FEASIBILITY STUDY ADDENDUM REPORT
FINAL

Kenilworth Park Landfill Site
Anacostia Park
Washington, D.C.

Prepared for:

National Park Service
National Capital Parks - East
Washington, D.C.

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Prepared by:

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LIST OF ABBREVIATIONS AND ACRONYMS

ARAR	applicable or relevant and appropriate requirements
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	chemical of concern
District	District of Columbia
DOEE	District of Columbia Department of Energy & Environment
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
FONSI	finding of no significant impact
FS	feasibility study
ISM	incremental sampling methodology
JCO	The Johnson Company, Inc.
KPN	Kenilworth Park North
KPS	Kenilworth Park South
LEL	lower explosive limit
Management Plan	Anacostia Park Management Plan/Environmental Assessment
NACE	National Capital Parks - East
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPS	National Park Service
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PRG	preliminary remediation goal
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
RI	remedial investigation
SACM	Superfund Accelerated Cleanup Model
Site	Kenilworth Park Landfill Site
TBC	to be considered
µg/dL	micrograms per deciliter
U.S.C.	United States Code
UXO	unexploded ordnance

FEASIBILITY STUDY ADDENDUM REPORT

Kenilworth Park Landfill Site
Washington, D.C.

EXECUTIVE SUMMARY

On behalf of the National Park Service (NPS), VHB (formerly The Johnson Company, Inc. or JCO) prepared this Feasibility Study (FS) Addendum Report for the Kenilworth Park Landfill Site (Site) located in Washington, D.C. (Figure 1). The Site is located along the eastern bank of the Anacostia River, within Anacostia Park, a unit of NPS which is managed by National Capital Parks – East (NACE). It is subdivided into two areas, Kenilworth Park North (KPN) and Kenilworth Park South (KPS).

NPS is exercising its authority to address the Site pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the CERCLA response requirements provided in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). NPS is the lead response agency for the Site under CERCLA. This report is an addendum to the 2012 Feasibility Study (JCO, 2012) and incorporates additional data collected as part of the Remedial Investigation (RI) Addendum (JCO, 2019).

The RI and RI Addendum concluded that there is a potential for a long-term exposure risk associated with visitor and park worker exposure to contaminants in surface soil and an unacceptable risk to excavation workers associated with potential for exposure to contaminants in buried waste, methane gas, and the possible presence of buried unexploded ordnance. Although these potential exposure risks are low, they are unacceptable in the context of NPS's responsibilities as a federal land manager and the Organic Act of 1916. This FS Addendum evaluates alternatives to mitigate identified potential exposure risks.

As described in more detail within this report, significant additional information was included in this FS Addendum that was not available for the 2012 FS evaluations, including:

- **Newly collected groundwater data**. The RI Addendum concluded that chemicals in groundwater migrating from the Site pose no unacceptable human health or ecological risk; and

- **Revisions to KPS management zoning**. NPS established in the Anacostia Park Management Plan/Environmental Assessment (Management Plan; NPS, 2017) that KPS will be managed for "Natural Resources Recreation" and no active recreational facilities will be developed (e.g., sports fields, playgrounds, picnic areas, etc.) in that area of Anacostia Park.

Activities NPS completed as part of the FS Addendum include an updated analysis of applicable or relevant and appropriate requirements (ARARs); confirmation of the remedial action objectives (RAOs) and remedial technologies developed in the 2012 FS; and, refinement and detailed analysis of the alternatives using updated information available since the 2012 FS was completed.

The five remedial alternatives considered in the FS Addendum include:

- **Alternative 1: No Action** - Under the No Action alternative, which is required by the NCP and used as a baseline for comparison to other alternatives, contaminated soils and landfill waste materials would be left in place with no treatment or controls to prevent human or ecological exposure.
- **Alternative 2: Limited Action/Institutional Controls** - This alternative would employ the use of institutional controls to restrict and/or manage future activities that might otherwise result in health risks or hazards.

- **Alternative 3: Selective Placement of Clean Fill Barriers & Institutional Controls** - To mitigate the potentially unacceptable risk to Site visitors and workers under the anticipated future land-use scenario, Alternative 3 would involve placement of clean soil barriers in areas of the Site reserved for Organized Sport and Recreation and Community Activities and Special Events (approximately 60 acres). Official trails (e.g., the Anacostia Riverwalk Trail) would also be paved with asphalt or covered with clean gravel. As with Alternative 2, Alternative 3 would employ the use of institutional controls to restrict and/or manage future activities that might otherwise result in potentially unacceptable health risks or hazards.
- **Alternative 4: Site-wide Clean Soil Barrier & Institutional Controls** - This alternative would include installation of a site wide (approximately 117 acres) soil barrier to prevent human exposure to contaminated surface soils. As with Alternatives 2 and 3, Alternative 4 would employ the use of institutional controls to restrict and/or manage future activities that might otherwise result in potentially unacceptable health risks or hazards.
- **Alternative 5: Landfill Removal & Shoreline Stabilization** - Alternative 5 involves removal and off-Site disposal of all waste materials and previously placed cover soils with re-establishment of the original grades and wetlands habitat that existed before the development of the landfills.

The table below provides an overall summary of the detailed analysis for each alternative presented in Section 6 of this Report. Cells in the table are shaded red if a threshold criterion is not met, orange when non-cost balancing criteria are not met, and green when non-cost criteria are met. Cost cells are shaded orange if the alternative does not comply with section 300.430(f)(1)(ii)(D) of the NCP that indicates a selected remedy must be "cost-effective," which means that "its costs are proportional to its overall effectiveness."

Evaluation Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Overall protection of human health and the environment	Not Protective	Protective	Protective	Protective	Protective
Compliance with ARARs	Not Compliant	Not Compliant	Compliant	Compliant	Compliant
Long-term effectiveness and permanence	Ineffective	Ineffective	Effective	Effective	Effective
Reduction of toxicity, mobility, or volume through treatment	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Short-term effectiveness	Effective	Effective	Effective	Ineffective	Ineffective
Implementability	Not Applicable	Implement-able	Implement-able	Implement-able	Implement-able
Capital Cost: NPW:	$0 $170,000	$86,000 $400,000	$7, 500,000 $9,000,000	$15,000,000 $18,000,000	$610,000,000 $620,000,000

This detailed analysis provides a basis for NPS to select a preferred remedial alternative which will be described in a Proposed Plan and made available for public review and comment. After consideration of public comments, NPS will select a remedy to address the Site and will document the decision in a Record of Decision (ROD).

1.0 INTRODUCTION

On behalf of the National Park Service (NPS), VHB (formerly The Johnson Company, Inc. or JCO) prepared this Feasibility Study (FS) Addendum Report for the Kenilworth Park Landfill Site (Site) located in Washington, D.C. (Figure 1). This FS Addendum Report was prepared under JCO BPA Contract P16PA00039, Call Orders P17PB00373 and 140P2018F0053.

The Site is located along the eastern bank of the Anacostia River within Anacostia Park, a national park managed by the National Capital Parks – East (NACE) administrative unit of the National Park Service (NPS). As shown on Figures 1 and 2, the Site is subdivided into two areas, Kenilworth Park North (KPN) and Kenilworth Park South (KPS). NPS divided the Site into two Operable Units (OUs): OU1 consists of surface and subsurface soils, including waste material in the landfill, and OU2 consists of shallow groundwater beneath OU1.

This report presents the basis for developing and selecting remedial alternatives and the results of detailed analysis of each alternative using criteria established by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), the regulations developed to implement the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

This report is an addendum to the 2012 Feasibility Study (JCO, 2012) and incorporates additional data collected as part of the Remedial Investigation (RI) Addendum (JCO, 2019). As described in more detail within this report, significant additional information was included in this FS Addendum that was not available for the 2012 FS evaluations, including:

- **Newly collected groundwater data**. The RI Addendum concluded that chemicals in groundwater migrating from the Site pose no unacceptable human health or ecological risk; and

- **Revisions to KPS management zoning**. NPS established in the Anacostia Park Management Plan Environmental Assessment (Management Plan) (NPS 2017) that KPS will be managed as a "Natural Resources Recreation" area, and NPS does not envision developing any active recreational facilities in that area of Anacostia Park.

The 2012 FS was developed specifically to address contamination within OU1 with the understanding that a further response action may be required to address contamination in OU2. Based on the RI Addendum findings, NPS determined that no further response actions are required for OU2; therefore, this FS only considers response activities for OU1.

1.1 NPS CERCLA Authority

NPS is authorized under CERCLA, 42 U.S.C. §§ 9601 et seq., to investigate and otherwise respond to the release or threatened release of hazardous substances on or from land under the jurisdiction, custody, or control of NPS. This FS Addendum Report was prepared in general accordance with the United States Environmental Protection Agency's (EPA) Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA, 1988).

CERCLA's implementing regulations, codified in the NCP, 40 Code of Federal Regulations (CFR) Part 300, establish the framework for responding to hazardous substance releases and threatened releases. The NCP outlines two general processes for responding to releases: a removal action process (including both time-critical and non-time-critical removal actions) and a remedial action process (see NCP Sections

300.400 through 300.440). NPS is following the remedial action process at the Kenilworth Park Landfill Site. Under the remedial action process, an RI/FS is performed to characterize the nature and extent of contamination and evaluate remedial alternatives to protect the public health or welfare or the environment from risks posed by the release or threatened release (see NCP Section 300.430).

1.2 Purpose

The purpose of this FS Addendum is to develop, screen, and analyze potential remedial alternatives that address contamination identified at the Site that is considered to be present at an unacceptable level of risk to human health or the environment. The FS Addendum process included: an updated analysis of applicable or relevant and appropriate requirements (ARARs); confirmation of the RAOs and remedial technologies; and refinement and detailed analysis of the alternatives.

The primary objective of the FS is to develop appropriate remedial alternatives and evaluate these alternatives such that relevant information concerning the remedial action options can be presented to a decision-maker and an appropriate remedy selected. This FS Addendum provides a basis for NPS to select a preferred remedial alternative, which will be described in a Proposed Plan and made available for public review and comment. After consideration of public comments, NPS will select a remedial action to address the Site and will document the decision in a Record of Decision (ROD).

1.3 Report Organization

The remainder of this report is organized by the following sections.

- **Background:** this section describes the site location and land use history. It summarizes the nature and extent of contamination and the conceptual site model as identified through the RI activities and summarized in the RI Addendum Report (JCO, 2019). Relevant documents that are also described in this section include the 2012 OU1 FS Report (JCO, 2012), to which this report is an addendum, and the Management Plan (NPS, 2017), which defines the current and anticipated future use of the park.
- **Basis for Remediation:** this section includes an analysis of ARARs and criteria to be considered (TBC) in the development and evaluation of alternatives. Remedial action objectives are defined in this section.
- **Preliminary Remedial Goals (PRGs):** this section defines the PRGs, which vary across the site based on the anticipated future land use and the potential for associated visitor and worker exposure risks. The PRGs also address potential risks associated with excavation that could be related to future construction or installation of utilities. PRG exceedances are evaluated for both KPS and KPN.
- **Development and Screening of Alternatives:** this section describes the five alternatives that were considered as part of this FS Addendum and the basis for selecting them.
- **Detailed Analysis of Alternatives:** this section includes an analysis of each alternative using the seven threshold and balancing criteria established in the NCP.
- **Comparative Analysis of Alternatives:** this section summarizes the findings of the detailed analysis relative to each alternative with respect to the threshold and balancing criteria.

2.0 BACKGROUND

This section provides a summary of the information used to support the development and analysis of alternatives. A detailed discussion of the prior investigation activities, and the identified nature and extent of contamination, is provided in the RI Addendum Report (JCO, 2019).

2.1 Site Location and Description

The Site is located within Anacostia Park, a unit of NPS managed by NACE in Washington, District of Columbia (District) (Figure 1). Access to KPN is from Deane Avenue NE near the intersection with Lee Street NE. Access to KPS is either from the Deane Avenue extension within KPN (currently blocked by jersey barriers) or via the Anacostia Riverwalk Trail with access at the intersection of Foote Place NE and Foote Street NE.

The Site consists of two closed landfills (KPN and KPS) separated by Watts Branch, a tributary of the Anacostia River. The Site occupies approximately 130 acres (KPN is approximately 80 acres and KPS is about 50 acres). As shown on Figure 2, the Anacostia River flows along the western boundary of both KPN and KPS. Kenilworth Marsh is located to the north of KPN and Watts Branch flows along the southern boundary of KPN and provides the boundary between KPN and KPS. An unnamed tributary to Watts Branch runs along the east side of KPS. The Site is bordered by residential neighborhoods to the east. The Thomas Elementary School and Educare of Washington, DC (CDC Child Development Center) are located about 300 feet southeast of KPS. The Benning Road solid waste transfer station is located to the south of KPS.

KPN consists of grassy open space with buffers or transition zones of trees and shrubs along riparian or marsh boundaries. A large portion of KPN is maintained for public recreation (e.g., soccer fields, a football field, tennis courts, and a running track). In 2016, the District Department of Transportation completed an extension of the asphalt-paved Anacostia Riverwalk Trail over a portion of KPN.

KPS consists of an open field with well-established grass cover and shrubs, and areas that are more densely vegetated with shrubs and trees. Although KPS is administratively closed, the asphalt paved extension of Deane Avenue NE is often used by the public for walking and biking. KPS is also visited by birders who likely explore off-trail areas.

2.2 Site History

Prior to its initial development as a landfill in 1942, the Site consisted of several recreational lakes that had been excavated within the tidal mud flats by the United States Army Corps of Engineers in the 1930s. The landfill was operated by the District as a burning dump and a landfill for District incinerator ash from 1942 until 1968. In 1968 the District discontinued the open burning practice but continued co-disposal of raw waste and incinerator ash until 1970 when the landfill was closed. The closure activities included placement of soil fill over the waste and grading to promote runoff toward the perimeter surface water bodies (Kenilworth Marsh, the Anacostia River, Watts Branch and the unnamed tributary to Watts Branch). Based on soil borings completed during the RI activities, the soil cover thickness generally ranges from approximately 2 to 7 feet but may be as thick as 15 feet in some areas of the Site. The soil cover appears to consist predominantly of fine-grained silt and clay, which limits the potential for rainwater and snow melt infiltration. Following closure, the Site was developed for recreational purposes with running tracks, sports fields and picnic areas.

In the late 1990s, NPS developed a plan to raise the elevation of KPS and develop additional sports fields. Soil and demolition debris were placed over portions of KPS but the effort was discontinued before the final grades were reached, and the sports fields were never constructed. In the early 2000s NPS removed demolition debris from the surface of KPS, improved the surface drainage by creating a series of storm water ditches and berms, and seeded the area to establish the vegetative cover that is present today.

Beginning in 1998 there have been multiple, increasingly more detailed, investigations of the Site culminating in RI reports prepared in 2007 (KPN; E&E, 2007) and 2008 (KPS; E&E, 2008) and then in the RI Addendum Report prepared in 2019 (JCO, 2019). The RI Addendum Report includes summaries of each investigation completed since 1998.

2.3 Nature and Extent of Contamination

The nature and extent of contamination at the Site was established in the 2007 and 2008 RIs, and the 2010 Supplemental Data Collection Report (published as Appendix A to the 2012 FS report; JCO, 2012). The subsequent groundwater, porewater, seep water, and surface soil assessments completed as part of the RI Addendum filled data gaps and allowed for a refinement of the conceptual site model. The RI Addendum findings confirmed prior conclusions related to potential human health exposure to surface soil and ecological risk associated with groundwater migration.

The inferred landfill boundaries shown on Figure 2 are based on a geophysical (EM-34) survey completed in 2006 supplemented with the review of historical aerial photographs and topography. The limits were established as part of the 2007/2008 RIs. As shown, the inferred limits of waste for KPS and KPN extend up to and along the Anacostia Riverbank. There are three locations identified from the historical aerial photographs where waste may have been disposed below the water line along the bank of the river and perimeter of Kenilworth Marsh. These areas were former inlets to the recreational lakes that were excavated by the US Army Corps of Engineers in the 1930s. Based on the results of the risk assessment completed as part of the RI Addendum, using the expanded groundwater data set, there is no evidence that buried waste at the landfill, or groundwater migrating from the buried waste, is causing an unacceptable risk to human health or the environment.

Certain polychlorinated biphenyl (PCB) Aroclors, dieldrin, certain polycyclic aromatic hydrocarbons (PAHs) and metals are present in surface soil at both KPN and KPS. There is no distinct pattern of distribution that would indicate an on-site spill or release. Some of these chemicals are widespread in the environment due to atmospheric fallout from air pollution; however, analysis presented in the RI Addendum Report indicates these chemicals are present at concentrations that are above off-site reference levels (E&E, 2007; E&E, 2008). These chemicals were likely present in the soil fill used to cover the landfill. Some level of surface soil contamination may also be due to atmospheric deposition (e.g., car exhaust, power plant smokestacks, etc.). Based on the conservative recreational exposure scenarios established for the 2007 and 2008 RIs, the potential risk associated with human exposure to these chemicals is greater than the NCP point of departure (excess cancer risk of 1×10^{-6}).

Prolonged worker exposure to buried soil and waste that contains lead could also cause adverse health effects associated with elevated blood lead levels if protective measures (engineering controls and/or personal protective equipment) are not taken by the workers. Excavation within the former landfill areas also requires precautions to be taken due to the potential presence of methane gas (generated during waste decomposition) and potentially buried unexploded ordnance.

2.4 Conceptual Site Model Summary

Refer to the RI Addendum Report (JCO, 2019) for a detailed description of the conceptual site model. The potential exposure pathways include visitor and park worker exposure to contaminants in surface soil, excavation worker exposure to buried waste and the potential explosion risks associated with methane gas and unexploded ordnances during excavation. There are no unacceptable ecological exposure risks associated with chemicals present in soil/waste (OU1) or groundwater (OU2). Based on detailed risk assessment, NPS concluded that, while relatively low, the potential human health exposure risks for visitors, park workers, and excavation workers are unacceptable and require further response actions.

2.5 2012 Feasibility Study

In April 2012, NPS published a Feasibility Study Report (JCO, 2012) that evaluated possible alternatives to address the Site and formed the basis for the 2013 Proposed Plan (NPS, 2013). The FS evaluated remedial alternatives for OU1 to address the potential combined KPN and KPS exposure risks associated with surface soil contamination, and to meet ARARs. The FS considered the following four alternatives:

- Alternative 1: No action;
- Alternative 2: Minor regrading combined with administrative institutional controls and three years of annual perimeter methane monitoring;
- Alternatives 3a and 3b: Soil cap (12-inch cap for Alternative 3a and 24-inch cap for Alternative 3b), localized shallow excavation and off-Site disposal where pre-excavation is required, administrative institutional controls, and perimeter methane monitoring before, during, and after remedial actions; and
- Alternative 4: Removal of all accessible waste material and existing cover soils, localized shallow excavation and off-Site disposal to accommodate a soil cap around existing development, wetlands restoration, and administrative institutional controls.

Alternative 3b was subsequently identified as the preferred alternative and presented for public review and comment in the 2013 Proposed Plan (NPS, 2013). NPS determined that both alternatives 3a and 3b would effectively address the potential exposure risk associated with surface soil contamination. Alternative 3b was selected over Alternative 3a because it also met Resource Conservation and Recovery Act (RCRA) Subtitle D closure specifications (40 CFR § 258.60) which were considered at the time to be "relevant and appropriate" in their entirety.[1] The RCRA closure specifications include a provision to limit potential infiltration of water at the surface of the landfill to prevent or limit impacts to groundwater quality.

The RI Addendum later demonstrated, however, that shallow groundwater, the groundwater most likely to be impacted by contaminants present in buried waste, migrating from the site is not causing an unacceptable risk to human health or the environment; therefore, NPS determined that additional capping to limit infiltration is not necessary. Based on the RI Addendum findings, NPS determined that the provisions of 40 CFR § 258.60 that address the cover system permeability and other components intended to minimize infiltration of water through the cap are no longer relevant or appropriate under section 300.400(g)(2) of the NCP. NPS determined the provisions of 40 CFR § 258.60 intended to protect against

[1] The RCRA Subtitle D closure requirements are not applicable because the landfill stopped receiving waste in 1970, before the effective date of the RCRA Subtitle D regulations (October 1991).

erosion of the final cover system, including 40 CFR § 258.60(a)(3) and 40 CFR § 258.60(b)(2), remain relevant and appropriate (ARARs are identified and discussed in Section 3.1).

2.6 Anacostia Park Management Plan

The Management Plan (NPS, 2017) was used to assess potential future visitor and park staff exposure risks and to develop and evaluate a remedial alternative that is protective of human health and the environment without creating an impairment to the park's intended future use and resources. The Management Plan is the primary guidance document for managing the park. It provides the framework for future decision making consistent with the goals for the park, which are:

- To provide broad guidance and long-term strategies for park operations, resource protection, and restoration;
- To promote partnership opportunities that will support and complement management of the park; and
- To define desired resource conditions and recommend actions that will lead to those conditions.

NPS evaluated four possible alternatives for managing Anacostia Park under the National Environmental Policy Act (NEPA) and presented them in the Management Plan. After releasing the Management Plan for public comment, presenting it in a public meeting, and consulting with various stakeholders (District agencies, the Anacostia Watershed Society/Kingfisher Water Trail Master Plan, and non-governmental organizations), NPS selected the preferred alternative (alternative 3). A finding of no significant impact (FONSI) for the implementation of alternative 3, as described in the Management Plan, was approved by the Director of the National Capital Region in November 2017.

As shown on Figure 3, the Management Plan identifies three "Management Zones" within the Site boundaries. Descriptions of each Management Zone are provided below.

- **Natural Resource Recreation** – intended to preserve and protect the natural landscape of forests and wetlands in the park; recreation activities that connect visitors to the natural setting will be encouraged where compatible. This zone provides passive recreation and interpretive opportunities to visitors within a managed natural setting including hiking, walking, boating, experiencing the river, and enjoying and learning about nature. Appropriate types of facilities in this zone include primarily unpaved trails (with limited use of paved trails); boardwalks and pedestrian bridges; limited roadways and parking; limited picnic and play facilities; educational, interpretative, and wayfinding signs; comfort stations; and water access facilities such as piers, docks, floating boat tie-ups, ramps, and non-motorized boat launches.
- **Organized Sport and Recreation** – intended to support organized league play and other recreational activities on maintained fields. This zone provides multi-purpose sports fields and their environs including mowed turf areas, managed plantings, buildings, parking, access roads, and interstitial natural areas would be maintained and operated.
- **Community Activities and Special Events** – intended to support a dynamic mix of educational and recreational uses (e.g., roller skating, picnicking, special events, and environmental programs). This zone provides visitors with opportunities to participate in recreational and educational activities traditionally found in neighborhood and regional parks, as well as multi-purpose sports fields and facilities that support play for a variety of sports. These opportunities would include neighborhood recreation, passive recreation, casual as well as concentrated visitor use, and small

social gatherings. Opportunities for heritage and environmental education and interpretation would be offered in these areas.

Public Law No. 108-335, § 344 118 Stat. 1322, 1350 (2004) directed the United States (NPS) to transfer administrative jurisdiction of KPN and certain adjacent areas to the District. Once transferred, the Management Plan will no longer apply to that area. However, the restrictions associated with the transfer, "for the provision of public recreational facilities, open space, or public outdoor recreational opportunities", imply that the future land uses will be consistent with those identified in the Management Plan. For the purposes of the FS, NPS considered land uses designated in the Management Plan and made reasonable assumptions regarding how KPN would likely be configured for organized sports and recreation/community activities and special events; these assumptions expanded the areas within KPN to be used for organized sports and recreation (see Figure 3).

3.0 BASIS FOR REMEDIAL ACTION

As summarized above, NPS determined that the potential human health risk associated with visitor and worker exposure to surface soil exceeds the excess cancer risk of 1×10^{-6} and is considered unacceptable to NPS at this Site. The threshold criteria for a remedy under CERCLA are to eliminate, reduce, or control site risks posed for each source-transport-receptor pathway and to comply with ARARs. This section identifies the Site-specific ARARs that were used in the evaluation of remedial alternatives and identifies RAOs that are the basis for selecting PRGs for the protection of human health and the environment.[1]

3.1 Applicable or Relevant and Appropriate Requirements (ARARs) and Criteria to be Considered (TBCs)

A listing of ARARs and TBCs is provided in Tables 1 through 3. For each ARAR/TBC listed in the tables, there is a citation, a description of the requirement, and an indication as to whether the requirement is "applicable", "relevant and appropriate", or "to be considered". The ARARs and TBCs reflect input obtained from the District of Columbia Department of Energy & Environment (DOEE) in its capacity as a support regulatory agency. The tables are structured around the following categories of ARARs.

Location Specific (Table 1): The governing location-specific ARAR is Non-Impairment, which reflects NPS's land management responsibilities under the Organic Act and the General Authorities Act. This ARAR is a critical factor for establishing PRGs that allow the park to be used and enjoyed in the manner to which it was intended under the enabling legislation and the governing Management Plan.

Chemical Specific (Table 2): Except for methane, there are no chemical-specific ARARs that can be used to develop PRGs for OU1. For the most part, PRGs for OU1 were developed based on the management of human health exposure risks. The RAOs presented in the following section are general in nature, and the associated PRGs are governed by acceptable levels of risk as defined under the NCP for the designated future land use scenarios.

Action Specific (Table 3): Action-specific ARARs relate to design and implementation of remedial alternatives. Some of the action specific ARARs may be eliminated once a remedial alternative is selected and put forward in the Proposed Plan.

[1] PRGs are developed under CERCLA for the protection of human health and the environment. At this Site, ecological risk assessments indicate there is no unacceptable risk to the environment; therefore, the focus of the alternatives is on the protection of human health.

3.2 Remedial Action Objectives (RAOs)

Although the Site was closed before the effective date of RCRA Subtitle D closure requirements, and before EPA developed a "presumptive remedy" for CERCLA Municipal Landfill Sites (EPA, 1993); the applicable RAOs for the presumptive remedy were generally met by the 1970 landfill closure activities. The presumptive remedy for landfills under CERCLA is containment with the RAOs listed below.

- **Preventing direct contact with landfill contents –** the soil cover, regrading, and revegetation activities that occurred in the early 1970s, after the landfill was closed, prevent direct contact with the landfill contents, except during excavation activities such as the installation of a buried utility.
- **Minimizing infiltration and resulting contaminant leaching to groundwater** – although an engineered low-permeability cap was not installed over the landfill at closure, based on observations made during exploration and testing, the soil used for capping appears to be fine grained in nature and therefore of relatively low permeability. Additionally, the landfill surface is generally graded to promote runoff and limit infiltration. Based on the results of groundwater sampling and analysis (multiple rounds of sampling conducted over a 20-year, post-closure period), NPS concluded that groundwater migrating from the landfill is not resulting in an unacceptable exposure risk to human health or the environment; therefore, additional measures to limit infiltration are not necessary.
- **Controlling surface water runoff and erosion** – following improvements made in the early 2000s, surface water runoff is controlled, and vegetation is maintained at the surface limiting the potential for erosion. Multiple detailed inspections of the landfill perimeter identified no evidence of significant erosion that could lead to the future exposure of buried waste.
- **Collecting and treating contaminated groundwater and leachate to contain the contaminant plume and prevent further migration from source area** – the results of the RI Addendum demonstrate that there is no contaminant plume and the low concentrations of chemicals found in groundwater that are associated with landfill waste do not present an unacceptable risk to human health or the environment.
- **Controlling and treating landfill gas** – based on the sampling and analysis of soil gas, there is no need for active or passive control of landfill gas; however, confirmatory soil gas testing is recommended as part of the active remedies under consideration and such remedies must comply with the chemical specific ARAR related to methane concentrations and exposures under RCRA Subtitle D.

As described above, the RAOs associated with containment have been met; therefore, the RAOs considered in this Feasibility Study Addendum are limited to those that address the unacceptable risk associated with potential visitor and worker exposure to surface soil, buried waste during excavation or subsurface exploration (including possible unexploded ordnances or UXO), and, in certain circumstances, methane.

The risk assessments completed as part of the RI and RI Addendum identified potentially unacceptable chronic human-health exposure risks to visitors and park staff. These risks were associated with certain PCB Aroclors, PAHs, metals, and the pesticide dieldrin in surface soil. Lead present in the subsurface soil/buried waste represents a potentially unacceptable risk to workers during excavation activities. Methane that may be present in soil gas and the possible presence of buried unexploded ordnance also represent potential risks to excavation workers.

No unacceptable ecological exposure risks were identified for surface soil or buried waste (OU1) and no unacceptable human health or ecological exposure risks were identified for groundwater (OU2).

The highest combined excess cancer risk from exposure to Site soil was estimated at 3.1×10^{-5}. According to the NCP, this is within the range of acceptable exposure risk (less than 1.0×10^{-4}); however, in the absence of site-specific mitigating factors, the NCP requires cleanup goals to be based on the 1×10^{-6} "point of departure." NPS identified no reason to raise the acceptable level of risk above 1×10^{-6} for this Site. Taking this into consideration, NPS established the following RAOs:

- Reducing or eliminating unacceptable carcinogenic and non-carcinogenic risks associated with surface soil contamination;
- Reducing or eliminating unacceptable non-carcinogenic risk associated with lead in subsurface soil/buried waste; and
- Reducing or eliminating risks and explosive hazard associated with methane gas and UXO.

4.0 PRELIMINARY REMEDIAL GOALS (PRGs)

Remediation Goals establish acceptable exposure levels that are protective of human health and the environment. Preliminary Remedial Goals (PRGs) are developed based on readily available information, such as chemical specific ARARs and risk assessment calculations that work backward from target risk levels (e.g., excess cancer risk of 1×10^{-6}). Final Remedial Goals are established when an alternative is selected and recorded in the Record of Decision (ROD). As summarized in Appendix A, PRGs were developed for this Site, based on calculated risk-based cleanup levels, to address the anticipated future land use(s) as described in the Management Plan. As noted above, the Management Plan was developed as a "framework for future decision making and management direction for the park" and it identifies the following three land use "Management Zones" at the Site:

- Natural Resource Recreation;
- Organized Sport and Recreation; and
- Community Activities and Special Events.

As documented in the Management Plan, the future land use at KPS is within the Management Zone identified for Natural Resources Recreation only. This designation is designed to preserve and protect natural areas and provide passive recreational opportunities (such as walking, biking, and exploring nature). The Anacostia Riverwalk Trail will eventually include a segment that crosses KPS and joins with the existing trail on KPN. Recreational facilities at KPS will be limited to the Anacostia Riverwalk Trail; there are no plans to develop other facilities (e.g., picnic areas or playgrounds) for public use. For the purposes of this FS Addendum, NPS assumed that the unofficial road that extends from Dean Avenue across KPS will be used by pedestrians and cyclists once this area of the park is re-opened.

As noted in Section 2.6, Congress directed NPS to transfer administrative jurisdiction of KPN to the District (PL 108-335 § 334) with the limitation that KPN may only be used "for the provision of public recreational facilities, open space, or public outdoor recreational opportunities." The District has not developed specific plans for development of KPN, but continued use for similar sports facilities is likely based on preliminary input from the District Department of Parks and Recreation. Current plans call for the Anacostia Riverwalk Trail to be extended within KPN with construction of a new bridge that will cross the

River and tie into the trail network within the National Arboretum. DDOT and DOEE continue to work with NPS to address any potential environmental concerns related to this project.

PRGs for addressing carcinogenic risk of various organic compounds and arsenic are developed by choosing a target excess cancer risk level and factoring in the likely exposure scenarios. The exposure scenarios consider the “frequency” a visitor might be exposed to surface soil at the Site and the “intensity” of that exposure. For example, someone who visits the park daily has a higher frequency of exposure than someone who participates in an organized seasonal sporting activity a few times per week. However, a visitor who participates in a sporting activity has a higher intensity of exposure to soil than visitors who are walking their dogs or jogging on paved trails through the park. To account for the different possible exposures, NPS developed PRGs for the Site considering four land use scenarios. As is customary, the PRGs were developed for target excess cancer risk levels of 1×10^{-6}, 1×10^{-5}, and 1×10^{-4}; a hazard index of 1 was used for non-chronic/acute risks. Although NPS has retained the target excess cancer risk level of 1×10^{-6} for the evaluation of alternatives, the implications of selecting target excess cancer risk levels of 1×10^{-5} and 1×10^{-4} are presented in Section 4.7 for additional perspective.

Descriptions of each potential land use scenario are provided below; PRGs for each chemical of concern (COC) are provided in Tables 4, 5, and 6 for each scenario and each target risk level. The assumptions associated with each risk exposure scenario are outlined in the sections that follow. The analysis performed to develop chronic and acute PRGs is documented in the memorandum included in Appendix A entitled “Development of Risk Based Cleanup Levels for Soil, Kenilworth Park Landfill, Washington, DC.” In addition to developing PRGs for carcinogenic chemicals, PRGs for addressing chronic, non-carcinogenic risk posed by certain metals were developed based on likely exposure scenarios. The effects of non-carcinogenic chemicals are not based on probabilistic/statistical models and, therefore, do not vary with the assumed target risk levels. For this reason, several PRGs listed on Tables 4 through 6 remain constant regardless of the target excess cancer risk on which each table is based.

4.1 Scenario 1: Recreational Land Use (high frequency/high intensity)

The exposure assumptions used to evaluate Scenario 1 are the same as those used for the 2007 and 2008 human health risk assessments. To be consistent, NPS also calculated risks associated with this scenario in the RI Addendum; however, the original exposure assumptions used under this Scenario were developed before the Management Plan was adopted and are similar to that which would be associated with residential land use. The frequency/intensity exposure assumptions for this scenario are identified below.

- Exposure duration of 26 years (standard residential exposure duration)
- Year-round exposure frequency (350 days per year)
- Exposure time outdoors of 2 hour/day
- All daily soil ingestion/contact dose is obtained at the Site

NPS chose to include this scenario to be consistent with the 2012 FS and Proposed Plan; however, based on the future land use established in the Management Plan, NPS now considers the organized sport and recreation/community activity and special events (Scenario 2) to better represent the most sensitive future land use at Kenilworth Park. Therefore, no remedial alternatives were developed to address Scenario 1 land use.

4.2 Scenario 2: Organized Sport and Recreation/Community Activities and Special Events (high frequency/moderate intensity)

NPS considered the two Management Zone categories included in this scenario to result in equal levels of potential exposure of visitors and park workers to surface soil. PRGs developed under this scenario apply to areas of the Site used for a variety of recreational sports and events, which include ballfields (e.g., soccer, football, baseball, and rugby) and accessory structures such as storage sheds, bleachers, and restrooms. The primary anticipated activities include playing sports and spectating at events. NPS developed PRGs for this scenario under the assumption that youth and adult visitors would engage in sporting activities during the non-winter months. The frequency/intensity exposure assumptions used to calculate Scenario 2 PRGs are identified below.

- Exposure duration of 26 years (standard residential exposure duration)
- Exposure frequency of 3 days/week for a child, approximately 10 months/year (spring/fall seasons)
- Exposure frequency of 3.8 days/week for a youth/adult, 10 months/year
- High potential soil contact activities (e.g., playing soccer or rugby)
- Exposure time of 2 hours/day for the child and 3 hour/day for the adult
- One-half of daily soil ingestion/contact dose is obtained from the Site

The exposure parameters outlined above apply to the organic compounds, arsenic, and all metals except lead. As noted in the risk-based concentrations development memorandum (Appendix A), PRGs for lead are developed based on modeling that predicts blood lead levels (typically in children). The PRG for lead under this land use scenario (153 mg/kg) is based on a residential setting with a small child receptor. The EPA residential Regional Screening Level (RSL) for lead in soil is 400 mg/kg (EPA, 2019). Therefore, these assumptions are considered conservative and err on the side of being more protective of visitors and site workers.

4.3 Scenario 3: Natural Resource Recreation (moderate frequency/moderate intensity)

Under this scenario, areas of the Site will be maintained as undeveloped open space/conservation land. These areas may include nature trails and walking/biking paths. Activities will primarily include walking/jogging/biking along established trails and wildlife viewing. This scenario addresses visitors who regularly use the park for exercise and to walk their dogs. The frequency/intensity exposure assumptions used to calculate Scenario 3 PRGs are identified below.

- Exposure duration of 26 years (full residential tenure)
- Exposure frequency of 4 days/week, approximately 10 months/year
- Low surface soil contact activities (e.g., walking)
- Exposure time of 2 hours/day
- One-third of daily soil ingestion/contact dose obtained from the Site

The model used to estimate blood lead levels associated with exposure to lead in surface soil at the Site was adjusted by removing the component of lead that is attributed to dust from outdoor soil that enters the home; therefore, the PRG established for lead in surface soil under this scenario (297 mg/kg) is higher than for Scenario 2, but still conservative when compared to the EPA Regional Screening Level for residential land use (400 mg/kg). This adjustment in the PRG calculation is considered reasonable considering the reduced frequency and duration of exposure anticipated under this scenario.

4.4 Scenario 4: Natural Resource Recreation (low frequency/low intensity)

This scenario is a refinement of Scenario 3. It was developed with the understanding that most nearby residents who regularly visit the park will most often follow the established roadways and paths or will spend time within the areas that are landscaped and designated for organized sports or community activities. Although there is nothing preventing visitors from venturing off trails within the designated natural resource recreation zones, the frequency at which a given individual does this is likely to be more limited than the typical walker/jogger. The frequency/intensity exposure assumptions used to calculate Scenario 4 PRGs are identified below.

- Exposure duration of 26 years (full residential tenure)
- Exposure frequency of 1 day/week, approximately 10 months/year
- Low surface soil contact activities (e.g., walking)
- Exposure time of 1 hour/day
- One-third of daily soil ingestion/contact dose is obtained from the Site

The same lead exposure assumptions used for Scenario 3 carry over to Scenario 4 resulting in the same PRG.

4.5 Methane PRG

Methane concentrations in soil gas measured within one interior landfill monitoring point at KPN and two interior landfill monitoring points at KPS were above the lower explosive limit (LEL) of 50,000 parts per million by volume, or 5 percent by volume. Methane concentrations in most soil gas samples were well below the LEL suggesting explosion risks associated with methane are very low but should not be ignored. Methane was not detected above the LEL in soil gas samples collected between the landfill and residential/occupied buildings indicating no evidence of subsurface methane migration from the former landfill areas. NPS selected a PRG for methane based on the RCRA Subtitle D ARAR that establishes permissible methane concentrations in structures on landfills (25% of the LEL) and in soil gas at the property boundary (100% of the LEL).

4.6 Unexploded Ordnance

Although PRGs can be developed for various chemicals found in soil and buried waste, and for methane that is present in soil gas, no PRGs can be developed for UXOs. UXOs are either present, and therefore a risk, or not present. Measures to mitigate potential UXO risk are related to work practices tied to subsurface-disturbing activities (e.g., utility trench excavation), rather than selection of protective concentration thresholds.

4.7 Implications of PRGs

Comparisons of exposure point concentrations (EPCs) and soil sample analytical results to various PRGs are provided for KPN and KPS in the following sections. EPCs are statistically calculated values derived from chemical analysis of samples collected from the Site. Statistical methods used to calculate EPCs are intended to provide conservative estimates of the overall concentration a receptor (e.g., visitor, Site worker) might be exposed to at the Site. EPCs are considered in the calculation of potential exposure risk along with assumptions of exposure frequency and intensity.

4.7.1 PRG Exceedances at KPN

As described in the RI Addendum, NPS evaluated surface soil quality at KPN based on discrete soil sample data reported in the 2007 KPN RI (E&E, 2007). Figure 4 shows the distribution of discrete sample PRG exceedances across KPN for the target excess cancer risk level of 1×10^{-6} and a target blood lead level of 5 micrograms per deciliter (µg/dL). The locations of discrete samples are color coded to show which PRGs, if any, were exceeded in a given sample. The most conservative PRG is for Organized Sport and Recreation/Community Activities and Special Events and the exceedance of this PRG is indicated with a yellow colored dot. A less conservative PRG was developed for the Natural Resource Recreation scenario for frequent visitors like dog walkers, joggers, and cyclists who would typically remain within the trails and landscaped areas of the park; exceedances of this PRG are indicated by an orange dot. The least conservative PRG was developed for Natural Resource Recreational use involving off-trail areas that are less accessible, heavily vegetated, and not associated with community or recreational activities; the exceedances of this PRG are indicated by a red dot. The KPN-wide EPCs were estimated for each COC using the discrete sample data set. The findings are summarized below.

- **Scenario 2:** As indicated in Table 4, EPCs for benzo[a]pyrene, dieldrin, PCB Aroclor 1254, and arsenic are above the Scenario 2 PRGs for a 1×10^{-6} target cancer risk threshold. This implies a potential long-term excess cancer risk that exceeds the NCP point of departure for visitors who engage in sporting and community events that involve a higher frequency and intensity of contact with surface soils. None of the KPN-wide EPCs exceed the carcinogenic PRGs established for a 1×10^{-5} or higher risk threshold (see Tables 5 and 6). The EPC for lead is above the Scenario 2 PRG based on target blood lead levels. PRGs for metals, including lead, do not vary based on the target cancer risk.
- **Scenario 3:** Except for benzo[a]pyrene no EPCs exceed the Scenario 3 PRGs for a 1×10^{-6} target cancer risk threshold. None of the KPN-wide EPCs exceed PRGs established for a 1×10^{-5} or higher target cancer risk threshold.
- **Scenario 4:** None of the COC EPCs exceed the Scenario 4 PRGs for a 1×10^{-6} target cancer risk threshold. This implies that the excess cancer risk for visitors who less frequently spend time off the established trails and sports fields would remain below 1×10^{-6} target excess cancer risk and below a hazard index of 1 for non-carcinogenic risk.

NPS calculated surface soil EPCs based on discrete samples collected from locations across KPN. Depending on the selected remedial alternative, there may be value in collecting additional data in selected areas to further evaluate the need for remediation. This additional sampling could be done at the Remedial Design phase.

Taking into consideration the land uses designated in the Management Plan and making reasonable assumptions regarding how KPN would likely be configured for organized sports and recreation/community activities and special events, Figures 5 and 6 show where discrete sample concentrations exceed PRGs developed for the target cancer risk levels of 1×10^{-6} and 1×10^{-5}, respectively. Because PRGs for lead are not sensitive to target cancer risk levels, PRG exceedances under a target excess cancer risk of 1×10^{-4} are the same as for 1×10^{-5}.

Methane concentrations in one soil gas sampling location were detected as high as 81% of the LEL, which is below the property boundary PRG (100% of the LEL). Methane concentrations did not exceed PRGs at the property boundaries or inside the Kenilworth-Parkside Recreation Center building (the sample was collected before the building was demolished in 2010).

4.7.2 PRG Exceedances at KPS

NPS used data obtained from analysis of discrete soil samples and samples collected using Incremental Sampling Methodology (ISM) to evaluate surface soil quality at KPS (E&E, 2008; NPS, 2019). Results from samples collected using ISM were used to establish EPCs for the former KPS landfill area. The ISM "sampling units" at KPS were established as approximately one-acre areas within which soil was collected from forty locations (increments); the increments were combined to create one ISM sample.

The samples were sent to the laboratory for processing in accordance with ISM protocols. Details regarding the ISM sampling conducted at KPS can be found in the RI Addendum Report (JCO 2019). The ISM data allowed for calculation of "upper concentration limits" (UCLs) within a 95% statistical confidence limit (95UCL). The 95UCL is used by convention for risk assessment purposes and is typically higher than the arithmetic mean (average). Figure 7 shows where the individual approximate one-acre sample unit 95UCLs are higher than the PRG for the target excess cancer risk level of 1×10^{-6} and a target blood lead level of 5 µg/dL. Although the PRG exceedances apply to one-acre sampling units, the exceedance color coding is the same as the discrete samples described for KPN (yellow for Organized Sport and Recreation/Community Activities and Special Events; orange for the Natural Resource Recreation scenario with more frequent visitors; and yellow for Natural Resource Recreation involving off-trail areas not associated with community or recreational activities. Evaluation of the KPS-wide EPCs for each COC is summarized below.

- **Scenario 2:** As indicated in Table 4, benzo[a]pyrene and arsenic were above the Scenario 2 PRGs for a 1×10^{-6} target cancer risk threshold; however, there are no proposed sporting fields or community event areas planned for KPS, so PRGs for Scenario 2 are not applicable for the foreseeable future. A change in proposed land use at KPS toward more recreational use, similar to what was proposed at the time of the 2013 Proposed Plan, could make Scenario 2 PRGs applicable.
- **Scenario 3:** The KPS-wide EPCs for benzo[a]pyrene and arsenic are slightly above the Scenario 3 PRGs for a 1×10^{-6} target cancer risk threshold. This implies that if the areas most frequented by visitors (i.e., a future segment of the Anacostia Riverwalk Trail and existing asphalt roadway extension of Dean Avenue) are not treated with asphalt or imported clean fill, there is a potential long-term excess cancer risk that exceeds the 1×10^{-6} target cancer risk threshold. None of the KPS-wide EPCs exceed PRGs established for the 1×10^{-5} or 1×10^{-4} risk thresholds (see Tables 5 and 6, respectively).
- **Scenario 4:** None of the KPS-wide COC EPCs exceed the Scenario 4 PRGs for a 1×10^{-6} target cancer risk threshold. This implies the excess cancer risk for visitors who less frequently spend time off paved or clean gravel trails will remain below this threshold.

The distributions of 1×10^{-6} and 1×10^{-5} PRG exceedances for each ISM sample unit are shown on Figures 8 and 9, respectively. There are six sample units out of forty-four where the sampling unit 95UCL exceed the Scenario 4 PRG either for a 1×10^{-6} target excess cancer risk threshold or for lead. As indicated by comparison to the Site-wide EPC for KPS, these limited areas are not considered to present a long-term exposure risk (i.e., it is unlikely that a visitor will spend one day per week for 10 months of the year for one hour exclusively within these one-acre sample unit areas). Because there are no ISM sample unit PRG exceedances for the 1 x 10^{-5} target excess cancer risk level, and because the PRG for lead is the same regardless of the target excess cancer risk, no figure was developed for a target excess cancer risk of 1 x 10^{-4}.

Methane concentrations exceeded the methane PRG for soil gas near the property boundary at two soil gas sampling locations within the KPS footprint at 181% and 280% of the LEL. These locations likely reflected methane concentrations in landfill material as opposed to the concentrations of soil gas that may be migrating toward the boundary. Additional methane testing near the Thomas Elementary School and D.C. Transfer Station in 2009 did not identify methane concentrations in excess of the property boundary PRG (100% of the LEL). Concentrations of methane near the transfer station were less than 0.02% and 4.6% of the LEL; concentrations of methane within a portion of the school yard, but within the park boundary, were all less than 0.02% of the LEL. These results indicated that methane was not migrating beyond the limits of waste disposal and was not presenting a risk to the school or the school yard.

5.0 DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES

General response actions were identified and summarized in the 2012 FS report (JCO, 2012). They have not changed with the additional data collected as part of the RI Addendum, or with the refinement to anticipated future land use. The general response actions include one or a combination of the following:

- No action;
- Limited action;
- Containment; and
- Removal with off-site disposal.

Similarly, there were no significant changes in the RAOs, or in the overall understanding of site conditions; therefore, the remedial technologies identified by the 2012 FS have not changed. For the most part, the remedial alternatives identified and evaluated as part of this FS Addendum are the same as those that were identified in 2012.

A significant development since the 2012 FS is that NPS has determined there is no unacceptable risk to human health or the environment associated with groundwater beneath the Site (OU2). In addition, with the adoption of the Anacostia Park Management Plan/Environmental Assessment, NPS has formally established the intended future land use at KPS as Natural Resource Recreation. These developments allow for a new perspective to be taken in the detailed analysis of alternatives. They have also resulted in development of an additional containment alternative that was not included in the original FS. A summary of each alternative is provided below.

5.1 Alternative 1: No Action

Under the No Action alternative, contaminated soils and landfill waste materials would be left in place with no treatment or controls to prevent human or ecological exposure. This alternative serves as a baseline for comparison with the other remedial alternatives. Under the no action alternative, nothing would be done to alter the current conditions of the Site to address contamination. Because the soil cover placed over the landfill at the time of closure has provided an effective waste containment measure that separates the waste from potential exposure at the surface, is sloped to promote stormwater runoff, and limits the potential for surface soil erosion, engineering controls typically associated with landfill closure were not necessary to consider in the development of alternatives. No unacceptable risk to ecological receptors was identified; therefore, the measures described in the following alternatives were selected to protect against potential human exposure to Site contaminants.

5.2 Alternative 2: Limited Action/Institutional Controls

Under Alternative 2, the existing landfill waste containment measures (soil cover and vegetation) would remain in-place and administrative institutional controls would be used to restrict and/or manage future activities that might otherwise result in human health risks or hazards. Institutional controls are administrative and/or legal instruments that reduce the potential for human exposure to contamination by establishing appropriate land or resource use. Both CERCLA and the NCP support the use of institutional controls as part of the remedial alternative at sites if necessary, to protect human health (CERCLA § 121(d); NCP § 300.430(a); EPA, 2000). To comply with the Organic Act of 1916 and the General Authorities Act, institutional controls must not result in an impairment of national park resources. That is, the institutional controls must allow the park to serve its intended use.

The objectives of the administrative institutional controls would be to:

1. Maintain existing engineering controls in good condition;
2. Prevent exposure to residual surface and subsurface hazards (e.g., contaminated soil, buried waste, unexploded ordnance, or explosive landfill gas);
3. Limit future land use (i.e., prohibit future development for residential use); and
4. Monitor for potential erosion (e.g., along the river and stream banks) to confirm the landfill cover material is maintaining a barrier that prevents exposure of buried waste.

Specific controls to be implemented at the Site would include the development and implementation of a soil management plan, to include a routine maintenance and monitoring program, as well as site-specific health and safety requirements for future projects involving excavation (e.g., construction and/or utility projects requiring soil excavation/trenching). In addition, prohibitions would be placed on residential as well as certain "high-intensity" recreational (i.e., organized sport and recreation/community activity and special event facilities) uses within certain areas of the Site. These types of institutional controls would be recorded either in the NACE Superintendent's Compendium and applicable management documents and/or other procedures to be identified during remedial design for KPS. For KPN, institutional controls would be included in the Declaration of Covenants associated with the transfer of administrative jurisdiction from NPS to the District. As indicated in the detailed analysis of alternatives (Section 6.0) the institutional controls required for this alternative would impair the intended use of the park.

Consistent with recommendations included in the 2012 FS Report (JCO, 2012) and Proposed Plan (NPS, 2013), this alternative would include a period of property boundary methane monitoring to confirm previous findings that landfill gas (methane) is not migrating off-site through the subsurface at levels that would exceed the chemical-specific RCRA Subtitle D Methane ARAR, which establishes permissible methane concentrations in structures on landfills and soil gas at the property boundary. For estimating feasibility-level costs, NPS assumed a monitoring network of 15 soil gas probes installed and sampled annually for a period of up to five years. If results from these events confirm previous observations, NPS would discontinue the monitoring program and decommission the soil gas probes at the end of the five-year monitoring period. If methane monitoring outside the landfill perimeter identifies concentrations significantly above the landfill perimeter concentrations measured during the RI (e.g., 25% of the LEL), additional landfill gas migration assessment would be required (e.g., installing and sampling soil gas monitoring probes located beyond the initial perimeter probes. A methane migration assessment plan would be developed as part of the Remedial Design).

This alternative would include remedy assessment and reporting associated with Five-Year Reviews as generally required under CERCLA when contamination remains on site above levels that permit unlimited use and unrestricted exposure.

5.3 Alternative 3: Containment/Selective Placement of Clean Soil Barriers & Institutional Controls

To mitigate potential unacceptable risk to Site visitors and workers under the anticipated future land-use scenario, Alternative 3 would involve the placement of clean soil barriers in areas of the Site reserved for Organized Sport and Recreation and Community Activities and Special Events. The barriers would consist of orange geotextile fabric, overlain by 1 foot of clean soil (i.e., 6 inches of common fill and 6 inches of topsoil). The orange fabric would serve as a warning to alert future excavation workers of the presence of contaminated soil and buried waste below the fabric.

For feasibility-level cost estimating purposes, NPS assumed soil barriers would be installed over approximately 60 acres of KPN, as shown on Figure 10. Official trails (e.g., the Anacostia Riverwalk Trail) would be paved with asphalt or covered with clean gravel. Prior to installation of the barrier in the vicinity of the former Kenilworth Parkside Recreation Center, concrete walkways, former building foundations and basketball courts that are in a state of advanced dis-repair would be demolished and removed from the Site.

Approximately 11 acres of “new fill” was imported to the Site in 2006 and 2007 and placed in the area of the track and tennis courts. The fill was placed after NPS had completed the surface soil sampling in that area as part of the RI activities; no sampling or laboratory analysis of the new fill was completed. For feasibility-level cost estimating, NPS assumes the new fill is clean; and therefore, no engineered control/barrier is required in that area. Confirmatory soil sampling of the new fill area is recommended to inform the remedial design.

As part of this alternative, administrative institutional controls would be implemented to:

1. Maintain the new and existing engineering controls in good condition;
2. Prevent exposure to remaining surface and subsurface hazards (e.g., contaminated soil, buried waste, unexploded ordnance, or explosive landfill gas);
3. Limit future land use (i.e., to non-residential uses); and
4. Monitor for potential erosion (e.g., along the river and stream banks) to confirm the landfill cover material is maintaining a barrier that prevents exposure of buried waste.

Similar to Alternative 2, specific controls would include the development and implementation of a soil management plan (including a routine Site maintenance program, and site-specific health and safety requirements for excavation activities below or outside the soil barrier). These types of institutional controls would be recorded in the NACE Superintendent’s Compendium and applicable management documents (KPS), Declaration of Covenants (KPN), and/or procedures to be identified during remedial design. With the implementation of engineering controls at KPN, prohibitions on “high-intensity” recreational uses would be limited to KPS.

Consistent with Alternative 2, Alternative 3 would include a period of property boundary methane monitoring to confirm previous findings regarding the lack of subsurface migration of landfill gas (methane). Five-Year Reviews would be required as part of this alternative.

5.4 Alternative 4: Containment/Site-wide Clean Soil Barrier & Institutional Controls

Alternative 4 would include installation of a site-wide soil barrier to prevent human exposure to contaminated surface soils. The barrier would extend across the majority of both KPN and KPS. Steep slopes along the Anacostia River and adjacent to the Kenilworth Marsh, as well as ecologically sensitive areas generally located within the floodway and proximate to the shoreline, would be left undisturbed to limit the potential for future erosion/sediment transport and associated impacts to the Anacostia River, Kenilworth Marsh, and Watts Branch. These areas, which represent a small portion of the total land area of the landfills, are heavily vegetated with mature bushes and trees and are not conducive to active recreation. As shown on Figure 11, the soil barrier is estimated to cover approximately 117 acres.

Consistent with Alternative 3, the barrier would consist of orange geotextile fabric (i.e., the warning layer), overlain by 1 foot of clean soil (6 inches of common fill and 6 inches of topsoil). Selective demolition in the vicinity of former Kenilworth Parkside Recreation Center and confirmatory soil sampling of the "new fill" area would be included as part of this alternative.

Administrative Institutional controls would be implemented to:

1. Maintain the new and existing engineering controls in good condition;
2. Prevent exposure to remaining subsurface hazards (e.g., contaminated soil, buried waste, unexploded ordnance, or explosive landfill gas);
3. Limit future land use (i.e., to non-residential uses); and
4. Monitor for potential erosion (e.g., along the river and stream banks) to confirm the landfill cover material is maintaining a barrier that prevents exposure of buried waste.

Similar to Alternatives 2 and 3, specific controls would include the use of a soil management plan (including routine Site maintenance program, and site-specific health and safety requirements for soil disturbance activities below or outside the soil barrier). These types of institutional controls would be recorded in the NACE Superintendent's Compendium and applicable management documents (KPS), Declaration of Covenants (KPN), and/or procedures to be identified during remedial design. With the implementation of site-wide engineering controls, prohibitions on "high-intensity" recreational uses would not be necessary.

Consistent with Alternative 2, Alternative 4 would include a period of property boundary methane monitoring to confirm previous findings regarding the lack of subsurface migration of landfill gas (methane). Five-Year Reviews would be implemented as part of this alternative.

5.5 Alternative 5: Removal/Landfill Removal & Shoreline Stabilization

Alternative 5 involves removal and off-Site disposal of all waste materials and previously placed cover soils and re-establishment of the original grades and wetlands habitat that existed before the development of the landfills. Based on review of historical topographic maps and aerial photography, as well as subsurface boring data from the RI, NPS estimates this would involve the excavation and removal of approximately 4.3 million cubic yards (6.5 million tons) of waste, cover, and fill materials from the Site. For feasibility-level cost estimating purposes, NPS assumes that the excavated material is non-hazardous and, therefore, could be disposed in a RCRA Subtitle D facility as either waste or alternate daily cover material. The aerial extent of wetlands restoration, estimated from historical maps/photographs, is approximately 150 acres. Over ½ mile of living shoreline would be reestablished to stabilize the shoreline and protect the tidal wetland area.

Vegetative monitoring would be required for a period of five years. Because complete removal of contaminated soil and municipal waste/incinerator ash is contemplated under this alternative, institutional controls and long-term monitoring (i.e., Five-Year Reviews) would not be required. Key elements of this alternative are shown on Figure 12.

6.0 DETAILED ANALYSIS OF ALTERNATIVES

Section 300.430(e)(9)(iii) of the NCP identifies the following nine criteria for evaluating and comparing the feasibility of alternatives:

Nine Criteria Established by the NCP	Type
1. Overall protection of human health and the environment	Threshold
2. Compliance with ARARs	
3. Long-term effectiveness and permanence	Balancing
4. Reduction of toxicity, mobility, or volume through treatment	
5. Short-term effectiveness	
6. Implementability	
7. Cost	
8. State acceptance	Modifying
9. Community acceptance	

The first two criteria listed are considered "threshold criteria"; without meeting them, an alternative may not be selected under the NCP. Criteria listed as 3 through 7 are considered "balancing criteria" and are used for comparative purposes. The last two criteria listed are "modifying" criteria and will be considered after the Proposed Plan has been put forward for review by the support agency (DOEE) and the public in accordance with the CERCLA community involvement requirements and the Community Involvement Plan (NPS, 2020). The NCP and CERCLA guidance (EPA, 1988) identify various factors to be evaluated with each of the seven threshold and balancing criteria as part of the detailed analysis, and those factors for each of the threshold and balancing criteria are listed below.

- **Overall protection of human health and the environment:**
    - Elimination, reduction, or control of site risks posed through each pathway; and
    - Unacceptable short-term or cross-media impacts.
- **Compliance with ARARs**
    - Chemical-specific ARARs;
    - Location-specific ARARs;
    - Action-specific ARARs; and
    - Other criteria, advisories and guidance.
- **Long-term effectiveness and permanence:**
    - Magnitude of residual risk; and
    - Adequacy and reliability of controls.

- **Reduction of Toxicity, Mobility, and Volume Through Treatment:**
  - Treatment process;
  - Volume treated;
  - Reduction of toxicity, mobility, and volume;
  - Permanence of treatment;
  - Type and quantity of treatment residuals; and
  - Degree to which principal threats are reduced per statutory preference.
- **Short-Term Effectiveness:**
  - Protection of the local community during remedial actions;
  - Protection of workers during remedial actions;
  - Environmental impacts of remedial action activities; and
  - Time until remedial action objectives are achieved.
- **Implementability:**
  - Ability to construct and operate the technology;
  - Reliability of the technology;
  - Ease of undertaking additional remedial actions if necessary;
  - Monitorability;
  - Administrative Feasibility - coordination with other agencies;
  - Availability and capacity of treatment and disposal facilities;
  - Availability of personnel, equipment, and materials; and
  - Availability of technology.
- **Cost:**
  - Capital;
  - Annual operation and maintenance;
  - Periodic investments; and
  - Net present worth.

The results of a detailed analysis of the five alternatives are presented in Table 7. The factors for consideration under each criterion are listed in the table followed by narrative explanations of whether each factor is met (e.g., whether the alternative is protective, acceptable, compliant, effective, or implementable). Feasibility-level costs (capital and present worth) are also provided in Table 7; cost details and assumptions are summarized in Appendix B.

7.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

The table below provides an overall summary of the detailed analysis for each alternative presented in Section 6 of this Report. Cells in the table are shaded red if a threshold criterion is not met, orange when non-cost balancing criteria are not met, and green when non-cost criteria are met. Cost cells are shaded orange if the alternative does not comply with section 300.430(f)(1)(ii)(D) of the NCP that indicates a selected remedy must be “cost-effective,” which means that “its costs are proportional to its overall effectiveness.”

Evaluation Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Overall protection of human health and the environment	Not Protective	Protective	Protective	Protective	Protective
Compliance with ARARs	Not Compliant	Not Compliant	Compliant	Compliant	Compliant
Long-term effectiveness and permanence	Ineffective	Ineffective	Effective	Effective	Effective
Reduction of toxicity, mobility, or volume through treatment	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Short-term effectiveness	Effective	Effective	Effective	Ineffective	Ineffective
Implementability	Not Applicable	Implement-able	Implement-able	Implement-able	Implement-able
Capital Cost: NPW:	$0 $170,000	$86,000 $400,000	$7,500,000 $9,000,000	$15,000,000 $18,000,000	$610,000,000 $620,000,000

7.1 Overall Protection of Human Health and the Environment

Alternative 1 would not meet the RAOs; it would not address the carcinogenic risk associated with surface soil contamination or the non-carcinogenic risk associated with lead in the subsurface soil and buried waste, nor would it reduce or eliminate the risk associated with methane gas and potential UXOs. Because **Alternative 1** does not meet this threshold criterion, it may not be selected.

Alternatives 2, 3, 4, and 5 meet all three RAOs and are considered protective of human health and the environment.

7.2 Compliance with ARARs and TBCs

The following sub-sections address each category of ARARs and TBCs. Refer to Tables 1 through 3 for a listing of ARARs and TBCs.

7.2.1 Chemical-Specific ARARs and TBCs

Alternative 1 would not meet the EPA Guidance for Evaluating Landfill Gas Emissions from Closed or Abandoned Facilities (EPA, 2005), which is not an ARAR, but to be considered. Additional monitoring is needed to confirm the RCRA Subtitle D methane requirements (42 U.S.C. §§ 6941 et seq. and 40 C.F.R. §§ 258.23 and 258.61) are met, which establish permissible limits of methane concentrations in structures on landfills and in soil gas at the property boundary. NPS requires additional monitoring and administrative institutional controls to confirm prior investigation findings that show there is no unacceptable risk associated with methane migration toward the site perimeter and precautions to be taken prior to excavation activities that could potentially encounter methane gas or unexploded ordnances.

Due to the proposed institutional controls, **Alternatives 2 through 4** are considered compliant with chemical-specific ARARs and TBCs for methane. The complete removal of contamination included as **Alternative 5** would also address the chemical-specific ARARs and TBCs, without the need for intuitional controls.

7.2.2 Location-Specific ARARs and TBCs

Alternatives 1 and 2 fail to meet the non-impairment requirement of the Organic Act, as amended, 54 U.S.C. § 100101(a) and the General Authorities Act, as amended 54 U.S.C. § 100101(b) due to the residual long-term human health exposure risk from PCBs, PAHs, lead and arsenic in surface soil; and buried lead, methane, and potential for unexploded ordnances in the subsurface. Land use restrictions included under **Alternative 2** would be required to meet what NPS considers acceptable exposure risk levels. These restrictions would be contrary to the intended use of the park as defined in the Anacostia Park enabling legislation and the land use as described in the Management Plan as well as the 2004 legislation directing transfer of administrative jurisdiction over KPN to the District (Pub. L. No. 108-335, § 344 118 Stat. 1322, 1350; 2004)[1]. **Alternatives 1 and 2** may not be selected because they do not meet ARARs (i.e., threshold criteria).

The clean fill barriers proposed under **Alternatives 3** would allow the park to be used in accordance with its intended use as defined in the Management Plan and legislation referenced above. The existing wildlife habitat is highly valued by the park and the community. **Alternative 4** would destroy most of the existing wildlife habitat at KPS. The existing wildlife habitat could be re-established over a number of years and is therefore considered compliant with ARARs; however, the short-term effects would cause significant impact to the surrounding community and wildlife.

Although contrary to the intended use of the park as currently envisioned by NPS and the District, the complete removal of the former landfill and re-creation of the pre-landfill conditions proposed under **Alternative 5** would comply with ARARs.

7.2.3 Action-Specific ARARs and TBCs

Action-Specific ARARs and TBCs do not apply to **Alternatives 1 and 2** because no physical actions are included in these alternatives.

With proper planning, design, and implementation, action specific ARARs and TBCs associated with earthwork could be met for **Alternatives 3 through 5** with a manageable level of effort. Action-specific ARARs would primarily be District requirements related to: noise (construction equipment and trucks); air quality (vehicle exhaust, dust); stormwater discharge quality; erosion, sedimentation and storm water; and water pollution control (see Table 3 for specific references to the applicable requirements). Imported fill and topsoil included in this alternative would require due diligence to identify the source and potential presence of contaminants; and testing to confirm no contaminants are present in the fill at concentrations that exceed the remedial goals and other relevant clean fill specifications. NPS would define site-specific revegetation requirements that would be specified as part of the remedial design. Due to the scope of **Alternative 5**, action specific ARARs would be significantly more challenging to meet than for **Alternatives 3 and 4**, particularly during work adjacent to Watts Branch, the Anacostia River, and Kenilworth Marsh.

7.3 Long-Term Effectiveness and Permanence

As noted, **Alternatives 1 and 2** fail to meet the RAOs to protect human health from carcinogenic and non-carcinogenic risks and from physical risks associated with methane gas and UXOs. Therefore, neither alternative provides adequate long-term effectiveness or permanence.

[1] The General Management Plan and enabling legislation are TBCs but define the NPS land use requirements that are addressed by the non-impairment ARAR. The land transfer legislation is an ARAR.

The proposed response actions defined in **Alternatives 3 and 4** would reduce the residual risk of exposure to acceptable levels, consistent with the RAOs. With appropriate controls, the measures would be stable, provided that healthy vegetation is maintained to prevent erosion and potential exposure of buried waste. Administrative Institutional controls can be established through the Superintendent's Compendium, a site management plan, and required five-year reviews to evaluate the performance of the remedy to ensure it remains protective of human health and the environment.

Removal of the landfill waste and contaminated soil cover as proposed for **Alternative 5** would eliminate associated residual exposure risks. No institutional controls would be necessary after full implementation, which would include a period of monitoring to confirm re-vegetation objectives are met.

7.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The criteria listed under this category relate to ex situ and in situ treatment alternatives. No such alternatives are under consideration, so these criteria are not applicable.

7.5 Short-Term Effectiveness

Existing Site conditions are stable and the exposure risk, while unacceptable to NPS in perpetuity, is acceptable in the short term; therefore, **Alternatives 1 and 2** meet the short-term effectiveness criteria (protection of the local community during remedial actions; protection of workers during remedial actions; environmental impacts of remedial action activities; and time until RAOs are achieved).

Measures would need to be taken to implement **Alternatives 3** consistent with the Action Specific ARARs noted above to protect the local community and workers from unacceptable exposure (noise, dust, truck traffic). Similarly, measures would be taken to protect against environmental impacts such as dust or sediment migration into surface water or damage to wetlands. Nevertheless, the short-term effectiveness criteria could be met.

Although measures can be taken to protect the local community and workers during the remedial actions, **Alternatives 4 and 5** would temporarily destroy existing habitat within KPS that is highly valued by NPS and the community. **Alternative 5** would have an even greater potential for impacts to surrounding natural resources due to the extensive work adjacent to surface waters and wetlands; and to the surrounding community due to the extended construction period and associated truck traffic, noise, dust, and vehicle/equipment exhaust.

7.6 Implementability

The Implementability criterion considers factors such as: ability to construct and operate the technology; reliability of the technology; ease of undertaking additional remedial actions if necessary; monitorability; administrative feasibility - coordination with other agencies; availability and capacity of treatment and disposal facilities; availability of personnel, equipment, and materials; and availability of technology) are not applicable to **Alternative 1**.

Administrative Institutional controls included as part of **Alternative 2** (i.e., notations in the Superintendent's compendium and site management plans) can be readily drafted and adopted. A limited level of staff awareness training would also be required.

Placement of a clean fill cap and establishing vegetation proposed as part of **Alternatives 3 and 4** requires standard and readily available construction techniques. As with **Alternative 2**, administrative institutional controls can be readily implemented. Capping and re-vegetation is a reliable measure that is applied to closed landfills and other sites with surface soil contamination. It can be visually monitored for erosion or a lack of sufficient or acceptable vegetation. Clean fill requires effort to identify and secure but is typically available from local sources.

Although with the right planning and resources **Alternative 5** could be implemented, it would cause significant disruptions and be significantly more challenging logistically than **Alternatives 3 and 4**. Obtaining the high level of funding required for this alternative could be an impediment to implementing **Alternative 5**.

7.7 Cost

As implied by the colored shading in the detailed analysis of alternatives summary, Alternative 3 meets the seven threshold and balancing criteria at the lowest cost. **Alternative 5** does not comply with section 300.430(f)(1)(ii)(D) of the NCP that indicates a selected remedy must be "cost-effective," which means that "its costs are proportional to its overall effectiveness."

8.0 REFERENCES

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TABLES

Table 1
Location-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Criteria
Feasibility Study Addendum Report
Kenilworth Park Landfill Site, Washington, DC

Standard, Requirement, Criteria, or Limitation	Citation	Requirement Description	Potentially Applicable, Relevant and Appropriate, or To Be Considered
NPS mandate to ensure the non-impairment of national park resources for the enjoyment of future generations and the non-derogation of park values and purposes.	NPS Organic Act of 1916, as amended, 54 U.S.C. § 100101(a) General Authorities Act, as amended 54 U.S.C. § 100101(b)	The NPS Organic Act provides that "[t]he Secretary, acting through the Director of the National Park Service, shall promote and regulate the use of the National Park System by means and measures that conform to the fundamental purpose of the System units, which purpose is to conserve the scenery, natural and historic objects, and wild life in the System units and to provide for the enjoyment of the scenery, natural and historic objects, and wild life in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." The General Authorities Act further provides that "the protection, management, and administration of the System units shall be conducted in light of the high public value and integrity of the System and shall not be exercised in derogation of the values and purposes for which the System units have been established."	**Applicable** to all Site activities that could potentially result in an impairment of the park's resources or values as described in the enabling legislation and management planning documents for the park
NPS management policy on implementation of the non-impairment mandate	2006 NPS Management Policies (MP), § 1.4	**NPS MP § 1.4.5** provides in part that "[t]he impairment that is prohibited by the Organic Act and the General Authorities Act is an impact that, in the professional judgment of the responsible NPS manager, would harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values. Whether an impact meets this definition depends on the particular resources and values that would be affected; the severity, duration, and timing of the impact; the direct and indirect effects of the impact; and the cumulative effects of the impact in question and other impacts. . . . An impact would be more likely to constitute impairment to the extent that it affects a resource or value whose conservation is: necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park; or key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or identified in the park's general management plan or other relevant NPS planning documents as being of significance. . . . An impact would be less likely to constitute an impairment if it is an unavoidable result of an action necessary to preserve or restore the integrity of park resources or values and it cannot be further mitigated." **NPS MP §1.4.3** further explains that "[t]he fundamental purpose of all parks also includes providing for the enjoyment of park resources and values by the people of the United States. The enjoyment that is contemplated by the statute is broad; it is the enjoyment of all the people of the United States and includes enjoyment both by people who visit parks and by those who appreciate them from afar. It also includes deriving benefit (including scientific knowledge) and inspiration from parks . . . ." **NPS MP §1.4.6** describes the "park resources and values" subject to non-impairment. **NPS MP §1.4.7** provides that "[b]efore approving a proposed action that could lead to an impairment of park resources and values, an NPS decision-maker must consider the impacts of the proposed action and determine, in writing, that the activity will not lead to an impairment of park resources and values. If there would be an impairment, the action must not be approved."	**TBC** for guidance on the implementation of the non-impairment mandate as set forth in the NPS Organic Act
Anacostia Park enabling legislation	Act of August 31, 1918, chapter 164, 40 Stat. 918, 951. An Act providing for a comprehensive development of the park and playground system of the National Capital, as amended, Pub. L. No. 68-202, 43 Stat. 463 (1924), as amended Capper-Crampton Act, Pub. L. No. 71-284, 46 Stat. 482 (1930), as amended	The 1918 statute established Anacostia Park (which includes the Site). The 1924 statute was enacted to "preserve the flow of water in Rock Creek, to prevent pollution of Rock Creek and the Potomac and Anacostia Rivers, to preserve forests and natural scenery in and about Washington, and to provide for the comprehensive, systematic, and continuous development of the park, parkway, and playground system of the National Capital" and to acquire lands for the development of that system (of which the Site is a part). The Capper-Crampton Act expressly provided for the extension of the Anacostia Park system up the valley of the Anacostia River.	**TBC** in the development of alternatives and in the selection and implementation of any remedies at the Site These statutes provide a framework for determining what is required to attain the Organic Act non-impairment requirement

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Standard, Requirement, Criteria, or Limitation	Citation	Requirement Description	Potentially Applicable, Relevant and Appropriate, or To Be Considered
District of Columbia Wetlands Regulations	21 DCMR § 1103.2	These regulations require, subject to certain exceptions, that wetlands with rooted vascular aquatic vegetation be protected from significant adverse hydrologic modifications, excessive sedimentation, deposition of toxic substances in toxic amounts, nutrient imbalances, and other adverse anthropogenic impacts.	**Applicable** to remedial activities that would have significant adverse effects on the type of wetlands covered by the regulations
Federal Floodplain Management Orders	Executive Order No. 11988 NPS Director's Order No. 77-2 [exp. 2007]	These orders require consideration of impacts to areas within the 100-year floodplain in order to reduce flood loss risks, minimize flood impacts on human health, safety, and welfare, and preserve and/or restore floodplain values.	**TBC** for remedial actions conducted within the 100-year floodplain
District of Columbia Flood Hazard Control	D.C. Code §§ 6-501 to 6-504 20 DCMR § 3105	This statute and its implementing regulations regulate the placement of fill, grading, excavation, and other disturbances within the defined flood hazard area and the floodplains of rivers and streams.	**Applicable** to remedial activities conducted within defined special flood hazard areas
National Historic Preservation Act	54 U.S.C. §§ 306101 – 306131 36 C.F.R. Part 800	The statute and its implementing regulations require federal agencies to consider the effect of any federally assisted undertaking on any district, site building, structure, or object that is included in, or is eligible for, the National Register of Historic Places and to minimize or mitigate reasonably unavoidable effects. Indian cultural and historical resources must be evaluated, and effects avoided, minimized, or mitigated.	**Applicable** to remedial activities that could affect historical or cultural resources (e.g., the seawall)
Archaeological and Historic Preservation Act	54 U.S.C. §§ 312502 – 312503	This statute establishes requirements for the evaluation and preservation of historical and archaeological data, including Indian cultural and historic data, which may be destroyed through alteration of the terrain as a result of, *inter alia*, federal construction projects. If eligible scientific, pre-historical, or archaeological data are discovered during site activities, such data must be preserved in accordance with these requirements.	**Applicable** to remedial activities involving soil disturbance that could result in the discovery of archaeological or historical resources
Historic Sites, Buildings, and Antiquities Act	54 U.S.C. § 320102(g)	This statute requires federal agencies to consider the existence and location of historic or prehistoric sites, buildings, objects, or properties of national historical or archaeological significance when evaluating remedial alternatives.	**Applicable** to remedial activities involving soil disturbance that could have an impact on areas of historical or archaeological significance
Archaeological Resources Protection Act	16 U.S.C. §§ 470ee(a) 43 C.F.R. §§ 7.4(a), 7.5, 7.8, 7.9, 7.33	This statute and its implementing regulations provide for the protection of archaeological resources located on public and tribal lands. If an activity involves soil disturbance, the land manager cannot approve the excavation or removal of archaeological resources unless specified criteria are met.	**Applicable** to remedial activities involving soil disturbance that could result in the discovery of archaeological resources
Native American Graves Protection and Repatriation Act (NAGPRA)	25 U.S.C. § 3002(d) 43 C.F.R. §§ 10.3(b), 10.4 – 10.6	NAGPRA and its implementing regulations provide for the disposition of Native American remains and objects inadvertently discovered on federal or tribal lands after November 1990. If the response activities result in the discovery of Native American human remains or related objects, the activity must stop while the head of the federal land management agency (in this case, NPS) and appropriate Indian tribes are notified of the discovery. After the discovery, the response activity must cease and a reasonable effort must be made to protect Native American human remains or related objects. The response action can resume once these requirements have been met.	**Applicable** to discovery of Native American human remains during remedial activities

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Standard, Requirement, Criteria, or Limitation	Citation	Requirement Description	Potentially Applicable, Relevant and Appropriate, or To Be Considered
Fish and Wildlife Coordination Act	16 U.S.C. §§ 661 et seq., as amended by Pub. L. No. 116-9, 133 Stat. 580 (2019)	This statute requires NPS to consider the impacts to wildlife resources resulting from the modification of waterways.	**Applicable** to remedial activities involving the diversion of other modification of any river or stream
Migratory Bird Treaty Act (MBTA)	16 U.S.C. §§ 703 et seq., as amended by Pub. L. No. 116-9, 133 Stat. 580 (2019)	This statute prohibits the intentional and unauthorized taking of migratory birds.	**TBC** in designing remedial alternatives that minimize impacts to migratory birds
Responsibilities of Federal Agencies to Protect Migratory Birds	Executive Order No. 13186	This order directs executive departments and agencies to take certain actions to further implement the MBTA, including supporting the conservation intent of the migratory bird conventions by integrating bird conservation principles, measures, and practices into agency activities and by avoiding or minimizing, to the extent practicable, adverse impacts on migratory bird resources when conducting agency actions.	**TBC** in designing remedial alternatives that minimize impacts to migratory birds and related resources
Legislation Directing Transfer of Administrative Jurisdiction over Kenilworth Park North (KPN)	Pub. L. No. 108-335, § 344 118 Stat. 1322, 1350 (2004)	This legislation directed the United States to transfer administrative jurisdiction over, but not title to, KPN to the District of Columbia and imposed limitations on the future use of the property.	**Applicable** to the future use assumptions used to develop remedial alternatives and to select a remedial action
National Park Resource Protection, Public Use, and Recreation	36 C.F.R. §§ 2.1(a), 2.2(a)(1), 2.12(a), 2.14(a), 2.31(a)(3), 2.31(a)(5)	These regulations authorize and prohibit certain activities by third parties within units of the National Park System.	**Relevant and appropriate** to remedial activities conducted within any unit of the National Park System
National Park Area Nuisance	36 C.F.R. § 5.13	This regulation prohibits the creation or maintenance of a nuisance upon any federally owned land within a park area or any privately owned land in a park area under the exclusive legislative jurisdiction of the United States.	**Relevant and appropriate** to remedial activities that could constitute a nuisance
Anacostia Park General Management Plan and Environmental Assessment (February 2017)	Available at: [Anacostia Park Management Plan/Environmental Assessment]	The General Management Plan for the Park is the primary guidance document for managing the Park for the next fifteen to twenty years. It identifies the preferred vision for the future of the Park and provides the framework for decision-making regarding the management of the Park's natural and cultural resources.	**TBC** in developing remedial alternatives and selecting a remedial action The General Management Plan for Anacostia Park provides a framework for determining what is required to attain the Organic Act non-impairment requirement.
NPS Foundation Document, National Capital Parks – East (September 2016)	Available at: [Foundation Document Overview]	The Foundation Document for National Capital Parks – East (NACE) provides a foundation for the planning and management of the Park in light of its purposes, significance, fundamental resources and values, other important resources and values, and interpretive themes.	**TBC** in developing remedial alternatives and selecting a remedial action The Foundation Document provides a framework for determining what is required to attain the Organic Act non-impairment requirement.

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Standard, Requirement, Criteria, or Limitation	Citation	Requirement Description	Potentially Applicable, Relevant and Appropriate, or To Be Considered
National Capital Parks – East, Superintendent's Compendium	Available at: [Superintendent's Compendium] (note that the link is an overview, rather than the entire document, which is not readily available online)	The Superintendent's Compendium establishes regulatory provisions for the proper management, protection, and government and public use of National Capital Parks – East.	**TBC** in developing remedial alternatives and selecting a remedial action The Superintendent's Compendium provides a framework for determining what is required to attain the Organic Act non-impairment requirement.
Environmental Assessment, Anacostia Riverwalk Trail Section 3 Realignment Anacostia Park (December 2011)	Available at: [Anacostia Riverwalk Trail Section 3 Realignment]	This document describes the selected alignment for the Anacostia Riverwalk Trail, including Design Section 3 (between Benning Road in Washington, D.C. and Bladensburg Trail in Maryland).	**TBC** in developing remedial alternatives and selecting a remedial action
Office of the Federal Executive, Guidance for Presidential Memorandum on Environmentally and Economically Beneficial Landscape Practices on Federal Landscaped Grounds	60 Fed. Reg. 40837 (August 10, 1955)	This guidance provides a framework for the use of environmentally and economically beneficial landscape practices on managed federal lands and federally funded projects.	**TBC** in developing remedial alternatives and selecting a remedial action
NPS Management Policies 2006	Available at: [Management Policies 2006]	The NPS Management Policies 2006 document provides policies and guidance for the management of natural, cultural, and historic resources within units of the National Park System, including revegetation of disturbed land.	**TBC** in developing remedial alternatives and selecting a remedial action
Chesapeake 2000 Agreement	Chesapeake 2000 Agreement and Chesapeake Executive Council Directives available at: [Chesapeake 2000]	This agreement, to which the United States is a party, establishes goals and directives for the protection and restoration of the Chesapeake Bay watershed, including vital habitat protection and restoration, water quality protection and restoration, and stewardship and community engagement.	**TBC** in developing remedial alternatives and selecting a remedial action
Comprehensive Plan Environmental Protection Element	10-A DCMR § 604	The Environmental Protection Element addresses the protection, restoration, and management of the District's land, air, water, energy, and biologic resources. The Element provides policies and actions on issues such as drinking water safety, the restoration of our tree canopy, energy conservation, air quality, watershed protection, pollution prevention and waste management, and the remediation of contaminated sites. More specifically, section E-1.2 "Protecting Rivers, Wetlands, and Riparian Areas" outlines policies pertaining to: river conservation; waterfront habitat restoration; retention of environmentally sensitive areas as open space; identification, protection, and restoration of wetlands; and wetland buffers.	**TBC** in developing remedial alternatives and selecting a remedial action
District of Columbia Harbor Regulations, Throwing or Depositing Matter in the Potomac River	D.C. Code § 22-4402	This statute prohibits the deposit of any stone, gravel, sand, ballast, dirt, oyster shells, or ashes in the water in any part of the Potomac River or its tributaries in the District of Columbia, or on the shores of the Potomac River below the high water mark. The statute also prohibits the deposit of "any filth of any kind whatsoever" in the river or its tributaries.	**Applicable** to site remediation activities on the shores of the Anacostia River

Table 2
Chemical-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Criteria
Feasibility Study Addendum Report
Kenilworth Park Landfill Site, Washington, DC

Standard, Requirement, Criteria, or Limitation	Citation	Requirement Description	Potentially Applicable, Relevant and Appropriate, or To Be Considered
Safe Drinking Water Act, National Primary Drinking Water Regulations, Maximum Contaminant Levels (MCLs)	42 U.S.C. §§ 300f et seq. 40 C.F.R. Part 141	The primary MCLs established under the Safe Drinking Water Act are human-health based standards that apply to drinking water from public water systems.	**Relevant and appropriate** for remediation of groundwater
Safe Drinking Water Act, National Secondary Drinking Water Regulations, Secondary MCLs	42 U.S.C. §§ 300f et seq. 40 C.F.R. Part 143	The secondary MCLs established under the Safe Drinking Water Act are non-enforceable aesthetic standards for drinking water from public water systems.	**TBC** in remediation of groundwater
District of Columbia Groundwater Protection and Quality Standards	D.C. Code § 8-103.04 21 DCMR §§ 1150-52, 1154-55, 1157-58	This statute and its implementing regulations establish water quality standards for groundwater supplies located in the District of Columbia.	**Applicable** to remediation of groundwater
National Park Service Protocol for the Selection and Use of Ecological Screening Values for Non-Radiological Analytes	NPS	This guidance addresses the selection of ecological screening values for surface water and sediment.	**TBC** in ecological risk assessment for surface water and sediment
Resource Conservation and Recovery Act, Subtitle D Methane Requirements	42 U.S.C. §§ 6941 et seq. 40 C.F.R. §§ 258.23 and 258.61	RCRA Subtitle D and its implementing regulations establish permissible limits of methane concentrations in structures on landfills and in soil gas at the property boundary.	**Relevant and appropriate** for assessment and remediation of methane
U.S. EPA Guidance for Evaluating Landfill Gas Emissions from Closed or Abandoned Facilities	EPA-600/R05/123a (September 2005)	This document provides guidance for evaluating inhalation risks to off-site receptors as well as the hazards of both on-site and off-site methane explosions and landfill fires.	**TBC** for evaluation and remediation of landfill gasses
Toxic Substances Control Act (TSCA)	15 U.S.C. §§ 2601 et seq. 40 C.F.R. Part 761, Subpart D	TSCA and its implementing regulations address polychlorinated biphenyl (PCB) remediation, soil disposal, and capping.	**TBC** for remediation, capping, and disposal of PCBs
District of Columbia Water Quality Standards for Surface Water	D.C. Code §§ 8-103.02, 8-103.06 21 DCMR §§ 1101-06, 1108	The water quality standards established under section 303(c) the federal Clean Water Act and section 5 of the Water Pollution Control Act of 1984 cover various classes of surface waters and include draft total maximum daily loads (TMDLs) for oil and grease, organics, and metals in the Anacostia River.	**Applicable** to the protection of surface water on the Site
District of Columbia Hazardous Waste Regulations	20 DCMR §§ 4200-03, 4261	These regulations establish criteria for the identification and classification of hazardous waste.	**Applicable** to the excavation and disposal of hazardous waste

Table 3
Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Criteria
Feasibility Study Addendum Report
Kenilworth Park Landfill Site, Washington, DC

Standard, Requirement, Criteria, or Limitation	Citation	Requirement Description	Potentially Applicable, Relevant and Appropriate, or To Be Considered
District of Columbia Noise Control Act	20 DCMR §§ 2701, 2704 20 DCMR § 2802	The statute and regulations establish maximum permissible sound levels for time of day and zoning locations.	**Applicable** to remediation activities that generate noise
District of Columbia Air Pollution Control Act, Air Quality Regulations	D.C. Code § 8-101.05 20 DCMR §§ 600, 603, 605-06, 699	This statute and its implementing regulations establish requirements for sources of particulate air pollution, including fugitive dust and visible emissions.	**Applicable** to remediation activities that generate particulate air pollution
District of Columbia Air Pollution Control Act, Engine Idling	D.C. Code § 8-101.05 20 DCMR § 900	This statute and its implementing regulations provide that a vehicle that is parked, stopped, or standing shall not idle for more than three minutes.	**Applicable** to remediation activities that involve the use of trucks on the Site (e.g., for removal of excavated soils for off-Site disposal or importation of clean soil)
District of Columbia Air Pollution Control Act, Vehicle Exhaust Emissions	D.C. Code § 8-101.05 20 DCMR § 901	This statute and its implementing regulations provide that the engine, power, and exhaust mechanism of each motor vehicle must be equipped, adjusted, and operated to prevent the escape of a trail of visible fumes or smoke for more than ten consecutive seconds.	**Applicable** to remediation activities that involve the use of trucks on the Site (e.g., for removal of excavated soils for off-Site disposal or importation of clean soil)
District of Columbia Air Pollution Control Act, Odorous or Other Nuisance Air Pollutants	D.C. Code § 8-101.05 20 DCMR § 903	This statute and its implementing regulations provide that any emission into the atmosphere of odorous or other air pollutants from any source in any quantity and of any characteristic and duration, which is or is likely to be injurious to the public health or welfare, or which interferes with the reasonable enjoyment of life and property, is prohibited.	**Applicable** to remediation activities that result in the generation and emission of air pollutants that could constitute a nuisance
Clean Water Act Effluent Guidelines and Standards	33 U.S.C. §§ 1311-12, 1316-17 40 C.F.R. Part 450	The Clean Water Act and its implementing regulations provide requirements for point source discharges of pollutants.	**Applicable** to remediation activities that result in the point source discharge of pollutants to surface water bodies
Clean Water Act Stormwater Program	33 U.S.C. § 1342(p) 40 C.F.R. § 122.26 2017 NPDES Construction General Permit	The Clean Water Act stormwater program regulates the discharge of stormwater from industrial and construction activities and require the implementation of best management practices such as the use of stormwater fencing and other measures to prevent the discharge of stormwater to surface waters. The *substantive* requirements of the most recent National Pollutant Discharge Elimination System (NPDES) Construction General Permit (2017) would apply to any remedial activities that are subject to the stormwater program.	**Applicable** to discharges of stormwater to surface waters from remediation activities that involve soil disturbance of one acre or more **Relevant and appropriate** to discharges of stormwater to surface waters bodies from remedial action involving soil disturbance of less than one acre
District of Columbia Soil Erosion and Sedimentation Control Act and Stormwater Regulations	21 DCMR §§ 524, 543	These regulations impose requirements on the discharge of stormwater from land-disturbing activities on sites located in the Anacostia Waterfront Development Zone, as well as erosion and sediment control associated with those activities.	**Applicable** to remediation activities that result in land disturbance

Table 3
Action-Specific Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) Criteria
Feasibility Study Addendum Report
Kenilworth Park Landfill Site, Washington, DC

Standard, Requirement, Criteria, or Limitation	Citation	Requirement Description	Potentially Applicable, Relevant and Appropriate, or To Be Considered
District of Columbia Water Pollution Control Act of 1984	D.C. Code §§ 8-103.02, 8-103.06	These sections of the statute prohibit the discharge of a pollutant into District waters (including groundwater) unless the discharge is permitted and meets certain standards.	**Applicable** to remediation activities that result in the discharge of pollutants into surface waters
District of Columbia Well Construction, Maintenance, and Abandonment Standards	D.C. Code § 8-103.13a 21 DCMR §§ 1809-26, 1827-28, 1830-31	These regulations ensure that the construction, use, maintenance, and abandonment of wells is undertaken in a manner that protects public health and the environment.	**Applicable** to the construction, use, maintenance, or abandonment of monitoring wells
USDOT Hazardous Materials Transportation Act and Implementing Regulations	49 U.S.C. § 5103 49 C.F.R. §§ 171-180	This statute and its implementing regulations establish classification, packaging, and labeling requirements for shipments of hazardous materials.	**Applicable** to remediation activities that result in the off-site transportation of hazardous materials
District of Columbia Hazardous Materials Transportation and Motor Carrier Safety Act	18 DCMR § 1403	This regulation establishes primary and alternate routes for the off-site transportation of hazardous materials in the District of Columbia.	**Applicable** to remedial action that involves the off-site transportation of hazardous materials within the District of Columbia
Resource Conservation and Recovery Act, Treatment, Storage, and Disposal of Hazardous Waste	42 U.S.C. § 6924 40 C.F.R. Part 264	RCRA and its implementing regulations specify requirements for the operation of hazardous waste treatment, storage, and disposal (TSD) facilities.	**Relevant and appropriate** for remediation activities that require active on-site hazardous waste management or storage or off-site disposal activities
Resource Conservation and Recovery Act, Subtitle D Solid Waste Landfill Closure and Post-Closure Requirements	42 U.S.C. §§ 6944-6945 40 C.F.R. §§ 258.60(a)(3), 258.60(b)(2), 258.61(a)(1), and 258.61(a)(3)	These regulations establish closure requirements, including a final cover system designed to minimize erosion, as well as post-closure care requirements, such as maintenance of the cover and monitoring groundwater.	**Relevant and appropriate** for portions of the Site that present unacceptable risks to human health or the environment related to direct exposure to hazardous substances
District of Columbia Hazardous Waste Management Regulations	20 DCMR Chapter § 4202	The District's Hazardous Waste Management Regulations incorporate most of the requirements of RCRA Subtitle C by reference. This section of the regulations provides additional requirements that, among other things, prohibit the disposal of any hazardous waste or any mixture of hazardous waste and another constituent into or on any land or water in the District of Columbia. It also provides that hazardous waste management units that are unable to achieve clean closure shall be considered to be landfills and subject to the closure and post-closure requirements for landfills as specified in the federal RCRA regulations applicable to the unit in question.	**Relevant and appropriate** for remedial action that leaves hazardous wastes on-site

Table 4
Preliminary Remediation Goals (PRGs) for Target Risk Level of 1 x 10^{-6}
Feasibility Study Addendum Report
Kenilworth Park Landfill Site, Washington, DC

Analyte	**Scenario #1 PRG**	**Scenario #2 PRG**	**Scenario #3 PRG**	**Scenario #4 PRG**	**EPC (KPN)**	**EPC (KPS)**
Semivolatiles (mg/kg)						
Benzo(a)anthracene	1.5	6.7	11	45	1.35	1.68
Benzo(a)pyrene	0.11	0.67	1.1	4.5	1.13	1.46
Benzo(b)fluoranthene	1.1	6.7	11	45	0.912	2.36
Benzo(k)fluoranthene	--	--	--	--	0.912	NA
Dibenzo(a,h)anthracene	0.11	0.67	1.1	4.5	0.62	0.118
Benzo(a)pyrene Equivalent	0.11	0.67	1.1	4.5	1.985	1.982
Pesticides (mg/kg)						
Aldrin	0.039	0.21	0.26	1.0	NA	NA
Dieldrin	0.034	0.14	0.24	0.95	0.234	NA
PCBs (mg/kg)						
Aroclor 1254	0.24	1.0	1.8	7.2	1.33	0.39
Aroclor 1260	0.24	1.0	1.8	7.2	0.76	0.409
Metals (mg/Kg)						
Aluminum	75000	430000	490000	2000000	7940	10000
Antimony	31	180	200	790	9.01	0.705
Arsenic	0.68	3.2	4.5	18	4.03	4.55
Cobalt	23	130	150	590	NA	11
Copper	3100	18000	20000	79000	185	129
Iron	55000	310000	350000	1400000	20900	17900
Lead	153	153	295	295	160	121
Manganese	1700	10000	12000	47000	316	263
Silver	390	2200	2500	9900	66.7	9.59
Thallium	0.78	4.4	4.9	20	2.52	0.463
Vanadium	390	2200	2500	9900	42.8	44.2
Mercury	23	130	150	590	6.14	1.18

Notes:
1) All values are expressed in miligrams per kilogram (mg/kg)
2) NA indicates the given analyte was not a COPC in the given park area, and therefore no EPC was calculated for it.
3) Exposure Point Concentrations (EPC) for KPN represent the lower value of either the 95% UCL or maximum detection (calculated from the RI, PA/SI, and DCSEC Investigation data).
4) Exposure Point Concentrations (EPC) for KPS are the arithmetic mean concentration of the UCLs calculated for each individual SU.
5) Benzo(a)pyrene equivalent values were calculated using the following Toxicity Equivalency Factors (TEFs)
Benzo(a)anthracene - 0.1
Benzo(a)pyrene - 1
Benzo(b)fluoranthene - 0.1
Benzo(k)fluoranthene - 0.01
Dibenzo(a,h)anthracene - 1
6) Scenario #1 is recreational use (High Use/High Intensity, and EPC values greater than it are shaded green.
7) Scenario #2 is organized sport and recreation/community activities and special events (High Use/Moderate Intensity), and EPC values greater than it are shaded yellow.
8) Scenario #3 is natural resource recreation (Moderate Use/Moderate Intensity), and EPC values greater than it are shaded orange.
9) Scenario #4 is natural resource recreation (Moderate Use/Low Intensity), and EPC values greater than it are shaded red.

Table 5
Preliminary Remediation Goals (PRGs) for Target Risk Level of 1 x 10^{-5}
Feasibility Study Addendum Report
Kenilworth Park Landfill Site, Washington, DC

Analyte	Scenario #1 PRG	Scenario #2 PRG	Scenario #3 PRG	Scenario #4 PRG	EPC (KPN)	EPC (KPS)
Semivolatiles (mg/kg)						
Benzo(a)anthracene	15	67	110	450	1.35	1.68
Benzo(a)pyrene	1.1	6.7	11	45	1.13	1.46
Benzo(b)fluoranthene	11	67	110	450	0.912	2.36
Benzo(k)fluoranthene	--	--	--	--	0.912	NA
Dibenzo(a,h)anthracene	1.1	6.7	11	45	0.62	0.118
Benzo(a)pyrene Equivalent	1.1	6.7	11	45	1.985	1.982
Pesticides (mg/kg)						
Aldrin	0.39	2.1	2.6	10	NA	NA
Dieldrin	0.34	1.4	2.4	10	0.234	NA
PCBs (mg/kg)						
Aroclor 1254	1.2	5.3	8.2	33	1.33	0.39
Aroclor 1260	2.4	10	18	72	0.76	0.409
Metals (mg/Kg)						
Aluminum	75000	430000	490000	2000000	7940	10000
Antimony	31	180	200	790	9.01	0.705
Arsenic	6.8	32	45	180	4.03	4.55
Cobalt	23	130	150	590	NA	11
Copper	3100	18000	20000	79000	185	129
Iron	55000	310000	350000	1400000	20900	17900
Lead	153	153	295	295	160	121
Manganese	1700	10000	12000	47000	316	263
Silver	390	2200	2500	9900	66.7	9.59
Thallium	0.78	4.4	4.9	20	2.52	0.463
Vanadium	390	2200	2500	9900	42.8	44.2
Mercury	23	130	150	590	6.14	1.18

Notes:
1) All values are expressed in miligrams per kilogram (mg/kg)
2) NA indicates the given analyte was not a COPC in the given park area, and therefore no EPC was calculated for it.
3) Exposure Point Concentrations (EPC) for KPN represent the lower value of either the 95% UCL or maximum detection (calculated from the RI, PA/SI, and DCSEC Investigation data).
4) Exposure Point Concentrations (EPC) for KPS are the arithmetic mean concentration of the UCLs calculated for each individual SU.
5) Benzo(a)pyrene equivalent values were calculated using the following Toxicity Equivalency Factors (TEFs)
Benzo(a)anthracene - 0.1
Benzo(a)pyrene - 1
Benzo(b)fluoranthene - 0.1
Benzo(k)fluoranthene - 0.01
Dibenzo(a,h)anthracene - 1
6) Scenario #1 is recreational (High Use/High Intensity), and EPC values greater than it are shaded green.
7) Scenario #2 is organized sport and recreation/community activities and special events (High Use/Moderate Intensity), and EPC values greater than it are shaded yellow.
8) Scenario #3 is natural resource recreation (Moderate Use/Moderate Intensity), and EPC values greater than it are shaded orange.
9) Scenario #4 is natural resource recreation (Moderate Use/Low Intensity), and EPC values greater than it are shaded red.

Table 6

Preliminary Remediation Goals (PRGs) for Target Risk Level of 1 x 10^{-4}

Feasibility Study Addendum Report

Kenilworth Park Landfill Site, Washington, DC

Analyte	Scenario #1 PRG	Scenario #2 PRG	Scenario #3 PRG	Scenario #4 PRG	EPC (KPN)	EPC (KPS)
Semivolatiles (mg/kg)						
Benzo(a)anthracene	150	670	1100	4500	1.35	1.68
Benzo(a)pyrene	11	67	110	450	1.13	1.46
Benzo(b)fluoranthene	110	670	1100	4500	0.912	2.36
Benzo(k)fluoranthene	--	--	--	--	0.912	NA
Dibenzo(a,h)anthracene	11	67	110	450	0.62	0.118
Benzo(a)pyrene Equivalent	11	67	110	450	1.985	1.982
Pesticides (mg/kg)						
Aldrin	2.3	13	15	59	NA	NA
Dieldrin	3.2	14	22	86	0.234	NA
PCBs (mg/kg)						
Aroclor 1254	1.2	5.3	8.2	33	1.33	0.39
Aroclor 1260	24	100	180	720	0.76	0.409
Metals (mg/Kg)						
Aluminum	75000	430000	490000	2000000	7940	10000
Antimony	31	180	200	790	9.01	0.705
Arsenic	35	180	230	920	4.03	4.55
Cobalt	23	130	150	590	NA	11
Copper	3100	18000	20000	79000	185	129
Iron	55000	310000	350000	1400000	20900	17900
Lead	153	153	295	295	160	121
Manganese	1700	10000	12000	47000	316	263
Silver	390	2200	2500	9900	66.7	9.59
Thallium	0.78	4.4	4.9	20	2.52	0.463
Vanadium	390	2200	2500	9900	42.8	44.2
Mercury	23	130	150	590	6.14	1.18

Notes:

1) All values are expressed in miligrams per kilogram (mg/kg)
2) NA indicates the given analyte was not a COPC in the given park area, and therefore no EPC was calculated for it.
3) Exposure Point Concentrations (EPC) for KPN represent the lower value of either the 95% UCL or maximum detection (calculated from the RI, PA/SI, and DCSEC Investigation data).
4) Exposure Point Concentrations (EPC) for KPS are the arithmetic mean concentration of the UCLs calculated for each individual SU.
5) Benzo(a)pyrene equivalent values were calculated using the following Toxicity Equivalency Factors (TEFs)
    - Benzo(a)anthracene - 0.1
    - Benzo(a)pyrene - 1
    - Benzo(b)fluoranthene - 0.1
    - Benzo(k)fluoranthene - 0.01
    - Dibenzo(a,h)anthracene - 1
6) Scenario #1 is recreational (High Use/High Intensity), and EPC values greater than it are shaded green.
7) Scenario #2 is organized sport and recreation/community activities and special events (High Use/Moderate Intensity), and EPC values greater than it are shaded yellow.
8) Scenario #3 is natural resource recreation (Moderate Use/Moderate Intensity), and EPC values greater than it are shaded orange.
9) Scenario #4 is natural resource recreation (Moderate Use/Low Intensity), and EPC values greater than it are shaded red.

Table 7
Detailed Analysis of Remedial Alternatives
Feasibility Study Addendum Report
Kenilworth Park Landfill Site, Washington, DC

Criteria	Alternative 1: No Action	Alternative 2: Limited Action/Institutional Controls	Alternative 3: Containment/Selective Placement of Clean Soil Barriers & Institutional Controls	Alternative 4: Containment/Site-wide Clean Soil Barrier & Institutional Controls	Alternative 5: Removal/Landfill Removal & Shoreline Stabilization
Overall Protection of Human Health and the Environment					
Elimination, reduction or control of site risks posed through each pathway	**Not Protective**: the excess cancer risk and estimated blood lead levels potentially resulting from exposure to contaminants present in surficial soil would exceed the 1 x 10^{-6} target cancer risk threshold under the more sensitive land use assumptions. Without protective institutional controls, potentially unacceptable risks associated with the presence of methane gas and possible UXOs also would remain. NPS determined that these residual risks are unacceptable and do not address the response action objectives.	**Protective**: NPS determined that there is an unacceptable exposure risk to visitors and park workers from contaminants in surface soil; however, institutional controls could address both the surface and subsurface exposure risks to visitors, park workers, and excavation workers by restricting land use.	**Protective**: Combined with applicable institutional controls, clean fill barriers placed in select areas of the site would reduce the potential risk to visitors and park staff to acceptable levels.	**Protective:** This alternative is similar to Alternative 3 but larger areas would be treated, reducing the land use restrictions.	**Protective:** This alternative eliminates exposure risk by removing contaminated media from the site completely.
Unacceptable short-term or cross-media impacts	**Acceptable**: Although unacceptable to NPS in perpetuity, the exposure risks are relatively low, and within the acceptable range established under the NCP. There are no unacceptable short-term or cross-media impacts.	**Acceptable**: Same as Alternative 1.	**Acceptable**: Same as Alternative 1.	**Acceptable**: Same as Alternative 1.	**Acceptable:** Through meeting the Action-Specific ARARs, the short-term or cross media impacts of implementation would be managed; however, the extensive level of construction effort around wetlands and surface water bodies increases the risk of associated environmental impacts.
Compliance with ARARs					
Chemical-Specific	**Non Compliant:** This alternative would not meet the EPA Guidance for Evaluating Landfill Gas Emissions from Closed or Abandoned Facilities (EPA-600/R05/123a; September 2005), which is not an ARAR, but To Be Considered. Additional monitoring is needed to confirm the RCRA Subtitle D methane requirements (42 U.S.C. §§ 6941 et seq. and 40 C.F.R. §§ 258.23 and 258.61) are met, which establish permissible limits of methane concentrations in structures on landfills and in soil gas at the property boundary.	**Compliant:** Institutional controls could be established to meet the EPA guidance for Evaluating Landfill Gas Emissions from Closed or Abandoned Facilities (EPA-600/R05/123a; September 2005) and to confirm the RCRA Subtitle D methane requirements (42 U.S.C. §§ 6941 et seq. and 40 C.F.R. §§ 258.23 and 258.61) are met.	**Compliant:** Same as Alternative 2.	**Compliant:** Same as Alternative 2.	**Compliant:** Removal of all waste would remove the potential for methane generation, meeting the RCRA Subtitle D ARAR related to methane concentrations and exposures.

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Location-Specific	**Non Compliant:** This alternative would not meet the non-impairment requirement of The Organic Act, as amended, 54 U.S.C. § 100101(a) and the General Authorities Act, as amended 54 U.S.C. § 100101(b) due to the residual long-term human health exposure risk from PCBs, PAHs, lead and arsenic in surficial soil; and buried lead, methane, and unexploded ordnances in the subsurface. This alternative would be contrary to the Anacostia Park enabling legislation and the land use as described in the February 2017 Anacostia Park General Management Plan and Environmental Assessment; and further, to the 2004 legislation directing transfer of administrative jurisdiction over KPN to the District "for the provision of public recreational facilities, open space, or public outdoor recreational opportunities" (Pub. L. No. 108-335, § 344 118 Stat. 1322, 1350; 2004).	**Non Compliant:** This alternative would require restrictions that contradict the intended future use of the park and would not meet the non-impairment requirement of The Organic Act, as amended, 54 U.S.C. § 100101(a) and the General Authorities Act, as amended 54 U.S.C. § 100101(b). The proposed institutional controls would mitigate excavation worker exposure to lead, methane gas, and unexploded ordnances.	**Compliant:** Selective placement of clean fill barriers would remove the impairment and allow the park to be used as intended and in compliance with the Organic Act, as amended, 54 U.S.C. § 100101(a) and the General Authorities Act, as amended 54 U.S.C. § 100101(b).	**Compliant:** This alternative is compliant for the same reasons as Alternative 3; however, the existing land surface within the area to be covered would need to be cleared and grubbed prior to placement of the warning layer and clean soil barrier. This activity would destroy existing habitat that is highly valued by the park and members of the public.	**Compliant:** Complete removal of the former landfills and re-creation of the original tidal mud flats and wetland areas would be contrary to the current vision for park land use held by NPS and the District; however, it would comply with ARARs.
Action-Specific	**None Apply**	**None Apply**	**Compliant:** With proper planning and design, action-specific ARARs associated with earthwork could be met with a manageable level of effort. Action-specific ARARs would primarily be District requirements related to: noise (construction equipment and trucks); air quality (vehicle exhaust, dust); stormwater discharge quality; erosion, sedimentation and storm water; and water pollution control. Imported fill and topsoil included in this alternative would require: due diligence to identify the source and potential presence of contaminants; and testing to confirm no contaminants are present in the fill at concentrations that exceed the remedial goals and other relevant clean fill specifications. NPS would have site-specific revegetation requirements that would be defined as part of the remedial design.	**Compliant:** Same as Alternative 3	**Compliant:** With proper planning and design, action-specific ARARs associated with soil excavation and filling could be met with a manageable, but relatively rigorous level of effort. Action-specific ARARs would primarily be District requirements related to: noise (construction equipment and trucks); air quality (vehicle exhaust, dust); stormwater discharge quality; erosion, sedimentation and storm water; water pollution control; DOT hazardous materials transportation, and hazardous waste management. Federal requirements related to: hazardous waste generation; transportation and disposal of hazardous waste.

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Criteria	Alternative 1: No Action	Alternative 2: Limited Action/Institutional Controls	Alternative 3: Containment/Selective Placement of Clean Soil Barriers & Institutional Controls	Alternative 4: Containment/Site-wide Clean Soil Barrier & Institutional Controls	Alternative 5: Removal/Landfill Removal & Shoreline Stabilization
Long-Term Effectiveness and Permanence					
Magnitude of residual risk	**Ineffective:** Long-term visitor and worker exposure to surficial soil contamination presents an unacceptable risk.	**Ineffective:** Same as Alternative 1.	**Effective:** The proposed measure would reduce the residual risk of exposure to acceptable levels. With appropriate controls, the measures would be stable provided that healthy vegetation is maintained to prevent erosion and potential exposure of buried waste.	**Effective:** Same as Alternative 3.	**Effective:** Removal of the landfill waste and contaminated soil cover would eliminate associated residual exposure risks.
Adequacy and reliability of controls	**Not Applicable:** No controls are included in No Action alternative**.**	**Ineffective:** Although institutional controls could address exposure risks to excavation workers, they would not address the visitor and worker exposure risk posed by contaminants in surface soil.	**Effective:** Institutional controls can be established through the Superintendent's Compendium, a site management plan, and required five-year reviews to monitor for and repair erosion and to maintain a working knowledge of site conditions among park management staff.	**Effective:** Same as Alternative 3.	**Effective:** No institutional controls would be necessary after full implementation, which would include a period of monitoring to confirm re-vegetation objectives are met.

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Reduction of Toxicity, Mobility, and Volume Through Treatment					
Treatment process; *Volume treated;* *Reduction of toxicity, mobility, and volume;* *Permanence of treatment;* *Type and quantity of treatment residuals; and* *Degree to which principal threats are reduced per statutory preference*	**Not Applicable:** No treatment proposed	**Not Applicable:** No treatment proposed	**Not Applicable:** No treatment proposed	**Not Applicable:** No treatment proposed	**Not Applicable:** No treatment proposed
Short-Term Effectiveness					
Protection of the local community during remedial actions; *Protection of workers during remedial actions;* *Environmental impacts of remedial action activities; and* *Time until remedial action objectives are achieved.*	**Effective:** Site conditions are stable and the exposure risk, while unacceptable to NPS for the long-term, is acceptable in the short term.	**Effective:** Same as Alternative 1.	**Effective:** Measures would be taken consistent with the Action Specific ARARs to protect the local community and workers from unacceptable exposure (noise, dust, truck traffic). Similarly, measures would be taken to protect against environmental impacts such as dust or sediment migration into surface water or damage to wetlands. Considering the lack of a short-term exposure risk, and the low level of long-term risk, the time until remediation is complete would not reduce the effectiveness of this alternative.	**Ineffective:** Although measures can be taken to protect the local community and workers during the remedial actions, this alternative would temporarily destroy existing habitat within Kenilworth Park South that is highly valued by NPS and the community.	**Ineffective:** Same as Alternative 4; however, the level of effort would be significantly greater and the duration of construction would likely be longer, increasing the potential for natural resource and community impacts associated with construction.
Implementability					
Ability to construct and operate the technology; *Reliability of the technology;* *Ease of undertaking additional remedial actions if necessary;* *Monitorability;* *Administrative Feasibility - Coordination with other agencies;* *Availability / Capacity of Treatment / Disposal Facilities;* *Availability of personnel, equipment, and materials; and* *Availability of technology.*	**Not Applicable** for the no-action alternative.	**Implementable:** Institutional controls such as notations in the Superintendent's compendium and site management plans can be readily drafted and adopted. A limited level of staff awareness training would be required.	**Implementable:** Placement of a clean fill cap, or other barrier, and establishing vegetation requires standard and readily available construction techniques. As with Alternative 2, institutional controls can be readily implemented. Capping and re-vegetation is a reliable measure that is applied to closed landfills and other sites with surficial soil contamination. It can be visually monitored for erosion or a lack of sufficient or acceptable vegetation. Clean fill requires effort to identify and secure but is typically available from local sources.	**Implementable:** Same as Alternative 3.	**Implementable:** Although with the right planning and resources, this alternative could be implemented, it would cause significant disruptions and be logistically challenging. It is also unlikely that the required level of funding could be obtained.

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Cost					
Capital	$0	$86,000	$7,500,000	$15,000,000	$610,000,000
Annual Operation & Maintenance	$0	$25,000/yr (5 years)	$68,000 to $43,000/yr (30+ years)	$130,000 to $83,000/yr (30+ years)	$350,000/yr (5 years)
Periodic	$30,000 every 5 years (Years 5 – 30)	$50,000 (Year 5), plus $30,000 every 5 years (Years 10 – 30+)	$50,000 (Year 5), plus $30,000 every 5 years (Years 10 – 30+)	$50,000 (Year 5), plus $30,000 every 5 years (Years 10 – 30)	$0
Present Worth	$170,000	$400,000	$9,000,000	$18,000,000	$620,000,000

Note:

1. Green shaded table cells represent non-cost balancing criteria that are met and costs that comply with Section 300.430(f)(1)(ii)(D) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), which indicates a selected remedy must be "cost-effective," which means that "its costs are proportional to its overall effectiveness."
2. Orange shaded table cells represent non-cost balancing criteria that are not met and costs that do not comply with Section 300.430(f)(1)(ii)(D) of the NCP.
3. Red shaded table cells represent threshold criteria that are not met. Under the NCP, alternatives that do not meet the threshold criteria cannot be selected.

FIGURES

0 500 1000 2000 Feet

KPN and KPS Landfill Boundaries

Kenilworth Park Landfill Site
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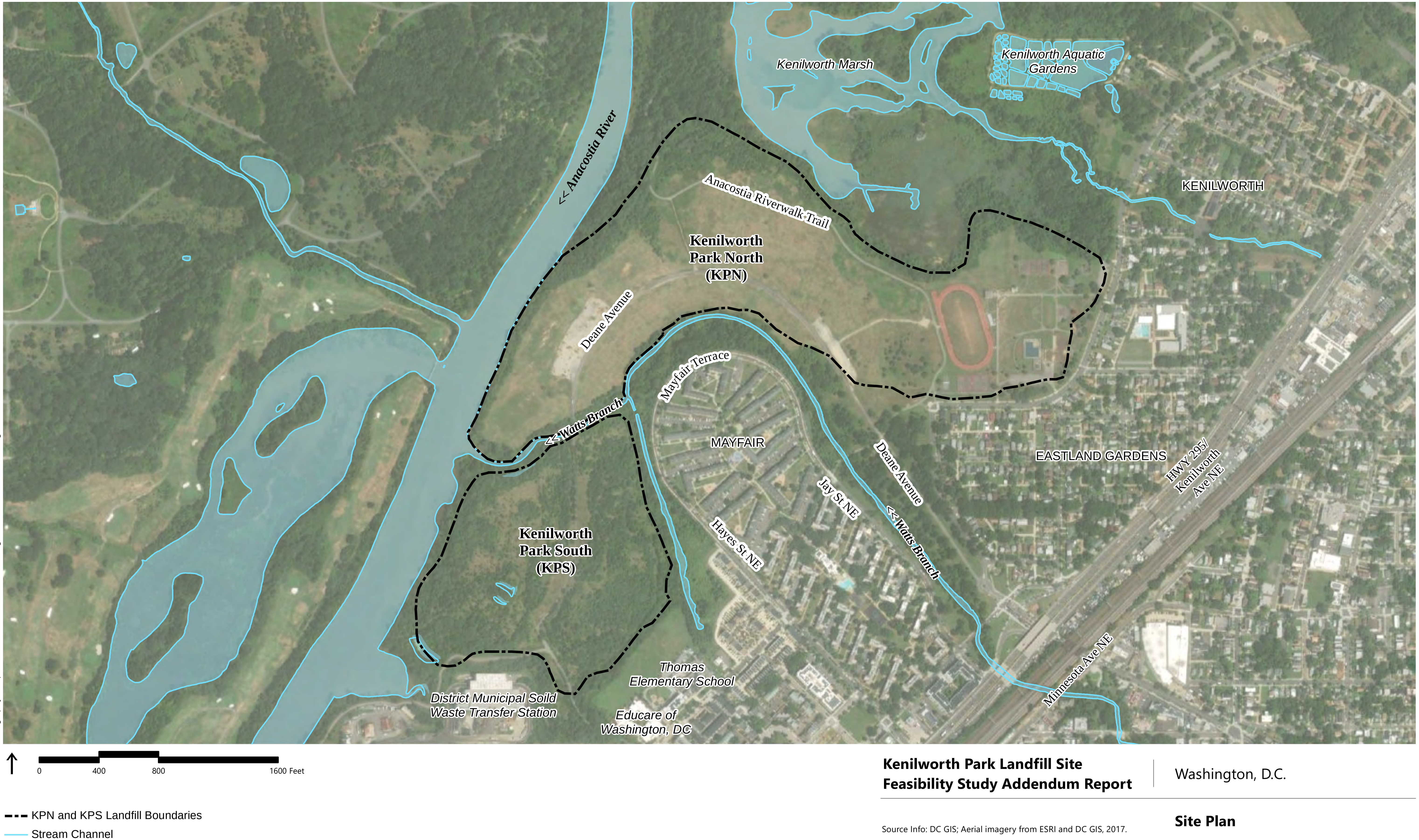
Washington, D.C.

Source Info: Ecology and Environment, 2003 and 2007; Aerial imagery from ESRI and DC GIS, 2017.

Site Area Map

\\vhb\gis\proj\Montpelier\58345.11 NPS Kenilworth Landfill\gis\FS_Addendum\VHB_MXDs\Figure 1 Site Area Map.mxd

July 29, 2020 | **FIGURE 2**



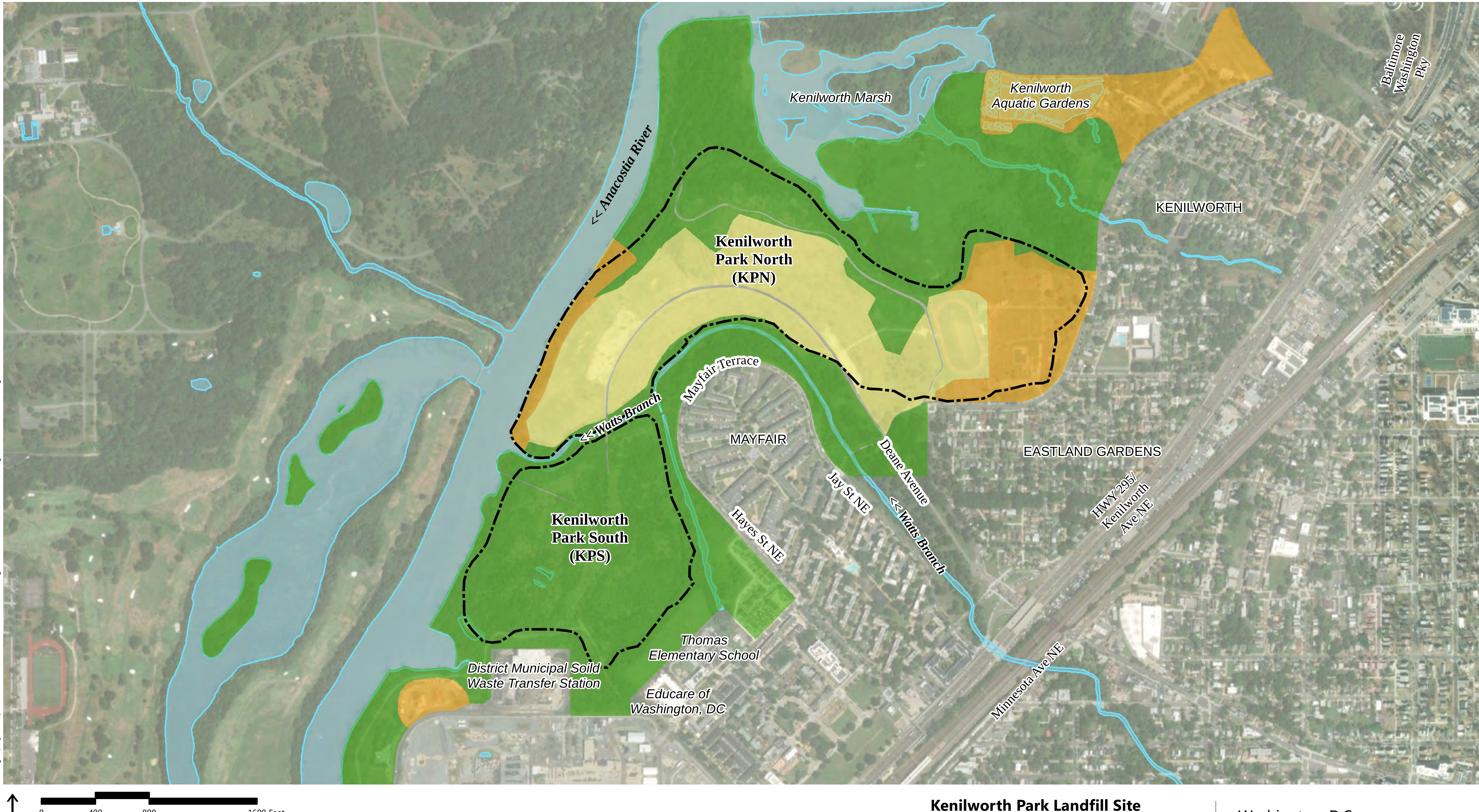
\\vhb\gis\proj\Montpelier\58345.11 NPS Kenilworth Landfill\gis\FS_Addendum\VHB_MXDs\Figure 2 Site Plan.mxd

Kenilworth Park Landfill Site Feasibility Study Addendum Report | Washington, D.C.

Site Plan

Source Info: DC GIS; Aerial imagery from ESRI and DC GIS, 2017.

July 29, 2020 | **FIGURE 3**



\\vhb\gis\proj\Montpelier\58345.11 NPS Kenilworth Landfill\gis\FS_Addendum\VHB_MXDs\Figure 3 Land Use Management Zones.mxd

- KPN and KPS Landfill Boundaries
- Stream Channel

Anacostia Park Management Zones

- Community Activities and Special Events
- Natural Resource Recreation Zone
- Organized Sport and Recreation Zone

Note: The Anacostia Park Management Zones shown on this figure are primarily based on those presented as Alternative 3 of the Anacostia Park Management Plan Environmental Assessment (February 2017); the Organized Sport and Recreation Zone has been expanded within Kenilworth Park North to account for potential future District development plans.

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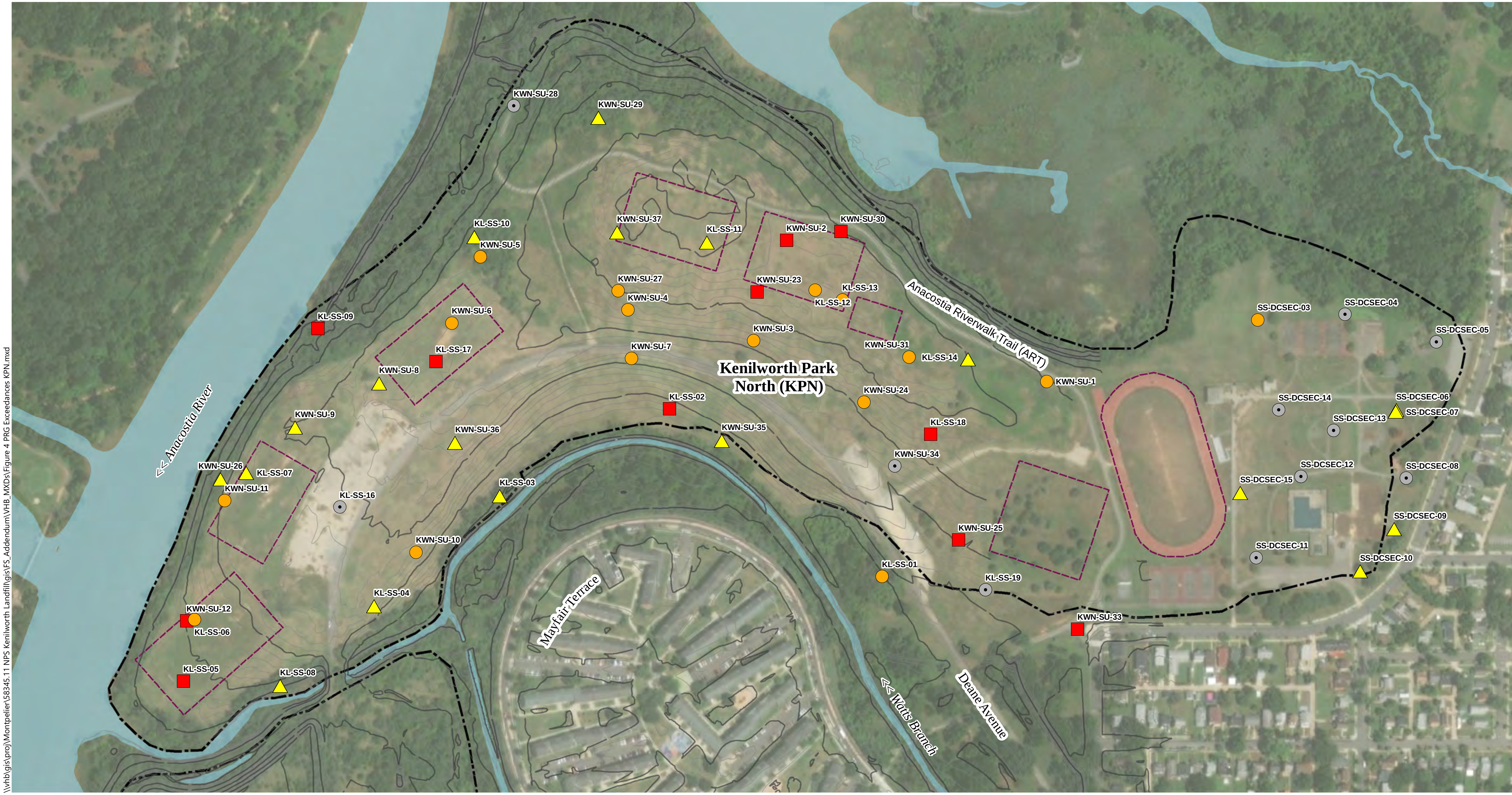
Source Info: Ecology and Environment, 2003 and 2007; Aerial imagery from ESRI and DC GIS, 2017.

NPS Land Use Management Zones



0 200 400 800 Feet

- Sample Does Not Exceed PRG
- Sample Exceeds Organized Sport and Recreation/Community Activities and Special Event - High Use/Moderate Intensity PRG (Scenario 2)
- Sample Exceeds Natural Resources Recreation - Moderate Use/Moderate Intensity PRG. This PRG applies to areas of the park that are most frequented by visitors such as the established trails, organized sport, and community activity areas (Scenario 3).
- Sample Exceeds Natural Resource Recreation - Low Use/Low Intensity PRG. This PRG applies to off-trail areas of the park that are not associated with organized sports or community activities (Scenario 4).
- KPN and KPS Landfill Boundaries
- 5 ft Contour (USACE 2000)
- 1 ft Contour (USACE 2000)
- Existing/Former/Future Sports Field

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Source Info: Ecology and Environment, 2003 and 2007; Aerial imagery from ESRI and DC GIS, 2017.

PRG Exceedances (1×10^{-6} Excess Cancer Risk) at Kenilworth Park North

\\vhb\gis\proj\Montpelier\58345.11 NPS Kenilworth Landfill\gis\FS_Addendum\VHB_MXDs\Figure 4 PRG Exceedances KPN.mxd

September 25, 2020 | **FIGURE 5**

Sample Does Not Exceed PRG Relative to the Designated Land Use Management Zone
Sample Exceeds PRG Relative to the Designated Management Zone
Water Access/Boat

Future Alignment of Anacostia Riverwalk Trail
Transfer Boundary
5 ft Contour (USACE 2000)
1 ft Contour (USACE 2000)
Existing/Former Sports Field
KPN and KPS Landfill Boundaries

Anacostia Park Management Zones

Community Activities and Special Events
Natural Resource Recreation Zone
Organized Sport and Recreation Zone

Note:
1. The "Organized Sport and Recreation" and "Community Activities and Special Events" Management Zones are areas where visitors may come into contact with surficial soils more frequently and with more intensity than in the "Natural Resources Recreation" Management Zone.
2. Changes to the management zone configuration may change the designation for sample exceedance shown on this figure.

Kenilworth Park Landfill Site
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Source Info: Ecology and Environment, 2003 and 2007; Aerial imagery from ESRI and DC GIS, 2017.

PRG Exceedances Relative to Land Use Management Zone (1×10^{-6} Excess Cancer Risk) at Kenilworth Park North

\\vhb\gis\proj\Montpelier\58345.11 NPS Kenilworth Landfill\gis\FS_Addendum\VHB_MXDs\Figure 5 KPN PRG Exceedances Relative to Land Use Management Zone 10-6.mxd

September 25, 2020 | **FIGURE 6**

\\vhb\gis\proj\Montpelier\58345.11 NPS Kenilworth Landfill\gis\FS_Addendum\VHB_MXDs\Figure 6 KPN PRG Exceedances Relative to Land Use Management Zone 10-5.mxd

- Sample Does Not Exceed PRG Relative to the Designated Land Use Management Zone
- Sample Exceeds PRG Relative to the Designated Management Zone
- Water Access/Boat Launch
- Future Alignment of Anacostia Riverwalk Trail
- Transfer Boundary
- 5 ft Contour (USACE 2000)
- 1 ft Contour (USACE 2000)
- Existing/Former Sports Field
- KPN and KPS Landfill Boundaries

Anacostia Park Management Zones

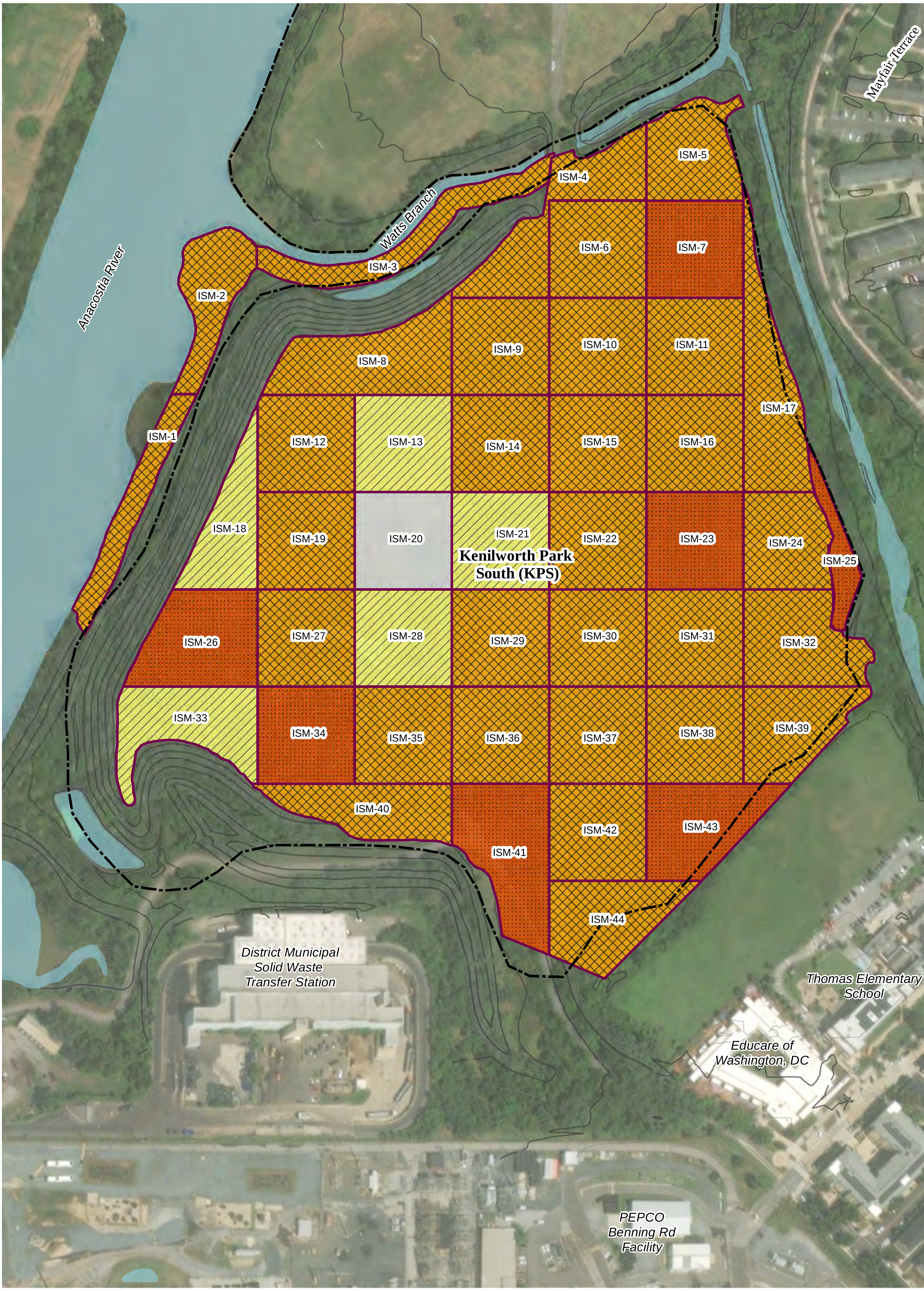
- Community Activities and Special Events Zone
- Natural Resource Recreation Zone
- Organized Sport and Recreation Zone

Note:
1. The "Organized Sport and Recreation" and "Community Activities and Special Events" Management Zones are areas where visitors may come into contact with surficial soils more frequently and with more intensity than in the "Natural Resources Recreation" Management Zone.
2. Changes to the management zone configuration may change the designation for sample exceedance shown on this figure.

Kenilworth Park Landfill Site Feasibility Study Addendum Report | Washington, D.C.

Source Info: Ecology and Environment, 2003 and 2007; Aerial imagery from ESRI and DC GIS, 2017.

PRG Exceedances Relative to Land Use Management Zone (1×10^{-5} Excess Cancer Risk) at Kenilworth Park North



\\vhb\gis\proj\Montpelier\58345.11 NPS Kenilworth Landfill\gis\FS_Addendum\VHB_MXDs\Figure 7 PRG Exceedances KPS.mxd

0 100 200 400 Feet

KPN and KPS Landfill Boundaries

ISM-01
Incremental Sampling Method (ISM) sampling unit boundary

5 ft Contour (USACE 2000)

1 ft Contour (USACE 2000)

Sample Does Not Exceed PRG

Sample Exceeds Organized Sport and Recreation/ Community Activities and Special Events - High Use/Moderate Intensity PRG. There are no KPS areas designated as "Organized Sport" or "Community Recreation" within the Anacostia Park Management Plan; therefore, this designation is not applicable to KPS (Scenario 2).

Sample Exceeds Natural Resource Recreation - Moderate Use/Moderate Intensity PRG. This PRG applies to areas of the park that are most frequented by visitors such as the established trails, organized sport, and community activity areas (Scenario 3).

Sample Exceeds Natural Resource Recreation - Low Use/Low Intensity PRG. This PRG applies to off-trail areas of the park that are not associated with organized sports or community activities (Scenario 4).

Kenilworth Park Landfill Site
Feasibility Study Addendum Report

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Note: Changes to the management zone configuration may change the designation for sample exceedance shown on this figure.

Source Info: Ecology and Environment, 2003 and 2007; Aerial imagery from ESRI and DC GIS, 2017.

PRG Exceedances (1 x 10^{-6} Excess Cancer Risk) at Kenilworth Park South

\\vhb\gis\proj\Montpelier\58345.11 NPS Kenilworth Landfill\gis\FS_Addendum\VHB_MXDs\Figure 8 KPS PRG Exceedances Relative to Land Use Management Zone 10-6.mxd

0 100 200 400 Feet

Kenilworth Park Landfill Site
Feasibility Study Addendum Report

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KPN and KPS Landfill Boundaries

ISM-01
Incremental Sampling Method
(ISM) sampling unit boundary

5 ft Contour (USACE 2000)

1 ft Contour (USACE 2000)

Sample Does Not Exceed PRG Relative to the Designated Land Use Management Zone

Sample Exceeds PRG Relative to the Designated Management Zone

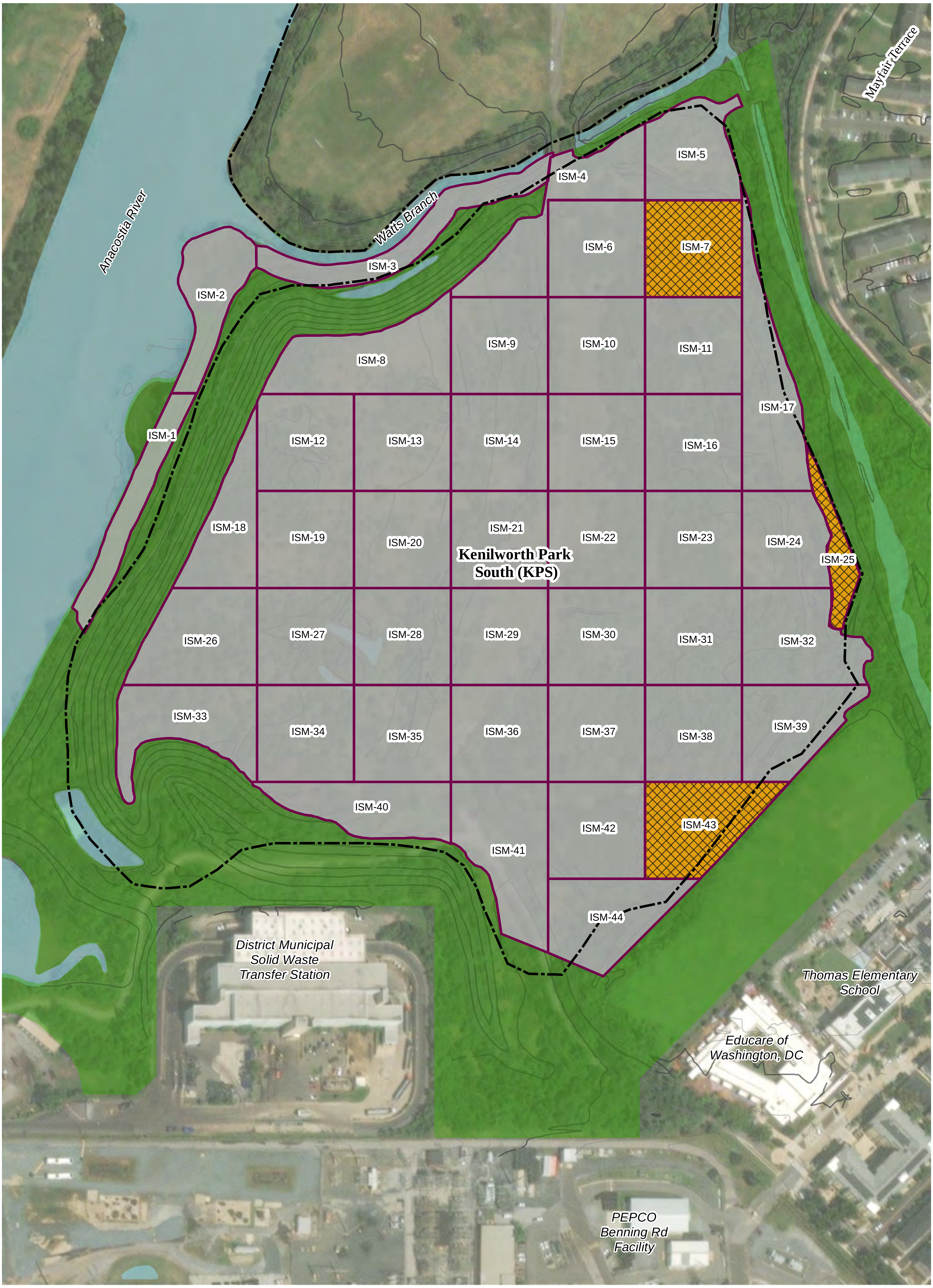
Anacostia Park Management - Natural Resource Recreation Zone

Note: Changes to the management zone configuration may change the designation for sample exceedance shown on this figure.

Source Info: Ecology and Environment, 2003 and 2007; Aerial imagery from ESRI and DC GIS, 2017.

PRG Exceedances Relative to Land Use Management Zone (1×10^{-6} Excess Cancer Risk) at Kenilworth Park South

September 17, 2020 | **FIGURE 9**



\\vhb\gis\proj\Montpelier\58345.11 NPS Kenilworth Landfill\gis\FS_Addendum\VHB_MXDs\Figure 9 KPS PRG Exceedances Relative to Land Use Management Zone 10-5.mxd

Kenilworth Park Landfill Site
Feasibility Study Addendum Report

Washington, D.C.

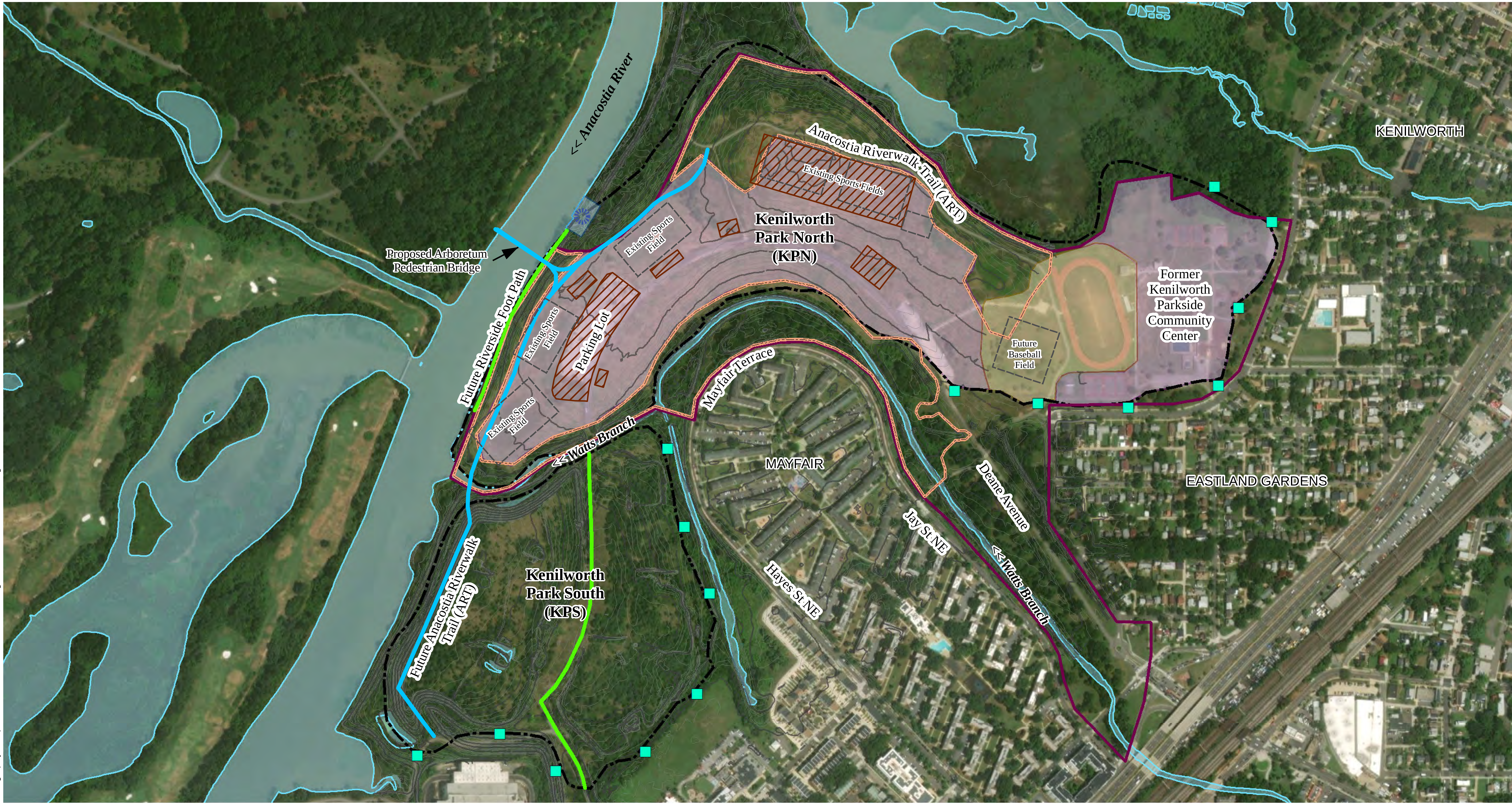
- KPN and KPS Landfill Boundaries
- ISM-01 Incremental Sampling Method (ISM) sampling unit boundary
- 5 ft Contour (USACE 2000)
- 1 ft Contour (USACE 2000)
- Sample Does Not Exceed PRG Relative to the Designated Land Use Management Zone
- Sample Exceeds PRG Relative to the Designated Management Zone
- Anacostia Park Management - Natural Resource Recreation Zone

Note: Changes to the management zone configuration may change the designation for sample exceedance shown on this figure.

Source Info: Ecology and Environment, 2003 and 2007; Aerial imagery from ESRI and DC GIS, 2017.

PRG Exceedances Relative to Land Use Management Zone (1×10^{-5} Excess Cancer Risk) at Kenilworth Park South

vhb July 29, 2020 | **FIGURE 10**



\\vhb\gis\proj\Montpelier\58345.11 NPS Kenilworth Landfill\gis\FS_Addendum\VHB_MXDs\Figure 10 Alt 3 Limited Action.mxd

- Future Alignment of Anacostia Riverwalk Trail
- Resource Management
- Transfer Boundary
- 5 ft Contour (USACE 2000)
- 1 ft Contour (USACE 2000)
- Stream Channel
- KPN and KPS Landfill Boundaries
- Water Access/Boat

Key Elements Of Remedial Alternative 3

- Area of Minor Grading
- Soil Barrier
- Confirmatory Soil Sampling (Recent Fill)
- Access Road/Trail Resurfacing
- Confirmatory Soil Vapor Monitoring Location (actual locations may differ)

Notes:
1. The approximate future alignments of the ART were copied from the December 2011 Environmental Assessment, Anacostia Riverwalk Trail, Section 3 Realignment.

Kenilworth Park Landfill Site
Feasibility Study Addendum Report

Washington, D.C.

Source Info: Ecology and Environment, 2003 and 2007; Aerial imagery from ESRI and DC GIS, 2017.

Remedial Alternative 3 - Selective Placement Of Clean Soil Barriers

July 29, 2020 | **FIGURE 11**

\\vhb\gis\proj\Montpelier\58345.11 NPS Kenilworth Landfill\gis\FS_Addendum\VHB_MXDs\Figure 11 Alt 4 Soil Cap - Dermal Cover.mxd

0 200 400 800 Feet

- 5 ft Contour (USACE 2000)
- 1 ft Contour (USACE 2000)
- Stream Channel
- KPN and KPS Landfill Boundaries
- Water Access/Boat Launch

Key Elements Of Remedial Alternative 4

- Soil Barrier (with Pre-Excavation)
- Soil Barrier (without Pre-Excavation)
- Confirmatory Soil Sampling (Recent Fill Area)
- Area of Minor Grading
- Access Road/Trail Resurfacing
- Proposed Soil Vapor Monitoring Location (actual locations may differ)

Notes:
1. The approximate future alignments of the ART were copied from the December 2011 Environmental Assessment, Anacostia Riverwalk Trail, Section 3 Realignment.

Kenilworth Park Landfill Site
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Washington, D.C.

Source Info: Ecology and Environment, 2003 and 2007; Aerial imagery from ESRI and DC GIS, 2017.

Remedial Alternative 4 - Site-wide Clean Soil Barrier

July 29, 2020 | **FIGURE 12**

\\vhb\gis\proj\Montpelier\58345.11 NPS Kenilworth Landfill\gis\FS_Addendum\VHB_MXDs\Figure 12 Alt 5 Landfill Removal.mxd

- 5 ft Contour (USACE 2000)
- 1 ft Contour (USACE 2000)
- Stream Channel
- KPN and KPS Landfill Boundaries

Key Elements Of Remedial Alternative 5

- Area of Excavation

Kenilworth Park Landfill Site Feasibility Study Addendum Report | Washington, D.C.

Source Info: Ecology and Environment, 2003 and 2007; Aerial imagery from ESRI and DC GIS, 2017.

Remedial Alternative 5 - Landfill Removal & Shoreline Stabilization

APPENDICES

APPENDIX A MEMORANDUM: DEVELOPMENT OF RISK BASED CLEANUP LEVELS FOR SOIL

COMMITMENT & INTEGRITY
DRIVE RESULTS

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MEMORANDUM

TO: Jon Ordway, Rene Nahlik – The Johnson Company

FROM: Lisa McIntosh – Woodard & Curran

DATE: September 15, 2020

RE: Development of Risk Based Cleanup Levels for Soil
Kenilworth Park Landfill
Washington, DC.

As requested by the Johnson Company (JCO), Woodard & Curran has developed risk-based cleanup levels for the chemicals of concern (COCs) in surficial soil at the Kenilworth Park Landfill, Washington, DC ("Site") for several recreational exposure scenarios. This memo provides a brief summary of human health risk assessment (HHRA) results related to exposure to COCs in soil, followed by a discussion of the development of risk-based concentrations (RBCs) for each COC for each exposure scenario at the Site.

Introduction and Background

The Site covers 130 acres within Kenilworth Park, which is part of the Anacostia Park unit of National Capital Parks-East (NACE), in Washington, D.C. The Site comprises two areas divided by the Watts Branch, a tributary to the Anacostia River: Kenilworth Park Landfill North (KPN) and Kenilworth Park Landfill South (KPS). KPN and KPS are 80 acres and 50 acres in size, respectively (JCO, 2012, p. i). KPN currently consists of multiple maintained ballfields and provides opportunity for visitors to engage in active recreational activities such as soccer, rugby and baseball. KPS is largely overgrown with dense vegetation, and most visitors to KPS use the central path for walking, bike riding, and birdwatching.

From 1942 to 1968, the District of Columbia operated the Site as a municipal burning dump and landfill for municipal solid waste (MSW) incinerator ash. Open burning was discontinued by the District in 1968. From 1968 to 1970, the Site was operated as a non-burning landfill where raw MSW was co-disposed with MSW incinerator ash. Upon closure, the landfill was covered with imported soil and made into the Kenilworth Park. The original Kenilworth Park included sports fields, walking trails and picnic areas. In the late 1990s, KPS was filled with soil and demolition debris with the ultimate goal of developing additional sports fields. The filling at KPS was discontinued before the final design grades and sports fields could be constructed. Drainage improvements were made to KPS in the late 1990s and early 2000s and the area was reseeded.

On behalf of the National Park Service (NPS), Ecology and Environment, Inc. (E&E) completed remedial investigations (RIs) (that included HHRAs) for KPN and KPS in 2007 and 2008, respectively (NPS, 2017, p. 46). The RIs identified contaminants in the surficial soil that was used to cover the former landfill as well as in buried waste and deeper soil. The HHRAs evaluated potential health risks for current and future park visitors, and future construction/utility workers. Both current and future visitors were assumed to be exposed to surface soil across the Site, whereas future construction/utility workers were assumed to be exposed to both surface and subsurface soils.

The HHRAs concluded that exposure to contaminants in surface soils posed an unacceptable excess lifetime cancer risk (above one in one million) to park visitors, primarily due to arsenic, dieldrin (KPN only)[1], polychlorinated biphenyl (PCB) Aroclors, and polycyclic aromatic hydrocarbons (PAHs); and that lead exceeded the screening level in select locations in subsurface soil, posing an unacceptable hazard to Site workers (JCO, 2012, pp. 42-45, 47, 74-80 and Tables 2-5 and 3-3). While arsenic was identified in the HHRAs as a cancer risk driver, this constituent was not identified as a COC because concentrations at the Site were consistent with background levels (JCO, 2012, p. 75).

To complement the updated surficial soil assessment at KPS that was performed by JCO, Woodard & Curran completed an updated HHRA for KPS. The updated HHRA evaluated the potential risk of harm to human health that could result from recreational exposures to chemicals of potential concern (COPC) in soil, utilizing surficial soil analytical data (from 0-6 inches below grade) collected in the fall of 2017. COPCs included metals, PAHs, and PCB Aroclors.

The updated HHRA evaluated risks for two exposure scenarios, including a visitor/recreator and an outdoor worker. The visitor scenario was based on exposure assumptions used in the 2008 HHRA, which were consistent with residential exposure scenarios. For this scenario, Woodard & Curran used updated values for exposure duration (26 years vs. 30 years), body weight (80 kg vs. 70 kg) and skin surface area (2,373 cm^2/day vs. 2,800 cm^2/day for the child, and 6,032 cm^2/day vs. 5,700 cm^2/day for the adult) based on more recent EPA guidance on recommended exposure parameters (USEPA 2014).

The second scenario evaluated in the updated HHRA included an outdoor adult park worker who may conduct occasional general maintenance activities that involve some soil disturbance or excavation, such as installation of signage. The 2008 HHRA evaluated a future construction worker scenario; however, future development is not planned for KPS. A long-term routine maintenance worker scenario is likely the most relevant type of worker for KPS at this time.

Under the more conservative recreational use exposure scenario used for screening potential risk, the updated HHRA for KPS indicated that exposure to concentrations of COPCs in surface soils at KPS have the potential to result in cumulative risk exceeding NCP default point of departure (excess cancer risk of 1×10^{-6}) for recreational users, as well as potential outdoor park workers. The majority of cumulative risk was attributed to Aroclor 1254, Aroclor 1260, benzo(a)pyrene, arsenic and, to a lesser extent, cobalt. Woodard & Curran also evaluated lead risks in soil for the visitor scenario using the USEPA Integrated Exposure Uptake Biokinetic Model (IEUBK); and for the outdoor park worker scenario using the USEPA Adult Lead Model (ALM). Based on this evaluation, lead concentrations at KPS are not expected to pose a risk.

Selection of Chemicals of Concern

Woodard & Curran derived RBCs for the chemicals of concern (COCs) in Site soil for the exposure scenarios summarized above according to USEPA risk assessment methodologies and guidance (USEPA, 1991; USEPA, 1996a; USEPA 2018). These COCs include aluminum, aldrin, antimony, arsenic, benzo(a)anthracene, benzo(a)pyrene, dibenz(a,h)anthracene, benzo(b)fluoranthene, cobalt, copper, dieldrin, iron, lead[2], manganese, mercury, silver, thallium and vanadium and polychlorinated biphenyl Aroclor 1254 and Aroclor 1260. Several of these COCs were identified as risk drivers (having a hazard quotient greater than one or excess cancer risk greater than 1×10^{-6}) for KPS and/or KPN in the 2007 and 2008 HHRAs conducted for the Site by E&E (JCO, 2012), as well as in Woodard & Curran's updated HHRA for KPS (Woodard & Curran, 2019). Additional COCs were selected based on a comparison of

[1] In the 2012 Feasibility Study, dieldrin is listed as a risk driver in Table 3-3 and Appendix B-1, but is not included in Table 3-5 as a COC.

[2] The 2008 risk assessment concluded that lead did not pose excess risk for the recreational user, but did pose a risk at select locations of the landfill for a Site worker. The Feasibility Study proposed a soil cleanup goal for lead of 455 mg/kg for the Site worker. Changes to the lead models used to evaluate risk since 2008 warranted reevaluation of RBCs for lead in soil.

constituent concentrations detected in soil at KPN (E&E, 2000; E&E, 2002 and E&E, 2007) to 2020 USEPA regional screening levels for residential soil (USEPA 2020a). This comparison is shown in Attachment 1.

Exposure Scenarios Evaluated

As stated above, Woodard & Curran has been tasked by JCO to develop RBCs for recreational exposure scenarios at the Site[3]. Woodard & Curran developed four exposure scenarios that characterize a range of potential future activities at the Site. Exposure scenarios were developed for the entire Site, including both KPN and KPS, based generally on the management zones defined in the Anacostia Park Management Plan Environmental Assessment (NPS, 2/2017). Areas of the Site, are identified in the Management Plan as one of the following three zones:

- Natural Resource Recreation Zone – The purpose of this zone is to preserve and protect areas of forest, wetlands, cultural resources. It would provide passive recreation and interpretive opportunities to visitors within a managed natural setting including hiking, walking, boating, experiencing the river, and enjoying and learning about nature.
- Organized Sport and Recreation Zone - This zone would provide multi-purpose sports fields and facilities for competitive league play for a variety of field sports. When utilized for competitive league play or special events, fields and facilities would support recreational and educational opportunities traditionally found within neighborhood and regional parks. This zone would also provide space for a variety of cultural and educational opportunities through multi-purpose fields and facilities focusing on programming of special events that celebrate national and local heritage.
- Community Activities and Special Events Zone - This zone would provide visitors with opportunities to participate in recreational and educational activities traditionally found in neighborhood and regional parks, as well as multi-purpose sports fields and facilities that support play for a variety of sports. It would provide opportunities to learn about the park's cultural and natural resources through a variety of educational and interpretive experiences including special events that celebrate national and local heritage.

Two passive recreator exposure scenarios (i.e., relatively low potential for exposure to contaminated soils such as hiking, biking, walking, boating, etc.), and an active recreator exposure scenario (i.e., greater potential for exposure to contaminated soils such as by participating in competitive league sports practice and games) were developed to meet the goals of the natural resource recreation (NRR) zone, and the organized sport and recreation/community activities and special events zones, respectively. In keeping with the NPS practice, a high-intensity recreational land use scenario was evaluated to provide upper bound RBCs protective of unrestricted use. The following table provides a summary of the exposure scenarios evaluated, and key exposure parameters.

[3] Excess risk/hazard was also identified for the park worker. The RBCs developed for the recreator/unrestricted scenarios will be protective of a park worker scenario, which is anticipated to have a lower level of exposure and older age range than those of Scenarios 1-4.

Summary of Exposure Scenarios Evaluated

Scenario	Exposure Assumptions
Scenario #1: Recreational - High Use/High Intensity	The exposure assumptions used to evaluate Scenario 1 are consistent with those that were used for the 2007 and 2008 human health risk assessments before the Management Plan was adopted. For consistency, they were also used in the updated risk calculations completed for the RI Addendum. However, the high use/high intensity exposure assumptions used for Scenario 1 and summarized below are similar to those that would be associated with residential land use and are not consistent with the foreseeable land use established by the Management Plan. Key exposure parameters include: • Exposure duration of 26 years (consistent with residential tenure) • Year-round exposure frequency (350 days per year) • Exposure time outdoors of 24 hour/day • Assumes all the daily soil ingestion/contact dose is obtained at Site.
Scenario #2: Organized Sport and Recreation/ Community Activities and Special Events - High Use/Moderate Intensity	Site will be used for a variety of recreational sports/events and will include ballfields (soccer, football, baseball etc.) and accessory structures such as storage sheds, bleachers, and restrooms. Main anticipated activities include playing sports and spectating at events. Assumes a youth and adult may engage in sporting activities during the non-winter months. Key exposure parameters include: • Exposure duration of 26 years (consistent with residential tenure) • Exposure frequency of 3 days/week for a child for approximately 10 months/year, or 125 days per year • Exposure frequency of 3.8 days/week for a youth/adult for 10 months/year (spring/fall seasons), or 158 days per year • High contact activities (e.g., playing soccer or rugby) • Exposure time outdoors of 2 hours/day for the child and 3 hour/day for the adult. • Assumes one-half of daily soil ingestion/contact dose is obtained at Site.

Scenario	Exposure Assumptions
Scenario #3: Natural Resource Recreation - Moderate Use/Moderate Intensity	Site will be maintained as undeveloped open space/conservation land and may include nature trails and walking/biking paths. Activities are primarily to include walking/jogging/biking along established trails and wildlife viewing. Key exposure parameters include: • Exposure duration of 26 years (consistent with residential tenure) • Exposure frequency of 4 days/week for approximately 10 months/year, or 168 days per year • Low contact activities (e.g., walking) • Exposure time outdoors of 2 hours/day • Assumes one-third of daily soil ingestion/contact dose obtained at Site.
Scenario #4: Natural Resource Recreation - Low Use/Low Intensity	Similar to Scenario #3, the Site will be maintained as undeveloped open space/conservation land and activities are primarily to include walking/jogging/biking along established trails and wildlife viewing. However, Scenario #4 assumes a lower level of exposure limited to occasional off-trail activities (such as wildlife viewing), with the assumption that future trails are paved or covered with clean fill. Key exposure parameters include: • Exposure duration of 26 years (consistent with residential tenure) • Exposure frequency of 1 day/week for approximately 10 months/year, or 42 days per year • Low contact activities (e.g., walking) • Exposure time outdoors of 1 hour/day • Assumes one-third of daily soil ingestion/contact dose is obtained at Site.

Calculation of Risk-Based Concentrations

RBCs are calculated using receptor specific exposure parameters, chemical-specific toxicity values and a target risk endpoint, i.e., hazard index (HI; non-cancer effects) and incremental lifetime cancer risk (ILCR; cancer risk). Exposure pathways in the RBC development include incidental ingestion of soil, dermal contact with soil and inhalation of fugitive dust. Woodard & Curran used a target HI of 1 and ILCR of 10^{-6}, in accordance with EPA guidance for calculation of RBCs. The equations and input parameters used to calculate RBCs are provided on Tables 1a to 4a for scenarios 1-4, respectively.

Toxicity values, including reference doses and reference concentrations for non-cancer effects, and cancer slope factors and inhalation unit risks for cancer effects, are summarized on Table 5. Toxicity information was obtained from the USEPA Integrated Risk Information System (IRIS) database (USEPA, 2020b), USEPA Provisional Peer-Reviewed Toxicity Values (PPRTV) (USEPA, 2020c), Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997), and the Agency for Toxic Substances & Disease Registry (ATSDR, 2020).

According to the USEPA's document "*Supplemental Guidance for Assessing Susceptibility from Early Life Exposure to Carcinogens"* (USEPA, 3/2005), benzo(a)anthracene, benzo(a)pyrene, dibenz(a,h)anthracene and benzo(b)fluoranthene have been determined to be carcinogenic by a mutagenic mode of action. Individuals exposed during early life to carcinogens with a mutagenic mode of action are assumed to have an increased risk for cancer. Therefore, age dependent adjustment factors (ADAFs) are combined with age specific exposure durations for the development of RBCs for these COCs. The equations and input parameters for the calculation of RBCs for these four PAHs are provided on Tables 1b to 4b for Scenarios 1-4, respectively.

Lead RBCs

Lead is evaluated in a manner different from that used to assess other COCs, using USEPA models that predict the percentage of a population that will result with blood lead levels (BLLs) exceeding a target BLL. Of the two models commonly employed, the USEPA's Integrated Exposure Uptake Biokinetic model (IEUBK) is designed to evaluate lead hazards specifically for young children in a residential setting (USEPA 1996b). The other model, the Adult Lead Methodology (ALM), is designed to address lead hazards for adults and is typically used in commercial/industrial scenarios. Because Scenarios #1-#4 above include a young child within the age ranges evaluated, the IEUBK was used to derive soil RBCs for lead.

There are multiple current and proposed types of recreational land use at Kenilworth Park. Portions of the park are actively used as ballfields, whereas other portions (particularly in Kenilworth Park South) are more remote and less easily accessible due to heavy vegetation and lack of recreational attractions. Park visitors are thus expected to have different levels of exposure, as described in the above table. Because of these differences in exposure potential, two separate lead RBCs were derived: one for a high-intensity recreational use (and particularly applicable in active areas of Kenilworth Park North closest to the residential neighborhood; i.e., Scenarios #1 and #2), and the other for a low-intensity, passive recreational use (i.e., Scenarios #3 and #4).

For both scenarios, a target BLL of 5 micrograms lead per deciliter blood (ug/dL) was used as the point of departure. While a threshold BLL of 10 ug/dL has historically been used in the IEUBK model, the Centers for Disease Control (CDC) has more recently specified a lower BLL of 5 ug/dL above which public health actions should be undertaken[4]. While USEPA has not officially stated use of this lower BLL in the models at this time, they recommend that lead risk assessments "should include a discussion of the most current toxicity information and Centers for Disease Control and Prevention Reference level" (USEPA, 2017).

The IEUBK does not allow for adjustment of exposure frequency, and while the soil ingestion rates may be adjusted in the model, USEPA does not recommend doing so without prior review by the Office of Emergency and Remedial Response (USEPA 1996b). Therefore, these and other default IEUBK model input parameters (including baseline blood BLLs, dietary inputs etc.) were not adjusted in deriving the RBC for the high-intensity recreational scenario. These standard default input parameters were used in the IEUBK model, and in conjunction with the CDC-recommended target BLL, resulted in an RBC of 153 mg/kg.

While this RBC is designed for a residential setting, it may be overly conservative for application in a non-residential setting, since only a portion of a receptor's time would be spent at the Site versus their home. Thus, a recreational RBC was derived using the target residential RBC, but assuming that one-third of a receptor's time is spent at the Site and the remainder of the time is spent at home at local background concentrations. This assumption is consistent with that used to adjust the soil ingestion rate used for other COCs. A lead background concentration of 82 mg/kg was used to represent background lead concentrations at a residence. This value is the arithmetic mean concentration among 23 individual soil samples collected from various background locations within the District of Columbia, including Kenilworth Park Aquatic Gardens and Neval Thomas Elementary School, and described in Appendix E of the Final Remedial Investigation Addendum Report (JCO, 2019).

The calculation of the passive recreational RBC for lead is shown as follows:

$$PRG_{residential}\ (153\ mg/kg) = (RBC_{passive\ recreational} * 0.33) + (background\ [82\ mg/kg] * 0.67]$$

Solving the equation for the passive recreational RBC yields an RBC of 295 mg/kg, applicable to Scenarios #3 and #4.

IEUBK output is provided in Attachment 2.

[4] https://www.cdc.gov/nceh/lead/default.htm

Summary

Tables 1c to 4c summarize the RBCs for each scenario based on noncancer effects, as well as the RBCs based on cancer risk set at 10^{-4}, 10^{-5} and 10^{-6}. The RBC tables calculated cancer-based RBCs based on 10^{-6} risk; cancer-based RBCs for other risk levels were calculated by multiplying the RBC by a factor of 10 (for 10^{-5} risk) or 100 (for 10^{-4} risk). Table 6 provides a summary of the final RBCs for Scenarios 1-4 at the 10^{-6} to 10^{-4} cancer levels; these final RBCs are the lower values between the carcinogenic and noncarcinogenic RBCs. As expected, the lowest (most conservative) RBCs are for Scenario 1, the more conservative recreational use scenario considered in prior risk assessments, followed by Scenarios 2 and 3, the active recreator and the moderate use/moderate intensity passive recreator, respectively. The least conservative RBCs are for Scenario 4, the low use/low intensity passive recreator.

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TABLES

TABLE 1A
CALCULATION OF RISK BASED CONCENTRATIONS
SCENARIO #1: RECREATOR (High Use/High Intensity)
Kenilworth Park Landfill
Washington, DC

EXPOSURE EQUATIONS:

Non Cancer

Ingestion:

$$RBC = \frac{THQ * AT\,nc * C2 * BW}{EF * ED * RBA * IR * FS * 1/RfDo * C1}$$

Dermal Contact:

$$RBC = \frac{THQ * AT\,nc * C2 * BW}{EF * ED * SA * AF * [1/(RfDo*GIABS)] * ABSd * C1}$$

Inhalation of Fugitive Dust:

Gastrointestinal uptake

$$RBC = \frac{THQ * AT\,nc * C2}{EF * ED * ET * (1/C3) * (1/RfC) * (1/VF + 1/PEF)}$$

All Pathways

$$\text{RBC-total nc} = \frac{1}{\text{1/RBC-ing nc} + \text{1/RBC-derm nc} + \text{1/RBC-inh nc}}$$

Cancer

$$\text{RBC-ing} = \frac{TR * ATc * C2}{CSFo * RBA * C1 * [(EDc * EFc * FS * IRc / BWc) + (EDa * EFa * FS * IRa / BWa)]}$$

$$\text{RBC-derm} = \frac{TR * ATc * C2}{(CSFo/GIABS) * ABSd * C1 * [(EDc * EFc * SAc * AFc * 1/BWc) + (EDa * EFa * SAa * AFa * 1/BWa)]}$$

$$\text{RBC -inh} = \frac{TR * AT * C2}{IUR * 1/C3 * (1/VF + 1/PEF) * [(EFc * EDc * ETc) + (EDa * EFa * ETa)]}$$

$$\text{RBC-total} = \frac{1}{\text{1/RBC-ing c} + \text{1/RBC-derm c} + \text{1/RBC-inh c}}$$

Parameter		Description	Units	Value	Reference	
Child						
IRsoilc	=	Ingestion rate of soil - child	mg/day	200	USEPA 2014	1
AFsoilc	=	Soil adherence factor - child	mg/cm^2	0.2	USEPA 2014	2
SAsoilc	=	Skin surface area - child	cm^2 / day	2,373	USEPA 2014	3
EFc	=	Exposure Frequency - child	days/yr	350	Professional judgment	4
EDc	=	Exposure Duration - child	years	6	USEPA 2014	5
Etc	=	Exposure time outdoors - child	hours/day	24	Professional judgment	6
FS	=	Fraction soil contact at Site	unitless	1	Professional judgment	7
BWc	=	Body Weight - child	kg	15	USEPA 2014	8
PEF	=	Particulate Emission Factor	m^3/kg	3.38E+08	E&E 2008	9
VF	=	Volatilization Factor	m^3/kg	Chemical-specific	USEPA 2018	10
ATc	=	Averaging Time - cancer	years	70	USEPA 1989	11
ATnc	=	Averaging Time - noncancer	years	6	USEPA 1989	12
Adult						
IRsoila	=	Ingestion rate of soil - adult	mg/day	100	USEPA 2014	1
AFsoila	=	Soil adherence factor - adult	mg/cm^2	0.07	USEPA 2014	2
SAsoila	=	Skin surface area - adult	cm^2 / day	6,032	USEPA 2014	3
EFa	=	Exposure Frequency - adult	days/yr	350	Professional judgment	4
EDa	=	Exposure Duration - adult	years	20	USEPA 2014	5
Eta	=	Exposure time outdoors - adult	hours/day	24	Professional judgment	6
FS	=	Fraction soil contact at Site	unitless	1	Professional judgment	7
BWa	=	Body Weight - adult	kg	80	USEPA 2014	8
PEF	=	Particulate Emission Factor	m^3/kg	3.38E+08	E&E 2008	9
VF	=	Volatilization Factor	m^3/kg	Chemical-specific	USEPA 2018	10
ATc	=	Averaging Time - cancer	years	70	USEPA 1989	11
ATnc	=	Averaging Time - noncancer	years	20	USEPA 1989	12
General Exposure Parameters						
THQ	=	Target Hazard Quotient	unitless	1	Site-specific	
TR	=	Target Cancer Risk	unitless	0.000001	Site-specific	
ABSd	=	Dermal absorption factor	unitless	Chemical-specific	USEPA 2004	13
RBA	=	Relative Bioavailability Factor	%	Chemical-specific	USEPA 2012	14
GIABS	=	Gastrointestinal absorption fraction	%	Chemical-specific	USEPA 2004	15
RfD	=	Reference Dose	mg/kg-d	Chemical-specific	Chemical-specific	
RfC	=	Reference Concentration	mg/m^3	Chemical-specific	Chemical-specific	
CSF	=	Cancer Slope Factor	$(mg/kg\text{-}d)^{-1}$	Chemical-specific	Chemical-specific	
IUR	=	Inhalation Unit Risk	$(mg/m^3)^{-1}$	Chemical-specific	Chemical-specific	
C1	=	Units conversion factor 1	kg/mg	0.000001		
C2	=	Units conversion factor 2	days/yr	365		
C3	=	Units conversion factor 3	hours/day	24		
RBC	=	Risk-based Soil Concentration	mg/kg	Chemical-specific	Calculated	

Chemical of Potential Concern	CAS	Toxicity Values				Chemical Specific Parameters				RBC - Non Cancer				RBC - Cancer			
		RFDo	RFCi	CSFo	IUR	GIABS	ABSd	RBA	VF	Ingestion	Dermal	Inhalation	All	Ingestion	Dermal	Inhalation	All
Arsenic	7440-38-2	3.0E-04	1.5E-05	1.5E+00	4.3E+00	1.0E+00	3.0E-02	6.0E-01	NA	3.9E+01	3.3E+02	5.3E+03	3.5E+01	7.7E-01	5.5E+00	2.2E+02	6.8E-01
Benzo(a)anthracene	56-55-3	NA	NA	*	*	1.0E+00	1.3E-01	1.0E+00	4.4E+06	NC	NC	NC	NC	*	*	*	*
Benzo(a)pyrene	50-32-8	3.0E-04	2.0E-06	*	*	1.0E+00	1.3E-01	1.0E+00	NA	2.3E+01	7.6E+01	7.0E+02	1.7E+01	*	*	*	*
Benzo(b)fluoranthene	205-99-2	NA	NA	*	*	1.0E+00	1.3E-01	1.0E+00	NA	NC	NC	NC	NC	*	*	*	*
Dibenz(a,h)anthracene	53-70-3	NA	NA	*	*	1.0E+00	1.3E-01	1.0E+00	NA	NC	NC	NC	NC	*	*	*	*
Aluminum	7429-90-5	1.0E+00	5.0E-03	NA	NA	1.0E+00	NA	1.0E+00	NA	7.8E+04	NC	1.8E+06	7.5E+04	NC	NC	NC	NC
Antimony	7440-36-0	4.0E-04	3.0E-04	NA	NA	1.5E-01	NA	1.0E+00	NA	3.1E+01	NC	1.1E+05	3.1E+01	NC	NC	NC	NC
Cobalt	7440-48-4	3.0E-04	6.0E-06	NA	9.0E+00	1.0E+00	NA	1.0E+00	NA	2.3E+01	NC	2.1E+03	2.3E+01	NC	NC	1.1E+02	1.1E+02
Copper	7440-50-8	4.0E-02	NA	NA	NA	1.0E+00	NA	1.0E+00	NA	3.1E+03	NC	NC	3.1E+03	NC	NC	NC	NC
Iron	7439-89-6	7.0E-01	NA	NA	NA	1.0E+00	NA	1.0E+00	NA	5.5E+04	NC	NC	5.5E+04	NC	NC	NC	NC
Manganese	7439-96-5	2.4E-02	5.0E-05	NA	NA	4.0E-02	NA	1.0E+00	NA	1.9E+03	NC	1.8E+04	1.7E+03	NC	NC	NC	NC
Mercury	7487-94-7	3.0E-04	3.0E-04	NA	NA	7.0E-02	NA	1.0E+00	NA	2.3E+01	NC	1.1E+05	2.3E+01	NC	NC	NC	NC
Silver	7440-22-4	5.0E-03	NA	NA	NA	4.0E-02	NA	1.0E+00	NA	3.9E+02	NC	NC	3.9E+02	NC	NC	NC	NC
Thallium	7440-28-0	1.0E-05	NA	NA	NA	1.0E+00	NA	1.0E+00	NA	7.8E-01	NC	NC	7.8E-01	NC	NC	NC	NC
Vanadium	7440-62-2	5.0E-03	1.0E-04	NA	NA	2.6E-02	NA	1.0E+00	NA	3.9E+02	NC	3.5E+04	3.9E+02	NC	NC	NC	NC
Aldrin	309-00-2	3.0E-05	NA	1.7E+01	4.9E+00	1.0E+00	NA	1.0E+00	1.7E+06	2.3E+00	NC	NC	2.3E+00	4.1E-02	NC	9.8E-01	3.9E-02
Dieldrin	60-57-1	5.0E-05	NA	1.6E+01	4.6E+00	1.0E+00	1.0E-01	1.0E+00	NA	3.9E+00	1.6E+01	NC	3.2E+00	4.3E-02	1.5E-01	2.1E+02	3.4E-02
Aroclor 1254	11097-69-1	2.0E-05	NA	2.0E+00	5.7E-01	1.0E+00	1.4E-01	1.0E+00	8.4E+05	1.6E+00	4.7E+00	NC	1.2E+00	3.5E-01	8.8E-01	4.1E+00	2.4E-01
Aroclor 1260	11096-82-5	NA	NA	2.0E+00	5.7E-01	1.0E+00	1.4E-01	1.0E+00	1.3E+06	NC	NC	NC	NC	3.5E-01	8.8E-01	6.4E+00	2.4E-01

Notes
NA = Not available
NC = Not calculated
*Risk based concentrations for benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene include a receptor-specific Age-Dependent Adjustment Factor. Derivation of cancer risk based concentrations for this compound are shown on Table 1B.

Table 1A Notes:

1. Soil ingestion rates are the recommended USEPA default soil ingestion rates for children and adult residents (USEPA 2014).
2. The soil adherence factors (AFsoil) are the USEPA default soil adherence factors for children and adults (Exhibit 3-5 of USEPA 2004). For the residential exposure, reasonable maximum exposure values were used.
3. The skin surface areas are the EPA-recommended default SAs for the adult and child resident (USEPA 2014) and reflect the weighted average of mean values for head, hands, forearms and lower legs (and feet, for the child).
4. The exposure frequency (EF) describes how often the exposure occurs over a given period of time. The EF is the USEPA default EF for a resident (USEPA 2014).
5. The exposure duration (ED) describes the length of time over which the receptor comes into contact with contaminants. ED is the current EPA-recommended value for residence time (USEPA 2014) which is a total 26 year residential tenure (0-26 years).
6. The exposure time (ET) is the amount of time spent outdoors. The USEPA default ET is 24 hours per day for the resident (USEPA 2014).
7. Soil ingestion parameters are reflective of the daily dose of soil. It was assumed that a resident would be exposed to 100% of the full daily dose when at the site; therefore, a FS of 1 was used, based on professional judgment.
8. The body weights (BW) for the child and adult are the recommended default body weights per USEPA 2014.
9. Site-specific PEF calculated in Table G-12 of Appendix G (Human Health Risk Assessment) of Remedial Investigation, Ecology and Environment 2008.
10. Volatilization factors (VF) were obtained from the USEPA Regional Screening Level (RSL) table, May 2020. https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables
11. The averaging time (AT) for cancer effects (AT_c) for all receptors is set equal to a lifetime (i.e., 70 years), as recommended in USEPA 1989.
12. The averaging time for non-cancer effects (AT_{nc}) for all receptors is set equal to the exposure duration, as recommended in USEPA 1989.
13. The dermal absorption factors (ABSd) are recommended values in Exhibit 3-4 of USEPA 2004, with updates as provided on: https://www.epa.gov/risk/risk-assessment-guidance-superfund-rags-part-e.
14. The EPA recommended default relative bioability (RBA) value of 60% is applied to oral arsenic exposures. An RBA of 100% is used for all other constituents (USEPA 2012).
15. Gastrointestinal absorption factors were obtained from the Final Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) (USEPA, 2004).

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TABLE 1B
CALCULATION OF RISK BASED CONCENTRATIONS FOR COPCS WITH A MUTAGENIC MODE OF ACTION
SCENARIO #1: RECREATOR (High Use/High Intensity)
Kenilworth Park Landfill
Washington, DC

Exposure Point:	Soil
Exposure Medium:	Soil
Receptor:	Residential

Exposure Pathway	COPC	TR (mg/kg)	Age (years)	BW (kg)	IR (mg/day)	FS (unitless)	EF (days/year)	ED (years)	AT_c (years)	C_1 (kg/mg)	C_2 (days/year)	CSF_o $(mg/kg\text{-}d)^{-1}$	RBA %	ADAF (unitless)	IF mg/kg
Incidental Ingestion of Soil	Benzo(a)anthracene	1.00E-06	0 through <2	15	200	1	350	2	70	1.00E-06	365	0.1	1	10	9.3E+04
		1.00E-06	2 through <6	15	200	1	350	4	70	1.00E-06	365	0.1	1	3	5.6E+04
		1.00E-06	6 through <16	80	100	1	350	10	70	1.00E-06	365	0.1	1	3	1.3E+04
		1.00E-06	16 through <26	80	100	1	350	10	70	1.00E-06	365	0.1	1	1	4.4E+03
		Risk Based Concentration - Incidental Ingestion of Soil:Benzo(a)anthracene													*1.5E+00*
	Benzo(a)pyrene	1.00E-06	0 through <2	15	200	1	350	2	70	1.00E-06	365	1	1	10	9.3E+04
		1.00E-06	2 through <6	15	200	1	350	4	70	1.00E-06	365	1	1	3	5.6E+04
		1.00E-06	6 through <16	80	100	1	350	10	70	1.00E-06	365	1	1	3	1.3E+04
		1.00E-06	16 through <26	80	100	1	350	10	70	1.00E-06	365	1	1	1	4.4E+03
		Risk Based Concentration - Incidental Ingestion of Soil:Benzo(a)pyrene													*1.5E-01*
	Benzo(b)fluoranthene	1.00E-06	0 through <2	15	200	1	350	2	70	1.00E-06	365	0.1	1	10	9.3E+04
		1.00E-06	2 through <6	15	200	1	350	4	70	1.00E-06	365	0.1	1	3	5.6E+04
		1.00E-06	6 through <16	80	100	1	350	10	70	1.00E-06	365	0.1	1	3	1.3E+04
		1.00E-06	16 through <26	80	100	1	350	10	70	1.00E-06	365	0.1	1	1	4.4E+03
		Risk Based Concentration - Incidental Ingestion of Soil:Benzo(b)fluoranthene													*1.5E+00*
	Dibenz(a,h)anthracene	1.00E-06	0 through <2	15	200	1	350	2	70	1.00E-06	365	1	1	10	9.3E+04
		1.00E-06	2 through <6	15	200	1	350	4	70	1.00E-06	365	1	1	3	5.6E+04
		1.00E-06	6 through <16	80	100	1	350	10	70	1.00E-06	365	1	1	3	1.3E+04
		1.00E-06	16 through <26	80	100	1	350	10	70	1.00E-06	365	1	1	1	4.4E+03
		Risk Based Concentration - Incidental Ingestion of Soil:Dibenz(a,h)anthracene													*1.5E-01*

Notes:
COPC = chemical of potential concern; BW = body weight; Tr = Target cancer risk; IR = soil or sediment ingestion rate; FS = fraction soil contact at Site; EF = exposure frequency; ED = exposure duration; AT_c = averaging time; CF = units conversion factor;
SA = skin surface area; AF =skin-soil adherence factor; ABSd = dermal absorption fraction; CSF_o = oral/dermal cancer slope factor; ADAF = age-dependent adjustment factor (USEPA 2005); RBA = Relative Bioavailability Factor
Risk = Incremental lifetime cancer risk; IF = soil ingestion factor for specific age group

Incidental Ingestion

$$RBC_{ing\ c\text{-}mut} = \frac{TR * C_2 * ATc}{CSFo * RBA * C_1 * (IF_{0\text{-}2} + IF_{2\text{-}6} + IF_{6\text{-}16} + IF_{16\text{-}28})}$$

Where:

$IF_{0\text{-}2}$ = $[(ED_{0\text{-}2} * EF_{0\text{-}2} * FS_{0\text{-}2} * IR_{0\text{-}2} * ADAF_{0\text{-}2} / BW_{0\text{-}2})$

$IF_{2\text{-}6}$ = $(ED_{2\text{-}6} * EF_{2\text{-}6} * FS_{2\text{-}6} * IR_{2\text{-}6} * ADAF_{2\text{-}6} / BW_{2\text{-}6})$

$IF_{6\text{-}16}$ = $(ED_{6\text{-}16} * EF_{6\text{-}16} * FS^{6\text{-}16} * IR_{6\text{-}16} * ADAF_{6\text{-}16} / BW_{6\text{-}16})$

$IF_{16\text{-}28}$ = $(ED_{16\text{-}28} * EF_{16\text{-}28} * FS_{16\text{-}28} * IR_{16\text{-}28} * ADA_{F19\text{-}28} / BW_{16\text{-}28})$

TABLE 1B
CALCULATION OF RISK BASED CONCENTRATIONS FOR COPCS WITH A MUTAGENIC MODE OF ACTION
SCENARIO #1: RECREATOR (High Use/High Intensity)
Kenilworth Park Landfill
Washington, DC

Exposure Point:	Soil
Exposure Medium:	Soil
Receptor:	Residential

Exposure Pathway	COPC	TR (mg/kg)	Age (years)	BW (kg)	SA (cm^2)	ABSd (unitless)	AF mg/cm^2	EF (days/year)	ED (years)	At_c (years)	C_1 (kg/mg)	C_2 (days/year)	CSF_o $(mg/kg\text{-}d)^{-1}$	GIABS %	ADAF (unitless)	DF mg/kg
Dermal Contact with Soil	Benzo(a)anthracene	1.00E-06	0 through <2	15	2,373	0.13	0.20	350	2	70	1.00E-06	365	0.1	1	10	2.2E+05
		1.00E-06	2 through <6	15	2,373	0.13	0.20	350	4	70	1.00E-06	365	0.1	1	3	1.3E+05
		1.00E-06	6 through <16	80	6,032	0.13	0.07	350	10	70	1.00E-06	365	0.1	1	3	5.5E+04
		1.00E-06	16 through <26	80	6,032	0.13	0.07	350	10	70	1.00E-06	365	0.1	1	1	1.8E+04
		Risk Based Concentration - Dermal Contact with Soil:Benzo(a)anthracene														*4.6E+00*
	Benzo(a)pyrene	1.00E-06	0 through <2	15	2,373	0.13	0.20	350	2	70	1.00E-06	365	1	1	10	2.2E+05
		1.00E-06	2 through <6	15	2,373	0.13	0.20	350	4	70	1.00E-06	365	1	1	3	1.3E+05
		1.00E-06	6 through <16	80	6,032	0.13	0.07	350	10	70	1.00E-06	365	1	1	3	5.5E+04
		1.00E-06	16 through <26	80	6,032	0.13	0.07	350	10	70	1.00E-06	365	1	1	1	1.8E+04
		Risk Based Concentration - Dermal Contact with Soil:Benzo(a)pyrene														*4.6E-01*
	Benzo(b)fluoranthene	1.00E-06	0 through <2	15	2,373	0.13	0.20	350	2	70	1.00E-06	365	0.1	1	10	2.2E+05
		1.00E-06	2 through <6	15	2,373	0.13	0.20	350	4	70	1.00E-06	365	0.1	1	3	1.3E+05
		1.00E-06	6 through <16	80	6,032	0.13	0.07	350	10	70	1.00E-06	365	0.1	1	3	5.5E+04
		1.00E-06	16 through <26	80	6,032	0.13	0.07	350	10	70	1.00E-06	365	0.1	1	1	1.8E+04
		Risk Based Concentration - Dermal Contact with Soil:Benzo(b)fluoranthene														*4.6E+00*
	Dibenz(a,h)anthracene	1.00E-06	0 through <2	15	2,373	0.13	0.20	350	2	70	1.00E-06	365	1	1	10	2.2E+05
		1.00E-06	2 through <6	15	2,373	0.13	0.20	350	4	70	1.00E-06	365	1	1	3	1.3E+05
		1.00E-06	6 through <16	80	6,032	0.13	0.07	350	10	70	1.00E-06	365	1	1	3	5.5E+04
		1.00E-06	16 through <26	80	6,032	0.13	0.07	350	10	70	1.00E-06	365	1	1	1	1.8E+04
		Risk Based Concentration - Dermal Contact with Soil:Dibenz(a,h)anthracene														*4.6E-01*

Notes:
COPC = chemical of potential concern; BW = body weight; Tr = target cancer risk; IR = soil or sediment ingestion rate; EF = exposure frequency; ED = exposure duration; AT_c = averaging time; CF = units conversion factor;
GIABS = gastrointestinal absorption factor; SA = skin surface area; AF =skin-soil adherence factor; ABSd = dermal absorption fraction; CSF_o = oral/dermal cancer slope factor; ADAF = age-dependent adjustment factor (USEPA 2005);
Risk = Incremental lifetime cancer risk; DF = dermal contact factor for specific age group

Dermal Contact

$$RBC_{derm\ c\text{-}mut} = \frac{TR * C_2 * ATc}{(CSFo/GIABS) * ABSd * C_1 * (DF_{2\text{-}6} + DF_{6\text{-}16} + DF_{16\text{-}28})}$$

Where:

$DF_{0\text{-}2}$ = $(ED_{0\text{-}2} * EF_{0\text{-}2} * AF_{0\text{-}2} * SA_{0\text{-}2} * ADAF_{0\text{-}2} / BW_{0\text{-}2})$

$DF_{2\text{-}6}$ = $(ED_{2\text{-}6} * EF_{2\text{-}6} * AF_{0\text{-}2} * SA_{2\text{-}6} * ADAF_{2\text{-}6} / BW_{2\text{-}6})$

$DF_{6\text{-}16}$ = $(ED_{6\text{-}16} * EF_{6\text{-}16} * AF_{6\text{-}16} * SA_{6\text{-}16} * ADAF_{6\text{-}16} / BW_{6\text{-}16})$

$DF_{16\text{-}28}$ = $(ED_{16\text{-}28} * EF_{16\text{-}28} * AF_{16\text{-}28} * SA_{16\text{-}28} * ADAF_{16\text{-}28} / BW_{16\text{-}28})$

TABLE 1B
CALCULATION OF RISK BASED CONCENTRATIONS FOR COPCS WITH A MUTAGENIC MODE OF ACTION
SCENARIO #1: RECREATOR (High Use/High Intensity)
Kenilworth Park Landfill
Washington, DC

Exposure Point:	Soil
Exposure Medium:	Soil
Receptor:	Residential

Exposure Pathway	COPC	TR (mg/kg)	Age (years)	VF m³/kg	PEF m³/kg	EF (days/year)	ET (hours)	ED (years)	AT (years)	C_2 (days/year)	C_3 hours/day	C_4 (ug/mg)	IUR (ug/m³)⁻¹	ADAF (unitless)	InhF days
Inhalation of Fugitive Dust	Benzo(a)anthracene	1.00E-06	0 through <2	4.41E+06	3.38E+08	350	24	2	70	365	24	1000	6.00E-05	10	7.0E+03
		1.00E-06	2 through <6	4.41E+06	3.38E+08	350	24	4	70	365	24	1000	6.00E-05	3	4.2E+03
		1.00E-06	6 through <16	4.41E+06	3.38E+08	350	24	10	70	365	24	1000	6.00E-05	3	1.1E+04
		1.00E-06	16 through <26	4.41E+06	3.38E+08	350	24	10	70	365	24	1000	6.00E-05	1	3.5E+03
		Risk Based Concentration - Inhalation of Fugitive Dust:Benzo(a)anthracene													*5.7E+03*
	Benzo(a)pyrene	1.00E-06	0 through <2	NA	3.38E+08	350	24	2	70	365	24	1000	6.00E-04	10	7.0E+03
		1.00E-06	2 through <6	NA	3.38E+08	350	24	4	70	365	24	1000	6.00E-04	3	4.2E+03
		1.00E-06	6 through <16	NA	3.38E+08	350	24	10	70	365	24	1000	6.00E-04	3	1.1E+04
		1.00E-06	16 through <26	NA	3.38E+08	350	24	10	70	365	24	1000	6.00E-04	1	3.5E+03
		Risk Based Concentration - Inhalation of Fugitive Dust:Benzo(a)pyrene													*5.7E+02*
	Benzo(b)fluoranthene	1.00E-06	0 through <2	NA	3.38E+08	350	24	2	70	365	24	1000	6.00E-05	10	7.0E+03
		1.00E-06	2 through <6	NA	3.38E+08	350	24	4	70	365	24	1000	6.00E-05	3	4.2E+03
		1.00E-06	6 through <16	NA	3.38E+08	350	24	10	70	365	24	1000	6.00E-05	3	1.1E+04
		1.00E-06	16 through <26	NA	3.38E+08	350	24	10	70	365	24	1000	6.00E-05	1	3.5E+03
		Risk Based Concentration - Inhalation of Fugitive Dust:Benzo(b)fluoranthene													*5.7E+03*
	Dibenz(a,h)anthracene	1.00E-06	0 through <2	NA	3.38E+08	350	24	2	70	365	24	1000	6.00E-04	10	7.0E+03
		1.00E-06	2 through <6	NA	3.38E+08	350	24	4	70	365	24	1000	6.00E-04	3	4.2E+03
		1.00E-06	6 through <16	NA	3.38E+08	350	24	10	70	365	24	1000	6.00E-04	3	1.1E+04
		1.00E-06	16 through <26	NA	3.38E+08	350	24	10	70	365	24	1000	6.00E-04	1	3.5E+03
		Risk Based Concentration - Inhalation of Fugitive Dust:Dibenz(a,h)anthracene													*5.7E+02*

Notes:
COPC = chemical of potential concern; TR = Target cancer risk; VF = volatilization factor; PEF = particulate emmision factor; EF = exposure frequency; ET = Exposure time; ED = exposure duration; AT_c = averaging time; CF = units conversion factor;
IUR = inhalation unit risk; ADAF = age-dependent adjustment factor (USEPA 2005); InhF = Inhalation factor for specific age group; Risk = Incremental lifetime cancer risk.

Inhalation

$$RBC_{inh\ c\text{-}mut} = \frac{TR * AT * C_2}{IUR * C_4\ (1/VF + 1/PEF) * (InhF_{2\text{-}6} + InhF_{6\text{-}16} + InhF_{16\text{-}28})}$$

Where:

$InhF_{2\text{-}6}$ = $(ET_{2\text{-}6} * EF_{2\text{-}6} * ED_{2\text{-}6} * ADAF_{2\text{-}6}/C_3)$

$InhF_{6\text{-}16}$ = $(ET_{6\text{-}16} * EF_{6\text{-}16} * ED_{6\text{-}16} * ADAF_{6\text{-}16}/C_3)$

$InhF_{16+}$ = $(ET_{16+} * EF_{16+} * ED_{16+} * ADAF_{16+}/C_3)$

Exposure Pathway	COPC	$RBC_{ing\ c\text{-}mut}$ mg/kg	$RBC_{derm\ c\text{-}mut}$ mg/kg	$RBC_{inh\ c\text{-}mut}$ mg/kg	RBC_{Total} mg/kg
	Benzo(a)anthracene	1.5E+00	5.7E+03	5.7E+03	1.5E+00
	Benzo(a)pyrene	1.5E-01	4.6E-01	5.7E+02	1.1E-01
	Benzo(b)fluoranthene	1.5E+00	4.6E+00	5.7E+03	1.1E+00
	Dibenz(a,h)anthracene	1.5E-01	4.6E-01	5.7E+02	1.1E-01

$$RBC_{total\ c\text{-}mut} = \frac{1}{1/RBC_{ing\ c\text{-}mut} + 1/RBC_{derm\ c\text{-}mut} + 1/RBC_{inh\ c\text{-}mut}}$$

TABLE 1C
SUMMARY OF RISK BASED CONCENTRATIONS FOR SOIL
SCENARIO #1: RECREATOR (High Use/High Intensity)
Kenilworth Park Landfill
Washington, DC

Chemical of Potential Concern	RBC-nc	RBC-c, 10-6	RBC-c, 10-5	RBC-c, 10-4
Arsenic	3.5E+01	6.8E-01	6.8E+00	6.8E+01
Benzo(a)anthracene	NC	1.5E+00	1.5E+01	1.5E+02
Benzo(a)pyrene	1.7E+01	1.1E-01	1.1E+00	1.1E+01
Benzo(b)fluoranthene	NC	1.1E+00	1.1E+01	1.1E+02
Dibenz(a,h)anthracene	NC	1.1E-01	1.1E+00	1.1E+01
Aluminum	7.5E+04	NC	NC	NC
Antimony	3.1E+01	NC	NC	NC
Cobalt	2.3E+01	1.1E+02	1.1E+03	1.1E+04
Copper	3.1E+03	NC	NC	NC
Iron	5.5E+04	NC	NC	NC
Manganese	1.7E+03	NC	NC	NC
Mercury	2.3E+01	NC	NC	NC
Silver	3.9E+02	NC	NC	NC
Thallium	7.8E-01	NC	NC	NC
Vanadium	3.9E+02	NC	NC	NC
Aldrin	2.3E+00	3.9E-02	3.9E-01	3.9E+00
Dieldrin	3.2E+00	3.4E-02	3.4E-01	3.4E+00
Aroclor 1254	1.2E+00	2.4E-01	2.4E+00	2.4E+01
Aroclor 1260	NC	2.4E-01	2.4E+00	2.4E+01

Notes:

Risk-based Soil Concentrations (RBCs) in units of milligrams per kilogram (mg/kg).

RBC-nc = RBC for noncancer effects

RBC-c = RBC for cancer effects, at stated target cancer risk (10^{-6} to 10^{-4})

NC = Not calculated

TABLE 2A
CALCULATION OF RISK BASED CONCENTRATIONS
SCENARIO #2: ACTIVE RECREATOR (High Use/Moderate Intensity)
Kenilworth Park Landfill
Washington, DC

EXPOSURE EQUATIONS:

Non Cancer

Ingestion:

$$RBC = \frac{THQ * AT\,nc * C2 * BW}{EF * ED * RBA * IR * FS * 1/RfDo * C1}$$

Dermal Contact:

$$RBC = \frac{THQ * AT\,nc * C2 * BW}{EF * ED * SA * AF * [1/(RfDo*GIABS)] * ABSd * C1}$$

Inhalation of Fugitive Dust:

Gastrointestinal uptake

$$RBC = \frac{THQ * AT\,nc * C2}{EF * ED * ET * (1/C3) * (1/RfC) * (1/VF + 1/PEF)}$$

All Pathways

$$RBC\text{-total nc} = \frac{1}{1/RBC\text{-ing nc} + 1/RBC\text{-derm nc} + 1/RBC\text{-inh nc}}$$

Cancer

$$RBC\text{-ing} = \frac{TR * ATc * C2}{CSFo * RBA * C1 * [(EDc * EFc * FS * IRc / BWc) + (EDa * EFa * FS * IRa / BWa)]}$$

$$RBC\text{-derm} = \frac{TR * ATc * C2}{(CSFo/GIABS) * ABSd * C1 * [(EDc * EFc * SAc * AFc * 1/BWc) + (EDa * EFa * SAa * AFa * 1/BWa)]}$$

$$RBC\text{ -inh} = \frac{TR * AT * C2}{IUR * 1/C3 * (1/VF + 1/PEF) * [(EFc * EDc * ETc) + (EDa * EFa * ETa)]}$$

$$RBC\text{-total} = \frac{1}{1/RBC\text{-ing c} + 1/RBC\text{-derm c} + 1/RBC\text{-inh c}}$$

Parameter		Description	Units	Value	Reference	
Child						
IRsoilc	=	Ingestion rate of soil - child	mg/day	200	USEPA 2014	1
AFsoilc	=	Soil adherence factor - child	mg/cm^2	0.2	USEPA 2014	2
SAsoilc	=	Skin surface area - child	cm^2 / day	2,373	USEPA 2014	3
EFc	=	Exposure Frequency - child	days/yr	125	Professional judgment	4
EDc	=	Exposure Duration - child	years	6	USEPA 2014	5
Etc	=	Exposure time outdoors - child	hours/day	2	Professional judgment	6
FS	=	Fraction soil contact at Site	unitless	0.5	Professional judgment	7
BWc	=	Body Weight - child	kg	15	USEPA 2014	8
PEF	=	Particulate Emission Factor	m^3/kg	3.38E+08	E&E 2008	9
VF	=	Volatilization Factor	m^3/kg	Chemical-specific	USEPA 2018	10
ATc	=	Averaging Time - cancer	years	70	USEPA 1989	11
ATnc	=	Averaging Time - noncancer	years	6	USEPA 1989	12
Adult						
IRsoila	=	Ingestion rate of soil - adult	mg/day	100	USEPA 2014	1
AFsoila	=	Soil adherence factor - adult	mg/cm^2	0.07	USEPA 2014	2
SAsoila	=	Skin surface area - adult	cm^2 / day	6,032	USEPA 2014	3
EFa	=	Exposure Frequency - adult	days/yr	158	Professional judgment	4
EDa	=	Exposure Duration - adult	years	20	USEPA 2014	5
Eta	=	Exposure time outdoors - adult	hours/day	3	Professional judgment	6
FS	=	Fraction soil contact at Site	unitless	0.5	Professional judgment	7
BWa	=	Body Weight - adult	kg	80	USEPA 2014	8
PEF	=	Particulate Emission Factor	m^3/kg	3.38E+08	E&E 2008	9
VF	=	Volatilization Factor	m^3/kg	Chemical-specific	USEPA 2018	10
ATc	=	Averaging Time - cancer	years	70	USEPA 1989	11
ATnc	=	Averaging Time - noncancer	years	20	USEPA 1989	12
General Exposure Parameters						
THQ	=	Target Hazard Quotient	unitless	1	Site-specific	
TR	=	Target Cancer Risk	unitless	0.000001	Site-specific	
ABSd	=	Dermal absorption factor	unitless	Chemical-specific	USEPA 2004	13
RBA	=	Relative Bioavailability Factor	%	Chemical-specific	USEPA 2012	14
GIABS	=	Gastrointestinal absorption fraction	%	Chemical-specific	USEPA 2004	15
RfD	=	Reference Dose	mg/kg-d	Chemical-specific	Chemical-specific	
RfC	=	Reference Concentration	mg/m^3	Chemical-specific	Chemical-specific	
CSF	=	Cancer Slope Factor	$(mg/kg\text{-}d)^{-1}$	Chemical-specific	Chemical-specific	
IUR	=	Inhalation Unit Risk	$(mg/m^3)^{-1}$	Chemical-specific	Chemical-specific	
C1	=	Units conversion factor 1	kg/mg	0.000001		
C2	=	Units conversion factor 2	days/yr	365		
C3	=	Units conversion factor 3	hours/day	24		
RBC	=	Risk-based Soil Concentration	mg/kg	Chemical-specific	Calculated	

Chemical of Potential Concern	CAS	Toxicity Values				Chemical Specific Parameters				RBC - Non Cancer				RBC - Cancer			
		RFDo	RFCi	CSFo	IUR	GIABS	ABSd	RBA	VF	Ingestion	Dermal	Inhalation	All	Ingestion	Dermal	Inhalation	All
Arsenic	7440-38-2	3.0E-04	1.5E-05	1.5E+00	4.3E+00	1.0E+00	3.0E-02	6.0E-01	NA	2.2E+02	9.2E+02	1.8E+05	1.8E+02	4.1E+00	1.4E+01	4.4E+03	3.2E+00
Benzo(a)anthracene	56-55-3	NA	NA	*	*	1.0E+00	1.3E-01	1.0E+00	4.4E+06	NC	NC	NC	NC	*	*	*	*
Benzo(a)pyrene	50-32-8	3.0E-04	2.0E-06	*	*	1.0E+00	1.3E-01	1.0E+00	NA	1.3E+02	2.1E+02	2.4E+04	8.1E+01	*	*	*	*
Benzo(b)fluoranthene	205-99-2	NA	NA	*	*	1.0E+00	1.3E-01	1.0E+00	NA	NC	NC	NC	NC	*	*	*	*
Dibenz(a,h)anthracene	53-70-3	NA	NA	*	*	1.0E+00	1.3E-01	1.0E+00	NA	NC	NC	NC	NC	*	*	*	*
Aluminum	7429-90-5	1.0E+00	5.0E-03	NA	NA	1.0E+00	NA	1.0E+00	NA	4.4E+05	NC	5.9E+07	4.3E+05	NC	NC	NC	NC
Antimony	7440-36-0	4.0E-04	3.0E-04	NA	NA	1.5E-01	NA	1.0E+00	NA	1.8E+02	NC	3.6E+06	1.8E+02	NC	NC	NC	NC
Cobalt	7440-48-4	3.0E-04	6.0E-06	NA	9.0E+00	1.0E+00	NA	1.0E+00	NA	1.3E+02	NC	7.1E+04	1.3E+02	NC	NC	2.1E+03	2.1E+03
Copper	7440-50-8	4.0E-02	NA	NA	NA	1.0E+00	NA	1.0E+00	NA	1.8E+04	NC	NC	1.8E+04	NC	NC	NC	NC
Iron	7439-89-6	7.0E-01	NA	NA	NA	1.0E+00	NA	1.0E+00	NA	3.1E+05	NC	NC	3.1E+05	NC	NC	NC	NC
Manganese	7439-96-5	2.4E-02	5.0E-05	NA	NA	4.0E-02	NA	1.0E+00	NA	1.1E+04	NC	5.9E+05	1.0E+04	NC	NC	NC	NC
Mercury	7487-94-7	3.0E-04	3.0E-04	NA	NA	7.0E-02	NA	1.0E+00	NA	1.3E+02	NC	3.6E+06	1.3E+02	NC	NC	NC	NC
Silver	7440-22-4	5.0E-03	NA	NA	NA	4.0E-02	NA	1.0E+00	NA	2.2E+03	NC	NC	2.2E+03	NC	NC	NC	NC
Thallium	7440-28-0	1.0E-05	NA	NA	NA	1.0E+00	NA	1.0E+00	NA	4.4E+00	NC	NC	4.4E+00	NC	NC	NC	NC
Vanadium	7440-62-2	5.0E-03	1.0E-04	NA	NA	2.6E-02	NA	1.0E+00	NA	2.2E+03	NC	1.2E+06	2.2E+03	NC	NC	NC	NC
Aldrin	309-00-2	3.0E-05	NA	1.7E+01	4.9E+00	1.0E+00	NA	1.0E+00	1.7E+06	1.3E+01	NC	NC	1.3E+01	2.2E-01	NC	2.0E+01	2.1E-01
Dieldrin	60-57-1	5.0E-05	NA	1.6E+01	4.6E+00	1.0E+00	1.0E-01	1.0E+00	NA	2.2E+01	4.6E+01	NC	1.5E+01	2.3E-01	4.0E-01	4.1E+03	1.4E-01
Aroclor 1254	11097-69-1	2.0E-05	NA	2.0E+00	5.7E-01	1.0E+00	1.4E-01	1.0E+00	8.4E+05	8.8E+00	1.3E+01	NC	5.3E+00	1.8E+00	2.3E+00	8.2E+01	1.0E+00
Aroclor 1260	11096-82-5	NA	NA	2.0E+00	5.7E-01	1.0E+00	1.4E-01	1.0E+00	1.3E+06	NC	NC	NC	NC	1.8E+00	2.3E+00	1.3E+02	1.0E+00

Notes
NA = Not available
NC = Not calculated
*Risk based concentrations for benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene include a receptor-specific Age-Dependent Adjustment Factor. Derivation of cancer risk based concentrations for this compound are shown on Table 2B.
** Lead risk based concentrations were calculated using the IEUBK model.
***The toxicity values for Aroclor 1254 were used to calculate risk based concentrations

Table 2A Notes:

1. Soil ingestion rates are the recommended USEPA default soil ingestion rates for children and adult residents (USEPA 2014).
2. The soil adherence factors (AFsoil) are the USEPA default soil adherence factors for Residential children and adults (Exhibit 3-5 of USEPA 2004). For the high use organized sport and recreation exposure, Residential reasonable maximum exposure values were used.
3. The skin surface areas are the EPA-recommended default SAs for the adult and child resident (USEPA 2014) and reflect the weighted average of mean values for head, hands, forearms and lower legs (and feet, for the child).
4. The exposure frequency (EF) describes how often the exposure occurs over a given period of time. The EF assumes that sports/recreational activities occur at the site 3 days per week for a child age 0-6 years and 3.8 days per week for an youth/adult (this is age-weighted, 5 days/wk for the 6-18 yr old and 2 day/week for the 18-26 yr old) for 42 weeks per year, assuming that it is raining, or the ground is frozen or covered by snow and not accessible the remaining 10 weeks.
5. The exposure duration (ED) describes the length of time over which the receptor comes into contact with contaminants. ED values for the recreator reflect a total 26 year residential tenure, which is the current EPA-recommended value for residence time (USEPA 2014). The age range of the recreator is assumed to be 1 though <27 years old. Children <1 year old in a stroller have minimal exposure to soil.
6. The exposure time (ET) is the amount of time spent outdoors. An ET of 2 hours per day was selected for the child, and 3 hours per day for the adult, based on professional judgment.
7. Soil ingestion parameters are reflective of the daily dose of soil. It was assumed that a resident would be exposed to one-half of the full daily dose when at the site; therefore, a FS of 0.5 was used, based on professional judgment. This value was also used in the human health risk assessment presented in the 2008 Remedial Investigation (Ecology & Environment, 2008).
8. The body weights (BW) for the child and adult are the recommended default body weights per USEPA 2014.
9. Site-specific PEF calculated in Table G-12 of Appendix G (Human Health Risk Assessment) of Remedial Investigation, Ecology and Environment 2008.
10. Volatilization factors (VF) were obtained from the USEPA Regional Screening Level (RSL) table, May 2020. https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables
11. The averaging time (AT) for cancer effects (AT_c) for all receptors is set equal to a lifetime (i.e., 70 years), as recommended in USEPA 1989.
12. The averaging time for non-cancer effects (AT_{nc}) for all receptors is set equal to the exposure duration, as recommended in USEPA 1989.
13. The dermal absorption factors (ABSd) are recommended values in Exhibit 3-4 of USEPA 2004, with updates as provided on: https://www.epa.gov/risk/risk-assessment-guidance-superfund-rags-part-e.
14. The EPA recommended default relative bioability (RBA) value of 60% is applied to oral arsenic exposures. An RBA of 100% is used for all other constituents (USEPA 2012).
15. Gastrointestinal absorption factors were obtained from the Final Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) (USEPA, 2004).

References:

USEPA 2014. Memorandum: Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. February 6, 2014. Office of Solid Waste and Emergency Response. OSWER Directive 9200.1-120.

USEPA 2012. Recommendations for the Default Value for Relative Bioavailability of Arsenic in Soil. December 2012. OSWER Directive 9200.1-113.

USEPA 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final, OSWER Directive 9285.7-02EP. EPA/540/R/99/005, USEPA, Washington D.C., July 2004.

USEPA 1989. Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part A, Interim Final, OSWER Directive 9285.701A. Office of Solid Waste and Emergency Response, USEPA, Washington D.C., December 1989.

E&C 2008. Final Remedial Investigation at the Kenilworth Park South Landfill, Washington, D.C. June 2008.

TABLE 2B
CALCULATION OF RISK BASED CONCENTRATIONS FOR COPCS WITH A MUTAGENIC MODE OF ACTION
SCENARIO #2: ACTIVE RECREATOR (High Use/Moderate Intensity)
Kenilworth Park Landfill
Washington, DC

Exposure Point:	Soil
Exposure Medium:	Soil
Receptor:	Active Recreator

Exposure Pathway	COPC	TR (mg/kg)	Age (years)	BW (kg)	IR (mg/day)	FS (unitless)	EF (days/year)	ED (years)	AT_c (years)	C_1 (kg/mg)	C_2 (days/year)	CSF_o $(mg/kg\text{-}d)^{-1}$	RBA %	ADAF (unitless)	IF mg/kg
Incidental Ingestion of Soil	Benzo(a)anthracene	1.00E-06	1 through <2	15	200	0.5	125	1	70	1.00E-06	365	0.1	1	10	8.3E+03
		1.00E-06	2 through <6	15	200	0.5	125	4	70	1.00E-06	365	0.1	1	3	1.0E+04
		1.00E-06	6 through <16	80	100	0.5	158	10	70	1.00E-06	365	0.1	1	3	3.0E+03
		1.00E-06	16 through <27	80	100	0.5	158	11	70	1.00E-06	365	0.1	1	1	1.1E+03
		Risk Based Concentration - Incidental Ingestion of Soil:Benzo(a)anthracene													*1.1E+01*
	Benzo(a)pyrene	1.00E-06	1 through <2	15	200	0.5	125	1	70	1.00E-06	365	1	1	10	8.3E+03
		1.00E-06	2 through <6	15	200	0.5	125	4	70	1.00E-06	365	1	1	3	1.0E+04
		1.00E-06	6 through <16	80	100	0.5	158	10	70	1.00E-06	365	1	1	3	3.0E+03
		1.00E-06	16 through <27	80	100	0.5	158	11	70	1.00E-06	365	1	1	1	1.1E+03
		Risk Based Concentration - Incidental Ingestion of Soil:Benzo(a)pyrene													*1.1E+00*
	Benzo(b)fluoranthene	1.00E-06	1 through <2	15	200	0.5	125	1	70	1.00E-06	365	0.1	1	10	8.3E+03
		1.00E-06	2 through <6	15	200	0.5	125	4	70	1.00E-06	365	0.1	1	3	1.0E+04
		1.00E-06	6 through <16	80	100	0.5	158	10	70	1.00E-06	365	0.1	1	3	3.0E+03
		1.00E-06	16 through <27	80	100	0.5	158	11	70	1.00E-06	365	0.1	1	1	1.1E+03
		Risk Based Concentration - Incidental Ingestion of Soil:Benzo(b)fluoranthene													*1.1E+01*
	Dibenz(a,h)anthracene	1.00E-06	1 through <2	15	200	0.5	125	1	70	1.00E-06	365	1	1	10	8.3E+03
		1.00E-06	2 through <6	15	200	0.5	125	4	70	1.00E-06	365	1	1	3	1.0E+04
		1.00E-06	6 through <16	80	100	0.5	158	10	70	1.00E-06	365	1	1	3	3.0E+03
		1.00E-06	16 through <27	80	100	0.5	158	11	70	1.00E-06	365	1	1	1	1.1E+03
		Risk Based Concentration - Incidental Ingestion of Soil:Dibenz(a,h)anthracene													*1.1E+00*

Notes:
COPC = chemical of potential concern; BW = body weight; Tr = Target cancer risk; IR = soil or sediment ingestion rate; FS = fraction soil contact at Site; EF = exposure frequency; ED = exposure duration; AT_c = averaging time; CF = units conversion factor;
SA = skin surface area; AF =skin-soil adherence factor; ABSd = dermal absorption fraction; CSF_o = oral/dermal cancer slope factor; ADAF = age-dependent adjustment factor (USEPA 2005); RBA = Relative Bioavailability Factor
Risk = Incremental lifetime cancer risk; IF = soil ingestion factor for specific age group

Incidental Ingestion

$$RBC_{ing\ c\text{-}mut} = \frac{TR * C_2 * ATc}{CSFo * RBA * C_1 * (IF_{0\text{-}2} + IF_{2\text{-}6} + IF_{6\text{-}16} + IF_{16\text{-}28})}$$

Where:

$IF_{0\text{-}2}$ = $[(ED_{0\text{-}2} * EF_{0\text{-}2} * FS_{0\text{-}2} * IR_{0\text{-}2} * ADAF_{0\text{-}2} / BW_{0\text{-}2})$

$IF_{2\text{-}6}$ = $(ED_{2\text{-}6} * EF_{2\text{-}6} * FS_{2\text{-}6} * IR_{2\text{-}6} * ADAF_{2\text{-}6} / BW_{2\text{-}6})$

$IF_{6\text{-}16}$ = $(ED_{6\text{-}16} * EF_{6\text{-}16} * FS^{6\text{-}16} * IR_{6\text{-}16} * ADAF_{6\text{-}16} / BW_{6\text{-}16})$

$IF_{16\text{-}28}$ = $(ED_{16\text{-}28} * EF_{16\text{-}28} * FS_{16\text{-}28} * IR_{16\text{-}28} * ADA_{F19\text{-}28} / BW_{16\text{-}28})$

TABLE 2B
CALCULATION OF RISK BASED CONCENTRATIONS FOR COPCS WITH A MUTAGENIC MODE OF ACTION
SCENARIO #2: ACTIVE RECREATOR (High Use/Moderate Intensity)
Kenilworth Park Landfill
Washington, DC

Exposure Point:	Soil
Exposure Medium:	Soil
Receptor:	Active Recreator

Exposure Pathway	COPC	TR (mg/kg)	Age (years)	BW (kg)	SA (cm^2)	ABSd (unitless)	AF mg/cm^2	EF (days/year)	ED (years)	At_c (years)	C_1 (kg/mg)	C_2 (days/year)	CSF_o $(mg/kg\text{-}d)^{-1}$	GIABS %	ADAF (unitless)	DF mg/kg
Dermal Contact with Soil	Benzo(a)anthracene	1.00E-06	1 through <2	15	2,373	0.13	0.20	125	1	70	1.00E-06	365	0.1	1	10	4.0E+04
		1.00E-06	2 through <6	15	2,373	0.13	0.20	125	4	70	1.00E-06	365	0.1	1	3	4.7E+04
		1.00E-06	6 through <16	80	6,032	0.13	0.07	158	10	70	1.00E-06	365	0.1	1	3	2.5E+04
		1.00E-06	16 through <27	80	6,032	0.13	0.07	158	11	70	1.00E-06	365	0.1	1	1	9.2E+03
		Risk Based Concentration - Dermal Contact with Soil:Benzo(a)anthracene														*1.6E+01*
	Benzo(a)pyrene	1.00E-06	1 through <2	15	2,373	0.13	0.20	125	1	70	1.00E-06	365	1	1	10	4.0E+04
		1.00E-06	2 through <6	15	2,373	0.13	0.20	125	4	70	1.00E-06	365	1	1	3	4.7E+04
		1.00E-06	6 through <16	80	6,032	0.13	0.07	158	10	70	1.00E-06	365	1	1	3	2.5E+04
		1.00E-06	16 through <27	80	6,032	0.13	0.07	158	11	70	1.00E-06	365	1	1	1	9.2E+03
		Risk Based Concentration - Dermal Contact with Soil:Benzo(a)pyrene														*1.6E+00*
	Benzo(b)fluoranthene	1.00E-06	1 through <2	15	2,373	0.13	0.20	125	1	70	1.00E-06	365	0.1	1	10	4.0E+04
		1.00E-06	2 through <6	15	2,373	0.13	0.20	125	4	70	1.00E-06	365	0.1	1	3	4.7E+04
		1.00E-06	6 through <16	80	6,032	0.13	0.07	158	10	70	1.00E-06	365	0.1	1	3	2.5E+04
		1.00E-06	16 through <27	80	6,032	0.13	0.07	158	11	70	1.00E-06	365	0.1	1	1	9.2E+03
		Risk Based Concentration - Dermal Contact with Soil:Benzo(b)fluoranthene														*1.6E+01*
	Dibenz(a,h)anthracene	1.00E-06	1 through <2	15	2,373	0.13	0.20	125	1	70	1.00E-06	365	1	1	10	4.0E+04
		1.00E-06	2 through <6	15	2,373	0.13	0.20	125	4	70	1.00E-06	365	1	1	3	4.7E+04
		1.00E-06	6 through <16	80	6,032	0.13	0.07	158	10	70	1.00E-06	365	1	1	3	2.5E+04
		1.00E-06	16 through <27	80	6,032	0.13	0.07	158	11	70	1.00E-06	365	1	1	1	9.2E+03
		Risk Based Concentration - Dermal Contact with Soil:Dibenz(a,h)anthracene														*1.6E+00*

Notes:
COPC = chemical of potential concern; BW = body weight; Tr = target cancer risk; IR = soil or sediment ingestion rate; EF = exposure frequency; ED = exposure duration; AT_c = averaging time; CF = units conversion factor;
GIABS = gastrointestinal absorption factor; SA = skin surface area; AF =skin-soil adherence factor; ABSd = dermal absorption fraction; CSF_o = oral/dermal cancer slope factor; ADAF = age-dependent adjustment factor (USEPA 2005);
Risk = Incremental lifetime cancer risk; DF = dermal contact factor for specific age group

Dermal Contact

$$RBC_{derm\ c\text{-}mut} = \frac{TR * C_2 * ATc}{(CSFo/GIABS) * ABSd * C_1 * (DF_{2\text{-}6} + DF_{6\text{-}16} + DF_{16\text{-}28})}$$

Where:

$$DF_{0\text{-}2} = (ED_{0\text{-}2} * EF_{0\text{-}2} * AF_{0\text{-}2} * SA_{0\text{-}2} * ADAF_{0\text{-}2} / BW_{0\text{-}2})$$

$$DF_{2\text{-}6} = (ED_{2\text{-}6} * EF_{2\text{-}6} * AF_{0\text{-}2} * SA_{2\text{-}6} * ADAF_{2\text{-}6} / BW_{2\text{-}6})$$

$$DF_{6\text{-}16} = (ED_{6\text{-}16} * EF_{6\text{-}16} * AF_{6\text{-}16} * SA_{6\text{-}16} * ADAF_{6\text{-}16} / BW_{6\text{-}16})$$

$$DF_{16\text{-}28} = (ED_{16\text{-}28} * EF_{16\text{-}28} * AF_{16\text{-}28} * SA_{16\text{-}28} * ADAF_{16\text{-}28} / BW_{16\text{-}28})$$

TABLE 2B
CALCULATION OF RISK BASED CONCENTRATIONS FOR COPCS WITH A MUTAGENIC MODE OF ACTION
SCENARIO #2: ACTIVE RECREATOR (High Use/Moderate Intensity)
Kenilworth Park Landfill
Washington, DC

Exposure Point:	Soil
Exposure Medium:	Soil
Receptor:	Active Recreator

Exposure Pathway	COPC	TR (mg/kg)	Age (years)	VF m^3/kg	PEF m^3/kg	EF (days/year)	ET (hours)	ED (years)	AT (years)	C_2 (days/year)	C_3 hours/day	C_4 (ug/mg)	IUR $(ug/m^3)^{-1}$	ADAF (unitless)	InhF days
Inhalation of Fugitive Dust	Benzo(a)anthracene	1.00E-06	1 through <2	4.41E+06	3.38E+08	125	2	1	70	365	24	1000	6.00E-05	10	1.0E+02
		1.00E-06	2 through <6	4.41E+06	3.38E+08	125	2	4	70	365	24	1000	6.00E-05	3	1.3E+02
		1.00E-06	6 through <16	4.41E+06	3.38E+08	158	3	10	70	365	24	1000	6.00E-05	3	5.9E+02
		1.00E-06	16 through <27	4.41E+06	3.38E+08	158	3	11	70	365	24	1000	6.00E-05	1	2.2E+02
		Risk Based Concentration - Inhalation of Fugitive Dust:Benzo(a)anthracene													*1.4E+05*
	Benzo(a)pyrene	1.00E-06	1 through <2	NA	3.38E+08	125	2	1	70	365	24	1000	6.00E-04	10	1.0E+02
		1.00E-06	2 through <6	NA	3.38E+08	125	2	4	70	365	24	1000	6.00E-04	3	1.3E+02
		1.00E-06	6 through <16	NA	3.38E+08	158	3	10	70	365	24	1000	6.00E-04	3	5.9E+02
		1.00E-06	16 through <27	NA	3.38E+08	158	3	11	70	365	24	1000	6.00E-04	1	2.2E+02
		Risk Based Concentration - Inhalation of Fugitive Dust:Benzo(a)pyrene													*1.4E+04*
	Benzo(b)fluoranthene	1.00E-06	1 through <2	NA	3.38E+08	125	2	1	70	365	24	1000	6.00E-05	10	1.0E+02
		1.00E-06	2 through <6	NA	3.38E+08	125	2	4	70	365	24	1000	6.00E-05	3	1.3E+02
		1.00E-06	6 through <16	NA	3.38E+08	158	3	10	70	365	24	1000	6.00E-05	3	5.9E+02
		1.00E-06	16 through <27	NA	3.38E+08	158	3	11	70	365	24	1000	6.00E-05	1	2.2E+02
		Risk Based Concentration - Inhalation of Fugitive Dust:Benzo(b)fluoranthene													*1.4E+05*
	Dibenz(a,h)anthracene	1.00E-06	1 through <2	NA	3.38E+08	125	2	1	70	365	24	1000	6.00E-04	10	1.0E+02
		1.00E-06	2 through <6	NA	3.38E+08	125	2	4	70	365	24	1000	6.00E-04	3	1.3E+02
		1.00E-06	6 through <16	NA	3.38E+08	158	3	10	70	365	24	1000	6.00E-04	3	5.9E+02
		1.00E-06	16 through <27	NA	3.38E+08	158	3	11	70	365	24	1000	6.00E-04	1	2.2E+02
		Risk Based Concentration - Inhalation of Fugitive Dust:Dibenz(a,h)anthracene													*1.4E+04*

Notes:
COPC = chemical of potential concern; TR = Target cancer risk; VF = volatilization factor; PEF = particulate emmision factor; EF = exposure frequency; ET = Exposure time; ED = exposure duration; AT_c = averaging time; CF = units conversion factor;
IUR = inhalation unit risk; ADAF = age-dependent adjustment factor (USEPA 2005); InhF = Inhalation factor for specific age group; Risk = Incremental lifetime cancer risk.

Inhalation

$$RBC_{inh\ c\text{-}mut} = \frac{TR * AT * C_2}{IUR\ * C_4\ (1/VF + 1/PEF) * (InhF_{2\text{-}6} + InhF_{6\text{-}16} + InhF_{16\text{-}28})}$$

Where:

$InhF_{0\text{-}2}$ = $(ET_{0\text{-}2} * EF_{0\text{-}2} * ED_{0\text{-}2} * ADAF_{0\text{-}2}/C_3)$

$InhF_{2\text{-}6}$ = $(ET_{2\text{-}6} * EF_{2\text{-}6} * ED_{2\text{-}6} * ADAF_{2\text{-}6}/C_3)$

$InhF_{6\text{-}16}$ = $(ET_{6\text{-}16} * EF_{6\text{-}16} * ED_{6\text{-}16} * ADAF_{6\text{-}16}/C_3)$

$InhF_{16+}$ = $(ET_{16+} * EF_{16+} * ED_{16+} * ADAF_{16+}/C_3)$

Exposure Pathway	COPC	$RBC_{ing\ c\text{-}mut}$ mg/kg	$RBC_{derm\ c\text{-}mut}$ mg/kg	$RBC_{inh\ c\text{-}mut}$ mg/kg	RBC_{Total} mg/kg
All	Benzo(a)anthracene	1.1E+01	1.6E+01	1.4E+05	6.7E+00
	Benzo(a)pyrene	1.1E+00	1.6E+00	1.4E+04	6.7E-01
	Benzo(b)fluoranthene	1.1E+01	1.6E+01	1.4E+05	6.7E+00
	Dibenz(a,h)anthracene	1.1E+00	1.6E+00	1.4E+04	6.7E-01

$$RBC_{total\ c\text{-}mut} = \frac{1}{1/RBC_{ing\ c\text{-}mut} + 1/RBC_{derm\ c\text{-}mut} + 1/RBC_{inh\ c\text{-}mut}}$$

TABLE 2C
SUMMARY OF RISK BASED CONCENTRATIONS FOR SOIL
SCENARIO #2 ACTIVE RECREATOR (High Use/Moderate Intensity)
Kenilworth Park Landfill
Washington, DC

Chemical of Potential Concern	RBC-nc	RBC-c, 10-6	RBC-c, 10-5	RBC-c, 10-4
Arsenic	1.8E+02	3.2E+00	3.2E+01	3.2E+02
Benzo(a)anthracene	NC	6.7E+00	6.7E+01	6.7E+02
Benzo(a)pyrene	8.1E+01	6.7E-01	6.7E+00	6.7E+01
Benzo(b)fluoranthene	NC	6.7E+00	6.7E+01	6.7E+02
Dibenz(a,h)anthracene	NC	6.7E-01	6.7E+00	6.7E+01
Aluminum	4.3E+05	NC	NC	NC
Antimony	1.8E+02	NC	NC	NC
Cobalt	1.3E+02	2.1E+03	2.1E+04	2.1E+05
Copper	1.8E+04	NC	NC	NC
Iron	3.1E+05	NC	NC	NC
Manganese	1.0E+04	NC	NC	NC
Mercury	1.3E+02	NC	NC	NC
Silver	2.2E+03	NC	NC	NC
Thallium	4.4E+00	NC	NC	NC
Vanadium	2.2E+03	NC	NC	NC
Aldrin	1.3E+01	2.1E-01	2.1E+00	2.1E+01
Dieldrin	1.5E+01	1.4E-01	1.4E+00	1.4E+01
Aroclor 1254	5.3E+00	1.0E+00	1.0E+01	1.0E+02
Aroclor 1260	NC	1.0E+00	1.0E+01	1.0E+02

Notes:

Risk-based Soil Concentrations (RBCs) in units of milligrams per kilogram (mg/kg).

RBC-nc = RBC for noncancer effects

RBC-c = RBC for cancer effects, at stated target cancer risk (10^{-6} to 10^{-4})

Nc = Not calculated

TABLE 3A
CALCULATION OF RISK BASED CONCENTRATIONS
SCENARIO #3: PASSIVE RECREATOR (Moderate Use/Moderate Intensity)
Kenilworth Park Landfill
Washington, DC

EXPOSURE EQUATIONS:

Non Cancer

Ingestion:

$$RBC = \frac{THQ * AT\ nc * C2 * BW}{EF * ED * RBA * IR * FS * 1/RfDo * C1}$$

Dermal Contact:

$$RBC = \frac{THQ * AT\ nc * C2 * BW}{EF * ED * SA * AF * [1/(RfDo*GIABS)] * ABSd * C1}$$

Inhalation of Fugitive Dust:

Gastrointestinal uptake

$$RBC = \frac{THQ * AT\ nc * C2}{EF * ED * ET * (1/C3) * (1/RfC) * (1/VF + 1/PEF)}$$

All Pathways

$$RBC\text{-total nc} = \frac{1}{1/RBC\text{-ing nc} + 1/RBC\text{-derm nc} + 1/RBC\text{-inh nc}}$$

Cancer

$$RBC\text{-ing} = \frac{TR * ATc * C2}{CSFo * RBA * C1 * [(EDc * EFc * FS * IRc / BWc) + (EDa * EFa * FS * IRa / BWa)]}$$

$$RBC\text{-derm} = \frac{TR * ATc * C2}{(CSFo/GIABS) * ABSd * C1 * [(EDc * EFc * SAc * AFc * 1/BWc) + (EDa * EFa * SAa * AFa * 1/BWa)]}$$

$$RBC\text{-inh} = \frac{TR * AT * C2}{IUR * 1/C3 * (1/VF + 1/PEF) * [(EFc * EDc * ETc) + (EDa * EFa * ETa)]}$$

$$RBC\text{-total} = \frac{1}{1/RBC\text{-ing c} + 1/RBC\text{-derm c} + 1/RBC\text{-inh c}}$$

Parameter		Description	Units	Value	Reference	
Child						
IRsoilc	=	Ingestion rate of soil - child	mg/day	200	USEPA 2014	1
AFsoilc	=	Soil adherence factor - child	mg/cm^2	0.04	USEPA 2014	2
SAsoilc	=	Skin surface area - child	cm^2 / day	2,373	USEPA 2014	3
EFc	=	Exposure Frequency - child	days/yr	168	Professional judgment	4
EDc	=	Exposure Duration - child	years	6	USEPA 2014	5
Etc	=	Exposure time outdoors - child	hours/day	2	Professional judgment	6
FS	=	Fraction soil contact at Site	unitless	0.33	Professional judgment	7
BWc	=	Body Weight - child	kg	15	USEPA 2014	8
PEF	=	Particulate Emission Factor	m^3/kg	3.38E+08	E&E 2008	9
VF	=	Volatilization Factor	m^3/kg	Chemical-specific	USEPA 2018	10
ATc	=	Averaging Time - cancer	years	70	USEPA 1989	11
ATnc	=	Averaging Time - noncancer	years	6	USEPA 1989	12
Adult						
IRsoila	=	Ingestion rate of soil - adult	mg/day	100	USEPA 2014	1
AFsoila	=	Soil adherence factor - adult	mg/cm^2	0.01	USEPA 2014	2
SAsoila	=	Skin surface area - adult	cm^2 / day	6,032	USEPA 2014	3
EFa	=	Exposure Frequency - adult	days/yr	168	Professional judgment	4
EDa	=	Exposure Duration - adult	years	20	USEPA 2014	5
Eta	=	Exposure time outdoors - adult	hours/day	2	Professional judgment	6
FS	=	Fraction soil contact at Site	unitless	0.33	Professional judgment	7
BWa	=	Body Weight - adult	kg	80	USEPA 2014	8
PEF	=	Particulate Emission Factor	m^3/kg	3.38E+08	E&E 2008	9
VF	=	Volatilization Factor	m^3/kg	Chemical-specific	USEPA 2018	10
ATc	=	Averaging Time - cancer	years	70	USEPA 1989	11
ATnc	=	Averaging Time - noncancer	years	20	USEPA 1989	12
General Exposure Parameters						
THQ	=	Target Hazard Quotient	unitless	1	Site-specific	
TR	=	Target Cancer Risk	unitless	0.000001	Site-specific	
ABSd	=	Dermal absorption factor	unitless	Chemical-specific	USEPA 2004	13
RBA	=	Relative Bioavailability Factor	%	Chemical-specific	USEPA 2012	14
GIABS	=	Gastrointestinal absorption fraction	%	Chemical-specific	USEPA 2004	15
RfD	=	Reference Dose	mg/kg-d	Chemical-specific	Chemical-specific	
RfC	=	Reference Concentration	mg/m^3	Chemical-specific	Chemical-specific	
CSF	=	Cancer Slope Factor	$(mg/kg\text{-}d)^{-1}$	Chemical-specific	Chemical-specific	
IUR	=	Inhalation Unit Risk	$(mg/m^3)^{-1}$	Chemical-specific	Chemical-specific	
C1	=	Units conversion factor 1	kg/mg	0.000001		
C2	=	Units conversion factor 2	days/yr	365		
C3	=	Units conversion factor 3	hours/day	24		
RBC	=	Risk-based Soil Concentration	mg/kg	Chemical-specific	Calculated	

Chemical of Potential Concern	CAS	Toxicity Values				Chemical Specific Parameters				RBC - Non Cancer				RBC - Cancer			
		RFDo	RFCi	CSFo	IUR	GIABS	ABSd	RBA	VF	Ingestion	Dermal	Inhalation	All	Ingestion	Dermal	Inhalation	All
Arsenic	7440-38-2	3.0E-04	1.5E-05	1.5E+00	4.3E+00	1.0E+00	3.0E-02	6.0E-01	NA	2.5E+02	3.4E+03	1.3E+05	2.3E+02	4.9E+00	6.4E+01	5.5E+03	4.5E+00
Benzo(a)anthracene	56-55-3	NA	NA	*	*	1.0E+00	1.3E-01	1.0E+00	4.4E+06	NC	NC	NC	NC	*	*	*	*
Benzo(a)pyrene	50-32-8	3.0E-04	2.0E-06	*	*	1.0E+00	1.3E-01	1.0E+00	NA	1.5E+02	7.9E+02	1.8E+04	1.2E+02	*	*	*	*
Benzo(b)fluoranthene	205-99-2	NA	NA	*	*	1.0E+00	1.3E-01	1.0E+00	NA	NC	NC	NC	NC	*	*	*	*
Dibenz(a,h)anthracene	53-70-3	NA	NA	*	*	1.0E+00	1.3E-01	1.0E+00	NA	NC	NC	NC	NC	*	*	*	*
Aluminum	7429-90-5	1.0E+00	5.0E-03	NA	NA	1.0E+00	NA	1.0E+00	NA	4.9E+05	NC	4.4E+07	4.9E+05	NC	NC	NC	NC
Antimony	7440-36-0	4.0E-04	3.0E-04	NA	NA	1.5E-01	NA	1.0E+00	NA	2.0E+02	NC	2.6E+06	2.0E+02	NC	NC	NC	NC
Cobalt	7440-48-4	3.0E-04	6.0E-06	NA	9.0E+00	1.0E+00	NA	1.0E+00	NA	1.5E+02	NC	5.3E+04	1.5E+02	NC	NC	2.6E+03	2.6E+03
Copper	7440-50-8	4.0E-02	NA	NA	NA	1.0E+00	NA	1.0E+00	NA	2.0E+04	NC	NC	2.0E+04	NC	NC	NC	NC
Iron	7439-89-6	7.0E-01	NA	NA	NA	1.0E+00	NA	1.0E+00	NA	3.5E+05	NC	NC	3.5E+05	NC	NC	NC	NC
Manganese	7439-96-5	2.4E-02	5.0E-05	NA	NA	4.0E-02	NA	1.0E+00	NA	1.2E+04	NC	4.4E+05	1.2E+04	NC	NC	NC	NC
Mercury	7487-94-7	3.0E-04	3.0E-04	NA	NA	7.0E-02	NA	1.0E+00	NA	1.5E+02	NC	2.6E+06	1.5E+02	NC	NC	NC	NC
Silver	7440-22-4	5.0E-03	NA	NA	NA	4.0E-02	NA	1.0E+00	NA	2.5E+03	NC	NC	2.5E+03	NC	NC	NC	NC
Thallium	7440-28-0	1.0E-05	NA	NA	NA	1.0E+00	NA	1.0E+00	NA	4.9E+00	NC	NC	4.9E+00	NC	NC	NC	NC
Vanadium	7440-62-2	5.0E-03	1.0E-04	NA	NA	2.6E-02	NA	1.0E+00	NA	2.5E+03	NC	8.8E+05	2.5E+03	NC	NC	NC	NC
Aldrin	309-00-2	3.0E-05	NA	1.7E+01	4.9E+00	1.0E+00	NA	1.0E+00	1.7E+06	1.5E+01	NC	NC	1.5E+01	2.6E-01	NC	2.5E+01	2.6E-01
Dieldrin	60-57-1	5.0E-05	NA	1.6E+01	4.6E+00	1.0E+00	1.0E-01	1.0E+00	NA	2.5E+01	1.7E+02	NC	2.2E+01	2.7E-01	1.8E+00	5.2E+03	2.4E-01
Aroclor 1254	11097-69-1	2.0E-05	NA	2.0E+00	5.7E-01	1.0E+00	1.4E-01	1.0E+00	8.4E+05	9.9E+00	4.9E+01	NC	8.2E+00	2.2E+00	1.0E+01	1.0E+02	1.8E+00
Aroclor 1260	11096-82-5	NA	NA	2.0E+00	5.7E-01	1.0E+00	1.4E-01	1.0E+00	1.3E+06	NC	NC	NC	NC	2.2E+00	1.0E+01	1.6E+02	1.8E+00

Notes
NA = Not available
NC = Not calculated
*Risk based concentrations for benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene include a receptor-specific Age-Dependent Adjustment Factor. Derivation of cancer risk based concentrations for this compound are shown on Table 3B.
** Lead risk based concentrations were calculated using the IEUBK model.
***The toxicity values for Aroclor 1254 were used to calculate risk based concentrations

Table 3A Notes:

1. Soil ingestion rates are the recommended USEPA default soil ingestion rates for children and adult residents (USEPA 2014).
2. The soil adherence factors (AFsoil) are the USEPA default soil adherence factors for children and adults (Exhibit 3-5 of USEPA 2004). For the passive recreational exposure, central tendency values were used.
3. The skin surface areas are the EPA-recommended default SAs for the adult and child resident (USEPA 2014) and reflect the weighted average of mean values for head, hands, forearms and lower legs (and feet, for the child).
4. The exposure frequency (EF) describes how often the exposure occurs over a given period of time. The EF assumes that a visitor may walk at the site 4 days per week for 42 weeks per year, assuming that the ground is frozen or covered by snow and not accessible, or the visitor is otherwise unable to visit the site (school, vacations etc.) the remaining 10 weeks.
5. The exposure duration (ED) describes the length of time over which the receptor comes into contact with contaminants. ED values for the recreator reflect a total 26 year residential tenure, which is the current EPA-recommended value for residence time (USEPA 2014). The age range of the recreator is assumed to be 1 though <27 years old. Children <1 year old in a stroller have minimal exposure to soil.
6. The exposure time (ET) is the amount of time spent outdoors. An ET of 2 hour per day was selected for both the adult and child visitor, based on professional judgment.
7. Soil ingestion parameters are reflective of the daily dose of soil. It was assumed that a visitor would be exposed to one-third of the full daily dose when at the site; therefore, a FS of 0.33 was used, based on professional judgment, given the relatively small overall percentage of the day that would be spent at the site.
8. The body weights (BW) for the child and adult are the recommended default body weights per USEPA 2014.
9. Site-specific PEF calculated in Table G-12 of Appendix G (Human Health Risk Assessment) of Remedial Investigation, Ecology and Environment 2008.
10. Volatilization factors (VF) were obtained from the USEPA Regional Screening Level (RSL) table, May 2020. https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables
11. The averaging time (AT) for cancer effects (AT_c) for all receptors is set equal to a lifetime (i.e., 70 years), as recommended in USEPA 1989.
12. The averaging time for non-cancer effects (AT_{nc}) for all receptors is set equal to the exposure duration, as recommended in USEPA 1989.
13. The dermal absorption factors (ABSd) are recommended values in Exhibit 3-4 of USEPA 2004, with updates as provided on: https://www.epa.gov/risk/risk-assessment-guidance-superfund-rags-part-e.
14. The EPA recommended default relative bioability (RBA) value of 60% is applied to oral arsenic exposures. An RBA of 100% is used for all other constituents (USEPA 2012).
15. Gastrointestinal absorption factors were obtained from the Final Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) (USEPA, 2004).

References:

USEPA 2014. Memorandum: Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. February 6, 2014. Office of Solid Waste and Emergency Response. OSWER Directive 9200.1-120.
USEPA 2012. Recommendations for the Default Value for Relative Bioavailability of Arsenic in Soil. December 2012. OSWER Directive 9200.1-113.
USEPA 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final, OSWER Directive 9285.7-02EP. EPA/540/R/99/005, USEPA, Washington D.C., July 2004.
USEPA 1989. Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part A, Interim Final, OSWER Directive 9285.701A. Office of Solid Waste and Emergency Response, USEPA, Washington D.C., December 1989.
E&C 2008. Final Remedial Investigation at the Kenilworth Park South Landfill, Washington, D.C. June 2008.

TABLE 3B
CALCULATION OF RISK BASED CONCENTRATIONS FOR COPCS WITH A MUTAGENIC MODE OF ACTION
SCENARIO #3: PASSIVE RECREATOR (Moderate Use/Moderate Intensity)
Kenilworth Park Landfill
Washington, DC

Exposure Point:	Soil
Exposure Medium:	Soil
Receptor:	Passive Recreator - Moderate Intensity

Exposure Pathway	COPC	TR (mg/kg)	Age (years)	BW (kg)	IR (mg/day)	FS (unitless)	EF (days/year)	ED (years)	AT_c (years)	C_1 (kg/mg)	C_2 (days/year)	CSF_o $(mg/kg\text{-}d)^{-1}$	RBA %	ADAF (unitless)	IF mg/kg
Incidental Ingestion of Soil	Benzo(a)anthracene	1.00E-06	1 through <2	15	200	0.33	168	1	70	1.00E-06	365	0.1	1	10	7.4E+03
		1.00E-06	2 through <6	15	200	0.33	168	4	70	1.00E-06	365	0.1	1	3	8.9E+03
		1.00E-06	6 through <16	80	100	0.33	168	10	70	1.00E-06	365	0.1	1	3	2.1E+03
		1.00E-06	16 through <27	80	100	0.33	168	11	70	1.00E-06	365	0.1	1	1	7.6E+02
		Risk Based Concentration - Incidental Ingestion of Soil:Benzo(a)anthracene													*1.3E+01*
	Benzo(a)pyrene	1.00E-06	1 through <2	15	200	0.33	168	1	70	1.00E-06	365	1	1	10	7.4E+03
		1.00E-06	2 through <6	15	200	0.33	168	4	70	1.00E-06	365	1	1	3	8.9E+03
		1.00E-06	6 through <16	80	100	0.33	168	10	70	1.00E-06	365	1	1	3	2.1E+03
		1.00E-06	16 through <27	80	100	0.33	168	11	70	1.00E-06	365	1	1	1	7.6E+02
		Risk Based Concentration - Incidental Ingestion of Soil:Benzo(a)pyrene													*1.3E+00*
	Benzo(b)fluoranthene	1.00E-06	1 through <2	15	200	0.33	168	1	70	1.00E-06	365	0.1	1	10	7.4E+03
		1.00E-06	2 through <6	15	200	0.33	168	4	70	1.00E-06	365	0.1	1	3	8.9E+03
		1.00E-06	6 through <16	80	100	0.33	168	10	70	1.00E-06	365	0.1	1	3	2.1E+03
		1.00E-06	16 through <27	80	100	0.33	168	11	70	1.00E-06	365	0.1	1	1	7.6E+02
		Risk Based Concentration - Incidental Ingestion of Soil:Benzo(b)fluoranthene													*1.3E+01*
	Dibenz(a,h)anthracene	1.00E-06	1 through <2	15	200	0.33	168	1	70	1.00E-06	365	1	1	10	7.4E+03
		1.00E-06	2 through <6	15	200	0.33	168	4	70	1.00E-06	365	1	1	3	8.9E+03
		1.00E-06	6 through <16	80	100	0.33	168	10	70	1.00E-06	365	1	1	3	2.1E+03
		1.00E-06	16 through <27	80	100	0.33	168	11	70	1.00E-06	365	1	1	1	7.6E+02
		Risk Based Concentration - Incidental Ingestion of Soil:Dibenz(a,h)anthracene													*1.3E+00*

Notes:
COPC = chemical of potential concern; BW = body weight; Tr = Target cancer risk; IR = soil or sediment ingestion rate; FS = fraction soil contact at Site; EF = exposure frequency; ED = exposure duration; AT_c = averaging time; CF = units conversion factor;
SA = skin surface area; AF =skin-soil adherence factor; ABSd = dermal absorption fraction; CSF_o = oral/dermal cancer slope factor; ADAF = age-dependent adjustment factor (USEPA 2005); RBA = Relative Bioavailability Factor
Risk = Incremental lifetime cancer risk; IF = soil ingestion factor for specific age group

Incidental Ingestion

$$RBC_{ing\ c\text{-}mut} = \frac{TR * C_2 * ATc}{CSFo * RBA * C_1 * (IF_{0\text{-}2} + IF_{2\text{-}6} + IF_{6\text{-}16} + IF_{16\text{-}28})}$$

Where:

$IF_{0\text{-}2} =$ $[(ED_{0\text{-}2} * EF_{0\text{-}2} * FS_{0\text{-}2} * IR_{0\text{-}2} * ADAF_{0\text{-}2} / BW_{0\text{-}2})$

$IF_{2\text{-}6} =$ $(ED_{2\text{-}6} * EF_{2\text{-}6} * FS_{2\text{-}6} * IR_{2\text{-}6} * ADAF_{2\text{-}6} / BW_{2\text{-}6})$

$IF_{6\text{-}16} =$ $(ED_{6\text{-}16} * EF_{6\text{-}16} * FS^{6\text{-}16} * IR_{6\text{-}16} * ADAF_{6\text{-}16} / BW_{6\text{-}16})$

$IF_{16\text{-}28} =$ $(ED_{16\text{-}28} * EF_{16\text{-}28} * FS_{16\text{-}28} * IR_{16\text{-}28} * ADA_{F19\text{-}28} / BW_{16\text{-}28})$

TABLE 3B
CALCULATION OF RISK BASED CONCENTRATIONS FOR COPCS WITH A MUTAGENIC MODE OF ACTION
SCENARIO #3: PASSIVE RECREATOR (Moderate Use/Moderate Intensity)
Kenilworth Park Landfill
Washington, DC

Exposure Point:	Soil
Exposure Medium:	Soil
Receptor:	Passive Recreator - Moderate Intensity

Exposure Pathway	COPC	TR (mg/kg)	Age (years)	BW (kg)	SA (cm^2)	ABSd (unitless)	AF mg/cm^2	EF (days/year)	ED (years)	At_c (years)	C_1 (kg/mg)	C_2 (days/year)	CSF_o $(mg/kg\text{-}d)^{-1}$	GIABS %	ADAF (unitless)	DF mg/kg
Dermal Contact with Soil	Benzo(a)anthracene	1.00E-06	1 through <2	15	2,373	0.13	0.04	168	1	70	1.00E-06	365	0.1	1	10	1.1E+04
		1.00E-06	2 through <6	15	2,373	0.13	0.04	168	4	70	1.00E-06	365	0.1	1	3	1.3E+04
		1.00E-06	6 through <16	80	6,032	0.13	0.01	168	10	70	1.00E-06	365	0.1	1	3	3.8E+03
		1.00E-06	16 through <27	80	6,032	0.13	0.01	168	11	70	1.00E-06	365	0.1	1	1	1.4E+03
		Risk Based Concentration - Dermal Contact with Soil:Benzo(a)anthracene														*6.9E+01*
	Benzo(a)pyrene	1.00E-06	1 through <2	15	2,373	0.13	0.04	168	1	70	1.00E-06	365	1	1	10	1.1E+04
		1.00E-06	2 through <6	15	2,373	0.13	0.04	168	4	70	1.00E-06	365	1	1	3	1.3E+04
		1.00E-06	6 through <16	80	6,032	0.13	0.01	168	10	70	1.00E-06	365	1	1	3	3.8E+03
		1.00E-06	16 through <27	80	6,032	0.13	0.01	168	11	70	1.00E-06	365	1	1	1	1.4E+03
		Risk Based Concentration - Dermal Contact with Soil:Benzo(a)pyrene														*6.9E+00*
	Benzo(b)fluoranthene	1.00E-06	1 through <2	15	2,373	0.13	0.04	168	1	70	1.00E-06	365	0.1	1	10	1.1E+04
		1.00E-06	2 through <6	15	2,373	0.13	0.04	168	4	70	1.00E-06	365	0.1	1	3	1.3E+04
		1.00E-06	6 through <16	80	6,032	0.13	0.01	168	10	70	1.00E-06	365	0.1	1	3	3.8E+03
		1.00E-06	16 through <27	80	6,032	0.13	0.01	168	11	70	1.00E-06	365	0.1	1	1	1.4E+03
		Risk Based Concentration - Dermal Contact with Soil:Benzo(b)fluoranthene														*6.9E+01*
	Dibenz(a,h)anthracene	1.00E-06	1 through <2	15	2,373	0.13	0.04	168	1	70	1.00E-06	365	1	1	10	1.1E+04
		1.00E-06	2 through <6	15	2,373	0.13	0.04	168	4	70	1.00E-06	365	1	1	3	1.3E+04
		1.00E-06	6 through <16	80	6,032	0.13	0.01	168	10	70	1.00E-06	365	1	1	3	3.8E+03
		1.00E-06	16 through <27	80	6,032	0.13	0.01	168	11	70	1.00E-06	365	1	1	1	1.4E+03
		Risk Based Concentration - Dermal Contact with Soil:Dibenz(a,h)anthracene														*6.9E+00*

Notes:
COPC = chemical of potential concern; BW = body weight; Tr = target cancer risk; IR = soil or sediment ingestion rate; EF = exposure frequency; ED = exposure duration; AT_c = averaging time; CF = units conversion factor;
GIABS = gastrointestinal absorption factor; SA = skin surface area; AF =skin-soil adherence factor; ABSd = dermal absorption fraction; CSF_o = oral/dermal cancer slope factor; ADAF = age-dependent adjustment factor (USEPA 2005);
Risk = Incremental lifetime cancer risk; DF = dermal contact factor for specific age group

Dermal Contact

$$RBC_{derm\ c\text{-}mut} = \frac{TR * C_2 * ATc}{(CSFo/GIABS) * ABSd * C_1 * (DF_{2\text{-}6} + DF_{6\text{-}16} + DF_{16\text{-}28})}$$

Where:

$$DF_{0\text{-}2} = (ED_{0\text{-}2} * EF_{0\text{-}2} * AF_{0\text{-}2} * SA_{0\text{-}2} * ADAF_{0\text{-}2} / BW_{0\text{-}2})$$

$$DF_{2\text{-}6} = (ED_{2\text{-}6} * EF_{2\text{-}6} * AF_{0\text{-}2} * SA_{2\text{-}6} * ADAF_{2\text{-}6} / BW_{2\text{-}6})$$

$$DF_{6\text{-}16} = (ED_{6\text{-}16} * EF_{6\text{-}16} * AF_{6\text{-}16} * SA_{6\text{-}16} * ADAF_{6\text{-}16} / BW_{6\text{-}16})$$

$$DF_{16\text{-}28} = (ED_{16\text{-}28} * EF_{16\text{-}28} * AF_{16\text{-}28} * SA_{16\text{-}28} * ADAF_{16\text{-}28} / BW_{16\text{-}28})$$

TABLE 3B
CALCULATION OF RISK BASED CONCENTRATIONS FOR COPCS WITH A MUTAGENIC MODE OF ACTION
SCENARIO #3: PASSIVE RECREATOR (Moderate Use/Moderate Intensity)
Kenilworth Park Landfill
Washington, DC

Exposure Point:	Soil
Exposure Medium:	Soil
Receptor:	Passive Recreator - Moderate Intensity

Exposure Pathway	COPC	TR (mg/kg)	Age (years)	VF m^3/kg	PEF m^3/kg	EF (days/year)	ET (hours)	ED (years)	AT (years)	C_2 (days/year)	C_3 hours/day	C_4 (ug/mg)	IUR $(ug/m^3)^{-1}$	ADAF (unitless)	InhF days
Inhalation of Fugitive Dust	Benzo(a)anthracene	1.00E-06	1 through <2	4.41E+06	3.38E+08	168	2	1	70	365	24	1000	6.00E-05	10	1.4E+02
		1.00E-06	2 through <6	4.41E+06	3.38E+08	168	2	4	70	365	24	1000	6.00E-05	3	1.7E+02
		1.00E-06	6 through <16	4.41E+06	3.38E+08	168	2	10	70	365	24	1000	6.00E-05	3	4.2E+02
		1.00E-06	16 through <27	4.41E+06	3.38E+08	168	2	11	70	365	24	1000	6.00E-05	1	1.5E+02
		Risk Based Concentration - Inhalation of Fugitive Dust:Benzo(a)anthracene													*2.1E+03*
	Benzo(a)pyrene	1.00E-06	1 through <2	NA	3.38E+08	168	2	1	70	365	24	1000	6.00E-04	10	1.4E+02
		1.00E-06	2 through <6	NA	3.38E+08	168	2	4	70	365	24	1000	6.00E-04	3	1.7E+02
		1.00E-06	6 through <16	NA	3.38E+08	168	2	10	70	365	24	1000	6.00E-04	3	4.2E+02
		1.00E-06	16 through <27	NA	3.38E+08	168	2	11	70	365	24	1000	6.00E-04	1	1.5E+02
		Risk Based Concentration - Inhalation of Fugitive Dust:Benzo(a)pyrene													*1.6E+04*
	Benzo(b)fluoranthene	1.00E-06	1 through <2	NA	3.38E+08	168	2	1	70	365	24	1000	6.00E-05	10	1.4E+02
		1.00E-06	2 through <6	NA	3.38E+08	168	2	4	70	365	24	1000	6.00E-05	3	1.7E+02
		1.00E-06	6 through <16	NA	3.38E+08	168	2	10	70	365	24	1000	6.00E-05	3	4.2E+02
		1.00E-06	16 through <27	NA	3.38E+08	168	2	11	70	365	24	1000	6.00E-05	1	1.5E+02
		Risk Based Concentration - Inhalation of Fugitive Dust:Benzo(b)fluoranthene													*1.6E+05*
	Dibenz(a,h)anthracene	1.00E-06	1 through <2	NA	3.38E+08	168	2	1	70	365	24	1000	6.00E-04	10	1.4E+02
		1.00E-06	2 through <6	NA	3.38E+08	168	2	4	70	365	24	1000	6.00E-04	3	1.7E+02
		1.00E-06	6 through <16	NA	3.38E+08	168	2	10	70	365	24	1000	6.00E-04	3	4.2E+02
		1.00E-06	16 through <27	NA	3.38E+08	168	2	11	70	365	24	1000	6.00E-04	1	1.5E+02
		Risk Based Concentration - Inhalation of Fugitive Dust:Dibenz(a,h)anthracene													*1.6E+04*

Notes:
COPC = chemical of potential concern; TR = Target cancer risk; VF = volatilization factor; PEF = particulate emmision factor; EF = exposure frequency; ET = Exposure time; ED = exposure duration; AT_c = averaging time; CF = units conversion factor;
IUR = inhalation unit risk; ADAF = age-dependent adjustment factor (USEPA 2005); InhF = Inhalation factor for specific age group; Risk = Incremental lifetime cancer risk.

Inhalation

$$RBC_{inh\ c\text{-}mut} = \frac{TR * AT * C_2}{IUR\ * C_4\ (1/VF + 1/PEF) * (InhF_{2\text{-}6} + InhF_{6\text{-}16} + InhF_{16\text{-}28})}$$

Where:

$InhF_{0\text{-}2}$ = $(ET_{0\text{-}2} * EF_{0\text{-}2} * ED_{0\text{-}2} * ADAF_{0\text{-}2}/C_3)$
$InhF_{2\text{-}6}$ = $(ET_{2\text{-}6} * EF_{2\text{-}6} * ED_{2\text{-}6} * ADAF_{2\text{-}6}/C_3)$
$InhF_{6\text{-}16}$ = $(ET_{6\text{-}16} * EF_{6\text{-}16} * ED_{6\text{-}16} * ADAF_{6\text{-}16}/C_3)$
$InhF_{16+}$ = $(ET_{16+} * EF_{16+} * ED_{16+} * ADAF_{16+}/C_3)$

Exposure Pathway	COPC	$RBC_{ing\ c\text{-}mut}$ mg/kg	$RBC_{derm\ c\text{-}mut}$ mg/kg	$RBC_{inh\ c\text{-}mut}$ mg/kg	RBC_{Total} mg/kg
All	Benzo(a)anthracene	1.3E+01	6.9E+01	2.1E+03	1.1E+01
	Benzo(a)pyrene	1.3E+00	6.9E+00	1.6E+04	1.1E+00
	Benzo(b)fluoranthene	1.3E+01	6.9E+01	1.6E+05	1.1E+01
	Dibenz(a,h)anthracene	1.3E+00	6.9E+00	1.6E+04	1.1E+00

$$RBC_{total\ c\text{-}mut} = \frac{1}{1/RBC_{ing\ c\text{-}mut} + 1/RBC_{derm\ c\text{-}mut} + 1/RBC_{inh\ c\text{-}mut}}$$

TABLE 3C
SUMMARY OF RISK BASED CONCENTRATIONS FOR SOIL
SCENARIO #3: PASSIVE RECREATOR (Moderate Use/Moderate Intensity)
Kenilworth Park Landfill
Washington, DC

Chemical of Potential Concern	RBC-nc	RBC-c, 10-6	RBC-c, 10-5	RBC-c, 10-4
Arsenic	2.3E+02	4.5E+00	4.5E+01	4.5E+02
Benzo(a)anthracene	NC	1.1E+01	1.1E+02	1.1E+03
Benzo(a)pyrene	1.2E+02	1.1E+00	1.1E+01	1.1E+02
Benzo(b)fluoranthene	NC	1.1E+01	1.1E+02	1.1E+03
Dibenz(a,h)anthracene	NC	1.1E+00	1.1E+01	1.1E+02
Aluminum	4.9E+05	NC	NC	NC
Antimony	2.0E+02	NC	NC	NC
Cobalt	1.5E+02	2.6E+03	2.6E+04	2.6E+05
Copper	2.0E+04	NC	NC	NC
Iron	3.5E+05	NC	NC	NC
Manganese	1.2E+04	NC	NC	NC
Mercury	1.5E+02	NC	NC	NC
Silver	2.5E+03	NC	NC	NC
Thallium	4.9E+00	NC	NC	NC
Vanadium	2.5E+03	NC	NC	NC
Aldrin	1.5E+01	2.6E-01	2.6E+00	2.6E+01
Dieldrin	2.2E+01	2.4E-01	2.4E+00	2.4E+01
Aroclor 1254	8.2E+00	1.8E+00	1.8E+01	1.8E+02
Aroclor 1260	NC	1.8E+00	1.8E+01	1.8E+02

Notes:

Risk-based Soil Concentrations (RBCs) in units of milligrams per kilogram (mg/kg).

RBC-nc = RBC for noncancer effects

RBC-c = RBC for cancer effects, at stated target cancer risk (10^{-6} to 10^{-4})

NC = Not calculated

TABLE 4A
CALCULATION OF RISK BASED CONCENTRATIONS
SCENARIO #4: PASSIVE RECREATOR (Low Use/Low Intensity)
Kenilworth Park Landfill
Washington, DC

EXPOSURE EQUATIONS:

Non Cancer

Ingestion:

$$RBC = \frac{THQ * AT_{nc} * C2 * BW}{EF * ED * RBA * IR * FS * 1/RfDo * C1}$$

Dermal Contact:

$$RBC = \frac{THQ * AT_{nc} * C2 * BW}{EF * ED * SA * AF * [1/(RfDo*GIABS)] * ABSd * C1}$$

Inhalation of Fugitive Dust:
Gastrointestinal uptake

$$RBC = \frac{THQ * AT_{nc} * C2}{EF * ED * ET * (1/C3) * (1/RfC) * (1/VF + 1/PEF)}$$

All Pathways

$$RBC\text{-total nc} = \frac{1}{1/RBC\text{-ing nc} + 1/RBC\text{-derm nc} + 1/RBC\text{-inh nc}}$$

Cancer

$$RBC\text{-ing} = \frac{TR * ATc * C2}{CSFo * RBA * C1 * [(EDc * EFc * FS * IRc / BWc) + (EDa * EFa * FS * IRa / BWa)]}$$

$$RBC\text{-derm} = \frac{TR * ATc * C2}{(CSFo/GIABS) * ABSd * C1 * [(EDc * EFc * SAc * AFc * 1/BWc) + (EDa * EFa * SAa * AFa * 1/BWa)]}$$

$$RBC\text{-inh} = \frac{TR * AT * C2}{IUR * 1/C3 * (1/VF + 1/PEF) * [(EFc * EDc * ETc) + (EDa * EFa * ETa)]}$$

$$RBC\text{-total} = \frac{1}{1/RBC\text{-ing c} + 1/RBC\text{-derm c} + 1/RBC\text{-inh c}}$$

Parameter		Description	Units	Value	Reference	
Child						
IRsoilc	=	Ingestion rate of soil - child	mg/day	200	USEPA 2014	1
AFsoilc	=	Soil adherence factor - child	mg/cm^2	0.04	USEPA 2014	2
SAsoilc	=	Skin surface area - child	cm^2 / day	2,373	USEPA 2014	3
EFc	=	Exposure Frequency - child	days/yr	42	Professional judgment	4
EDc	=	Exposure Duration - child	years	6	USEPA 2014	5
Etc	=	Exposure time outdoors - child	hours/day	1	Professional judgment	6
FS	=	Fraction soil contact at Site	unitless	0.33	Professional judgment	7
BWc	=	Body Weight - child	kg	15	USEPA 2014	8
PEF	=	Particulate Emission Factor	m^3/kg	3.38E+08	E&E 2008	9
VF	=	Volatilization Factor	m^3/kg	Chemical-specific	USEPA 2018	10
ATc	=	Averaging Time - cancer	years	70	USEPA 1989	11
ATnc	=	Averaging Time - noncancer	years	6	USEPA 1989	12
Adult						
IRsoila	=	Ingestion rate of soil - adult	mg/day	100	USEPA 2014	1
AFsoila	=	Soil adherence factor - adult	mg/cm^2	0.01	USEPA 2014	2
SAsoila	=	Skin surface area - adult	cm^2 / day	6,032	USEPA 2014	3
EFa	=	Exposure Frequency - adult	days/yr	42	Professional judgment	4
EDa	=	Exposure Duration - adult	years	20	USEPA 2014	5
Eta	=	Exposure time outdoors - adult	hours/day	1	Professional judgment	6
FS	=	Fraction soil contact at Site	unitless	0.33	Professional judgment	7
BWa	=	Body Weight - adult	kg	80	USEPA 2014	8
PEF	=	Particulate Emission Factor	m^3/kg	3.38E+08	E&E 2008	9
VF	=	Volatilization Factor	m^3/kg	Chemical-specific	USEPA 2018	10
ATc	=	Averaging Time - cancer	years	70	USEPA 1989	11
ATnc	=	Averaging Time - noncancer	years	20	USEPA 1989	12
General Exposure Parameters						
THQ	=	Target Hazard Quotient	unitless	1	Site-specific	
TR	=	Target Cancer Risk	unitless	0.000001	Site-specific	
ABSd	=	Dermal absorption factor	unitless	Chemical-specific	USEPA 2004	13
RBA	=	Relative Bioavailability Factor	%	Chemical-specific	USEPA 2012	14
GIABS	=	Gastrointestinal absorption fraction	%	Chemical-specific	USEPA 2004	15
RfD	=	Reference Dose	mg/kg-d	Chemical-specific	Chemical-specific	
RfC	=	Reference Concentration	mg/m^3	Chemical-specific	Chemical-specific	
CSF	=	Cancer Slope Factor	$(mg/kg\text{-}d)^{-1}$	Chemical-specific	Chemical-specific	
IUR	=	Inhalation Unit Risk	$(mg/m^3)^{-1}$	Chemical-specific	Chemical-specific	
C1	=	Units conversion factor 1	kg/mg	0.000001		
C2	=	Units conversion factor 2	days/yr	365		
C3	=	Units conversion factor 3	hours/day	24		
RBC	=	Risk-based Soil Concentration	mg/kg	Chemical-specific	Calculated	

Chemical of Potential Concern	CAS	Toxicity Values				Chemical Specific Parameters				RBC - Non Cancer				RBC - Cancer			
		RFDo	RFCi	CSFo	IUR	GIABS	ABSd	RBA	VF	Ingestion	Dermal	Inhalation	All	Ingestion	Dermal	Inhalation	All
Arsenic	7440-38-2	3.0E-04	1.5E-05	1.5E+00	4.3E+00	1.0E+00	3.0E-02	6.0E-01	NA	9.9E+02	1.4E+04	1.1E+06	9.2E+02	2.0E+01	2.5E+02	4.4E+04	1.8E+01
Benzo(a)anthracene	56-55-3	NA	NA	*	*	1.0E+00	1.3E-01	1.0E+00	4.4E+06	NC	NC	NC	NC	*	*	*	*
Benzo(a)pyrene	50-32-8	3.0E-04	2.0E-06	*	*	1.0E+00	1.3E-01	1.0E+00	NA	5.9E+02	3.2E+03	1.4E+05	5.0E+02	*	*	*	*
Benzo(b)fluoranthene	205-99-2	NA	NA	*	*	1.0E+00	1.3E-01	1.0E+00	NA	NC	NC	NC	NC	*	*	*	*
Dibenz(a,h)anthracene	53-70-3	NA	NA	*	*	1.0E+00	1.3E-01	1.0E+00	NA	NC	NC	NC	NC	*	*	*	*
Aluminum	7429-90-5	1.0E+00	5.0E-03	NA	NA	1.0E+00	NA	1.0E+00	NA	2.0E+06	NC	3.5E+08	2.0E+06	NC	NC	NC	NC
Antimony	7440-36-0	4.0E-04	3.0E-04	NA	NA	1.5E-01	NA	1.0E+00	NA	7.9E+02	NC	2.1E+07	7.9E+02	NC	NC	NC	NC
Cobalt	7440-48-4	3.0E-04	6.0E-06	NA	9.0E+00	1.0E+00	NA	1.0E+00	NA	5.9E+02	NC	4.2E+05	5.9E+02	NC	NC	2.1E+04	2.1E+04
Copper	7440-50-8	4.0E-02	NA	NA	NA	1.0E+00	NA	1.0E+00	NA	7.9E+04	NC	NC	7.9E+04	NC	NC	NC	NC
Iron	7439-89-6	7.0E-01	NA	NA	NA	1.0E+00	NA	1.0E+00	NA	1.4E+06	NC	NC	1.4E+06	NC	NC	NC	NC
Manganese	7439-96-5	2.4E-02	5.0E-05	NA	NA	4.0E-02	NA	1.0E+00	NA	4.7E+04	NC	3.5E+06	4.7E+04	NC	NC	NC	NC
Mercury	7487-94-7	3.0E-04	3.0E-04	NA	NA	7.0E-02	NA	1.0E+00	NA	5.9E+02	NC	2.1E+07	5.9E+02	NC	NC	NC	NC
Silver	7440-22-4	5.0E-03	NA	NA	NA	4.0E-02	NA	1.0E+00	NA	9.9E+03	NC	NC	9.9E+03	NC	NC	NC	NC
Thallium	7440-28-0	1.0E-05	NA	NA	NA	1.0E+00	NA	1.0E+00	NA	2.0E+01	NC	NC	2.0E+01	NC	NC	NC	NC
Vanadium	7440-62-2	5.0E-03	1.0E-04	NA	NA	2.6E-02	NA	1.0E+00	NA	9.9E+03	NC	7.0E+06	9.9E+03	NC	NC	NC	NC
Aldrin	309-00-2	3.0E-05	NA	1.7E+01	4.9E+00	1.0E+00	NA	1.0E+00	1.7E+06	5.9E+01	NC	NC	5.9E+01	1.0E+00	NC	2.0E+02	1.0E+00
Dieldrin	60-57-1	5.0E-05	NA	1.6E+01	4.6E+00	1.0E+00	1.0E-01	1.0E+00	NA	9.9E+01	6.9E+02	NC	8.6E+01	1.1E+00	7.2E+00	4.1E+04	9.5E-01
Aroclor 1254	11097-69-1	2.0E-05	NA	2.0E+00	5.7E-01	1.0E+00	1.4E-01	1.0E+00	8.4E+05	4.0E+01	2.0E+02	NC	3.3E+01	8.8E+00	4.1E+01	8.3E+02	7.2E+00
Aroclor 1260	11096-82-5	NA	NA	2.0E+00	5.7E-01	1.0E+00	1.4E-01	1.0E+00	1.3E+06	NC	NC	NC	NC	8.8E+00	4.1E+01	1.3E+03	7.2E+00

Notes
NA = Not available
NC = Not calculated
*Risk based concentrations for benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene include a receptor-specific Age-Dependent Adjustment Factor. Derivation of cancer risk based concentrations for this compound are shown on Table 4B.
** Lead risk based concentrations were calculated using the IEUBK model.
***The toxicity values for Aroclor 1254 were used to calculate risk based concentrations

Table 4A Notes

1. Soil ingestion rates are the recommended USEPA default soil ingestion rates for children and adult residents (USEPA 2014).
2. The soil adherence factors (AFsoil) are the USEPA default soil adherence factors for children and adults (Exhibit 3-5 of USEPA 2004). For the passive recreational exposure, central tendency values were used.
3. The skin surface areas are the EPA-recommended default SAs for the adult and child resident (USEPA 2014) and reflect the weighted average of mean values for head, hands, forearms and lower legs (and feet, for the child).
4. The exposure frequency (EF) describes how often the exposure occurs over a given period of time. The EF assumes that a visitor may walk at the site 1 day per week for 42 weeks per year, assuming that the ground is frozen or covered by snow and not accessible, or the visitor is otherwise unable to visit the site (school, vacations etc.) the remaining 10 weeks.
5. The exposure duration (ED) describes the length of time over which the receptor comes into contact with contaminants. ED values for the recreator reflect a total 26 year residential tenure, which is the current EPA-recommended value for residence time (USEPA 2014). The age range of the recreator is assumed to be 1 though <27 years old. Children <1 year old in a stroller have minimal exposure to soil.
6. The exposure time (ET) is the amount of time spent outdoors. An ET of 1 hour per day was selected for both the adult and child visitor, based on professional judgment.
7. Soil ingestion parameters are reflective of the daily dose of soil. It was assumed that a visitor would be exposed to one-third of the full daily dose when at the site; therefore, a FS of 0.33 was used, based on professional judgment, given the relatively small overall percentage of the day that would be spent at the site.
8. The body weights (BW) for the child and adult are the recommended default body weights per USEPA 2014.
9. Site-specific PEF calculated in Table G-12 of Appendix G (Human Health Risk Assessment) of Remedial Investigation, Ecology and Environment 2008.
10. Volatilization factors (VF) were obtained from the USEPA Regional Screening Level (RSL) table, May 2020. https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables
11. The averaging time (AT) for cancer effects (AT_c) for all receptors is set equal to a lifetime (i.e., 70 years), as recommended in USEPA 1989.
12. The averaging time for non-cancer effects (AT_{nc}) for all receptors is set equal to the exposure duration, as recommended in USEPA 1989.
13. The dermal absorption factors (ABSd) are recommended values in Exhibit 3-4 of USEPA 2004, with updates as provided on: https://www.epa.gov/risk/risk-assessment-guidance-superfund-rags-part-e.
14. The EPA recommended default relative bioability (RBA) value of 60% is applied to oral arsenic exposures. An RBA of 100% is used for all other constituents (USEPA 2012).
15. Gastrointestinal absorption factors were obtained from the Final Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) (USEPA, 2004).

References:

USEPA 2014. Memorandum: Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. February 6, 2014. Office of Solid Waste and Emergency Response. OSWER Directive 9200.1-120.
USEPA 2012. Recommendations for the Default Value for Relative Bioavailability of Arsenic in Soil. December 2012. OSWER Directive 9200.1-113.
USEPA 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final, OSWER Directive 9285.7-02EP. EPA/540/R/99/005, USEPA, Washington D.C., July 2004.
USEPA 1989. Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part A, Interim Final, OSWER Directive 9285.701A. Office of Solid Waste and Emergency Response, USEPA, Washington D.C., December 1989.
E&C 2008. Final Remedial Investigation at the Kenilworth Park South Landfill, Washington, D.C. June 2008.

TABLE 4B
CALCULATION OF RISK BASED CONCENTRATIONS FOR COPCS WITH A MUTAGENIC MODE OF ACTION
SCENARIO #4: PASSIVE RECREATOR (Low Use/Low Intensity)
Kenilworth Park Landfill
Washington, DC

Exposure Point:	Soil
Exposure Medium:	Soil
Receptor:	Passive Recreator - Low Intensity

Exposure Pathway	COPC	TR	Age	BW	IR	FS	EF	ED	AT_c	C_1	C_2	CSF_o	RBA	ADAF	IF
		(mg/kg)	(years)	(kg)	(mg/day)	(unitless)	(days/year)	(years)	(years)	(kg/mg)	(days/year)	$(mg/kg\text{-}d)^{-1}$	%	(unitless)	mg/kg
Incidental Ingestion of Soil	Benzo(a)anthracene	1.00E-06	1 through <2	15	200	0.33	42	1	70	1.00E-06	365	0.1	1	10	1.8E+03
		1.00E-06	2 through <6	15	200	0.33	42	4	70	1.00E-06	365	0.1	1	3	2.2E+03
		1.00E-06	6 through <16	80	100	0.33	42	10	70	1.00E-06	365	0.1	1	3	5.2E+02
		1.00E-06	16 through <27	80	100	0.33	42	11	70	1.00E-06	365	0.1	1	1	1.9E+02
		Risk Based Concentration - Incidental Ingestion of Soil:Benzo(a)anthracene													*5.3E+01*
	Benzo(a)pyrene	1.00E-06	1 through <2	15	200	0.33	42	1	70	1.00E-06	365	1	1	10	1.8E+03
		1.00E-06	2 through <6	15	200	0.33	42	4	70	1.00E-06	365	1	1	3	2.2E+03
		1.00E-06	6 through <16	80	100	0.33	42	10	70	1.00E-06	365	1	1	3	5.2E+02
		1.00E-06	16 through <27	80	100	0.33	42	11	70	1.00E-06	365	1	1	1	1.9E+02
		Risk Based Concentration - Incidental Ingestion of Soil:Benzo(a)pyrene													*5.3E+00*
	Benzo(b)fluoranthene	1.00E-06	1 through <2	15	200	0.33	42	1	70	1.00E-06	365	0.1	1	10	1.8E+03
		1.00E-06	2 through <6	15	200	0.33	42	4	70	1.00E-06	365	0.1	1	3	2.2E+03
		1.00E-06	6 through <16	80	100	0.33	42	10	70	1.00E-06	365	0.1	1	3	5.2E+02
		1.00E-06	16 through <27	80	100	0.33	42	11	70	1.00E-06	365	0.1	1	1	1.9E+02
		Risk Based Concentration - Incidental Ingestion of Soil:Benzo(b)fluoranthene													*5.3E+01*
	Dibenz(a,h)anthracene	1.00E-06	1 through <2	15	200	0.33	42	1	70	1.00E-06	365	1	1	10	1.8E+03
		1.00E-06	2 through <6	15	200	0.33	42	4	70	1.00E-06	365	1	1	3	2.2E+03
		1.00E-06	6 through <16	80	100	0.33	42	10	70	1.00E-06	365	1	1	3	5.2E+02
		1.00E-06	16 through <27	80	100	0.33	42	11	70	1.00E-06	365	1	1	1	1.9E+02
		Risk Based Concentration - Incidental Ingestion of Soil:Dibenz(a,h)anthracene													*5.3E+00*

Notes:

COPC = chemical of potential concern; BW = body weight; Tr = Target cancer risk; IR = soil or sediment ingestion rate; FS = fraction soil contact at Site; EF = exposure frequency; ED = exposure duration; AT_c = averaging time; CF = units conversion factor;

SA = skin surface area; AF =skin-soil adherence factor; ABSd = dermal absorption fraction; CSF_o = oral/dermal cancer slope factor; ADAF = age-dependent adjustment factor (USEPA 2005); RBA = Relative Bioavailability Factor

Risk = Incremental lifetime cancer risk; IF = soil ingestion factor for specific age group

Incidental Ingestion

$$RBC_{ing\ c\text{-}mut} = \frac{TR * C_2 * ATc}{CSFo * RBA * C_1 * (IF_{0\text{-}2} + IF_{2\text{-}6} + IF_{6\text{-}16} + IF_{16\text{-}28})}$$

Where:

$IF_{0\text{-}2}$ = $[(ED_{0\text{-}2} * EF_{0\text{-}2} * FS_{0\text{-}2} * IR_{0\text{-}2} * ADAF_{0\text{-}2}/ BW_{0\text{-}2})$

$IF_{2\text{-}6}$ = $(ED_{2\text{-}6} * EF_{2\text{-}6} * FS_{2\text{-}6} * IR_{2\text{-}6} * ADAF_{2\text{-}6}/ BW_{2\text{-}6})$

$IF_{6\text{-}16}$ = $(ED_{6\text{-}16} * EF_{6\text{-}16} * FS^{6\text{-}16} * IR_{6\text{-}16} * ADAF_{6\text{-}16}/ BW_{6\text{-}16})$

$IF_{16\text{-}28}$ = $(ED_{16\text{-}28} * EF_{16\text{-}28} * FS_{16\text{-}28} * IR_{16\text{-}28} * ADA_{F19\text{-}28}/ BW_{16\text{-}28})$

TABLE 4B
CALCULATION OF RISK BASED CONCENTRATIONS FOR COPCS WITH A MUTAGENIC MODE OF ACTION
SCENARIO #4: PASSIVE RECREATOR (Low Use/Low Intensity)
Kenilworth Park Landfill
Washington, DC

Exposure Point:	Soil
Exposure Medium:	Soil
Receptor:	Passive Recreator - Low Intensity

Exposure Pathway	COPC	TR (mg/kg)	Age (years)	BW (kg)	SA (cm^2)	ABSd (unitless)	AF mg/cm^2	EF (days/year)	ED (years)	At_c (years)	C_1 (kg/mg)	C_2 (days/year)	CSF_o $(mg/kg\text{-}d)^{-1}$	GIABS %	ADAF (unitless)	DF mg/kg
Dermal Contact with Soil	Benzo(a)anthracene	1.00E-06	1 through <2	15	2,373	0.13	0.04	42	1	70	1.00E-06	365	0.1	1	10	2.7E+03
		1.00E-06	2 through <6	15	2,373	0.13	0.04	42	4	70	1.00E-06	365	0.1	1	3	3.2E+03
		1.00E-06	6 through <16	80	6,032	0.13	0.01	42	10	70	1.00E-06	365	0.1	1	3	9.5E+02
		1.00E-06	16 through <27	80	6,032	0.13	0.01	42	11	70	1.00E-06	365	0.1	1	1	3.5E+02
		Risk Based Concentration - Dermal Contact with Soil:Benzo(a)anthracene														*2.8E+02*
	Benzo(a)pyrene	1.00E-06	1 through <2	15	2,373	0.13	0.04	42	1	70	1.00E-06	365	1	1	10	2.7E+03
		1.00E-06	2 through <6	15	2,373	0.13	0.04	42	4	70	1.00E-06	365	1	1	3	3.2E+03
		1.00E-06	6 through <16	80	6,032	0.13	0.01	42	10	70	1.00E-06	365	1	1	3	9.5E+02
		1.00E-06	16 through <27	80	6,032	0.13	0.01	42	11	70	1.00E-06	365	1	1	1	3.5E+02
		Risk Based Concentration - Dermal Contact with Soil:Benzo(a)pyrene														*2.8E+01*
	Benzo(b)fluoranthene	1.00E-06	1 through <2	15	2,373	0.13	0.04	42	1	70	1.00E-06	365	0.1	1	10	2.7E+03
		1.00E-06	2 through <6	15	2,373	0.13	0.04	42	4	70	1.00E-06	365	0.1	1	3	3.2E+03
		1.00E-06	6 through <16	80	6,032	0.13	0.01	42	10	70	1.00E-06	365	0.1	1	3	9.5E+02
		1.00E-06	16 through <27	80	6,032	0.13	0.01	42	11	70	1.00E-06	365	0.1	1	1	3.5E+02
		Risk Based Concentration - Dermal Contact with Soil:Benzo(b)fluoranthene														*2.8E+02*
	Dibenz(a,h)anthracene	1.00E-06	1 through <2	15	2,373	0.13	0.04	42	1	70	1.00E-06	365	1	1	10	2.7E+03
		1.00E-06	2 through <6	15	2,373	0.13	0.04	42	4	70	1.00E-06	365	1	1	3	3.2E+03
		1.00E-06	6 through <16	80	6,032	0.13	0.01	42	10	70	1.00E-06	365	1	1	3	9.5E+02
		1.00E-06	16 through <27	80	6,032	0.13	0.01	42	11	70	1.00E-06	365	1	1	1	3.5E+02
		Risk Based Concentration - Dermal Contact with Soil:Dibenz(a,h)anthracene														*2.8E+01*

Notes:
COPC = chemical of potential concern; BW = body weight; Tr = target cancer risk; IR = soil or sediment ingestion rate; EF = exposure frequency; ED = exposure duration; AT_c = averaging time; CF = units conversion factor;
GIABS = gastrointestinal absorption factor; SA = skin surface area; AF =skin-soil adherence factor; ABSd = dermal absorption fraction; CSF_o = oral/dermal cancer slope factor; ADAF = age-dependent adjustment factor (USEPA 2005);
Risk = Incremental lifetime cancer risk; DF = dermal contact factor for specific age group

Dermal Contact

$$RBC_{derm\ c\text{-}mut} = \frac{TR * C_2 * ATc}{(CSFo/GIABS) * ABSd * C_1 * (DF_{2\text{-}6} + DF_{6\text{-}16} + DF_{16\text{-}28})}$$

Where:

$DF_{0\text{-}2}$ = $(ED_{0\text{-}2} * EF_{0\text{-}2} * AF_{0\text{-}2} * SA_{0\text{-}2} * ADAF_{0\text{-}2} / BW_{0\text{-}2})$

$DF_{2\text{-}6}$ = $(ED_{2\text{-}6} * EF_{2\text{-}6} * AF_{0\text{-}2} * SA_{2\text{-}6} * ADAF_{2\text{-}6} / BW_{2\text{-}6})$

$DF_{6\text{-}16}$ = $(ED_{6\text{-}16} * EF_{6\text{-}16} * AF_{6\text{-}16} * SA_{6\text{-}16} * ADAF_{6\text{-}16} / BW_{6\text{-}16})$

$DF_{16\text{-}28}$ = $(ED_{16\text{-}28} * EF_{16\text{-}28} * AF_{16\text{-}28} * SA_{16\text{-}28} * ADAF_{16\text{-}28} / BW_{16\text{-}28})$

TABLE 4B
CALCULATION OF RISK BASED CONCENTRATIONS FOR COPCS WITH A MUTAGENIC MODE OF ACTION
SCENARIO #4: PASSIVE RECREATOR (Low Use/Low Intensity)
Kenilworth Park Landfill
Washington, DC

Exposure Point:	Soil
Exposure Medium:	Soil
Receptor:	Passive Recreator - Low Intensity

Exposure Pathway	COPC	TR (mg/kg)	Age (years)	VF m^3/kg	PEF m^3/kg	EF (days/year)	ET (hours)	ED (years)	AT (years)	C_2 (days/year)	C_3 hours/day	C_4 (ug/mg)	IUR $(ug/m^3)^{-1}$	ADAF (unitless)	InhF days
Inhalation of Fugitive Dust	Benzo(a)anthracene	1.00E-06	1 through <2	4.41E+06	3.38E+08	42	1	1	70	365	24	1000	6.00E-05	10	1.8E+01
		1.00E-06	2 through <6	4.41E+06	3.38E+08	42	1	4	70	365	24	1000	6.00E-05	3	2.1E+01
		1.00E-06	6 through <16	4.41E+06	3.38E+08	42	1	10	70	365	24	1000	6.00E-05	3	5.3E+01
		1.00E-06	16 through <27	4.41E+06	3.38E+08	42	1	11	70	365	24	1000	6.00E-05	1	1.9E+01
		Risk Based Concentration - Inhalation of Fugitive Dust:Benzo(a)anthracene													*1.3E+06*
	Benzo(a)pyrene	1.00E-06	1 through <2	NA	3.38E+08	42	1	1	70	365	24	1000	6.00E-04	10	1.8E+01
		1.00E-06	2 through <6	NA	3.38E+08	42	1	4	70	365	24	1000	6.00E-04	3	2.1E+01
		1.00E-06	6 through <16	NA	3.38E+08	42	1	10	70	365	24	1000	6.00E-04	3	5.3E+01
		1.00E-06	16 through <27	NA	3.38E+08	42	1	11	70	365	24	1000	6.00E-04	1	1.9E+01
		Risk Based Concentration - Inhalation of Fugitive Dust:Benzo(a)pyrene													*1.3E+05*
	Benzo(b)fluoranthene	1.00E-06	1 through <2	NA	3.38E+08	42	1	1	70	365	24	1000	6.00E-05	10	1.8E+01
		1.00E-06	2 through <6	NA	3.38E+08	42	1	4	70	365	24	1000	6.00E-05	3	2.1E+01
		1.00E-06	6 through <16	NA	3.38E+08	42	1	10	70	365	24	1000	6.00E-05	3	5.3E+01
		1.00E-06	16 through <27	NA	3.38E+08	42	1	11	70	365	24	1000	6.00E-05	1	1.9E+01
		Risk Based Concentration - Inhalation of Fugitive Dust:Benzo(b)fluoranthene													*1.3E+06*
	Dibenz(a,h)anthracene	1.00E-06	1 through <2	NA	3.38E+08	42	1	1	70	365	24	1000	6.00E-04	10	1.8E+01
		1.00E-06	2 through <6	NA	3.38E+08	42	1	4	70	365	24	1000	6.00E-04	3	2.1E+01
		1.00E-06	6 through <16	NA	3.38E+08	42	1	10	70	365	24	1000	6.00E-04	3	5.3E+01
		1.00E-06	16 through <27	NA	3.38E+08	42	1	11	70	365	24	1000	6.00E-04	1	1.9E+01
		Risk Based Concentration - Inhalation of Fugitive Dust:Dibenz(a,h)anthracene													*1.3E+05*

Notes:
COPC = chemical of potential concern; TR = Target cancer risk; VF = volatilization factor; PEF = particulate emmision factor; EF = exposure frequency; ET = Exposure time; ED = exposure duration; AT_c = averaging time; CF = units conversion factor;
IUR = inhalation unit risk; ADAF = age-dependent adjustment factor (USEPA 2005); InhF = Inhalation factor for specific age group; Risk = Incremental lifetime cancer risk.

Inhalation

$$RBC_{inh\ c\text{-}mut} = \frac{TR * AT * C_2}{IUR * C_4\ (1/VF + 1/PEF) * (InhF_{2\text{-}6} + InhF_{6\text{-}16} + InhF_{16\text{-}28})}$$

Where:

$InhF_{2\text{-}6}$ = $(ET_{2\text{-}6} * EF_{2\text{-}6} * ED_{2\text{-}6} * ADAF_{2\text{-}6}/C_3)$

$InhF_{6\text{-}16}$ = $(ET_{6\text{-}16} * EF_{6\text{-}16} * ED_{6\text{-}16} * ADAF_{6\text{-}16}/C_3)$

$InhF_{16+}$ = $(ET_{16+} * EF_{16+} * ED_{16+} * ADAF_{16+}/C_3)$

Exposure Pathway	COPC	$RBC_{ing\ c\text{-}mut}$ mg/kg	$RBC_{derm\ c\text{-}mut}$ mg/kg	$RBC_{inh\ c\text{-}mut}$ mg/kg	RBC_{Total} mg/kg
All	Benzo(a)anthracene	5.3E+01	2.8E+02	1.3E+06	4.5E+01
	Benzo(a)pyrene	5.3E+00	2.8E+01	1.3E+05	4.5E+00
	Benzo(b)fluoranthene	5.3E+01	2.8E+02	1.3E+06	4.5E+01
	Dibenz(a,h)anthracene	5.3E+00	2.8E+01	1.3E+05	4.5E+00

$$RBC_{total\ c\text{-}mut} = \frac{1}{1/RBC_{ing\ c\text{-}mut} + 1/RBC_{derm\ c\text{-}mut} + 1/RBC_{inh\ c\text{-}mut}}$$

TABLE 4C
SUMMARY OF RISK BASED CONCENTRATIONS FOR SOIL
SCENARIO #4: PASSIVE RECREATOR (Low Use/Low Intensity)
Kenilworth Park Landfill
Washington, DC

Chemical of Potential Concern	RBC-nc	RBC-c, 10-6	RBC-c, 10-5	RBC-c, 10-4
Arsenic	9.2E+02	1.8E+01	1.8E+02	1.8E+03
Benzo(a)anthracene	NC	4.5E+01	4.5E+02	4.5E+03
Benzo(a)pyrene	5.0E+02	4.5E+00	4.5E+01	4.5E+02
Benzo(b)fluoranthene	NC	4.5E+01	4.5E+02	4.5E+03
Dibenz(a,h)anthracene	NC	4.5E+00	4.5E+01	4.5E+02
Aluminum	2.0E+06	NC	NCC	NCC
Antimony	7.9E+02	NC	NCC	NCC
Cobalt	5.9E+02	2.1E+04	2.1E+05	2.1E+06
Copper	7.9E+04	NC	NCC	NCC
Iron	1.4E+06	NC	NCC	NCC
Manganese	4.7E+04	NC	NCC	NCC
Mercury	5.9E+02	NC	NCC	NCC
Silver	9.9E+03	NC	NCC	NCC
Thallium	2.0E+01	NC	NCC	NCC
Vanadium	9.9E+03	NC	NCC	NCC
Aldrin	5.9E+01	1.0E+00	1.0E+01	1.0E+02
Dieldrin	8.6E+01	9.5E-01	9.5E+00	9.5E+01
Aroclor 1254	3.3E+01	7.2E+00	7.2E+01	7.2E+02
Aroclor 1260	NC	7.2E+00	7.2E+01	7.2E+02

Notes:

Risk-based Soil Concentrations (RBCs) in units of milligrams per kilogram (mg/kg).

RBC-nc = RBC for noncancer effects

RBC-c = RBC for cancer effects, at stated target cancer risk (10^{-6} to 10^{-4})

NC = Not calculated

TABLE 5

NON-CANCER and CANCER TOXICITY DATA

Kenilworth Park Landfill, Washington, DC

Chemical of Potential Concern	Oral Reference Dose (RfD)		Inhalation Reference Concentration (RfC)		Oral Cancer Slope Factor (CSF)		Inhalation Unit Risk (IUR)		Primary Target Organs (Non Cancer)	Source (1)
	Value	Units	Value	Units	Value	Units	Value	Units		
Constituents of Concern										
Arsenic	3.0E-04	(mg/kg-day)	1.5E-05	mg/m^3	1.5E+00	$(mg/kg\text{-}day)^{-1}$	4.3E-03	$(ug/m^3)^{-1}$	Cardiovascular / Skin	IRIS
Benzo(a)anthracene	-		-		1.0E-01	$(mg/kg\text{-}day)^{-1}$	6.0E-05	$(ug/m^3)^{-1}$	-	IRIS*
Benzo(a)pyrene	3.0E-04	(mg/kg-day)	2.0E-06	mg/m^3	1.0E+00	$(mg/kg\text{-}day)^{-1}$	6.0E-04	$(ug/m^3)^{-1}$	Neurobehavioral	IRIS
Benzo(b)fluoranthene	-		-		1.0E-01	$(mg/kg\text{-}day)^{-1}$	6.0E-05	$(ug/m^3)^{-1}$	-	IRIS*
Dibenz(a,h)anthracene	-		-		1.0E+00	$(mg/kg\text{-}day)^{-1}$	6.0E-04	$(ug/m^3)^{-1}$	-	IRIS*
Aluminum	1.0E+00	(mg/kg-day)	5.0E-03	mg/m^3	-		-		Nervous System	PPRTV
Antimony (Metallic)	4.0E-04	(mg/kg-day)	3.0E-04	mg/m^3	-		-		Blood / Whole Body	IRIS (RfD) / ATSDR (RfC)
Cobalt	3.0E-04	(mg/kg-day)	6.0E-06	mg/m^3	-		9.0E-03	$(ug/m^3)^{-1}$	Thyroid / Respiratory	PPRTV
Copper	4.0E-02	(mg/kg-day)	-		-		-		Gastrointestinal	HEAST
Iron	7.0E-01	(mg/kg-day)	-		-		-		Gastrointestinal	PPRTV
Manganese (Non-Diet)	2.4E-02	(mg/kg-day)	5.0E-05	mg/m^3	-		-		Nervous System	IRIS
Mercury (Mercuric Chloride)	3.0E-04	(mg/kg-day)	3.0E-04	mg/m^3	-		-		Immune / Nervous / Urinary	IRIS
Silver	5.0E-03	(mg/kg-day)	-		-		-		Skin	IRIS
Thallium (Soluble Salts)	1.0E-05	(mg/kg-day)	-		-		-		Skin	PPRTV
Vanadium	5.0E-03	(mg/kg-day)	1.0E-04	mg/m^3	-		-		Skin / Respiratory	ATSDR
Aldrin	3.0E-05	(mg/kg-day)	-		1.7E+01	$(mg/kg\text{-}day)^{-1}$	4.9E-03	$(ug/m^3)^{-1}$	Liver	IRIS
Dieldrin	5.0E-05	(mg/kg-day)	-		1.6E+01	$(mg/kg\text{-}day)^{-1}$	4.6E-03	$(ug/m^3)^{-1}$	Liver	IRIS
Aroclor 1254	2.0E-05	(mg/kg-day)	-		2.0E+00	$(mg/kg\text{-}day)^{-1}$	5.7E-04	$(ug/m^3)^{-1}$	Skin / Immune / Ocular	IRIS
Aroclor 1260	-		-		2.0E+00	$(mg/kg\text{-}day)^{-1}$	5.7E-04	$(ug/m^3)^{-1}$	Skin / Immune / Ocular	IRIS

Notes

mg/kg-day = milligrams per kilogram per day

mg/m^3 = milligrams per cubic meter

$(ug/m^3)^{-1}$ = micrograms per cubic meter

"'-" = Not applicable

(1) IRIS = Integrated Risk Information System. IRIS Final Assessments Search. https://cfpub.epa.gov/ncea/iris_drafts/AtoZ.cfm. Values current as of September 2020.

*CSF and IUR for benzo(a)pyrene modified by applying relative potency factor.

PPRTV = EPA Provisional Peer-Reviewed Toxicity Values for Superfund. https://hhpprtv.ornl.gov/

ATSDR = Agency for Toxic Substances & Disease Registry. Minimal Risk Levels (MRLs) for Hazardous Substances. August 2020. https://www.atsdr.cdc.gov/mrls/mrllist.asp#16tag

HEAST = Health Effects Assessment Summary Tables for Superfund. https://epa-heast.ornl.gov/.

TABLE 6
SUMMARY OF RISK BASED CONCENTRATIONS FOR SOIL
SCENARIOS #1 THROUGH #4
Kenilworth Park Landfill
Washington, DC

Chemical of Potential Concern	SCENARIO #1: Active Recreator (High Use/High Intensity)			SCENARIO #2: Active Recreator (High Use/Moderate Intensity)			SCENARIO #3: Passive Recreator (Moderate Use/Moderate Intensity)			SCENARIO #4 (Low Use/Low Intensity)		
	RBC-c, 10^{-6}	RBC-c, 10^{-5}	RBC-c, 10^{-4}	RBC-c, 10^{-6}	RBC-c, 10^{-5}	RBC-c, 10^{-4}	RBC-c, 10^{-6}	RBC-c, 10^{-5}	RBC-c, 10^{-4}	RBC-c, 10^{-6}	RBC-c, 10^{-5}	RBC-c, 10^{-4}
Arsenic	6.8E-01	6.8E+00	3.5E+01	3.2E+00	3.2E+01	1.8E+02	4.5E+00	4.5E+01	2.3E+02	1.8E+01	1.8E+02	9.2E+02
Benzo(a)anthracene	1.5E+00	1.5E+01	1.5E+02	6.7E+00	6.7E+01	6.7E+02	1.1E+01	1.1E+02	1.1E+03	4.5E+01	4.5E+02	4.5E+03
Benzo(a)pyrene	1.1E-01	1.1E+00	1.1E+01	6.7E-01	6.7E+00	6.7E+01	1.1E+00	1.1E+01	1.1E+02	4.5E+00	4.5E+01	4.5E+02
Benzo(b)fluoranthene	1.1E+00	1.1E+01	1.1E+02	6.7E+00	6.7E+01	6.7E+02	1.1E+01	1.1E+02	1.1E+03	4.5E+01	4.5E+02	4.5E+03
Dibenz(a,h)anthracene	1.1E-01	1.1E+00	1.1E+01	6.7E-01	6.7E+00	6.7E+01	1.1E+00	1.1E+01	1.1E+02	4.5E+00	4.5E+01	4.5E+02
Aluminum	7.5E+04	7.5E+04	7.5E+04	4.3E+05	4.3E+05	4.3E+05	4.9E+05	4.9E+05	4.9E+05	2.0E+06	2.0E+06	2.0E+06
Antimony	3.1E+01	3.1E+01	3.1E+01	1.8E+02	1.8E+02	1.8E+02	2.0E+02	2.0E+02	2.0E+02	7.9E+02	7.9E+02	7.9E+02
Cobalt	2.3E+01	2.3E+01	2.3E+01	1.3E+02	1.3E+02	1.3E+02	1.5E+02	1.5E+02	1.5E+02	5.9E+02	5.9E+02	5.9E+02
Copper	3.1E+03	3.1E+03	3.1E+03	1.8E+04	1.8E+04	1.8E+04	2.0E+04	2.0E+04	2.0E+04	7.9E+04	7.9E+04	7.9E+04
Iron	5.5E+04	5.5E+04	5.5E+04	3.1E+05	3.1E+05	3.1E+05	3.5E+05	3.5E+05	3.5E+05	1.4E+06	1.4E+06	1.4E+06
Lead	1.5E+02	1.5E+02	1.5E+02	1.5E+02	1.5E+02	1.5E+02	3.0E+02	3.0E+02	3.0E+02	3.0E+02	3.0E+02	3.0E+02
Manganese	1.7E+03	1.7E+03	1.7E+03	1.0E+04	1.0E+04	1.0E+04	1.2E+04	1.2E+04	1.2E+04	4.7E+04	4.7E+04	4.7E+04
Mercury	2.3E+01	2.3E+01	2.3E+01	1.3E+02	1.3E+02	1.3E+02	1.5E+02	1.5E+02	1.5E+02	5.9E+02	5.9E+02	5.9E+02
Silver	3.9E+02	3.9E+02	3.9E+02	2.2E+03	2.2E+03	2.2E+03	2.5E+03	2.5E+03	2.5E+03	9.9E+03	9.9E+03	9.9E+03
Thallium	7.8E-01	7.8E-01	7.8E-01	4.4E+00	4.4E+00	4.4E+00	4.9E+00	4.9E+00	4.9E+00	2.0E+01	2.0E+01	2.0E+01
Vanadium	3.9E+02	3.9E+02	3.9E+02	2.2E+03	2.2E+03	2.2E+03	2.5E+03	2.5E+03	2.5E+03	9.9E+03	9.9E+03	9.9E+03
Aldrin	3.9E-02	3.9E-01	2.3E+00	2.1E-01	2.1E+00	1.3E+01	2.6E-01	2.6E+00	1.5E+01	1.0E+00	1.0E+01	5.9E+01
Dieldrin	3.4E-02	3.4E-01	3.2E+00	1.4E-01	1.4E+00	1.4E+01	2.4E-01	2.4E+00	2.2E+01	9.5E-01	9.5E+00	8.6E+01
Aroclor 1254	2.4E-01	1.2E+00	1.2E+00	1.0E+00	5.3E+00	5.3E+00	1.8E+00	8.2E+00	8.2E+00	7.2E+00	3.3E+01	3.3E+01
Aroclor 1260	2.4E-01	2.4E+00	2.4E+01	1.0E+00	1.0E+01	1.0E+02	1.8E+00	1.8E+01	1.8E+02	7.2E+00	7.2E+01	7.2E+02

Notes:

Risk-based Soil Concentrations (RBCs) in units of milligrams per kilogram (mg/kg).

RBC-c = The lowest value between the non-cancer based level, set at a a target hazard index of one, and the cancer risk-based level, set at either the 10^{-6}, 10^{-5} or 10^{-4} risk level. See Tables 1c, 2c, 3c and 4c.

Lead RBC for Scenarios #1 and #2 was calculated using Integrated Exposure Uptake Biokinetic Model; see Attachment 2. Lead RBC for Scenarios #3 and #4 is based on the RBC for Scenarios #1/#2, but adjusted for time spent on Site. See memorandum text for derivation.

ATTACHMENTS

ATTACHMENT 1: SUMMARY OF SOIL ANALYTICAL RESULTS

ATTACHMENT 1
SUMMARY OF SOIL ANALYTICAL RESULTS
Kenilworth Park Landfill
Washington, D.C.

Analyte	USEPA Residential Soil RSL	EPC	KWN-SU-1		KWN-SU-2		KWN-SU-3		KWN-SU-4		KWN-SU-5		KWN-SU-6		KWN-SU-7		KWN-SU-8		KWN-SU-9		KWN-SU-10		KWN-SU-11		KWN-SU-12		KWN-SS-23	KWN-SS-24
Semivolatiles (mg/kg)																												
2-Methylnaphthalene	24	--	2.7	U	4.8	U	2.1	U	0.43	U	0.44	U	0.39	U	4.8	U	0.44	U	0.48	U	0.42	U	0.037	J	8	U	ND	ND
4-Chloroaniline	2.7	--	2.7	U	0.36	J	2.1	U	0.23	J	0.027	J	0.39	U	4.8	U	0.093	J	0.092	J	0.42	U	0.23	J	8	U	0.944	ND
Acenaphthene	360	--	2.7	U	4.8	U	2.1	U	0.43	U	0.44	U	0.065	J	4.8	U	0.44	U	0.48	U	0.42	U	0.081	J	8	U	ND	ND
Acenaphthylene	360	--	2.7	U	4.8	U	2.1	U	0.038	J	0.44	U	0.04	J	4.8	U	0.044	J	0.026	J	0.036	J	0.11	J	8	U	0.425	0.143
Anthracene	1800	--	2.7	U	4.8	U	2.1	U	0.072	J	0.038	J	0.19	J	4.8	U	0.042	J	0.072	J	0.078	J	0.27	J	8	U	0.203	0.112
Benzo(a)anthracene	1.1	1.35	0.28	J	0.3	J	0.2	J	0.28	J	0.14	J	1.1		0.53	J	0.16	J	0.21	J	0.32	J	0.88		0.85	J	0.342	0.185
Benzo(a)pyrene	0.11	1.13	0.24	J	0.27	J	0.19	J	0.24	J	0.13	J	1.1		0.72	J	0.18	J	0.21	J	0.32	J	0.85		0.71	J	0.351	0.189
Benzo(b)fluoranthene	1.1	0.912	0.36	J	0.53	J	0.34	J	0.33	J	0.18	J	1.3		1	J	0.3	J	0.31	J	0.53		1.4		0.89	J	0.449	0.229
Benzo(ghi)perylene	180	--	2.7	U	4.8	U	2.1	U	0.22	J	0.12	J	0.72		0.36	J	0.12	J	0.13	J	0.18	J	0.41	J	0.41	J	0.143	0.088
Benzo(k)fluoranthene	11	0.912	2.7	U	4.8	U	2.1	U	0.43	U	0.44	U	0.24	J	4.8	U	0.12	J	0.48	U	0.4	J	1.5		8	U	0.421	0.255
Bis(2-ethylhexyl) phthalate	39	--	2.7	U	0.55	J	2.1	U	0.31	J	0.16	J	0.075	J	0.36	J	0.24	J	0.25	J	0.1	J	1.1		0.49	J	0.338	0.430
Butyl benzyl phthalate	290	--	2.7	U	4.8	U	2.1	U	0.045	J	0.44	U	0.39	U	4.8	U	0.067	J	0.038	J	0.42	U	0.061	J	8	U	ND	ND
Carbazole	--	--	2.7	U	4.8	U	2.1	U	0.042	J	0.024	J	0.07	J	4.8	U	0.44	U	0.027	J	0.03	J	0.11	J	8	U	ND	ND
Chrysene	110	--	0.26	J	0.27	J	0.19	J	0.29	J	0.15	J	0.99		0.52	J	0.18	J	0.22	J	0.32	J	0.83		0.7	J	0.396	0.195
Dibenzo(a,h)anthracene	0.11	0.62	2.7	U	4.8	U	2.1	U	0.057	J	0.033	J	0.22	J	0.38	J	0.034	J	0.042	J	0.056	J	0.13	J	8	U	NA	NA
Dibenzofuran	7.3	--	2.7	U	4.8	U	2.1	U	0.43	U	0.44	U	0.027	J	4.8	U	0.44	U	0.48	U	0.42	U	0.05	J	8	U	NA	NA
Di-n-butyl phthalate	630	--	2.7	U	4.8	U	2.1	U	0.055	J	0.44	U	0.39	U	4.8	U	0.027	J	0.046	J	0.42	U	0.095	J	8	U	ND	0.110
Fluoranthene	240	--	0.53	J	0.46	J	0.33	J	0.53		0.28	J	1.8		0.69	J	0.3	J	0.45	J	0.62		1.6		1.5	J	0.857	0.525
Naphthalene	3.8	--	2.7	U	4.8	U	2.1	U	0.43	U	0.44	U	0.39	U	4.8	U	0.44	U	0.48	U	0.42	U	0.049	J	8	U	NA	NA
Fluorene	240	--	2.7	U	4.8	U	2.1	U	0.022	J	0.44	U	0.05	J	4.8	U	0.44	U	0.48	U	0.42	U	0.083	J	8	U	ND	ND
Indeno(1,2,3-cd)pyrene	1.1	0.54	2.7	U	4.8	U	2.1	U	0.19	J	0.098	J	0.67		0.78	J	0.11	J	0.12	J	0.18	J	0.38	J	0.4	J	0.183	ND
Phenanthrene	180	--	0.35	J	4.8	U	0.15	J	0.27	J	0.14	J	0.76		0.26	J	0.13	J	0.27	J	0.32	J	0.95		0.85	J	0.384	0.221
Pyrene	180	--	0.39	J	0.34	J	0.24	J	0.45		0.21	J	1.5		0.69	J	0.24	J	0.32	J	0.50		1.2		1	J	0.318	0.254
Total PAH	--	--	2.41	J	2.17	J	1.64	J	2.99		1.519		10.7		5.93		1.96		2.38		3.86		10.72		7.31		NA	NA
Pesticides (mg/kg)																												
4,4´-DDD	0.19	--	NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		0.175	0.076
4,4'-DDE	2	--	0.022	U	0.24		0.0087	U	0.022	U	0.0091	U	0.008	U	0.049	U	0.022	U	0.024	U	0.021	U	0.022	U	0.02	U	0.283	ND
4,4´-DDT	1.9	--	NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		ND	0.298
Aldrin	0.039	--	NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		ND	ND
alpha-Chlordane	1.7	--	NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		0.410	0.247
delta-BHC	--	--	NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		ND	ND
Dieldrin	0.034	0.234	0.065		0.82		0.036		0.31		0.062		0.0087		0.11		0.13		0.15		0.060		0.25		0.18		0.494	0.344
Endosulfan I	47	--	NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		0.127	ND
Endosulfan II	47	--	NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		ND	ND
Endosulfan sulfate	--	--	NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA	NA
Endrin	1.9	--	NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		ND	0.036
Endrin aldehyde	--	--	0.022	U	0.049	U	0.0087	U	0.067		0.0091	U	0.008	U	0.049	U	0.022	U	0.024	U	0.021	U	0.031		0.18		ND	ND
Endrin ketone	--	--	NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		0.082	ND
gamma-Chlordane	1.7	0.202	NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		0.438	0.246
Heptachlor epoxide	0.07	--	0.022	U	0.049	U	0.0087	U	0.022	U	0.0091	U	0.008	U	0.049	U	0.022	U	0.024	U	0.021	U	0.054		0.045		NA	NA
Methoxychlor	32	--	0.022	U	0.049	U	0.0087	U	0.022	U	0.0091	U	0.025		0.049	U	0.022	U	0.024	U	0.021	U	0.022	U	0.02	U	NA	NA

ATTACHMENT 1
SUMMARY OF SOIL ANALYTICAL RESULTS
Kenilworth Park Landfill
Washington, D.C.

Analyte	USEPA Residential Soil RSL	EPC	KWN-SU-1	KWN-SU-2	KWN-SU-3	KWN-SU-4	KWN-SU-5	KWN-SU-6	KWN-SU-7	KWN-SU-8	KWN-SU-9	KWN-SU-10	KWN-SU-11	KWN-SU-12	KWN-SS-23	KWN-SS-24
PCBs (mg/kg)																
Aroclor 1254	0.12	1.33	0.54	5.3	0.31	2.4	0.54	0.28	0.92	1.4	1.4	0.56	2.0	1.3	6.980	3.350
Aroclor 1260	0.24	0.76	0.37	2.6	0.14	1.2	0.51	0.28	0.64	0.84	0.69	0.43	1.1	0.64	2.500	1.780
Metals (mg/kg)																
Aluminum	7700	7940	4510	7310	6400	8300	7180	8880	7670	3980	7730	6360	8160 J	7850	11,700	5,630
Antimony	3.1	9.01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	9.01	2.09
Arsenic	0.68	4.03	4.1	5.8	4.7	7.1	5.3	5.9	5.2	3.5	3.2	4.9	5.0	6.2	6.63	3.60
Barium	1500	--	69.5	444	80.8	338	165	104	188	159	254	141	277	325	490	398
Beryllium	16	--	0.39	0.74	0.47	0.61	0.54	0.52	0.53	0.55	0.62	0.57	0.59	0.56	0.842	0.594
Cadmium	7.1	3.55	0.55	6.0	0.43	4.1	1.7	0.57	3.1	2.1	3.4	1.4	3.1	3.4	7.95	6.83
Calcium	--	--	1520	11800	1600	5960	5340	3890	12900	3750	6840	3300	11600	10100	8,820	10,200
Chromium	12000	--	26.3	172	25.4	131	70.0	33.4	109	77.8	108	61.7	97.1	186	452	186
Cobalt	2.3	--	4.2	11.0	7.2	7.9	6.1	8.6	10.7	5.1	7.8	7.0	8.2	7.2	10.2	7.79
Copper	310	185	56.5	329	60.8	259	101	63.6	142	122	171	85.2	196 J	206	481	305
Iron	5500	20900	17500	24800	19100	21900	15600	20200	19600	13200	18000	17900	19900	18000	24,200	18,200
Lead	400	160	67.8	270	68.2	205	97.1	79.2	160	107	161	104	187	281	357	256
Magnesium	--	--	681	2230	781	1280	940	1040	5100	720	3050	1390	1940	1900	2,980	1,580
Manganese	180	316	98.7	366	181	234	258	278	407	151	296	258	302 J	217	289	245
Nickel	150	26.7	8.7	28.9	9.7	18.3	12.8	13.2	54.8	13.2	23.0	15.6	19.8	19.0	30.0	18.6
Potassium	--	--	355	782	714	664	563	791	800	610	2020	917	1010	910	1,490	609
Selenium	39	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	0.895
Silver	39	66.7	4.9	62.7	4.5	43.7	17.6	6.4	25.2	22.1	34.9	14.4	32.7	38.2	84.0	62.7
Sodium	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,410	933
Thallium	0.078	2.52	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.88	1.26
Vanadium	39	42.8	32.8	70.0	29.5	36.7	40.2	35.6	74.4	32.6	41.2	40.0	48.2	43.0	57.0	42.4
Zinc	2300	407	108	630	105	452	221	118	394	239	386	201	397	517	930	661
Mercury	1.1	6.14	1.4	4.1	0.55	3.3	1.3	0.60	1.9	1.6	3.0	1.4	1.7	2.3	9.45	6.50

Data taken from:
1) Remedial Investigation at the Kenilworth Park North Landfill (E&E, 2007)
2) Preliminary Assessment/Site Investigation of Kenilworth Park Landfill North (E&E, 2002)
3) Kenilworth Park Landfill North Geoprobe Sampling (E&E, 2000)
Surface soil samples were also collected by E&E in 2005 and published in a DCSEC Investigation, but this report could not be located at time of table creation
Concentrations are expressed in milligrams per kilogram (mg/kg)
ND indicates that the specified analyte was not detected
NA indicates that the specified analytes was not analyzed for or was not reported
J indicates an estimated value
U indicates the specified analyte was not detected at the reported value
U.S. Environmental Protection Agency (USEPA) Regional Screening Levels (RSLs) for Residential Soil (CR 10-6, HQ 0.1), November 2018.
Highlighted values exceed USEPA RSLs for Residential Soil.
i. The following surrogates were used for PAHs without screening toxicity values: acenaphthene RSL was used for acenaphthylene; and, pyrene RSL was used for benzo(g,h,i)perylene and phenanthrene.
ii. RSL for chromium III (insoluble salts) is used for screening purposes given known site history and likely contaminant sources (i.e., landfilling, and not on-site manufacturing operations).
iii. Nickel Soluble Salts RSL is used for comparison to nickel results.
iv. Endosulfan RSL is used for comparison to endosulfan I and endosulfan II results.

ATTACHMENT 1
SUMMARY OF SOIL ANALYTICAL RESULTS
Kenilworth Park Landfill
Washington, D.C.

Analyte	USEPA Residential Soil RSL	EPC	KWN-SS-25	KWN-SS-26	KWN-SS-27	KWN-SS-28	KWN-SS-29	KWN-SS-30	KWN-SS-31	KWN-SS-32	KWN-SS-33	KWN-SS-34	KWN-SS-35	KWN-SS-35 DUP	KWN-SS-36	KWN-SS-37	KL-SS-01		KL-SS-02		KL-SS-03		KL-SS-04	
Semivolatiles (mg/kg)																								
2-Methylnaphthalene	24	--	0.073	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA		NA		NA		NA	
4-Chloroaniline	2.7	--	1.160	ND	ND	ND	ND	1.440	ND	0.804	ND	ND	ND	ND	0.227	ND	ND		NA		ND		NA	
Acenaphthene	360	--	ND	0.085	ND	ND	ND	ND	ND	ND	ND	ND	0.147	0.065	ND	ND	ND		NA		ND		NA	
Acenaphthylene	360	--	0.144	0.298	0.138	0.102	0.119	ND	0.238	ND	0.075	ND	ND	0.089	0.133	0.074	ND		NA		ND		NA	
Anthracene	1800	--	0.084	0.263	0.098	0.119	0.087	ND	ND	ND	0.087	0.114	0.337	0.193	0.133	0.075	0.0833	J	NA		0.0449	J	NA	
Benzo(a)anthracene	1.1	1.35	0.150	0.519	0.124	0.354	0.197	0.344	ND	ND	0.190	0.257	0.668	0.396	0.300	0.200	0.327	J	NA		0.222	J	NA	
Benzo(a)pyrene	0.11	1.13	0.164	0.520	0.147	0.345	0.195	0.341	ND	ND	0.216	0.239	0.622	0.402	0.294	0.219	0.318	J	NA		0.245	J	NA	
Benzo(b)fluoranthene	1.1	0.912	0.277	0.629	0.194	0.326	0.236	0.424	ND	ND	0.234	0.267	0.539	0.480	0.386	0.282	0.348	J	NA		0.251	J	NA	
Benzo(ghi)perylene	180	--	0.084	0.167	ND	0.105	0.063	ND	ND	ND	0.104	ND	0.244	0.082	ND	0.084	0.314	J	NA		0.187	J	NA	
Benzo(k)fluoranthene	11	0.912	0.291	0.602	0.203	0.393	0.236	0.404	ND	ND	0.231	0.281	0.712	0.433	0.361	0.303	0.22	J	NA		0.223	J	NA	
Bis(2-ethylhexyl) phthalate	39	--	0.791	0.177	0.500	ND	0.163	0.629	0.323	0.363	0.069	ND	ND	0.129	0.146	0.162	3.41	E	NA		0.521		NA	
Butyl benzyl phthalate	290	--	0.105	0.116	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA		NA		NA		NA	
Carbazole	--	--	ND	0.147	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.077	ND	ND	NA		NA		NA		NA	
Chrysene	110	--	0.208	0.551	0.172	0.373	0.204	0.401	0.205	0.186	0.240	0.278	0.689	0.404	0.311	0.243	0.367	J	NA		0.252	J	NA	
Dibenzo(a,h)anthracene	0.11	0.62	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA		NA		NA	
Dibenzofuran	7.3	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA		NA		NA	
Di-n-butyl phthalate	630	--	0.131	ND	0.149	ND	ND	1.780	ND	ND	ND	ND	ND	ND	ND	ND	0.12	J	NA		0.168	J	NA	
Fluoranthene	240	--	0.472	1.880	0.377	0.814	0.481	0.935	0.329	0.262	0.437	0.695	1.740	1.160	0.945	0.646	0.553		NA		0.281	J	NA	
Naphthalene	3.8	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND		NA		ND		NA	
Fluorene	240	--	ND	0.072	ND	ND	ND	ND	ND	ND	ND	ND	0.149	0.078	ND	ND	ND		NA		ND		NA	
Indeno(1,2,3-cd)pyrene	1.1	0.54	ND	0.132	ND	0.088	ND	ND	0.481	ND	0.128	ND	0.251	0.068	ND	ND	0.335	J	NA		0.136	J	NA	
Phenanthrene	180	--	0.237	0.704	0.151	0.288	0.166	0.486	0.193	ND	0.190	0.310	1.100	0.564	0.293	0.184	0.289	J	NA		0.203	J	NA	
Pyrene	180	--	0.288	0.708	0.143	0.410	0.193	0.395	0.245	ND	0.161	0.229	0.696	0.378	0.339	0.277	0.583		NA		0.514		NA	
Total PAH	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA		NA		NA	
Pesticides (mg/kg)																								
4,4´-DDD	0.19	--	0.140	0.024	0.070	0.004	0.007	0.109	0.041	0.047	0.007	0.003	0.018	0.015	0.014	0.027	0.037	J	NA		0.042	J	NA	
4,4'-DDE	2	--	ND	ND	0.110	0.010	0.036	0.120	0.084	ND	0.025	0.003	0.046	0.043	0.050	0.036	0.023	J	NA		ND		NA	
4,4´-DDT	1.9	--	0.377	ND	ND	0.008	0.006	0.034	0.028	ND	0.041	ND	0.018	0.018	0.013	0.013	0.168		NA		0.226		NA	
Aldrin	0.039	--	ND	ND	ND	0.005	0.015	ND	ND	ND	0.004	ND	0.012	ND	ND	ND	0.008	J	NA		0.040	J	NA	
alpha-Chlordane	1.7	--	0.389	0.076	0.229	0.009	0.040	0.337	0.181	0.312	0.023	0.004	0.066	0.059	0.101	0.052	0.151		NA		0.193		NA	
delta-BHC	--	--	ND	ND	ND	ND	0.003	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA		NA		NA		NA	
Dieldrin	0.034	0.234	0.526	0.134	0.324	0.016	0.099	0.426	0.237	0.372	0.015	ND	0.129	0.118	0.162	0.076	0.117		NA		0.171		NA	
Endosulfan I	47	--	ND	0.024	0.053	0.005	0.015	0.057	0.037	0.057	0.004	ND	0.024	0.023	0.026	0.022	NA		NA		NA		NA	
Endosulfan II	47	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.081	ND	ND	0.094	NA		NA		NA		NA	
Endosulfan sulfate	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND		NA		ND		NA	
Endrin	1.9	--	0.061	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.034	J	NA		0.035	J	NA	
Endrin aldehyde	--	--	0.377	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA		NA		NA		NA	
Endrin ketone	--	--	ND	ND	ND	0.008	0.019	ND	ND	ND	0.010	0.003	ND	ND	ND	ND	NA		NA		NA		NA	
gamma-Chlordane	1.7	0.202	0.373	0.082	0.221	0.012	0.045	0.340	0.175	0.324	0.015	0.010	0.061	0.053	0.104	0.041	0.127		NA		0.189		NA	
Heptachlor epoxide	0.07	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND		NA		ND		NA	
Methoxychlor	32	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND		NA		ND		NA	

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Analyte	USEPA Residential Soil RSL	EPC	KWN-SS-25	KWN-SS-26	KWN-SS-27	KWN-SS-28	KWN-SS-29	KWN-SS-30	KWN-SS-31	KWN-SS-32	KWN-SS-33	KWN-SS-34	KWN-SS-35	KWN-SS-35 DUP	KWN-SS-36	KWN-SS-37	KL-SS-01	KL-SS-02	KL-SS-03	KL-SS-04
PCBs (mg/kg)																				
Aroclor 1254	0.12	1.33	4.730	1.070	2.510	0.210	0.959	4.080	2.240	3.240	0.296	0.052	1.050	0.936	1.510	1.160	ND	NA	ND	NA
Aroclor 1260	0.24	0.76	2.810	0.866	1.490	0.236	0.743	2.680	1.720	2.040	0.307	0.049	0.720	0.561	0.859	0.722	ND	NA	ND	NA
Metals (mg/kg)																				
Aluminum	7700	7940	6,850	7,490	8,910	9,350	8,940	9,150	6,070	7,860	4,470	7,600	10,100	9,870	NA	8,400	4350	5210	4870	5490
Antimony	3.1	9.01	3.15	1.33	2.56	1.52	2.47	2.06	1.38	2.16	3.78	1.14	1.88	8.01	NA	1.09	5.18	9.74	5.44	2.10
Arsenic	0.68	4.03	5.81	3.58	2.96	3.18	3.35	6.30	2.80	5.78	1.92	1.49	3.29	3.69	NA	2.83	4.69	5.74	4.19	4.14
Barium	1500	--	616	226	433	116	230	637	388	619	268	46.7	240	223	NA	214	277	461	282	98.4
Beryllium	16	--	0.704	0.546	0.648	0.615	0.528	0.829	0.610	0.790	0.396	0.425	0.585	0.570	NA	0.716	0.542	ND	ND	0.552
Cadmium	7.1	3.55	10.5	3.24	7.05	1.34	4.08	10.2	6.20	10.2	1.76	0.589	3.49	3.23	NA	3.22	6.06	9.59	6.26	3.21
Calcium	--	--	10,700	23,100	12,000	3,510	5,160	12,900	7,440	10,900	2,830	6,300	6,530	5,980	NA	6,490	7480	7460	6300	3730
Chromium	12000	--	302	87.8	212	41.9	101	268	218	273	44.4	20.2	111	110	NA	170	143	293	181	32.2
Cobalt	2.3	--	9.79	12.1	9.31	9.04	9.87	9.74	6.99	9.19	8.43	8.13	11.1	10.8	NA	8.73	7.66	7.71	9.79	8.26
Copper	310	185	537	143	345	80.3	195	480	293	519	141	32.8	180	170	NA	148	197	395	221	68.6
Iron	5500	20900	21,400	17,300	22,000	18,700	24,200	22,200	16,400	19,700	19,200	13,600	22,100	23,700	NA	16,500	19700	19900	16500	31600
Lead	400	160	377	146	270	114	155	407	236	377	396	50.6	159	149	NA	177	256	304	212	152
Magnesium	--	--	1,660	3,250	1,750	1,790	1,100	2,190	1,380	2,050	1,470	1,700	1,290	1,210	NA	2,280	1200	1370	6610	1570
Manganese	180	316	292	521	286	214	269	326	194	269	264	236	371	386	NA	231	201	204	215	230
Nickel	150	26.7	24.2	15.2	21.8	14.3	22.8	31.3	17.1	25.6	31.9	16.4	14.9	16.6	NA	23.3	18.6	22.4	70.7	16.4
Potassium	--	--	481	851	689	1,040	566	769	605	562	736	489	788	741	NA	1,480	302	470	398	983
Selenium	39	--	ND	ND	ND	ND	ND	1.15	ND	0.875	ND	ND	ND	ND	NA	ND	1.33	1.95	ND	1.29
Silver	39	66.7	97.2	28.5	66.1	8.74	33.1	97.2	58.0	102	8.60	1.27	31.4	30.7	NA	29.7	38.7	76.0	45.4	4.70
Sodium	--	--	1,470	221	993	163	257	1,500	858	1,540	272	128	227	135	NA	328	ND	ND	ND	ND
Thallium	0.078	2.52	1.92	ND	1.80	1.61	2.28	1.38	0.954	1.71	1.72	0.911	1.31	2.23	NA	0.770	ND	ND	ND	ND
Vanadium	39	42.8	48.1	45.3	54.8	31.9	50.8	56.7	34.6	46.1	26.4	45.6	42.9	49.5	NA	51.0	35.9	42.0	36.1	36.5
Zinc	2300	407	960	310	727	284	395	1,020	622	990	336	93.8	348	317	NA	370	520	766	506	159
Mercury	1.1	6.14	5.68	4.39	7.57	1.00	3.59	9.25	5.47	9.31	0.899	0.215	3.39	3.19	NA	2.93	6.10	8.25	4.22	1.09

Data taken from:
1) Remedial Investigation at the Kenilworth Park North Landfill (E&E, 2007)
2) Preliminary Assessment/Site Investigation of Kenilworth Park Landfill North (E&E, 2002)
3) Kenilworth Park Landfill North Geoprobe Sampling (E&E, 2000)
Surface soil samples were also collected by E&E in 2005 and published in a DCSEC Investigation, but this report could not be located at time of table creation

Concentrations are expressed in milligrams per kilogram (mg/kg)
ND indicates that the specified analyte was not detected
NA indicates that the specified analytes was not analyzed for or was not reported
J indicates an estimated value
U indicates the specified analyte was not detected at the reported value
U.S. Environmental Protection Agency (USEPA) Regional Screening Levels (RSLs) for Residential Soil (CR 10-6, HQ 0.1), November 2018.
Highlighted values exceed USEPA RSLs for Residential Soil.
i. The following surrogates were used for PAHs without screening toxicity values: acenaphthene RSL was used for acenaphthylene; and, pyrene RSL was used for benzo(g,h,i)perylene and phenanthrene.
ii. RSL for chromium III (insoluble salts) is used for screening purposes given known site history and likely contaminant sources (i.e., landfilling, and not on-site manufacturing operations).
iii. Nickel Soluble Salts RSL is used for comparison to nickel results.
iv. Endosulfan RSL is used for comparison to endosulfan I and endosulfan II results.

ATTACHMENT 1
SUMMARY OF SOIL ANALYTICAL RESULTS
Kenilworth Park Landfill
Washington, D.C.

Analyte	USEPA Residential Soil RSL	EPC	KL-SS-05	KL-SS-06	KL-SS-07	KL-SS-08	KL-SS-09	KL-SS-10	KL-SS-11	KL-SS-12	KL-SS-13	KL-SS-14	KL-SS-15	KL-SS-16	KL-SS-17	KL-SS-18	KL-SS-19	KL-SS-19 DUP
Semivolatiles (mg/kg)																		
2-Methylnaphthalene	24	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Chloroaniline	2.7	--	NA	ND	NA	ND	0.354 J	NA	ND	NA	NA	NA	0.357 J	ND	NA	NA	ND	ND
Acenaphthene	360	--	NA	0.0867 J	NA	ND	ND	NA	ND	NA	NA	NA	ND	ND	NA	NA	0.0968 J	ND
Acenaphthylene	360	--	NA	0.0566 J	NA	ND	ND	NA	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND
Anthracene	1800	--	NA	0.197 J	NA	0.0488 J	ND	NA	ND	NA	NA	NA	ND	ND	NA	NA	0.221 J	0.102 J
Benzo(a)anthracene	1.1	1.35	NA	0.679	NA	0.172 J	0.129 J	NA	0.0837 J	NA	NA	NA	0.316 J	0.0643 J	NA	NA	0.633 J	0.547 J
Benzo(a)pyrene	0.11	1.13	NA	0.68	NA	0.181 J	0.154 J	NA	0.0769 J	NA	NA	NA	0.279 J	0.0628 J	NA	NA	0.489 J	0.497 J
Benzo(b)fluoranthene	1.1	0.912	NA	0.627	NA	0.209 J	0.203 J	NA	0.0844 J	NA	NA	NA	0.352 J	0.0579 J	NA	NA	0.544 J	0.528 J
Benzo(ghi)perylene	180	--	NA	0.588	NA	0.164 J	ND	NA	ND	NA	NA	NA	0.176 J	ND	NA	NA	0.185 J	0.183 J
Benzo(k)fluoranthene	11	0.912	NA	0.533	NA	0.143 J	0.218 J	NA	0.111 J	NA	NA	NA	0.33 J	ND	NA	NA	0.515 J	0.533 J
Bis(2-ethylhexyl) phthalate	39	--	NA	0.283 J	NA	0.207 J	0.932	NA	0.304 J	NA	NA	NA	0.637 J	ND	NA	NA	0.227 J	0.198 J
Butyl benzyl phthalate	290	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbazole	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	110	--	NA	0.643	NA	0.18 J	0.169 J	NA	0.088 J	NA	NA	NA	0.366 J	0.0641 J	NA	NA	0.637 J	0.572 J
Dibenzo(a,h)anthracene	0.11	0.62	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzofuran	7.3	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Di-n-butyl phthalate	630	--	NA	0.0861 J	NA	ND	ND	NA	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND
Fluoranthene	240	--	NA	0.973	NA	0.255 J	0.165 J	NA	0.0992 J	NA	NA	NA	0.406 J	0.0952 J	NA	NA	0.861	0.679 J
Naphthalene	3.8	--	NA	0.0756 J	NA	ND	ND	NA	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND
Fluorene	240	--	NA	0.0977 J	NA	ND	ND	NA	ND	NA	NA	NA	ND	ND	NA	NA	0.0904 J	ND
Indeno(1,2,3-cd)pyrene	1.1	0.54	NA	0.718	NA	0.165 J	ND	NA	ND	NA	NA	NA	ND	ND	NA	NA	ND	ND
Phenanthrene	180	--	NA	0.707	NA	0.151 J	0.17 J	NA	0.0883 J	NA	NA	NA	0.327 J	0.0657 J	NA	NA	0.926	0.427 J
Pyrene	180	--	NA	1.05	NA	0.299 J	0.432 J	NA	0.248 J	NA	NA	NA	0.928	0.108 J	NA	NA	1.76	1.5
Total PAH	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pesticides (mg/kg)																		
4,4´-DDD	0.19	--	NA	0.007 J	NA	0.038 J	0.066	NA	0.016	NA	NA	NA	0.037 J	ND	NA	NA	0.010 J	0.012 J
4,4'-DDE	2	--	NA	0.018 J	NA	0.057 J	0.014 J	NA	0.009 J	NA	NA	NA	0.062 J	0.00241 J	NA	NA	0.005 J	0.003 J
4,4´-DDT	1.9	--	NA	0.069	NA	0.246	ND	NA	0.067	NA	NA	NA	ND	0.00586 J	NA	NA	ND	0.043
Aldrin	0.039	--	NA	0.014	NA	0.049	ND	NA	0.004 J	NA	NA	NA	0.020 J	0.00136 J	NA	NA	ND	ND
alpha-Chlordane	1.7	--	NA	0.059	NA	0.174	0.259	NA	0.030	NA	NA	NA	0.206	0.00479 J	NA	NA	0.035	0.041
delta-BHC	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dieldrin	0.034	0.234	NA	0.071	NA	0.10	0.390	NA	0.079	NA	NA	NA	0.364	ND	NA	NA	0.039	0.053
Endosulfan I	47	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endosulfan II	47	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endosulfan sulfate	--	--	NA	ND	NA	ND	ND	NA	0.005 J	NA	NA	NA	ND	ND	NA	NA	0.005 J	ND
Endrin	1.9	--	NA	0.011 J	NA	0.058 J	0.022 J	NA	0.015	NA	NA	NA	0.030 J	ND	NA	NA	0.005 J	0.008 J
Endrin aldehyde	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endrin ketone	--	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
gamma-Chlordane	1.7	0.202	NA	0.042	NA	0.093	0.272	NA	0.026	NA	NA	NA	0.288	0.00356 J	NA	NA	0.034	0.037
Heptachlor epoxide	0.07	--	NA	0.026	NA	ND	0.011 J	NA	ND	NA	NA	NA	ND	0.00263 J	NA	NA	ND	ND
Methoxychlor	32	--	NA	0.026 J	NA	ND	ND	NA	ND	NA	NA	NA	ND	ND	NA	NA	0.010 J	ND

ATTACHMENT 1
SUMMARY OF SOIL ANALYTICAL RESULTS
Kenilworth Park Landfill
Washington, D.C.

Analyte	USEPA Residential Soil RSL	EPC	KL-SS-05	KL-SS-06	KL-SS-07	KL-SS-08	KL-SS-09	KL-SS-10	KL-SS-11	KL-SS-12	KL-SS-13	KL-SS-14	KL-SS-15	KL-SS-16	KL-SS-17	KL-SS-18	KL-SS-19	KL-SS-19 DUP
PCBs (mg/kg)																		
Aroclor 1254	0.12	1.33	NA	ND	NA	ND	2.91	NA	0.60	NA	NA	NA	3.40	ND	NA	NA	0.42	0.48
Aroclor 1260	0.24	0.76	NA	ND	NA	ND	1.48	NA	0.45	NA	NA	NA	4.53	ND	NA	NA	0.34	0.35
Metals (mg/kg)																		
Aluminum	7700	7940	9210	5450	8270	4710	4660	6370	5140	6480	6130	4810	9850	6020	8670	7740	3190	3130
Antimony	3.1	9.01	24.7	1.70	ND	3.77	6.30	4.03	3.20	5.25	5.17	4.89	9.49	1.64	15.4	107	1.88	2.13
Arsenic	0.68	4.03	10.6	5.12	4.29	3.89	3.87	3.44	3.53	4.52	5.01	3.35	8.66	2.34	9.32	7.22	2.86	3.08
Barium	1500	--	896	108	195	179	455	222	209	193	263	269	664	36.7	545	416	99.7	103
Beryllium	16	--	ND	ND	ND	ND	0.668	0.711	0.708	0.842	0.767	ND	0.874	0.688	0.878	0.745	ND	ND
Cadmium	7.1	3.55	17.9	2.56	4.24	3.83	9.06	5.57	4.51	4.57	5.99	5.25	13.7	2.36	10.2	8.50	2.16	2.55
Calcium	--	--	12100	3200	5050	3110	7230	6140	9610	4460	9110	6170	26400	1840	15200	6270	5760	6720
Chromium	12000	--	820	42.6	79.2	125	182	109	88.4	105	137	128	299	27.6	469	192	41.6	48.5
Cobalt	2.3	--	10.0	7.03	9.84	7.89	8.98	10.0	9.94	13.3	9.68	7.98	8.05	10.0	9.65	12.5	4.73	6.63
Copper	310	185	802	74.8	130	131	391	186	158	114	192	188	559	23.0	463	319	53.8	62.5
Iron	5500	20900	26400	14900	21300	14500	20700	21900	20100	25100	27000	16300	33300	33600	24600	25000	11000	13100
Lead	400	160	567	77.6	119	119	313	165	131	139	196	198	453	47.2	376	1350	67.6	73.3
Magnesium	--	--	2480	1930	2650	1670	1430	1830	1780	1120	2320	1420	2110	725	3100	1810	2030	2630
Manganese	180	316	319	213	304	186	284	453	491	451	286	274	270	305	303	410	256	263
Nickel	150	26.7	37.0	16.9	18.8	18.8	23.2	18.9	19.8	19.0	22.1	17.7	25.5	11.4	30.5	21.2	16.4	35.4
Potassium	--	--	637	614	1310	809	446	713	500	648	685	495	466	495	1260	379	338	341
Selenium	39	--	ND	ND	ND	ND	ND	2.10	1.02	4.63	2.29	1.36	2.35	3.43	1.55	2.25	ND	ND
Silver	39	66.7	158	10.2	23.7	27.4	69.4	32.5	29.5	26.1	37.2	36.3	106	0.870	90.3	63.3	8.89	10.1
Sodium	--	--	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	91.1	ND	ND	ND	ND	ND
Thallium	0.078	2.52	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium	39	42.8	56.3	26.9	37.4	37.4	42.6	43.7	39.1	50.8	48.7	34.7	50.9	49.0	55.3	42.5	23.4	23.8
Zinc	2300	407	1920	165	281	327	751	392	359	264	455	453	1080	52.1	1150	642	133	160
Mercury	1.1	6.14	17.2	2.36	3.36	4.46	9.20	5.32	3.47	4.20	5.29	5.79	13.6	0.400	7.33	2.99	0.186	1.05

Data taken from:
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2) Preliminary Assessment/Site Investigation of Kenilworth Park Landfill North (E&E, 2002)
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Surface soil samples were also collected by E&E in 2005 and published in a DCSEC Investigation, but this report could not be located at time of table creation

Concentrations are expressed in milligrams per kilogram (mg/kg)
ND indicates that the specified analyte was not detected
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J indicates an estimated value
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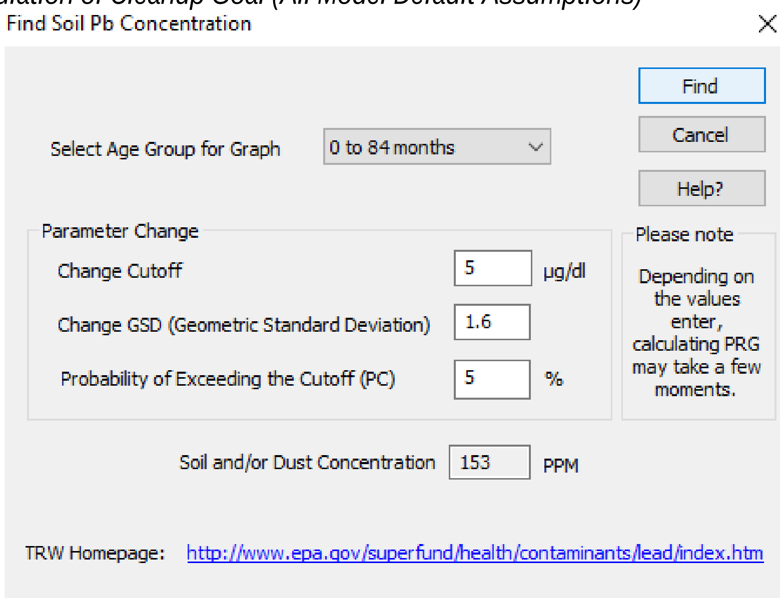
U.S. Environmental Protection Agency (USEPA) Regional Screening Levels (RSLs) for Residential Soil (CR 10-6, HQ 0.1), November 2018.
Highlighted values exceed USEPA RSLs for Residential Soil.

i. The following surrogates were used for PAHs without screening toxicity values: acenaphthene RSL was used for acenaphthylene; and, pyrene RSL was used for benzo(g,h,i)perylene and phenanthrene.
ii. RSL for chromium III (insoluble salts) is used for screening purposes given known site history and likely contaminant sources (i.e., landfilling, and not on-site manufacturing operations).
iii. Nickel Soluble Salts RSL is used for comparison to nickel results.
iv. Endosulfan RSL is used for comparison to endosulfan I and endosulfan II results.

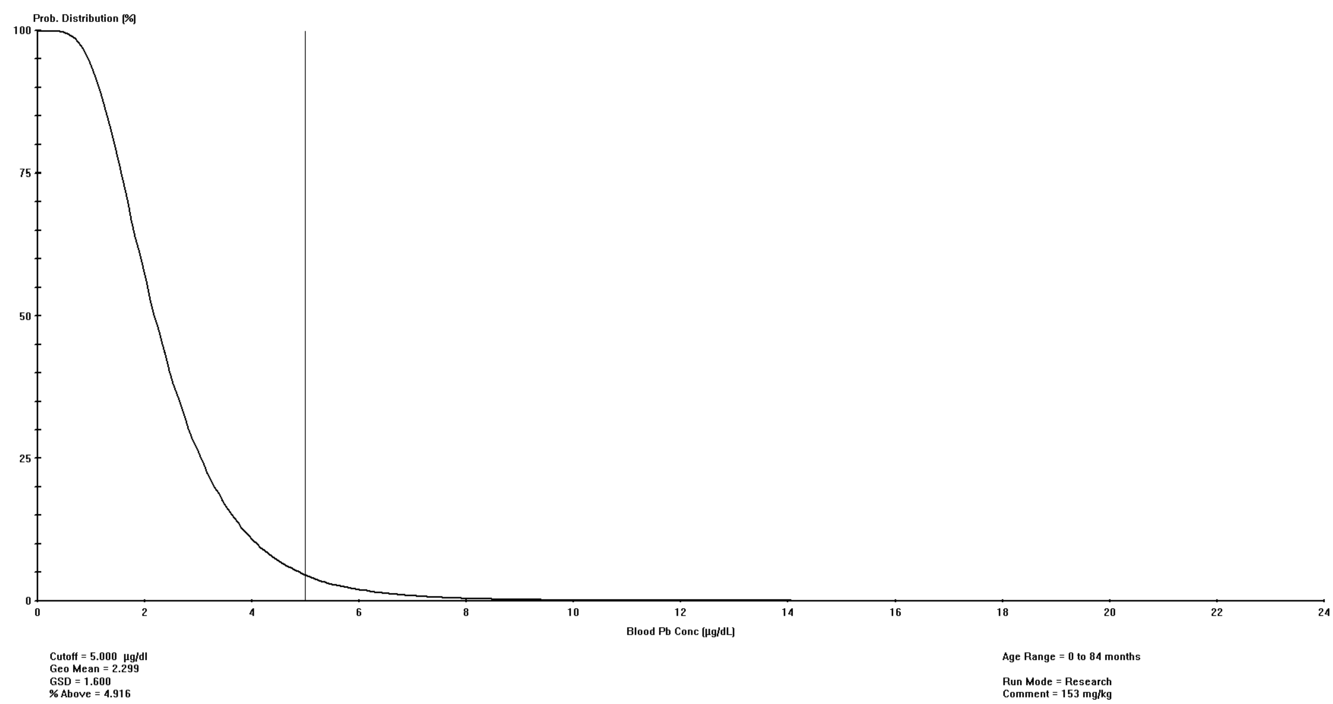
ATTACHMENT 2: INTEGRATED EXPOSURE UPTAKE BIOKINETIC MODEL – RISK-BASED CONCENTRATIONS (RBC) FOR LEAD

Risk-Based Concentration for Lead
High-Intensity Active Recreational Use Scenario
Lead RBC = 153 mg/kg

IEUBK Output -Calculation of Cleanup Goal (All Model Default Assumptions)



Probability Distribution Chart, 153 PPM Lead.



APPENDIX B DETAILED OPINION OF COSTS & ASSUMPTIONS

TABLE B.1
Cost Estimate for Alternative 1: No Action
Feasibility Study Addendum Report
Kenilworth Park Landfill Site, Washington, DC

CAPITAL COSTS	Qty	Unit	Unit Cost	Ext. Cost	Comments
None					

ANNUAL O&M COSTS	Qty	Unit	Unit Cost	Ext. Cost	Comments
None					

PERIODIC COSTS	Qty	Unit	Unit Cost	Ext. Cost	Comments
Five year review (FYR)	1	LS	$30,000	$30,000	Engineers estimate, based on experience.

PRESENT VALUE ANALYSIS	Year	Discount Factor	Total Cost	Present Value	Comments
Periodic Cost	5	0.980	$30,000	$29,407	Five year review (FYR)
Periodic Cost	10	0.961	$30,000	$28,826	Five year review (FYR)
Periodic Cost	15	0.942	$30,000	$28,256	Five year review (FYR)
Periodic Cost	20	0.923	$30,000	$27,698	Five year review (FYR)
Periodic Cost	25	0.905	$30,000	$27,151	Five year review (FYR)
Periodic Cost	30	0.887	$30,000	$26,614	Five year review (FYR)
			TOTAL, Present Value of Alternative:	**$167,952**	

References:
1. "Means" indicates unit cost for noted section item from "2018 Site Work & Landscape Costs Book with RSMeans Data", Gordian, 2017.
2. U.S. Environmental Proction Agency (EPA), 2000. "A Guide to Developing and Documenting Cost Estimates during the Feasibility Study", EPA 540-R-00-002 / OSWER 9355.0-75, July 2000.
3. Consistent with the November 2019 update of Appendix C of the Office of Management and Budget (OMB) Circular A-94, Guidelines and Discount Rates for Benefit-Cost Analyses of Federal Programs (OMB Circular A-94) and EPA, 2000, a discount factor of 0.4% has been used for the present value analysis.

TABLE B.2
Cost Estimate for Alternative 2: Limited Action / Institutional Controls
Feasibility Study Addendum Report
Kenilworth Park Landfill Site, Washington, DC

CAPITAL COSTS	Qty	Unit	Unit Cost	Ext. Cost	Comments
Construction Services					
Soil gas implant installation	15	ea	$1,500	$22,500	Engineers estimate, based on experience.
Institutional controls / site management plan	1	LS	$25,000	$25,000	Engineers estimate, based on experience.
			Subtotal, Construction Services:	$47,500	
Scope Contingency	1	LS	$7,125	$7,125	Assume 15% of Construction Services subtotal (EPA, 2000).
Bid Contingency	1	LS	$4,750	$4,750	Assume 10% of Construction Services subtotal (EPA, 2000).
			Subtotal, Construction Services including Contingencies:	**$59,375**	
Professional/Technical Services					
Project Management	1	LS	$5,937.50	$5,938	Project Managment cost estimated based on CERCLA guidance (EPA, 2000, Exhibit 5-8).
Remedial Design	1	LS	$11,875.00	$11,875	Remedial Design cost estimated based on CERCLA guidance (EPA, 2000, Exhibit 5-8).
Construction Management	1	LS	$8,906.25	$8,906	Construction Managment cost estimated based on CERCLA guidance (EPA, 2000, Exhibit 5-8).
			Subtotal, Professional/Technical Services:	**$26,719**	
			TOTAL, Capital Costs:	**$86,094**	

ANNUAL O&M COSTS	Qty	Unit	Unit Cost	Ext. Cost	Comments
Soil gas monitoring event	1	LS	$25,000	$25,000	Engineers estimate, based on experience.
			TOTAL, Annual O&M Costs:	**$25,000**	

PERIODIC COSTS	Qty	Unit	Unit Cost	Ext. Cost	Comments
Soil gas implant decommissioning	1	LS	$20,000	$20,000	Engineers estimate, based on experience.
Five year review (FYR)	1	LS	$30,000	$30,000	Engineers estimate, based on experience.

TABLE B.2
Cost Estimate for Alternative 2: Limited Action / Institutional Controls
Feasibility Study Addendum Report
Kenilworth Park Landfill Site, Washington, DC

PRESENT VALUE ANALYSIS	Year	Discount Factor	Total Cost	Present Value	Comments
Capital Cost	0	1.000	$86,094	$86,094	
Annual O&M Cost	1-5	4.941	$25,000	$123,514	Soil gas monitoring event
Periodic Cost	5	0.980	$50,000	$49,012	Five year review (FYR); Soil gas implant decommissioning
Periodic Cost	10	0.961	$30,000	$28,826	Five year review (FYR)
Periodic Cost	15	0.942	$30,000	$28,256	Five year review (FYR)
Periodic Cost	20	0.923	$30,000	$27,698	Five year review (FYR)
Periodic Cost	25	0.905	$30,000	$27,151	Five year review (FYR)
Periodic Cost	30	0.887	$30,000	$26,614	Five year review (FYR)
			TOTAL, Present Value of Alternative:	**$397,164**	

References:
1. "Means" indicates unit cost for noted section item from "2018 Site Work & Landscape Costs Book with RSMeans Data", Gordian, 2017.
2. U.S. Environmental Proction Agency (EPA), 2000. "A Guide to Developing and Documenting Cost Estimates during the Feasibility Study", EPA 540-R-00-002 / OSWER 9355.0-75, July 2000.
3. Consistent with the November 2019 update of Appendix C of the Office of Management and Budget (OMB) Circular A-94, Guidelines and Discount Rates for Benefit-Cost Analyses of Federal Programs (OMB Circular A-94) and EPA, 2000, a discount factor of 0.4% has been used for the present value analysis.

TABLE B.3
Cost Estimate for Alternative 3: Selective Placement of Clean Soil Barriers Institutional Controls
Feasibility Study Addendum Report
Kenilworth Park Landfill Site, Washington, DC

CAPITAL COSTS	Qty	Unit	Unit Cost	Ext. Cost	Comments
Construction Services					
Contractor mobilization / demobilization					
Small equipment	2	Ea	$320	$639	Means 01 54 36.50 1300
Medium equipment	4	Ea	$888	$3,554	Means 01 54 36.50 1400
Large equipment	4	Ea	$3,088	$12,352	Means 01 54 36.50 1600
Site facilities					
Office trailer, rental	6	Mo	$295	$1,768	Means 01 52 13.20 0350
Temporary electrical service	1	Ea	$1,327	$1,327	Means 01 51 13.50 0040
Site security & control					
Site security service	4380	Hr	$30	$130,508	Means 01 56 32.50 0020
Silt fencing / erosion control	5000	LF	$2.04	$10,185	Means 31 25 14.16 1000
Silt fencing maintenance	12	Mo	$1,018	$12,222	Means 31 25 14.16 1100
Dust & traffic control	100	Day	$1,111	$111,059	Means 31 23 23.20 2500
H&S / decontamination	6	Mo	$5,000	$30,000	Engineers estimate, based on experience.
Selective site demolition					
Pavement removal, bituminous	10,434	SY	$6.23	$65,008	Means 02 41 13.17 5010
Pavement removal, concrete up to 6"	2,988	SY	$17	$50,667	Means 02 41 13.17 5200
Small building demolition	3	Ea	$4,171	$12,514	Means 02 41 16.13 1000
Waste transportion / hauling	1,627	LCY	$13	$21,857	Means 31 23 23.20 4714
Waste disposal as ADC at Subtitle D facility	3,091	Ton	$32	$98,909	Engineers estimate, based on experience.
Site preparation					
Rough grading, small area	4	Ea	$1,652	$6,609	Means 31 22 13.20 0220
Rough grading, medium area	1	Ea	$2,492	$2,492	Means 31 22 13.20 0250
Rough grading, large area	2	Ea	$5,553	$11,106	Means 31 22 13.20 0280
Confirmatory ISM soil sampling	11	acre	$2,500	$28,002	Engineers estimate, based on experience.
Barrier installation					
Demarcation layer, woven geotextile	291,145	SY	$1.54	$447,946	Means 31 32 19.16 1500
Backfill transportion / hauling	121,310	LCY	$5.58	$676,914	Means 31 23 23.20 4108
Backfill, common earth	48,524	BCY	$22	$1,046,260	Means 31 23 23.15 4070; assumes 6-inch thickness
Backfill, topsoil	48,524	BCY	$31	$1,498,412	Means 31 23 23.15 7070; assumes 6-inch thickness
Rough grading, large area	26	Ea	$5,553	$145,504	Means 31 22 13.20 0280
Backfill compaction	97,048	ECY	$1.05	$101,997	Means 31 23 23.23 5600

TABLE B.3

Cost Estimate for Alternative 3: Selective Placement of Clean Soil Barriers Institutional Controls

Feasibility Study Addendum Report

Kenilworth Park Landfill Site, Washington, DC

Hydro seeding, with fertilizer	320,259	SY	$0.88	$281,071	Means 32 92 19.13 1000; assumes 110% of barrier area
Trail / access road resurfacing	2,838	SY	$4.75	$13,467	Means 32 11 23.23 0050
Site restoration					
Driveway repaving	28,000	SF	$2.87	$80,396	Means 32 12 16.14 0020
Asphalt transportion / hauling	519	CY	$13	$6,967	Means 31 23 23.20 4108
Parking area replacement	13,867	SY	$4.75	$65,807	Means 32 11 23.23 0050
Soil gas implant installation	15	ea	$1,500	$22,500	Engineers estimate, based on experience.
Institutional controls / site management plan	1	LS	$25,000	$25,000	Engineers estimate, based on experience.
			Subtotal, Construction Services:	$5,023,018	
Scope Contingency	1	LS	$753,453	$753,453	Assume 15% of Construction Services subtotal (EPA, 2000).
Bid Contingency	1	LS	$502,302	$502,302	Assume 10% of Construction Services subtotal (EPA, 2000).
			Subtotal, Construction Services including Contingencies:	**$6,278,772**	
Professional/Technical Services					
Project Management	1	LS	$313,938.61	$313,939	Project Managment cost estimated based on CERCLA guidance (EPA, 2000, Exhibit 5-8).
Remedial Design	1	LS	$502,301.77	$502,302	Remedial Design cost estimated based on CERCLA guidance (EPA, 2000, Exhibit 5-8).
Construction Management	1	LS	$376,726.33	$376,726	Construction Managment cost estimated based on CERCLA guidance (EPA, 2000, Exhibit 5-8).
			Subtotal, Professional/Technical Services:	**$1,192,967**	
			TOTAL, Capital Costs:	**$7,471,739**	

ANNUAL O&M COSTS	Qty	Unit	Unit Cost	Ext. Cost	Comments
Soil barrier maintenance, KPN	1	LS	$42,657	$42,657	Assume 10% of grading & reseeding capital costs.
Soil gas monitoring event	1	LS	$25,000	$25,000	Engineers estimate, based on experience.
			TOTAL, Annual O&M Costs:	**$67,657**	

TABLE B.3

Cost Estimate for Alternative 3: Selective Placement of Clean Soil Barriers Institutional Controls

Feasibility Study Addendum Report

Kenilworth Park Landfill Site, Washington, DC

PERIODIC COSTS	Qty	Unit	Unit Cost	Ext. Cost	Comments
Soil gas implant decommissioning	1	LS	$20,000	$20,000	Engineers estimate, based on experience.
Five year review (FYR)	1	LS	$30,000	$30,000	Engineers estimate, based on experience.

PRESENT VALUE ANALYSIS	Year	Discount Factor	Total Cost	Present Value	Comments
Capital Cost	0	1.000	$7,471,739	$7,471,739	
Annual O&M Cost	1-30	28.217	$42,657	$1,203,656	Soil barrier maintenance, KPN
Annual O&M Cost	1-5	4.941	$25,000	$123,514	Soil gas monitoring event
Periodic Cost	5	0.980	$50,000	$49,012	Five year review (FYR); Soil gas implant decommissioning
Periodic Cost	10	0.961	$30,000	$28,826	Five year review (FYR)
Periodic Cost	15	0.942	$30,000	$28,256	Five year review (FYR)
Periodic Cost	20	0.923	$30,000	$27,698	Five year review (FYR)
Periodic Cost	25	0.905	$30,000	$27,151	Five year review (FYR)
Periodic Cost	30	0.887	$30,000	$26,614	Five year review (FYR)
TOTAL, Present Value of Alternative:				**$8,986,466**	

References:

1. "Means" indicates unit cost for noted section item from "2018 Site Work & Landscape Costs Book with RSMeans Data", Gordian, 2017.
2. U.S. Environmental Proction Agency (EPA), 2000. "A Guide to Developing and Documenting Cost Estimates during the Feasibility Study", EPA 540-R-00-002 / OSWER 9355.0-75, July 2000.
3. Consistent with the November 2019 update of Appendix C of the Office of Management and Budget (OMB) Circular A-94, Guidelines and Discount Rates for Benefit-Cost Analyses of Federal Programs (OMB Circular A-94) and EPA, 2000, a discount factor of 0.4% has been used for the present value analysis.

TABLE B.4

Cost Estimate for Alternative 4: Site-wide Clean Soil Barrier Institutional Controls

Feasibility Study Addendum Report

Kenilworth Park Landfill Site, Washington, DC

CAPITAL COSTS	Qty	Unit	Unit Cost	Ext. Cost	Comments
Construction Services					
Contractor mobilization / demobilization					
Small equipment	2	Ea	$320	$639	Means 01 54 36.50 1300
Medium equipment	4	Ea	$888	$3,554	Means 01 54 36.50 1400
Large equipment	4	Ea	$3,088	$12,352	Means 01 54 36.50 1600
Site facilities					
Office trailer	1	Ea	$12,027	$12,027	Means 01 52 13.20 0020
Temporary electrical service	1	Ea	$1,327	$1,327	Means 01 51 13.50 0040
Site security & control					
Site security service	8760	Hr	$30	$261,015	Means 01 56 32.50 0020
Silt fencing / erosion control	8000	LF	$2.04	$16,296	Means 31 25 14.16 1000
Silt fencing maintenance	12	Mo	$1,630	$19,555	Means 31 25 14.16 1100
Dust & traffic control, heavy	200	Day	$2,248	$449,653	Means 31 23 23.20 2500
H&S / decontamination	12	Mo	$5,000	$60,000	Engineers estimate, based on experience.
Selective site demolition					
Pavement removal, bituminous	10,434	SY	$6.23	$65,008	Means 02 41 13.17 5010
Pavement removal, concrete up to 6"	2,988	SY	$17	$50,667	Means 02 41 13.17 5200
Small building demolition	3	Ea	$4,171	$12,514	Means 02 41 16.13 1000
Waste transportion / hauling	1,627	LCY	$13	$21,857	Means 31 23 23.20 4714
Waste disposal as ADC at Subtitle D facility	3,091	Ton	$32	$98,909	Engineers estimate, based on experience.
Site preparation					
Cut & chips light trees to 6" diam.	5	Ac	$5,142	$25,708	Means 31 11 10.10 0020
Grub stumps and remove	5	Ac	$2,140	$10,700	Means 31 11 10.10 0150
Clear & grub brush including stumps	20	Ac	$7,341	$146,245	Means 31 11 10.10 0160
Clear & grub dense brush including stumps	20	Ac	$9,074	$180,783	Means 31 11 10.10 0260
Rough grading, small area	4	Ea	$1,652	$6,609	Means 31 22 13.20 0220
Rough grading, medium area	4	Ea	$2,492	$9,968	Means 31 22 13.20 0250
Rough grading, large area	2	Ea	$5,553	$11,106	Means 31 22 13.20 0280
Confirmatory ISM soil sampling	11	acre	$2,500	$28,002	Engineers estimate, based on experience.
Barrier installation					
Demarcation layer, woven geotextile	567,687	SY	$1.54	$873,426	Means 31 32 19.16 1500

TABLE B.4
Cost Estimate for Alternative 4: Site-wide Clean Soil Barrier Institutional Controls
Feasibility Study Addendum Report
Kenilworth Park Landfill Site, Washington, DC

Backfill transportion / hauling	236,536	LCY	$5.58	$1,319,877	Means 31 23 23.20 4108
Backfill, common earth	94,614	BCY	$22	$2,040,044	Means 31 23 23.15 4070; assumes 6-inch thickness
Backfill, topsoil	94,614	BCY	$31	$2,921,670	Means 31 23 23.15 7070; assumes 6-inch thickness
Rough grading, large area	51	Ea	$5,553	$283,710	Means 31 22 13.20 0280
Backfill compaction	189,229	ECY	$1.05	$198,879	Means 31 23 23.23 5600
Hydro seeding, with fertilizer	624,455	SY	$0.88	$548,044	Means 32 92 19.13 1000; assumes 110% of barrier area
Trail / access road resurfacing	727	SY	$4.75	$3,449	Means 32 11 23.23 0050
Site restoration					
Driveway repaving	28,000	SF	$2.87	$80,396	Means 32 12 16.14 0020
Asphalt transportion / hauling	519	CY	$13	$6,967	Means 31 23 23.20 4108
Parking area replacement	15,133	SY	$4.75	$71,819	Means 32 11 23.23 0050
Native plantings, KPS	40	acre	$6,000	$239,070	EPA, 2016.
Soil gas implant installation	15	ea	$1,500	$22,500	Engineers estimate, based on experience.
Institutional controls / site management plan	1	LS	$25,000	$25,000	Engineers estimate, based on experience.
		Subtotal, Construction Services:		$10,139,343	
Scope Contingency	1	LS	$1,520,901	$1,520,901	Assume 15% of Construction Services subtotal (EPA, 2000).
Bid Contingency	1	LS	$1,013,934	$1,013,934	Assume 10% of Construction Services subtotal (EPA, 2000).
Subtotal, Construction Services including Contingencies:				**$12,674,179**	
Professional/Technical Services					
Project Management	1	LS	$633,708.93	$633,709	Project Managment cost estimated based on CERCLA guidance (EPA, 2000, Exhibit 5-8).
Remedial Design	1	LS	$760,450.71	$760,451	Remedial Design cost estimated based on CERCLA guidance (EPA, 2000, Exhibit 5-8).
Construction Management	1	LS	$760,450.71	$760,451	Construction Managment cost estimated based on CERCLA guidance (EPA, 2000, Exhibit 5-8).
		Subtotal, Professional/Technical Services:		**$2,154,610**	
			TOTAL, Capital Costs:	**$14,828,789**	

TABLE B.4
Cost Estimate for Alternative 4: Site-wide Clean Soil Barrier Institutional Controls
Feasibility Study Addendum Report
Kenilworth Park Landfill Site, Washington, DC

ANNUAL O&M COSTS	Qty	Unit	Unit Cost	Ext. Cost	Comments
Soil barrier maintenance, KPN	1	LS	$83,175	$83,175	Assume 10% of grading & reseeding capital costs.
Soil barrier maintenance, KPS	1	LS	$23,907	$23,907	Assume 10% of replanting capital cost.
Soil gas monitoring event	1	LS	$25,000	$25,000	Engineers estimate, based on experience.
			TOTAL, Annual O&M Costs:	**$48,907**	

PERIODIC COSTS	Qty	Unit	Unit Cost	Ext. Cost	Comments
Soil gas implant decommissioning	1	LS	$20,000	$20,000	Engineers estimate, based on experience.
Five year review (FYR)	1	LS	$30,000	$30,000	Engineers estimate, based on experience.

PRESENT VALUE ANALYSIS	Year	Discount Factor	Total Cost	Present Value	Comments
Capital Cost	0	1.000	$14,828,789	$14,828,789	
Annual O&M Cost	1-30	28.217	$83,175	$2,346,943	Soil barrier maintenance, KPN
Annual O&M Cost	1-5	4.941	$23,907	$118,114	Soil barrier maintenance, KPS
Annual O&M Cost	1-5	4.941	$25,000	$123,514	Soil gas monitoring event
Periodic Cost	5	0.980	$50,000	$49,012	Five year review (FYR); Soil gas implant decommissioning
Periodic Cost	10	0.961	$30,000	$28,826	Five year review (FYR)
Periodic Cost	15	0.942	$30,000	$28,256	Five year review (FYR)
Periodic Cost	20	0.923	$30,000	$27,698	Five year review (FYR)
Periodic Cost	25	0.905	$30,000	$27,151	Five year review (FYR)
Periodic Cost	30	0.887	$30,000	$26,614	Five year review (FYR)
			TOTAL, Present Value of Alternative:	**$17,604,916**	

TABLE B.4

Cost Estimate for Alternative 4: Site-wide Clean Soil Barrier Institutional Controls

Feasibility Study Addendum Report

Kenilworth Park Landfill Site, Washington, DC

References:

1. "Means" indicates unit cost for noted section item from "2018 Site Work & Landscape Costs Book with RSMeans Data", Gordian, 2017.
2. U.S. Environmental Proction Agency (EPA), 2000. "A Guide to Developing and Documenting Cost Estimates during the Feasibility Study", EPA 540-R-00-002 / OSWER 9355.0-75, July 2000.
3. EPA, 2016. "A Source Book on Natural Landscaping for Public Officials", February 21. https://archive.epa.gov/greenacres/web/html/chap2.html
4. Consistent with the November 2019 update of Appendix C of the Office of Management and Budget (OMB) Circular A-94, Guidelines and Discount Rates for Benefit-Cost Analyses of Federal Programs (OMB Circular A-94) and EPA, 2000, a discount factor of 0.4% has been used for the present value analysis.

TABLE B.5

Cost Estimate for Alternative 5: Landfill Removal Shoreline Stabilization

Feasibility Study Addendum Report

Kenilworth Park Landfill Site, Washington, DC

CAPITAL COSTS	Qty	Unit	Unit Cost	Ext. Cost	Comments
Construction Services					
Contractor mobilization / demobilization					
Small equipment	4	Ea	$320	$1,279	Means 01 54 36.50 1300
Medium equipment	4	Ea	$888	$3,554	Means 01 54 36.50 1400
Large equipment	8	Ea	$3,088	$24,704	Means 01 54 36.50 1600
Site facilities					
Office trailer	1	Ea	$18,853	$18,853	Means 01 52 13.20 0300
Temporary electrical service	1	Ea	$1,327	$1,327	Means 01 51 13.50 0040
Site security & control					
Site security service	26280	Hr	$30	$783,045	Means 01 56 32.50 0020
Safety fencing	20000	LF	$5.18	$103,583	Means 31 23 23.20 4108
Silt fencing / erosion control	16000	LF	$2.04	$32,592	Means 31 25 14.16 1000
Silt fencing maintenance	36	Mo	$3,259	$117,330	Means 31 25 14.16 1100
Dust & traffic control, heavy	600	Day	$2,248	$1,348,958	Means 31 23 23.20 2500
H&S / decontamination	36	Mo	$5,000	$180,000	Engineers estimate, based on experience.
Selective site demolition					
Pavement removal, bituminous	10,434	SY	$6.23	$65,008	Means 02 41 13.17 5010
Pavement removal, concrete up to 6"	2,988	SY	$17	$50,667	Means 02 41 13.17 5200
Small building demolition	3	Ea	$4,171	$12,514	Means 02 41 16.13 1000
Waste transportion / hauling	1,627	LCY	$13	$21,857	Means 31 23 23.20 4714
Waste disposal as ADC at Subtitle D facility	3,091	Ton	$32	$98,909	Engineers estimate, based on experience.
Site preparation					
Cut & chips light trees to 6" diam.	5	Ac	$5,142	$25,708	Means 31 11 10.10 0020
Grub stumps and remove	5	Ac	$2,140	$10,700	Means 31 11 10.10 0150
Clear & grub brush including stumps	23	Ac	$7,341	$172,078	Means 31 11 10.10 0160
Clear & grub dense brush including stumps	23	Ac	$9,074	$212,716	Means 31 11 10.10 0260
Landfill Excavation					
Excavation of landfill waste, cover & fill	4,305,819	BCY	$0.79	$3,405,709	Means 31 23 16.43 4740
On-site stockpiling / hauling	4,305,819	BCY	$1.05	$4,525,394	Means 31 14 13.23 0200
Loading of landfill waste, cover & fill	5,382,274	LCY	$0.77	$4,140,503	Means 31 23 16.43 2400

TABLE B.5
Cost Estimate for Alternative 5: Landfill Removal Shoreline Stabilization
Feasibility Study Addendum Report
Kenilworth Park Landfill Site, Washington, DC

Waste transportion & disposal					
Waste transportion / hauling	5,382,274	LCY	$13	$72,313,003	Means 31 23 23.20 4714
Waste disposal as ADC at Subtitle D facility	2,906,428	Ton	$32	$93,005,693	Engineers estimate, based on experience.; assumes 50% of material exacavated
Waste disposal as non-hazardous waste at Subtitle D facility	2,906,428	Ton	$80	$232,514,232	Engineers estimate, based on experience.; assumes 50% of material exacavated
Site restoration					
Backfill transportion / hauling	42,438	LCY	$5.58	$236,807	Means 31 23 23.20 4108
Backfill, common earth	29,282	BCY	$22	$631,377	Means 31 23 23.15 4070
Backfill, topsoil	4,668	BCY	$31	$144,153	Means 31 23 23.15 7070
Rough grading, large area	64	Ea	$5,553	$353,320	Means 31 22 13.20 0280
Backfill compaction	33,951	ECY	$1.05	$35,682	Means 31 23 23.23 5600
Tidal marsh restoration	146	acre	$25,000	$3,651,716	Engineers estimate, based on experience.
Living shoreline restoration	3,336	LF	$500	$1,668,000	NOAA, 2015.
			Subtotal, Construction Services:	$419,910,968	
Scope Contingency	1	LS	$62,986,645	$62,986,645	Assume 15% of Construction Services subtotal (EPA, 2000).
Bid Contingency	1	LS	$41,991,097	$41,991,097	Assume 10% of Construction Services subtotal (EPA, 2000).
			Subtotal, Construction Services including Contingencies:	**$524,888,710**	
Professional/Technical Services					
Project Management	1	LS	$26,244,436	$26,244,436	Project Managment cost estimated based on CERCLA guidance (EPA, 2000, Exhibit 5-8).
Remedial Design	1	LS	$31,493,323	$31,493,323	Remedial Design cost estimated based on CERCLA guidance (EPA, 2000, Exhibit 5-8).
Construction Management	1	LS	$31,493,323	$31,493,323	Construction Managment cost estimated based on CERCLA guidance (EPA, 2000, Exhibit 5-8).
			Subtotal, Professional/Technical Services:	**$89,231,081**	
			TOTAL, Capital Costs:	**$614,119,791**	

TABLE B.5
Cost Estimate for Alternative 5: Landfill Removal Shoreline Stabilization
Feasibility Study Addendum Report
Kenilworth Park Landfill Site, Washington, DC

ANNUAL O&M COSTS	Qty	Unit	Unit Cost	Ext. Cost	Comments
Tidal marsh maintenance	1	LS	$182,586	$182,586	Assume 5% of tidal marsh restoration costs
Living shoreline maintenance	3,336	LF	$50	$166,800	NOAA, 2015.
			TOTAL, Annual O&M Costs:	**$349,386**	

PERIODIC COSTS	Qty	Unit	Unit Cost	Ext. Cost	Comments
None					

PRESENT VALUE ANALYSIS	Year	Discount Factor	Total Cost	Present Value	Comments
Capital Cost	0	1.000	$614,119,791	$614,119,791	
Annual O&M Cost	1-5	4.941	$349,386	$1,726,160	Tidal marsh maintenance; Living shoreline maintenance
			TOTAL, Present Value of Alternative:	**$615,845,951**	

References:
1. "Means" indicates unit cost for noted section item from "2018 Site Work & Landscape Costs Book with RSMeans Data", Gordian, 2017.
2. U.S. Environmental Proction Agency (EPA), 2000. "A Guide to Developing and Documenting Cost Estimates during the Feasibility Study", EPA 540-R-00-002 / OSWER 9355.0-75, July 2000.
3. National Oceanic and Atomspheric Administration (NOAA), 2015. "Natural and Structural Measures for Shoreline Stabilization", February 2015. https://coast.noaa.gov/data/digitalcoast/pdf/living-shoreline.pdf
4. Consistent with the November 2019 update of Appendix C of the Office of Management and Budget (OMB) Circular A-94, Guidelines and Discount Rates for Benefit-Cost Analyses of Federal Programs (OMB Circular A-94) and EPA, 2000, a discount factor of 0.4% has been used for the present value analysis.