal	**$ 2,865,997**
Engineering/Consulting				
Pre-design Evaluation, Plan, Report, and Permit	6%	%	$ 2,865,997	$ 171,960
Design & Project Management	12%	%	$ 2,865,997	$ 343,920
Construction Management	8%	%	$ 2,865,997	$ 229,280
			Engineering/Consulting Subtotal	**$ 745,160**
			TOTAL	**$ 3,611,157**
			ROUNDED TOTAL	**$ 3,600,000**

TABLE C-8
Brandenburg Industrial Service Company
Estimated Cost for Stormwater Protection and Treatment, Temporary Detention Ponds, and Utility Removal

Stormwater Protection						
Silt Fencing Install	10,430	Lin Ft	$	2.48	$	25,866
Silt Fencing Repair / Replace	10,430	Lin Ft	$	2.48	$	25,866
Inlet Basket Install	227	Each	$	143.00	$	32,461
Inlet Basket Repair / Replace	227	Each	$	143.00	$	32,461
Construction Entrance	89	Cu Yds	$	58.80	$	5,233
Construction Entrance Repair / Replace	89	Cu Yds	$	58.80	$	5,233
				Subtotal	**$**	**127,120**
Temporary Detention Ponds						
Excavate / Stockpile Soil for 3 Ponds	117,416	Cu Yds	$	12.85	$	1,508,796
Clear and Grub 4th Pond Area	40,000	Sq Ft	$	0.41	$	16,400
Install Liner in Ponds	412,000	Sq Ft	$	1.96	$	807,520
Install RipRap in Ponds	1,291	Cu Yds	$	78.46	$	101,292
New Manholes	4	Each	$	2,695.00	$	10,780
New Sewer Piping	307	Lin Ft	$	626.00	$	192,182
Skimmers Purchase / Install	4	Each	$	10,519.08	$	42,076
Remove Accumulated Silt and Liner	12,500	Tons	$	56.78	$	709,750
				Subtotal	**$**	**3,388,796**
Temporary Carbon Systems for Stormwater Treatment						
Temporary Structures	4	Each	$	76,139.80	$	304,559
Concrete Blocks for Structure	80	Each	$	425.00	$	34,000
Install Temp Structures	4	Each	$	48,839.00	$	195,356
Power Install to Structures	4	Each	$	48,480.00	$	193,920
Carbon and Filter Systems	4	Each	$	654,005.00	$	2,616,020
Install Carbon and Filter Systems	4	Each	$	27,644.00	$	110,576
Piping / Pumps / Supplies for System	4	Each	$	65,680.00	$	262,720
Carbon Replacements	24	Each	$	44,000.00	$	1,056,000
Carbon Disposal	280	Tons	$	225.00	$	63,000
Maintenance Supplies / Repairs	4	Each	$	29,040.00	$	116,160
Replacement Bag and Multimedia Filters	4	Each	$	44,000.00	$	176,000
Propane Torpedo Heaters	4	Each	$	706.00	$	2,824
Power/Gas Consumption	136	Month	$	1,800.00	$	244,800
Labor for Operation and Maintenance	428	Days	$	2,343.00	$	1,003,741
Sampling of Water Pre/Post Filters	272	Each	$	1,100.00	$	299,200
Disassemble Temp Structures	4	Each	$	48,839.00	$	195,356
				Subtotal	**$**	**6,874,232**
Temporary Sedimentation Basins, Stormwater Protection and Treatment TOTAL					**$**	**10,390,148**
Temporary Sedimentation Basins, Stormwater Protection and Treatment ROUNDED TOTAL					**$**	**10,400,000**

Utility Removal						
Excavation of Utilites	161,332	Cu Yd	$	12.88	$	2,077,956
Disposal of Hazardous or PCB >50 ppm	19,028	Ton	$	165.00	$	3,139,620
Disposal of Non-Hazardous / Non-Recyclable	39,027	Ton	$	48.77	$	1,903,347
				Utility Removal TOTAL	**$**	**7,120,923**
				Utility Removal ROUNDED TOTAL	**$**	**7,100,000**

TABLE C-9
Estimated Cost to Close Outfalls, Grade Site, Install New Outfalls, Install Utilities, and Repair/Upgrade Treatment Building

LUTJEN

1301 Burlington, # 100
North Kansas City, MO 64116
816.587.4320
816.587.1393 fax
www.lutjen.com

surveying
planning
engineering
landscape architecture

Engineer's Construction Estimate

PROJECT: Bannister Federal Complex
LOCATION: NE Cor., Bannister Road and Troost Ave
CLIENT: Centerpoint Properties

ITEM OF WORK	TOTAL
Close Outfalls 001-004, and F	
Outfall 001 Separation and Termination	
Demolition and Soil Management	$1,412,100
Grading and New Infrastructure - UPRR/GSA	$3,252,353
Outfall 002 Separation and Termination	
Demolition and Soil Management	$1,359,788
Outfalls 003/004/F Separation and Termination	
Outfall 003 - Demolition and Soil Management	$731,741
Outfall 004 - Demolition and Soil Management	$1,906,538
Outfall F/C - Demolition and Soil Management	$224,775
Close Outfalls 001-004, and F - TOTAL	**$8,887,295**
Close Outfalls 001-004, and F - ROUNDED TOTAL	**$8,900,000**
Grade Site and Install New Outfalls	
Area Grading	$22,289,760
Detention Basin and New Outfall - NE - Boone Creek (001)	$2,331,788
Detention Basin and New Outfall - SE - Blue River (D)	$1,207,913
Detention Basin and New Outfall - SW - Indian Creek (004)	$1,268,663
Grade Site and Install New Outfalls - TOTAL	**$27,098,124**
Grade Site and Install New Outfalls - ROUNDED TOTAL	**$27,100,000**
Install Public and Private Utilities	
Sanitary Sewer Main Extension	$2,597,792
Water Main Extension	$1,265,599
Power Relocations (KCPL)	$620,000
Gas Relocations (MGE	$620,000
Communication Relocations	$387,500
Install Public and Private Utilities - TOTAL	**$5,490,891**
Install Public and Private Utilities - ROUNDED TOTAL	**$5,500,000**
Repair and Upgrade Groundwater Treatment Plant Building	
Ground Water Treatment Plant Accommodation	$722,250
Repair and Upgrade Groundwater Treatment Plant Building - TOTAL	**$722,250**
Repair and Upgrade Groundwater Treatment Plant Building- ROUNDED TOTAL	**$700,000**

We do not guarantee that our opinions will not differ materially from negotiated prices or bids. If assurances as to probable construction costs are desired, an independent estimator or contractor should be employed.

TABLE C-10
Estimated Cost of Vapor Barriers and Passive Venting for Future Buildings

Vapor Barriers and Passive Venting				
Description	**Qty**	**Unit**	**Unit Cost**	**Cost**
Composite Membrane	1800000	SF	$ 4.4	$ 7,920,000
Subslab Passive Venting System	1800000	SF	$ 0.28	$ 504,000
Vertical Risers	1	LS	$ 650,000	$ 650,000
Gravel, Bollards, Roof Penetrations and Walk Pads	1800000	SF	$ 0.62	$ 1,116,000
			Subtotal	**$ 10,190,000**
Engineering/Consulting				
Design & Project Management	5%	%	$ 10,190,000	$ 509,500
Construction Management	10%	%	$ 10,190,000	$ 1,019,000
			Engineering/Consulting Subtotal	**$ 1,528,500**
			TOTAL	**$ 11,718,500**
			ROUNDED TOTAL	**$ 11,700,000**

Note: Costs for corrective measures addressing potential vapor intrusion have been estimated considering MDNR, EPA and DHSS comments on the draft CMR, and related discussions during a conference call with the Agencies on November 4, 2016.

TABLE C-11
Estimated Cost of Groundwater Extraction and Treatment O&M

Groundwater Extraction and Treatment - Annual O&M				
Description	**Quan.**	**Unit**	**Unit Cost**	**Cost**
Demolition Phase Annual O&M				
Annual Cap Maintenance during Demolition	1	YR	$ 150,000	$ 150,000
GW System O&M during Demolition	1	YR	$ 416,800	$ 416,800
Annual Sanitary Sewer Discharge Costs	1	YR	$ 152,900	$ 152,900
Subtotal Demolition Phase Annual O&M				**$ 719,700**
Other Costs				
Project Management	5%	%	$ 719,700	$ 35,985
Subtotal, Other Costs				**$ 35,985**
ANNUAL DEMO PHASE O&M YEARS 1 to 4				**$ 755,685**
TOTAL DEMO PHASE O&M YEARS 1 to 4				**$ 3,022,740**
Post- Demolition Annual O&M				
Annual Cap Maintenance	1	YR	$ 50,000	$ 50,000
GW System O&M during Demolition	1	YR	$ 413,800	$ 413,800
Annual Sanitary Sewer Discharge Costs	1	YR	$ 146,100	$ 146,100
Subtotal, Post Demolition Annual O&M				**$ 609,900**
Other Costs				
Project Management	5%	%	$ 609,900	$ 30,495
5-year Reviews Every Five Years (Prorated)	1	LS	$ 50,000	$ 50,000
Subtotal, Other Costs				**$ 80,495**
ANNUAL POST DEMO O&M YEARS 5 to 30				**$ 690,395**
TOTAL O&M YEARS 5 to 30				**$ 17,950,270**
TOTAL YEARS 1 to 30				**$ 20,973,010**
ROUNDED TOTAL YEARS 1 to 30				**$ 21,000,000**

TABLE C-12
Estimated Cost of Groundwater Monitoring and Reporting

Groundwater Monitoring and Reporting					
Description	**Quantity**	**Unit**	**Unit Cost**	**QAQC Mult.**	**Cost**
Well Sampling	300	wells	$ 318.67	1	$ 95,600
Volatiles Analyses	300	sample	$ 65	1.2	$ 23,400
Metals Analyses	5	sample	$ 70	1.1	$ 385
PCB Analysis	15	sample	$ 55	1.1	$ 908
1,4 Dioxane Analysis	75	sample	$ 250	1.2	$ 22,500
Data validation	17.5%	%	$ 50,000	1	$ 8,750
MW Well Maintenance	1	LS	$ 85,000	1	$ 85,000
Annual Corrective Action Reporting	1	LS	$ 70,000	1	$ 70,000
				Subtotal	**$ 306,543**
Other Costs					
Data Management/GIS	1	LS	$ 35,000	1	$ 35,000
Revise GW model/Contaminant Transport	1	LS	$ 65,000	1	$ 65,000
Evaluate GW Capture, Update Monitoring Plans	1	LS	$ 20,000	1	$ 20,000
Regulatory Interface, Strategic Planning	1	LS	$ 60,000	1	$ 60,000
Project Management	8%	%	$ 306,543	1	$ 24,523
				Subtotal	**$ 204,523**
				Subtotal Annual GW Monitoring	**$ 511,066**
Additional Quarterly Monitoring of Replacement Wells on Years 1 to 4 (over 4 years)	150	well	$ 790	1	$ 118,500
Additional Data Management, Reporting and MDNR Response Actions for Years 1 to 4 (over 4 years)	1	LS	$ 40,000	1	$ 40,000
				Subtotal	**$ 158,500**
				ANNUAL GW Mon YEARS 1 to 4	**$ 669,566**
				TOTAL GW Mon - YEARS 1 to 4	**$ 2,678,264**
				ANNUAL GW Mon YEARS 5 to 30	**$ 511,066**
				TOTAL GW Mon YEARS 5 to 30	**$ 13,287,716**
				TOTAL GW Mon YEARS 1 to 30	**$ 15,965,980**
				ROUNDED TOTAL YEARS 1 to 30	**$ 16,000,000**

TABLE C-13
Estimated Cost for MSOP Surface Water Compliance Monitoring and Reporting

MSOP Compliance Monitoring and Reporting				
Description	**QTY**	**Units**	**Unit Cost**	**Cost**
4 Outfalls				
Analytical	1	LS	$26,200	$26,200
Labor, Equipment, and Materials	1	LS	$124,800	$124,800
Downstream Sampling Point				
Analytical	1	LS	$2,300	$2,300
Labor, Equipment, and Materials	1	LS	$2,600	$2,600
Reporting and Project Management				
Reporting and Project Management	1	LS	$19,400	$19,400
			MSOP Annual Total	**$175,300**
			MSOP Years 1 to 30 TOTAL	**$5,259,000**
			MSOP Years 1 to 30 ROUNDED TOTAL	**$5,300,000**

Note: Scope includes surface water management per current Operating Permit requirements for Years 1 to 30 including 4 outfalls and 1 downstream sampling point.

TABLE C-14
Estimated Cost for MHWMF Surface Water/Sediment/Outfall Compliance Monitoring and Reporting

Description	QTY	Units	Unit Cost	Cost
MHWMF Monitoring Years 1 to 4				
Surface Water Locatons				
Analytical Costs	1	LS	$26,300	$26,300
Labor, Equipment and Materials	1	LS	$9,040	$9,040
Outfall 002 Stormwater				
Analytical Costs	1	LS	$54,100	$54,100
Labor, Equipment and Materials	1	LS	$58,760	$58,760
Outfall 002 Sediment				
Analytical Costs	1	LS	$26,400	$26,400
Labor, Equipment and Materials	1	LS	$27,120	$27,120
Fish Studies every five years (prorated)	1	LS	$44,600	$44,600
Indian Creek Including Sediment				
Analytical Costs	1	LS	$1,210	$1,210
Labor, Equipment and Materials	1	LS	$9,920	$9,920
Inspect and Clean Outfall 002	1	LS	$8,800	$8,800
002 Low Flow Diversion	1	LS	$17,250	$17,250
			Subtotal	**$283,500**
Project Management and Reporting	1	LS	$34,800	$34,800
			MHWMF Years 1 to 4 Annual Total	**$318,300**
			MHWMF Years 1 to 4 Total	**$1,273,200**
MHWMF Monitoring Years 5 to 30				
Surface Water Locatons				
Analytical Costs	1	LS	$26,300	$26,300
Labor, Equipment and Materials	1	LS	$9,040	$9,040
Indian Creek Sediment				
Analytical Costs	1	LS	$1,210	$1,210
Labor, Equipment and Materials	1	LS	$9,920	$9,920
Fish Studies every five years (prorated)	1	LS	$44,600	$44,600
			Subtotal	**$91,070**
Reporting and Project Management				
Reporting and Project Management	1	LS	$17,700	$17,700
			MHWMF Years 5 to 30 Annual Total	**$108,770**
			MHWMF Years 5 to 30 Total	**$2,828,020**
			MHWMF Years 1 to 30 TOTAL	**$4,101,220**
			MHWMF Years 1 to 30 ROUNDED TOTAL	**$4,100,000**

Note: Year 1 to 4 scope includes surface water management per current MO Hazardous Waste Management Facility Permit part 1 (MHWMF Permit) including 10 surface water locations, 2 outfall 002 locations, and 5 Indian Creek sediment locations.
Year 5 to 30 scope assumes a revision to MO Hazardous Waste Management Facility Permit (MHWMF Permit) including 10 surface water locations and 5 Indian Creek Sediment locations.

Appendix D

Proposed Land Uses for BFC Property to be Transferred

BFC CenterPoint		
Allowable and Restricted Land Uses [1, 2]		
NOTES:		
Current Zoning of BFC Site is M3-5.		
Red = a use allowed in M3-5 which is proposed to be not allowed or restricted in UR		
Blue = not allowed in M3-5 but proposed to be allowed under UR		
Black = no change from M3-5 to UR		
Prohibited Uses are noted with a hyphen "-"		
Permitted Uses are noted with a "P"		
Restricted Uses are noted with "Restricted" and may be restricted by geography or require special review.		
Special Uses are only in the M3-5 Use Table and require a special use permit. They are noted with an "S"		
USEGROUP	**ZONING DISTRICT**	
Use Category		**DRAFT**
>> specific use type	**Allowed per M3-5**	**BFC UR**
RESIDENTIAL		
Household Living	-	-
>> Single-family home	-	-
>> In single-purpose residential building	-	-
>> Above ground floor (in mixed-use building)	-	-
Group Living	-	-
PUBLIC / CIVIC		
Bicycle-Sharing Facilities	P	P
Club, Lodge, or Fraternal Organization	-	-
College/University	-	-
Day Care	S	-
Detention and Correctional Facilities	S	-
Halfway House	S	-
Hospital	-	-
Park/Recreation	P	-
Religious Assembly	P	-
Safety Services	P	P
Schools	P	-
Utilities & Services (except as noted below)	S	**P**
>> Basic, minor	P	P
>> Basic, major		**P**

BFC CenterPoint		
Allowable and Restricted Land Uses [1, 2]		
NOTES:		
Current Zoning of BFC Site is M3-5.		
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Restricted Uses are noted with "Restricted" and may be restricted by geography or require special review.		
Special Uses are only in the M3-5 Use Table and require a special use permit. They are noted with an "S"		
USEGROUP	**ZONING DISTRICT**	
Use Category		**DRAFT**
>> specific use type	**Allowed per M3-5**	**BFC UR**
COMMERCIAL		
Adult Business		
>> Adult media store	P	-
>> Adult motion picture theater	P	-
>> Sex shop	P	-
Animal Service	P	-
Artist Work or Sales Space	P	-
Building Maintenance Service	P	P
Business Equipment Sales and Service	P	P
Business Support Service (except as noted below)	P	P
>> Day labor employment agency	P	-
Communications Service Establishments	P	P
Drive-through Facility	-	-
Eating and Drinking Establishments	P	-
Entertainment and Spectator Sports	S	-
Financial Services (except as noted below)	S	**P**
>> Short-term Loan Establishment		-
Food and Beverage Retail Sales	P	-
Funeral and Interment Services		
>> Cemetery/columbarium/mausoleum	-	-
>> Cremating	P	P
>> Undertaking	P	P
Gasoline and Fuel Sales	P	-
Lodging	-	-
Office, Administrative, Professional or General	P	P
Office, Medical	-	-
Parking, Non-accessory	P	P
Personal Improvement Service (NO DAY CARE)	P	P
Repair or Laundry Service, Consumer	P	-
Research Service	P	P
Retail Sales	P	-
Sports and Recreation, Participant (NO DAY CARE)	S	-
Vehicle Sales and Service	P	P
>> Light equipment sales/rental (indoor)	-	**P**
>> Light equipment sales/rental (outdoor)	-	**P**

BFC CenterPoint		
Allowable and Restricted Land Uses [1, 2]		
NOTES:		
Current Zoning of BFC Site is M3-5.		
Red = a use allowed in M3-5 which is proposed to be not allowed or restricted in UR		
Blue = not allowed in M3-5 but proposed to be allowed under UR		
Black = no change from M3-5 to UR		
Prohibited Uses are noted with a hyphen "-"		
Permitted Uses are noted with a "P"		
Restricted Uses are noted with "Restricted" and may be restricted by geography or require special review.		
Special Uses are only in the M3-5 Use Table and require a special use permit. They are noted with an "S"		
USEGROUP	**ZONING DISTRICT**	
Use Category		**DRAFT**
>> specific use type	**Allowed per M3-5**	**BFC UR**
INDUSTRIAL		
Junk/Salvage Yard	S	-
Manufacturing, Production and Industrial Service		
>> Artisan	P	P
>> Limited	P	P
>> General	P	P
>> Intensive	P	P
Mining/Quarrying	S	-
Outdoor Storage	P	P
Recycling Service		
>> Limited	P	P
>> General	P	P
Residential Storage Warehouse	P	-
Warehousing, Wholesaling, Freight Movement		
>> Indoor	P	P
>> Outdoor	S	**P**
Waste-Related Use		
>> Composting facility	S	**Restricted**
>> Demolition debris landfill	S	**Restricted**
>> Solid waste separation facility	S	**Restricted**
>> Transfer station	S	**Restricted**

BFC CenterPoint		
Allowable and Restricted Land Uses [1, 2]		
NOTES:		
Current Zoning of BFC Site is M3-5.		
Red = a use allowed in M3-5 which is proposed to be not allowed or restricted in UR		
Blue = not allowed in M3-5 but proposed to be allowed under UR		
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Permitted Uses are noted with a "P"		
Restricted Uses are noted with "Restricted" and may be restricted by geography or require special review.		
Special Uses are only in the M3-5 Use Table and require a special use permit. They are noted with an "S"		
USEGROUP	**ZONING DISTRICT**	
Use Category		**DRAFT**
>> specific use type	**Allowed per M3-5**	**BFC UR**
AGRICULTURAL		
Agriculture, Crop	P	-
Agriculture, Animal	P	-
Agriculture, Urban		
>> Home garden	P	-
>> Community garden	P	-
>> Community suported agricultre (CSA) farm	P	-
ACCESSORY SERVICES		
Wireless Communication Facility		
>> Freestanding	P	P
>> Co-located antenna	P	P

BFC CenterPoint		
Allowable and Restricted Land Uses [1, 2]		
NOTES:		
Current Zoning of BFC Site is M3-5.		
Red = a use allowed in M3-5 which is proposed to be not allowed or restricted in UR		
Blue = not allowed in M3-5 but proposed to be allowed under UR		
Black = no change from M3-5 to UR		
Prohibited Uses are noted with a hyphen "-"		
Permitted Uses are noted with a "P"		
Restricted Uses are noted with "Restricted" and may be restricted by geography or require special review.		
Special Uses are only in the M3-5 Use Table and require a special use permit. They are noted with an "S"		
USEGROUP	**ZONING DISTRICT**	
Use Category		**DRAFT**
>> specific use type	**Allowed per M3-5**	**BFC UR**
SUMMARY OF PROHIBITED USES		
All residential uses		
Club, Lodge, or Fraternal Organization		
College/University		
Day Care		
Detention and Correctional Facilities		
Halfway House		
Hospital		
Park/Recreation		
Religious Assembly		
Schools		
All Adult businesses		
Animal Service		
Artist Work or Sales Space		
Day labor employment agencies		
Drive-through facilities		
Eating and Drinking Establishments		
Short-term Loan Establishment		
Cemetery/columbarium/mausoleum		
Gasoline and Fuel Sales		
All lodging uses		
Repair or Laundry Service		
Residential support services		
Retail Sales		
Sports and Recreation, Participant		
Junk/Salvage Yard		
Mining/Quarrying		
Residential Storage Warehouse		
All agricultural uses		
[1] These proposals have not yet been approved by the KCMO Dept. of Planning		

[2] See the "Request for Non-Residential Exposure Scenarios in the Baseline Risk Assessment for the Bannister Federal Complex (BFC), Kansas City, Missouri EPA ID# MO9890010524", Letter from Rich Nussbuam, MNDR Permits Section, to Mr. Andy Gibler (US DOE) and Mr. Kevin Phillips (GSA), April 1, 2015.

Appendix E

Response to MNDR Comments on Draft Report

Bannister Federal Complex – CenterPoint Revised Corrective Measures Report (December 2016)

CenterPoint's Response to Comments from

The Missouri Department of Natural Resources and U.S. Environmental Protection Agency Region 7

(Received in Letter from Donald Dicks (MDNR) to CenterPoint, March 2, 2017

Comment	Response
Numbered Comments	
Comment #1, **Page ES-2, Executive Summary,** first bullet, Editorial Note: The following language: " ..... excavation and disposal of soils exceeding SSCLs to 12 feet below future surface grade", specifically " below future surface grade", could be confusing to outside readers. The public could come to expect that twelve feet of soil below the current surface grade will be excavated and disposed of off-site. The language in the draft Statement of Basis (SB) is much clearer on this point. It may be useful to provide further clarity on this issue in the Executive Summary and in other areas throughout the text by referring the reader Section 5.1.1 which indicates how much excavation below current surface grade is proposed in specific areas.	The executive summary and remainder of the document will be revised to clarify that utility work will include removal of infrastructure and known utilities to a depth of 12 feet below future grades in areas west of the groundwater treatment system and to 6 feet below future grade in areas to the east, as per Figure . This translates to 2 to 10 feet below current grade. Lines deeper than these vertical extents will be abandoned in place."
Comment #2, **Page ES-2, Executive Summary,** fifth bullet. Should also mention intended use of '"clean fill" and "approved beneficial reuse materials" derived from onsite building demolition as part of the materials used in regrading.	The text has been modified as requested.
Comment #3, **Page ES-3 Executive Summary,** first bullet. Add "... and on-site treatment of groundwater which is extracted up gradient of the barrier."	The text has been modified as requested.
Comment #4, **Page ES-3, Executive Summary,** sixth bullet. The bullet states that all new buildings will incorporate vapor mitigation technology. For consistency with the discussion in Section 5.5 of this document, the draft Statement of Basis and future intentions with	The text has been modified as requested.

respect to the content of the Environmental Covenant, this summary should include a reference to the future ability to demonstrate to the Department's satisfaction (and with the Department's approval) that vapor control technology is not needed in a specific building(s).	
Comment #5, **Page ES-3, Executive Summary.** The discussion regarding surface water outfalls should include mention of the redirection of storm water from the property to be transferred (southeast parking lot) to a new outfall such that storm water will not be conveyed onto the GSA property and discharged through outfall D. See footnote 19 on page 30.	The text has been modified as requested.
Comment #6**, Page 1, Section 1, Introduction,** fourth paragraph, second sentence. The word "protect" is missing in the text, it currently reads "safeguards are in place to human health and the environment." Please correct.	The text has been modified as requested.
Comment #7, **Page 4, Section 2.4 Geology and Hydrogeology, reference to figure 4**. The groundwater isopleths which represent groundwater elevations in this figure should include hash marks to indicate groundwater depressions. Otherwise they could be confused as groundwater mounds.	The figure has been updated as requested.
Comment #8, **Page 4, Section 2.5 Regulatory Status**. Need to reconcile number of SWMUs (45 stated) here and amongst various documents especially since the modified MHWMF Part I Permit will likely identify a couple of new SWMUs on the GSA portion of the BFC.	This Section, and related Table 1, have been updated with a footnote that reads: "As of March, 2017, additional areas of the BFC are under consideration by MDNR for designation as Areas of Concern (AOCs) and inclusion as such in future versions of the MWHMF Permit. These are, however, located outside of the property to be transferred."
Comment #9, **Page 10, Section 2.7.1 Outfall 001 (SWMU No. 8)**, last sentence in the first paragraph. It appears that the approved Anchor QEA Indian Creek/Blue River Fate and Transport Study Final Report, February 2016, has been misinterpreted. Page 20 and 21 of the report says, *"Lastly, similar to the BFC dataset, PCB concentration at the two locations (upstream and downstream of Outfall 001) in Boone Creek were the highest of all locations and ranged from 30 ng/L and 95*	This sentence was erroneous, and since it is not essential to the further sections of the CMR, has been deleted.

ng/L." The text should read "Boone Creek" contributed the largest PCB load, not Outfall 001. Please correct.	
Comment #10, **Page 10, Section 2.7.2 Outfall 002 (SWMU 15) and SWMUs 14 and 42,** fifth sentence. The text states ".... at a location is referred to as ...." Please remove "is."	The text has been modified as requested.
Comment #11, **Page 13, Section 3 Existing Corrective Measures,** bullet number eight. The text has the dates of the submittals switched on the Indian Creek/Blue River Fate and Transport Study Final report and the BRA. The F&T report should be March 2016 and the BRA should be July 2016. Please correct.	The text has been modified as requested.
Comment #12, **Page 15, Section 4.1 Proposed Site-Specific Cleanup Levels,** 2nd sentence. "UEPA" should be "USEPA." Please correct.	The text has been modified as requested.
Comment #13, **Page 16, Section 4.1.1 Soil.** The proposed SSCLS are based on 0-2 feet below ground surface (BGS) and 2-12 feet bgs. The last sentence in this section refers the reader to Appendix A for additional detail. Please explain why the intervals in Appendix A maps are 0-3.5 feet bgs and 3.5-13.5 bgs, rather than the intervals specified above, and clarify what intervals and how many feet have actually been used in the risk calculations.	The intervals used in risk calculations are based upon samples in the top 2 feet of soil. Much of the BFC, however, is currently overlain by paving and buildings and their respective subgrade materials. To account for this future change in site conditions, we applied a conservative assumption that up to 1.5 feet of building materials could be removed from any location during demolition, and considered potential risk at up to 3.5 feet below the current grade. This will be clarified in the figures and text.
Comment #14, **Page 16, footnote 11.** "artefact" should be "artifact." Please correct.	The text has been modified as requested. The footnote is now #12.
Comment #15, **Page 17, footnote 12.** "resources" should be "Resources." Please correct. Also, need to discuss if 1,4-dioxane contamination in groundwater has been confirmed. If so, it will be added to the permit tables with a groundwater protection standard as part of the proposed draft permit modification.	These comments apply to the re-numbered footnote #14. The footnote has been updated by replacing the last sentence with the following: "Detections of 1,4-dioxane in the shallow and deep alluvium were confirmed in 2016 (see the Groundwater Corrective Action Report for Calendar Year 2016, March 2017) and the Groundwater Protection Standards are updated in Table 4 of this report."
Comment #16, **Page 17, Section 4.1.3 Stormwater.** The Executive Summary indicates that unregulated outfalls B and C will also be removed and/or plugged. Those outfalls should be included in this discussion. In addition, surface water from the transferred property	The text has been modified as requested.

which currently flows through unregulated outfall D will be rerouted to a new outfall. This will result in no surface water flow from the transferred property being directed onto the GSA property and through outfall D. This discussion regarding surface water flow to outfall D should be included.	
Comment #17, **Page 19, Section 5 Proposed Corrective Measures,** Surface Water Corrective Measures bullets. The fifth bullet under this section mentions that periodic collection of fish tissue samples will be collected as required under the current MHWMF Part 1 Permit. As the current permit only called for fish tissue sampling to be conducted in 2013, this should reference the recommendations in the approved *Indian Creek/Blue River Fate and Transport Study Final Report* and the proposed draft modifications to the MHWMF Part I Permit.	The bullet has been revised to reference both the existing Part 1 Permit and the approved Indian Creek/Blue River Fate and Transport Study Final Report.
Comment #18, **Page 20, Section 5.1 Soil Excavation.** "All areas with SSCL exceedances will receive at least 2 feet of fill. Therefore, the SSCLs for soils between 2 and 12 feet bgs (construction worker and utility worker risk scenarios) were used as the basis for delineating excavation areas." To be sure, we presume this means that the upper two feet of fill (presumably clean fill) placed over any areas with SSCL exceedances was not used in any of the risk-calculations. Of course it is inappropriate to reclassify the 0-2' soil zone after adding clean fill on top of it. Please confirm.	This section has been clarified to indicate that soils between 0 and 2 feet depth are compared to the shallow soil risk criteria.
Comment #19, **Page 22, Section 5.1.1 Risk-Based Soil Excavation.** The last sentence, "'The actual lateral and vertical extent of excavations will be refined after demolition during pre-design sampling and analysis." Please clarify this section by adding that the bottom and sidewalls of the excavations will be sampled to verify that contamination levels are below SSCLs and that the plans to do so will be contained in a Corrective Measures Implementation (CMI) Work Plan to be submitted to the Department for review and approval post-transfer of the property.	The text has been modified to indicate that procedures for post-excavation sampling will be delineated in a CMI Work Plan to be submitted to the Department for review and approval post-transfer of the property. The depth of excavation, however, is based upon construction worker and site worker exposure scenarios, assuming a maximum exposure depth of 12 feet below future grade. Contamination in excess of SSCLs may remain in soils below that depth, and thus the comment is incorrect in suggesting that in all cases bottom sampling would "verify that contamination levels are below SSCLs."
Comment #20, **Page 22, Section 5.1.2 Additional Excavation Areas,** second and third bullet. Please clarify what is meant by the	This section was intended to address identification of soils requiring risk management, but was badly worded and confusing. The bullets

term "hazardous waste criteria." Does this refer to soil containing "listed" hazardous wastes or is this a reference to soil that will undergo TCLP testing to determine if it demonstrates a "characteristic" of hazardous waste.	have been clarified. When potentially contaminated soils are identified on the basis of odor, staining, PID readings, or observable product, those requiring risk-management (by excavation or other measures) will be identified by direct comparison of contaminant concentrations to SSCLs, not hazardous waste criteria such as TCLP. Regarding disposal, no listed wastes have been identified in BFC soils, and we anticipate that all decisions regarding off-site disposal locations will be made on the basis of waste characteristics including toxicity as per TCLP testing.
Comment #21, **Page 23, Section 5.1.2 Additional Excavation Areas,** the first bullet on page 23 mentions methylcyclohexane and the constituent is shown in Figure 13. The response to comments to the Department's previous comment #73 indicated the maximum concentration was 62,000 µg/kg. What screening value was used for this constituent?	ToxStrategies used cyclohexane as the toxicological surrogate in evaluating potential risk from methylcyclohexane. For purposes of identifying chemicals of potential concern (COPCs) the screening level for this compound (UESPA RSL), based on a residential soil exposure scenario, was 650,000 ug/kg.
Comment #22, **Page 24, Section 5.2.2.** The last paragraph includes ""asphalt pavement" as a type of cap. In instances where infiltration of precipitation is concerned, asphalt may not be as effective in preventing infiltration as other options. The text should reference that the design, materials and plans to do capping will be contained in a Corrective Measures Implementation (CMI) Work Plan to be submitted to the Department for review and approval post-transfer of the property.	The text has been updated a requested.
Comment #23, **Page 25, Section 5.3.1 Environmental Covenant.** Please include the following language in the first sentence. "In addition to the institutional control plan, a new environmental covenant, (following MoECA requirements), between the site owner(s) and MDNR will be developed prior to property transfer, **and executed following the transfer**, to memorialize the elements listed below."	The text has been updated a requested.
Comment #24, **Page 25, Section 5.3.1 Environmental Covenant and page 29, Section 5.5 Vapor Intrusion Management.** Both Sections discuss required vapor barriers for new construction with the provision to request a waiver from MDNR. Section 5.5 should also	The text has been updated with the following statement: “the efficacy of vapor mitigation measures will be confirmed via future monitoring, specification of minimum air exchange rates for any new buildings, or other methods approved by MDNR.”

contain a future commitment to validate the efficacy of any vapor barriers or mitigation strategies that are installed in buildings, via future monitoring, and/or specification of minimum air exchange rates for any new buildings. Please add language to acknowledge that future performance of any building vapor control measures that are implemented will be assessed.	
Comment #25, **Page 26, Section 5.4 Groundwater Control.** The second paragraph, "'In addition, leakage of water from ageing water mains, sewers, and distribution lines also plays a major role in maintaining the current groundwater environment." To clarify the role of leaking mains in the area, "impacts" is probably a better description than "plays a major role in maintaining." Leaking mains may dilute the contamination found in the plume, increase groundwater flow rates and influence groundwater flow direction(s) therefore impact contaminant plume migration and management.	The text has been updated as requested.
Comment #26, **Page 27, Section 5.4.1 Groundwater Extraction and Treatment,** fourth bullet. The text states that up to 9 new extraction wells, inclusive of two contingent wells, will be installed during the demolition phase and their locations are shown on Figure 19. Figure 19 depicts the location of 10 extraction wells (EWELL-01 through EWELL-10) inclusive of two contingent wells (EWELL-08 and 09). Please clarify this discrepancy.	The statement in the text was an error. This has been corrected to indicate up to 10 new extraction wells.
Comment #27, **Page 30, Section 5.7.1 Outfall Abandonment/Plugging.** "As part of the proposed corrective measure, the existing regulated outfalls 001 through 004 and unregulated Outfalls B, C and F will be abandoned in place, filled with grout, and a segment will be excavated/removed and replaced with compacted clay or flowable fill to reduce the potential for preferential pathways. In addition, the existing segment of Outfall 004 beneath the flood wall, near the southwest parking lot, is proposed to be re-purposed as a sleeve for a new storm sewer pipe." This explanation addresses the potential for movement of contaminants in the pipe bedding for outfalls that will be abandoned. However, Outfall 004 will still be used as a sleeve. Does this mean that Outfall 004 will not have a segment excavated/removed and replaced with compacted clay or	The text has been updated to clarify that Outfall 004 will be cut-off upstream of the flood wall, and only the portion under the barrier wall will be utilized as “sleeve.” Figure 26 shows abandonment of the old Outfall 004, and new outfall to Indian Creek.

flowable fill since it will not be abandoned? Will there be other actions taken on Outfall 004 to make sure that the repurposed segment does not allow for potential movement of contaminants in the future? Please clarify.	
Comment #28, **Page 36, Section 6.0 Evaluation of the Proposed Corrective Measures.** Please review the Department's draft comments on the common elements in the SB to ensure consistency.	This section has been revised to be more consistent with the draft SOB
Comment #29, **Page 36, 6.2 Performance Standards,** second bullet and throughout. Consistent with the Department's draft comments on the SB, please replace the term "anthropogenic" with "released to the environment during historical facility operations."	The text has been updated as requested.
Comment #30, **Page 38, Section 6.2 Performance Standards, The Proposed Corrective Measures,** eighth bullet. This bullet should include a brief description of what pathways/exposures will be controlled via institutional controls (e.g., restrict the use of groundwater, etc.)	The text has been updated as requested.
Comment #31, **Pages 36-38, Section 6.2 Attain Media Cleanup Objectives,** The Proposed Corrective Measures Bullets. A bullet should be included in the appropriate location specifying the passive vapor mitigation required in new construction to eliminate/reduce the indoor air exposure pathway.	The text has been updated as requested.
Comment #32, **Page 40, Section 6.3. Balancing Criteria,** 5) Cost. The last paragraph initially references Table 6 for estimated costs, but should reference Table 7. Please correct.	The text has been updated as requested.
Comment #33, **Page 43, Section 7 References.** The URS Final BRA has a date of 2015; however, the approved BRA was dated June 2016. Please correct.	The text has been updated as requested.
Comment #34, **Figures ES-1, Fig. 6, Fig. 10, Fig. 19, and Fig. 20.** The extent of soil and groundwater contamination for the former landfill and the parking lot east of the former IRS building have not yet	The text has been updated as requested.

been determined by the responsible parties. While the figures indicate "general area of groundwater contamination" we would suggest adding an additional paragraph on page 12 as a disclaimer to state: "Additionally, the extent of soil and groundwater contamination for the Former Landfill (SWMU 44) and the parking lot east of the former IRS building have not yet been determined by the responsible parties, GSA and the U.S. Army Corps of Engineers (USACE). As these areas are part of the BFC but are not part of the property to be transferred, CenterPoint did not collect any data in these areas during the Due Diligence sampling and did not conduct any analysis of these areas as they will remain the responsibility of GSA/USACE under the proposed modified MHWMF Part I Permit."	
Comment #35, **Figure 18** should illustrate a conceptual schematic of the preferred passive vapor venting that was discussed, with the vertical vents. Please revise.	The figure has been revised to illustrate the preferred option of sub-barrier vapor collection, vertical risers, and venting to the atmosphere at roof level.
Comment #36, **Figure 21** should indicate that Outfall 004 will be reconfigured, as opposed to abandoned and tilled with grout.	Figures 21 and 26 have been revised with additional detail on the reconfiguration of Outfall 004
Comment #37, **Table 1.** Will need to reconcile the number of SWMUs and post-remediation status designation with that discussed in draft comments on the SB.	As per comment #8, Table 1 has been updated with a footnote indicating that: “As of March, 2017, additional areas of the BFC are under consideration by MDNR for designation as Areas of Concern (AOCs) and inclusion as such in future versions of the MWHMF Permit. These are, however, located outside of the property to be transferred.”
Comment #38, **Table 4**. Will need to update table to current numbers and reference sources as will be reflected in the draft modified MHWMF Part I Permit and possibly add 1,4-dioxane to the groundwater protection standard based on current status of that evaluation.	The groundwater protection standards and he footnote regarding 1,4-dioxane have been updated to reflect the Class 1 permit modification and confirmation of 1,4-dioxane in monitoring wells.
Comment #39, **Table 6.** Why are constituents listed in this table that are not related to releases at the facility nor are they targeted for clean-up? Recommend removing those compounds that are not addressed by the proposed revised remedy as this could be confusing	Proposed cleanup levels associated with non-facility-related compounds / elements will be removed from the table.

to the public. Also note one value exceeds unity (aluminum=1,248,782 mg/kg (ppm)) which is not possible unless the units are in error and should be µg/kg (ppb).	
Comment #40, **Page 8, Appendix B, 2.6 Dual Phase Extraction.** Please remove one of the "was eliminated" in the first sentence in the second paragraph.	The text has been updated as requested.
Comment #41, **Appendix E** Response to Comment #41, p. 162 of 196. CenterPoint work plans stated that surface soil was defined as 0-2'; however, some areas used 0-3' depth. Please note in Section 4.1.1 Soils, where soil samples outside of this 0-2' depth were used to determine the SSLs.	The text has been updated as requested, with a new footnote explaining from where the 0-3 foot bgs samples were collected.