This *Proposed Plan* provides:

- Background on the remedy change
- Justification for the selected remedy
- Description of the selected remedy
- Information on the public comment period
- Location of additional information

YOUR OPINION IS INVITED

The U. S. Department of Energy invites you to express your opinion on the revised remedial action in Zone 1 at the East Tennessee Technology Park. You are encouraged to read the information in the administrative record for background and more detailed technical information. A comment form is attached to this *Proposed Plan*, but you are not restricted to this form. Decision makers will consider any comments received before the end of the public comment period.

Community involvement is critical to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 process. A 30-day public comment period has been established, during which time local residents and interested parties can express their views and concerns on all aspects of this plan.

United States Department of Energy
Environmental Management Program
DOE/OR/01-2515&D0

Proposed Plan for the Amendment of the Record of Decision for Interim Actions in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee

May 2011

PURPOSE

The *Record of Decision for Interim Actions in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE 2002a) (ROD) addresses contaminated soil and debris for unrestricted industrial use to a depth of ten feet below ground surface and for protection of groundwater. This *Proposed Plan* additionally addresses contaminated soil for ecological protection, for a recreational end use, and as a source of surface water contamination and the plugging and abandonment of wells.

This document is approved for public release per review by:

5/2/11

BJC ETTP Classification & Information Office Date

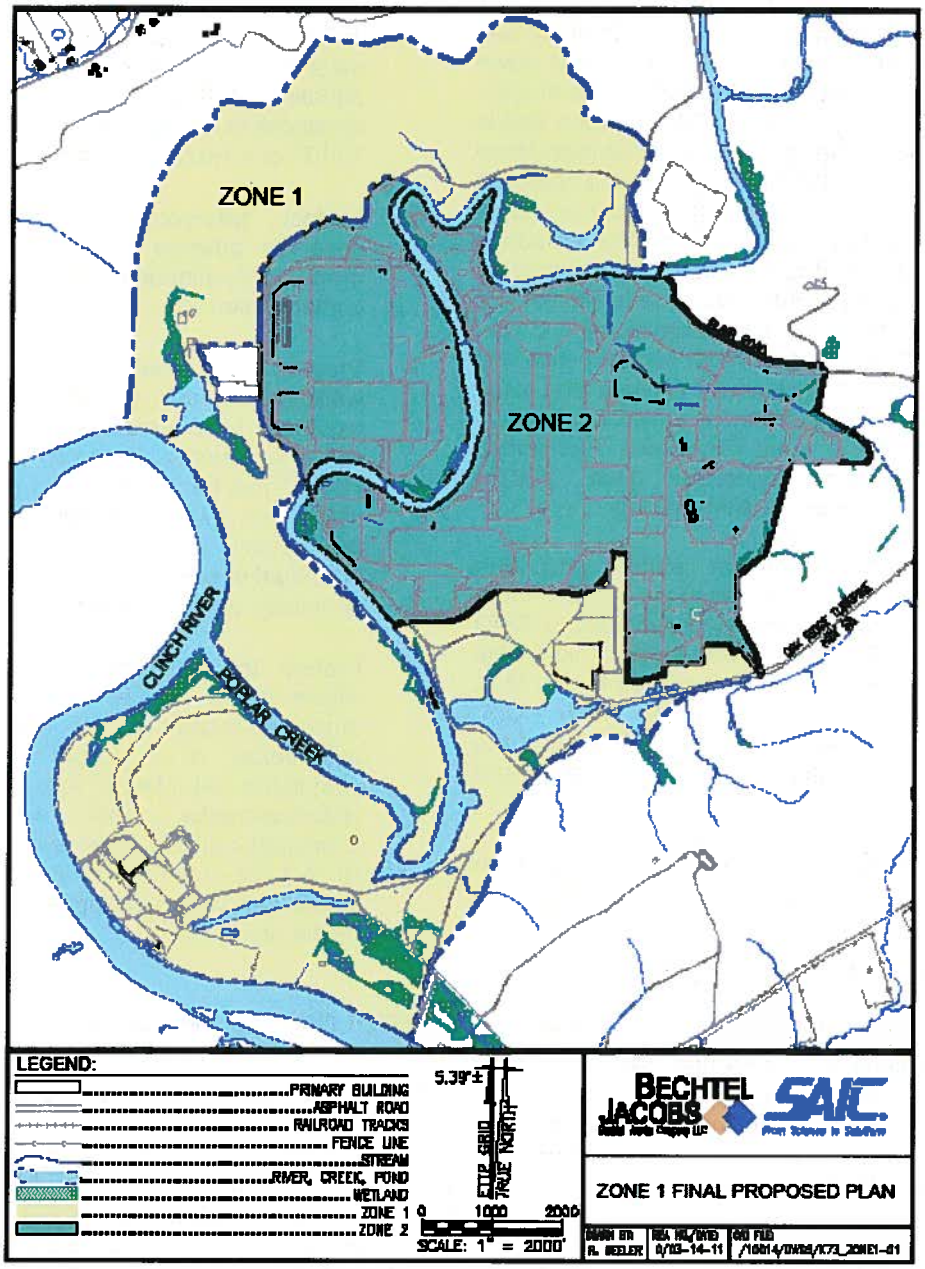

Fig. 1. Location of Zone 1.

BACKGROUND

The East Tennessee Technology Park (ETTP) was built beginning in 1942 to enrich uranium for use in nuclear weapons and for commercial and research nuclear reactors. ETTP was shut down in 1987. Zone 1, approximately 1400 acres in area, is the site for this proposed remedial action and is defined as the land located outside of the main fence of ETTP (Fig. 1). The ROD identifies the remedial actions necessary to allow unrestricted industrial use down to a depth of ten feet and to remediate potential sources of groundwater contamination. This *Proposed Plan* addresses contaminated soil for ecological protection, for a recreational end use, and as a source of surface water contamination and the plugging and abandonment of wells and uses the *Final Sitewide Remedial Investigation and Feasibility Study for East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE 2007a) (RI/FS) as a basis for decision-making.

After the public comment period and due consideration of public response, and if the proposed remedial action is acceptable, a ROD amendment presenting the revised remedial action will be prepared and approved by the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the Tennessee Department of Environment and Conservation (TDEC).

A subsequent Zone 1 final ROD will be prepared that will address groundwater.

REMEDIAL ACTION OBJECTIVES

Remedial action objectives (RAOs) provide a general description of what the remediation will accomplish. The general RAOs are to protect human health and the environment and to meet applicable or relevant and appropriate requirements (ARARs), and the specific RAOs are to:

- Protect human health under an unrestricted industrial land use to a risk level not to exceed $1X10^{-4}$
- Control selected releases from contaminated soil to help minimize further impacts to groundwater
- Protect terrestrial ecological receptor populations from contamination in surface soil
- Prevent migration from soil and groundwater to adjacent surface water bodies in order to meet ARARs in surface water, protect the aquatic environment, and protect recreational receptors to a target risk range of $1X10^{-6}$ to $1X10^{-4}$ or a Hazard Index (HI) of 1
- Protect piscivorous wildlife to lowest observed adverse effect levels (LOAELs) from polychlorinated biphenyl (PCB)-contaminated fish
- Protect adult exercisers who may use walking, hiking, or running paths from exposure to radionuclides and chemicals in soil at a target risk of $1X10^{-4}$ cumulative risk ($1X10^{-5}$ risk for an individual chemical-media risk where multiple chemicals and/or media are present) and an HI of 1 (HI of 0.1 for an individual chemical-media risk where multiple chemicals and/or media are present).
- Protect the child/teen recreator in areas where future use is suitable for potential organized recreation, e.g., baseball or soccer ball fields, at a target risk of $1X10^{-4}$ cumulative risk ($1X10^{-5}$ risk for an individual chemical-media risk where multiple chemicals and/or media are present) and an HI of 1 (HI of 0.1 for an individual chemical-media risk where multiple chemicals and/or media are present).

ECOLOGICAL DECISION

SUMMARY OF ECOLOGICAL RISKS

ETTP is organized into six geographic areas for ecological risk assessment--Administrative, Duct Island, K-901, Powerhouse, Support, and Process (Fig. 2) in the RI/FS. The Support and Process geographic areas are in Zone 2 and will be addressed in a subsequent decision. Additionally, the K-1007-P1 Holding Ponds (K-1007-P1, K-1007-P3, K-1007-P4, and K-1007-P5), K-901-A Holding Pond, K-720 Slough, and K-770 Embayment have been remediated (DOE 2007b; DOE 2011), and this removal action is now considered final as part of this Amendment. Terrestrial habitats occur in industrial and non-

industrial (referred to as ecological) areas (Fig. 3). The ecological areas provide natural habitats for ecological receptors. Industrial areas are dominated by buildings, roads, paved and gravel parking areas, and small lawn areas and contain poor quality habitat for ecological receptors.

Administrative Geographic Area

Several metals had maximum concentrations above plant benchmarks, suggesting adverse effects are possible. However, multiple lines of evidence including observations of unstressed vegetation, low confidence in the benchmarks, concentration levels that did not show toxicity at other sites at ETTP where plant toxicity tests were conducted, and maximum concentrations within two times background levels, lead to the conclusion that potential risk to plants is expected to be small.

No adverse effects to soil invertebrates are expected. Risks to wildlife populations are expected to be low, although the highest selenium and thallium concentrations may cause an isolated area of risk. Because the extent of contamination is small and the estimated hazards are low, there are no expected large-scale impacts or risks to local area or wide-ranging species. Thus, no remedial action is required.

Duct Island Geographic Area

After remediation under the ROD, only two areas remain that are contaminated with PCBs and chromium at levels which pose a potential environmental threat and may require remediation. At the maximum detected concentrations for isolated sampling stations, plants may be at threat from elevated levels of chromium, mercury, and silver, while the chromium and mercury may pose a threat to invertebrates, and elevated levels of chromium, mercury, PCBs, and uranium pose a threat to wildlife. The affected areas defined by the sampling results and areal extent supported by geospatial modeling are, however, so small that any risk to wildlife populations that access greater tracts of land is low. Results of additional sampling and walkovers under the post-ROD sampling program suggest that these locations are isolated, presumably resulting from small spills or dumping activities.

K-901 Geographic Area

Radionuclides were only a potential issue for plant and wildlife receptors in the K-895 Cylinder Destruct Facility. Radioactivity was removed to levels below the human health remediation levels. Plants may be at threat because maximum concentrations of boron, chromium, manganese, uranium, antimony, lead, mercury, nickel, and selenium in this area were outside the concentration range in soils of other areas where plant toxicity tests elsewhere showed no impacts. The metals are present in several locations throughout the area, but there was no discovery of a consolidated area of contamination. Most areas of elevated contamination were represented by one or two adjacent samples. It is possible that soil invertebrates may be at risk by being exposed to the metals chromium, lead, mercury, zinc, and uranium that were located in several portions of the geographic area.

Potential risks to wildlife receptors are relatively low; however, when smaller sites for local area receptors were evaluated, it was discovered that lead at Blair Quarry, chromium at McKinney Ridge slope and in the K-901 drainage ditch, and selenium at the K-1070-A Landfarm may pose potential risk to wildlife. Exceedances of benchmarks were infrequent, isolated, and often not elevated more than 1 to 2 times the protective benchmark. Potential risks in the K-895 Cylinder Destruct Facility area have been remediated under the ROD.

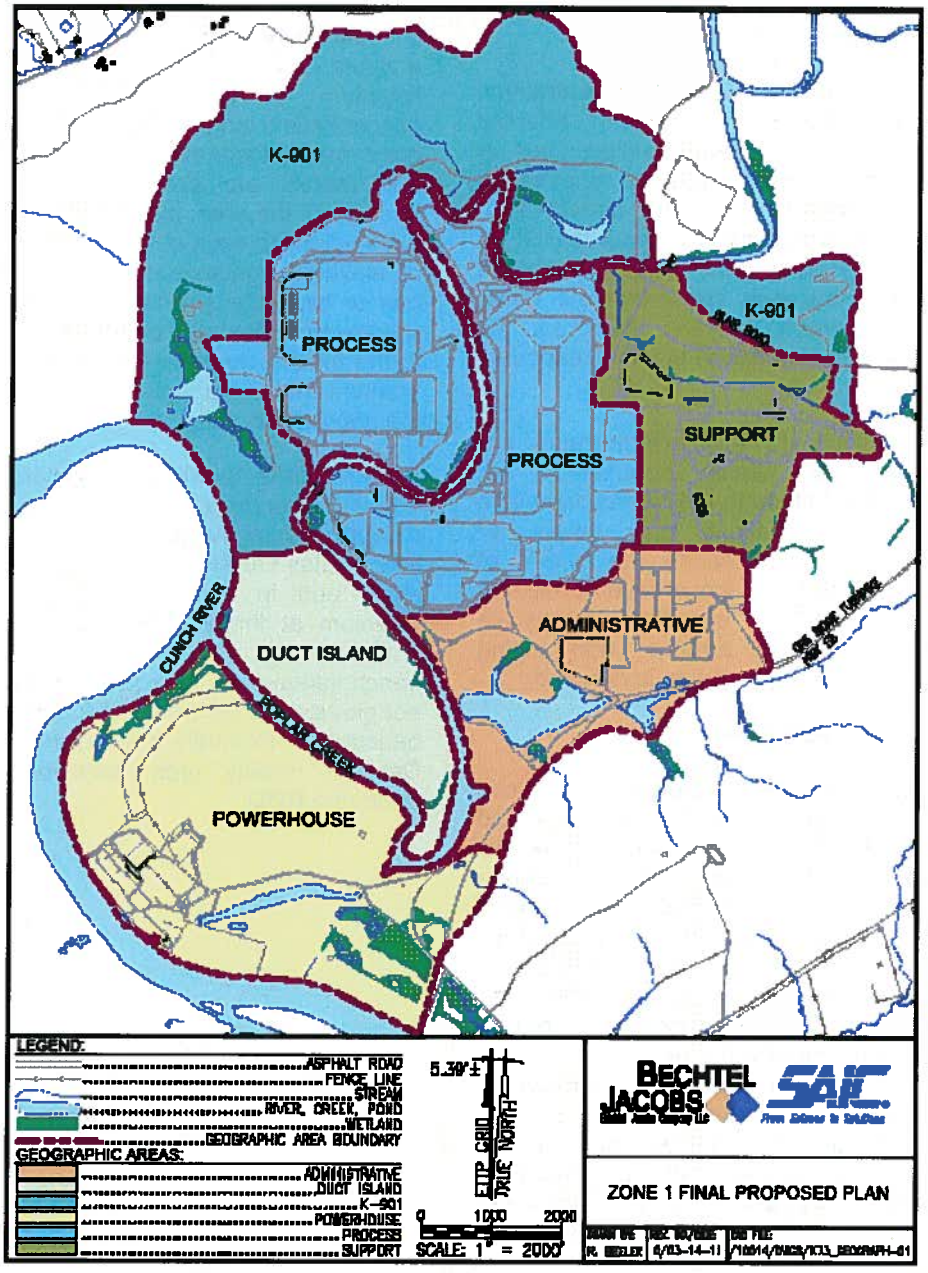

Fig. 2. Geographic areas evaluated for ecological risk.

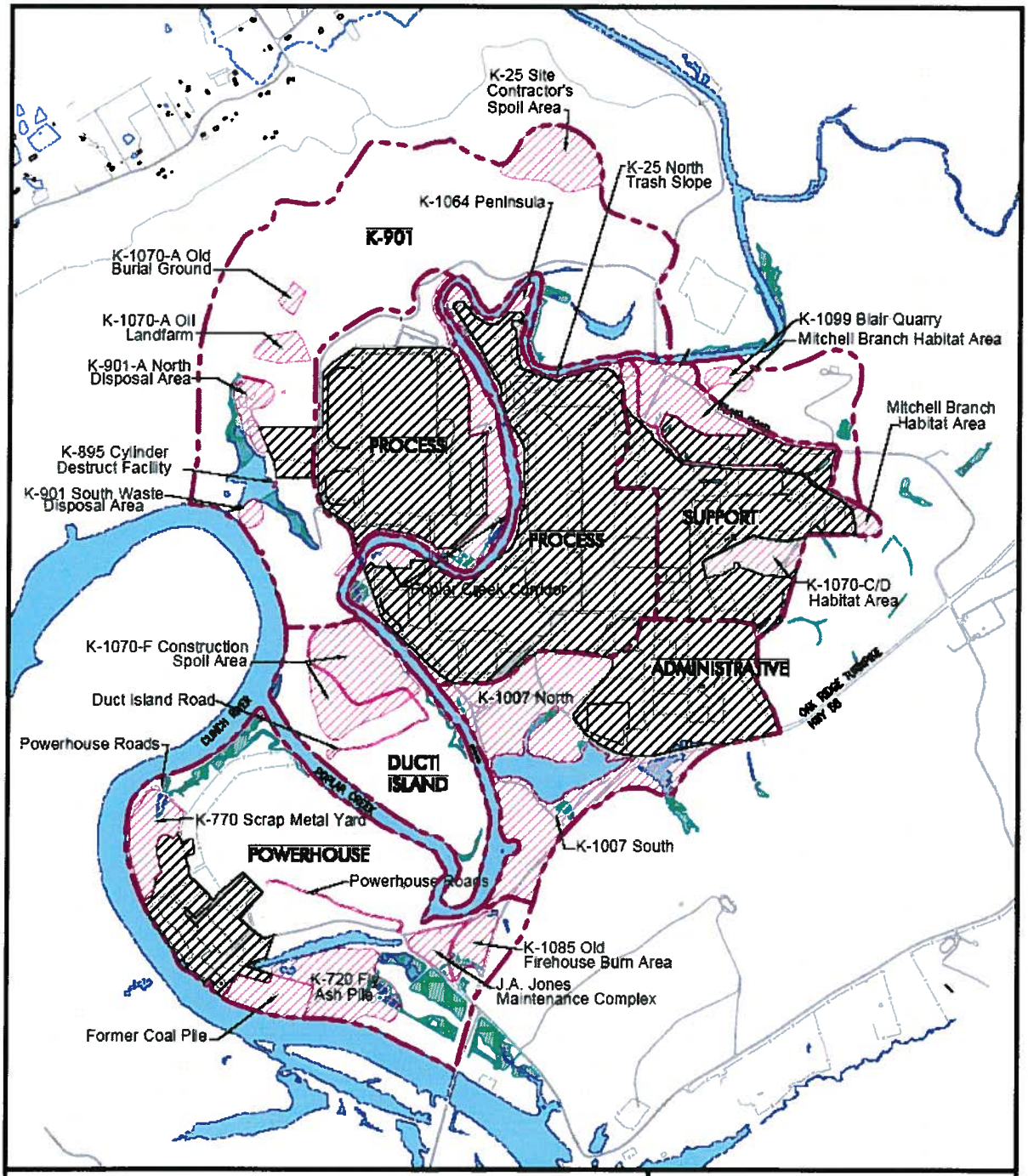
K-25 Site Contractor's Spoil Area
K-25 North Trash Slope
K-1064 Peninsula
K-901
K-1070-A Old Burial Ground
K-1070-A Oil Landfarm
K-901-A North Disposal Area
K-1099 Blair Quarry
Mitchell Branch Habitat Area
Mitchell Branch Habitat Area
K-895 Cylinder Destruct Facility
K-901 South Waste Disposal Area
PROCESS
PROCESS
SUPPORT
Poplar Creek Corridor
K-1070-C/D Habitat Area
K-1070-F Construction Spoil Area
ADMINISTRATIVE
Duct Island Road
K-1007 North
Powerhouse Roads
DUCT ISLAND
K-770 Scrap Metal Yard
K-1007 South
POWERHOUSE
Powerhouse Roads
K-1085 Old Firehouse Burn Area
K-720 Fly Ash Pile
J.A. Jones Maintenance Complex
Former Coal Pile
LEGEND:
PRIMARY BUILDING
ASPHALT ROAD
FENCE LINE
STREAM
RIVER, CREEK, POND
WETLAND
SOIL HABITAT AREAS
INDUSTRIAL AREAS
GEOGRAPHIC AREA BOUNDARY
BECHTEL JACOBS
Bechtel Jacobs Company LLC
SAIC
Science Applications International Corporation
PROPOSED PLAN FOR RESIDUAL CONTAMINATION AT ETTP
OAK RIDGE, TENNESSEE
DRAWN BY: P. HOLM
REV. NO./DATE: REV. 3/05-18-05
CAD FILE: 05021/DWGS/B01HABIT

Fig. 3. Industrial and ecological areas.

Powerhouse Geographic Area

The lines of evidence of risk to plants are not in agreement. The soil toxicity tests showed no adverse effects on plant growth or germination. However, the soil concentrations represented by the toxicity tests were not the maximum levels found in the area. Also, screening against ecological benchmarks shows potential risks to plant life from boron, chromium, lead, mercury, nickel, selenium, thallium, zinc, uranium, and molybdenum. Similar conflicting conclusions exist for soil invertebrates, with chromium, mercury, and uranium soil concentrations exceeding those found to have no effect during toxicity testing.

Wildlife receptors are potentially at risk from selenium, lead, nickel, uranium, PCBs, and radionuclides. Much of the contamination is centered at the site of the K-770 Scrap Yard, which was remediated under the ROD. Albeit lower, there remain residual areas of elevated radioactivity that could cause a risk to wildlife with very small home ranges that overlap the areas of contamination. The affected areas of contamination are in a small portion of the geographic area, which attenuates risks to wide-ranging receptors and lessens the impacts to site-wide populations of smaller-range receptors.

REMEDIATION LEVELS

Remediation levels establish the permissible risk, concentrations, or exposure level of contaminants that must be achieved by the remedy. Remediation levels for remedial actions under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) are developed principally using site-specific risk assessments and ARARs or other guidance. However, when ARARs are not available or are not sufficiently protective, site-specific risk assessments are used to develop the remediation levels. There are no chemical-specific ARARs to use to set ecological remediation levels in soil.

A range of risk-based remedial goal options (RGOs) was developed for surface soil. The most widespread or elevated contaminants of concern (COCs) for ecological receptors are chromium, lead, mercury, PCB-1254, PCB-1260, ^{234}Uranium, and zinc. These contaminants have been identified to be representative of all contamination. To determine the remediation levels, the range of RGOs presented in the baseline ecological risk assessment (DOE 2007a) was considered. RGOs are values that have been demonstrated to be protective of various receptors through scientific study. The range of no observed adverse effect levels (NOAELs) to LOAELs represents the range of RGOs for wildlife. NOAELs are levels below which scientists believe there is no impact to the associated receptor. LOAELs are levels above which impact is likely. Between these two levels, the impact is uncertain. Table 1 contains the RGOs for the representative COCs in surface soil.

To provide a range of protectiveness, RGOs for both local wildlife (represented by a shrew or woodcock; with home-range approximately 2 acres) and wide-ranging wildlife (represented by a weasel or hawk; home-range approximately 100 acres) were selected for development into alternatives. The local wildlife RGOs are at concentrations below or near the concentrations for plant and soil invertebrate RGOs. In accordance with the BERA, the wildlife LOAEL RGOs were selected instead of the NOAEL RGOs to protect populations instead of individuals.

Effects to terrestrial populations at levels below LOAELs are uncertain; hence, remediation decisions to protect receptor poplations below these levels are difficult to justify. A few individual receptors may be impacted at the LOAEL, but populations will be protected. An analogous line of reasoning is used in selecting the 100 mrad/d goal as opposed to a lower 20 mrad/d goal for radionuclides. The basis for these goals is discussed in Sect. 7.2.4.1 of the RI/FS (DOE 2007). A dose rate below 100 mrad/d is unlikely to cause observable changes in animal populations. In Table 1, the entire 100 mrad/d is assigned to ^{234}Uranium as a remediation level. However, should action be taken on radiologically contaminated sites, the 100 mrad/d will be apportioned among the radionuclides present at those sites.

To provide population-level protection, these remediation levels are averaged across a unit of land. Land units of varying sizes are considered when developing alternatives to represent different home-range sizes. Although the remediation levels selected are protective of plants and soil invertebrates, the land-unit sizes are developed primarily to protect wildlife populations only. This can result in small areas of residual impact to lower trophic-level populations. However, the residual areas of contamination are

sufficiently small in size as not to disrupt the food supply to the higher trophic-level populations.

Table 1. Soil remedial goal options and selected remediation levels for ecological protection

Contaminant	Plant RGO (mg/kg)	Soil invertebrate RGO (mg/kg)	Local Wildlife NOAEL (mg/kg)	Local Wildlife LOAEL (mg/kg)	Wide-ranging Wildlife NOAEL (mg/kg)	Wide-ranging Wildlife LOAEL (mg/kg)	100 mrad/d Soil RGO (pCi/g)
Chromium	163[a]	163[a]	45	**49.7**	257	**1579**	NA
Lead	3740[a]	3740[a]	38	**138**	319	**4811**	NA
Mercury	7.3[a]	7.3[a]	3.13	**10.9**	NA	NA	NA
PCB-1254	40	NA	0.15	**0.84**	0.17	**0.97**	NA
PCB-1260	40	NA	0.15	**0.84**	0.17	**0.97**	NA
U-234	NA	NA	NA	NA	NA	NA	**129**
Zinc	1310[a]	1310[a]	90	**386**	4700	**62,000**	NA

[a]Based on highest level present at locations where toxicity tests indicated no toxicity.
Bold indicates RGOs used in setting remediation levels. PCB levels were rounded to the nearest 1.0.
LOAEL = lowest observed adverse effect level.
NA = not applicable; the contaminant does not pose a risk to this receptor.
NOAEL = no observed adverse effect level.
RGO = remedial goal option.
PCB = polychlorinated biphenyl
U = uranium

REMEDIAL ALTERNATIVES

When developing remedial alternatives, problems to be addressed are defined first. Based on the risk assessment and a comparison to remediation levels, the following problems are addressed:

- potential risk to local wildlife and smaller-ranging receptors
- possible localized risk to wide-ranging species from surface soil containing metals, PCBs, and radionuclides

The question that is answered through an evaluation of soil alternatives is the extent of ecological protection to provide. At one extreme end of the spectrum, the option to protect individuals of all species at every location by removing all contamination above the remediation levels was considered but not developed into an alternative. This option is not cost-effective because the resultant estimated soil-removal volume is more than 100,000 cubic yards, assuming 1 foot in depth. Moving away from the extreme end of the spectrum is the consideration of the option to protect all local (small home range) terrestrial wildlife species at a small population level (roughly 2-acre areas). The other option considered is to protect wide-ranging wildlife populations across the zones. The remediation levels vary for the two receptor groups, and they are applied as an average over differing parcels of land, representing differing levels of populations. In this way, the cost benefit of protecting various population levels and ecological species can be assessed. An alternative that allows for differing levels of protection in Zone 1 (less likely to be reindustrialized) and Zone 2 (most likely to be reindustrialized) also is evaluated. Three alternatives result from this analysis, as presented below:

1. Protect wide-ranging terrestrial ecological species with excavation or containment in Zones 1 and 2.
2. Protect local terrestrial wildlife species with excavation or containment in Zone 1 only.
3. Protect local terrestrial wildlife species with excavation or containment throughout Zones 1 and 2.

These alternatives are more fully described in the RI/FS. Even though this *Proposed Plan* only addresses Zone 1, the alternatives evaluated in the RI/FS address both Zone 1 and Zone 2, so the following discussion includes Zone 2.

Alternative 1 - Protect Wide-Ranging Species (No Action)

To protect wide-ranging terrestrial ecological species, areas of higher contamination can be excavated to allow the average area-weighted residual contamination throughout Zones 1 and 2 to reach the set remediation levels. However, in no case does an area of higher contamination require removal in order for the average concentration across Zones 1 and 2 to reach the remediation levels for wide-ranging wildlife receptors. Therefore, this alternative results in no action being required.

Alternative 2 - Protect Local Species in Zone 1

The goal of this alternative is to protect local wildlife receptors in Zone 1. Only Zone 1 was considered for remediation under this alternative, as it is the area most likely to revert to a natural habitat. Zone 2 will most likely be reindustrialized in the future and will not provide sufficient terrestrial habitat areas to allow for the establishment of natural ecological populations.

Local receptors are those receptors with smaller home ranges (roughly 2-acre areas) than the wide-ranging species. These local receptors include small mammals, such as shrews and voles, and birds, such as the American woodcock. Because of the smaller home range, a smaller area over which to average the contaminant concentrations is selected resulting in multiple, smaller areas under consideration for each geographic area. These smaller areas average roughly 2 acres. It should be noted that this approach will focus on the worst case impacted population among the numerous populations considered within a given geographic area and across Zone 1.

An evaluation similar to that used in Alternative 1 illustrates that remediation will be required to meet an average local wildlife remediation level across five of the subareas in Zone 1. Remediation will be needed at elevated areas in the Duct Island geographic area for PCBs and chromium; the northern Powerhouse geographic area for lead; the K-770 geographic area for ^{234}Uranium; the K-901-A Holding Pond drainage area, the K-1070-A Oil Landfarm for selenium, the Blair Quarry area for lead, and the eastern portion of the K-901 geographic area for chromium. The Blair Quarry Area will be covered with soil because of the potential for deeper contamination. The other locations are isolated areas of surface soil contamination and can be excavated. An excavation volume of up to 3,500 cubic yards (1- to 2-feet depth) is assumed. The 1- to 2-feet depth provides protection for burrowing activities. The excavated soil will most likely be disposed at the Environmental Management Waste Management Facility (EMWMF).

Alternative 3 - Protect Local Species in Zones 1 and 2

This alternative is the same as Alternative 2, except that both Zone 1 and Zone 2 are considered. The only additional area that will require remediation is the K-25 Site North Trash Slope which will be covered because of the potential for deeper contamination. A total excavation volume of up to 3,500 cubic yards (same as Alternative 2) and a total cover volume of 1,000 cubic yards are estimated.

EVALUATION OF ALTERNATIVES

All remediation alternatives must be evaluated against the following nine CERCLA criteria:

- overall protection of human health and the environment
- compliance with ARARs
- long-term effectiveness and permanence
- reduction of toxicity, mobility, or volume through treatment
- short-term effectiveness
- implementability
- cost
- state acceptance
- community acceptance

The first two criteria are the threshold criteria that must be met in the ROD amendment. The next five criteria are the balancing criteria that are evaluated together to identify the advantages and disadvantages of an action and to weigh trade-offs. The last two criteria are modifying criteria and will be evaluated after regulatory agency review and public comment period for the *Proposed Plan*.

The alternatives also are evaluated against National Environmental Policy Act (NEPA) values (DOE 1994). Cumulative impact is the value most relevant to this decision and is evaluated as a separate criterion. Other relevant values already are covered by the CERCLA criteria. The comparative analysis of alternatives for ecological protection is summarized in Table 2 and below. Additional discussion is contained in the RI/FS.

Threshold Criteria

All three alternatives will protect the environment, but to varying degrees. For all alternatives, there is the potential that individuals or small groups within a population of receptors that have limited mobility, e.g., soil invertebrates, or have very small home ranges can be at risk. However, a risk-management decision was made that the effort involved in removing all areas of elevated contamination to protect all individuals at all locations was too great.

All three alternatives meet the required chemical-, location-, and action-specific ARARs. No waivers are requested. Appendix A contains the ARARs.

Balancing Criteria

All three alternatives are effective. Removal through excavation is a permanent solution. Removal is used in Alternatives 2 and 3. A soil cover is applied in one area in Zone 2 (Alternative 3). Covers are not permanent but are effective if maintained. Maintenance requirements are limited for soil covers, comprising visual inspections and periodic regrading.

None of the alternatives reduces the toxicity, mobility, or volume of contamination through treatment. However, toxicity, mobility, or volume is reduced through excavation and capping.

The notable difference between the alternatives is in near-term impacts to local environments. Under Alternatives 2 and 3, the local habitats in the excavation or cover areas will be destroyed temporarily to provide long-term protection. These areas should recover in several years if restored properly.

All three alternatives are easy to implement.

Alternative 1 has no cost, and Alternatives 2 and 3 have similar capital costs.

Table 2. Comparative analysis of alternatives for ecological protection

Criteria	Alternative 1: Wide-Ranging Receptors: No Action	Alternative 2: Zone 1, Local Receptors	Alternative 3: Zones 1 and 2, Local Receptors
Overall protection of human health and the environment	Protects wide-ranging species in Zones 1 and 2. Protects local species in most geographic areas. Some individuals of local species may be impacted. Only a localized potential risk to soil invertebrates and plants. Human health risk addressed elsewhere.	Protects wide-ranging species in Zone 1. Protects local species in Zone 1. Less localized potential risk to soil invertebrates and plants. Human health risk addressed elsewhere.	Protects wide-ranging species in Zones 1 and 2. Protects local species in Zone 1 and Zone 2. Less localized potential risk to soil invertebrates and plants. Human health risk addressed elsewhere.
Compliance with ARARs	No ARARs for a no action alternative	Meets all ARARs.	Meets all ARARs.
Long-term effectiveness and permanence	As no action is required to provide protection of wide-ranging species, inherently effective and permanent.	Protection provided by excavation. Excavation is effective and permanent.	Protection provided by excavation, except at the K-25 North Trash Slope. Excavation is effective and permanent. Soil cover requires minimal long-term maintenance.
Reduction of toxicity, mobility, or volume through treatment	No treatment, so no reduction.	No treatment, so no reduction.	No treatment, so no reduction.
Short-term effectiveness	No short-term impacts.	Minor excavations will have a minimal short-term impact on local environment. Habitats destroyed are not of high value.	See Alternative 2.
Implementability	No implementability issues.	Easy to implement. Standard construction techniques.	Much like Alternative 2, but soil cover at the K-25 North Trash Slope may be more difficult due to topography.
Cost (escalated)	None.	Capital: $1.0 million. Annual O&M: $0. Present value: $1.0 million.	Capital: $1.1 million. Annual O&M: $10,000. Present value: $1.1 million.
NEPA-cumulative impacts	No addition to ORR cumulative impacts.	Minor transportation additions with up to 200 extra trucks to already congested roads. No loss of significant habitat.	Similar to Alternative 2.

ARAR = applicable or relevant and appropriate requirement.
NEPA = National Environmental Policy Act of 1969.
O&M = operation and maintenance.
ORR = Oak Ridge Reservation.
ROD = Record of Decision.

National Environmental Policy Act

The major cumulative impact of these three alternatives is transportation-related. The habitat destroyed by the remediation is not of high value or unique; therefore, there is no net loss of important habitat across the Oak Ridge Reservation. The transportation additions are not large, but Alternatives 2 and 3 will add up to 200 trucks on the haul road. This remediation will have the opportunity to occur in roughly a one-year period only, diminishing the opportunity to spread the additional trucks over time.

PREFERRED ECOLOGICAL PROTECTION ALTERNATIVE

Based on the available information, DOE believes that the preferred alternative, Alternative 2, meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. This alternative recognizes the unlikelihood of Zone 2 becoming a viable terrestrial habitat and focuses on Zone 1. DOE expects the preferred alternative to satisfy the following statutory requirements of CERCLA 121(b) to: (1) be protective of human health and the environment, (2) comply with ARARs, (3) be cost-effective, and (4) use permanent solutions to the maximum extent practicable. Another statutory requirement, to satisfy the preference for treatment as a principal element, is not met by the remedy because none of the alternatives considered treatment.

The preferred alternative was evaluated against seven of the nine CERCLA evaluation criteria. Consistent with DOE policy, NEPA values were incorporated into this evaluation. In summary, the preferred alternative provides protection of wide-ranging and local wildlife receptors; while, at the same time, accepts some potential risk to individuals or small populations of receptors with home–ranges smaller than two acres.

The areas of contamination to be excavated to reach the remediation levels wherever exceeded in a two acre area across Zone 1 are illustrated in Fig. 4.

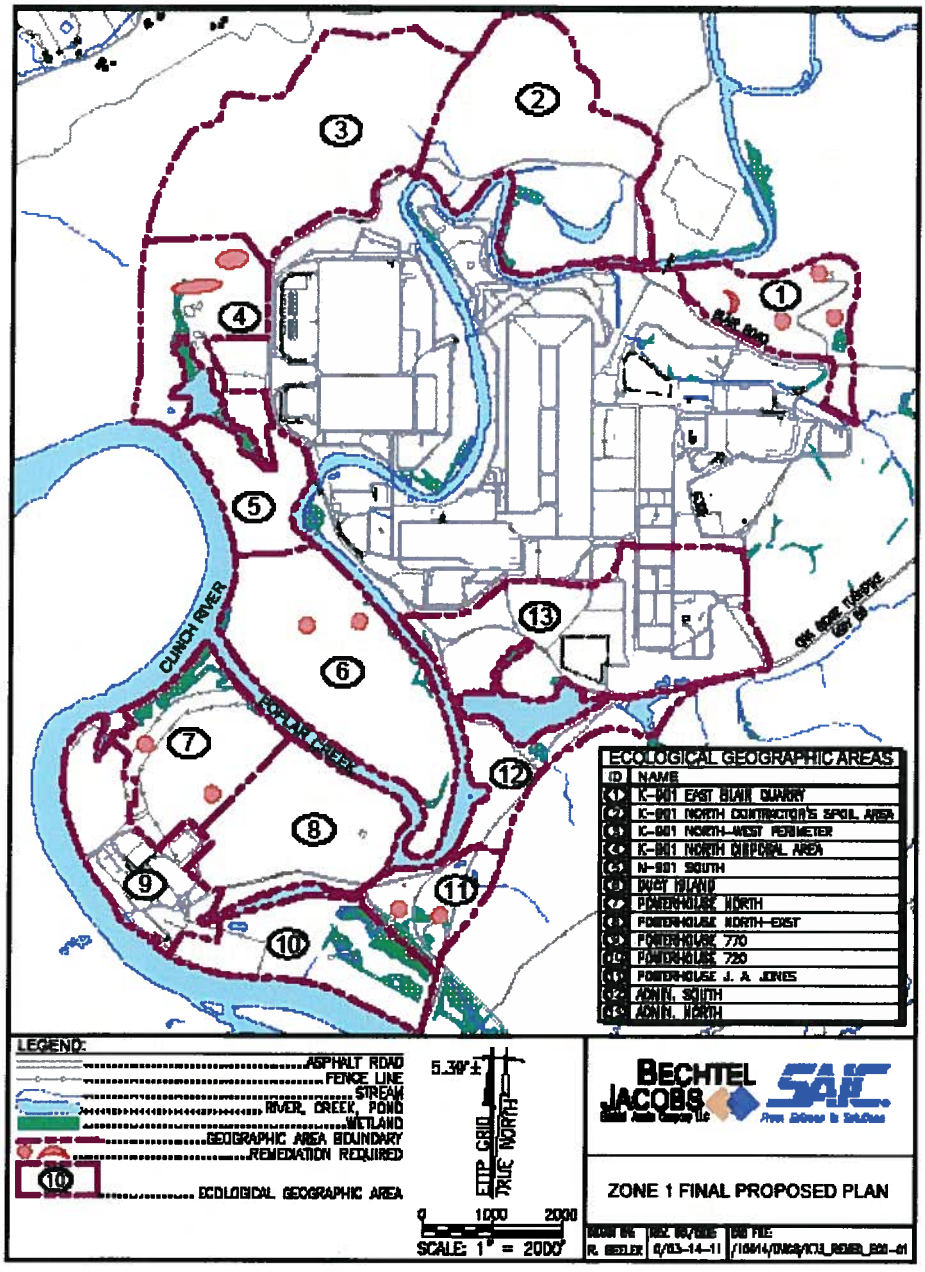
CLINCH RIVER
POPLAR CREEK
ECOLOGICAL GEOGRAPHIC AREAS
ID NAME
1 K-901 EAST BLAIR QUARRY
2 K-901 NORTH CONTRACTOR'S SPOIL AREA
3 K-901 NORTH-WEST PERIMETER
4 K-901 NORTH DISPOSAL AREA
5 K-901 SOUTH
6 EAST WETLAND
7 POWERHOUSE NORTH
8 POWERHOUSE NORTH-EAST
9 POWERHOUSE 770
10 POWERHOUSE 720
11 POWERHOUSE J. A. JONES
12 ADMIN. SOUTH
13 ADMIN. NORTH
LEGEND:
ASPHALT ROAD
FENCE LINE
STREAM
RIVER, CREEK, POND
WETLAND
GEOGRAPHIC AREA BOUNDARY
REMEDIATION REQUIRED
ECOLOGICAL GEOGRAPHIC AREA
5.39'±
FTTP GRID
TRUE NORTH
0 1000 2000
SCALE: 1" = 2000'
BECHTEL JACOBS
SAIC
ZONE 1 FINAL PROPOSED PLAN

Fig. 4. Areas requiring remediation for ecological protection.

RECREATIONAL END USE DECISION

RECREATIONAL RISK APPROACH

The ROD selected actions for soil remediation to be protective of an industrial end use. Subsequently, two events have occurred that require a recreational end use to be evaluated. First, as part of the recent Natural Resources Damage Assessment settlement on the Oak Ridge Reservation, DOE agreed to place into a conservation easement 2,966 acres of DOE property on Black Oak Ridge and McKinney Ridge. A portion of this Black Oak Ridge Conservation Easement (BORCE) is in Zone 1. This new conservation easement (Fig. 5) is being managed by the state of Tennessee as a Wildlife Management Area and State Natural Area and includes a greenway/hiking trail.

Second, as part of the evolving process to transfer ETTP land to private entities, not all of the land may be used for industrial purposes and some may be used for recreational purposes.

Therefore, recreational action levels were developed and compared to residual soil contamination levels following remediation required by the ROD for an industrial end use. Where residual soil contamination levels exceed the recreational action levels, recreational use will not be pursued unless soil remediation occurs. This evaluation process involved the following steps:

- Develop RAOs for recreational use
- Develop action levels for recreational receptors
- Compare residual soil concentrations to the action levels to identify potential risks
- Identify locations where soil will require remediation for a recreational end use

Appendix B contains the details of the recreational risk screening.

SUMMARY OF SITE RISKS

The risk evaluation considered two receptors:

- Adult Recreator – individual who may walk, run, hike, or ride bicycles and is exposed to soil via inhalation of dust and vapors, external exposure, and dermal contact and incidental ingestion
- Child/Teen Recreator - individual age 6 to 18 who participates in organized athletic events within a ball park and is exposed to soil via inhalation of dust and vapors, external exposure, dermal contact, and incidential ingestion while participating in sports

Zone 1 was divided into 6 recreational groups for this exercise (Fig. 5):

- BORCE Group
- Duct Island Group
- K-770 Group
- Powerhouse Group
- K-1007 Group
- Blair Quarry Group

These recreational groups were delineated based on the potential for recreational activities to span the area, e.g., ball fields in the Powerhouse Group and running/hiking/biking in the Duct Island Group. However, for the comparison to action levels, no presumption of they type of recreational activities was made.

Table 3 summarizes the recreational risk issues in each recreational group. Due to the presence of subsurface asbestos, recreational use for the K-770 Group is not recommended.

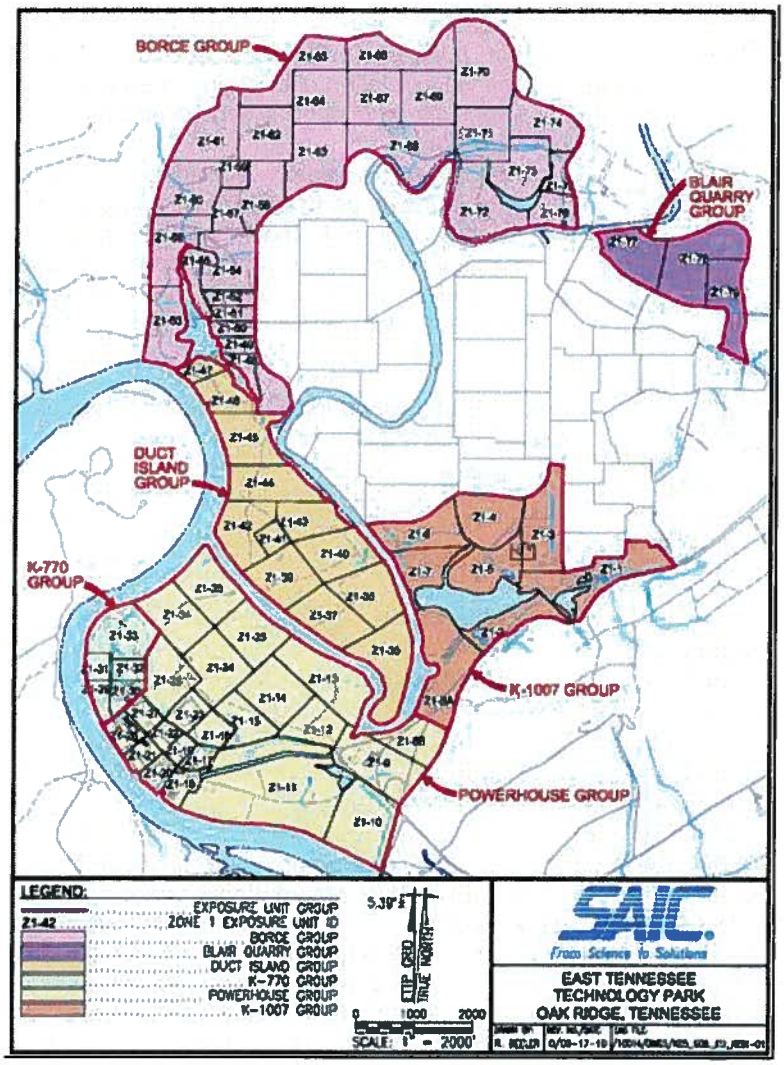

Fig. 5. Recreational risk geographical areas.

Table 3. Recreational risk summary

Group	Risk Issue
Blair Quarry	PAH, arsenic, and lead
K-1007	PAH
Powerhouse	PAH, arsenic, and lead
Duct Island	Radionuclides, arsenic, and PCB
BORCE	PAH, PCB, and Arsenic
K-770	Will not be considered for recreational use

BORCE = Black Oak Ridge Conservation Easement

PAH = polycyclic aromatic hydrocarbon

PCB = polychlorinated biphenyls

REMEDIAL ALTERNATIVES

The following two remedial alternatives were evaluated:

1. No action
2. Remediate for recreational end use

Alternative 1 – No Action

No additional remediation is considered for a recreational receptor, and Zone 1 remains suitable for unrestricted industrial use to a depth of ten feet per the ROD.

Alternative 2 – Remediation

Adequate soil excavation takes place for the risk drivers identified in Table 3 for Zone 1 to be protective of the recreational receptors. K-770 is not included and remains industrial.

EVALUATION OF ALTERNATIVES

The evaluation of the two alternatives against the CERCLA criteria is summarized in Table 4 and discussed below.

Threshold Criteria

Alternative 1 does not satisfy the threshold criteria, but Alternative 2 does. The BORCE already is used for recreation.

Balancing Criteria

Alternative 1 is not effective, but Alternative 2 is effective because the contaminated soil is excavated. Neither alternative provides treatment, but Alternative 2 removes the contaminated soil to a waste disposal facility. Alternative 1 has no short term impacts, but Alternative 2 has minor impacts due to excavation. Both alternatives are easy to implement. However, Alternative 2 will require land use controls to ensure appropriate use of the land. Alternative 2 has a capital cost, but the cost is considered appropriate for releasing the land for recreational use. All of the areas requiring remediation are co-located with the areas requiring remediation for ecological protection except for Happy Valley. Therefore, the incremental cost is small.

NEPA

Alternative 1 has no cumulative impacts, and Alternative 2 has minor additional transportation impacts due to waste disposal.

PREFERRED RECREATIONAL PROTECTION ALTERNATIVE

Based on the available information, DOE believes that the preferred alternative, Alternative 2, meets the threshold criteria and provides the best balance of tradeoffs between the two alternatives with respect to the balancing and modifying criteria. This alternative recognizes the BORCE already is a recreational area. DOE expects the preferred alternative to satisfy the following statutory requirements of CERCLA 121(b) to: (1) be protective of human health and the environment, (2) comply with ARARs, (3) be cost-effective, and (4) use permanent solutions to the maximum extent practicable. Another statutory requirement, to satisfy the preference for treatment as a principal element, is not met by the remedy because neither of the alternatives considered treatment.

The preferred alternative was evaluated against seven of the nine CERCLA evaluation criteria. Consistent with DOE policy, NEPA values were incorporated into this evaluation. In summary, the preferred alternative provides protection of recreational receptors.

Fig. 6 illustrates the recreational uses for each area and the areas of contamination to be excavated to reach the remediation levels.

Table 4. Comparative analysis of alternatives for recreational protection

Criteria	Alternative 1: No Action	Alternative 2: Remediate
Overall protection of human health and the environment	Does not protect recreational receptors. BORCE already a recreational area	Protects recreational receptors
Compliance with ARARs	No ARARs for a no action alternative	Meets all ARARs
Long-term effectiveness and permanence	Does not provide any long-term effectiveness and permanence	Excavation of contaminated soil provides long-term effectiveness and permanence
Reduction of toxicity, mobility, or volume through treatment	No treatment, so no reduction. Due to proximity to BORCE, land use controls will be required to prevent inadvertent recreational use.	No treatment, so no reduction. However, excavation removes the contaminated soil from Zone 1.
Short-term effectiveness	No short-term impacts	Minor excavations will have a minimal short-term impact on local environment
Implementability	No implementability issues	Easy to implement. Standard excavation techniques. Land use controls will have to be implemented.
Cost (escalated)	None	Capital: $5.000 Annual O&M: $0 Present value: $5000
NEPA-cumulative impacts	None	Minor transportation additions for waste disposal. No loss of significant habitat.

ARAR = applicable or relevant and appropriate requirements

BORCE = Black Oak Ridge Conservation Easement

NEPA = National Environmental Policy Act

O&M = operations & maintenance

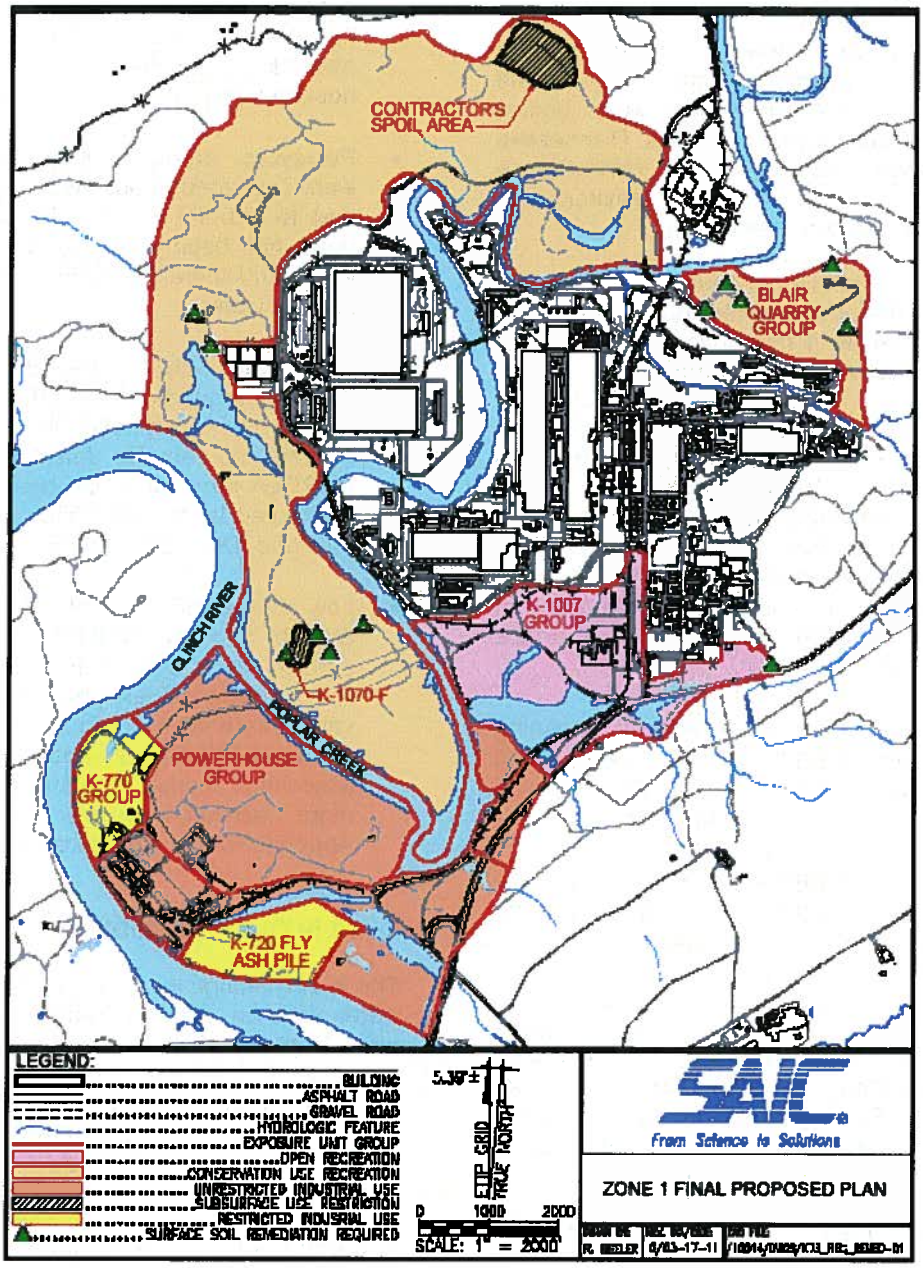

Fig. 6. Recreational use and remediation areas.

SURFACE WATER DECISION

SUMMARY OF SITE RISKS

The surface water RAOs are to prevent contaminant migration from soil and groundwater to adjacent surface water bodies (Fig. 7) in order to meet ARARs [Tennessee ambient water quality criteria (AWQC)] in surface water, protect the aquatic environment, and protect recreational receptors.

The RI/FS does not identify the soil in Zone 1 to be a source of surface water contamination. In order to determine if this analysis is still valid, the following activities were performed:

- Compared the storm water characterization data from 2005 to present against applicable TN AWQC and 4% of the DOE Order 5400.5 Derived Concentration Guide (DCG) (4% of the DCGs equates to drinking water levels) as an initial screening. This screening was performed to identify potential impacts of Zone 1 soils and groundwater on surface water discharges.

- Compared exceedances of the screening level criteria to surface water background data and sample results in the receiving waters of the respective ponds or river.

- Evaluated analytical results at the subwatershed level to determine the potential for legacy contribution of contaminants.

The water bodies receiving storm drain discharges that were evaluated are the Clinch River, K-720 Slough, K-1007-P Ponds, and K-901-A Pond (Fig. 7). Additional Zone 1 water bodies that were evaluated are the Oxbow Lake and the Beaver Dam Ponds in the K-720 area.

The detailed results of this evaluation are contained in Appendix C.

A summary of the parameters that exceeded storm water screening criteria for the four water bodies with storm drain discharges follow:

- Metals were exceeded in storm drains in all four surface water areas. Based upon surface water sampling in the receiving water, the current discharge of metals are not creating impacts in the receiving water.

- Radionuclide discharge levels only exceeded screening criteria from outfalls to the Clinch River. The surface water evaluation indicated these discharges are not impacting the receiving stream

- Polycyclic aromatic hydrocarbons levels were exceeded at outfalls to the K-901 Pond and K-1007-P1 Pond. These parameters have not been detected in the receiving water and therefore have no impact on the surface water.

- PCBs were only detected in a storm drain that discharges to the K-1007-P1 Pond. The surface water evaluation indicated only one of thirty-one samples detected PCBs, and a CERCLA removal action has recently been completed to address PCBs in the K-1007-P1 Pond (DOE 2007b; DOE 2011).

- Low pH values were detected at the K-720 Slough and the K-1007-P1 Pond. The surface water evaluation of the K-1007-P1 Pond did not indicate any concerns. The pH values from storm drain 992 that discharges to the K-720 Slough and the potential for associated metals at this outfall triggered a more extensive review as detailed in Appendix C and summarized below.

K-720 SLOUGH REMEDIAL ALTERNATIVES

The K-720 Slough was the "discharge flume" for water with an elevated temperature that was used in the K-700 Powerhouse facility boilers. In addition to the water discharges to the flume, the powerhouse operations discharged fly ash and bottom ash to a sluice pond immediately south of the K-720 Slough. The ash was pushed away from the sluice with a dozer on an as-needed basis and was spread and piled across the acreage south of the K-720 Slough. The dozer operations resulted in the formation of a small pond at the outlet of the discharge pipe which was located at the northwest corner of the overall fly ash pile.

In the early 1990s during negotiations for the ETTP NPDES storm drain permit, the storm drain 992 discharge that flowed over the uncovered fly ash pile through storm drain 992

into the K-720 Slough was identified as an area of concern. Of particular concern was the pH of the storm water discharge that was consistently measured at levels less than 4.0. A RCRA corrective actions study in the 1980s identified pH water samples back in the water shed as low as 2.6 and 2.7.

In response to these concerns, a series of correction actions were initiated starting in the 1990s that included numerous applications of lime on the fly ash, an application of sewage, establishing storm water collection systems, and placing a soil cover over the fly ash at a thickness of 1.5 to 2 feet. Corrective maintenance actions have occurred in recent years with additional storm water conveyance modifications and an additional application of lime.

Based upon this history, a field assessment was conducted that indicated the vegetative cover over the vast majority of the fly ash pile was in good shape. However, there were some areas on the north side of the fly ash pile where either the cover had eroded or the area was not completely covered during the work in the 1990s. The direct runoff in this area showed pH measurements as low as 4.2 in Calendar Year 2011.

Based upon the corrective action history of this site, recent walk downs, and water quality investigations, the following four remedial alternatives were evaluated.

Alternative 1 – No Action

No additional remediation is performed for the protection of surface water, and no land use controls are required.

Alternative 2 – Land Use Controls

The existing soil vegetative cover will remain, land use controls will require maintenance of the cover to minimize storm water contact with the fly ash, and monitoring will be required.

Alternative 3 – Remediation and Land Use Controls

The existing soil vegetative cover will remain, land use controls will require maintenance of the cover to minimize storm water contact with the fly ash, and monitoring will be required, as in Alternative 2. In addition, the soil cover will be extended to areas that have eroded or were not adequately covered during corrective actions in the 1990s, and storm water discharge pathways will be reworked in selected areas to minimize direct seep discharges into water bodies.

Alternative 4 – Removal

The fly ash will be excavated and disposed in an appropriate land fill; a soil vegetative cover will be established; and discharge pathways will be established to minimize erosion. Land use controls and monitoring will not be needed.

EVALUATION OF ALTERNATIVES

The evaluation of the four alternatives against the CERCLA criteria is summarized in Table 5 and discussed below.

Threshold Criteria

Alternative 1 does not satisfy the threshold criteria. Alternative 2 is marginal over the long term. Alternatives 3 and 4 meet the threshold criteria.

Balancing Criteria

Alternative 1 is not effective, and Alternative 2 is only marginally effective because the soil cover is not in place in some areas which exposes the surface water to low pH and elevated metal concentration discharges. This creates the potential need for additional long term maintenance actions.

Alternatives 3 and 4 are both protective over the long term. Alternative 4 has some short term impacts due to the excavation and trucking activities.

All the alternatives are easy to implement.

Alternative 4 has significant capital costs in comparison to the other three alternatives.

Table 5. Comparative analysis of alternatives for K-720 Slough

Criteria	Alternative 1: No Action	Alternative 2: Land Use Controls	Alternative 3: Remediation and Land Use Controls	Alternative 4: Removal
Overall protection of human health and the environment	Does not protect surface water discharge receptors	Limited protection over long term	Is protective	Is protective
Compliance with ARARs	No ARARs for a no action alternative	Does not meet all ARARs over long term	Meets all ARARs	Meets all ARARs
Long-term effectiveness and permanence	Does not provide any long-term effectiveness and permanence	Provides limited long-term effectiveness and permanence	Provides long-term effectiveness and permanence	Provides long-term effectiveness and permanence
Reduction of toxicity, mobility, or volume through treatment	No treatment, so no reduction. Without land use controls, toxicity and mobility of metals could increase	Current vegetative cover does provide limited long term protection	Improved cover and storm water runoff controls will further reduce metals and low pH discharges	Excavation removes the fly ash source
Short-term effectiveness	No short-term impacts	Surface water discharges should not degrade over the short term	Improved vegetative cover will be effective with limited impact on local environment; wetland may be impacted in the short-term but will be improved in the long-term	Minor excavations will have a minimal short-term impact on local environment
Implementability	No implementability issues	No implementability issues	Easy to implement with standard soil field techniques	Easy to implement with standard excavation techniques
Cost (escalated)	None	Capital: $0 Annual O&M: $23,000 Present value: $375,400	Capital: $95,000 Annual O&M: $21,000 Present value: $398,000	Capital: $1,540,000 Annual O&M: $0 Present value: $1,540,000
NEPA-cumulative impacts	None	No loss of significant habitat	Minor transportation additions for bringing in soil cover and lime. No loss of significant habitat.	Minor transportation additions for fly ash waste disposal and then bringing in clean fill material. No loss of significant habitat.

ARAR = applicable or relevant and appropriate requirements

NEPA = National Environmental Policy Act

O&M = operations & maintenance

NEPA

Alternatives 1 and 2 have no cumulative impacts. Alternatives 3 and 4 have minor additional transportation impacts due to waste disposal in Alternative 4 and bringing in clean fill in Alternatives 3 and 4.

PREFERRED SURFACE WATER ALTERNATIVE

Based on the available information, DOE believes that the preferred alternative for the K-720 Slough, Alternative 3, meets the threshold criteria and provides the best balance of tradeoffs among the four alternatives.

A summary of the analysis for all six of the watersheds reviewed is provided in Table 6 with details on each of the six areas provided in Appendix C.

No actions were proposed for the Oxbow Lake and Beaver Ponds. Actions to monitor at surface water locations were identified for the Clinch River, K-720 Slough, K-1007-P Pond, and K-901-A Pond. A remedial action for additional cover material at the K-720 Fly Ash Pile is proposed.

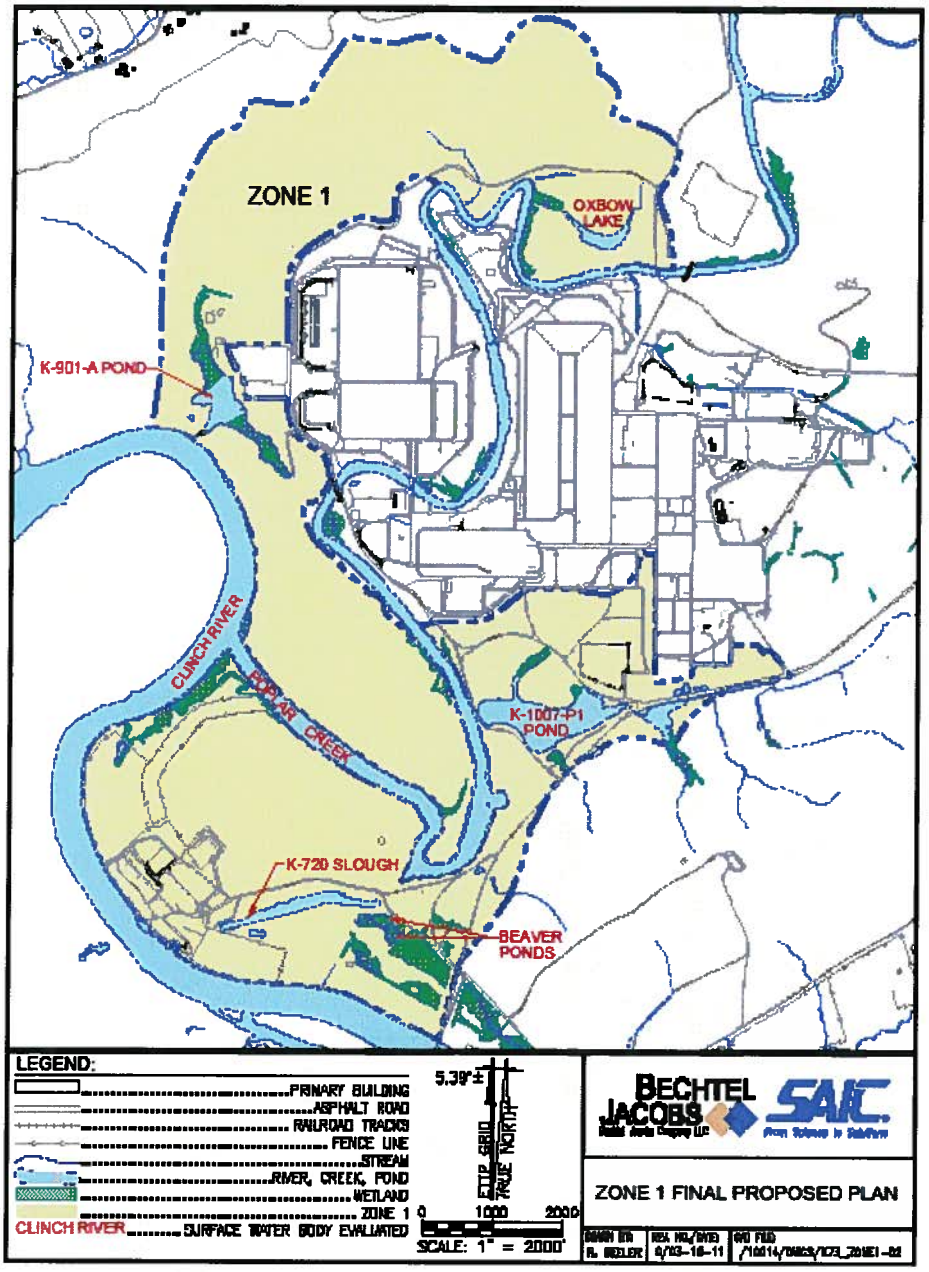

Fig. 7. Surface water bodies evaluated.

Table 6. Surface water actions

Area	Proposed Actions	Evaluation	Monitoring Parameters	Monitoring Frequency
Clinch River	Monitoring	NPDES program surface water mixing zone calculations, Surface Water Comparison	radiological, and metals	Annual
K-720 Slough	Monitoring; add additional soil cover material over selected fly ash areas and maintain the overall cover as a land use control	Surface water comparison, water shed walk downs, watershed sampling investigations	pH and metals	Semi Annual
K-1007-P1 Pond	Monitoring	Surface water comparison	PCBs and metals	Annual
K-901-A Pond	Monitoring	Surface water comparison	PCBs and metals	Annual
Beaver Dam Ponds	No Action	Surface water comparison	No Action	No Action
Oxbow Lake	No Action	Surface water comparison	No Action	No Action

WELL PLUGGING AND ABANDONMENT DECISION

There are 63 groundwater monitoring wells in Zone 1. Fourteen of these wells will be plugged and abandoned (5 bedrock and 9 unconsolidated zone wells) to eliminate the potential contaminant pathway. The wells to be plugged and abandoned were selected based on the following criteria:

- No groundwater plume present
- Do not monitor active flow paths (plume present in vicinity, but not at well location)
- Have suspect construction

The wells to be plugged and abandoned are located in Fig. 8 and listed in Table 7 along with the rational for plugging and abandoning.

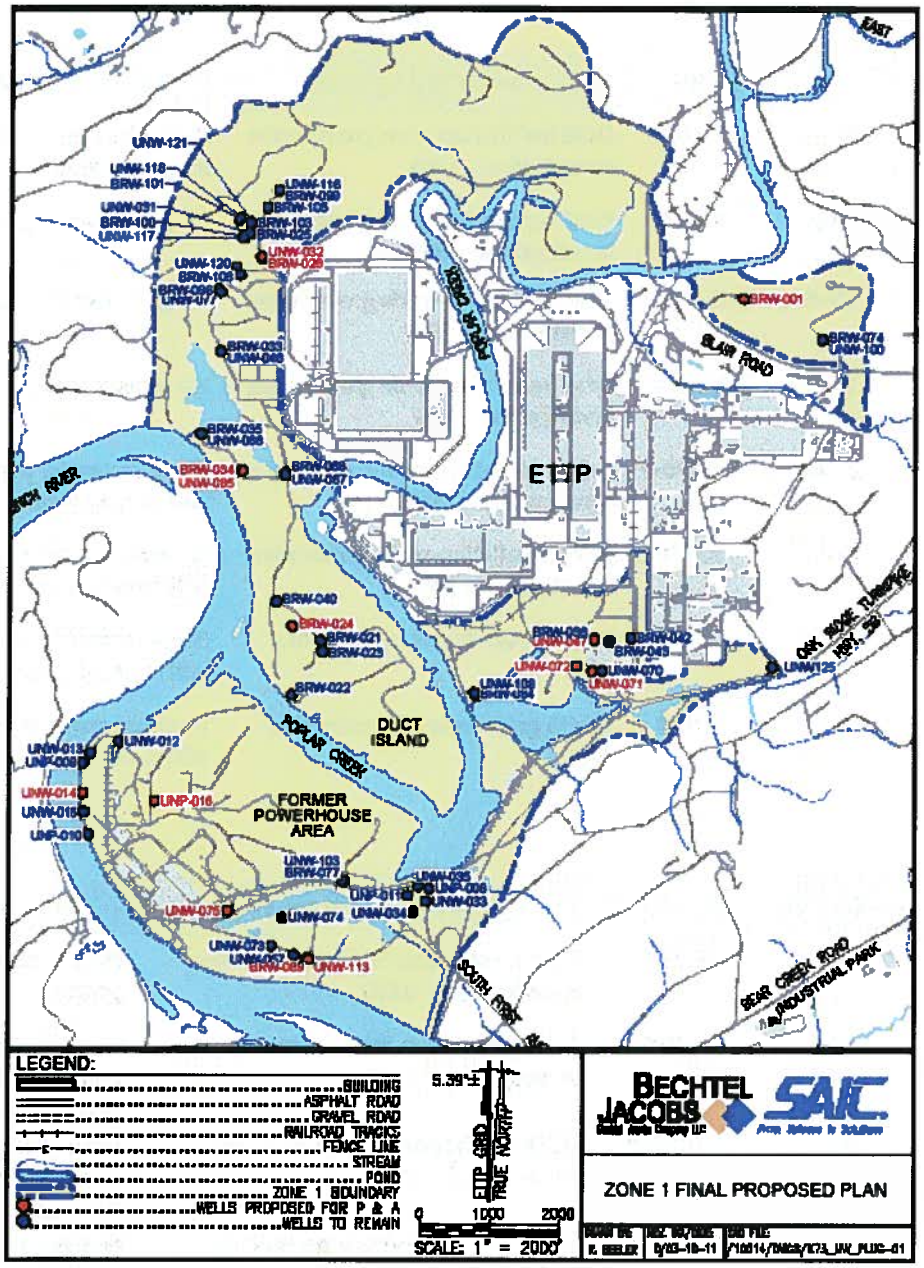

Fig. 8. Wells to be plugged and abandoned.

Table 7. Wells to be plugged and abandoned

WELL	EU	SITE	REASON FOR INSTALLATION	CRITERIA
BRW-001	Z1-77	K-1099	DOE installation-wide groundwater investigation - 1985	Remedial action complete; no long-term monitoring required
UNW-071	Z1-5	K-1007	DOE installation-wide groundwater investigation - 1989	No groundwater plume present
UNW-072	Z1-5	K-1007	DOE installation-wide groundwater investigation - 1989	No groundwater plume present
UNW-047	Z1-5	K-1004	DOE installation-wide groundwater investigation - 1987	No groundwater plume present
BRW-024	Z1-42	K-1070-F	DOE installation-wide groundwater investigation - 1986	No groundwater plume present; will re-sample prior P&A
UNW-075	Z1-17	K-720	DOE installation-wide groundwater investigation - 1989	No groundwater plume present; will re-sample prior to P&A
UNW-113	Z1-11	K-720	USGS groundwater investigation - 1981	Suspect construction integrity; will re-sample prior to P&A
BRW-089	Z1-11	K-720	USGS groundwater investigation - 1981	Suspect construction integrity; will re-sample prior to P&A

WELL	EU	SITE	REASON FOR INSTALLATION	CRITERIA
UNP-016	28	K-770	DOE installation-wide groundwater investigation - 1985	No groundwater plume present
UNW-014	31	K-770	DOE installation-wide groundwater investigation - 1986	No groundwater plume present; will re-sample prior to plugging
BRW-026	58	K-1070-A	DOE installation-wide groundwater investigation - 1987	Not in active K-1070-A groundwater plume flowpath
UNW-032	58	K-1070-A	DOE installation-wide groundwater investigation - 1987	Not in active K-1070-A groundwater plume flowpath
BRW-034	46	K-901-A	DOE installation-wide groundwater investigation - 1987	No groundwater plume present
UNW-065	46	K-901-A	DOE installation-wide groundwater investigation - 1987	Dry well

In addition, a there are 30 soil gas piezometers that were installed to support property transfers. These will be plugged and abandoned also. The piezometers to be plugged and abandoned are located in Fig. 9 and listed in Table 8 along with the rational for plugging and abandoning.

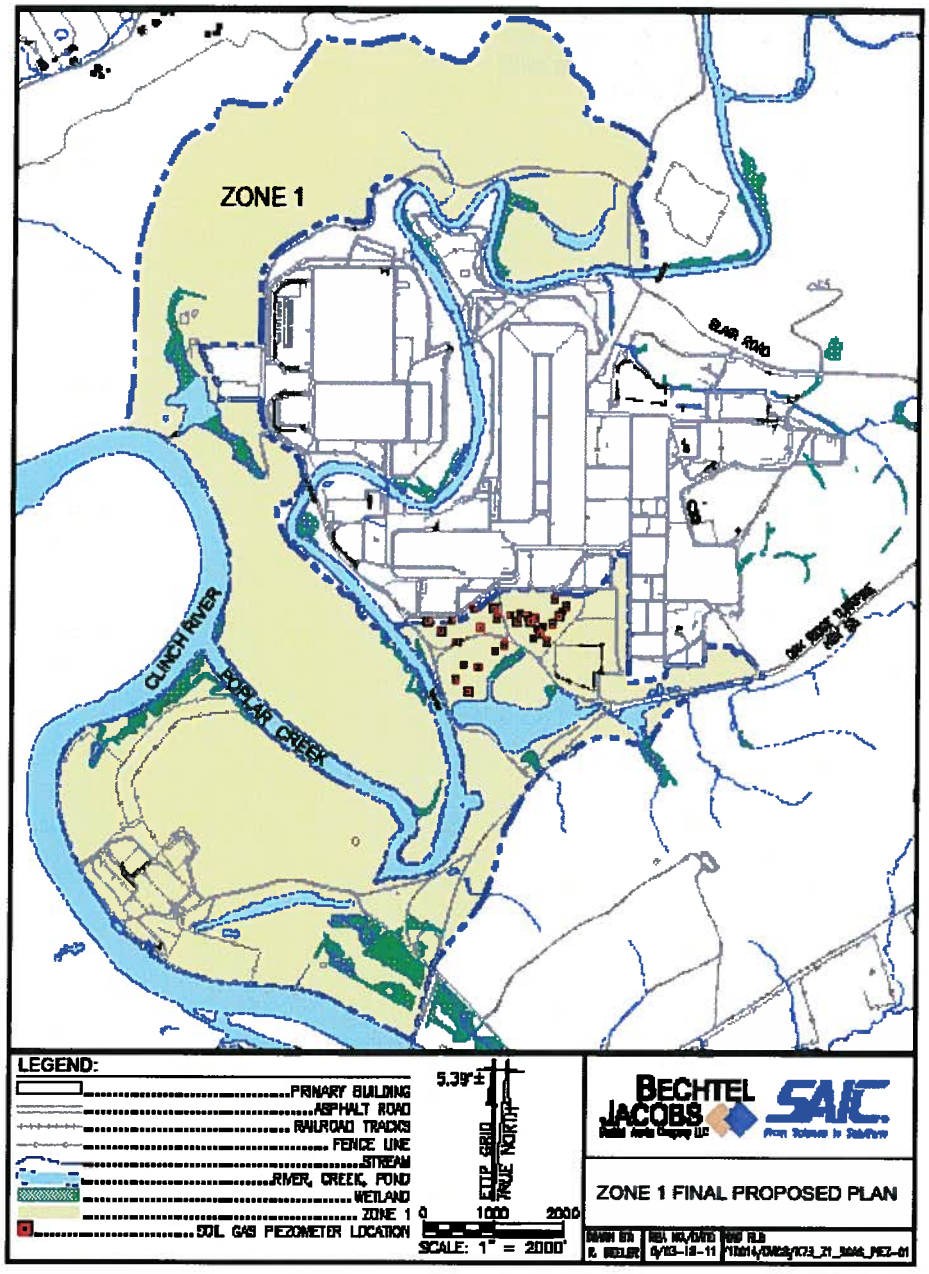

Fig. 9. Piezometers to be plugged and abandoned.

Table 8. Wells to be plugged and abandoned

WELL	EU	SITE	REASON FOR INSTALLATION	CRITERIA
01, 02, 03, 04, 05, 06, 07, 08, 13 and 14	Z1-6	ED-5 West	Soil vapor investigation to support property transfer	Complete pathway not identified – property has been transferred
09, 10, 11, 12	Z1-7	ED-5 West	Soil vapor investigation to support property transfer	Complete pathway not identified – property has been transferred
1, 2, 4, 5, 7, 8, 9, 11, 12, 14, A1, A2, A3, A4, A5, and A7	Z1-4	ED-5 East	Soil vapor investigation to support property transfer	Complete pathway not identified – property has been transferred

NATURAL RESOURCE DAMAGES

Hazardous substances known to be above health-based levels, based on a residential use, will remain in the soil upon completion of remedial action. It is recognized by DOE, TDEC, and the EPA that Natural Resource Damage claims, in accordance with CERCLA, may be applicable. This document does not address restoration or rehabilitation of any natural resource injuries that may have occurred, or whether any such injuries have occurred. Neither DOE nor TDEC waives any rights or defenses they may have under CERCLA, Sect. 107(1)4(c).

COMMITMENT TO STEWARDSHIP

The preferred alternative will result in leaving hazardous material on-site known to be above health-based levels based on a residential use. DOE is committed to maintaining the necessary land use controls (Table 9) to protect future users of the site.

COMMUNITY PARTICIPATION

This *Proposed Plan* is based on the data and information presented in the RI/FS (DOE 2007) and is being published to solicit public review and comment on all information presented herein, specifically on information pertaining to the preferred alternative. DOE (the lead agency for Oak Ridge Reservation remedial activities) is issuing this *Proposed Plan* as part of public participation requirements under Sect. 117(a) of CERCLA, as amended by Superfund Amendments and Reauthorization Act of 1986 and the National Oil and Hazardous substances Pollution Contingency Plan 300.430(f)(2).

DOE, EPA, and TDEC encourage the public to review this document and other relevant documents in the Administrative Record file to gain an understanding of the proposed residual contamination cleanup actions. A copy of this *Proposed Plan*, as well as the entire Administrative Record file, is located at the DOE Information Center, 475 Oak Ridge Turnpike, Oak Ridge, Tennessee 37830. The Center is open Monday through Friday, 8 a.m. to 5 p.m.; the telephone number is (865) 241-4780.

Community involvement is critical to the CERCLA process. DOE has established a 30-day public comment period, which allows the public time to review the document and submit comments on the preferred and other alternatives. DOE will document, evaluate, and respond to comments as part of the subsequent ROD. Comments may be addressed to David Adler, Federal Facility Agreement Project Manager, Oak Ridge Environmental Management, DOE Oak Ridge Operations, P.O. Box 2001, Oak Ridge, Tennessee 37830.

CONCLUSION

The preferred alternative identified in this *Proposed Plan* represents the recommended remedial action for contaminated soil for ecological protection, for a recreational end use, and as a source of surface water contamination and the plugging and abandonment of wells. This *Proposed Plan* provides stakeholders the information necessary to determine if remedial action is warranted and to provide comments on the potential alternatives. DOE may modify the preferred alternative or select a different alternative in response to public input. DOE will select the remedial action after all comments are considered. DOE, EPA, and TDEC will consider all comments and suggestions before the remedial alternative is selected and documented in a ROD amendment.

Table 9. Land use controls for Zone 1

Type of control	Purposes of control	Duration	Implementation	Affected areas[a]
1. DOE land notation (Property Record Restrictions)[b] A. Land use B. Groundwater	A. Restrict use of property by imposing limitations. B. Prohibit uses of groundwater.	Until the concentrations of hazardous substances in the environmental media are at such levels to allow for unrestricted use and exposure.	Drafted and implemented by DOE after completion of remediation (approval of Remedial Action Report) or transfer of affected areas out of DOE federal control. Recorded by DOE in accordance with state law at County Register of Deeds office.	Throughout all of Zone 1.
2. Property Record and Other Notices[c]	Provide information to the public about the existence and location of disposal sites and contaminated areas and media and limitations on their use.	Until the concentrations of hazardous substances in the environmental media are at such levels to allow for unrestricted use and exposure.	Notice will be provided by DOE EM to the public. This notice will be supplemented with the DOE land notation after completion of remediation (approval of Remedial Action Report).	Throughout all of Zone 1.
3. Zoning Notices[d]	Provide notice to City Planning Commission about the existence and location of disposal sites and contaminated areas and limitations on their use for zoning/planning purposes if/when these areas are transferred out of DOE federal control.	Until the concentrations of hazardous substances in the environmental media are at such levels to allow for unrestricted use and exposure.	Zoning Notice, use limitation information, and boundary survey plat will be filed with the City Planning Commission if when these areas are transferred out of DOE federal control.	Throughout all of Zone 1.
4. Excavation/ Penetration Permit Program[e]	Provide notice to worker/developer on extent of contamination and prohibit or limit excavation/penetration activity.	As long as property remains under DOE control.	Implemented by DOE and its contractors. Initiated by permit request.	All areas where hazardous substances are known to be left in the subsurface below 10 feet and where waste is disposed.
5. Access Controls[f] (e.g., fences, gates, and	Control and restrict access to workers and the public to prevent unauthorized uses.	Until the concentrations of hazardous substances in the environmental	Maintained by DOE.	Specific locations will be identified in the Remedial Action Report.

portals)		media are at such levels to allow for unrestricted use and exposure.		
6. Signs[g]	Provide notice or warning to prevent unauthorized access.	Until the concentrations of hazardous substances in the environmental media are at such levels to allow for unrestricted use and exposure.	Maintained by DOE.	Specific locations will be identified in the Remedial Action Report.
7. Surveillance Patrols	Control and monitor access by workers/public.	Until the concentrations of hazardous substances in the environmental media are at such levels to allow for unrestricted use and exposure.	Established and maintained by DOE.	Specific locations will be identified in the Remedial Action Report.

[a]Affected Areas – Specific locations identified in the ETTP LUCIP as part of a remedial design report/remedial action work plan.
[b]Property Record Restrictions – Includes conditions and/or covenants that restrict or prohibit certain uses of real property and are recorded along with original property acquisition records of DOE and its predecessor agencies.
[c]Property Record Notices – Refers to any non-enforceable, purely informational document recorded along with the original property acquisition records of DOE and its predecessor agencies that alerts anyone searching property records to important information about residual contamination/waste disposal areas on the property.
[d]Zoning Notices – Includes information on the location of waste disposal areas and residual contamination depicted on a survey plat, which is provided to a zoning authority (i.e., City Planning Commission) for consideration in appropriate zoning decisions for non-DOE property.
[e]Excavation/Penetration Permit Program – Refers to the internal DOE/DOE contractor administrative program(s) that require the permit requestor to obtain authorization, usually in the form of a permit, before beginning any excavation/penetration activity (e.g., well drilling) for the purpose of ensuring that the proposed activity will not affect underground utilities/structures, or in the case of contaminated soil or groundwater, will not disturb the affected area without the appropriate precautions and safeguards.
[f]Access Controls – Physical barriers or restrictions to entry.
[g]Signs – Posted command, warning, or direction.
bgs = below ground surface.
DOE = U. S. Department of Energy.
EM = Environmental Management.
ETTP = East Tennessee Technology Park.
ROD = Record of Decision.

REFERENCES

DOE (U.S. Department of Energy) 1994. *Secretarial Policy Statement on the National Environmental Policy Act of 1969*, U.S. Department of Energy, Washington, D.C.

DOE 2002. *Record of Decision for Interim Actions in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/OR/01-1997&D2, Office of Environmental Management, Oak Ridge, TN.

DOE 2007a. *Final Sitewide Remedial Investigation and Feasibility Study for East Tennessee Technology Park, Oak Ridge, Tennessee, DOE/OR/01-2279&D3,* Office of Environmental Management, Oak Ridge, TN.

DOE 2007b. *Action Memorandum for the Ponds at the East Tennessee Technology Park, Oak Ridge, Tennessee: K-1007-P Holding Ponds, K-901-A Holding Pond, K-720 Slough, and K-770 Embayment*, DOE/OR/01-2314&D2, Office of Environmental Management, Oak Ridge, TN.

DOE 2011. *Removal Action Report for the Ponds at the East Tennessee Technology Park, Oak Ridge, Tennessee: K-1007-P Holding Ponds, K-901-A Holding Pond, K-720 Slough, and K-770 Embayment*, DOE/OR/01-2456&D1/R1, Office of Environmental Management, Oak Ridge, TN.

GLOSSARY

Applicable or relevant and appropriate requirement (ARAR) – Those cleanup standards and other substantive requirements, criteria, or limitations promulgated under federal or more stringent state environmental or facility siting laws that are either legally "applicable" or "relevant and appropriate" to the hazardous substances, pollutant, contaminant, remedial action, location, or other circumstance found at the CERCLA site.

Baseline risk assessment – An assessment that evaluates the potential threat to human health and the environment in the absence of any remedial action. Provides basis for determining if remedial action is necessary and justification for performing remedial actions.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) – The federal law that establishes, among other requirements, a program for parties (including federal agencies) for identifying, investigating, and, if determined necessary, remediating inactive site-facilities contaminated with a hazardous substance, pollutant, or contaminant. It is also known as the "Superfund law."

Contaminants of concern – Chemicals and radioactive contaminants that pose an unacceptable risk to human health or ecological receptor.

Ecological receptor – Animals or plants potentially exposed to contaminants in the environment.

Feasibility Study – The step in the CERCLA process in which alternatives for remediation of a contaminated site are developed and evaluated.

Groundwater – Underground water that fills pores in soils or openings in rocks to the point of saturation.

Monitoring – The ongoing collection of information about the environment that helps gauge the effectiveness of a cleanup action.

National Environmental Policy Act of 1969 (NEPA) – A federal law that requires federal agencies to consider and evaluate environmental impacts associated with any significant proposed actions or activities. For CERCLA actions undertaken by the DOE, any impacts (i.e., NEPA values) associated with the proposed action are considered along with other factors required to be evaluated.

Proposed Plan – The formal document in which the lead agency identifies its preferred alternative for remedial action, explains why this alternative was preferred, and solicits comments from the public.

Record of Decision – The formal document in which the lead agency sets forth the selected remedial action and the reasons for its selection.

ACRONYMS

ARAR	applicable or relevant and appropriate requirement
BORCE	Black Oak Ridge Conservation Easement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	*Code of Federal Regulations*
COC	contaminant of concern
DCG	Derived Concentration Guidance
DOE	U. S. Department of Energy
EMWMF	Environmental Management Waste Management Facility
EPA	U. S. Environmental Protection Agency
ETTP	East Tennessee Technology Park
HI	hazard index
LOAEL	lowest observed adverse effect level
NEPA	National Environmental Policy Act of 1969
NOAEL	no observed adverse effect level
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
RAO	remedial action objective
RGO	remedial goal option
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
TDEC	Tennessee Department of Environment and Conservation

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PROPOSED PLAN FOR AMENDMENT OF THE RECORD OF DECISION FOR INTERIM ACTIONS IN ZONE 1, EAST TENNESSEE TECHNOLOGY PARK, OAK RIDGE, TENNESSEE
PUBLIC COMMENT SHEET

DOE is interested in your comments on the alternatives being considered in the *Proposed Plan for Amendment of the Record of Decision for Interim Actions in Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee,* including the preferred alternative. The mailing address is preprinted on the back of this form. You may use this form to submit your comments. We must receive your comments on or before the close of the public comment period. If you have questions, please contact Mr. David Adler, FFA Project Manager; Oak Ridge Environmental Management; DOE Oak Ridge Operations; P.O. Box 2001, Oak Ridge, TN 37830; (865) 576-4094.

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Name: _____

Address: _____

City: _____ State/Zip: _____

Phone: _____

MAILING LIST ADDITIONS:

Please add my name to the Environmental Management Program mailing list to receive additional information on the progress at the Oak Ridge Reservation: ☐ Yes ☐ No

Place stamp here

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APPENDIX A

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Table A.1. Applicable or relevant and appropriate requirements and to-be-considered guidance for the preferred alternatives, ETTP sitewide remedial action, Oak Ridge, Tennessee

Media/Location/Action	Requirements	Prerequisite	Citation
	Chemical-specific ARARs		
Surface water	Shall not exceed the numeric fish and aquatic life and recreation AWQC for toxic substances in surface waters, based on the designated use(s) of the water bodies, as an instream concentration at the edge of a designated mixing zone. [There are no numeric AWQC for the other designated uses for Zone 1 surface waters.]	Release of contaminants to surface water or actions potentially impacting surface water – **applicable**	TDEC 1200-4-3.03(3) *and* (4)
	Shall not violate other physical and chemical parameters or conditions set forth in TDEC, Chap. 1200-4-3-.03(2) through (6), as appropriate for designated uses for each surface water body.		TDEC 1200-4-3.03(2) through (6)
	Waters shall not contain toxic substance(s) or other pollutants that might cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions, or physical deformations or that might restrict or impair growth in fish or aquatic life or their offspring.		TDEC 1200-4-3-.03(3)(g) *and* (h)
	Shall not modify the water through the addition of pollutants or through physical alteration to the extent that the diversity and/or productivity of aquatic biota within the receiving waters are substantially decreased or adversely affected, except as allowed under TDEC, Chap. 1200-4-3-.06.		TDEC 1200-4-3-.03(3)(m)
Radiation protection of the public and the environment	Except as provided in 5400.1(II)(1)(a)(4), exposure to individual members of the public from radiation shall not exceed a total EDE of 0.1 rem/year (100 mrem/year), exclusive of the dose contributions from background radiation, any medical administration the individual has received, or voluntary participation in medical/research programs.	Release of radionuclides to the environment from an active NRC-licensed operation – **relevant and appropriate**	10 CFR 20.1301(a)(1) DOE O 5400.5(II)(1)(a) (TBC guidance)
	Shall use, to the extent practicable, procedures and engineering controls based on sound radiation protection principles to achieve doses to members of the public that are ALARA.		10 CFR 20.1101(b) DOE O 5400.5(II)(2) (TBC guidance)
Airborne radionuclide emissions	Emissions of radionuclides to the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive an EDE of 10 mrem per yr.	Radionuclide air emissions from point sources, as well as diffuse or fugitive emissions, at DOE facilities – **applicable**	40 CFR 61.92
	Radionuclide materials released to the atmosphere as a consequence of routine DOE activities shall not cause members of the public to receive, in a year, an EDE > 10 mrem per year.	Dose received from all sources of radionuclides via airborne emissions - **TBC**	DOE O 5400.5(II)(1)(b)

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Table A.1. Applicable or relevant and appropriate requirements and to-be-considered guidance for the preferred alternatives, ETTP sitewide remedial action, Oak Ridge, Tennessee

Media/Location/Action	Requirements	Prerequisite	Citation
	Location-specific ARARs		
	Wetlands		
Presence of wetlands as defined in 10 CFR 1022.4	Avoid, to the extent possible, the long- and short-term adverse effects associated with destruction, occupancy, and modification of wetlands.	DOE actions that involve potential impacts to, or take place within, wetlands – **applicable**	10 CFR 1022.3(c)
	Take action, to extent practicable, to minimize destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands.		10 CFR 1022.3(a)(7) and (8)
	Undertake a careful evaluation of the potential effects of any new construction in wetlands. Identify, evaluate, and, as appropriate, implement alternative actions that may avoid or mitigate adverse impacts on wetlands.		10 *CFR* 1022.3(b) and (d)
	Measures to take to mitigate adverse effects of actions in wetlands include, but are not limited to, minimum grading requirements, runoff controls, design and construction constraints, and protection of ecology-sensitive areas.		10 CFR 1022.13(a)(3)
	If no practicable alternative to locating or conducting the action in the wetland is available, then before taking action design or modify the action in order to minimize potential harm to or within the wetland, consistent with the policies set forth in Executive Order 11990.		10 CFR 1022.14(a)
Presence of jurisdictional wetlands as defined in 40 CFR 230.3; 33 CFR 328.3(a), and 33 CFR 328.4	The discharge of dredged or fill material into waters of the United States, including jurisdictional wetlands, is prohibited if there is a practical alternative that would have less adverse impact. No discharge shall be permitted that results in violation of state water quality standards, violates any toxic effluent standard, and/or jeopardizes an endangered species or its critical habitat. No discharge will be permitted that will cause significant degradation of waters of the United States. No discharge is permitted unless mitigation measures have been taken in accordance with 40 CFR 230, Subpart H.	Actions that involve the discharge of dredged or fill material into waters of the United States, including jurisdictional wetlands – **applicable**	40 CFR 230.10(a), (b), (c) and (d) 40 CFR 230, Subpart H

Table A.1. Applicable or relevant and appropriate requirements and to-be-considered guidance for the preferred alternatives, ETTP sitewide remedial action, Oak Ridge, Tennessee

Media/Location/Action	Requirements	Prerequisite	Citation
Presence of wetlands as defined under TDEC 1200-4-7-.03	Mitigation must be provided where any activity would result in an appreciable permanent loss of resource value of wetlands. For isolated wetlands of less than 0.25 acre, compensatory mitigation is not required. Compensatory measures must be at a ratio of 2:1 for restoration, 4:1 for creation and enhancement, and 10:1 for preservation or at a best professional judgment ratio agreed to by the state.	Activity that would cause loss of wetlands of more than 0.25 acre – **applicable**	TDEC 1200-4-7-.04 (7)(b)
Presence of minor isolated wetlands of less than 0.25 acre	Alteration of up to 0.25 acre of wetlands that are degraded or of low functional capacity must meet certain requirements as follows: • The alteration shall not adversely affect the functions and classified use support of adjacent wetlands. • Any material discharged into wetlands shall be free of contaminants, including toxic pollutants, hazardous substances, waste metals, or construction debris, or other wastes. • Excavation and fill activities shall be kept to a minimum, and all excess material shall be hauled upland and properly stabilized or disposed of. • Erosion and sediment controls shall be designed according to the size and slope of disturbed or drainage to detain runoff and trap sediment, and shall be properly selected, installed, and maintained in accordance with manufacturer's specifications and good engineering practices. • Erosion and sedimentation control shall be in place and functional before earthmoving operations begin and must be maintained throughout the construction period. Temporary measures may be removed at the beginning of the work day but shall be replaced at the end of the work day. • Litter, construction debris, and construction chemicals exposed to stormwater shall be picked up prior to anticipated storm events or otherwise prevented from becoming a pollutant source for stormwater discharges. • Clearing, grubbing, or other disturbance of areas immediately adjacent to waters of the state shall be limited to the minimum necessary to accomplish the proposed activity. Unnecessary vegetation removal is prohibited, and disturbed areas shall be stabilized and revegetated as soon as practicable.	Alteration of minor wetlands – **TBC**	TDEC ARAP General Permit for Minor Alterations to Wetlands (effective July 1, 2010)

Table A.1. Applicable or relevant and appropriate requirements and to-be-considered guidance for the preferred alternatives, ETTP sitewide remedial action, Oak Ridge, Tennessee

Media/Location/Action	Requirements	Prerequisite	Citation
	Floodplains		
Presence of floodplain as defined in 10 CFR 1022.4	Design or modify selected alternatives to reduce risk of flood loss, minimize harm to or within floodplains, and restore and preserve floodplain values to extent practicable. Structures constructed in a floodplain shall meet, at a minimum, building standards pursuant to the National Flood Insurance Program.	DOE actions that involve potential impacts to, or take place within, floodplains – **applicable**	10 CFR 1022.3(a)(1) through (4)
	Undertake a careful evaluation of the potential effects of any new construction in floodplains. Identify, evaluate, and, as appropriate, implement alternative actions that may avoid or mitigate adverse impacts on floodplains.		10 *CFR* 1022.3(b) and (d)
	Avoid, to the extent possible, the long- and short-term adverse effects associated with occupancy and modification of floodplains.		10 CFR 1022.3(c)
	Measures to take to mitigate adverse effects of actions in floodplains include, but are not limited to, minimum grading requirements, runoff controls, design and construction constraints, and protection of ecology-sensitive areas.		10 CFR 1022.13(a)(3)
	If no practicable alternative to locating or conducting the action in the floodplain is available, then before taking action design or modify the action in order to minimize potential harm to or within the floodplain, consistent with the policies set forth in Executive Order 11990.		10 *CFR* 1022.14(a)
	Aquatic resources		
Within area impacting stream or any other body of water –and- presence of wildlife resources (e.g., fish)	The effects of water-related projects on fish and wildlife resources and their habitat shall be considered with a view to the conservation of fish and wildlife resources by preventing loss of and damage to such resources.	Action that impounds, modifies, diverts, or controls a stream or other body of water, except where the maximum surface area of an impoundment is less than 10 acres or for land management activities by federal agencies with respect to federal lands under their jurisdiction– **relevant and appropriate**	16 USC 662(a) (*Fish and Wildlife Coordination Act*)
Waters of the state as defined in *TCA* 69-3-103(33)	Must comply with the substantive requirements of the ARAP for erosion and sediment control to prevent pollution of waters of the state.	Action potentially altering the properties of any waters of the state – **applicable**	*TCA* 69-3-108(b)(1)(j)

Table A.1. Applicable or relevant and appropriate requirements and to-be-considered guidance for the preferred alternatives, ETTP sitewide remedial action, Oak Ridge, Tennessee

Media/Location/Action	Requirements	Prerequisite	Citation
	Pollution control requirements, as detailed in each particular General Permit, include but are not limited to, the following: • Activity must not result in discharge of waste or substances that may be harmful to humans or wildlife; • Material may not be placed in a location or manner so as to impair surface water flow into or out of any wetland area; • Work must be carried out in a manner that does not violate water quality criteria as stated in TDEC 1200-4-3-.03, including, but not limited to, prevention of discharges that cause a condition in which visible solids, bottom deposits, or turbidity impairs the usefulness of waters of the state for any of the designated uses for that water body by TDEC 1200-4-4; • Excavation and fill activities shall be kept to a minimum, and all excess material shall be hauled upland and properly stabilized or disposed of. • Sediment shall be prevented from entering waters of the state; erosion and sediment controls shall be designed according to the size and slope of disturbed or drainage to detain runoff and trap sediment, and shall be properly selected, installed, and maintained in accordance with manufacturer's specifications and good engineering practices. • Erosion and sedimentation control shall be in place and functional before earthmoving operations begin and must be maintained throughout the construction period. Temporary measures may be removed at the beginning of the work day but shall be replaced at the end of the work day. • Litter, construction debris, and construction chemicals exposed to stormwater shall be picked up prior to anticipated storm events or otherwise prevented from becoming a pollutant source for stormwater discharges. • Clearing, grubbing, or other disturbance of areas immediately adjacent to waters of the state shall be limited to the minimum necessary to accomplish the proposed activity. Unnecessary vegetation removal is prohibited, and disturbed areas shall be stabilized and revegetated as soon as practicable.	Action potentially altering the properties of any waters of the state – **TBC**	TDEC ARAP Program conditions common to all General Permits

Table A.1. Applicable or relevant and appropriate requirements and to-be-considered guidance for the preferred alternatives, ETTP sitewide remedial action, Oak Ridge, Tennessee

Media/Location/Action	Requirements	Prerequisite	Citation
	• Appropriate steps shall be taken to ensure petroleum products or other chemical pollutants are prevented from entering waters of the state, including groundwater; • Adverse impacts to T&E species or cultural, historical, or archeological features or sites are prohibited.		
Waters of the state as defined in *TCA* 69-3-103(33)	Bank stabilization activities along waters of the state must be conducted in accordance with the requirements of the ARAP Program (Rules of the TDEC, Chap. 1200-4-7). The general permit requirements for stream bank stabilization include the following: • The erosion and sedimentation control practices indicated above under the TDEC ARAP general conditions apply; • Stream beds must not be used as transportation routes for construction equipment; • Temporary stream crossings shall be limited to one point in the construction area and erosion control measures shall be utilized where stream banks are disturbed; crossing shall be constructed so that stream flow is not obstructed; • Following construction, all materials used for the temporary crossing shall be removed and disturbed banks shall be restored and stabilized if needed; • Materials used in bank stabilization shall include clean rock, riprap, anchored trees or other non-erodible materials found in the natural environment; materials shall be free of contaminants including toxic pollutants, hazardous substances, waste metals, or construction debris, or other wastes. ▪ Activity may not be conducted in a manner that would permanently disrupt the movement of fish and aquatic life; ▪ Material may not be placed such that it impairs surface water flow into or out of any wetland area; ▪ Except under certain conditions detailed in the permit, length of bank stabilization is limited to 300 linear ft.	Bank-stabilization activities affecting waters of the state – **TBC**	TDEC ARAP General Permit for Bank Stabilization Activities (effective July 1, 2010)

Table A.1. Applicable or relevant and appropriate requirements and to-be-considered guidance for the preferred alternatives, ETTP sitewide remedial action, Oak Ridge, Tennessee

Media/Location/Action	Requirements	Prerequisite	Citation
Waters of the state as defined as *TCA* 69-3-103	Wet-weather conveyances may be altered provided the following conditions are met: • The erosion and sedimentation control practices indicated above under the TDEC ARAP general conditions apply; ▪ Check dams shall be utilized where runoff is concentrated but shall not be constructed in streams; ▪ Clean rock, log, sandbag, or straw bale check dams shall be properly constructed to detain runoff and trap sediment and shall not contain fines, soils, or other wastes or contaminants;	Activities that alter wet-weather conveyances – **TBC**	TDEC ARAP General Permit for the Alteration of Wet-Weather Conveyances (effective July 1, 2010)
Location encompassing aquatic ecosystem as defined in 40 CFR 230.3(c)	The discharge of dredged or fill material into waters of the United States is prohibited if there is a practical alternative that would have less adverse impact. No discharge shall be permitted that results in violation of state water quality standards, violates any toxic effluent standard, and/or jeopardizes an endangered species or its critical habitat. No discharge will be permitted that will cause significant degradation of waters of the United States. No discharge of dredged or fill material shall be permitted unless appropriate and practicable steps in accordance with 40 CFR 230.70 et seq. are taken that will minimize potential adverse impacts of the discharge on the aquatic ecosystem.	Action that involves discharge of dredged or fill material into waters of the United States, including jurisdictional wetlands – **applicable**	40 CFR 230.10(a), (b), (c), and (d) 40 CFR 23,0 Subpart H
	Endangered, threatened, or rare species		
Presence of Tennessee nongame species as defined in *TCA* 70-8-103	May not take (i.e., harass, hunt, capture, kill, or attempt to kill), possess, transport, export, or process wildlife species.	Action impacting Tennessee nongame species, including wildlife species that are "in need of management" (as listed in TWRCP 94-16 and 94-17) – **applicable**	*TCA* 70-8-104(c)
	May not knowingly destroy the habitat of such wildlife species.		TWRCP 94-16(II)(1)(a) and TWRCP 94-17(II) (TBC guidance)
	Upon good cause shown and where necessary to protect human health or safety, endangered or threatened species may be removed, captured, or destroyed.		*TCA* 70-8-106(e) TWRCP 94-16(II)(1)(c) (TBC guidance)

Table A.1. Applicable or relevant and appropriate requirements and to-be-considered guidance for the preferred alternatives, ETTP sitewide remedial action, Oak Ridge, Tennessee

Media/Location/Action	Requirements	Prerequisite	Citation
Presence of Tennessee-listed endangered or rare plant species as listed in TDEC 0400-6-2.04	May not knowingly uproot, dig, take, remove, damage or destroy, possess, or otherwise disturb for any purpose any endangered species.	Action impacting rare plant species, including, but not limited to, federally listed endangered species – **applicable**	*TCA* 70-8-309 TWRCP 94-16(II)(1)(a) and TWRCP 94-17(II) (TBC guidance)
Presence of federally endangered or threatened species, as designated in 50 CFR 17.11 and 17.12 or critical habitat of such species	Actions that jeopardize the existence of a listed species or results in the destruction or adverse modification of critical habitat must be avoided or reasonable and prudent mitigation measures taken.	Action that is likely to jeopardize fish, wildlife, or plant species or destroy or adversely modify critical habitat — **applicable**	16 USC 1531 et seq., Sect. 7(a)(2)
Presence of migratory birds as defined in 50 CFR 10.13, and their habitats	Unlawful killing, possession, and sale of migratory bird species, as defined in 50 CFR 10.13, native to the U.S. or its territories are prohibited.	Federal agency action that is likely to impact migratory birds – **applicable**	16 USC 703-704
	Requirements are as follows: • Avoid or minimize, to the extent practicable, adverse impacts on migratory bird resources when conducting agency action; • Restore and enhance the habitats of migratory birds, as practicable; • Prevent or abate the pollution or detrimental alteration of the environment for the benefit of migratory birds, as practicable.	Federal agency action that is likely to impact migratory birds – **TBC**	Executive Order 13186
	Cultural resources		
Presence of archaeological resources	Must provide for the preservation of significant historical and archeological data which might otherwise be irreparably lost or destroyed as a result of any alternation of terrain caused as a result of any federal construction project. May not excavate, remove, damage, or otherwise alter or deface such resource unless by permit or exception.	Federal agency construction or excavation projects that would cause the irreparable loss or destruction of significant historical or archeological resources or data – **applicable**	16 USC 469 43 CFR 7.4(a)
Presence of human remains, funerary objects, sacred objects, or objects of cultural patrimony for Native Americans	Must stop activities in the area of the discovery and take reasonable effort to secure and protect the objects discovered. Must consult with Indian tribe likely to be affiliated with the objects to determine further disposition per 43 CFR 10.5(b).	Federal agency construction or excavation activities that inadvertently discover such resources on federal lands or under federal control – **applicable**	25 USC 3002(d) 43 CFR 10.4(c) and (d)

Table A.1. Applicable or relevant and appropriate requirements and to-be-considered guidance for the preferred alternatives, ETTP sitewide remedial action, Oak Ridge, Tennessee

Media/Location/Action	Requirements	Prerequisite	Citation
Presence of historical resources	Federal agencies must take into account the effect of the undertaking on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register.	Federal agency undertaking that may impact historical properties listed or eligible for inclusion on the National Register of Historic Places – **applicable**	16 USC 470f 36 CFR 800.1(a) 36 CFR 800.3
	Federal agencies must initiate measures to assure that where, as a result of federal action, a historic property is to be substantially altered or demolished, timely steps are taken to make or have made appropriate records.	Substantial alterations or demolition of a historic property – **applicable**	16 USC 470h-2(b) 36 CFR 800.5(a) and (d) 36 CFR 800.6
Presence of a cemetery	Intentional desecration of a place of burial is prohibited.	Action that would alter or destroy property in a cemetery – **applicable**	*TCA* 39-17-311
Action-specific ARARs			
Site preparation, construction, and excavation activities			
Activities causing fugitive dust emissions	Shall take reasonable precautions to prevent particulate matter from becoming airborne; reasonable precautions shall include, but are not limited to, the following:	Fugitive emissions from demolition of existing buildings or structures, construction operations, grading of roads, or the clearing of land—**applicable**	TDEC 1200-3-8-.01(1)
	• use, where possible, of water or chemicals for control of dust, and		TDEC 1200-3-8-.01(1)(a)
	• application of asphalt, oil, water, or suitable chemicals on dirt roads, materials stock piles, and other surfaces which can create airborne dusts.		TDEC 1200-3-8-.01(1)(b)
	Shall not cause or allow fugitive dust to be emitted in such a manner as to exceed 5 min/h or 20 min/d beyond property boundary lines on which emission originates.		TDEC 1200-3-8-.01(2)
Activities causing storm water runoff (e.g., clearing, grading, excavation)	Implement good construction management techniques (including sediment and erosion controls, vegetative controls, and structural controls) in accordance with the substantive requirements of *General Permit No. TNR10-0000* ("General Permit for Stormwater Discharges Associated with Construction Activities") to ensure that storm water discharge:	Dewatering or storm water runoff discharges from land disturbed by construction activity— disturbance of ≥1 acre total—**applicable**	*TCA* 69-3-108(j) TDEC 1200-4-10-.03(2)(a) *General Permit No. TNR10-0000* (effective June 16, 2005) (TBC guidance)
	• does not violate water quality criteria as stated in TDEC 1200-4-3-.03, including, but not limited to, prevention of discharges that cause a condition in which visible solids, bottom deposits, or turbidity impairs the usefulness of waters of the state for any of the designated uses for that water body by TDEC 1200-4-4;	Storm water discharges from construction activities—**TBC**	*General Permit No. TNR10-0000,* Section 4.3

Table A.1. Applicable or relevant and appropriate requirements and to-be-considered guidance for the preferred alternatives, ETTP sitewide remedial action, Oak Ridge, Tennessee

Media/Location/Action	Requirements	Prerequisite	Citation
	• does not contain distinctly visible floating scum, oil, or other matter; • does not cause an objectionable color contrast in the receiving stream; and • results in no materials in concentrations sufficient to be hazardous or otherwise detrimental to humans, livestock, wildlife, plant life, or fish and aquatic life in the receiving stream.		
	Removal of contaminated soils		
PCB-contaminated soil/sediments	Risk-based cleanup levels may be established in coordination with the EPA Regional Administrator. Such cleanup levels must not pose an unreasonable risk of injury to the environment.	Soil contaminated by a release, spill, or disposal of material after July 2, 1979, where the PCB concentration in the original material was ≥ 50 ppm – **applicable**	40 CFR 761.61(c)
Radioactively contaminated soils/sediments	Guidelines for residual concentrations of radionuclides in soil shall be derived from the basic dose limit using an environmental pathway analysis.	Residual radioactive material in soil – **TBC**	DOE O 5400.5(IV)(4)(a)
	Well plugging and abandonment		
Closure of monitoring wells	Before abandonment, clean well of obstructions and disinfect using bleach or hypochlorite granules to produce free chlorine residual concentrations of 25 ppm.	Plugging and closure of a water production well – **relevant and appropriate**	TDEC 1200-4-9-.16(1)(a) – (c)
	Use one of several different methods to close well depending on depth of well, construction details, whether it is cased or uncased, and whether or not it intercepts multiple aquifers.		TDEC 1200-4-9-.16(2)(a) – (c)
	Backfill must be placed so that there are no gaps or bridging. Backfill top must be level with land surface.		TDEC 1200-4-9-.16(2)(d)
	Wells intercepting multiple aquifers must be sealed so that no migration of water or contaminants between aquifers is possible.		TDEC 1200-4-9-.16(3)
	Flowing wells must be treated to stop flow before sealing.		TDEC 1200-4-9-.16(4)
	Alternate method of closure may be approved by TDEC.		TDEC 1200-4-9-.16(5)

Table A.1. Applicable or relevant and appropriate requirements and to-be-considered guidance for the preferred alternatives, ETTP sitewide remedial action, Oak Ridge, Tennessee

Media/Location/Action	Requirements	Prerequisite	Citation
	Waste generation, characterization, and segregation		
Characterization of solid waste (*all primary and secondary wastes*)	Must determine if solid waste is hazardous or is excluded under 40 CFR 261.4; and	Generation of solid waste as defined in 40 CFR 261.2—**applicable**	40 CFR 262.11(a) TDEC 1200-1-11-.03(1)(b)(1)
	Must determine if waste is listed as a hazardous waste in 40 CFR Part 261; or	Generation of solid waste which is not excluded under 40 CFR 261.4—**applicable**	40 CFR 262.11(b) TDEC 1200-1-11-.03(1)(b)(2)
	Must determine whether the waste is identified in subpart C of 40 CFR 261, characterizing the waste by using prescribed testing methods or applying generator knowledge based on information regarding material or processes used.	Generation of solid waste that is not listed in subpart D of 40 CFR 261 and not excluded under 40 CFR 261.4—**applicable**	40 CFR 262.11(c) TDEC 1200-1-11-.03(1)(b)(3)
	Must refer to Parts 261, 262, 264, 265, 266, 268, and 273 of Chapter 40 for possible exclusions or restrictions pertaining to management of the specific waste.	Generation of solid waste that is determined to be hazardous—**applicable**	40 CFR 262.11(d) TDEC 1200-1-11-.03(1)(b)(4)
Characterization of hazardous waste	Must obtain a detailed chemical and physical analysis of a representative sample of the waste(s) which at a minimum contains all the information which must be known to treat, store, or dispose of the waste in accordance with 40 CFR 264 and 268.	Generation of RCRA hazardous waste for storage, treatment or disposal—**applicable**	40 CFR 264.13(a)(1) TDEC 1200-1-11-.06(2)(d)(1)
	Must determine if the waste meets the treatment standards in 40 CFR 268.40, 268.45, or 268.49 by testing in accordance with prescribed methods or use of generator knowledge of waste.		40 CFR 268.7(a) TDEC 1200-1-11-.10(1)(g)(1)(i)
	Must determine each EPA Hazardous Waste Number (Waste Code) to determine the applicable treatment standards under 40 CFR 268.40 et seq.	Generation of RCRA hazardous waste for storage, treatment or disposal—**applicable**	40 CFR 268.9(a) TDEC 1200-1-11-.10(1)(i)(1)
	Must determine the underlying hazardous constituents [as defined in 40 CFR 268.2(i)] in the waste.	Generation of RCRA characteristically hazardous waste (and is not D001 non-wastewaters treated by CMBST, RORGS, or POLYM of Section 268.42 Table 1) for storage, treatment or disposal—**applicable**	40 CFR 268.9(a) TDEC 1200-1-11-.10(1)(i)(1)

Table A.1. Applicable or relevant and appropriate requirements and to-be-considered guidance for the preferred alternatives, ETTP sitewide remedial action, Oak Ridge, Tennessee

Media/Location/Action	Requirements	Prerequisite	Citation
Characterization and management of industrial wastewater	All onsite wastewater treatment units (including tank systems, conveyance systems, and ancillary equipment used to treat, store or convey wastewater to the wastewater treatment facility) subject to regulation under § 402 or § 307(b) of the CWA are exempt from the requirements of RCRA Subtitle C standards.	On-site wastewater treatment units subject to regulation under § 402 or § 307(b) of the CWA—**applicable**	40 CFR 264.1(g)(6) TDEC 1200-1-11-.06(1)(b)(5)
Characterization of LLW	Shall be characterized using direct or indirect methods and the characterization documented in sufficient detail to ensure safe management and compliance with the WAC of the receiving facility.	Generation of LLW for storage or disposal at a DOE facility—**TBC**	DOE M 435.1-1 IV.I
	Characterization data shall, at a minimum, include the following information relevant to the management of the waste:		DOE M 435.1-1 IV.I(2)
	• physical and chemical characteristics;		DOE M 435.1-1 IV.(2)(a)
	• volume, including the waste and any stabilization or absorbent media;		DOE M 435.1-1 IV.I(2)(b)
	• weight of the container and contents;		DOE M 435.1-1 IV.I(2)(c)
	• identities, activities, and concentrations of major radionuclides;		DOE M 435.1-1 IV.I(2)(d)
	• characterization date;		DOE M 435.1-1 IV.I(2)(e)
	• generating source; and		DOE M 435.1-1 IV.I(2)(f)
	• any other information which may be needed to prepare and maintain the disposal facility performance assessment, or demonstrate compliance with performance objectives.		DOE M 435.1-1 IV.I(2)(g)
Decontamination of radioactively contaminated equipment	Must meet surface contamination guidelines for residual activity provided in Figure IV-1 of the Order for specified radionuclides.	Residual radioactive material on equipment and building structures for unrestricted use – **TBC**	DOE O 5400.5(IV)(4)(d) and Figure IV-1
Management and storage of used oil	Used oil shall not be stored in a unit other than a tank or container.	Generation and storage of used oil, as defined in 40 CFR 279.1]—**applicable**	40 CFR 279.22(a) TDEC 1200-1-11-.11(3)(c)(1)
	Containers and aboveground tanks used to store used oil must be in good condition (no severe rusting, apparent structural defects or deterioration); and not leaking (no visible leaks).		40 CFR 279.22(b)(1) and (2) TDEC 1200-1-11-.11(3)(c)(2)(i) and (ii)

Table A.1. Applicable or relevant and appropriate requirements and to-be-considered guidance for the preferred alternatives, ETTP sitewide remedial action, Oak Ridge, Tennessee

Media/Location/Action	Requirements	Prerequisite	Citation
	Containers and aboveground tanks used to store used oil and fill pipes used to transfer used oil into USTs must be labeled or marked clearly with the words "Used Oil".		40 CFR 279.22(c)(1) and (2) TDEC 1200-1-11-.11(3)(c)(3)(i) and (ii)
	Upon detection of a release of used oil to the environment, a generator must stop the release; contain, clean up, and properly manage the released used oil; and, if necessary, repair or replace any leaking used oil storage containers or tanks prior to returning the to service.	Release of used oil to the environment - **applicable**	40 CFR 279.22(d) TDEC 1200-1-11.11(3)(c)(4)
Management of PCB waste	Any person storing or disposing of PCB waste must do so in accordance with 40 CFR 761, Subpart D.	Generation of waste containing PCBs at concentrations ≥ 50 ppm—**applicable**	40 CFR 761.50(a)
	Any person cleaning up and disposing of PCBs shall do so based on the concentration at which the PCBs are found.	Generation of PCB remediation waste as defined in 40 CFR 761.3—**applicable**	40 CFR 761.61
Cleanup of new PCB spills	Spills shall be cleaned up in accordance with 40 CFR 761, Subpart G, "PCB Spill Cleanup Policy". This policy does not apply to existing spills (old spills which occurred prior to May 4, 1987).	Release into the environment of materials containing PCBs at ≥ 50 ppm which occur after May 4, 1987—**applicable**	40 CFR 761.125
	There may be exceptional spill situations that require less stringent cleanup or a different approach to cleanup because of factors associated with the particular spill. These factors may mitigate expected exposures and risks or make cleanup to these requirements impracticable.		40 CFR 761.120(a)(4)
Decontamination of PCB wastes prior to disposal as a non-TSCA waste	Decontaminate to standards listed in 40 CFR 761.79(b) or to an alternate risk-based decontamination standard approved by EPA under 40 CFR 761.79(h)(5).	Generation of PCB wastes, including water, organic liquids—**applicable**	40 CFR 761.79(b) and (h) 40 CFR 761.79(a)(4)
	Materials from which PCBs have been removed in accordance with this standard are considered unregulated for disposal under Subpart D of TSCA.		
Disposal of PCB decontamination waste and residues	Shall be disposed of at their existing PCB concentration unless otherwise specified in 40 CFR 761.79(g).	PCB decontamination waste and residues for disposal—**applicable**	40 CFR 761.79(g)
Management of PCB/radioactive waste	Any person storing such waste ≥ 50 ppm PCBs must do so taking into account both its PCB concentration and radioactive properties, except as provided in 40 CFR 761.65(a)(1), (b)(1)(ii) and (c)(6)(i).	Generation of PCB/radioactive waste for storage and disposal—**applicable**	40 CFR 761.50(b)(7)(i)
	Any person disposing of such waste must do so taking into account both its PCB concentration and its radioactive properties.		40 CFR 761.50(b)(7)(ii)

Table A.1. Applicable or relevant and appropriate requirements and to-be-considered guidance for the preferred alternatives, ETTP sitewide remedial action, Oak Ridge, Tennessee

Media/Location/Action	Requirements	Prerequisite	Citation
	If, after taking into account only the PCB properties in the waste, the waste meets the requirements for disposal in a facility permitted, licensed, or registered by a state as a municipal or non-municipal non-hazardous waste landfill, then the person may dispose of such waste without regard to the PCBs, based on its radioactive properties alone.		40 CFR 761.50(b)(7)(ii)
		Storage	
Storage of hazardous wastes restricted from land disposal	Prohibits storage of hazardous waste restricted from land disposal unless the generator stores such waste in tanks, containers, or containment buildings on-site solely for the purpose of accumulating such quantities as necessary to facilitate proper recovery, treatment, or disposal. Must comply with the pertinent substantive requirements in 40 CFR 262.34 and 40 CFR Parts 264.	Accumulation of hazardous wastes restricted from land disposal solely for purpose of accumulation of quantities as necessary to facilitate proper recovery, treatment, or disposal – **applicable**	40 CFR 268.50 TDEC 1200-1-11-.10(4)(a)
Temporary storage of hazardous waste in containers on-site	A generator may accumulate hazardous waste at the facility provided that: • the waste is placed in containers that comply with 40 CFR 265.171-173 (Subpart I); and	Accumulation of RCRA hazardous waste on-site as defined in 40 CFR 260.10—**applicable**	40 CFR 262.34(a)(1)(i) TDEC 1200-1-11-.03(4)(e)(2)(i)(I)
	• container is marked with the date upon which each period of accumulation begins		40 CFR 262.34(a)(2) TDEC 1200-1-11-.03(4)(e)(2)(ii)
	• container is marked with the words "hazardous waste" or		40 CFR 262.34(a)(3) TDEC 1200-1-11-.03(4)(e)(2)(iii)
	• container may be marked with other words that identify contents.	Accumulation of 55 gal. or less of RCRA hazardous waste at or near any point of generation—**applicable**	40 CFR 262.34(c)(1)(ii) TDEC 1200-1-11-.03(4)(e)(5)(i)(II)
Management of hazardous waste stored in containers	If container is not in good condition (e.g., severe rusting, structural defects) or if it begins to leak, must transfer waste into container in good condition.	Storage of RCRA hazardous waste in containers—**applicable**	40 CFR 264.171 TDEC 1200-1-11-.05(9)(b)
	Use container made or lined with materials compatible with waste to be stored so that the ability of the container is not impaired.		40 CFR 264.172 TDEC 1200-1-11-.05(9)(c)
	Keep containers closed during storage, except to add/remove waste.		40 CFR 264.173(a) TDEC 1200-1-11-.05(9)(d)(1)

Table A.1. Applicable or relevant and appropriate requirements and to-be-considered guidance for the preferred alternatives, ETTP sitewide remedial action, Oak Ridge, Tennessee

Media/Location/Action	Requirements	Prerequisite	Citation
	Open, handle and store containers in a manner that will not cause containers to rupture or leak.		40 CFR 264.173(b) TDEC 1200-1-11-.05(9)(d)(2)
Operation of a RCRA container storage area	Area must be sloped or otherwise designed and operated to drain liquid from precipitation, or containers must be elevated or otherwise protected from contact with accumulated liquid.	Storage in containers of RCRA hazardous waste that do not contain free liquids—**applicable**	40 CFR 264.175(c) TDEC 1200-1-11-.06(9)(f)(3)
Temporary storage of RCRA remediation waste in a staging pile	May be temporarily stored (including mixing, sizing, blending, or other similar physical operations intended to prepare the wastes for subsequent management or treatment) at a facility provided that the staging pile will be designed to:	Accumulation of non-flowing hazardous remediation waste (or remediation waste otherwise subject to land disposal restrictions) as defined in 40 CFR 260.10 —**applicable**	40 CFR 264.554(d)(1) TDEC 1200-1-11-.06(22)(e)(4)(i)
	• facilitate a reliable, effective and protective remedy;		40 CFR 264.554(d)(1)(i) TDEC 1200-1-11-.06(22)(e)(4)(i)(I)
	• prevent or minimize releases of hazardous wastes and constituents into the environment, and minimize or adequately control cross-media transfer, as necessary to protect human health and the environment (e.g., through the use of liners, covers, runon/runoff controls, as appropriate).		40 CFR 264.554(d)(1)(ii) TDEC 1200-1-11-.06(22)(e)(4)(i)(II)
	Must not place incompatible wastes in same pile unless comply with 40 CFR 264.17(b).	Storage of "incompatible" remediation waste in staging pile—**applicable**	40 CFR 264.554(f)(1) TDEC 1200-1-11-.06(22)(e)(6)(i)
	Incompatible wastes must be separated from any waste or nearby materials or must protect them from one another by using a dike, berm, wall, or other device.		40 CFR 264.554(f)(2) TDEC 1200-1-11-.06(22)(e)(6)(ii)
	Must not pile remediation waste on the same base where incompatible wastes or materials were previously piled, unless the base has been decontaminated sufficiently to comply with 40 CFR 274.17(b).		40 CFR 264.554(f)(3) TDEC 1200-1-11-.06(22)(e)(6)(iii)
Temporary storage of PCB waste in containers	Container(s) shall be marked as illustrated in 40 CFR 761.45(a).	Storage of PCBs and PCB Items at concentrations ≥ 50 ppm for disposal—**applicable**	40 CFR 761.40(a)(1)
	Storage area must be properly marked as required by 40 CFR 761.40(a)(10).		40 CFR 761.65(c)(3)
	Any leaking PCB Items and their contents shall be transferred immediately to a properly marked non-leaking container(s).		40 CFR 761.65(c)(5)

Table A.1. Applicable or relevant and appropriate requirements and to-be-considered guidance for the preferred alternatives, ETTP sitewide remedial action, Oak Ridge, Tennessee

Media/Location/Action	Requirements	Prerequisite	Citation
	Except as provided in 40 CFR 761.65(c)(6)(i) and (ii), container(s) shall be in accordance with requirements set forth in DOT HMR at 49 CFR 171-180.		40 CFR 761.65(c)(6)
Storage of PCB/radioactive waste in containers	For liquid wastes, containers must be nonleaking.	Storage of PCB/radioactive waste in containers other than those meeting DOT HMR performance standards—**applicable**	40 CFR 761.65(c)(6)(i)(A)
	For nonliquid wastes, containers must be designed to prevent buildup of liquids if such containers are stored in an area meeting the containment requirements of 40 CFR 761.65(b)(1)(ii); and		40 CFR 761.65(c)(6(i)(B)
	For both liquid and nonliquid wastes, containers must meet all regulations and requirements pertaining to nuclear criticality safety.		40 CFR 761.65(c)(6)(i)(C)
Risk-based storage of PCB remediation waste	May store in a manner other than prescribed in 40 CFR 761.65 if approved in writing by EPA and method will not pose an unreasonable risk of injury to health or the environment.	Storage of PCB remediation waste prior to disposal—**applicable**	40 CFR 761.61(c)
Temporary storage of PCB-remediation waste in a TSCA waste pile	Waste must be placed and managed in accordance with the design and operation standards, including liner and cover requirements and run-off control systems, in 40 CFR 761.65(c)(9).	Storage of PCB-remediation waste at cleanup site or site of generation—**applicable**	40 CFR 761.65(c)(9)(i)
	Requirements of 40 CFR 761.65(c)(9) of this part may be modified under the risk-based disposal option of Sect. 761.61(c).		40 CFR 761.65(c)(9)(iv)
Preparation of solid LLW for storage	Shall be packaged in a manner that provides containment and protection for the duration of the anticipated storage period and until disposal is achieved or until waste has been removed from container.	Management and storage of LLW in containers at a DOE facility—**TBC**	DOE M 435.1-1 IV.L(1)(a)
	Vents or other measures shall be provided if the potential exists for pressurizing or generating flammable or explosive concentrations of gases within the waste container.		DOE M 435.1-1 IV.L(1)(b)
	Containers shall be marked such that their contents can be identified.		DOE M 435.1-1 IV.L(1)(c)
Temporary staging and storage of LLW	Ensure that radioactive waste is stored in a manner that protects the public, workers, and the environment and that the integrity of waste storage is maintained for the expected time of storage. Shall not be readily capable of detonation, explosive decomposition, reaction at anticipated pressures and temperatures, or explosive reaction with water.	Management and storage of LLW at a DOE facility—**TBC**	DOE M 435.1-1 IV.N(1)
	Shall be stored in a location and manner that protects the integrity of waste for the expected time of storage.		DOE M 435.1-1 IV.N(3)

Table A.1. Applicable or relevant and appropriate requirements and to-be-considered guidance for the preferred alternatives, ETTP sitewide remedial action, Oak Ridge, Tennessee

Media/Location/Action	Requirements	Prerequisite	Citation
	Shall be managed to identify and segregate LLW from mixed waste.		DOE M 435.1-1 IV.N(6)
	Staging of LLW shall be for the purpose of accumulation of such quantities of waste as necessary to facilitate transportation, treatment, and disposal.		DOE M 435.1-1 IV.N(7)
		Treatment/disposal	
Disposal of RCRA-prohibited hazardous waste in a land-based unit	May be land disposed only if it meets the requirements in the table "Treatment Standards for Hazardous Waste" at 40 CFR 268.40 before land disposal. The table lists either "total waste" standards, "waste-extract" standards, or "technology-specific" standards (as detailed further in 40 CFR 268.42).	Land disposal, as defined in 40 CFR 268.2, of RCRA restricted waste—**applicable**	40 CFR 268.40(a) TDEC 1200-1-11-.10(3)(a)
	Are not prohibited if the wastes no longer exhibit a characteristic at the point of land disposal, unless the wastes are subject to a specified method of treatment other than DEACT in 40 CFR 628.40, or are D003 reactive cyanide.	Land disposal of RCRA-restricted characteristic wastes—**applicable**	40 CFR 268.1(c)(4)(iv) TDEC 1200-1-11-.10(1)(a)(3)(iv)
Debris	May be land disposed if treated prior to disposal as provided under the "Alternative Treatment Standards for Hazardous Debris" in 40 CFR 268.45(a)(1)-(5) unless it is determined under 40 CFR 261.3(f)(2) that the debris is no longer is contaminated with hazardous waste or the debris is treated to the waste specific treatment standard provided in 40 CFR 268.40 for the waste contaminating the debris.	Land disposal, as defined in 40 CFR 268.2, of RCRA-restricted hazardous debris—**applicable**	40 CFR 268.45(a) TDEC 1200-1-11-.10(3)(f)(1)
Soils	May be land disposed if treated prior to disposal according to the alternative treatment standards of 40 268.49(c) or according to the UTS specified in 40 CFR 268.48 applicable to the listed hazardous waste and/or applicable characteristic of hazardous waste if the soil is characteristic.	Land disposal, as defined in 40 CFR 268.2, of RCRA-restricted hazardous soils—**applicable**	40 CFR 268.49(b) TDEC 1200-1-11-.10(3)(j)(2)
Prohibition of dilution to meet LDRs	Except as provided under 40 CFR 268.3(b), must not in any way dilute a restricted waste or the residual from treatment of a restricted waste as a substitute for adequate treatment to achieve compliance with land disposal restriction levels.	Land disposal, as defined in 40 CFR 268.2, of RCRA-restricted hazardous soils—**applicable**	40 CFR 268.3(a) TDEC 1200-1-11-.10(1)(c)(1)
Treatment of LLW	Waste treatment to provide more stable waste forms and to improve the long-term performance of a LLW disposal facility shall be implemented as necessary to meet performance objectives of the disposal facility.	Generation of LLW for disposal at a DOE facility—**TBC**	DOE M 435.1-1 IV.O

Table A.1. Applicable or relevant and appropriate requirements and to-be-considered guidance for the preferred alternatives, ETTP sitewide remedial action, Oak Ridge, Tennessee

Media/Location/Action	Requirements	Prerequisite	Citation
Treatment of uranium and thorium bearing LLW	Such wastes shall be properly conditioned so that the generation and escape of biogenic gases will not cause exceedance of Rn-222 emission limits of DOE O 5400.5(IV)(6)(d)(1)(b) and will not result in premature structural failure of the facility.	Placement of potentially biodegradable contaminated wastes in a long-term management facility —**TBC**	DOE O 5400.5(IV)(6)(d)(1)(c)
Disposal of solid LLW at DOE facilities	Shall be certified as meeting waste acceptance requirements before it is transferred to the receiving facility.	Generation of LLW for disposal at a DOE facility—**TBC**	DOE M 435.1-1 IV.J(2)
Performance-based disposal of PCB remediation waste	Shall be disposed according to 40 CFR 761.60(a) or (e), or decontaminate in accordance with 40 CFR 761.79.	Disposal of liquid PCB remediation waste—**applicable**	40 CFR 761.61(b)(1)
	May dispose by one of the following methods: • in a high-temperature incinerator approved under 40 CFR 761.70(b); • by an alternate disposal method approved under 40 CFR 761.60(e); • in a chemical waste landfill approved under 40 CFR 761.75; • in a facility with a coordinated approval issued under 40 CFR 761.77; or • through decontamination in accordance with 40 CFR 761.79.	Disposal of nonliquid PCB remediation waste (as defined in 40 CFR 761.3)—**applicable**	40 CFR 761.61(b)(2) 40 CFR 761.61(b)(2)(i) 40 CFR 761.61(b)(2)(ii)
Risk-based disposal of PCB remediation waste	May dispose of in a manner other than prescribed in 40 CFR 761.61(a) or (b) if approved in writing by EPA and method will not pose an unreasonable risk of injury to health or the environment.	Disposal of PCB remediation waste—**applicable**	40 CFR 761.61(c)
	Closure		
Clean closure of a RCRA container storage area	Must remove all hazardous waste and residues from containment system. Remaining containers, liners, bases and soil containing or contaminated with hazardous waste or residues must be decontaminated or removed.	Management of RCRA hazardous waste in a container storage area—**applicable**	40 CFR 264.178 TDEC 1200-1-11.06(9)(i)
Closure of a RCRA remediation waste staging pile	Must be closed by removing or decontaminating all remediation waste, contaminated containment system components, and structures and equipment contaminated with waste and leachate.	Storage of remediation waste in staging pile located in previously contaminated area—**applicable**	40 CFR 264.554(j)(1) TDEC 1200-1-11.06(22)(e)(10)(i)
	Must decontaminate contaminated subsoils in a manner that will protect human health and the environment.		40 CFR 264.554(j)(2) TDEC 1200-1-11.06(22)(e)(10)(ii)

Table A.1. Applicable or relevant and appropriate requirements and to-be-considered guidance for the preferred alternatives, ETTP sitewide remedial action, Oak Ridge, Tennessee

Media/Location/Action	Requirements	Prerequisite	Citation
	Must be closed according to substantive requirements in 40 CFR 264.258(a) and 264.111 or 265.258(a) and 265.111.	Storage of remediation waste in staging pile located in an uncontaminated area—**applicable**	40 CFR 264.554(k) TDEC 1200-1-11.06(22)(e)(11)(i)
Closure of TSCA storage facility (container storage area or waste pile)	Must close in a manner that eliminates the potential for postclosure releases of PCBs which may present an unreasonable risk to human health or the environment.	Closure of a TSCA storage facility—**applicable**	40 CFR 761.65(e)(1)
	Must remove or decontaminate PCB waste residues and contaminated containment system components, equipment, structures, and soils during closure in accordance with the levels specified in the PCB Spills Cleanup Policy in subpart G of 40 CFR 761.		40 CFR 761.65(e)(1)(iv)
	A TSCA/RCRA storage facility closed under RCRA is exempt from the TSCA closure requirements of 40 CFR 761.65(e).	Closure of TSCA/RCRA storage facility—**applicable**	40 CFR 761.65(e)(3)
	Transportation		
Transportation of hazardous waste on-site	The generator manifesting requirements of 40 CFR 262.20-262.32(b) do not apply.	Transportation of hazardous wastes on a public or private right-of-way within or along the border of contiguous property under the control of the same person, even if such contiguous property is divided by a public or private right-of-way—**applicable**	40 CFR 262.20(f) TDEC 1200-1-11-.03(3)(a)(6)
	Generator or transporter must comply with the requirements set forth in 40 CFR 263.30 and 263.31 in the event of a discharge of hazardous waste on a private or public right-of-way.		
Transportation of LLW off-site	LLW waste shall be packed and transported in accordance with DOE O 460.1C (*Packaging and Transportation Safety*) and DOE O 460.2A (*Departmental Materials Transportation and Packaging Management*), as detailed in the accompanying DOE Manuals and Guides for these Orders.	Shipment of LLW off-site—**TBC**	DOE M 435.1-1 I.1(E)(11)
	To the extent practicable, the volume of waste and number of shipments shall be minimized.		DOE M 435.1-1 III.L(2) DOE M 435.1-1 IV.L(2)
Transportation of PCB wastes off-site	Must comply with the manifesting provisions at 40 CFR 761.207 through 218.	Relinquishment of control over PCB wastes by transporting, or offering for transport—**applicable**	40 CFR 761.207(a)

Table A.1. Applicable or relevant and appropriate requirements and to-be-considered guidance for the preferred alternatives, ETTP sitewide remedial action, Oak Ridge, Tennessee

Media/Location/Action	Requirements	Prerequisite	Citation
Transportation of hazardous waste off-site	Must comply with the generator requirements of 40 CFR 262.20-23 for manifesting, Sect. 262.30 for packaging, Sect. 262.31 for labeling, Sect. 262.32 for marking, Sect. 262.33 for placarding and Sect. 262.40, 262.41(a) for record keeping requirements and Sect. 262.12 to obtain EPA ID number.	Off-site transportation of RCRA hazardous waste—**applicable**	40 CFR 262.10(h) TDEC 1200-1-11-.03(1)(a)(8)
	Must comply with the requirements of 40 CFR 263.11 – 263.31. A transporter who meets all applicable requirements of 49 CFR 171 – 179 and the requirements of 40 CFR 263.11 and 263.31 will be deemed in compliance with 40 CFR 263.	Transportation of hazardous waste within the U.S. requiring a manifest—**applicable**	40 CFR 263.10(a) TDEC 1200-1-11-.04(1)(a)(1)
Transportation of universal waste off-site	Off-site shipments of universal waste by a large quantity handler of universal waste shall be made in accordance with 40 CFR 273-38 [TDEC 1200-1-11-.12(3)(i)].	Off-site shipment of universal waste by a large quantity generator of universal waste—**applicable**	40 CFR 273.38 TDEC 1200-1-11-.12(3)(i)
Transportation of used oil off-site	Except as provided in paragraphs (a) to (c) of this rule, generators must ensure that their used oil is transported by transporters who have obtained U.S. EPA ID numbers.	Off-site shipment of used oil by generators of used oil—**applicable**	40 CFR 279.24 TDEC 1200-1-11-.11(3)(e)
Transportation of hazardous materials off-site	Shall be subject to and must comply with all applicable provisions of the HMTA and HMR at 49 CFR 171 – 180.	Any person who, under contract with an department or agency of the federal government, transports "in commerce", or causes to be transported or shipped, a hazardous material—**applicable**	49 CFR 171.1(c)

ALARA = as low as reasonably achievable.
ARAP = aquatic resource alteration permit.
AWQC = ambient water quality criteria.
CFR = *Code of Federal Regulations.*
CMBST = combustion.
CWA = Clean Water Act.
DEACT = deactivation.
DOE = U. S. Department of Energy.
DOE M = DOE Manual.
DOE O = DOE Order.
DOT = U.S. Department of Transportation.
EDE = effective dose equivalent.
EPA = U.S. Environmental Protection Agency.
ETTP = East Tennessee Technology Park.
HMR = Hazardous Materials Regulations.
HMTA = Hazardous Materials Transportation Act.
ID = identification.
LDRs = land disposal restrictions.
LLW = low-level (radioactive) waste.
NESHAP = National Emission Standards for Hazardous Air Pollutants.
PCB = polychlorinated biphenyl.
POLYM = polymerization.
RCRA = Resource Conservation and Recovery Act of 1976.
RORG = recovery of organics.
TCA = *Tennessee Code Annotated.*
TDEC = Tennessee Department of Environment and Conservation.
TSCA = Toxic Substances Control Act of 1976.
TWRCP = Tennessee Wildlife Resources Commission Proclamation.
USC = *United States Code*
UST = underground storage tank.

APPENDIX B

RECREATIONAL RISK ASSESSMENT

RECREATIONAL RISK SCREENING SUPPORT FOR ZONE 1 AT THE EAST TENNESSEE TECHNOLOGY PARK

1. INTRODUCTION

The *Record of Decision for Interim Actions Zone 1, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE 2002), selected actions for soil remediation to be protective of an industrial end use. Two events have occurred since the signing of the Record of Decision (ROD) indicated a recreational end use should also be evaluated.

First, as part of the recent Natural Resources Damage Assessment (NRDA) settlement on the Oak Ridge Reservation (ORR), the U. S. Department of Energy (DOE) agreed to place into a conservation easement 2966 acres of DOE property on Black Oak Ridge and McKinney Ridge. A portion of this Black Oak Ridge Conservation Easement (BORCE) is in Zone 1 of the East Tennessee Technology Park (ETTP). This new conservation easement (Fig. 1) is being managed by the state of Tennessee as a Wildlife Management Area and State Natural Area and includes a greenway/hiking trail.

Second, as part of the evolving process to transfer ETTP land to private entities, it is being realized that the Community Reuse Organization of East Tennessee (CROET) needs the flexibility to pursue leasing the land for recreational purposes. Since the precise future use of specific areas will be an evolving process for several years and will require optimizing and balancing the desire for future uses with the cost of addressing residual contamination, it was decided that all of Zone 1 should be evaluated to identify areas that could be released for future unrestricted recreational use.

2. BACKGROUND

Since the Zone 1 project is well beyond the remedial investigation/feasibility study (RI/FS) stage of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) project, the approach selected to evaluate future recreational use of Zone 1 soil is to develop recreational action levels (ALs) and compare these levels with residual soil contamination levels. In cases where residual contamination levels exceed the recreational actions levels, recreational use would not be pursued unless some soil remedial actions were to occur. The steps of this evaluation process involved:

1. Define Remedial Action Objectives (RAOs) for recreational use.

2. Develop ALs that are protective of unrestricted recreational users.

3. Compare residual soil concentrations in Zone 1 to the remediation levels (RLs) to characterize potential unacceptable risks.

4. Identify if and where there are remaining soils that may need to be excavated to achieve recreational end use goals.

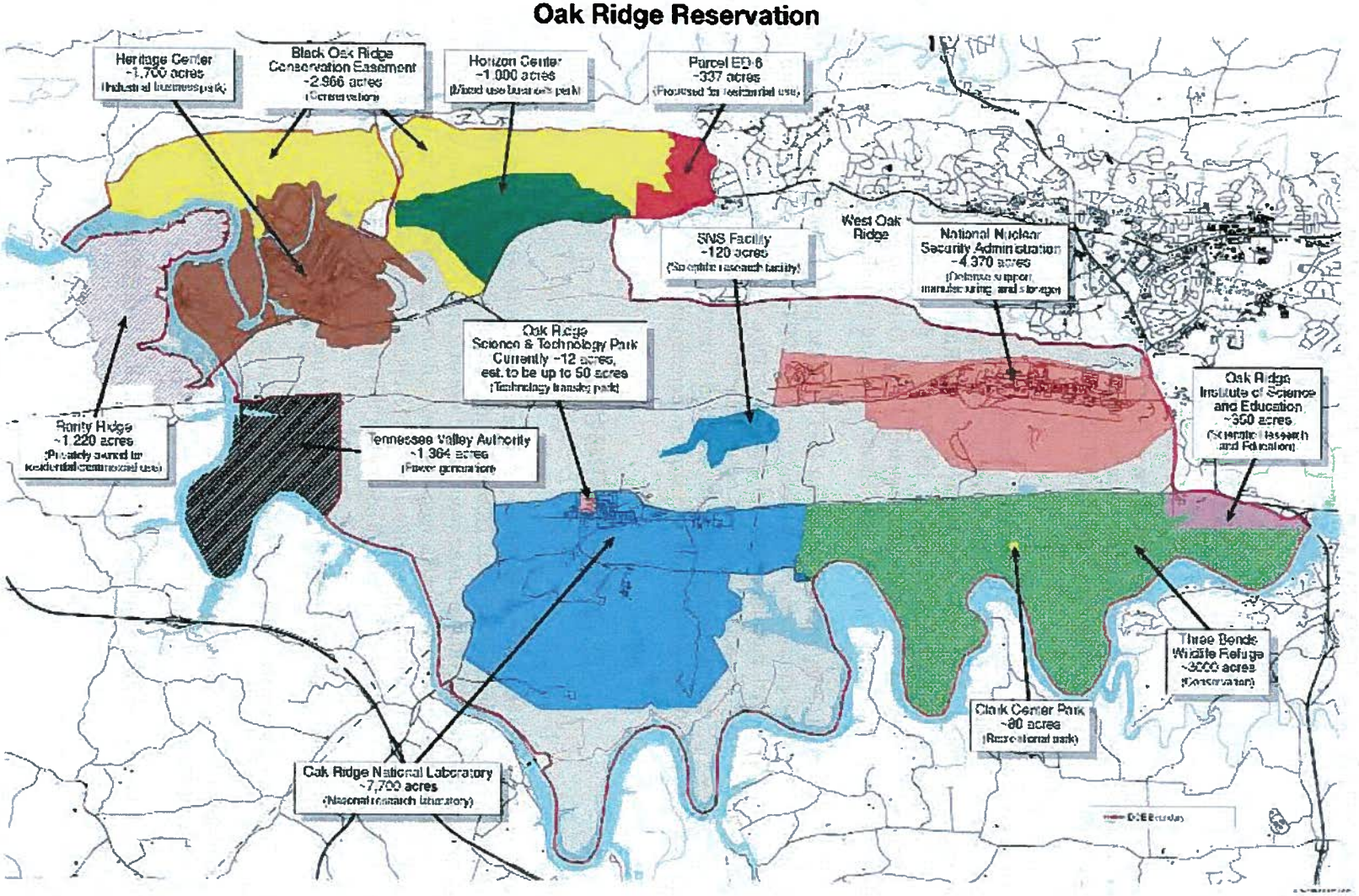

Fig. 1. Black Oak Ridge Conservation Easement (BORCE) in Zone 1.

3. ESTABLISH REMEDIAL ACTION OBJECTIVES

An RAO is a statement of intent that establishes the land use, receptors, environmental media, and target risk goals for a selected remedial action. For the future potential recreational user in Zone 1, the RAOs are:

- In the areas where future use is suitable for potential organized recreation (e.g., baseball or soccer ball fields), protect the child/teen recreator at a target risk of 1×10^{-4} cumulative risk (1×10^{-5} risk for an individual chemical-media risk where multiple chemicals and/or media are present), and a hazard index (HI) = 1 (HI = 0.1 for an individual chemical-media risk where multiple chemicals and/or media are present).

- Protect adult exercisers who may use walking, hiking, or running paths from exposure to radionuclides and chemicals in soils at a target risk of 1×10^{-4} cumulative risk (1×10^{-5} risk for an individual chemical-media risk where multiple chemicals and/or media are present), and an HI = 1 (HI = 0.1 for an individual chemical-media risk where multiple chemicals and/or media are present).

This adult exerciser receptor is different from the receptor evaluated in a recent risk assessment for the Contractor's Spoil Area (CSA) located in the BORCE (DOE 2011). The CSA receptor was assumed to visit the BORCE one time per week, and while in the BORCE, only be in the CSA area for a fraction of the visit. Hence, the CSA receptor was "restricted" by the specific types of uses in the conservation area. The receptor evaluated in this effort is considered an "unrestricted recreational receptor," who visits the site more frequently (e.g., during the time the child/teen is using the baseball or soccer fields). This receptor is evaluated to determine if NO restrictions can be placed on future recreational use.

4. DEVELOP ACTION LEVELS

ALs represent the concentration of a contaminant in soil that results in an acceptable risk to the receptors identified in the RAO. The methods and equations used to develop RLs are the same as the methods and equations used for estimating risk in a baseline risk assessment:

1. Identify chemicals of potential concern (COPCs) in the media of concern (soil).

2. Perform an exposure assessment, including land use, receptors, exposure pathways and exposure parameters.

3. Identify the toxicity of the COPCs.

4. Develop the RLs using risk characterization equations.

4.1 CHEMICALS OF POTENTIAL CONCERN

The Zone 1 soil data set representing data collected as part of the Dynamic Verification Strategy (DVS) process from 2006 through 2010 was retrieved from the Oak Ridge Environmental Information System (OREIS) database. This data set contains over 140,000 individual data records, representing various soil depths and multiple chemical and radionuclide results. This data set was established based on a process defined in the Remedial Action Work Plan (RAWP) for Zone 1 (DOE 2005) that laid out a plan

for focusing characterization efforts on areas where former activities occurred, and required lesser efforts in undisturbed areas.

The following screening approach was used to identify soil COPCs from this dataset:

- Compare chemicals to the latest U. S. Environmental Protection Agency (EPA) Regional Screening Levels (RSLs) based on a risk level of 10^{-6} and HI = 0.1 (the most up-to-date values were obtained at http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/).

- Compare radionuclides to the EPA Preliminary Remediation Goals (PRGs) [the most up-to-date values were obtained at http://epa-prgs.ornl.gov/radionuclides/].

- Eliminate essential nutrients.

Table 1 presents the COPCs identified from the screening process.

4.2 LAND USE

Given that precise recreational uses for the Zone 1 area have not been determined, a recreational scenario was identified that would represent a reasonable maximum exposure (RME) recreational use. The assessment was careful to stay away from recreational activities that would be common near residential or day care areas since there is no intention of adjacent residential use (Rarity Ridge is across the river but there is no direct access between this area and Zone 1). The following two default future recreational exposure scenarios have been identified for this evaluation:

- Child/Teen Recreator – an individual, age 6 to 18, who participates in organized athletic events within a ballpark facility in Zone 1.

- Adult Recreator – An adult individual who lives in the area and utilizes Zone 1 for running/hiking/biking.

The supplemental risk assessment that was performed to address the potential recreational exposures in the CSA within the BORCE (DOE 2011) assumed limited exposure because of intended use restrictions in the BORCE and because of the relatively small area of the CSA. It was determined that these CSA site-specific assumptions were too limiting for a broad Zone 1 recreational risk screen.

4.3 EXPOSURE PATHWAYS

The following exposure pathways are identified for the adult recreator and child recreator exposure scenarios:

- incidental soil ingestion,
- inhalation of vapors and particulates,
- dermal contact with chemicals in soil, and
- external exposure to ionizing radiation emitted from soil.

For each of these pathways, intake of chemicals and radionuclides was estimated and compared with available toxicity data.

4.4 INTAKE EQUATIONS

4.4.1 Ingestion Pathway

The ingestion pathway was evaluated using equations presented in risk assessment guidance documents (EPA 1989).

4.4.1.1 Chemical exposure via ingestion

Calculation for the carcinogenic and non-carcinogenic chemicals are similar, using the general equation:

$$I_S = \frac{(C_S)(IR_S)(FI_S)(EF_T)(ED)(CF)}{(BW)(AT)},$$

where

I_S = ingested intake of COPC in soil (mg/kg-day, calculated),
C_S = concentration of COPC in soil (mg/kg),
IR_S = ingestion rate of soil (mg/day),
FI_S = fraction of exposure attributed to site soil (unitless),
EF_T = exposure frequency (days/year),
ED = exposure duration (years),
CF = conversion factor (10^{-6} kg/mg),
BW = body weight (kg),
AT = averaging time (days).

The carcinogenic intake is based on an averaging time of 25,550 days (a 70-year lifetime), and non-carcinogenic intake is based on an averaging time equal to 365 (days/year) × ED (in years).

4.4.1.2 Radiological exposure via ingestion

The ingestion intake equation for radiological constituents is:

$$\text{Intake (pCi)} = (C_s)(IR)(FI)(EF)(ED)(CF),$$

where

C_S = soil concentration (pCi/g),
CF = conversion factor (g/kg)
IR = ingestion rate of soil (kg/day),
FI = fraction of exposure attributed to site soil (unitless),
EF = exposure frequency (days/year),
ED = exposure duration (years).

The ingestion pathway is based on incidental ingestion of soil while engaged in sports activities, or while eating without removing soil adhering to skin. Exposure based on intentional ingestion of soils is not included in this evaluation.

4.4.2 Inhalation Pathway

The inhalation pathway was based on equations presented in Risk Assessment Guidance for Superfund (RAGS) Part F (EPA 2009a) for chemical constituents and RAGS Part B (EPA 1991) for radiological constituents.

4.4.2.1 Chemical exposure via inhalation

The calculation of inhalation intake for chemicals is based on an exposure concentration in air. The air concentration is a yearly averaged value, intended to represent typical air encountered by the receptor over a long period of time. Since the recreational exposures are of a short duration, the air concentration is the short-term maximum without averaging.

Carcinogenic Exposure Concentration for Inhalation Pathway

$$EC = (C_A)(ET)(EF)(ED) / (AT),$$

where

EC = exposure concentration ($\mu g/m^3$),
C_A = contaminant concentration in air ($\mu g/m^3$),
ET = exposure time (hours/day),
EF = exposure frequency (days/year),
ED = exposure duration (years),
AT = averaging time (hours in a 70-year lifetime).

Noncarcinogenic Exposure Concentration for Inhalation Pathway – Acute Exposure

$$EC = C_A,$$

where

EC = exposure concentration ($\mu g/m^3$),
C_A = contaminant concentration in air ($\mu g/m^3$).

Concentration in Air – Chemicals

$$CA = (C_s)(CF) / [(1/PEF) + (1/VF)],$$

where

C_s = constituent concentration in soil (mg/kg),
CF = conversion of soil concentration units ($\mu g/mg$),
PEF = particulate emission factor, site and receptor specific (m^3/kg),
VF = volatilization factor, constituent-specific (m^3/kg).

Radionuclide Exposure via Inhalation

Intake from Inhalation Pathway is expressed as follows:

$$\text{Intake (pCi)} = (C_s)(CF)(IRa)(ET)(EF)(ED) / (PEF),$$

where

C_s = soil concentration (pCi/g),
IR_a = inhalation rate (m^3/day),
ET = outdoor exposure time fraction (unitless)
EF = exposure frequency time fraction (unitless),
ED = exposure duration (years),
PEF = particulate emission factor (m^3/kg),
CF = conversion factor for radionuclides (g/kg).

The PEF and VF used in the chemical and radiological calculations were based on Atlanta, Georgia, meteorological information as a surrogate location. The default PEF was approximately 6E+09 m^3/kg, which corresponds to a dust loading of 0.2 $\mu g/m^3$ for the adult exerciser. The child recreator is assumed to be exposed to an order of magnitude larger dust loading of 2 $\mu g/m^3$, corresponding to a PEF of 6E+08 m^3/kg, based on increased intensity of activities in the soil.

4.4.2.2 Dermal contact pathway

This pathway is specific to chemical constituents and is most significant for inorganics and semivolatile constituents. Volatile chemicals are likely to be in vapor phase and not remain on the skin, available for absorption. For inorganics, the compound species is important in determining the magnitude of dermal absorption.

Chemical Exposure via Dermal Contact

Methodologies for estimating inhaled or ingested intake of a constituent account for the amount of constituent presented to the barrier membrane of the pulmonary or gastrointestinal mucosa, respectively. However, the dermal dose is estimated as the dose that crosses the skin and is systematically absorbed. For this reason, dermal toxicity values are also based on absorbed dose. The dermally absorbed dose (DAD) of a COPC is estimated from the following equation:

$$DAD = \frac{(DA)(SA)(EF_T)(ED)}{(BW)(AT)},$$

where

DAD = average dermally absorbed dose of the COPC (mg/kg-day, calculated),
DA = dose absorbed per unit body surface area per day (mg/cm^2-day),
SA = exposed skin surface area (cm^2),
EF_T = exposure frequency (days/year),
ED = exposure duration (years),
BW = body weight (kg),
AT = averaging time (days).

The averaging times for the dermal contact pathway are calculated as for the ingestion pathway. The carcinogenic intake is based on an averaging time of 25,550 days (a 70-year lifetime), and non-carcinogenic intake is based on an averaging time equal to 365 (days/year) × ED (in years).

Dermal uptake of constituents from soil assumes that absorption is a function of the fraction of a dermally applied dose that is absorbed. It is calculated from the following equation:

$$DA = (C_s)(FI_s)(CF)(AF)(ABS),$$

where

DA = dose absorbed per unit body surface area per day (mg/cm^2-day, calculated),
C_s = concentration of COPC in soil (mg/kg),
FI_s = fraction of exposure attributed to site soil or sediment (unitless),
CF = conversion factor (10^{-6} kg/mg),
AF = soil-to-skin adherence factor (mg/cm^2-day),
ABS = absorption fraction (unitless, constituent specific).

Values for ABS are taken from RAGS Part E. The AF parameter is based on RAGS Part E for the adult exerciser and for the child recreator.

4.4.2.3 External exposure pathway

The external exposure pathway is specific to radiological constituents and assumes that the receptor is exposed to an infinite plane source of radiation for the duration of the activity.

Radionuclide Exposure via External Gamma

External exposure to radionuclides in soil is calculated as follows:

$$\text{Intake (pCi-yr/g)} = (C_s)(EF)(ED)(Te)(1\text{-}Se),$$

where

C_s = radiological soil concentration (pCi/g),
Te = daily exposure fraction (unitless based on exposed hours/24 hours),
EF = yearly exposure fraction (day/year based on exposed days/365 days),
ED = exposure duration (years),
Se = shielding factor (unitless).

The intake for the external exposure pathway is calculated as the fraction of the total yearly hours spent in proximity to the source, multiplied by the unshielded portion of the gamma dose (1-Se) in the equation above.

4.5 EXPOSURE PARAMETERS

The exposure parameters for the scenarios and pathways previously described are presented in Table 2. The values of the variables and their basis are discussed in detail in the following sections.

4.5.1 Child/Teen Recreator

The child/teen recreator may be exposed to soils via inhalation of dust and vapors, external exposure, dermal contact, and incidental ingestion while participating in sports and other activities at the hypothetical facilities in Zone 1.

This evaluation is focused on older children >5 years old to 17 years old, who would be more active in sporting events and would have a greater number of visits to a ball park area. While younger children

might experience higher exposures due to greater mouthing behavior and potentially higher soil ingestion rates, it is assumed that children under five are not likely to be heavily involved in organized sports. Children >5 years old are not as likely to exhibit mouthing behavior; therefore, soil ingestion exposures are likely to be inadvertent and activity related.

It is assumed that the RME child recreator represents a child who plays competitive sports at a relatively high level and uses a ball field on a routine basis throughout the year (e.g., for competitive soccer). This child is present at the sports complex for an average of 2 days each week throughout the year. The two-day assumption accounts for variations in the number of visits during periods in the summer (when the frequency might increase to three or more visits per week) and in the winter (when there may not be visits to the sports complex).

The total number of visits to the ballpark is therefore estimated to be 104 times per year for an active child/teen recreator. Additional consideration could be given to the number of wet days and the limitations that might be placed on the total days available for sports activities. Exposures could also be mitigated by the frequency of activities played on grass-covered fields (where minimal soil exposure would be expected) versus fields with sparse grass or bare soils. These factors were considered, but not included, in the analysis to provide a conservative estimate of the potential exposure frequency.

4.5.2 Adult Recreator

The adult recreator represents an individual who may walk, run, hike, or ride bicycles in the recreation area within Zone 1. The adult recreator may be exposed to soils via inhalation of dust and vapors, external exposure, and dermal contact and incidental ingestion from direct contact with soils. It is assumed that this individual lives adjacent to the property and frequently accesses the recreational area (e.g., weekly).

The exposure frequency for the adult recreator is based on two visits per week. Although this receptor is expected to be active up to five times per week, it is assumed that the value of 104 annual visits accounts for time spent in other forms of exercise and/or times of inclement weather. All daily soil ingestion is conservatively assumed to occur while within Zone 1, although the recreator is assumed to be present for only 2 hours of each day of exposure.

The adult exposure factors for soil ingestion rate (50 mg/d), inhalation rate (20 m^3/d), and skin surface area (5300 cm^2) are averages for residential exposures (EPA 1997) and are assumed to reflect the daily rate for a recreator. For conservatism, the soil adherence factor is assumed to be 1 mg/cm^2, a value that is unlikely to be exceeded. The particulate emission factor of 5.8E+09 m^3/kg is based on calculated site-specific wind scour and is equivalent to a dust loading factor of 0.2 µg/m^3. These parameters are likely to provide a conservative estimate of exposure to the exerciser.

Ingestion Exposure

Soil ingestion rates for the child/teen recreator are based on studies of children, mainly in a residential setting (EPA 2008). Those studies found that outdoor soil ingestion is 50 mg/day and indoor dust/soil ingestion rates were 50 mg/d for a total of 100 mg/d of soil.

The outdoor recreator is expected to ingest soil via the following mechanisms:

- direct ingestion of soil (young child or inadvertent ingestion during activities);
- subsequent ingestion due to lack of washing prior to eating; and
- ingestion of inhaled soil, which is filtered into mucus membranes.

Although the outdoor recreator is exposed to only outdoor sources, the ingestion rate of 50 mg/day (equivalent to the residential indoor and outdoor ingestion rate) was used to account for the potentially increased ingestion pathways encountered during outdoor sporting activities.

Inhalation Exposure

For the inhalation evaluation, individuals at the ballpark facility are assumed to be engaged in moderate to strenuous activity for the duration of the visit. This is assumed to represent participation on a sports team, either during practice or official games. Although there may be times of low activity (e.g., while listening to coaches, waiting as a substitute, or for periods of a practice), it is likely that this will be a minority of the total time spent at the park. Therefore, the inhalation rate used in the exposure assessment likely represents a conservative value for the parameter.

The inhalation exposure is dependent on the respirable soil particles that are suspended in the breathing zone of the receptor. These particles become airborne due to mechanical disturbance, such as running over bare soil during sporting events. Although no direct measurements are available for this parameter, a dust loading of 2 $\mu g/m^3$ is assumed (10 times the ambient wind scour value).

The inhalation rate selected for the child/teen recreator considers less than daily values and incorporates information regarding time spent outdoors engaged in sporting activities. A breathing rate of 0.03 m^3/min was generated from data for all sexes aged 6 to 21, breathing at a moderate rate of 0.025 m^3/min for 80% of each hour and a heavy rate of 0.05 m^3/min for 20% of each hour (EPA 2008). Combining this information with the average time spent participating in active outdoor sports (for all sexes aged 6 to 21) of 150 min/day (90th percentile of 300 min/day) provides the inhalation rate of 5 m^3/day for the child recreator.

Dermal Contact

The evaluation of dermal exposures is primarily dependent on the body surface area in contact with contaminants and the associated adherence factors. Data are available for specific body part surface areas for a range of ages. It was assumed that the face (one-third of the head), arms, hands, and legs were in contact with soils. Mean surface areas were averaged for both sexes in the 6- to 21-year range to arrive at a surface area of 0.8 m^2. A surface area weighted adherence factor of 0.03 mg/cm^2 was calculated, based on data collected from soccer players (EPA 2008).

External Exposure

Individuals participating in sports at the park may be exposed to radiation emitted from soils. It is assumed that no shielding is provided by any vehicles or structures at the facility and that the receptor is surrounded by soils (i.e., exposed to radiation from all sides). The child/teen recreator is assumed to be outdoors exposed to soils for 2.5 hours during each visit to Zone 1.

4.6 TOXICITY ASSESSMENT

The calculated intake of chemicals and radionuclides is combined with toxicity data to determine the potential for human health impacts. A chemical may have both toxic effects and carcinogenic risk, while radionuclides generally cause carcinogenic risk only. The type of toxicity data utilized is dependent on whether the human health effect is carcinogenic or non-carcinogenic.

Non-carcinogenic effects are estimated by utilizing reference doses (RfDs) for ingestion and dermal contact, and reference concentrations (RfCs) for inhalation exposures. The ratio of the calculated intake to the RfD/RfC is called the hazard quotient (HQ) and is used as the basis for estimating the potential for adverse health effects. The recreational exposures are considered acute, in that the exposure frequency is relatively low (<5 days/week). Where acute toxicity data were not available for a particular constituent, an available sub-chronic or chronic RfD/RfC was substituted.

Carcinogenic risks are expressed in terms of the probability of an increased incidence of cancer in the exposed population, such as 1 in 10,000 (1E-04) or 1 in 1,000,000 (1E-06). The cancer risk is estimated by multiplying the intake by a slope factor (SF), which is the risk per unit intake for a specific exposure pathway (e.g., SFO is the oral slope factor in units of risk per unit intake). SFs are given in units of risk per milligram per kilogram per day (mg/kg-d) for chemicals, and units of risk per picocurie (pCi) for radionuclides.

An additional consideration is the mutagenic potential associated with childhood (<16 years old) exposures. For the constituents under consideration in this evaluation, only benzo(*a*)pyrene has been identified as a potential mutagen (EPA 2005). For the child recreator (ages 6 through 17), the age-dependent adjustment factor (ADAF) of three (for ages 2 to 16) was selected as representative of the recreational exposure time frame. The calculated unit intakes and risks/hazards are multiplied by the ADAF to generate results which consider the mutagenic potential of benzo(*a*)pyrene.

The toxicity data used in this evaluation are presented in the following:

- Table 3 – Carcinogenic Toxicity Data.
- Table 4 – Non-Carcinogenic Ingestion and Dermal Toxicity Data.
- Table 5 – Non-Carcinogenic Inhalation Toxicity Data.

Values for the chemical toxicity parameters are consistent with those used for the EPA RSLs and the Oak Ridge National Laboratory (ORNL) Risk Assessment Information System (RAIS). Radionuclide toxicity was based on values from Federal Guidance Report (FGR) 13.

4.7 METHOD FOR QUANTIFYING ACTION LEVELS

To facilitate generation of ALs and estimates of risk/hazard, the exposure pathway intakes were calculated using a unit soil concentration of 1 milligram per kilogram (mg/kg) and 1 picocurie per gram (pCi/g) for chemicals and radionuclides, respectively. These unit intake values are scaled to produce a soil concentration that results in an assumed acceptable risk/hazard. To calculate risk/hazard, the unit intake values can be multiplied by the actual soil concentration to arrive at a site-specific estimate.

The target risk level (TRL) and target HI (THI) for these calculations are selected to achieve overall health protection for the selected exposure scenarios. The overall TRL, for all constituents and pathways for a single receptor, is generally in the range of 1×10^{-4} to 1×10^{-6}; therefore, the TRL is set at 1×10^{-5} for individual constituents to achieve the overall risk goal. This is consistent with the approach used for the development of the industrials RLs (DOE 2002). The THI is set at 1, which is the threshold for adverse health effects via all pathways from an individual constituent. These TRLs and THIs are consistent with the Zone 1 Interim Record of Decision (IROD) methods (DOE 2002).

ALs are calculated for both carcinogenic and toxic impacts for each individual constituent. The unit intakes used in the equations are generated by entering a soil concentration of 1 mg/kg or 1 pCi/g into the calculations. Unit intakes are expressed per mg/kg or milligram per cubic meter (mg/m^3) for chemicals,

and per pCi/g or picocurie per year per gram (pCi-yr/g) for radionuclides. The resulting risks and hazards can then be scaled to provide a concentration corresponding with the selected TRL or THI. These equations are presented in the following sections.

4.7.1 Chemical Action Levels

The RLs for the ingestion and dermal pathways for carcinogenic chemicals are calculated from:

$$RL\ (mg/kg) = TRL / [Unit\ Intake\ (mg/kg\text{-}d\ per\ mg/kg) \times SF\ (risk\ per\ mg/kg\text{-}d)],$$

while non-carcinogenic RLs are calculated from:

$$RL\ (mg/kg) = THI \times RfD\ (mg/kg\text{-}d) / Unit\ Intake\ (mg/kg\text{-}d\ per\ mg/kg).$$

The inhalation RLs for chemicals are calculated from one of the following equations:

$$RL\ (mg/kg) = TRL / [Unit\ EC\ (mg/m^3\ per\ mg/kg) \times IUR\ (risk\ per\ mg/m^3)]$$

$$RL\ (mg/kg) = Target\ Hazard\ Quotient\ (THQ) \times RfC\ (mg/m^3) / Unit\ EC\ (mg/m^3\ per\ mg/kg).$$

4.7.2 Radiological Action Levels

For radionuclides, RLs for the ingestion and inhalation pathways are calculated from:

$$RL\ (pCi/g) = TRL / [Unit\ Intake\ (pCi\ per\ pCi/g) \times SF\ (risk\ per\ pCi)],$$

and for the external exposure pathway from:

$$RL\ (pCi/g) = TRL / [Unit\ Intake\ (pCi\text{-}year/g\ per\ pCi/g) \times SF\ (risk\ per\ pCi\text{-}yr/g)].$$

4.8 ACTION LEVELS FOR ARSENIC AND POLYCYCLIC AROMATIC HYDROCARBONS

There is considerable controversy surrounding certain chemicals regulated under CERCLA that are also naturally occurring or have become anthropogenic in the environment due to human activities. In the case of Zone 1, arsenic and polycyclic aromatic hydrocarbons (PAHs) fall into this category.

In the case of arsenic, the recreational risk-based level is 1.8 mg/kg, which is below arsenic background levels. Nationwide arsenic background levels range from 0.1 to 40 mg/kg (NAS 1997). The ETTP background (DOE 2007 – sitewide) was estimated to be 14.95 mg/kg. As a result that recreational AL is unusable. A literature search was performed to find information on arsenic ALs throughout the nation and the world. There is extensive literature and web discussion on this topic. Teaf et al. (2010) recently compiled much of this information; however, in general, there was little to no information on ALs for recreational use. Decisions tended to default to background levels and, in some cases, residential levels. A few state decisions cited values of 20 to 200 mg/kg as the desired cleanup levels for residential and industrial use, respectively (TNRCC 1998; State of California 2007; and Washington State DEC 2007, www.ecy.wa.gov/biblio/wac173340.html). No specific information was found on arsenic recreational ALs in the state of Tennessee's Underground Storage Tanks "Technical Guidance Documents" or Brownfields guidance documents. However, the state does defer to a risk assessment process to determine cleanup requirements (http://www.tn.gov/environment/dor/toolbox/pdf/TennesseeBrownfieldsRedevelopmentToolbox.pdf). The Inter-Department Committee on the Redevelopment of Contaminated Land (ICRCL)

[www.contaminatedland.co.uk/std-guid/icrcl-1.htm] listed an arsenic AL for "parks, playing fields, and open space" as 40 mg/kg.

Therefore, in addition to the comparison to the risk-based arsenic AL, the arsenic results will be evaluated qualitatively relative to the 20 to 40 mg/kg surrogate level range identified in the literature. The industrial RL for arsenic listed in the Zone 1 ROD is 300 mg/kg.

In the case of PAHs, Bradley et al. (1994) cited anthropogenic levels ranging from 0.04 to 13 mg/kg for benzo(*a*)pyrene [B(*a*)P] and 0.68 to 77 mg/kg for total carcinogenic PAHs. Risk-based cleanup levels are typically below these anthropogenic levels (e.g., the recreational AL for Zone 1 is 0.11 mg/kg). A search of the literature found most states had not attempted to address this issue in regulatory documents or in risk-based corrective action (RBCA) decisions, including documents available from the state of Tennessee. One citation noted a B(*a*)P AL of 10 mg/kg. In addition to the comparison to the risk-based recreational ALs, PAHs will be evaluated qualitatively relative to the 10 mg/kg surrogate level.

4.9 LEAD ACTION LEVELS

EPA addresses lead at CERCLA sites differently than other chemicals of concern (COCs). EPA has developed special exposure models for lead that account for the cumulative toxic impact of both background blood lead levels that are found in most Americans due to historical amounts of lead in paint, gasoline, and other sources, as well as the exposure from the CERCLA site being reviewed. EPA has worked on three models over the past 20 years. Two have been validated and are in use:

- The Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead in Children (EPA 2009b; EPA 2007), which addresses impact to children ages 0 to 5 years.

- The Adult Lead Model (ALM) [EPA 2009c, 2009d], which addresses impacts to adults and uses a woman of child-bearing age as the limiting receptor.

The third model, the "All-Ages Lead Model" (AALM) is still in the development stage (http://cfpub.epa.gov/ncea/CFM/recordisplay.cfm?deid=139314). The AALM is expanding the existing models to be able to include older children.

During a recent experience on performing a human health risk assessment at a former rifle range where the primary COC was lead and the receptor was a recreational child 7+ years old, EPA indicated that the AALM is still not available for application and recommended use of the ALM to best represent the older child/teenage recreator.

The key ALM equation used to evaluate recreational land use is:

$$\text{PbB}_{\text{adult, central}} = PbBadult,0 + \frac{PbS \times BKSF \times IR_s \times A_{Fs} \times EF_s}{AT},$$

where

$\text{PbB}_{\text{adult,central}}$ = central estimate of blood lead concentrations (µg/deciliter [dL]) in adult women of child-bearing age who are exposed to lead from the site under evaluation,

$\text{PbB}_{\text{adult,}}$ = central estimate of blood lead concentrations (1 to 1.5 µg/dL, EPA 2009d) in adult women of child-bearing age in the absence of exposure to lead from the site under evaluation,

PbS	=	soil lead concentration (µg/g, site-specific EPCs) from the site,
BKSF	=	biokinetic slope factor relating increase in blood lead concentrations to average daily uptake (µg/dL blood lead increase)(0.4 µg/d lead uptake, EPA 2009d),
IR^s	=	intake rate of soil (0.05 g/day, site-specific),
AFs	=	absolute gastrointestinal absorption factor for ingested lead in soil (0.12 unitless, EPA 2009d),
EF_s	=	exposure frequency (155 days/year, site-specific),
AT	=	averaging time (365 days/year).

For Zone 1, the ALM was run solving for PbS and using the child recreator exposure frequency (155 days/year), which is slightly greater than the adult recreator. This is the only factor that varies between the adult and child in the model.

One parameter, the baseline lead level (PbB) is currently being reviewed by EPA. Baseline blood lead levels have changed in Americans over time as sources of lead are reduced (e.g., in paint and gasoline). The current range of values is 1.0 to 1.5 µg/dL, with the higher end being retained in this analysis since the Zone 1 recreator is younger than the ALM adult. Also under discussion is the value used for the target endpoint (used in place of $PbB_{adult,central}$ in the model), which ranges from 5 to 10 µg/dL lead. This value, like the target cancer risk level, is needed to back calculate the acceptable lead soil level.

Using the EF = 155 days/year and the above ranges of values for PbB and the target blood lead level, the estimated range of ALs is 601 to 3164 parts per million (ppm). The EPA default value from the ALM is 2240 ppm. The final AL value will be selected as part of the risk assessment/risk management process.

4.10 RECREATIONAL ACTION LEVELS

Table 6 presents the RLs developed for the two recreational receptors, the adult exerciser and the child recreator. The adult recreator resulted in the most limiting RL for carcinogenic health effects and the child recreator resulted in the limiting effect for some non-carcinogens.

The values provided in Table 6 represent that value that would be protective of the RME recreator. As such, the value would be compared to the soil concentration representing the upper confidence limit (UCL) on the average concentration for an area that represents the space used by the selected recreational receptors (see Sect. 4).

Consistent with the Zone 1 IRODs and the Melton Valley Soils and Sediment IROD (DOE 2000), it is necessary to also identify hot spots that have significant contamination that excavation is required even if the average concentration is acceptable. In the Zone 1 IROD, these hot spot delineation values were referred to as "maximum action levels." These maximum levels represented a lesser exposure frequency – 200 hours/year as opposed to 2000 hours/year used for the average (or one-tenth the exposure frequency per year) to account for the fact that a receptor would spend less time in a smaller area. In the Melton Valley ROD, these hot-spot delineation values were referred to as "not-to-exceed" (NTE) levels and they represented 10 times the average RL. Mathematically these two approaches are the same; hence the 10 times approach from Melton Valley will be applied for identification of maximum ALs in Zone 1 soil for recreational land uses.

5. COMPARISON OF ACTION LEVELS WITH RESIDUAL SOIL CONCENTRATIONS IN ZONE 1

Residual soil concentrations in Zone 1 were compared to the unrestricted recreational ALs to identify areas that could be released for unrestricted future recreational use. Zone 1 soil data from the DVS sampling effort were obtained from the OREIS database. OREIS sample results were reviewed by Zone 1 team members to eliminate data that represented soils that had subsequently been excavated. Data were delineated into three soil depth groups for this screening exercise: 0 to 2 ft below ground surface (bgs), 2 to 10 ft bgs, and >10 bgs. Some soil samples did not cleanly fit into these categories (e.g., samples listed in the database as representing a 0- to 5-ft bgs depth). For each of these samples, the Zone 1 project team identified the proper group, ensuring that any samples with a depth range falling within the 0- to 2-ft bgs depth were placed in that group. This ensured that analysis of recreational activities on the surface would capture any potential contamination in that upper depth zone.

For this analysis Zone 1 was divided into six recreational groups (Fig. 2):

- The Blair Quarry Group, a separate area in the northeast portion of the site along McKinney Ridge.
- The K-1007 Group, the area with the most existing reindustrialization efforts to date in Zone 1.
- The Powerhouse Group in the southern portion of Zone 1.
- The K-770 Group, defined by the area for which a separate land use control (LUC) plan is being developed due to the presence of buried asbestos; the precise boundary of this area will be defined through the completion of an Explanation of Significant Difference (ESD) to the Zone 1 IROD.
- The Duct Island Group, which is surrounded by Poplar Creek to the east, south, and west, and by K-901 and the BORCE to the north, and is the most topographically varied portion of the non-BORCE area of Zone 1.
- The BORCE Group in the northern portion of the site defined by the boundaries of the conservation easement.

These groups were delineated based on the potential for contiguous recreational activities to span the area (e.g., ball fields in the Powerhouse Area, or hiking and biking on Duct Island). However, for the comparisons to RLs, no presumption of the type of recreational activities was made.

In each area two types of comparisons will be made:

- Individual data results were compared to the maximum RLs to identify any potential hot spots.
- The UCL of the mean soil concentration in each area was compared to the associated average RL. The UCL was estimated using the statistical approach best suited for the distribution of the concentration results (e.g. normal, lognormal, etc.).

The UCL is completely dependent on the selected area across which the averaging occurs; therefore, it was determined that the UCL comparison would be used as a supplemental tool for optimizing final land use decisions. Tables 7 through 20 show the results of the recreational screening.

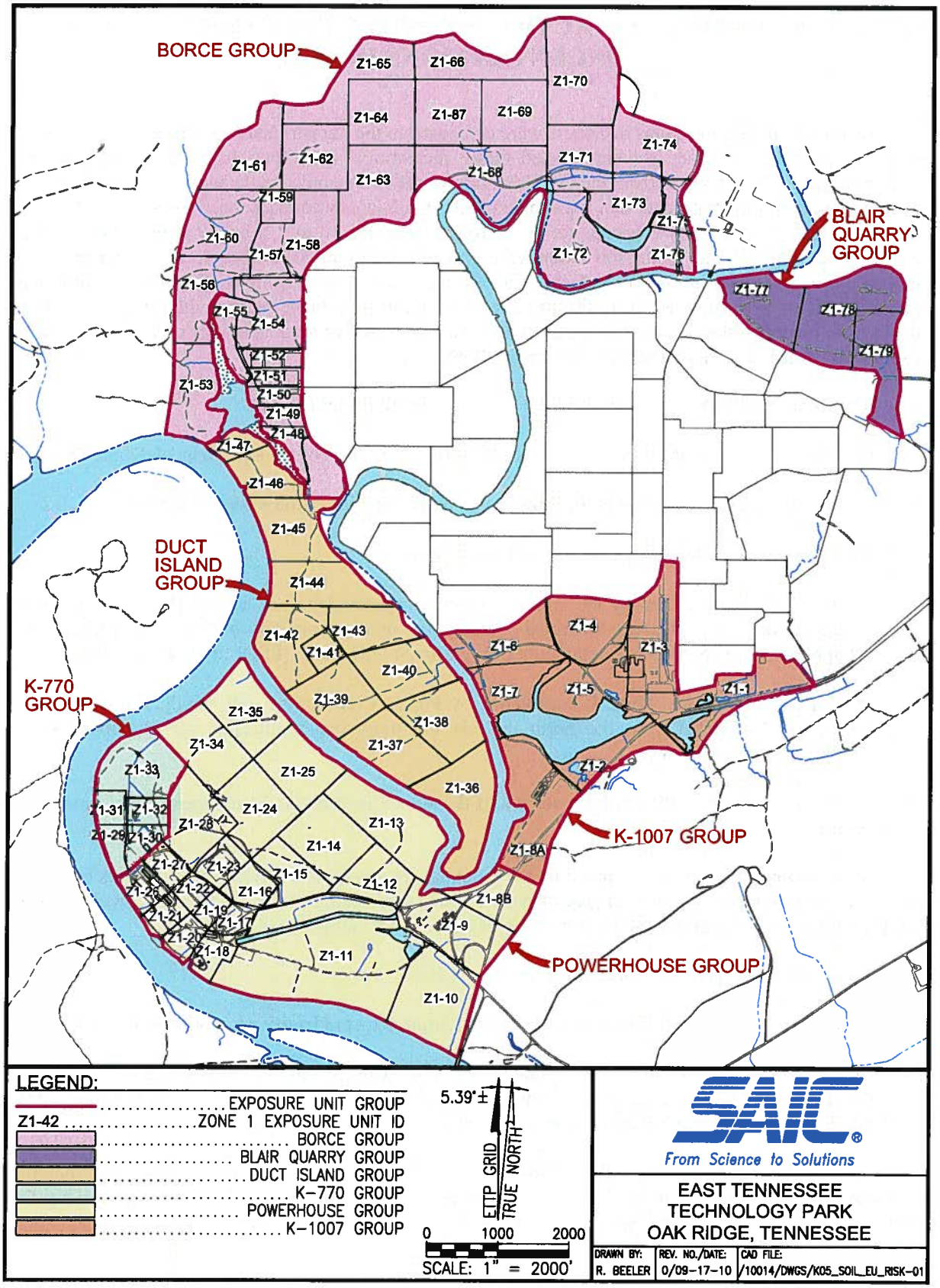

Fig. 2. Zone 1 EU Grouping for soil exposure recreational risk screening.

6. IDENTIFY AREAS FOR FUTURE RECREATIONAL USE

Results of the point-by-point comparisons to the unrestricted recreational use ALs are presented in Figs. 3 through 9 and discussed below.

6.1 BLAIR QUARRY

Figure 3 shows the location of sample results that exceed the unrestricted recreational ALs. There are four separate areas of exceedances identified. Three are isolated exceedances of the 20 mg/kg arsenic AL (the north slope of McKinney Ridge and on the east and west ends of the south slope of McKinney Ridge). Two of the three arsenic exceedances are above the 40 mg/kg surrogate level. The fourth area (around EU-77) has exceedances of multiple contaminants including arsenic, PAHs, and lead.

6.2 K-1007

Figure 4 shows two locations in the K-1007 Area where unrestricted recreational hot spots were identified: in the western portion of the area, west of the railroad spur, and in the far southeastern portion of the area at the location of the former Happy Valley Service Station. PAHs are the concern at both locations.

6.3 POWERHOUSE AREA

Analysis of the residual contamination in the Powerhouse Area is presented in Fig. 5. In general, Powerhouse residual contamination is representative of an industrial brownfield site with widespread, low-level metals (arsenic, lead) and PAH contamination.

Located south of "Powerhouse Road" are several areas that are currently being evaluated further as potential sources of groundwater contamination, including the K-1085 Firehouse Burn Drum Removal area, the Former J.A. Jones Maintenance Complex, and the K-720 Fly Ash Pile. In the case of the Fly Ash Pile, fly ash is visible at ground surface. Until these areas are fully addressed, they will not be considered for unrestricted recreational use.

North of the road are several areas where residual contamination exceeds the recreational risk ALs. In the eastern portion of the peninsula, old debris is present along a steep slope leading down to Poplar Creek. PAH levels exceed even the surrogate AL of 10 mg/kg. In the central portion of the peninsula, along a gravel road, samples collected on old debris piles exceed the PAH ALs. A site visit to this area indicates that the debris piles cover a larger area than indicated by the sample exceedance so additional samples would be needed to delineate the extent of recreational exceedances. There are some hot spots in the former K-709 Switch Yard area, including a PAH value of 270 mg/kg. Arsenic levels throughout the Powerhouse Area are all less than the 40 mg/kg surrogate AL, with the exception of one location (EU11-220) in the Fly Ash Pile.

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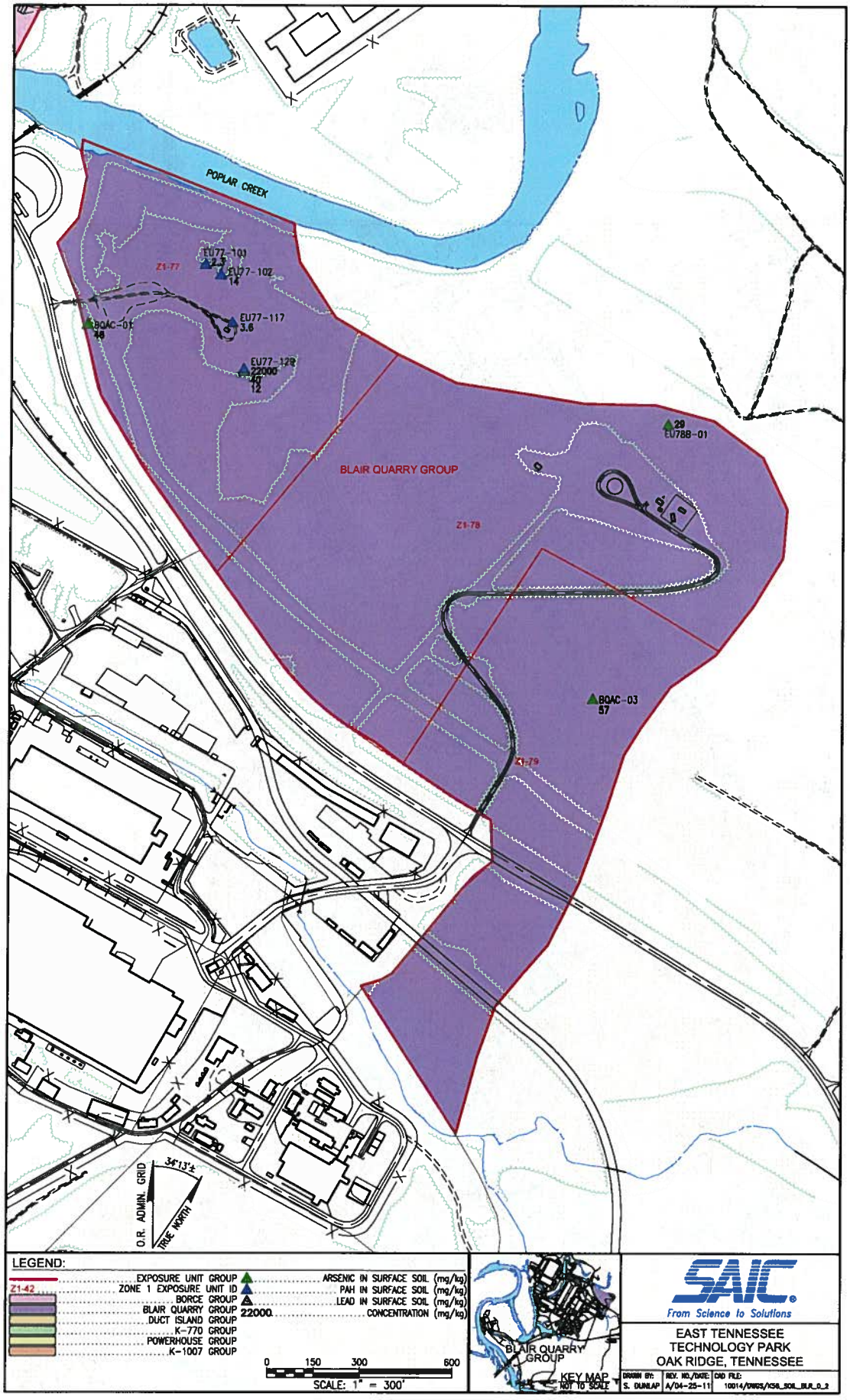

Fig. 3. Recreational risk screening for Blair Quarry Group.

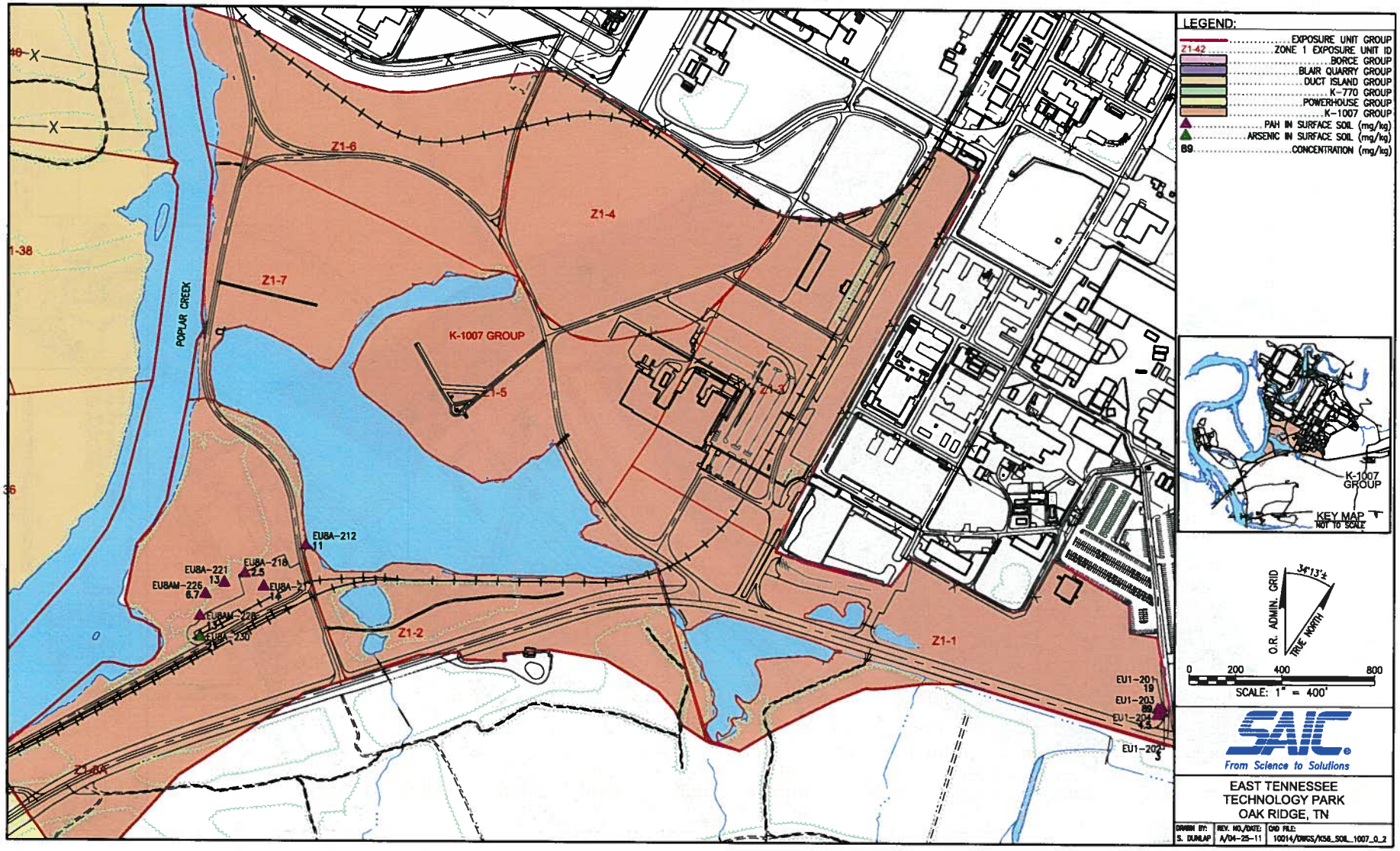

Fig. 4. Recreational risk screening for K-1007 Group.

Fig. 5. Recreational risk screening for Powerhouse Area.

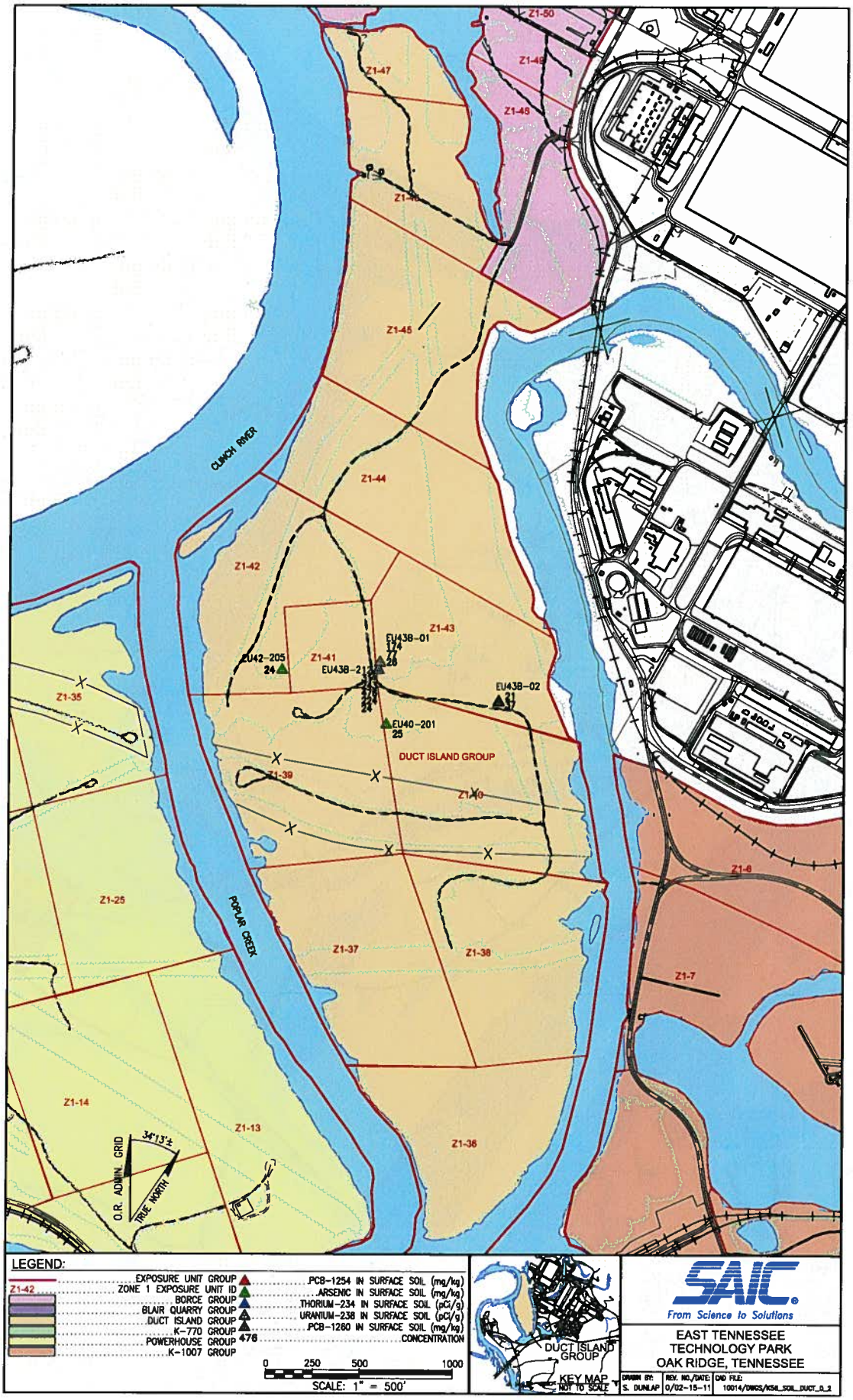

Fig. 6. Recreational risk screening for Duct Island, 0 to 2 ft bgs.

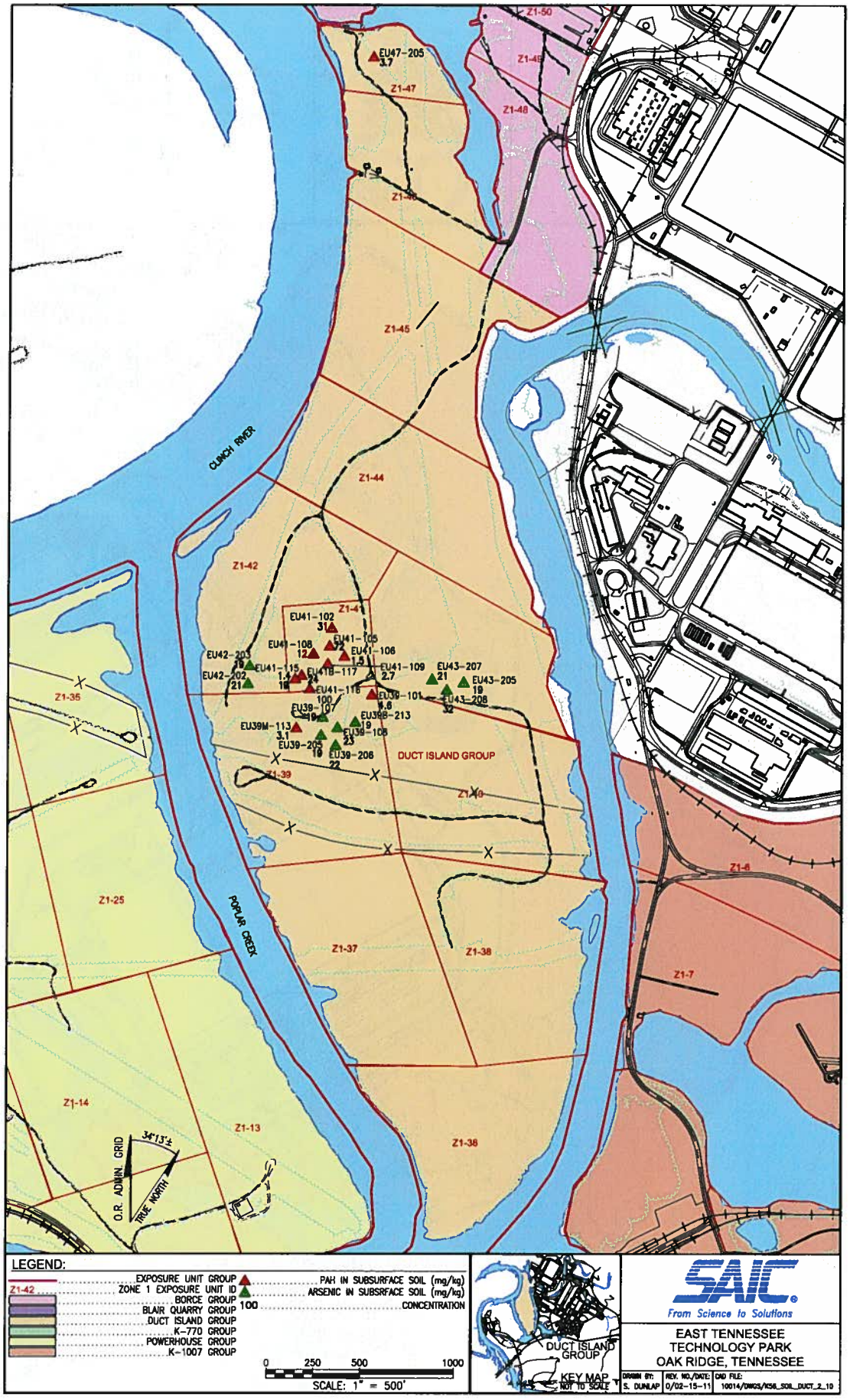

Fig. 7. Recreational risk screening for Duct Island, 2 to 10 ft bgs.

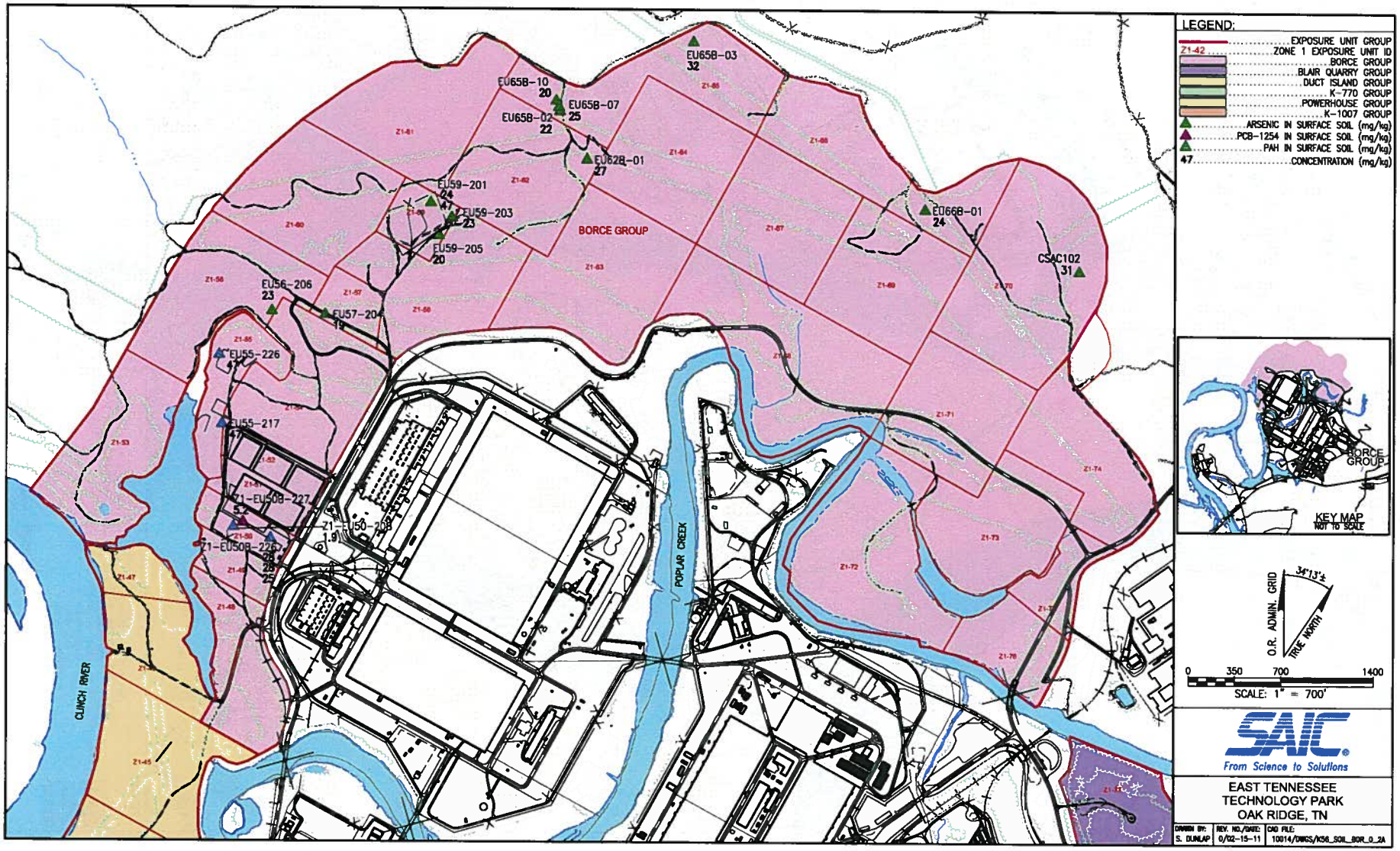

Fig. 8. Recreational risk screening for the BORCE, 0 to 2 ft bgs.

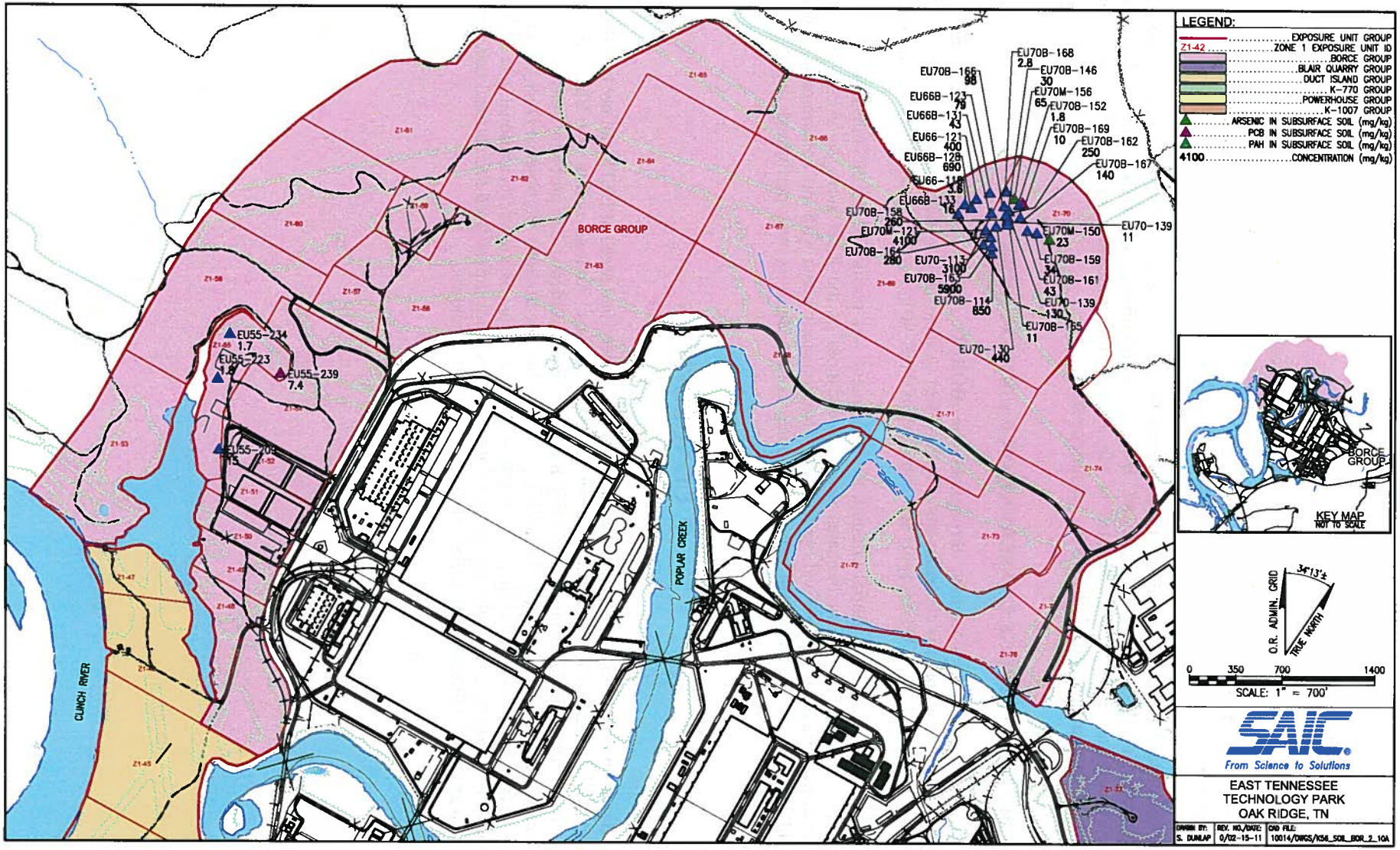

Fig. 9. Recreational risk screening for the BORCE, 2 to 10 ft bgs.

6.4 DUCT ISLAND

Two locations in the Duct Island area indicate unrestricted recreational hot spots (Fig. 6). The eastern location has polychlorinated biphenyls (PCBs) and arsenic. The arsenic value is less than the 40 mg/kg surrogate level. The location in the center portion of Duct Island has exceedances of multiple contaminants, including arsenic, PCBs, and the radionuclides uranium and thorium.

Duct Island also contains a site that is being further evaluated as a source of contamination to groundwater, the K-1070-F Burial Ground. Because of this subsurface soil located within the burial groundwater was assessed. As indicated in Fig. 7, there are numerous exceedances greater than the 10-mg/kg surrogate level for PAHs in the subsurface soil.

6.5 BLACK OAK RIDGE CONSERVATION EASEMENT (BORCE)

There are random locations throughout the BORCE surface soils that exceed unrestricted recreational ALs for various contaminants (Fig. 8). Most of these exceedances are arsenic levels that fall below the surrogate AL. PAH hot spots are identified in the K-901 Disposal Area above the surrogate AL.

As with the K-1070-F Burial Ground, an assessment was performed on the subsurface soil of the CSA (Fig. 9). This assessment indicates many exceedances of the PAH surrogate ALs, some several orders of magnitude above the level. Additional restrictions on contact with this contamination should be considered even for conservation use since no excavation analysis was performed during the CSA assessment.

7. CONCLUSIONS

Based on the findings of this assessment, each of the identified areas of ETTP can not be released for unrestricted recreational use without further remedial actions. Actions within the Blair Quarry and Powerhouse areas would require additional delineation of the problems. The problem areas in the K-1007 area are better defined (e.g., at the former Happy Valley Service Station). Portions of Duct Island and the entire BORCE are located in an area currently designated as restricted recreational use within the conservation easement, and thus may never be able to be used for unrestricted recreational use. Figure 10 shows a proposed delineation of future land use based on this analysis.

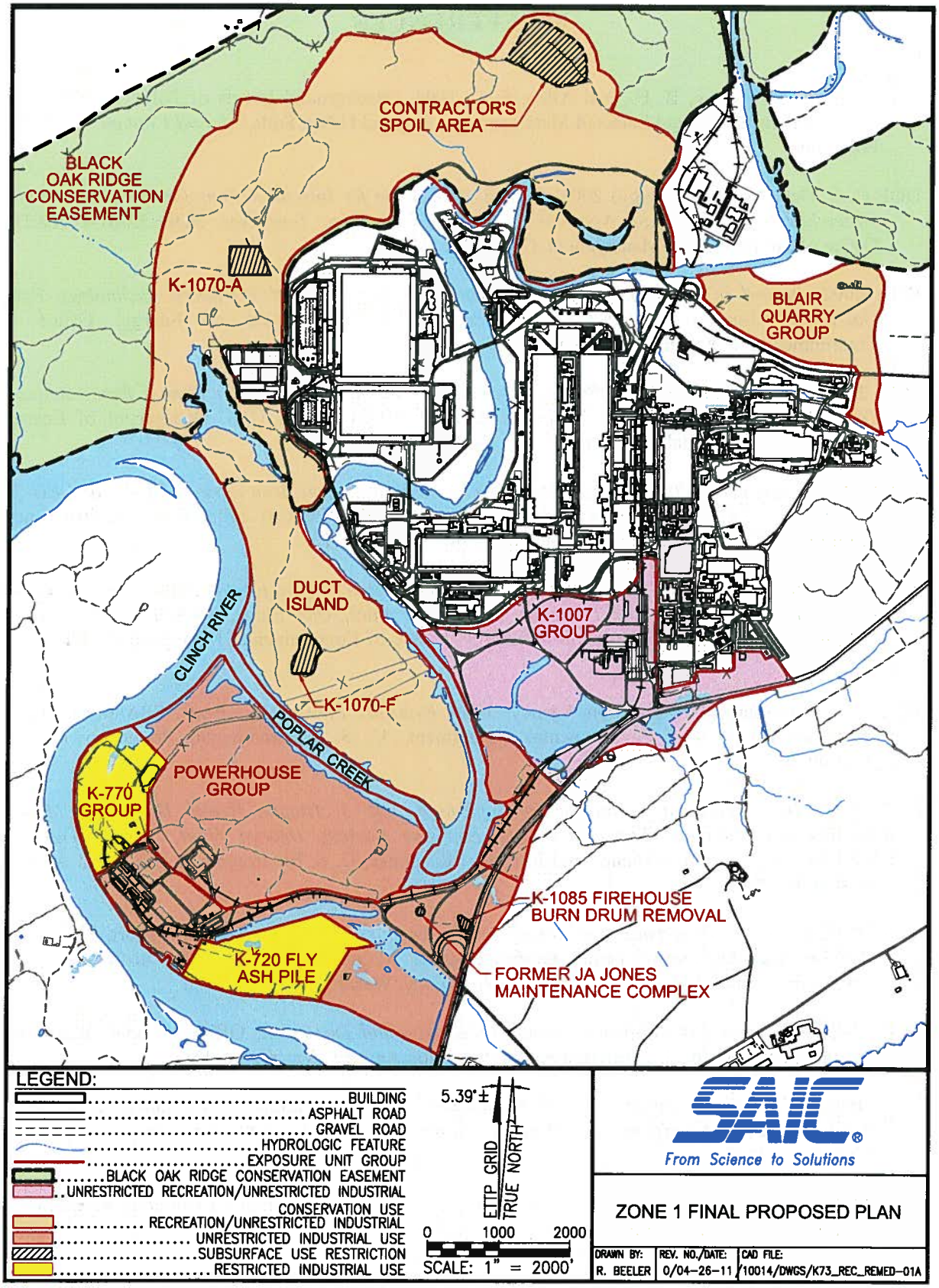

Fig. 10. Recommended future land use for ETTP Zone 1.

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Table 1. ETTP Zone 1 DVS soil dataset – selection of chemicals of potential concern

Chemical	Analyte type	CAS number	Units	Number of detections	Number of samples	Fraction of samples with a detection	Mean of detections	Standard deviation of detections	Minimum detection	Maximum detection	Residential RSL	Number of detections over Residential RSL	Fraction of detections that exceed RSL	COPC?	Justification for COPC
Aluminum	METAL	7429905	mg/kg	492	492	1.00	1.2E+04	4.2E+03	1.0E+03	2.8E+04	7.7E+03	407	0.83	Yes	Detected above risk criteria
Antimony	METAL	7440360	mg/kg	436	482	0.90	4.4E-01	2.2E+00	5.7E-03	4.2E+01	3.1E+00	13	0.03	Yes	Detected above risk criteria
Arsenic	METAL	7440382	mg/kg	486	521	0.93	1.0E+01	1.5E+01	1.4E+00	2.6E+02	3.9E-01	486	1.00	Yes	Detected above risk criteria
Barium	METAL	7440393	mg/kg	495	521	0.95	8.3E+01	9.7E+01	5.0E-01	1.7E+03	1.5E+03	1	0.00	Yes	Detected above risk criteria
Beryllium	METAL	7440417	mg/kg	532	559	0.95	1.8E+00	2.0E+01	8.4E-02	4.4E+02	1.6E+01	3	0.01	Yes	Detected above risk criteria
Boron	METAL	7440428	mg/kg	349	479	0.73	4.0E+00	3.3E+00	3.2E-01	2.0E+01	1.6E+03	0	0.00	No	Not detected above risk criteria
Cadmium	METAL	7440439	mg/kg	491	521	0.94	2.2E+00	2.8E+00	4.5E-02	4.5E+01	7.0E+00	10	0.02	Yes	Detected above risk criteria
Calcium	METAL	7440702	mg/kg	492	492	1.00	3.6E+04	5.9E+04	5.1E+01	3.0E+05	–	0	0.00	No	Essential nutrient
Chromium III, Soluble Salts	METAL	16065831	mg/kg	497	521	0.95	9.7E+01	8.6E+02	3.9E+00	1.6E+04	1.2E+04	1	0.00	Yes	Detected above risk criteria
Cobalt	METAL	7440484	mg/kg	492	492	1.00	1.3E+01	4.3E+01	1.3E+00	8.9E+02	2.3E+00	481	0.98	Yes	Detected above risk criteria
Copper	METAL	7440508	mg/kg	492	492	1.00	5.0E+01	1.6E+02	7.3E-01	2.0E+03	3.1E+02	16	0.03	Yes	Detected above risk criteria
Iron	METAL	7439896	mg/kg	492	492	1.00	2.8E+04	1.4E+04	1.5E+03	2.2E+05	5.5E+03	485	0.99	No	Essential nutrient
Lead	METAL	7439921	mg/kg	493	521	0.95	9.5E+01	9.9E+02	4.1E+00	2.2E+04	4.0E+01	99	0.20	Yes	Detected above risk criteria
Lithium	METAL	7439932	mg/kg	474	474	1.00	9.7E+00	7.3E+00	1.9E+00	1.0E+02	1.6E+01	50	0.11	Yes	Detected above risk criteria
Magnesium	METAL	7439954	mg/kg	492	492	1.00	6.4E+03	1.1E+04	1.7E+02	8.4E+04	–	0	0.00	No	Essential nutrient
Manganese	METAL	7439965	mg/kg	492	492	1.00	8.4E+02	7.5E+02	3.7E+01	5.7E+03	1.8E+02	458	0.93	Yes	Detected above risk criteria
Mercury	METAL	1344485	mg/kg	457	513	0.89	5.8E-01	3.1E+00	1.5E-03	3.4E+01	2.3E+00	18	0.04	Yes	Detected above risk criteria
Molybdenum	METAL	7439987	mg/kg	336	479	0.70	3.1E+00	2.2E+01	1.2E-01	4.0E+02	3.9E+01	3	0.01	Yes	Detected above risk criteria
Nickel	METAL	7440020	mg/kg	492	492	1.00	3.3E+01	1.1E+02	2.5E+00	1.9E+03	1.5E+02	15	0.03	Yes	Detected above risk criteria
Phosphorous	METAL	7723140	mg/kg	15	15	1.00	5.9E+02	6.9E+02	1.9E+02	3.1E+03	1.6E-01	15	1.00	Yes	Detected above risk criteria
Potassium	METAL	7440097	mg/kg	487	492	0.99	9.7E+02	5.1E+02	1.7E+02	4.0E+03	–	0	0.00	No	Essential nutrient
Selenium	METAL	7782492	mg/kg	188	521	0.36	1.9E+00	3.4E+00	1.3E-01	3.1E+01	3.9E+01	0	0.00	No	Not detected above risk criteria
Silver	METAL	7440224	mg/kg	164	521	0.31	6.5E+00	4.1E+01	3.3E-02	4.1E+02	3.9E+01	4	0.02	Yes	Detected above risk criteria
Sodium	METAL	7440235	mg/kg	325	479	0.68	7.4E+01	7.4E+01	1.0E+00	5.8E+02	–	0	0.00	No	Essential nutrient
Strontium	METAL	7440246	mg/kg	20	20	1.00	3.9E+01	5.6E+01	4.1E+00	2.2E+02	4.7E+03	0	0.00	No	Not detected above risk criteria
Thallium	METAL	7440280	mg/kg	477	487	0.98	2.9E-01	4.3E-01	1.9E-02	4.5E+00	–	0	0.00	No	No available risk criteria
Tin	METAL	7440315	mg/kg	14	15	0.93	3.1E+00	7.6E+00	4.4E-01	2.9E+01	4.7E+03	0	0.00	No	Not detected above risk criteria
Titanium	METAL	7440326	mg/kg	15	15	1.00	1.3E+02	4.2E+01	6.5E+01	2.3E+02	–	0	0.00	No	No available risk criteria
Uranium	METAL	7440611	mg/kg	514	519	0.99	1.2E+02	2.4E+03	2.8E-01	5.4E+04	2.3E+01	51	0.10	Yes	Detected above risk criteria
Vanadium	METAL	36907423	mg/kg	491	491	1.00	3.0E+01	1.1E+01	3.4E+00	9.4E+01	1.6E+02	0	0.00	No	Not detected above risk criteria
Zinc	METAL	7440666	mg/kg	492	492	1.00	9.4E+01	1.9E+02	9.8E+00	2.1E+03	2.3E+03	0	0.00	No	Not detected above risk criteria
1,2,3,4,6,7,8-Heptachlorodibenzofuran	DI/FURA	67562394	mg/kg	1	5	0.20	3.1E-04	–	3.1E-04	3.1E-04	–	0	0.00	No	No available risk criteria
Heptachlorodibenzofuran	DI/FURA	38998753	mg/kg	1	5	0.20	8.2E-04	–	8.2E-04	8.2E-04	–	0	0.00	No	No available risk criteria
Octachloro-dibenzo[b,e][1,4]dioxin	DI/FURA	3268879	mg/kg	2	5	0.40	3.3E-04	2.1E-04	1.8E-04	4.7E-04	–	0	0.00	No	No available risk criteria
Octachlorodibenzofuran	DI/FURA	39001020	mg/kg	1	5	0.20	3.2E-04	–	3.2E-04	3.2E-04	–	0	0.00	No	No available risk criteria
MCPP	HERB	93652	mg/kg	2	8	0.25	2.3E+00	4.2E-01	2.0E+00	2.6E+00	6.1E+00	0	0.00	No	Not detected above risk criteria
PCB-1016	PPCB	12674112	mg/kg	2	473	0.00	1.3E-01	1.6E-01	1.5E-02	2.4E-01	3.9E-01	0	0.00	No	Not detected above risk criteria
PCB-1248	PPCB	12672296	mg/kg	7	473	0.01	2.8E+00	2.8E+00	1.6E-01	6.1E+00	2.2E-01	6	0.86	Yes	Detected above risk criteria
PCB-1254	PPCB	11097691	mg/kg	109	499	0.22	2.4E+00	9.0E+00	6.1E-03	7.7E+01	1.1E-01	57	0.52	Yes	Detected above risk criteria
PCB-1260	PPCB	11096825	mg/kg	156	499	0.31	6.0E-01	3.5E+00	3.7E-03	3.7E+01	2.2E-01	28	0.18	Yes	Detected above risk criteria
Polychlorinated biphenyl	PPCB	1336363	mg/kg	79	200	0.40	5.8E-01	3.2E+00	5.4E-03	2.8E+01	2.2E-01	15	0.19	Yes	Detected above risk criteria
1,2,4-Trichlorobenzene	SVOA	120821	mg/kg	1	569	0.00	5.5E-02	–	5.5E-02	5.5E-02	6.2E+00	0	0.00	No	Not detected above risk criteria
1,4-Dichlorobenzene	SVOA	106467	mg/kg	1	570	0.00	1.3E-01	–	1.3E-01	1.3E-01	2.4E+00	0	0.00	No	Not detected above risk criteria
1-Methylnaphthalene	SVOA	90120	mg/kg	2	4	0.50	9.2E-01	9.6E-01	2.4E-01	1.6E+00	2.2E+01	0	0.00	No	Not detected above risk criteria
2,4,6-Trichlorophenol	SVOA	88062	mg/kg	1	399	0.00	3.1E-02	–	3.1E-02	3.1E-02	6.1E+00	0	0.00	No	Not detected above risk criteria
2,4-Dimethylphenol	SVOA	105679	mg/kg	8	399	0.02	1.1E-01	9.1E-02	1.7E-02	2.9E-01	1.2E+02	0	0.00	No	Not detected above risk criteria
2-Methylnaphthalene	SVOA	91576	mg/kg	166	400	0.42	5.2E-01	2.0E+00	1.4E-02	2.2E+01	3.1E+01	0	0.00	No	Not detected above risk criteria
2-Methylphenol	SVOA	95487	mg/kg	6	399	0.02	7.0E-02	5.4E-02	1.5E-02	1.7E-01	3.1E+02	0	0.00	No	Not detected above risk criteria
3-Methylphenol	SVOA	108394	mg/kg	9	266	0.03	1.3E-01	1.5E-01	2.9E-02	5.1E-01	3.1E+02	0	0.00	No	Not detected above risk criteria
4-Methylphenol	SVOA	106445	mg/kg	2	131	0.02	9.2E-02	9.6E-02	2.4E-02	1.6E-01	3.1E+01	0	0.00	No	Not detected above risk criteria
Acenaphthene	SVOA	83329	mg/kg	78	399	0.20	2.6E+00	1.3E+01	9.7E-03	1.1E+02	3.4E+02	0	0.00	No	Not detected above risk criteria
Acenaphthylene	SVOA	208968	mg/kg	47	399	0.12	5.9E-01	1.8E+00	1.4E-02	1.1E+01	–	0	0.00	No	No available risk criteria

Table 1. ETTP Zone 1 DVS soil dataset – selection of chemicals of potential concern (continued)

Chemical	Analyte type	CAS number	Units	Number of detections	Number of samples	Fraction of samples with a detection	Mean of detections	Standard deviation of detections	Minimum detection	Maximum detection	Residential RSL	Number of detections over Residential RSL	Fraction of detections that exceed RSL	COPC?	Justification for COPC
Anthracene	SVOA	120127	mg/kg	110	399	0.28	5.0E+00	2.7E+01	1.9E-02	2.5E+02	1.7E+03	0	0.00	No	Not detected above risk criteria
Benz(*a*)anthracene	SVOA	56553	mg/kg	221	399	0.55	4.5E+00	2.2E+01	1.7E-02	2.1E+02	1.5E-01	101	0.46	Yes	Detected above risk criteria
Benzo(*a*)pyrene	SVOA	50328	mg/kg	211	397	0.53	3.8E+00	1.8E+01	1.5E-02	1.7E+02	1.5E-02	210	1.00	Yes	Detected above risk criteria
Benzo(*b*)fluoranthene	SVOA	205992	mg/kg	220	398	0.55	5.7E+00	2.6E+01	1.9E-02	2.7E+02	1.5E-01	126	0.57	Yes	Detected above risk criteria
Benzo(*g,h,i*)perylene	SVOA	191242	mg/kg	142	397	0.36	2.8E+00	9.7E+00	3.6E-02	9.5E+01	–	0	0.00	No	No available risk criteria
Benzo(*k*)fluoranthene	SVOA	207089	mg/kg	162	398	0.41	3.7E+00	1.6E+01	2.8E-02	1.6E+02	1.5E+00	35	0.22	Yes	Detected above risk criteria
Benzoic acid	SVOA	65850	mg/kg	3	389	0.01	1.2E+00	9.1E-01	2.1E-01	2.0E+00	2.4E+04	0	0.00	No	Not detected above risk criteria
Bis(2-ethylhexyl)phthalate	SVOA	117817	mg/kg	72	397	0.18	6.4E-01	1.8E+00	2.9E-02	1.4E+01	3.5E+01	0	0.00	No	Not detected above risk criteria
Butyl benzyl phthalate	SVOA	85687	mg/kg	7	397	0.02	2.6E-01	5.5E-01	3.1E-02	1.5E+00	2.6E+02	0	0.00	No	Not detected above risk criteria
Carbazole	SVOA	86748	mg/kg	85	389	0.22	2.2E+00	7.1E+00	2.3E-02	5.2E+01	–	0	0.00	No	No available risk criteria
Chrysene	SVOA	218019	mg/kg	199	399	0.50	4.4E+00	2.0E+01	1.8E-02	1.8E+02	1.5E+01	10	0.05	Yes	Detected above risk criteria
Di-n-butyl phthalate	SVOA	84742	mg/kg	18	394	0.05	1.6E-01	2.3E-01	2.4E-02	7.8E-01	6.1E+02	0	0.00	No	Not detected above risk criteria
Di-n-octylphthalate	SVOA	117840	mg/kg	6	383	0.02	3.8E-01	4.0E-01	7.6E-02	1.1E+00	–	0	0.00	No	No available risk criteria
Dibenz(*a,h*)anthracene	SVOA	53703	mg/kg	53	389	0.14	2.6E+00	7.6E+00	2.9E-02	5.1E+01	1.5E-02	53	1.00	Yes	Detected above risk criteria
Dibenzofuran	SVOA	132649	mg/kg	101	399	0.25	1.4E+00	5.9E+00	1.6E-02	4.8E+01	7.8E+00	4	0.04	Yes	Detected above risk criteria
Diethyl phthalate	SVOA	84662	mg/kg	7	399	0.02	3.1E+00	2.9E+00	2.0E-02	7.0E+00	4.9E+03	0	0.00	No	Not detected above risk criteria
Dimethyl phthalate	SVOA	131113	mg/kg	1	399	0.00	1.3E-01	–	1.3E-01	1.3E-01	–	0	0.00	No	No available risk criteria
Fluoranthene	SVOA	206440	mg/kg	239	399	0.60	9.1E+00	5.5E+01	1.4E-02	7.7E+02	2.3E+02	1	0.00	Yes	Detected above risk criteria
Fluorene	SVOA	86737	mg/kg	80	399	0.20	3.3E+00	1.6E+01	1.9E-02	1.3E+02	2.3E+02	0	0.00	No	Not detected above risk criteria
Indeno(1,2,3-cd)pyrene	SVOA	193395	mg/kg	127	396	0.32	2.8E+00	9.7E+00	3.5E-02	8.6E+01	1.5E-01	79	0.62	Yes	Detected above risk criteria
Isophorone	SVOA	78591	mg/kg	1	399	0.00	7.1E-02	–	7.1E-02	7.1E-02	5.1E+02	0	0.00	No	Not detected above risk criteria
Naphthalene	SVOA	91203	mg/kg	155	570	0.27	5.9E-01	2.2E+00	1.4E-03	1.8E+01	3.6E+00	4	0.03	Yes	Detected above risk criteria
Pentachlorophenol	SVOA	87865	mg/kg	1	398	0.00	1.3E+00	–	1.3E+00	1.3E+00	3.0E+00	0	0.00	No	Not detected above risk criteria
Phenanthrene	SVOA	85018	mg/kg	215	399	0.54	7.8E+00	4.6E+01	1.9E-02	5.1E+02	–	0	0.00	No	No available risk criteria
Phenol	SVOA	108952	mg/kg	3	399	0.01	1.3E-01	1.1E-01	3.4E-02	2.5E-01	1.8E+03	0	0.00	No	Not detected above risk criteria
Pyrene	SVOA	129000	mg/kg	209	399	0.52	7.7E+00	3.6E+01	2.6E-02	4.2E+02	1.7E+02	2	0.01	Yes	Detected above risk criteria
1-Methyl-4-(1-methylethyl)benzene	VOA	99876	mg/kg	3	170	0.02	1.7E-01	2.0E-01	2.0E-03	3.9E-01	–	0	0.00	No	No available risk criteria
2-Butanone	VOA	78933	mg/kg	2	194	0.01	1.0E-02	0.0E+00	1.0E-02	1.0E-02	2.8E+03	0	0.00	No	Not detected above risk criteria
Acetone	VOA	67641	mg/kg	13	176	0.07	9.0E-02	1.5E-01	1.0E-02	4.6E-01	6.1E+03	0	0.00	No	Not detected above risk criteria
Benzene	VOA	71432	mg/kg	4	194	0.02	9.3E-04	3.1E-04	5.9E-04	1.2E-03	1.1E+00	0	0.00	No	Not detected above risk criteria
Bromomethane	VOA	74839	mg/kg	1	194	0.01	2.0E-03	–	2.0E-03	2.0E-03	7.3E-01	0	0.00	No	Not detected above risk criteria
Carbon disulfide	VOA	75150	mg/kg	2	195	0.01	2.4E-03	1.8E-03	1.1E-03	3.7E-03	8.2E+01	0	0.00	No	Not detected above risk criteria
Chloroform	VOA	67663	mg/kg	1	195	0.01	3.3E-03	–	3.3E-03	3.3E-03	2.9E-01	0	0.00	No	Not detected above risk criteria
Ethylbenzene	VOA	100414	mg/kg	1	195	0.01	5.6E-04	–	5.6E-04	5.6E-04	5.4E+00	0	0.00	No	Not detected above risk criteria
Methylene chloride	VOA	75092	mg/kg	34	195	0.17	7.9E-02	1.3E-01	1.2E-03	4.7E-01	1.1E+01	0	0.00	No	Not detected above risk criteria
Styrene	VOA	100425	mg/kg	1	195	0.01	3.7E-03	–	3.7E-03	3.7E-03	6.3E+02	0	0.00	No	Not detected above risk criteria
Toluene	VOA	108883	mg/kg	13	195	0.07	6.4E-03	1.7E-02	4.1E-04	6.4E-02	5.0E+02	0	0.00	No	Not detected above risk criteria
Total Xylene	VOA	1330207	mg/kg	5	25	0.20	2.0E-03	1.0E-03	6.9E-04	3.2E-03	6.3E+01	0	0.00	No	Not detected above risk criteria
cis-1,2-Dichloroethene	VOA	156592	mg/kg	2	189	0.01	2.8E-04	8.5E-05	2.2E-04	3.4E-04	7.8E+01	0	0.00	No	Not detected above risk criteria
Actinium-228	RADS	14331830	pCi/g	249	253	0.98	2.6E+00	1.3E+01	2.2E-01	1.5E+02	6.8E+02	0	0.00	No	Not detected above risk criteria
Aluminum-26	RADS	14682667	pCi/g	14	16	0.88	1.3E-01	4.4E-02	6.5E-02	1.9E-01	–	0	0.00	No	No available risk criteria
Americium-241	RADS	14596102	pCi/g	6	10	0.60	1.0E+01	1.9E+01	1.2E-01	4.8E+01	1.8E+00	3	0.50	Yes	Detected above risk criteria
Antimony-125	RADS	14234356	pCi/g	1	1	1.00	7.1E-01	–	7.1E-01	7.1E-01	4.7E-01	1	1.00	Yes	Detected above risk criteria
Beryllium-7	RADS	13966024	pCi/g	1	1	1.00	1.7E+00	–	1.7E+00	1.7E+00	7.6E+01	0	0.00	No	Not detected above risk criteria
Bismuth-212	RADS	14913496	pCi/g	34	35	0.97	8.7E+00	2.3E+01	2.1E+00	1.3E+02	2.8E+03	0	0.00	No	Not detected above risk criteria
Bismuth-214	RADS	14733030	pCi/g	268	272	0.99	9.6E-01	4.4E-01	3.4E-01	3.2E+00	8.0E+03	0	0.00	No	Not detected above risk criteria
Cesium-134	RADS	13967709	pCi/g	2	6	0.33	9.6E-01	1.1E+00	1.8E-01	1.7E+00	1.6E-01	2	1.00	Yes	Detected above risk criteria
Cesium-137	RADS	10045973	pCi/g	136	380	0.36	2.2E+00	1.6E+01	1.9E-02	1.8E+02	6.2E-02	128	0.94	Yes	Detected above risk criteria
Cobalt-56	RADS	14093039	pCi/g	6	6	1.00	4.0E-01	8.8E-02	3.2E-01	5.3E-01	6.5E-01	0	0.00	No	Not detected above risk criteria
Cobalt-57	RADS	13981505	pCi/g	1	1	1.00	1.4E-01	–	1.4E-01	1.4E-01	8.1E+00	0	0.00	No	Not detected above risk criteria
Cobalt-58	RADS	13981389	pCi/g	1	1	1.00	1.8E-01	–	1.8E-01	1.8E-01	2.8E+00	0	0.00	No	Not detected above risk criteria
Europium-152	RADS	14683239	pCi/g	1	2	0.50	6.1E-01	–	6.1E-01	6.1E-01	4.1E-02	1	1.00	Yes	Detected above risk criteria

Table 1. ETTP Zone 1 DVS soil dataset – selection of chemicals of potential concern (continued)

Chemical	Analyte type	CAS number	Units	Number of detections	Number of samples	Fraction of samples with a detection	Mean of detections	Standard deviation of detections	Minimum detection	Maximum detection	Residential RSL	Number of detections over Residential RSL	Fraction of detections that exceed RSL	COPC?	Justification for COPC
Europium-155	RADS	14391163	pCi/g	8	8	1.00	2.9E+00	4.6E+00	3.2E-01	1.4E+01	3.6E+00	2	0.25	Yes	Detected above risk criteria
Lead-212	RADS	15092941	pCi/g	318	318	1.00	1.7E+00	7.1E+00	1.8E-01	1.2E+02	3.6E+03	0	0.00	No	Not detected above risk criteria
Lead-214	RADS	15067284	pCi/g	307	309	0.99	1.0E+00	4.6E-01	3.9E-01	3.3E+00	4.5E+04	0	0.00	No	Not detected above risk criteria
Manganese-54	RADS	13966319	pCi/g	1	1	1.00	2.3E+00	–	2.3E+00	2.3E+00	7.3E-01	1	1.00	Yes	Detected above risk criteria
Neptunium-237	RADS	13994202	pCi/g	52	362	0.14	5.8E-01	5.3E-01	3.8E-02	2.5E+00	1.2E-01	47	0.90	Yes	Detected above risk criteria
Niobium-94	RADS	14681631	pCi/g	2	2	1.00	2.0E-01	4.6E-02	1.7E-01	2.4E-01	1.6E-02	2	1.00	Yes	Detected above risk criteria
Niobium-95	RADS	13967765	pCi/g	20	20	1.00	3.9E+00	1.2E+01	2.0E-01	5.6E+01	7.1E+00	2	0.10	Yes	Detected above risk criteria
Plutonium-238	RADS	13981163	pCi/g	3	7	0.43	3.5E-01	2.3E-01	8.6E-02	5.2E-01	3.0E+00	0	0.00	No	Not detected above risk criteria
Plutonium-240	RADS	14119336	pCi/g	2	7	0.29	1.1E-01	3.2E-02	9.2E-02	1.4E-01	2.6E+00	0	0.00	No	Not detected above risk criteria
Potassium-40	RADS	13966002	pCi/g	335	354	0.95	1.1E+01	5.9E+00	1.9E+00	3.5E+01	1.2E-01	335	1.00	Yes	Detected above risk criteria
Protactinium-234m	RADS	15100284m	pCi/g	40	41	0.98	7.9E+02	3.4E+03	2.9E+01	2.2E+04	–	0	0.00	No	No available risk criteria
Protactinium-234m	RADS	378783767	pCi/g	9	22	0.41	1.5E+01	2.1E+01	1.3E+00	5.8E+01	–	0	0.00	No	No available risk criteria
Radium-226	RADS	13982633	pCi/g	360	376	0.96	1.1E+00	5.3E-01	1.4E-01	3.9E+00	1.2E-02	360	1.00	Yes	Detected above risk criteria
Silver-110m	RADS	14391765m	pCi/g	1	1	1.00	1.6E+00	–	1.6E+00	1.6E+00	–	0	0.00	No	No available risk criteria
Sodium-22	RADS	13966320	pCi/g	1	1	1.00	1.9E-01	–	1.9E-01	1.9E-01	9.0E-02	1	1.00	Yes	Detected above risk criteria
Technetium-99	RADS	14133767	pCi/g	80	328	0.24	6.9E+01	1.5E+02	3.0E-01	1.0E+03	2.6E-01	80	1.00	Yes	Detected above risk criteria
Thallium-208	RADS	14913509	pCi/g	221	225	0.98	6.4E-01	2.7E+00	1.8E-01	3.8E+01	2.3E+04	0	0.00	No	Not detected above risk criteria
Thorium-228	RADS	14274829	pCi/g	310	312	0.99	3.1E+00	2.4E+01	1.6E-01	4.2E+02	2.3E+01	3	0.01	Yes	Detected above risk criteria
Thorium-230	RADS	14269637	pCi/g	309	312	0.99	2.0E+00	7.5E+00	1.6E-01	1.2E+02	3.5E+00	12	0.04	Yes	Detected above risk criteria
Thorium-231	RADS	14932402	pCi/g	1	1	1.00	1.2E-01	–	1.2E-01	1.2E-01	2.9E+04	0	0.00	No	Not detected above risk criteria
Thorium-232	RADS	N2608	pCi/g	355	356	1.00	3.1E+00	2.8E+01	1.5E-01	5.3E+02	3.1E+00	7	0.02	Yes	Detected above risk criteria
Thorium-234	RADS	15065108	pCi/g	111	345	0.32	1.5E+02	9.2E+02	5.7E-01	9.5E+03	2.8E+02	5	0.05	Yes	Detected above risk criteria
Uranium-234	RADS	13966295	pCi/g	340	340	1.00	8.6E+01	1.2E+03	1.9E-01	2.1E+04	4.0E+00	79	0.23	Yes	Detected above risk criteria
Uranium-235	RADS	15117961	pCi/g	301	427	0.70	9.8E+00	9.0E+01	2.2E-02	1.4E+03	4.0E+00	50	0.17	Yes	Detected above risk criteria
Uranium-238	RADS	24678828	pCi/g	380	380	1.00	6.1E+01	8.2E+02	1.2E-01	1.6E+04	7.0E-01	347	0.91	Yes	Detected above risk criteria
Zinc-65	RADS	13982393	pCi/g	2	2	1.00	6.8E-01	1.0E-01	6.1E-01	7.5E-01	1.3E+00	0	0.00	No	Not detected above risk criteria

Notes:
The summary is based on analysis of the Zone 1 DVS soil dataset, utilizing samples collected from 0 to 2 feet below ground surface.
The risk criteria are the U. S. Environmental Protection Agency residential soil RSLs (for chemicals) and preliminary remediation goals [PRGs] (for radionuclides) at an incremental lifetime cancer risk (ILCR) of 1E-06 and hazard quotient (HQ) = 0.1.
Chemicals of potential concern (COPCs) are constituents detected at least once in soil at a concentration above the risk criteria. Constituents without risk criteria are eliminated from further quantitative analysis.
CAS = Chemical Abstracts Service.
DVS = Dynamic Verification Strategy.
ETTP = East Tennessee Technology Park.
PCB = polychlorinated biphenyl.
pCi/g = picocuries per gram.
RSL = Regional Screening Level.

Table 2. Exposure parameters for recreational receptors within Zone 1 soils

Parameter	Units	Adult exerciser	Child recreator
Incidental ingestion			
Soil ingestion rate	mg/day	50[a]	50[a]
Fraction ingested from area	unitless	1	1
Exposure frequency	days/year	104[b]	155[b]
Exposure duration	years	30[a]	12[a]
Body weight	kg	70[a]	45[a]
Carcinogen averaging time	days	25550[c]	25550[c]
Noncarcinogen averaging time	days	10950[c]	4015[c]
Dermal contact			
Skin area	m^2/event	0.53[e]	0.8[e]
Adherence factor	mg/cm^2	1[f]	0.03[f]
Absorption fraction	unitless	CS[g]	CS[g]
Exposure frequency	events/year	104[b]	155[b]
Exposure duration	years	30[a]	12[a]
Body weight	kg	70[a]	45[a]
Carcinogen averaging time	days	25550[c]	25550[c]
Noncarcinogen averaging time	days	10950[c]	4015[c]
Conversion Factor	$(kg\text{-}cm^2)/(mg\text{-}m^2)$	0.01	0.01
Inhalation of VOCs and dust			
Inhalation rate	m^3/hour	10	2
Particulate emission factor	m^3/kg	5.66E+09[h]	5.66E+08[g]
Volatilization factor	m^3/kg	CS[h]	CS[h]
Exposure time	hours/day	2	2.5
Exposure frequency	days/year	104[b]	155[b]
Exposure duration	years	30[a]	12[a]
Body weight	kg	70[a]	45[a]
Carcinogen averaging time	days	25550[c]	25550[c]
Non-carcinogen averaging time	days	10950[c]	4015[c]
External exposure to radionuclides			
Daily exposure fraction	unitless (hours/24 hours)	2/24	2.5/24
Yearly exposure fraction	unitless (days/365 days)	104/365[b]	155/365[b]
Exposure duration	years	30[a]	12[a]
Shielding factor	unitless	0	0

CS = contaminant-specific value.
EPA = U. S. Environmental Protection Agency.
VOC = volatile organic compound.
Source of parameter values:
[a] Adult values from EPA 1991a and child values ingestion from outdoor sources from EPA 2008.
[b] Assumed site-specific value of 2 days/week for the exerciser and 3 days/week for the recreator.
[c] Definition of averaging time (AT) per EPA 1989 (25,550 days for carcinogenic AT and exposure duration in years × 365 days/year for noncarcinogenic AT).
[d] Default values from EPA 2004.
[e] Adult values from EPA 1992 and child values from EPA 2008.
[f] Adult values are from EPA 2000 and child values calculated from EPA 2008.
[g] For the dermal absorption fraction, chemical-specific values from EPA 1992 are used; when chemical-specific values are not available, default values of 1% for organics and 0.1% for inorganics are used (EPA 2000).
[h] The particulate emissions factor (PEF) and soil volatilization factor (VF) are derived using methods found in the Soil Screening Guidance (EPA 1996), using site-specific parameter values for Atlanta, Georgia. The PEF is used for all contaminants; the VF is used only for VOCs. A PEF value of 5.66E+09 is equivalent to 0.2 $\mu g/m^3$ of dust.
[g] The particulate emissions factor (PEF) of 5.66E+08 is based on a dust loading of 2 $\mu g/m^3$, which is 10 times the wind-generated dust load.

Table 3. Carcinogenic toxicity data

Analysis	Oral SF (risk per mg/kg-d or pCi)	Oral unit risk (risk per mg/kg or pCi/g)	Inhalation SF (risk per mg/kg-d or pCi)	Inhalation unit risk (risk per mg/m^3 or pCi/m^3)	GI absorption factor (unitless)	Dermal absorption factor (unitless)	Dermal SF (risk per mg/kg-d or pCi)	External exposure SF (risk per pCi-yr/g)
Inorganics								
Arsenic, Inorganic	1.50E+00	5.00E-02	5.00E+01	4.30E+00	4.10E-01	1.00E-03	3.66E+00	–
Beryllium and compounds	–	–	8.40E+00	2.40E+00	1.00E-02	1.00E-03	–	–
Organics								
Aroclor 1254	2.00E+00	–	2.00E+00	5.71E-01	9.00E-01	6.00E-02	2.22E+00	–
Benzo(*a*)pyrene	7.30E+00	2.10E-01	3.10E+00	1.10E-03	3.10E-01	1.00E-02	2.35E+01	–
Trichloroethylene	5.90E-03	3.20E-04	4.00E-01	2.00E-06	1.50E-01	1.00E-02	2.67E+00	–
Radionuclides								
Cs-137+D	4.33E-11	–	1.19E-11	–	9.50E-01	–	–	2.55E-06
U-234	1.58E-10	–	1.14E-08	–	5.00E-02	–	–	2.52E-10
Ra-226+D	7.30E-10	–	1.16E-08	–	2.00E-01	–	–	8.49E-06
Np-237+D	1.62E-10	–	1.77E-08	–	1.00E-03	–	–	7.97E-07
U-235+D	1.63E-10	–	1.01E-08	–	5.00E-02	–	–	5.43E-07
Th-232	2.31E-10	–	4.33E-08	–	2.00E-04	–	–	3.42E-10
U-238+D	2.10E-10	–	9.35E-09	–	5.00E-02	–	–	1.14E-07

Notes:
GI = gastrointestinal.
mg/kg-d = milligrams per kilogram per day.
mg/m^3 = milligrams per cubic meter.
pCi/g = picocuries per gram.
pCi/m^3 = picocuries per cubic meter.
pCi-yr/g = picocuries per year per gram.
SF - Slope factor for carcinogenic effects.

Table 4. Inhalation toxicity data for non-carcinogens

Analysis	Particulate emission factor (m^3/kg)	Volatilization factor (m^3/kg)	Acute inhalation RfD (mg/kg-d)	Acute inhalation RfC (mg/m^3)	Chronic inhalation RfD (mg/kg-d)	Chronic inhalation RfC (mg/m^3)
Arsenic, Inorganic	5.38E+09	–	–	2.00E-04	–	1.50E-05
Beryllium and compounds	5.38E+09	–	6.00E-06	0.00E+00	5.71E-06	2.00E-05
Mercury, Inorganic Salts	5.38E+09	3.67E+04	–	6.00E-04	–	3.00E-04
Trichloroethylene	5.38E+09	3.61E+03	1.14E-02	1.07E+01	1.14E-02	6.00E-01

Notes:
m^3/kg = cubic meters per kilogram.
mg/kg-d = milligrams per kilogram per day.
mg/m^3 = milligrams per cubic meter.
RfD - Reference dose for toxic effects.
RfC - Reference concentration for toxic effects.
Where no acute toxicity values were available, chronic values were substituted in the evaluation.
Particulate emission factor was 5E+09 m^3/kg and 5E+08 m^3/kg for the adult exerciser and child recreator, respectively.

Table 5. Ingestion and dermal toxicity data for non-carcinogens

Analysis	Acute oral RfD (mg/kg-d)	Subchronic oral RfD (mg/kg-d)	Chronic oral RfD (mg-kg-d)	GI absorption factor (unitless)	Dermal absorption factor (unitless)	Acute dermal RfD (mg/kg-d)	Subchronic dermal RfD (mg/kg-d)	Chronic dermal RfD (mg/kg-d)
Inorganics								
Arsenic, Inorganic	5.00E-03	5.00E-03	3.00E-04	4.10E-01	1.00E-03	2.05E-03	2.05E-03	1.23E-04
Beryllium and compounds	5.00E-03	5.00E-03	2.00E-03	1.00E-02	1.00E-03	5.00E-05	5.00E-05	2.00E-05
Mercury, Inorganic Salts	2.00E-03	3.00E-03	3.00E-04	7.00E-02	1.00E-03	1.40E-04	2.10E-05	2.10E-05
Organics								
Aroclor 1254	5.00E-05	5.00E-05	2.00E-05	9.00E-01	6.00E-02	4.50E-05	4.50E-05	1.80E-05
Trichloroethylene	2.00E-01	–	3.00E-04	1.50E-01	1.00E-02	3.00E-02	–	4.50E-05

Notes:
GI = gastrointestinal.
ng/kg-d = milligrams per kilogram per day.
RfD - Reference dose for toxic effects.
RfC - Reference concentration for toxic effects.

Table 6. ETTP Zone 1 recreational action levels for COPCs

Constituent	Units	Selected recreational AL	Source of AL	Adult AL	Child AL
Chemicals					
Aluminum	mg/kg	1.8E+05	Child Non-Cancer	4.2E+05	1.8E+05
Antimony	mg/kg	3.9E+01	Child Non-Cancer	9.8E+01	3.9E+01
Arsenic	mg/kg	1.8E+00	Adult Cancer	1.8E+00	7.2E+00
Barium	mg/kg	1.4E+04	Child Non-Cancer	3.4E+04	1.4E+04
Benz(*a*)anthracene	mg/kg	1.1E+00	Adult Cancer	1.1E+00	1.0E+01
Benzo(*a*)pyrene	mg/kg	1.1E-01	Adult Cancer	1.1E-01	1.0E+00
Benzo(*b*)fluoranthene	mg/kg	1.1E+00	Adult Cancer	1.1E+00	1.0E+01
Benzo(*k*)fluoranthene	mg/kg	1.1E+01	Adult Cancer	1.1E+01	1.0E+02
Beryllium	mg/kg	2.7E+00	Adult Cancer	2.7E+00	2.9E+00
Cadmium	mg/kg	9.4E+01	Adult Non-Cancer	9.4E+01	1.6E+02
Chromium III, Soluble Salts	mg/kg	2.9E+05	Child Non-Cancer	7.4E+05	2.9E+05
Chrysene	mg/kg	1.1E+02	Adult Cancer	1.1E+02	1.0E+03
Cobalt	mg/kg	5.7E+01	Child Non-Cancer	1.4E+02	5.7E+01
Copper	mg/kg	7.8E+03	Child Non-Cancer	2.0E+04	7.8E+03
Dibenz(*a,h*)anthracene	mg/kg	1.1E-01	Adult Cancer	1.1E-01	1.0E+00
Dibenzofuran	mg/kg	7.8E+02	Child Non-Cancer	2.0E+03	7.8E+02
Fluoranthene	mg/kg	1.3E+04	Adult Non-Cancer	1.3E+04	4.8E+04
Indeno(*1,2,3-cd*)pyrene	mg/kg	1.1E+00	Adult Cancer	1.1E+00	1.0E+01
Lithium	mg/kg	3.9E+02	Child Non-Cancer	9.8E+02	3.9E+02
Manganese	mg/kg	–		–	–
Mercury	mg/kg	5.8E+01	Child Non-Cancer	1.5E+02	5.8E+01
Molybdenum	mg/kg	9.7E+02	Child Non-Cancer	2.5E+03	9.7E+02
Naphthalene	mg/kg	6.6E+02	Adult Non-Cancer	6.6E+02	2.4E+03
Nickel	mg/kg	3.9E+03	Child Non-Cancer	9.8E+03	3.9E+03
PCB-1248	mg/kg	3.6E-01	Adult Cancer	3.6E-01	3.7E+00
PCB-1254	mg/kg	3.6E-01	Adult Cancer	3.6E-01	3.7E+00
PCB-1260	mg/kg	3.6E-01	Adult Cancer	3.6E-01	3.7E+00
Phosphorous	mg/kg	3.9E+00	Child Non-Cancer	9.8E+00	3.9E+00
Polychlorinated biphenyl	mg/kg	3.6E-01	Adult Cancer	3.6E-01	3.7E+00
Pyrene	mg/kg	1.0E+04	Adult Non-Cancer	1.0E+04	3.6E+04
Silver	mg/kg	9.7E+02	Child Non-Cancer	2.5E+03	9.7E+02
Uranium	mg/kg	1.2E+02	Child Non-Cancer	2.9E+02	1.2E+02
Radionuclides					
Americium-241	pCi/g	2.2E+01	Adult Cancer	2.2E+01	3.5E+01
Antimony-125	pCi/g	1.3E+00	Adult Cancer	1.3E+00	1.7E+00
Cesium-134	pCi/g	3.3E-01	Adult Cancer	3.3E-01	4.4E-01
Cesium-137	pCi/g	9.2E-01	Adult Cancer	9.2E-01	1.2E+00
Europium-152	pCi/g	4.4E-01	Adult Cancer	4.4E-01	5.9E-01
Europium-155	pCi/g	1.9E+01	Adult Cancer	1.9E+01	2.5E+01
Manganese-54	pCi/g	6.0E-01	Adult Cancer	6.0E-01	8.1E-01
Neptunium-237	pCi/g	2.7E+00	Adult Cancer	2.7E+00	3.7E+00
Niobium-94	pCi/g	3.2E-01	Adult Cancer	3.2E-01	4.3E-01
Niobium-95	pCi/g	6.6E-01	Adult Cancer	6.6E-01	8.9E-01
Potassium-40	pCi/g	2.9E+00	Adult Cancer	2.9E+00	3.9E+00
Radium-226	pCi/g	2.7E-01	Adult Cancer	2.7E-01	3.6E-01
Sodium-22	pCi/g	2.3E-01	Adult Cancer	2.3E-01	3.0E-01
Technetium-99	pCi/g	8.1E+02	Adult Cancer	8.1E+02	1.4E+03
Thorium-228	pCi/g	2.1E+01	Adult Cancer	2.1E+01	3.5E+01
Thorium-230	pCi/g	3.1E+01	Adult Cancer	3.1E+01	5.2E+01
Thorium-232	pCi/g	2.8E+01	Adult Cancer	2.8E+01	4.6E+01
Thorium-234	pCi/g	2.1E+01	Adult Cancer	2.1E+01	2.8E+01

Table 6. ETTP Zone 1 recreational action levels for COPCs (continued)

Constituent	Units	Selected recreational AL	Source of AL	Adult AL	Child AL
Uranium-234	pCi/g	4.0E+01	Adult Cancer	4.0E+01	6.8E+01
Uranium-235	pCi/g	3.9E+01	Adult Cancer	3.9E+01	6.6E+01
Uranium-238	pCi/g	1.2E+01	Adult Cancer	1.2E+01	1.8E+01

Notes:

The list of COPCs is based on detected concentrations exceeding risk screening criteria (U. S. Environmental Protection Agency Regional Screening Level [RSL]/Preliminary Remediation Goals [PRGs]).

The recreational remediation levels (RLs) are based on the most conservative value, considering both adult and child exposures.

AL = action level.

COPC = contaminant of potential concern.

ETTP = East Tennessee Technology Park.

pCi/g = picocuries per gram.

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Table 7. ETTP Zone 1 DVS soil summary statistics for BORCE Group (0 to 2 ft)

Constituent	Frequency of detection	Units	Non-detect reporting limits[a]		Detected																				
			Min	Max	Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Min	Mean	Max	S.D.	Dist.	UCL 95	Adult RL	Detected freq. > adult RL	UCL95 > adult RL?	Child RL	Detected freq. > child RL	UCL95 > child RL?	Max RL	Detected freq. > max RL?	Back-ground	Detected freq. > bkgd
BORCE Group (0 to 2 ft)																									
Metals																									
Aluminum	107 / 107	mg/kg	–	–	2100	11,272	11,000	28,000	4569	2100	11,272	28,000	4569	G	12,061	415,514	0 / 107	No	181,199	0 / 107	No	1.8E+06	0 / 107	40,300	0 / 107
Antimony	101 / 107	mg/kg	0.025	5	0.013	0.33	0.089	6.9	1.11	0.013	0.346	6.9	1.15	X*	0.803	98.2	0 / 107	No	38.9	0 / 107	No	389	0 / 107	1.52	**4 / 107**
Arsenic	103 / 107	mg/kg	5	5	1.3	10.0	7.3	47	7.49	1.3	10.3	47	7.57	L*	11.3	1.83	**101 / 107**	**Yes**	7.2	**54 / 107**	**Yes**	18.3	**14 / 107**	15.0	**20 / 107**
Barium	107 / 107	mg/kg	–	–	16	70.1	52	480	60.0	16	70.1	480	60.0	X	95.4	33,960	0 / 107	No	13,531	0 / 107	No	135,309	0 / 107	125	**9 / 107**
Beryllium	107 / 107	mg/kg	–	–	0.084	0.538	0.46	2	0.345	0.084	0.538	2	0.345	L	0.598	2.67	0 / 107	No	2.88	0 / 107	No	26.7	0 / 107	2.2	0 / 107
Cadmium	107 / 107	mg/kg	–	–	0.045	1.18	0.93	4.9	0.983	0.045	1.18	4.9	0.983	X	1.6	93.8	0 / 107	No	163	0 / 107	No	938	0 / 107	0.22	**94 / 107**
Chromium	107 / 107	mg/kg	–	–	4.8	35.9	18	590	87.5	4.8	35.9	590	87.5	X	72.8	737,019	0 / 107	No	291,411	0 / 107	No	2.9E+06	0 / 107	44.9	**8 / 107**
Cobalt	107 / 107	mg/kg	–	–	1.6	12.5	8.4	320	30.7	1.6	12.5	320	30.7	X	25.5	141	**1 / 107**	No	57.3	**1 / 107**	No	573	0 / 107	42	**1 / 107**
Copper	107 / 107	mg/kg	–	–	2.2	14.2	8.7	300	29.2	2.2	14.2	300	29.2	X	26.5	19,654	0 / 107	No	7771	0 / 107	No	77,710	0 / 107	22.5	**11 / 107**
Lead	107 / 107	mg/kg	–	–	4.6	25.4	18	360	37.0	4.6	25.4	360	37.0	X	41.0	–	–	–	–	–	–	11,000	0 / 107	37.9	**11 / 107**
Lithium	102 / 102	mg/kg	–	–	1.9	11.0	8.1	55	9.91	1.9	11.0	55	9.91	L	13.0	983	0 / 102	No	389	0 / 102	No	3886	0 / 102	48.9	**1 / 102**
Mercury	101 / 102	mg/kg	0.017	0.017	0.009	0.195	0.065	6	0.68	0.009	0.197	6	0.686	X*	0.49	147	0 / 102	No	58.3	0 / 102	No	583	0 / 102	0.17	**8 / 102**
Molybdenum	77 / 107	mg/kg	0.1	1.1	0.05	0.903	0.5	24	2.34	0.12	1.17	24	2.73	X*	1.9	2457	0 / 107	No	971	0 / 107	No	9714	0 / 107	–	–
Nickel	107 / 107	mg/kg	–	–	2.8	15.8	10	350	33.8	2.8	15.8	350	33.8	X	30.1	9827	0 / 107	No	3885	0 / 107	No	38,855	0 / 107	26.1	**11 / 107**
Phosphorous	3 / 3	mg/kg	–	–	186	318	304	464	140	186	318	464	140	D	–	9.83	**3 / 3**	–	3.89	**3 / 3**	–	38.9	**3 / 3**	–	–
Silver	44 / 107	mg/kg	0.06	0.6	0.03	0.173	0.065	4.6	0.444	0.082	0.296	4.6	0.681	X*	0.363	2457	0 / 107	No	971	0 / 107	No	9714	0 / 107	0.6	**2 / 107**
Uranium	102 / 107	mg/kg	3	3	0.44	1.67	0.97	49	4.68	0.44	1.7	49	4.82	X*	3.65	295	0 / 107	No	117	0 / 107	No	1166	0 / 107	–	–
Polychlorinated biphenyls																									
PCB-1248	1 / 106	mg/kg	0.017	2.7	0.009	0.038	0.021	1.35	0.133	0.16	0.16	0.16	–	X	0.094	0.36	0 / 106	No	3.7	0 / 106	No	3.6	0 / 106	–	–
PCB-1254	19 / 106	mg/kg	0.017	0.081	0.009	0.345	0.021	28	2.75	0.011	1.85	28	6.44	X*	1.54	0.36	**3 / 106**	**Yes**	3.7	**2 / 106**	No	3.6	**2 / 106**	–	–
PCB-1260	12 / 106	mg/kg	0.017	2.7	0.005	0.02	0.021	1.35	0.037	0.005	0.077	0.32	0.091	X*	0.04	0.36	0 / 106	No	3.7	0 / 106	No	3.6	0 / 106	–	–
Polychlorinated biphenyl	13 / 19	mg/kg	0.017	0.064	0.009	1.8	0.054	28	6.28	0.01	2.63	28	7.75	X*	8.34	0.36	**2 / 19**	**Yes**	3.7	**2 / 19**	**Yes**	3.6	**2 / 19**	–	–
Semivolatile organics																									
Benz(*a*)anthracene	24 / 63	mg/kg	0.35	1.3	0.019	0.96	0.21	38	4.86	0.019	2.34	38	7.84	X*	3.69	1.06	**5 / 63**	**Yes**	10.4	**1 / 63**	No	10.6	**1 / 63**	–	–
Benzo(*a*)pyrene	24 / 63	mg/kg	0.35	1.3	0.016	0.813	0.21	31	3.98	0.016	1.97	31	6.42	X*	3.05	0.11	**11 / 63**	**Yes**	1.04	**5 / 63**	**Yes**	1.1	**5 / 63**	–	–
Benzo(*b*)fluoranthene	25 / 63	mg/kg	0.35	1.3	0.021	1.48	0.21	47	6.77	0.021	3.56	47	10.6	X*	5.27	1.06	**8 / 63**	**Yes**	10.4	**2 / 63**	No	10.6	**2 / 63**	–	–
Benzo(*k*)fluoranthene	19 / 63	mg/kg	0.35	1.3	0.028	0.627	0.215	19	2.62	0.028	1.79	19	4.68	X*	2.11	10.6	**1 / 63**	No	104	0 / 63	No	106	0 / 63	–	–
Chrysene	23 / 63	mg/kg	0.35	1.3	0.018	0.89	0.21	31	4.11	0.018	2.26	31	6.74	X*	3.2	106	0 / 63	No	1043	0 / 63	No	1063	0 / 63	–	–
Dibenz(*a,h*)anthracene	6 / 63	mg/kg	0.35	1.3	0.14	0.331	0.21	3.9	0.544	0.14	1.24	3.9	1.61	X*	0.68	0.11	**6 / 63**	**Yes**	1.04	**2 / 63**	No	1.1	**2 / 63**	–	–
Dibenzofuran	9 / 63	mg/kg	0.35	1.3	0.022	0.121	0.205	3.5	0.432	0.022	0.448	3.5	1.15	X*	0.384	1965	0 / 63	No	777	0 / 63	No	7771	0 / 63	–	–
Fluoranthene	26 / 63	mg/kg	0.35	1.3	0.014	2.13	0.21	83	10.9	0.014	5.01	83	16.8	X*	8.21	13,298	0 / 63	No	47,851	0 / 63	No	132,976	0 / 63	–	–
Indeno(*1,2,3-cd*)pyrene	14 / 63	mg/kg	0.35	1.3	0.035	0.442	0.21	12	1.63	0.035	1.58	12	3.32	X*	1.38	1.06	**3 / 63**	**Yes**	10.4	**1 / 63**	No	10.6	**1 / 63**	–	–
Naphthalene	10 / 81	mg/kg	0.005	1.3	0.003	0.098	0.195	3.4	0.387	0.029	0.506	3.4	1.06	X*	0.298	665	0 / 81	No	2389	0 / 81	No	6646	0 / 81	–	–
Pyrene	21 / 63	mg/kg	0.35	1.3	0.039	2.14	0.215	79	10.4	0.039	6.16	79	17.8	X*	8.0	9973	0 / 63	No	35,888	0 / 63	No	99,732	0 / 63	–	–
Radionuclides																									
Cesium-134	1 / 2	pCi/g	0.021	0.021	0.021	0.103	0.103	0.184	0.115	0.184	0.184	0.184	–	D	–	0.33	0 / 2	–	0.44	0 / 2	–	3.3	0 / 2	–	–
Cesium-137	21 / 72	pCi/g	-0.105	0.215	-0.105	0.222	0.109	1.32	0.242	0.108	0.499	1.32	0.312	L*	0.25	0.92	**1 / 72**	No	1.23	**1 / 72**	No	9.2	0 / 72	–	–
Neptunium-237	0 / 72	pCi/g	-0.047	0.051	-0.047	0.005	0.007	0.051	0.021	–	–	–	–	N	0.009	2.74	0 / 72	No	3.72	0 / 72	No	27.4	0 / 72	–	–
Potassium-40	63 / 72	pCi/g	0.809	15	0.809	9.41	8.94	24.2	5.81	1.92	10.3	24.2	5.62	G*	10.7	2.85	**61 / 72**	**Yes**	3.85	**57 / 72**	**Yes**	28.5	0 / 72	32.1	0 / 72
Radium-226	70 / 72	pCi/g	0.098	0.169	0.098	0.891	0.858	2.07	0.366	0.24	0.909	2.07	0.357	G*	0.977	0.27	**69 / 72**	**Yes**	0.36	**69 / 72**	**Yes**	2.7	0 / 72	1.25	**8 / 72**
Technetium-99	3 / 72	pCi/g	-1.35	5.65	-1.35	7.71	1.62	42	4.85	6.91	26.1	42	17.8	X*	10.8	813	0 / 72	No	1354	0 / 72	No	8132	0 / 72	–	–
Thorium-228	70 / 72	pCi/g	0.288	0.354	0.288	1.29	1.27	3.12	0.382	0.678	1.31	3.12	0.376	G*	1.38	21.0	0 / 72	No	34.9	0 / 72	No	210	0 / 72	1.86	**3 / 72**
Thorium-230	69 / 72	pCi/g	0.109	0.465	0.109	1.07	0.99	2.44	0.373	0.561	1.09	2.44	0.367	X*	1.26	31.4	0 / 72	No	52.5	0 / 72	No	314	0 / 72	1.2	**21 / 72**

Table 7. ETTP Zone 1 DVS soil summary statistics for BORCE Group (0 to 2 ft) - continued

Constituent	Frequency of detection	Units	Non-detect reporting limits[a]		Detected									UCL 95	Adult RL	Detected freq. > adult RL	UCL95 > adult RL?	Child RL	Detected freq. > child RL	UCL95 > child RL?	Max RL	Detected freq. > max RL?	Back-ground	Detected freq. > bkgd
			Min	Max	Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Min	Mean	Max	S.D.	Dist.											
Thorium-232	71 / 72	pCi/g	0.169	0.169	0.169	1.2	1.22	2.37	0.368	0.287	1.22	2.37	0.356	N*	1.28	27.6	0 / 72	No	46.3	0 / 72	No	276	0 / 72	1.95	3 / 72
Thorium-234	3 / 72	pCi/g	-1.79	4.31	-1.79	1.37	0.979	16.7	1.84	1.12	7	16.7	8.46	L*	1.47	20.5	0 / 72	No	27.5	0 / 72	No	205	0 / 72	--	--
Uranium-234	71 / 71	pCi/g	--	--	0.491	1.49	1.16	9.55	1.22	0.491	1.49	9.55	1.22	X	2.12	40.4	0 / 71	No	67.7	0 / 71	No	404	0 / 71	--	--
Uranium-235	34 / 71	pCi/g	-0.004	0.169	-0.004	0.146	0.092	0.952	0.183	0.045	0.253	0.952	0.222	L*	0.168	39.3	0 / 71	No	66.0	0 / 71	No	393	0 / 71	--	--
Uranium-238	72 / 72	pCi/g	--	--	0.612	1.48	1.14	17.2	1.96	0.612	1.48	17.2	1.96	X	2.48	12.3	1 / 72	No	17.9	0 / 72	No	123	0 / 72	1.47	16 / 72

[a] One-half of the reporting limits shown are used as proxy values for organics and inorganics. The reporting limits shown are used as proxy values for non-detect radionuclides.
[b] This summary statistic is calculated using both detects and non-detects. The Kaplan-Meier mean and standard deviation are reported for Kaplan-Meier UCL95.
Background values are from Table 4 from *Soil Background Supplemental Data Set for the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2105&D1).
Dist. = distribution. Distribution flags are defined as:
D = UCL95 is not calculated with fewer than five samples.
G = gamma; UCL95 is calculated using the adjusted or unadjusted gamma as described in ProUCL.
L = lognormal; UCL95 is calculated using Land's statistic or Chebyshev minimum variance unbiased estimator.
N = normal; UCL95 is calculated using t statistic.
X = neither normal, lognormal, nor gamma; UCL95 is calculated using a nonparametric bootstrap or the nonparametric Chebyshev inequality method.
BORCE = Black Oak Ridge Conservation Easement.
DVS = Dynamic Verification Strategy.
ETTP = East Tennessee Technology Park.
mg/kg = milligrams per kilogram.
pCi/g = picocuries per gram.
RL = remediation level. Recreational RL is the smaller of the adult and child RL. Max RL is 10 times the recreational RL.
S.D. = standard deviation.
UCL95 = upper confidence limit on the mean concentration with 95% confidence.
-- = Not applicable, not available, or insufficient data to calculate the statistic.
* Kaplan-Meier estimates of the overall mean, standard deviation, and UCL95 are shown for chemicals with both non-detects and at least two detects.

Table 8. ETTP Zone 1 DVS soil summary statistics for BORCE Group (2 to 10 ft)

Constituent	Frequency of detection	Units	Non-detect reporting limits[a]		Detected																				
			Min	Max	Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Min	Mean	Max	S.D.	Dist.	UCL 95	Adult RL	Detected freq. > adult RL	UCL95 > adult RL?	Child RL	Detected freq. > child RL	UCL95 > child RL?	Max RL	Detected freq. > max RL?	Back-ground	Detected freq. > bkgd
BORCE Group (2 to 10 ft)																									
Metals																									
Aluminum	242 / 242	mg/kg	--	--	1400	11,308	11,000	21,000	3467	1400	11,308	21,000	3467	X	12,280	415,514	0 / 242	No	181,199	0 / 242	No	1.8E+06	0 / 242	40,300	0 / 242
Antimony	228 / 239	mg/kg	0.008	0.063	0.004	0.23	0.096	6.5	0.544	0.008	0.239	6.5	0.556	X*	0.383	98.2	0 / 239	No	38.9	0 / 239	No	389	0 / 239	1.52	**5 / 239**
Arsenic	242 / 242	mg/kg	--	--	1.4	18.1	8.3	190	26.0	1.4	18.1	190	26.0	X	25.4	1.83	**238 / 242**	Yes	7.2	**141 / 242**	Yes	18.3	**57 / 242**	15.0	**74 / 242**
Barium	242 / 242	mg/kg	--	--	2	59.5	48	410	50.0	2	59.5	410	50.0	X	73.5	33,960	0 / 242	No	13,531	0 / 242	No	135,309	0 / 242	125	**19 / 242**
Beryllium	241 / 242	mg/kg	0.073	0.073	0.015	0.812	0.615	4	0.635	0.015	0.815	4	0.635	X*	0.99	2.67	**6 / 242**	No	2.88	**5 / 242**	No	26.7	0 / 242	2.2	**10 / 242**
Cadmium	232 / 242	mg/kg	0.046	0.076	0.023	1.12	1	4.5	0.807	0.032	1.16	4.5	0.793	X*	1.34	93.8	0 / 242	No	163	0 / 242	No	938	0 / 242	0.22	**210 / 242**
Chromium	242 / 242	mg/kg	--	--	2.6	22.7	18	430	31.0	2.6	22.7	430	31.0	X	31.4	737,019	0 / 242	No	291,411	0 / 242	No	2.9E+06	0 / 242	44.9	**9 / 242**
Cobalt	242 / 242	mg/kg	--	--	0.18	10.4	8.8	110	9.86	0.18	10.4	110	9.86	X	13.1	141	0 / 242	No	57.3	**2 / 242**	No	573	0 / 242	42	**2 / 242**
Copper	242 / 242	mg/kg	--	--	1.9	22.0	13	400	38.1	1.9	22.0	400	38.1	X	32.7	19,654	0 / 242	No	7771	0 / 242	No	77,710	0 / 242	22.5	**51 / 242**
Lead	242 / 242	mg/kg	--	--	1.3	21.4	16	140	15.7	1.3	21.4	140	15.7	X	25.8	--	--	--	--	--	--	11,000	0 / 242	37.9	**21 / 242**
Lithium	241 / 242	mg/kg	4.3	4.3	0.47	10.6	9.2	66	7.76	0.47	10.7	66	7.77	G*	11.4	983	0 / 242	No	389	0 / 242	No	3886	0 / 242	48.9	**1 / 242**
Mercury	226 / 242	mg/kg	0.032	0.18	0.004	0.142	0.08	4.6	0.358	0.004	0.147	4.6	0.37	X*	0.242	147	0 / 242	No	58.3	0 / 242	No	583	0 / 242	0.17	**30 / 242**
Molybdenum	138 / 242	mg/kg	0.095	1.6	0.048	1.12	0.445	15	1.83	0.13	1.82	15	2.19	X*	1.64	2457	0 / 242	No	971	0 / 242	No	9714	0 / 242	--	--
Nickel	241 / 241	mg/kg	--	--	1.3	18.9	13	190	20.0	1.3	18.9	190	20.0	X	24.5	9827	0 / 241	No	3885	0 / 241	No	38,855	0 / 241	26.1	**44 / 241**
Phosphorous	14 / 14	mg/kg	--	--	111	264	234	677	147	111	264	677	147	L	352	9.83	**14 / 14**	Yes	3.89	**14 / 14**	Yes	38.9	**14 / 14**	--	--
Silver	46 / 242	mg/kg	0.017	0.56	0.009	0.066	0.046	0.63	0.06	0.031	0.15	0.63	0.093	X*	0.088	2457	0 / 242	No	971	0 / 242	No	9714	0 / 242	0.6	**1 / 242**
Uranium	242 / 242	mg/kg	--	--	0.043	1.89	1.15	15	2.08	0.043	1.89	15	2.08	X	2.47	295	0 / 242	No	117	0 / 242	No	1166	0 / 242	--	--
Polychlorinated biphenyls																									
PCB-1248	5 / 237	mg/kg	0.019	2.1	0.01	0.125	0.021	10	0.815	0.037	4.19	10	4.28	X*	0.383	0.36	**4 / 237**	Yes	3.7	**2 / 237**	No	3.6	**2 / 237**	--	--
PCB-1254	40 / 237	mg/kg	0.019	1	0.008	0.099	0.021	11	0.751	0.008	0.519	11	1.79	X*	0.314	0.36	**6 / 237**	No	3.7	**1 / 237**	No	3.6	**1 / 237**	--	--
PCB-1260	40 / 237	mg/kg	0.019	2.1	0.005	0.027	0.021	1.05	0.052	0.005	0.093	0.56	0.101	X*	0.044	0.36	**1 / 237**	No	3.7	0 / 237	No	3.6	0 / 237	--	--
Polychlorinated biphenyl	7 / 44	mg/kg	0.019	0.1	0.01	0.247	0.011	10	1.49	0.014	1.47	10	3.76	X*	1.3	0.36	**1 / 44**	Yes	3.7	**1 / 44**	No	3.6	**1 / 44**	--	--
Semivolatile organics																									
Benz(*a*)anthracene	63 / 123	mg/kg	0.37	5.2	0.018	102	0.21	4400	512	0.018	199	4400	707	X*	305	1.06	**31 / 123**	Yes	10.4	**20 / 123**	Yes	10.6	**20 / 123**	--	--
Benzo(*a*)pyrene	64 / 123	mg/kg	0.37	5.2	0.015	83.2	0.21	3700	423	0.015	160	3700	581	X*	251	0.11	**40 / 123**	Yes	1.04	**27 / 123**	Yes	1.1	**26 / 123**	--	--
Benzo(*b*)fluoranthene	65 / 123	mg/kg	0.37	5.2	0.02	137	0.21	5900	702	0.02	259	5900	957	X*	415	1.06	**30 / 123**	Yes	10.4	**21 / 123**	Yes	10.6	**21 / 123**	--	--
Benzo(*k*)fluoranthene	51 / 123	mg/kg	0.37	5.2	0.026	55.4	0.21	2700	293	0.026	133	2700	448	X*	172	10.6	**17 / 123**	Yes	104	**10 / 123**	Yes	106	**10 / 123**	--	--
Chrysene	60 / 123	mg/kg	0.37	5.2	0.022	91.3	0.21	3900	457	0.022	187	3900	646	X*	272	106	**12 / 123**	Yes	1043	**3 / 123**	No	1063	**3 / 123**	--	--
Dibenz(*a,h*)anthracene	13 / 112	mg/kg	0.37	56	0.059	1.78	0.21	110	10.9	0.059	13.4	110	30.5	X*	6.45	0.11	**12 / 112**	Yes	1.04	**7 / 112**	Yes	1.1	**7 / 112**	--	--
Dibenzofuran	36 / 123	mg/kg	0.37	5.2	0.034	14.1	0.21	520	62.7	0.034	47.7	520	110	X*	39.1	1965	0 / 123	No	777	0 / 123	No	7771	0 / 123	--	--
Fluoranthene	65 / 123	mg/kg	0.37	5.2	0.017	240	0.22	10,000	1170	0.017	454	10,000	1592	X*	703	13,298	0 / 123	No	47,851	0 / 123	No	132,976	0 / 123	--	--
Indeno(*1,2,3-cd*)pyrene	44 / 123	mg/kg	0.37	5.2	0.034	39.2	0.21	1800	191	0.034	110	1800	311	X*	115	1.06	**25 / 123**	Yes	10.4	**16 / 123**	Yes	10.6	**16 / 123**	--	--
Naphthalene	52 / 170	mg/kg	0.005	0.49	0.002	12.1	0.205	490	52.9	0.008	39.5	490	90.8	X*	30.0	665	0 / 170	No	2389	0 / 170	No	6646	0 / 170	--	--
Pyrene	58 / 123	mg/kg	0.37	5.2	0.04	199	0.215	9100	996	0.04	422	9100	1431	X*	594	9973	0 / 123	No	35,888	0 / 123	No	99,732	0 / 123	--	--
Radionuclides																									
Cesium-137	10 / 89	pCi/g	-0.135	0.28	-0.135	0.148	0.014	0.933	0.155	0.103	0.503	0.933	0.284	L*	0.155	0.92	**1 / 89**	No	1.23	0 / 89	No	9.2	0 / 89	--	--
Europium-152	1 / 4	pCi/g	0.847	1.34	0.737	1.01	0.984	1.34	0.272	0.737	0.737	0.737	--	D	--	0.44	**1 / 4**	--	0.59	**1 / 4**	--	4.4	0 / 4	--	--
Neptunium-237	2 / 89	pCi/g	-0.059	0.053	-0.059	0.043	0.005	0.07	0.003	0.043	0.057	0.07	0.019	N*	0.044	2.74	0 / 89	No	3.72	0 / 89	No	27.4	0 / 89	--	--
Potassium-40	84 / 89	pCi/g	1.76	5.23	1.76	10.7	10.9	25.4	5.03	2.24	11.2	25.4	4.77	N*	11.6	2.85	**82 / 89**	Yes	3.85	**82 / 89**	Yes	28.5	0 / 89	32.1	0 / 89
Radium-226	86 / 89	pCi/g	-0.075	0.554	-0.075	1.44	1.06	5.71	1.1	0.258	1.47	5.71	1.1	X*	1.95	0.27	**85 / 89**	Yes	0.36	**85 / 89**	Yes	2.7	**11 / 89**	1.25	**33 / 89**
Technetium-99	10 / 89	pCi/g	-0.744	4.92	-0.744	3.37	1.6	77	8.54	1.67	16.8	77	22.3	X*	7.53	813	0 / 89	No	1354	0 / 89	No	8132	0 / 89	--	--
Thorium-228	86 / 89	pCi/g	0.322	1.26	0.322	1.49	1.29	4.41	0.765	0.354	1.52	4.41	0.762	L*	1.65	21.0	0 / 89	No	34.9	0 / 89	No	210	0 / 89	1.86	**18 / 89**
Thorium-230	85 / 89	pCi/g	0.289	0.946	0.289	1.79	1.27	7.19	1.44	0.443	1.85	7.19	1.45	X*	2.46	31.4	0 / 89	No	52.5	0 / 89	No	314	0 / 89	1.2	**47 / 89**

Table 8. ETTP Zone 1 DVS soil summary statistics for BORCE Group (2 to 10 ft) - continued

Constituent	Frequency of detection	Units	Non-detect reporting limits[a]		Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Detected				Dist.	UCL 95	Adult RL	Detected freq. > adult RL	UCL95 > adult RL?	Child RL	Detected freq. > child RL	UCL95 > child RL?	Max RL	Detected freq. > max RL?	Back-ground	Detected freq. > bkgd
			Min	Max						Min	Mean	Max	S.D.												
Thorium-232	87 / 89	pCi/g	0.128	0.836	0.128	1.41	1.22	3.82	0.714	0.156	1.43	3.82	0.707	X*	1.74	27.6	0 / 89	No	46.3	0 / 89	No	276	0 / 89	1.95	**14 / 89**
Thorium-234	14 / 89	pCi/g	-0.67	5.85	-0.67	2.98	1.59	23	3.18	2.11	7.58	23	6.48	X*	4.5	20.5	**1 / 89**	No	27.5	0 / 89	No	205	0 / 89	--	--
Uranium-234	89 / 89	pCi/g	--	--	0.518	3.12	1.47	40.8	5.37	0.518	3.12	40.8	5.37	X	5.6	40.4	**1 / 89**	No	67.7	0 / 89	No	404	0 / 89	--	--
Uranium-235	58 / 89	pCi/g	-0.018	0.388	-0.018	0.201	0.14	2.83	0.332	0.044	0.278	2.83	0.392	X*	0.356	39.3	0 / 89	No	66.0	0 / 89	No	393	0 / 89	--	--
Uranium-238	89 / 89	pCi/g	--	--	0.433	2.87	1.5	41.9	5.17	0.433	2.87	41.9	5.17	X	5.26	12.3	**3 / 89**	No	17.9	**2 / 89**	No	123	0 / 89	1.47	**45 / 89**

[a] One-half of the reporting limits shown are used as proxy values for organics and inorganics. The reporting limits shown are used as proxy values for non-detect radionuclides.
[b] This summary statistic is calculated using both detects and non-detects. The Kaplan-Meier mean and standard deviation are reported for Kaplan-Meier UCL95.
Background values are from Table 4 from *Soil Background Supplemental Data Set for the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2105&D1).
Dist. = distribution. Distribution flags are defined as:
D = UCL95 is not calculated with fewer than five samples.
G = gamma; UCL95 is calculated using the adjusted or unadjusted gamma as described in ProUCL.
L = lognormal; UCL95 is calculated using Land's statistic or Chebyshev minimum variance unbiased estimator.
N = normal; UCL95 is calculated using t statistic.
X = neither normal, lognormal, nor gamma; UCL95 is calculated using a nonparametric bootstrap or the nonparametric Chebyshev inequality method.
BORCE = Black Oak Ridge Conservation Easement.
DVS = Dynamic Verification Strategy.
ETTP = East Tennessee Technology Park.
mg/kg = milligrams per kilogram.
pCi/g = picocuries per gram.
RL = remediation level. Recreational RL is the smaller of the adult and child RL. Max RL is 10 times the recreational RL.
S.D. = standard deviation.
UCL95 = upper confidence limit on the mean concentration with 95% confidence.
-- = Not applicable, not available or insufficient data to calculate the statistic.
* Kaplan-Meier estimates of the overall mean, standard deviation, and UCL95 are shown for chemicals with both non-detects and at least two detects.

Table 9. ETTP Zone 1 DVS soil summary statistics for BORCE Group (> 10 ft)

Constituent	Frequency of detection	Units	Non-detect reporting limits[a] Min	Non-detect reporting limits[a] Max	Detected Min[b]	Detected Mean[b]	Detected Median[b]	Detected Max[b]	Detected S.D.[b]	Detected Min	Detected Mean	Detected Max	Detected S.D.	Dist.	UCL 95	Adult RL	Detected freq. > adult RL	UCL95 > adult RL?	Child RL	Detected freq. > child RL	UCL95 > child RL?	Max RL	Detected freq. > max RL?	Back-ground	Detected freq. > bkgd
BORCE Group (> 10 ft)																									
Metals																									
Aluminum	7 / 7	mg/kg	--	--	6300	8900	8400	13,000	2124	6300	8900	13,000	2124	N	10,460	415,514	0 / 7	No	181,199	0 / 7	No	1.8E+06	0 / 7	40,300	0 / 7
Antimony	7 / 7	mg/kg	--	--	0.16	0.3	0.32	0.52	0.145	0.16	0.3	0.52	0.145	N	0.406	98.2	0 / 7	No	38.9	0 / 7	No	389	0 / 7	1.52	0 / 7
Arsenic	7 / 7	mg/kg	--	--	11	24.9	20	41	11.3	11	24.9	41	11.3	N	33.2	1.83	7 / 7	Yes	7.2	7 / 7	Yes	18.3	4 / 7	15.0	6 / 7
Barium	7 / 7	mg/kg	--	--	5.9	23.9	11	71	24.7	5.9	23.9	71	24.7	L	96.7	33,960	0 / 7	No	13,531	0 / 7	No	135,309	0 / 7	125	0 / 7
Beryllium	7 / 7	mg/kg	--	--	0.23	0.521	0.49	1.1	0.31	0.23	0.521	1.1	0.31	N	0.749	2.67	0 / 7	No	2.88	0 / 7	No	26.7	0 / 7	2.2	0 / 7
Cadmium	7 / 7	mg/kg	--	--	0.65	1.14	1	1.8	0.453	0.65	1.14	1.8	0.453	N	1.47	93.8	0 / 7	No	163	0 / 7	No	938	0 / 7	0.22	7 / 7
Chromium	7 / 7	mg/kg	--	--	15	26	19	56	14.5	15	26	56	14.5	L	41.4	737,019	0 / 7	No	291,411	0 / 7	No	2.9E+06	0 / 7	44.9	1 / 7
Cobalt	7 / 7	mg/kg	--	--	1.5	8.64	8.5	19	5.66	1.5	8.64	19	5.66	N	12.8	141	0 / 7	No	57.3	0 / 7	No	573	0 / 7	42	0 / 7
Copper	7 / 7	mg/kg	--	--	5.4	19.9	18	38	11.1	5.4	19.9	38	11.1	N	28.1	19,654	0 / 7	No	7771	0 / 7	No	77,710	0 / 7	22.5	3 / 7
Lead	7 / 7	mg/kg	--	--	6.6	59.7	19	210	76.8	6.6	59.7	210	76.8	L	167	--	--	--	--	--	--	11,000	0 / 7	37.9	2 / 7
Lithium	7 / 7	mg/kg	--	--	1.6	5.64	4.5	11	3.43	1.6	5.64	11	3.43	N	8.16	983	0 / 7	No	389	0 / 7	No	3886	0 / 7	48.9	0 / 7
Mercury	6 / 7	mg/kg	0.12	0.12	0.06	0.162	0.12	0.29	0.076	0.1	0.172	0.29	0.085	N*	0.223	147	0 / 7	No	58.3	0 / 7	No	583	0 / 7	0.17	2 / 7
Molybdenum	7 / 7	mg/kg	--	--	0.82	1.7	1.9	2.5	0.643	0.82	1.7	2.5	0.643	N	2.18	2457	0 / 7	No	971	0 / 7	No	9714	0 / 7	--	--
Nickel	7 / 7	mg/kg	--	--	4.6	17.7	13	47	14.4	4.6	17.7	47	14.4	N	28.3	9827	0 / 7	No	3885	0 / 7	No	38,855	0 / 7	26.1	1 / 7
Silver	1 / 7	mg/kg	0.058	0.3	0.029	0.058	0.034	0.15	0.046	0.091	0.091	0.091	--	X	0.134	2457	0 / 7	No	971	0 / 7	No	9714	0 / 7	0.6	0 / 7
Uranium	7 / 7	mg/kg	--	--	0.82	2.33	2	4.3	1.38	0.82	2.33	4.3	1.38	N	3.35	295	0 / 7	No	117	0 / 7	No	1166	0 / 7	--	--
Polychlorinated biphenyls																									
PCB-1248	0 / 7	mg/kg	0.039	0.11	0.02	0.026	0.022	0.055	0.013	--	--	--	--	O	--	0.36	0 / 7	--	3.7	0 / 7	--	3.6	0 / 7	--	--
PCB-1254	1 / 7	mg/kg	0.039	0.046	0.02	0.044	0.022	0.18	0.06	0.18	0.18	0.18	--	X	0.143	0.36	0 / 7	No	3.7	0 / 7	No	3.6	0 / 7	--	--
PCB-1260	0 / 7	mg/kg	0.039	0.11	0.02	0.026	0.022	0.055	0.013	--	--	--	--	O	--	0.36	0 / 7	--	3.7	0 / 7	--	3.6	0 / 7	--	--
Semivolatile organics																									
Benz(*a*)anthracene	5 / 6	mg/kg	0.45	0.45	0.02	2.15	0.713	6.8	2.68	0.02	2.57	6.8	3.07	L*	10.1	1.06	3 / 6	Yes	10.4	0 / 6	No	10.6	0 / 6	--	--
Benzo(*a*)pyrene	4 / 6	mg/kg	0.45	0.45	0.033	1.41	0.553	4.7	1.77	0.033	2.1	4.7	2.08	N*	3.09	0.11	3 / 6	Yes	1.04	2 / 6	Yes	1.1	2 / 6	--	--
Benzo(*b*)fluoranthene	4 / 6	mg/kg	0.45	0.45	0.054	2.41	0.763	7.8	3.02	0.054	3.59	7.8	3.56	L*	9.84	1.06	3 / 6	Yes	10.4	0 / 6	No	10.6	0 / 6	--	--
Benzo(*k*)fluoranthene	3 / 6	mg/kg	0.4	0.45	0.2	1.03	0.373	2.3	0.736	0.52	1.54	2.3	0.918	L*	3.68	10.6	0 / 6	No	104	0 / 6	No	106	0 / 6	--	--
Chrysene	4 / 6	mg/kg	0.45	0.45	0.037	1.58	0.603	5.2	1.97	0.037	2.35	5.2	2.31	N*	3.45	106	0 / 6	No	1043	0 / 6	No	1063	0 / 6	--	--
Dibenz(*a,h*)anthracene	0 / 4	mg/kg	0.4	0.47	0.2	0.221	0.225	0.235	0.015	--	--	--	--	O	--	0.11	0 / 4	--	1.04	0 / 4	--	1.1	0 / 4	--	--
Dibenzofuran	3 / 6	mg/kg	0.4	0.45	0.2	0.53	0.225	1.4	0.482	0.2	0.86	1.4	0.609	X*	1.58	1965	0 / 6	No	777	0 / 6	No	7771	0 / 6	--	--
Fluoranthene	5 / 6	mg/kg	0.45	0.45	0.04	1.99	1.46	4.9	2.02	0.04	2.37	4.9	2.24	N*	3.84	13,298	0 / 6	No	47,851	0 / 6	No	132,976	0 / 6	--	--
Indeno(*1,2,3-cd*)pyrene	3 / 6	mg/kg	0.4	0.45	0.2	1.64	0.328	5.3	1.85	0.43	2.84	5.3	2.44	L*	3.9	1.06	2 / 6	Yes	10.4	0 / 6	No	10.6	0 / 6	--	--
Naphthalene	5 / 10	mg/kg	0.007	0.36	0.003	1.69	0.17	10	3.17	0.084	3.27	10	4.33	L*	3.63	665	0 / 10	No	2389	0 / 10	No	6646	0 / 10	--	--
Pyrene	4 / 6	mg/kg	0.45	0.45	0.081	5.59	1.76	18	6.97	0.081	8.35	18	8.17	L*	25.7	9973	0 / 6	No	35,888	0 / 6	No	99,732	0 / 6	--	--
Radionuclides																									
Cesium-137	0 / 7	pCi/g	-0.085	0.082	-0.085	-0.009	-0.013	0.082	0.054	--	--	--	--	N	0.031	0.92	0 / 7	No	1.23	0 / 7	No	9.2	0 / 7	--	--
Neptunium-237	0 / 7	pCi/g	-0.01	0.079	-0.01	0.012	-0.002	0.079	0.032	--	--	--	--	L	0.187	2.74	0 / 7	No	3.72	0 / 7	No	27.4	0 / 7	--	--
Potassium-40	6 / 7	pCi/g	1.55	1.55	1.55	6.79	5.19	15.2	3.7	3.69	7.3	15.2	4.11	N*	9.76	2.85	6 / 7	Yes	3.85	5 / 7	Yes	28.5	0 / 7	32.1	0 / 7
Radium-226	7 / 7	pCi/g	--	--	0.627	1.89	1.64	4.15	1.17	0.627	1.89	4.15	1.17	N	2.75	0.27	7 / 7	Yes	0.36	7 / 7	Yes	2.7	1 / 7	1.25	4 / 7
Technetium-99	0 / 7	pCi/g	-0.212	0.372	-0.212	0.016	-0.129	0.372	0.229	--	--	--	--	N	0.184	813	0 / 7	No	1354	0 / 7	No	8132	0 / 7	--	--
Thorium-228	7 / 7	pCi/g	--	--	0.945	1.5	1.15	3.09	0.763	0.945	1.5	3.09	0.763	L	2.25	21.0	0 / 7	No	34.9	0 / 7	No	210	0 / 7	1.86	1 / 7
Thorium-230	7 / 7	pCi/g	--	--	1.08	2.57	2.11	6.4	1.82	1.08	2.57	6.4	1.82	L	4.99	31.4	0 / 7	No	52.5	0 / 7	No	314	0 / 7	1.2	6 / 7
Thorium-232	7 / 7	pCi/g	--	--	0.892	1.49	1.18	3.16	0.811	0.892	1.49	3.16	0.811	L	2.31	27.6	0 / 7	No	46.3	0 / 7	No	276	0 / 7	1.95	1 / 7
Thorium-234	0 / 7	pCi/g	1.36	5.9	1.36	2.27	1.68	5.9	1.63	--	--	--	--	X	4.95	20.5	0 / 7	No	27.5	0 / 7	No	205	0 / 7	--	--

Table 9. ETTP Zone 1 DVS soil summary statistics for BORCE Group (> 10 ft) - continued

Constituent	Frequency of detection	Units	Non-detect reporting limits[a]		Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Detected				Dist.	UCL 95	Adult RL	Detected freq. > adult RL	UCL95 > adult RL?	Child RL	Detected freq. > child RL	UCL95 > child RL?	Max RL	Detected freq. > max RL?	Back-ground	Detected freq. > bkgd
			Min	Max						Min	Mean	Max	S.D.												
Uranium-234	7 / 7	pCi/g	--	--	1.16	2.31	2.15	5.14	1.38	1.16	2.31	5.14	1.38	N	3.32	40.4	0 / 7	No	67.7	0 / 7	No	404	0 / 7	--	--
Uranium-235	4 / 7	pCi/g	0.023	0.253	0.023	0.141	0.121	0.253	0.031	0.12	0.152	0.195	0.038	N*	0.169	39.3	0 / 7	No	66.0	0 / 7	No	393	0 / 7	--	--
Uranium-238	7 / 7	pCi/g	--	--	1.2	2.26	1.88	5.34	1.43	1.2	2.26	5.34	1.43	L	3.78	12.3	0 / 7	No	17.9	0 / 7	No	123	0 / 7	1.47	5 / 7

[a] One-half of the reporting limits shown are used as proxy values for organics and inorganics. The reporting limits shown are used as proxy values for non-detect radionuclides.
[b] This summary statistic is calculated using both detects and non-detects. The Kaplan-Meier mean and standard deviation are reported for Kaplan-Meier UCL95.
Background values are from Table 4 from *Soil Background Supplemental Data Set for the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2105&D1).
Dist. = distribution. Distribution flags are defined as:
L = lognormal; UCL95 is calculated using Land's statistic or Chebyshev minimum variance unbiased estimator.
N = normal; UCL95 is calculated using t statistic.
O = no detected results to calculate some summary statistics.
X = neither normal, lognormal, nor gamma; UCL95 is calculated using a nonparametric bootstrap or the nonparametric Chebyshev inequality method.
BORCE = Black Oak Ridge Conservation Easement.
DVS = Dynamic Verification Strategy.
ETTP = East Tennessee Technology Park.
mg/kg = milligrams per kilogram.
pCi/g = picocuries per gram.
RL = remediation level. Recreational RL is the smaller of the adult and child RL. Max RL is 10 times the recreational RL.
S.D. = standard deviation.
UCL95 = upper confidence limit on the mean concentration with 95% confidence.
-- = Not applicable, not available or insufficient data to calculate the statistic.
* Kaplan-Meier estimates of the overall mean, standard deviation, and UCL95 are shown for chemicals with both non-detects and at least two detects.

Table 10. ETTP Zone 1 DVS soil summary statistics for Blair Quarry Group (0 to 2 ft)

Constituent	Frequency of detection	Units	Non-detect reporting limits[a]		Detected																				
			Min	Max	Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Min	Mean	Max	S.D.	Dist.	UCL 95	Adult RL	Detected freq. > adult RL	UCL95 > adult RL?	Child RL	Detected freq. > child RL	UCL95 > child RL?	Max RL	Detected freq. > max RL?	Back-ground	Detected freq. > bkgd
Blair Quarry Group (0 to 2 ft)																									
Metals																									
Aluminum	9 / 9	mg/kg	--	--	1000	7311	8500	16,000	4900	1000	7311	16,000	4900	N	10,349	415,514	0 / 9	No	181,199	0 / 9	No	1.8E+06	0 / 9	40,300	0 / 9
Antimony	6 / 9	mg/kg	0.02	0.048	0.01	0.444	0.26	1.5	0.402	0.22	0.557	1.5	0.496	L*	1.37	98.2	0 / 9	No	38.9	0 / 9	No	389	0 / 9	1.52	0 / 9
Arsenic	9 / 32	mg/kg	75	75	1.9	23.2	37.5	57	19.7	1.9	23.2	57	20.9	X*	53.6	1.83	**9 / 32**	**Yes**	7.2	**6 / 32**	**Yes**	18.3	**4 / 32**	15.0	**4 / 32**
Barium	9 / 32	mg/kg	2000	2000	27	116	1000	1000	146	27	116	520	155	X*	341	33,960	0 / 32	No	13,531	0 / 32	No	135,309	0 / 32	125	**1 / 32**
Beryllium	9 / 32	mg/kg	500	500	0.28	0.577	250	250	0.227	0.28	0.577	0.98	0.241	X*	0.927	2.67	0 / 32	No	2.88	0 / 32	No	26.7	0 / 32	2.2	0 / 32
Cadmium	9 / 32	mg/kg	20	20	0.15	1.24	10	10	1.48	0.15	1.24	5.2	1.57	X*	3.52	93.8	0 / 32	No	163	0 / 32	No	938	0 / 32	0.22	**7 / 32**
Chromium	14 / 32	mg/kg	100	100	3.9	64.8	50	471	100	3.9	111	471	140	X*	148	737,019	0 / 32	No	291,411	0 / 32	No	2.9E+06	0 / 32	44.9	**7 / 32**
Cobalt	9 / 9	mg/kg	--	--	2.6	19.2	14	50	17.0	2.6	19.2	50	17.0	N	29.7	141	0 / 9	No	57.3	0 / 9	No	573	0 / 9	42	**1 / 9**
Copper	9 / 9	mg/kg	--	--	4.8	97.9	28	550	178	4.8	97.9	550	178	L	268	19,654	0 / 9	No	7771	0 / 9	No	77,710	0 / 9	22.5	**5 / 9**
Lead	11 / 32	mg/kg	100	100	4.1	739	50	22,000	3819	4.1	2101	22,000	6601	X*	3826	--	--	--	--	--	--	11,000	**1 / 32**	37.9	**6 / 32**
Lithium	9 / 9	mg/kg	--	--	2.2	7.96	8.1	16	5.34	2.2	7.96	16	5.34	N	11.3	983	0 / 9	No	389	0 / 9	No	3886	0 / 9	48.9	0 / 9
Mercury	9 / 32	mg/kg	150	150	0.002	2.11	75	75	3.25	0.002	2.11	10	3.44	X*	7.12	147	0 / 32	No	58.3	0 / 32	No	583	0 / 32	0.17	**4 / 32**
Molybdenum	7 / 9	mg/kg	0.17	0.17	0.085	2.43	1.1	8	2.55	0.29	3.05	8	2.79	N*	4.14	2457	0 / 9	No	971	0 / 9	No	9714	0 / 9	--	--
Nickel	9 / 9	mg/kg	--	--	4.9	166	41	700	274	4.9	166	700	274	L	510	9827	0 / 9	No	3885	0 / 9	No	38,855	0 / 9	26.1	**6 / 9**
Silver	1 / 32	mg/kg	0.053	100	0.027	36.4	50	50	22.3	13	13	13	--	X	53.5	2457	0 / 32	No	971	0 / 32	No	9714	0 / 32	0.6	**1 / 32**
Uranium	9 / 9	mg/kg	--	--	0.28	10.5	2.3	76	24.6	0.28	10.5	76	24.6	L	25.3	295	0 / 9	No	117	0 / 9	No	1166	0 / 9	--	--
Polychlorinated biphenyls																									
PCB-1248	0 / 9	mg/kg	0.034	1.4	0.017	0.118	0.022	0.7	0.227	--	--	--	--	O	--	0.36	0 / 9	--	3.7	0 / 9	--	3.6	0 / 9	--	--
PCB-1254	0 / 32	mg/kg	0.034	2.5	0.017	0.932	1.25	1.25	0.53	--	--	--	--	O	--	0.36	0 / 32	--	3.7	0 / 32	--	3.6	0 / 32	--	--
PCB-1260	8 / 32	mg/kg	0.042	2.5	0.011	0.577	1.25	1.8	0.716	0.011	0.718	1.8	0.786	X*	1.63	0.36	**4 / 32**	**Yes**	3.7	0 / 32	No	3.6	0 / 32	--	--
Semivolatile organics																									
Benz(*a*)anthracene	9 / 13	mg/kg	0.42	0.47	0.039	2.2	0.35	9.5	3.25	0.039	3.09	9.5	3.77	L*	7.92	1.06	**6 / 13**	**Yes**	10.4	0 / 13	No	10.6	0 / 13	--	--
Benzo(*a*)pyrene	10 / 13	mg/kg	0.42	0.47	0.028	2.09	0.54	9.7	2.93	0.028	2.69	9.7	3.27	L*	8.95	0.11	**8 / 13**	**Yes**	1.04	**5 / 13**	**Yes**	1.1	**5 / 13**	--	--
Benzo(*b*)fluoranthene	10 / 13	mg/kg	0.42	0.47	0.045	3.25	0.74	13	4.37	0.045	4.17	13	4.85	L*	14.0	1.06	**6 / 13**	**Yes**	10.4	**2 / 13**	**Yes**	10.6	**2 / 13**	--	--
Benzo(*k*)fluoranthene	8 / 13	mg/kg	0.35	0.47	0.14	1.05	0.25	4.3	1.36	0.14	1.58	4.3	1.61	X*	2.81	10.6	0 / 13	No	104	0 / 13	No	106	0 / 13	--	--
Chrysene	9 / 13	mg/kg	0.42	0.47	0.038	2.07	0.34	9.4	3.11	0.038	2.91	9.4	3.63	L*	7.25	106	0 / 13	No	1043	0 / 13	No	1063	0 / 13	--	--
Dibenz(*a,h*)anthracene	3 / 13	mg/kg	0.35	3.2	0.13	0.295	0.235	1.6	0.356	0.13	0.733	1.2	0.548	X*	0.868	0.11	**3 / 13**	**Yes**	1.04	**1 / 13**	No	1.1	**1 / 13**	--	--
Dibenzofuran	7 / 13	mg/kg	0.35	0.47	0.016	0.22	0.215	1.2	0.317	0.016	0.32	1.2	0.428	L*	0.617	1965	0 / 13	No	777	0 / 13	No	7771	0 / 13	--	--
Fluoranthene	10 / 13	mg/kg	0.42	0.47	0.071	4.64	0.71	26	7.39	0.071	5.97	26	8.39	L*	17.1	13,298	0 / 13	No	47,851	0 / 13	No	132,976	0 / 13	--	--
Indeno(*1,2,3-cd*)pyrene	7 / 13	mg/kg	0.35	0.47	0.175	2.57	0.41	14	3.76	0.41	4.42	14	4.69	X*	7.48	1.06	**5 / 13**	**Yes**	10.4	**1 / 13**	No	10.6	**1 / 13**	--	--
Naphthalene	7 / 13	mg/kg	0.35	0.47	0.035	0.238	0.22	0.74	0.19	0.035	0.283	0.74	0.242	X*	0.526	665	0 / 13	No	2389	0 / 13	No	6646	0 / 13	--	--
Pyrene	10 / 13	mg/kg	0.42	0.47	0.062	5.67	1.1	28	8.72	0.062	7.32	28	9.84	L*	24.6	9973	0 / 13	No	35,888	0 / 13	No	99,732	0 / 13	--	--
Radionuclides																									
Cesium-137	38 / 50	pCi/g	-0.04	0.214	-0.04	0.423	0.212	5.36	0.801	0.05	0.54	5.36	0.9	L*	0.585	0.92	**4 / 50**	No	1.23	**3 / 50**	No	9.2	0 / 50	--	--
Neptunium-237	33 / 50	pCi/g	-0.49	0.51	-0.49	0.626	0.43	2.5	0.49	0.33	0.778	2.5	0.553	X*	0.933	2.74	0 / 50	No	3.72	0 / 50	No	27.4	0 / 50	--	--
Potassium-40	45 / 45	pCi/g	--	--	2.55	10.7	8.71	29.5	7.04	2.55	10.7	29.5	7.04	L	13.3	2.85	**43 / 45**	**Yes**	3.85	**37 / 45**	**Yes**	28.5	**2 / 45**	32.1	0 / 45
Radium-226	44 / 50	pCi/g	0.01	0.46	0.01	1.07	1.01	3.23	0.726	0.14	1.19	3.23	0.696	G*	1.3	0.27	**42 / 50**	**Yes**	0.36	**41 / 50**	**Yes**	2.7	**2 / 50**	1.25	**16 / 50**
Technetium-99	4 / 8	pCi/g	0.59	1.35	0.59	1.93	1.37	3.67	0.858	1.39	2.46	3.67	1.1	N*	2.59	813	0 / 8	No	1354	0 / 8	No	8132	0 / 8	--	--
Thorium-232	46 / 46	pCi/g	--	--	0.26	0.961	0.83	2.6	0.478	0.26	0.961	2.6	0.478	L	1.1	27.6	0 / 46	No	46.3	0 / 46	No	276	0 / 46	1.95	**2 / 46**
Thorium-234	13 / 22	pCi/g	-0.42	2.96	-0.42	2.87	2.18	10.4	2.48	0.9	4.18	10.4	2.58	G*	3.95	20.5	0 / 22	No	27.5	0 / 22	No	205	0 / 22	--	--

Table 10. ETTP Zone 1 DVS soil summary statistics for Blair Quarry Group (0 to 2 ft) - continued

Constituent	Frequency of detection	Units	Non-detect reporting limits[a]		Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Detected				Dist.	UCL 95	Adult RL	Detected freq. > adult RL	UCL95 > adult RL?	Child RL	Detected freq. > child RL	UCL95 > child RL?	Max RL	Detected freq. > max RL?	Back-ground	Detected freq. > bkgd
			Min	Max						Min	Mean	Max	S.D.												
Uranium-234	50 / 50	pCi/g	--	--	0.19	3.07	1.17	25.9	5.19	0.19	3.07	25.9	5.19	L	4.14	40.4	0 / 50	No	67.7	0 / 50	No	404	0 / 50	--	--
Uranium-235	37 / 50	pCi/g	0.02	0.05	0.02	0.217	0.12	1.87	0.326	0.022	0.286	1.87	0.359	L*	0.325	39.3	0 / 50	No	66.0	0 / 50	No	393	0 / 50	--	--
Uranium-238	50 / 50	pCi/g	--	--	0.12	2.15	0.8	23.3	3.73	0.12	2.15	23.3	3.73	L	3.02	12.3	1 / 50	No	17.9	1 / 50	No	123	0 / 50	1.47	18 / 50

[a] One-half of the reporting limits shown are used as proxy values for organics and inorganics. The reporting limits shown are used as proxy values for non-detect radionuclides.
[b] This summary statistic is calculated using both detects and non-detects. The Kaplan-Meier mean and standard deviation are reported for Kaplan-Meier UCL95.
Background values are from Table 4 from *Soil Background Supplemental Data Set for the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2105&D1).
Dist. = distribution. Distribution flags are defined as:
G = gamma; UCL95 is calculated using the adjusted or unadjusted gamma as described in ProUCL.
L = lognormal; UCL95 is calculated using Land's statistic or Chebyshev minimum variance unbiased estimator.
N = normal; UCL95 is calculated using t statistic.
O = no detected results to calculate some summary statistics.
X = neither normal, lognormal, nor gamma; UCL95 is calculated using a nonparametric bootstrap or the nonparametric Chebyshev inequality method.
DVS = Dynamic Verification Strategy.
ETTP = East Tennessee Technology Park.
mg/kg = milligrams per kilogram.
pCi/g = picocuries per gram.
RL = remediation level. Recreational RL is the smaller of the adult and child RL. Max RL is 10 times the recreational RL.
S.D. = standard deviation.
UCL95 = upper confidence limit on the mean concentration with 95% confidence.
-- = Not applicable, not available or insufficient data to calculate the statistic.
* Kaplan-Meier estimates of the overall mean, standard deviation, and UCL95 are shown for chemicals with both non-detects and at least two detects.

Table 11. ETTP Zone 1 DVS soil summary statistics for Blair Quarry Group (2 to 10 ft)

Constituent	Frequency of detection	Units	Non-detect reporting limits[a]		Detected																				
			Min	Max	Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Min	Mean	Max	S.D.	Dist.	UCL 95	Adult RL	Detected freq. > adult RL	UCL95 > adult RL?	Child RL	Detected freq. > child RL	UCL95 > child RL?	Max RL	Detected freq. > max RL?	Back-ground	Detected freq. > bkgd
Blair Quarry Group (2 to 10 ft)																									
Metals																									
Aluminum	4 / 4	mg/kg	--	--	11,000	14,500	15,000	17,000	2646	11,000	14,500	17,000	2646	D	--	415,514	0 / 4	--	181,199	0 / 4	--	1.8E+06	0 / 4	40,300	0 / 4
Antimony	4 / 4	mg/kg	--	--	0.16	0.45	0.385	0.87	0.299	0.16	0.45	0.87	0.299	D	--	98.2	0 / 4	--	38.9	0 / 4	--	389	0 / 4	1.52	0 / 4
Arsenic	5 / 18	mg/kg	75	75	2.8	22.6	37.5	72	26.2	2.8	22.6	72	29.3	X*	79.7	1.83	**5 / 18**	**Yes**	7.2	**2 / 18**	**Yes**	18.3	**2 / 18**	15.0	**2 / 18**
Barium	4 / 18	mg/kg	2000	2000	43	55.8	1000	1000	11.0	43	55.8	72	12.7	X*	83.4	33,960	0 / 18	No	13,531	0 / 18	No	135,309	0 / 18	125	0 / 18
Beryllium	4 / 18	mg/kg	500	500	0.83	1.16	250	250	0.206	0.83	1.16	1.4	0.238	X*	1.68	2.67	0 / 18	No	2.88	0 / 18	No	26.7	0 / 18	2.2	0 / 18
Cadmium	5 / 18	mg/kg	20	20	0.94	4.01	10	13	4.55	0.94	4.01	13	5.08	X*	13.9	93.8	0 / 18	No	163	0 / 18	No	938	0 / 18	0.22	**5 / 18**
Chromium	5 / 18	mg/kg	100	100	13	36.2	50	76	25.0	13	36.2	76	28.0	X*	90.7	737,019	0 / 18	No	291,411	0 / 18	No	2.9E+06	0 / 18	44.9	**2 / 18**
Cobalt	4 / 4	mg/kg	--	--	12	34.5	13	100	43.7	12	34.5	100	43.7	D	--	141	0 / 4	--	57.3	**1 / 4**	--	573	0 / 4	42	**1 / 4**
Copper	4 / 4	mg/kg	--	--	18	50.5	27	130	53.2	18	50.5	130	53.2	D	--	19,654	0 / 4	--	7771	0 / 4	--	77,710	0 / 4	22.5	**3 / 4**
Lead	7 / 18	mg/kg	100	100	12	120	50	1020	238	12	255	1020	366	X*	386	--	--	--	--	--	--	11,000	0 / 18	37.9	**4 / 18**
Lithium	4 / 4	mg/kg	--	--	9.3	11.1	11	13	1.72	9.3	11.1	13	1.72	D	--	983	0 / 4	--	389	0 / 4	--	3886	0 / 4	48.9	0 / 4
Mercury	4 / 18	mg/kg	150	150	0.036	0.108	75	75	0.07	0.036	0.108	0.2	0.08	X*	0.283	147	0 / 18	No	58.3	0 / 18	No	583	0 / 18	0.17	**1 / 18**
Molybdenum	4 / 4	mg/kg	--	--	0.44	1.42	0.72	3.8	1.59	0.44	1.42	3.8	1.59	D	--	2457	0 / 4	--	971	0 / 4	--	9714	0 / 4	--	--
Nickel	4 / 4	mg/kg	--	--	13	46.8	37	100	39.5	13	46.8	100	39.5	D	--	9827	0 / 4	--	3885	0 / 4	--	38,855	0 / 4	26.1	**2 / 4**
Silver	0 / 18	mg/kg	0.071	100	0.036	38.9	50	50	21.4	--	--	--	--	O	--	2457	0 / 18	--	971	0 / 18	--	9714	0 / 18	0.6	0 / 18
Uranium	4 / 4	mg/kg	--	--	1.8	17.1	7.35	52	23.6	1.8	17.1	52	23.6	D	--	295	0 / 4	--	117	0 / 4	--	1166	0 / 4	--	--
Polychlorinated biphenyls																									
PCB-1248	0 / 4	mg/kg	0.039	0.046	0.02	0.022	0.022	0.023	0.001	--	--	--	--	O	--	0.36	0 / 4	--	3.7	0 / 4	--	3.6	0 / 4	--	--
PCB-1254	0 / 18	mg/kg	0.039	2.5	0.02	0.977	1.25	1.25	0.526	--	--	--	--	O	--	0.36	0 / 18	--	3.7	0 / 18	--	3.6	0 / 18	--	--
PCB-1260	5 / 18	mg/kg	2.5	2.5	0.024	0.334	1.25	1.25	0.393	0.024	0.334	1	0.439	X*	1.19	0.36	**2 / 18**	**Yes**	3.7	0 / 18	No	3.6	0 / 18	--	--
Semivolatile organics																									
Benz(*a*)anthracene	4 / 5	mg/kg	0.45	0.45	0.11	0.911	0.26	2.5	0.946	0.11	1.09	2.5	1.13	N*	1.95	1.06	**2 / 5**	**Yes**	10.4	0 / 5	No	10.6	0 / 5	--	--
Benzo(*a*)pyrene	4 / 5	mg/kg	0.45	0.45	0.16	1.19	0.35	3	1.18	0.16	1.43	3	1.39	N*	2.49	0.11	**4 / 5**	**Yes**	1.04	2 / 5	Yes	1.1	2 / 5	--	--
Benzo(*b*)fluoranthene	4 / 5	mg/kg	0.45	0.45	0.225	1.53	0.5	3.7	1.5	0.23	1.86	3.7	1.75	N*	3.19	1.06	**2 / 5**	**Yes**	10.4	0 / 5	No	10.6	0 / 5	--	--
Benzo(*k*)fluoranthene	3 / 5	mg/kg	0.44	0.45	0.16	0.596	0.225	1.4	0.542	0.16	0.887	1.4	0.647	N*	1.23	10.6	0 / 5	No	104	0 / 5	No	106	0 / 5	--	--
Chrysene	4 / 5	mg/kg	0.45	0.45	0.12	0.848	0.24	2.3	0.867	0.12	1.02	2.3	1.03	N*	1.8	106	0 / 5	No	1043	0 / 5	No	1063	0 / 5	--	--
Dibenz(*a,h*)anthracene	2 / 5	mg/kg	0.43	0.45	0.215	0.41	0.225	0.61	0.1	0.36	0.485	0.61	0.177	L*	0.55	0.11	**2 / 5**	**Yes**	1.04	0 / 5	No	1.1	0 / 5	--	--
Dibenzofuran	2 / 5	mg/kg	0.43	0.45	0.074	0.162	0.22	0.25	0.088	0.074	0.162	0.25	0.124	X*	0.546	1965	0 / 5	No	777	0 / 5	No	7771	0 / 5	--	--
Fluoranthene	4 / 5	mg/kg	0.45	0.45	0.13	1.49	0.3	4.2	1.64	0.13	1.81	4.2	1.95	N*	3.3	13,298	0 / 5	No	47,851	0 / 5	No	132,976	0 / 5	--	--
Indeno(*1,2,3-cd*)pyrene	3 / 5	mg/kg	0.44	0.45	0.22	1.01	0.29	2.3	0.896	0.29	1.5	2.3	1.06	X*	3.15	1.06	**2 / 5**	**Yes**	10.4	0 / 5	No	10.6	0 / 5	--	--
Naphthalene	2 / 5	mg/kg	0.43	0.45	0.15	0.285	0.22	0.42	0.135	0.15	0.285	0.42	0.191	N*	0.573	665	0 / 5	No	2389	0 / 5	No	6646	0 / 5	--	--
Pyrene	4 / 5	mg/kg	0.45	0.45	0.15	2.44	0.48	6.1	2.68	0.15	3.01	6.1	3.13	L*	7.92	9973	0 / 5	No	35,888	0 / 5	No	99,732	0 / 5	--	--
Radionuclides																									
Cesium-137	13 / 18	pCi/g	0	0.044	0	0.185	0.105	0.848	0.193	0.07	0.229	0.848	0.22	L*	0.276	0.92	0 / 18	No	1.23	0 / 18	No	9.2	0 / 18	--	--
Neptunium-237	14 / 18	pCi/g	0.32	0.52	0.29	0.585	0.51	1.23	0.29	0.29	0.662	1.23	0.294	L*	0.729	2.74	0 / 18	No	3.72	0 / 18	No	27.4	0 / 18	--	--
Potassium-40	18 / 18	pCi/g	--	--	5.87	13.5	13.2	27.0	5.43	5.87	13.5	27.0	5.43	N	15.7	2.85	**18 / 18**	**Yes**	3.85	**18 / 18**	**Yes**	28.5	0 / 18	32.1	0 / 18
Radium-226	15 / 18	pCi/g	-0.05	0.54	-0.05	1.18	0.955	4.29	0.863	0.55	1.31	4.29	0.924	L*	1.53	0.27	**15 / 18**	**Yes**	0.36	**15 / 18**	**Yes**	2.7	**1 / 18**	1.25	**6 / 18**
Technetium-99	1 / 6	pCi/g	0.132	1.29	0.132	0.854	0.969	1.3	0.482	1.3	1.3	1.3	--	N	1.25	813	0 / 6	No	1354	0 / 6	No	8132	0 / 6	--	--
Thorium-232	17 / 17	pCi/g	--	--	0.57	0.971	0.96	1.92	0.331	0.57	0.971	1.92	0.331	L	1.12	27.6	0 / 17	No	46.3	0 / 17	No	276	0 / 17	1.95	0 / 17
Thorium-234	7 / 9	pCi/g	2.03	2.49	1.17	6.15	4.32	18	5.22	1.17	7.57	18	5.5	N*	9.65	20.5	0 / 9	No	27.5	0 / 9	No	205	0 / 9	--	--

Table 11. ETTP Zone 1 DVS soil summary statistics for Blair Quarry Group (2 to 10 ft) - continued

Constituent	Frequency of detection	Units	Non-detect reporting limits[a]		Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Detected				Dist.	UCL 95	Adult RL	Detected freq. > adult RL	UCL95 > adult RL?	Child RL	Detected freq. > child RL	UCL95 > child RL?	Max RL	Detected freq. > max RL?	Back-ground	Detected freq. > bkgd
			Min	Max						Min	Mean	Max	S.D.												
Uranium-234	18 / 18	pCi/g	--	--	0.5	3.89	1.74	16.4	4.46	0.5	3.89	16.4	4.46	L	8.02	40.4	0 / 18	No	67.7	0 / 18	No	404	0 / 18	--	--
Uranium-235	15 / 18	pCi/g	0.06	0.14	0.06	0.286	0.14	1.04	0.288	0.068	0.328	1.04	0.308	L*	0.487	39.3	0 / 18	No	66.0	0 / 18	No	393	0 / 18	--	--
Uranium-238	18 / 18	pCi/g	--	--	0.35	3.21	1.11	17.5	4.42	0.35	3.21	17.5	4.42	L	7.06	12.3	1 / 18	No	17.9	0 / 18	No	123	0 / 18	1.47	8 / 18

[a] One-half of the reporting limits shown are used as proxy values for organics and inorganics. The reporting limits shown are used as proxy values for non-detect radionuclides.
[b] This summary statistic is calculated using both detects and non-detects. The Kaplan-Meier mean and standard deviation are reported for Kaplan-Meier UCL95.
Background values are from Table 4 from *Soil Background Supplemental Data Set for the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2105&D1).
Dist. = distribution. Distribution flags are defined as:
D = UCL95 is not calculated with fewer than five samples.
L = lognormal; UCL95 is calculated using Land's statistic or Chebyshev minimum variance unbiased estimator.
N = normal; UCL95 is calculated using t statistic.
O = no detected results to calculate some summary statistics.
X = neither normal, lognormal, nor gamma; UCL95 is calculated using a nonparametric bootstrap or the nonparametric Chebyshev inequality method.
DVS = Dynamic Verification Strategy.
ETTP = East Tennessee Technology Park.
mg/kg = milligrams per kilogram.
pCi/g = picocuries per gram.
RL = remediation level. Recreational RL is the smaller of the adult and child RL. Max RL is 10 times the recreational RL.
S.D. = standard deviation.
UCL95 = upper confidence limit on the mean concentration with 95% confidence.
-- = Not applicable, not available or insufficient data to calculate the statistic.
* Kaplan-Meier estimates of the overall mean, standard deviation, and UCL95 are shown for chemicals with both non-detects and at least two detects.

Table 12. ETTP Zone 1 DVS soil summary statistics for Blair Quarry Group (> 10 ft)

Constituent	Frequency of detection	Units	Non-detect reporting limits[a]		Detected																				
			Min	Max	Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Min	Mean	Max	S.D.	Dist.	UCL 95	Adult RL	Detected freq. > adult RL	UCL95 > adult RL?	Child RL	Detected freq. > child RL	UCL95 > child RL?	Max RL	Detected freq. > max RL?	Back-ground	Detected freq. > bkgd
Blair Quarry Group (> 10 ft)																									
Metals																									
Aluminum	4 / 4	mg/kg	--	--	8400	15,850	18,000	19,000	4989	8400	15,850	19,000	4989	D	--	415,514	0 / 4	--	181,199	0 / 4	--	1.8E+06	0 / 4	40,300	0 / 4
Antimony	4 / 4	mg/kg	--	--	0.13	3.96	3.55	8.6	3.61	0.13	3.96	8.6	3.61	D	--	98.2	0 / 4	--	38.9	0 / 4	--	389	0 / 4	1.52	3 / 4
Arsenic	4 / 4	mg/kg	--	--	13	19.8	17	32	9.0	13	19.8	32	9.0	D	--	1.83	4 / 4	--	7.2	4 / 4	--	18.3	2 / 4	15.0	2 / 4
Barium	4 / 4	mg/kg	--	--	38	270	305	430	179	38	270	430	179	D	--	33,960	0 / 4	--	13,531	0 / 4	--	135,309	0 / 4	125	3 / 4
Beryllium	4 / 4	mg/kg	--	--	0.47	1.16	1.04	2.1	0.714	0.47	1.16	2.1	0.714	D	--	2.67	0 / 4	--	2.88	0 / 4	--	26.7	0 / 4	2.2	0 / 4
Cadmium	4 / 4	mg/kg	--	--	0.47	8.27	6.8	19	7.78	0.47	8.27	19	7.78	D	--	93.8	0 / 4	--	163	0 / 4	--	938	0 / 4	0.22	4 / 4
Chromium	4 / 4	mg/kg	--	--	12	62	68	100	38.9	12	62	100	38.9	D	--	737,019	0 / 4	--	291,411	0 / 4	--	2.9E+06	0 / 4	44.9	3 / 4
Cobalt	4 / 4	mg/kg	--	--	7.8	36.2	38.5	60	21.5	7.8	36.2	60	21.5	D	--	141	0 / 4	--	57.3	1 / 4	--	573	0 / 4	42	1 / 4
Copper	4 / 4	mg/kg	--	--	11	925	1045	1600	695	11	925	1600	695	D	--	19,654	0 / 4	--	7771	0 / 4	--	77,710	0 / 4	22.5	3 / 4
Lead	4 / 4	mg/kg	--	--	25	444	575	600	279	25	444	600	279	D	--	--	--	--	--	--	--	11,000	0 / 4	37.9	3 / 4
Lithium	4 / 4	mg/kg	--	--	5.6	15.2	15	25	7.92	5.6	15.2	25	7.92	D	--	983	0 / 4	--	389	0 / 4	--	3886	0 / 4	48.9	0 / 4
Mercury	4 / 4	mg/kg	--	--	0.13	2.06	1.05	6	2.68	0.13	2.06	6	2.68	D	--	147	0 / 4	--	58.3	0 / 4	--	583	0 / 4	0.17	3 / 4
Molybdenum	4 / 4	mg/kg	--	--	1.5	17.9	16	38	15.3	1.5	17.9	38	15.3	D	--	2457	0 / 4	--	971	0 / 4	--	9714	0 / 4	--	--
Nickel	4 / 4	mg/kg	--	--	11	7753	3500	24,000	10,963	11	7753	24,000	10,963	D	--	9827	1 / 4	--	3885	2 / 4	--	38,855	0 / 4	26.1	3 / 4
Silver	3 / 4	mg/kg	0.059	0.059	0.03	6.28	3.55	18	8.01	2.8	8.37	18	8.38	D	--	2457	0 / 4	--	971	0 / 4	--	9714	0 / 4	0.6	3 / 4
Uranium	4 / 4	mg/kg	--	--	1.2	28.8	32.5	49	20.5	1.2	28.8	49	20.5	D	--	295	0 / 4	--	117	0 / 4	--	1166	0 / 4	--	--
Polychlorinated biphenyls																									
PCB-1248	0 / 4	mg/kg	0.52	6	0.26	1.05	0.463	3	1.31	--	--	--	--	O	--	0.36	0 / 4	--	3.7	0 / 4	--	3.6	0 / 4	--	--
PCB-1254	3 / 4	mg/kg	0.52	0.52	0.26	4.92	3.2	13	5.57	2.9	6.47	13	5.67	D	--	0.36	3 / 4	--	3.7	1 / 4	--	3.6	1 / 4	--	--
PCB-1260	2 / 4	mg/kg	0.55	6	0.1	2.04	1.64	4.8	2.27	0.1	2.45	4.8	3.32	D	--	0.36	1 / 4	--	3.7	1 / 4	--	3.6	1 / 4	--	--
Semivolatile organics																									
Benz(*a*)anthracene	4 / 4	mg/kg	--	--	2.6	90.4	89.5	180	97.8	2.6	90.4	180	97.8	D	--	1.06	4 / 4	--	10.4	2 / 4	--	10.6	2 / 4	--	--
Benzo(*a*)pyrene	4 / 4	mg/kg	--	--	1.7	72.3	73.8	140	78.2	1.7	72.3	140	78.2	D	--	0.11	4 / 4	--	1.04	4 / 4	--	1.1	4 / 4	--	--
Benzo(*b*)fluoranthene	4 / 4	mg/kg	--	--	2.5	108	111	210	117	2.5	108	210	117	D	--	1.06	4 / 4	--	10.4	3 / 4	--	10.6	3 / 4	--	--
Benzo(*k*)fluoranthene	4 / 4	mg/kg	--	--	0.94	35.9	32.9	77	38.8	0.94	35.9	77	38.8	D	--	10.6	2 / 4	--	104	0 / 4	--	106	0 / 4	--	--
Chrysene	4 / 4	mg/kg	--	--	3.4	75.2	73.8	150	80.7	3.4	75.2	150	80.7	D	--	106	2 / 4	--	1043	0 / 4	--	1063	0 / 4	--	--
Dibenz(*a,h*)anthracene	0 / 4	mg/kg	5	6	2.5	2.79	2.83	3	0.232	--	--	--	--	O	--	0.11	0 / 4	--	1.04	0 / 4	--	1.1	0 / 4	--	--
Dibenzofuran	4 / 4	mg/kg	--	--	0.64	16.0	13.2	37	18.0	0.64	16.0	37	18.0	D	--	1965	0 / 4	--	777	0 / 4	--	7771	0 / 4	--	--
Fluoranthene	4 / 4	mg/kg	--	--	8.5	225	226	440	243	8.5	225	440	243	D	--	13,298	0 / 4	--	47,851	0 / 4	--	132,976	0 / 4	--	--
Indeno(*1,2,3-cd*)pyrene	4 / 4	mg/kg	--	--	0.88	62.0	58.7	130	67.5	0.88	62.0	130	67.5	D	--	1.06	3 / 4	--	10.4	2 / 4	--	10.6	2 / 4	--	--
Naphthalene	5 / 5	mg/kg	--	--	0.24	257	21	1200	528	0.24	257	1200	528	L	1346	665	1 / 5	Yes	2389	0 / 5	No	6646	0 / 5	--	--
Pyrene	4 / 4	mg/kg	--	--	5.6	401	405	790	443	5.6	401	790	443	D	--	9973	0 / 4	--	35,888	0 / 4	--	99,732	0 / 4	--	--
Radionuclides																									
Cesium-137	1 / 4	pCi/g	-0.045	0.087	-0.045	0.072	0.079	0.174	0.09	0.174	0.174	0.174	--	D	--	0.92	0 / 4	--	1.23	0 / 4	--	9.2	0 / 4	--	--
Neptunium-237	0 / 4	pCi/g	-0.156	0.018	-0.156	-0.033	0.002	0.018	0.082	--	--	--	--	O	--	2.74	0 / 4	--	3.72	0 / 4	--	27.4	0 / 4	--	--
Niobium-95	1 / 1	pCi/g	--	--	0.1	0.1	0.1	0.1	--	0.1	0.1	0.1	--	D	--	0.66	0 / 1	--	0.89	0 / 1	--	6.6	0 / 1	--	--
Potassium-40	4 / 4	pCi/g	--	--	8.32	10.1	9.12	13.9	2.59	8.32	10.1	13.9	2.59	D	--	2.85	4 / 4	--	3.85	4 / 4	--	28.5	0 / 4	32.1	0 / 4
Radium-226	4 / 4	pCi/g	--	--	0.449	0.741	0.682	1.15	0.315	0.449	0.741	1.15	0.315	D	--	0.27	4 / 4	--	0.36	4 / 4	--	2.7	0 / 4	1.25	0 / 4
Technetium-99	0 / 4	pCi/g	-0.124	0.776	-0.124	0.321	0.315	0.776	0.477	--	--	--	--	O	--	813	0 / 4	--	1354	0 / 4	--	8132	0 / 4	--	--
Thorium-228	4 / 4	pCi/g	--	--	0.494	0.81	0.803	1.14	0.278	0.494	0.81	1.14	0.278	D	--	21.0	0 / 4	--	34.9	0 / 4	--	210	0 / 4	1.86	0 / 4
Thorium-230	4 / 4	pCi/g	--	--	0.801	0.896	0.871	1.04	0.115	0.801	0.896	1.04	0.115	D	--	31.4	0 / 4	--	52.5	0 / 4	--	314	0 / 4	1.2	0 / 4
Thorium-232	4 / 4	pCi/g	--	--	0.544	0.889	0.871	1.27	0.321	0.544	0.889	1.27	0.321	D	--	27.6	0 / 4	--	46.3	0 / 4	--	276	0 / 4	1.95	0 / 4
Thorium-234	3 / 4	pCi/g	1.1	1.1	1.1	10.5	10.5	20	7.74	9.83	13.7	20	5.52	D	--	20.5	0 / 4	--	27.5	0 / 4	--	205	0 / 4	--	--

Table 12. ETTP Zone 1 DVS soil summary statistics for Blair Quarry Group (> 10 ft) - continued

Constituent	Frequency of detection	Units	Non-detect reporting limits[a]		Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Detected				Dist.	UCL 95	Adult RL	Detected freq. > adult RL	UCL95 > adult RL?	Child RL	Detected freq. > child RL	UCL95 > child RL?	Max RL	Detected freq. > max RL?	Background	Detected freq. > bkgd
			Min	Max						Min	Mean	Max	S.D.												
Uranium-234	4 / 4	pCi/g	--	--	1.0	23.2	26.8	38.4	15.9	1.0	23.2	38.4	15.9	D	--	40.4	0 / 4	--	67.7	0 / 4	--	404	0 / 4	--	--
Uranium-235	3 / 4	pCi/g	0.039	0.039	0.039	1.28	1.37	2.34	0.975	1.07	1.69	2.34	0.636	D	--	39.3	0 / 4	--	66.0	0 / 4	--	393	0 / 4	--	--
Uranium-238	4 / 4	pCi/g	--	--	0.875	11.6	11.2	23.3	9.17	0.875	11.6	23.3	9.17	D	--	12.3	1 / 4	--	17.9	1 / 4	--	123	0 / 4	1.47	3 / 4

[a] One-half of the reporting limits shown are used as proxy values for organics and inorganics. The reporting limits shown are used as proxy values for non-detect radionuclides.
[b] This summary statistic is calculated using both detects and non-detects. The Kaplan-Meier mean and standard deviation are reported for Kaplan-Meier UCL95.
Background values are from Table 4 from *Soil Background Supplemental Data Set for the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2105&D1).
Dist. = distribution. Distribution flags are defined as:
D = UCL95 is not calculated with fewer than five samples.
L = lognormal; UCL95 is calculated using Land's statistic or Chebyshev minimum variance unbiased estimator.
O = no detected results to calculate some summary statistics.
DVS = Dynamic Verification Strategy.
ETTP = East Tennessee Technology Park.
mg/kg = milligrams per kilogram.
pCi/g = picocuries per gram.
RL = remediation level. Recreational RL is the smaller of the adult and child RL. Max RL is 10 times the recreational RL.
S.D. = standard deviation.
UCL95 = upper confidence limit on the mean concentration with 95% confidence.
-- = Not applicable, not available or insufficient data to calculate the statistic.

Table 13. ETTP Zone 1 DVS soil summary statistics for Duct Island Group (0 to 2 ft)

Constituent	Frequency of detection	Units	Non-detect reporting limits[a]		Detected																				
			Min	Max	Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Min	Mean	Max	S.D.	Dist.	UCL 95	Adult RL	Detected freq. > adult RL	UCL95 > adult RL?	Child RL	Detected freq. > child RL	UCL95 > child RL?	Max RL	Detected freq. > max RL?	Back-ground	Detected freq. > bkgd
Duct Island Group (0 to 2 ft)																									
Metals																									
Aluminum	26 / 26	mg/kg	--	--	7000	13,254	13,500	22,000	3244	7000	13,254	22,000	3244	N	14,341	415,514	0 / 26	No	181,199	0 / 26	No	1.8E+06	0 / 26	40,300	0 / 26
Antimony	26 / 26	mg/kg	--	--	0.028	0.349	0.11	3.2	0.699	0.028	0.349	3.2	0.699	X	0.946	98.2	0 / 26	No	38.9	0 / 26	No	389	0 / 26	1.52	**2 / 26**
Arsenic	26 / 26	mg/kg	--	--	3.9	11.2	8.15	31	7.81	3.9	11.2	31	7.81	X	17.8	1.83	**26 / 26**	Yes	7.2	**17 / 26**	Yes	18.3	**5 / 26**	15.0	**6 / 26**
Barium	26 / 26	mg/kg	--	--	24	93.0	65	580	110	24	93.0	580	110	X	187	33,960	0 / 26	No	13,531	0 / 26	No	135,309	0 / 26	125	**4 / 26**
Beryllium	26 / 26	mg/kg	--	--	0.32	0.975	0.945	2	0.392	0.32	0.975	2	0.392	N	1.11	2.67	0 / 26	No	2.88	0 / 26	No	26.7	0 / 26	2.2	0 / 26
Cadmium	26 / 26	mg/kg	--	--	0.57	4.11	2.45	23	4.59	0.57	4.11	23	4.59	L	6.05	93.8	0 / 26	No	163	0 / 26	No	938	0 / 26	0.22	**26 / 26**
Chromium	26 / 26	mg/kg	--	--	14	1137	19	16,000	3522	14	1137	16,000	3522	X	4147	737,019	0 / 26	No	291,411	0 / 26	No	2.9E+06	0 / 26	44.9	**3 / 26**
Cobalt	26 / 26	mg/kg	--	--	5.7	18.4	16	72	12.9	5.7	18.4	72	12.9	L	22.7	141	0 / 26	No	57.3	**1 / 26**	No	573	0 / 26	42	**1 / 26**
Copper	26 / 26	mg/kg	--	--	6.4	72.7	19.5	740	160	6.4	72.7	740	160	X	209	19,654	0 / 26	No	7771	0 / 26	No	77,710	0 / 26	22.5	**12 / 26**
Lead	26 / 26	mg/kg	--	--	12	104	34.5	940	197	12	104	940	197	X	272	--	--	--	--	--	--	11,000	0 / 26	37.9	**12 / 26**
Lithium	26 / 26	mg/kg	--	--	3.7	12.7	11.5	28.5	6.29	3.7	12.7	28.5	6.29	N	14.8	983	0 / 26	No	389	0 / 26	No	3886	0 / 26	48.9	0 / 26
Mercury	26 / 26	mg/kg	--	--	0.048	3.24	0.077	34	9.08	0.048	3.24	34	9.08	X	11.0	147	0 / 26	No	58.3	0 / 26	No	583	0 / 26	0.17	**6 / 26**
Molybdenum	11 / 26	mg/kg	0.12	0.78	0.06	3.45	0.2	46	9.87	0.18	7.88	46	14.7	X*	12.3	2457	0 / 26	No	971	0 / 26	No	9714	0 / 26	--	--
Nickel	26 / 26	mg/kg	--	--	11	51.4	28	370	87.6	11	51.4	370	87.6	X	126	9827	0 / 26	No	3885	0 / 26	No	38,855	0 / 26	26.1	**14 / 26**
Phosphorous	1 / 1	mg/kg	--	--	3070	3070	3070	3070	--	3070	3070	3070	--	D	--	9.83	1 / 1	--	3.89	1 / 1	--	38.9	1 / 1	--	--
Silver	3 / 26	mg/kg	0.063	0.31	0.032	173	0.04	410	50.4	160	273	410	127	X*	226	2457	0 / 26	No	971	0 / 26	No	9714	0 / 26	0.6	**3 / 26**
Uranium	26 / 26	mg/kg	--	--	0.8	58.3	2	950	196	0.8	58.3	950	196	X	226	295	**2 / 26**	No	117	**3 / 26**	Yes	1166	0 / 26	--	--
Polychlorinated biphenyls																									
PCB-1248	0 / 25	mg/kg	0.04	27	0.02	0.661	0.023	13.5	2.71	--	--	--	--	O	--	0.36	0 / 25	--	3.7	0 / 25	--	3.6	0 / 25	--	--
PCB-1254	6 / 25	mg/kg	0.04	0.048	0.02	4.9	0.023	77	15.9	0.021	20.3	77	29.9	X*	20.1	0.36	**3 / 25**	Yes	3.7	**3 / 25**	Yes	3.6	**3 / 25**	--	--
PCB-1260	7 / 25	mg/kg	0.04	27	0.004	1.49	0.023	37	7.25	0.004	5.3	37	14.0	X*	8.32	0.36	**1 / 25**	Yes	3.7	**1 / 25**	Yes	3.6	**1 / 25**	--	--
Semivolatile organics																									
Benz(*a*)anthracene	13 / 21	mg/kg	0.4	0.49	0.022	0.14	0.21	0.42	0.121	0.022	0.143	0.42	0.129	X*	0.288	1.06	0 / 21	No	10.4	0 / 21	No	10.6	0 / 21	--	--
Benzo(*a*)pyrene	11 / 21	mg/kg	0.4	0.49	0.026	0.16	0.215	0.4	0.12	0.026	0.162	0.4	0.127	N*	0.225	0.11	**6 / 21**	Yes	1.04	0 / 21	No	1.1	0 / 21	--	--
Benzo(*b*)fluoranthene	13 / 21	mg/kg	0.4	0.49	0.029	0.209	0.215	0.76	0.202	0.029	0.25	0.76	0.239	L*	0.377	1.06	0 / 21	No	10.4	0 / 21	No	10.6	0 / 21	--	--
Benzo(*k*)fluoranthene	7 / 21	mg/kg	0.4	0.49	0.042	0.159	0.22	0.34	0.097	0.042	0.159	0.34	0.104	X*	0.331	10.6	0 / 21	No	104	0 / 21	No	106	0 / 21	--	--
Chrysene	11 / 21	mg/kg	0.4	0.49	0.033	0.17	0.215	0.39	0.123	0.033	0.17	0.39	0.129	X*	0.339	106	0 / 21	No	1043	0 / 21	No	1063	0 / 21	--	--
Dibenz(*a,h*)anthracene	0 / 21	mg/kg	0.39	0.51	0.195	0.222	0.22	0.255	0.017	--	--	--	--	O	--	0.11	0 / 21	--	1.04	0 / 21	--	1.1	0 / 21	--	--
Dibenzofuran	3 / 21	mg/kg	0.4	0.49	0.02	0.022	0.22	0.245	0.001	0.02	0.022	0.023	0.002	X*	0.026	1965	0 / 21	No	777	0 / 21	No	7771	0 / 21	--	--
Fluoranthene	15 / 21	mg/kg	0.4	0.49	0.021	0.215	0.21	0.97	0.239	0.021	0.249	0.97	0.272	L*	0.464	13,298	0 / 21	No	47,851	0 / 21	No	132,976	0 / 21	--	--
Indeno(*1,2,3-cd*)pyrene	7 / 21	mg/kg	0.4	0.49	0.066	0.124	0.215	0.25	0.064	0.066	0.124	0.25	0.069	X*	0.239	1.06	0 / 21	No	10.4	0 / 21	No	10.6	0 / 21	--	--
Naphthalene	4 / 22	mg/kg	0.31	0.49	0.025	0.039	0.185	0.245	0.012	0.025	0.039	0.053	0.014	X*	0.069	665	0 / 22	No	2389	0 / 22	No	6646	0 / 22	--	--
Pyrene	9 / 21	mg/kg	0.4	0.49	0.097	0.292	0.22	1.2	0.24	0.097	0.39	1.2	0.341	X*	0.57	9973	0 / 21	No	35,888	0 / 21	No	99,732	0 / 21	--	--
Radionuclides																									
Cesium-137	11 / 34	pCi/g	-0.126	0.249	-0.126	0.437	0.147	3.44	0.638	0.205	0.922	3.44	1.0	L*	0.527	0.92	**3 / 34**	No	1.23	**2 / 34**	No	9.2	0 / 34	--	--
Europium-155	1 / 1	pCi/g	--	--	0.371	0.371	0.371	0.371	--	0.371	0.371	0.371	--	D	--	18.6	0 / 1	--	25	0 / 1	--	186	0 / 1	--	--
Neptunium-237	4 / 34	pCi/g	-0.032	0.054	-0.032	0.08	0.013	0.289	0.047	0.066	0.183	0.289	0.093	L*	0.093	2.74	0 / 34	No	3.72	0 / 34	No	27.4	0 / 34	--	--
Niobium-94	1 / 1	pCi/g	--	--	0.235	0.235	0.235	0.235	--	0.235	0.235	0.235	--	D	--	0.32	0 / 1	--	0.43	0 / 1	--	3.2	0 / 1	--	--
Niobium-95	1 / 1	pCi/g	--	--	0.786	0.786	0.786	0.786	--	0.786	0.786	0.786	--	D	--	0.66	1 / 1	--	0.89	0 / 1	--	6.6	0 / 1	--	--
Potassium-40	34 / 34	pCi/g	--	--	6.07	15.8	14.3	27.3	6.22	6.07	15.8	27.3	6.22	L	18.2	2.85	**34 / 34**	Yes	3.85	**34 / 34**	Yes	28.5	0 / 34	32.1	0 / 34
Radium-226	34 / 34	pCi/g	--	--	0.635	1.31	1.31	2.56	0.536	0.635	1.31	2.56	0.536	L	1.5	0.27	**34 / 34**	Yes	0.36	**34 / 34**	Yes	2.7	0 / 34	1.25	**18 / 34**
Sodium-22	1 / 1	pCi/g	--	--	0.192	0.192	0.192	0.192	--	0.192	0.192	0.192	--	D	--	0.23	0 / 1	--	0.3	0 / 1	--	2.3	0 / 1	--	--
Technetium-99	6 / 34	pCi/g	0.057	4.29	0.057	5.85	1.36	67.5	14.4	1.59	25.7	67.5	28.9	X*	17.6	813	0 / 34	No	1354	0 / 34	No	8132	0 / 34	--	--
Thorium-228	34 / 34	pCi/g	--	--	0.76	1.68	1.66	2.59	0.424	0.76	1.68	2.59	0.424	N	1.8	21.0	0 / 34	No	34.9	0 / 34	No	210	0 / 34	1.86	**9 / 34**
Thorium-230	34 / 34	pCi/g	--	--	0.896	2.22	1.71	12.1	2.11	0.896	2.22	12.1	2.11	X	3.8	31.4	0 / 34	No	52.5	0 / 34	No	314	0 / 34	1.2	**26 / 34**

Table 13. ETTP Zone 1 DVS soil summary statistics for Duct Island Group (0 to 2 ft) - continued

Constituent	Frequency of detection	Units	Non-detect reporting limits[a]		Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Detected				Dist.	UCL 95	Adult RL	Detected freq. > adult RL	UCL95 > adult RL?	Child RL	Detected freq. > child RL	UCL95 > child RL?	Max RL	Detected freq. > max RL?	Back-ground	Detected freq. > bkgd
			Min	Max						Min	Mean	Max	S.D.												
Thorium-232	34 / 34	pCi/g	--	--	0.7	1.56	1.58	2.45	0.376	0.7	1.56	2.45	0.376	N	1.67	27.6	0 / 34	No	46.3	0 / 34	No	276	0 / 34	1.95	5 / 34
Thorium-234	9 / 34	pCi/g	-1.0	4.53	-1.0	15.4	1.9	224	45.6	2.5	51.1	224	83.0	X*	51.6	20.5	3 / 34	Yes	27.5	3 / 34	Yes	205	1 / 34	--	--
Uranium-234	34 / 34	pCi/g	--	--	0.716	33.9	2.19	476	107	0.716	33.9	476	107	X	114	40.4	3 / 34	Yes	67.7	3 / 34	Yes	404	1 / 34	--	--
Uranium-235	30 / 34	pCi/g	0.018	0.092	0.018	1.7	0.148	24	5.22	0.053	1.92	24	5.61	X*	5.67	39.3	0 / 34	No	66.0	0 / 34	No	393	0 / 34	--	--
Uranium-238	34 / 34	pCi/g	--	--	0.754	15.3	1.71	243	50.4	0.754	15.3	243	50.4	X	53.0	12.3	3 / 34	Yes	17.9	3 / 34	Yes	123	2 / 34	1.47	22 / 34

[a] One-half of the reporting limits shown are used as proxy values for organics and inorganics. The reporting limits shown are used as proxy values for non-detect radionuclides.
[b] This summary statistic is calculated using both detects and non-detects. The Kaplan-Meier mean and standard deviation are reported for Kaplan-Meier UCL95.
Background values are from Table 4 from *Soil Background Supplemental Data Set for the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2105&D1).
Dist. = distribution. Distribution flags are defined as:
D = UCL95 is not calculated with fewer than five samples.
L = lognormal; UCL95 is calculated using Land's statistic or Chebyshev minimum variance unbiased estimator.
N = normal; UCL95 is calculated using t statistic.
O = no detected results to calculate some summary statistics.
X = neither normal, lognormal, nor gamma; UCL95 is calculated using a nonparametric bootstrap or the nonparametric Chebyshev inequality method.
DVS = Dynamic Verification Strategy.
ETTP = East Tennessee Technology Park.
mg/kg = milligrams per kilogram.
pCi/g = picocuries per gram.
RL = remediation level. Recreational RL is the smaller of the adult and child RL. Max RL is 10 times the recreational RL.
S.D. = standard deviation.
UCL95 = upper confidence limit on the mean concentration with 95% confidence.
-- = Not applicable, not available or insufficient data to calculate the statistic.
* Kaplan-Meier estimates of the overall mean, standard deviation, and UCL95 are shown for chemicals with both non-detects and at least two detects.

Table 14. ETTP Zone 1 DVS soil summary statistics for Duct Island Group (2 to 10 ft)

Constituent	Frequency of detection	Units	Non-detect reporting limits[a]		Detected																				
			Min	Max	Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Min	Mean	Max	S.D.	Dist.	UCL 95	Adult RL	Detected freq. > adult RL	UCL95 > adult RL?	Child RL	Detected freq. > child RL	UCL95 > child RL?	Max RL	Detected freq. > max RL?	Back-ground	Detected freq. > bkgd
Duct Island Group (2 to 10 ft)																									
Metals																									
Aluminum	76 / 76	mg/kg	--	--	6000	13,524	13,000	26,000	3603	6000	13,524	26,000	3603	L	14,261	415,514	0 / 76	No	181,199	0 / 76	No	1.8E+06	0 / 76	40,300	0 / 76
Antimony	76 / 76	mg/kg	--	--	0.022	0.161	0.11	3.2	0.362	0.022	0.161	3.2	0.362	X	0.342	98.2	0 / 76	No	38.9	0 / 76	No	389	0 / 76	1.52	1 / 76
Arsenic	76 / 76	mg/kg	--	--	3.7	11.0	9.35	32	5.68	3.7	11.0	32	5.68	L	12.3	1.83	**76 / 76**	**Yes**	7.2	**49 / 76**	**Yes**	18.3	**11 / 76**	15.0	**18 / 76**
Barium	76 / 76	mg/kg	--	--	23	57.7	50	220	33.6	23	57.7	220	33.6	L	63.7	33,960	0 / 76	No	13,531	0 / 76	No	135,309	0 / 76	125	**2 / 76**
Beryllium	76 / 76	mg/kg	--	--	0.28	0.926	0.81	2.4	0.414	0.28	0.926	2.4	0.414	L	1.01	2.67	0 / 76	No	2.88	0 / 76	No	26.7	0 / 76	2.2	**1 / 76**
Cadmium	76 / 76	mg/kg	--	--	0.77	3.84	4	14	2.27	0.77	3.84	14	2.27	X	4.97	93.8	0 / 76	No	163	0 / 76	No	938	0 / 76	0.22	**76 / 76**
Chromium	76 / 76	mg/kg	--	--	10	25.3	19.5	99	15.7	10	25.3	99	15.7	X	33.2	737,019	0 / 76	No	291,411	0 / 76	No	2.9E+06	0 / 76	44.9	**9 / 76**
Cobalt	76 / 76	mg/kg	--	--	2.6	17.0	12	75	14.0	2.6	17.0	75	14.0	X	24.1	141	0 / 76	No	57.3	**1 / 76**	No	573	0 / 76	42	**5 / 76**
Copper	76 / 76	mg/kg	--	--	7.4	28.6	23.5	93	17.8	7.4	28.6	93	17.8	L	32.5	19,654	0 / 76	No	7771	0 / 76	No	77,710	0 / 76	22.5	**39 / 76**
Lead	76 / 76	mg/kg	--	--	9.6	46.7	30	270	42.8	9.6	46.7	270	42.8	L	54.4	--	--	--	--	--	--	11,000	0 / 76	37.9	**32 / 76**
Lithium	76 / 76	mg/kg	--	--	3.3	13.1	11	47	7.27	3.3	13.1	47	7.27	L	14.5	983	0 / 76	No	389	0 / 76	No	3886	0 / 76	48.9	0 / 76
Mercury	76 / 76	mg/kg	--	--	0.03	0.755	0.093	43	4.92	0.03	0.755	43	4.92	X	3.22	147	0 / 76	No	58.3	0 / 76	No	583	0 / 76	0.17	**13 / 76**
Molybdenum	32 / 73	mg/kg	0.1	0.62	0.05	0.533	0.24	7.7	0.97	0.14	1.02	7.7	1.34	X*	1.04	2457	0 / 73	No	971	0 / 73	No	9714	0 / 73	--	--
Nickel	71 / 76	mg/kg	10	20	5	26.4	22	130	18.8	6.1	27.5	130	19.0	L*	30.0	9827	0 / 76	No	3885	0 / 76	No	38,855	0 / 76	26.1	**29 / 76**
Phosphorous	4 / 4	mg/kg	--	--	112	355	350	609	205	112	355	609	205	D	--	9.83	**4 / 4**	--	3.89	**4 / 4**	--	38.9	**4 / 4**	--	--
Silver	4 / 76	mg/kg	0.058	0.26	0.029	0.065	0.033	0.19	0.019	0.061	0.13	0.19	0.057	X*	0.076	2457	0 / 76	No	971	0 / 76	No	9714	0 / 76	0.6	0 / 76
Uranium	76 / 76	mg/kg	--	--	0.43	2.13	1.8	7.6	1.42	0.43	2.13	7.6	1.42	L	2.37	295	0 / 76	No	117	0 / 76	No	1166	0 / 76	--	--
Polychlorinated biphenyls																									
PCB-1248	0 / 75	mg/kg	0.039	0.44	0.02	0.029	0.021	0.22	0.033	--	--	--	--	O	--	0.36	0 / 75	--	3.7	0 / 75	--	3.6	0 / 75	--	--
PCB-1254	29 / 75	mg/kg	0.039	0.2	0.005	0.097	0.023	1.7	0.246	0.005	0.22	1.7	0.369	X*	0.223	0.36	**6 / 75**	No	3.7	0 / 75	No	3.6	0 / 75	--	--
PCB-1260	29 / 75	mg/kg	0.039	0.44	0.006	0.053	0.022	0.77	0.111	0.006	0.108	0.77	0.164	X*	0.11	0.36	**2 / 75**	No	3.7	0 / 75	No	3.6	0 / 75	--	--
Semivolatile organics																									
Benz(*a*)anthracene	48 / 71	mg/kg	0.4	0.5	0.023	3.17	0.225	83	12.7	0.023	4.62	83	15.3	X*	9.78	1.06	**11 / 71**	**Yes**	10.4	**4 / 71**	No	10.6	**4 / 71**	--	--
Benzo(*a*)pyrene	45 / 70	mg/kg	0.4	0.5	0.022	2.71	0.225	69	10.4	0.022	4.14	69	12.9	X*	8.2	0.11	**34 / 70**	**Yes**	1.04	**12 / 70**	Yes	1.1	**11 / 70**	--	--
Benzo(*b*)fluoranthene	47 / 70	mg/kg	0.4	0.5	0.026	4.09	0.228	100	15.1	0.026	6.02	100	18.3	X*	12.0	1.06	**14 / 70**	**Yes**	10.4	**5 / 70**	Yes	10.6	**5 / 70**	--	--
Benzo(*k*)fluoranthene	37 / 70	mg/kg	0.4	0.5	0.045	1.46	0.215	39	5.5	0.045	2.65	39	7.47	X*	4.37	10.6	**2 / 70**	No	104	0 / 70	No	106	0 / 70	--	--
Chrysene	47 / 71	mg/kg	0.4	0.5	0.022	2.91	0.225	83	11.6	0.022	4.32	83	14.2	X*	8.97	106	0 / 71	No	1043	0 / 71	No	1063	0 / 71	--	--
Dibenz(*a,h*)anthracene	10 / 68	mg/kg	0.38	1.9	0.066	0.256	0.21	7.5	0.908	0.066	1.14	7.5	2.28	X*	0.767	0.11	**6 / 68**	**Yes**	1.04	**2 / 68**	No	1.1	**2 / 68**	--	--
Dibenzofuran	25 / 71	mg/kg	0.38	1.9	0.018	0.76	0.21	36	4.26	0.018	1.98	36	7.16	X*	3.01	1965	0 / 71	No	777	0 / 71	No	7771	0 / 71	--	--
Fluoranthene	48 / 71	mg/kg	0.4	0.5	0.037	6.6	0.235	190	27.1	0.037	9.68	190	32.8	X*	20.8	13,298	0 / 71	No	47,851	0 / 71	No	132,976	0 / 71	--	--
Indeno(*1,2,3-cd*)pyrene	34 / 70	mg/kg	0.4	1.9	0.068	1.39	0.215	33	5.24	0.068	2.69	33	7.41	X*	4.16	1.06	**9 / 70**	**Yes**	10.4	**2 / 70**	No	10.6	**2 / 70**	--	--
Naphthalene	35 / 92	mg/kg	0.006	0.5	0.003	0.98	0.173	63	6.58	0.018	2.46	63	10.7	X*	4.02	665	0 / 92	No	2389	0 / 92	No	6646	0 / 92	--	--
Pyrene	49 / 71	mg/kg	0.4	0.5	0.044	8.49	0.25	280	37.1	0.044	12.2	280	44.6	X*	27.9	9973	0 / 71	No	35,888	0 / 71	No	99,732	0 / 71	--	--
Radionuclides																									
Americium-241	1 / 1	pCi/g	--	--	0.302	0.302	0.302	0.302	--	0.302	0.302	0.302	--	D	--	21.9	0 / 1	--	34.5	0 / 1	--	219	0 / 1	--	--
Cesium-137	2 / 30	pCi/g	-0.162	0.254	-0.162	0.174	0.04	0.54	0.068	0.161	0.351	0.54	0.268	L*	0.189	0.92	0 / 30	No	1.23	0 / 30	No	9.2	0 / 30	--	--
Neptunium-237	2 / 30	pCi/g	-0.079	0.046	-0.079	0.085	0.005	0.093	0.002	0.085	0.089	0.093	0.006	L*	0.086	2.74	0 / 30	No	3.72	0 / 30	No	27.4	0 / 30	--	--
Potassium-40	30 / 30	pCi/g	--	--	8.09	15.4	14.7	30.4	4.77	8.09	15.4	30.4	4.77	N	16.9	2.85	**30 / 30**	**Yes**	3.85	**30 / 30**	**Yes**	28.5	**1 / 30**	32.1	0 / 30
Radium-226	29 / 30	pCi/g	0.114	0.114	0.114	1.42	1.26	3.15	0.784	0.363	1.45	3.15	0.786	N*	1.67	0.27	**29 / 30**	**Yes**	0.36	**29 / 30**	**Yes**	2.7	**4 / 30**	1.25	**15 / 30**
Technetium-99	7 / 30	pCi/g	-0.601	1.76	-0.601	24.8	0.675	710	127	0.82	104	710	267	X*	134	813	0 / 30	No	1354	0 / 30	No	8132	0 / 30	--	--
Thorium-228	30 / 30	pCi/g	--	--	0.757	1.47	1.43	2.46	0.366	0.757	1.47	2.46	0.366	N	1.58	21.0	0 / 30	No	34.9	0 / 30	No	210	0 / 30	1.86	**5 / 30**
Thorium-230	30 / 30	pCi/g	--	--	0.76	2.0	1.66	8.07	1.4	0.76	2.0	8.07	1.4	L	2.39	31.4	0 / 30	No	52.5	0 / 30	No	314	0 / 30	1.2	**20 / 30**
Thorium-232	30 / 30	pCi/g	--	--	0.931	1.42	1.36	2.33	0.352	0.931	1.42	2.33	0.352	L	1.53	27.6	0 / 30	No	46.3	0 / 30	No	276	0 / 30	1.95	**3 / 30**
Thorium-234	7 / 30	pCi/g	-0.277	3.34	-0.277	4.68	1.81	53.6	9.09	2.83	10.7	53.6	18.9	X*	12.5	20.5	**1 / 30**	No	27.5	**1 / 30**	No	205	0 / 30	--	--

Table 14. ETTP Zone 1 DVS soil summary statistics for Duct Island Group (2 to 10 ft) - continued

Constituent	Frequency of detection	Units	Non-detect reporting limits[a]		Detected																					
			Min	Max	Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Min	Mean	Max	S.D.	Dist.	UCL 95	Adult RL	Detected freq. > adult RL	UCL95 > adult RL?	Child RL	Detected freq. > child RL	UCL95 > child RL?	Max RL	Detected freq. > max RL?	Back-ground	Detected freq. > bkgd
Uranium-234	30 / 30	pCi/g	--	--	0.806	4.16	1.95	64.4	11.4	0.806	4.16	64.4	11.4	X	13.2	40.4	1 / 30	No	67.7	0 / 30	No	404	0 / 30	--	--
Uranium-235	18 / 30	pCi/g	0.03	0.105	0.03	0.269	0.114	3.9	0.678	0.1	0.382	3.9	0.881	X*	0.824	39.3	0 / 30	No	66.0	0 / 30	No	393	0 / 30	--	--
Uranium-238	30 / 30	pCi/g	--	--	1.02	3.85	1.87	57.9	10.2	1.02	3.85	57.9	10.2	X	12.0	12.3	1 / 30	No	17.9	1 / 30	No	123	0 / 30	1.47	19 / 30

[a] One-half of the reporting limits shown are used as proxy values for organics and inorganics. The reporting limits shown are used as proxy values for non-detect radionuclides.
[b] This summary statistic is calculated using both detects and non-detects. The Kaplan-Meier mean and standard deviation are reported for Kaplan-Meier UCL95.
Background values are from Table 4 from *Soil Background Supplemental Data Set for the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2105&D1).
Dist. = distribution. Distribution flags are defined as:
D = UCL95 is not calculated with fewer than 5 samples.
L = lognormal; UCL95 is calculated using Land's statistic or Chebyshev minimum variance unbiased estimator.
N = normal; UCL95 is calculated using t statistic.
O = no detected results to calculate some summary statistics.
X = neither normal, lognormal, nor gamma; UCL95 is calculated using a nonparametric bootstrap or the nonparametric Chebyshev inequality method.
DVS = Dynamic Verification Strategy.
ETTP = East Tennessee Technology Park.
mg/kg = milligrams per kilogram.
pCi/g = picocuries per gram.
RL = remediation level. Recreational RL is the smaller of the adult and child RL. Max RL is 10 times the recreational RL.
S.D. = standard deviation.
UCL95 = upper confidence limit on the mean concentration with 95% confidence.
-- = Not applicable, not available or insufficient data to calculate the statistic.
* Kaplan-Meier estimates of the overall mean, standard deviation, and UCL95 are shown for chemicals with both non-detects and at least two detects.

Table 15. ETTP Zone 1 DVS soil summary statistics for K-1007 Group (0 to 2 ft)

Constituent	Frequency of detection	Units	Non-detect reporting limits[a]		Detected																				
			Min	Max	Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Min	Mean	Max	S.D.	Dist.	UCL 95	Adult RL	Detected freq. > adult RL	UCL95 > adult RL?	Child RL	Detected freq. > child RL	UCL95 > child RL?	Max RL	Detected freq. > max RL?	Back-ground	Detected freq. > bkgd
K-1007 Group (0 to 2 ft)																									
Metals																									
Aluminum	55 / 55	mg/kg	--	--	2400	12,360	12,000	24,000	3907	2400	12,360	24,000	3907	N	13,242	415,514	0 / 55	No	181,199	0 / 55	No	1.8E+06	0 / 55	40,300	0 / 55
Antimony	54 / 55	mg/kg	0.007	0.007	0.004	0.121	0.11	0.54	0.099	0.009	0.123	0.54	0.1	G*	0.149	98.2	0 / 55	No	38.9	0 / 55	No	389	0 / 55	1.52	0 / 55
Arsenic	55 / 55	mg/kg	--	--	2.1	6.55	5.4	21	3.43	2.1	6.55	21	3.43	X	8.56	1.83	**55 / 55**	**Yes**	7.2	**12 / 55**	**Yes**	18.3	**1 / 55**	15.0	**2 / 55**
Barium	55 / 55	mg/kg	--	--	36	95.6	85	230	44.0	36	95.6	230	44.0	L	107	33,960	0 / 55	No	13,531	0 / 55	No	135,309	0 / 55	125	**12 / 55**
Beryllium	55 / 55	mg/kg	--	--	0.35	0.926	0.87	1.8	0.327	0.35	0.926	1.8	0.327	L	1.01	2.67	0 / 55	No	2.88	0 / 55	No	26.7	0 / 55	2.2	0 / 55
Cadmium	55 / 55	mg/kg	--	--	0.43	1.93	1.5	6.3	1.26	0.43	1.93	6.3	1.26	L	2.25	93.8	0 / 55	No	163	0 / 55	No	938	0 / 55	0.22	**55 / 55**
Chromium	55 / 55	mg/kg	--	--	7.1	22.1	19	88	14.6	7.1	22.1	88	14.6	X	30.7	737,019	0 / 55	No	291,411	0 / 55	No	2.9E+06	0 / 55	44.9	**3 / 55**
Cobalt	55 / 55	mg/kg	--	--	4.1	13.8	14	24	4.75	4.1	13.8	24	4.75	N	14.8	141	0 / 55	No	57.3	0 / 55	No	573	0 / 55	42	0 / 55
Copper	55 / 55	mg/kg	--	--	6.9	19.2	17	53	8.84	6.9	19.2	53	8.84	L	21.0	19,654	0 / 55	No	7771	0 / 55	No	77,710	0 / 55	22.5	**10 / 55**
Lead	55 / 55	mg/kg	--	--	10.6	35.0	29	190	26.1	10.6	35.0	190	26.1	X	50.3	--	--	--	--	--	--	11,000	0 / 55	37.9	**13 / 55**
Lithium	55 / 55	mg/kg	--	--	5.2	12.6	12	26	4.38	5.2	12.6	26	4.38	L	13.7	983	0 / 55	No	389	0 / 55	No	3886	0 / 55	48.9	0 / 55
Mercury	54 / 55	mg/kg	6.9E-04	6.9E-04	3.5E-04	0.06	0.057	0.17	0.03	0.013	0.061	0.17	0.03	X*	0.078	147	0 / 55	No	58.3	0 / 55	No	583	0 / 55	0.17	0 / 55
Molybdenum	40 / 55	mg/kg	0.13	1.4	0.065	1.55	0.45	53	7.02	0.16	2.01	53	8.29	X*	5.73	2457	0 / 55	No	971	0 / 55	No	9714	0 / 55	--	--
Nickel	55 / 55	mg/kg	--	--	9	21.3	20	93	12.0	9	21.3	93	12.0	X	28.3	9827	0 / 55	No	3885	0 / 55	No	38,855	0 / 55	26.1	**7 / 55**
Phosphorous	5 / 5	mg/kg	--	--	285	408	400	497	84.4	285	408	497	84.4	N	488	9.83	**5 / 5**	**Yes**	3.89	**5 / 5**	**Yes**	38.9	**5 / 5**	--	--
Silver	23 / 55	mg/kg	0.057	0.37	0.029	0.109	0.081	0.65	0.119	0.033	0.176	0.65	0.16	G*	0.129	2457	0 / 55	No	971	0 / 55	No	9714	0 / 55	0.6	**2 / 55**
Uranium	55 / 55	mg/kg	--	--	0.29	1.28	1.1	4.5	0.706	0.29	1.28	4.5	0.706	L	1.45	295	0 / 55	No	117	0 / 55	No	1166	0 / 55	--	--
Polychlorinated biphenyls																									
PCB-1248	0 / 55	mg/kg	0.018	0.21	0.009	0.017	0.014	0.105	0.014	--	--	--	--	O	--	0.36	0 / 55	--	3.7	0 / 55	--	3.6	0 / 55	--	--
PCB-1254	9 / 55	mg/kg	0.019	0.045	0.01	0.047	0.02	0.93	0.139	0.011	0.229	0.93	0.296	X*	0.133	0.36	**2 / 55**	No	3.7	0 / 55	No	3.6	0 / 55	--	--
PCB-1260	31 / 55	mg/kg	0.018	0.21	0.008	0.037	0.021	0.23	0.043	0.008	0.055	0.23	0.051	X*	0.064	0.36	0 / 55	No	3.7	0 / 55	No	3.6	0 / 55	--	--
Polychlorinated biphenyl	12 / 30	mg/kg	0.019	0.027	0.008	0.074	0.011	0.93	0.18	0.008	0.169	0.93	0.269	X*	0.224	0.36	**2 / 30**	No	3.7	0 / 30	No	3.6	0 / 30	--	--
Semivolatile organics																									
Benz(*a*)anthracene	51 / 57	mg/kg	0.38	0.46	0.021	2.23	0.17	60	8.17	0.021	2.47	60	8.68	X*	6.99	1.06	**14 / 57**	**Yes**	10.4	**3 / 57**	No	10.6	**3 / 57**	--	--
Benzo(*a*)pyrene	51 / 57	mg/kg	0.38	0.46	0.021	2.26	0.215	50	6.95	0.021	2.51	50	7.38	X*	6.31	0.11	**34 / 57**	**Yes**	1.04	**14 / 57**	**Yes**	1.1	**14 / 57**	--	--
Benzo(*b*)fluoranthene	51 / 57	mg/kg	0.38	0.46	0.028	3.71	0.28	89	12.1	0.028	4.12	89	12.9	X*	10.8	1.06	**15 / 57**	**Yes**	10.4	**6 / 57**	**Yes**	10.6	**6 / 57**	--	--
Benzo(*k*)fluoranthene	46 / 57	mg/kg	0.38	0.46	0.032	2.54	0.19	100	13.1	0.032	3.12	100	14.7	X*	10.2	10.6	**1 / 57**	No	104	0 / 57	No	106	0 / 57	--	--
Chrysene	47 / 57	mg/kg	0.054	0.46	0.027	2.1	0.195	54	7.36	0.028	2.52	54	8.13	X*	6.39	106	0 / 57	No	1043	0 / 57	No	1063	0 / 57	--	--
Dibenz(*a,h*)anthracene	18 / 56	mg/kg	0.38	0.55	0.034	0.383	0.21	6.3	0.852	0.034	0.835	6.3	1.43	X*	0.908	0.11	**14 / 56**	**Yes**	1.04	**3 / 56**	No	1.1	**2 / 56**	--	--
Dibenzofuran	25 / 57	mg/kg	0.38	0.81	0.02	0.458	0.195	18	2.36	0.02	0.948	18	3.57	X*	1.85	1965	0 / 57	No	777	0 / 57	No	7771	0 / 57	--	--
Fluoranthene	50 / 57	mg/kg	0.1	0.46	0.019	4.69	0.21	120	16.6	0.019	5.32	120	17.8	X*	14.3	13,298	0 / 57	No	47,851	0 / 57	No	132,976	0 / 57	--	--
Indeno(*1,2,3-cd*)pyrene	40 / 57	mg/kg	0.38	0.55	0.037	0.892	0.21	15	2.18	0.037	1.21	15	2.57	X*	2.17	1.06	**11 / 57**	**Yes**	10.4	**1 / 57**	No	10.6	**1 / 57**	--	--
Naphthalene	46 / 86	mg/kg	0.005	0.55	0.001	0.255	0.047	12	1.31	0.001	0.456	12	1.79	X*	0.879	665	0 / 86	No	2389	0 / 86	No	6646	0 / 86	--	--
Pyrene	49 / 57	mg/kg	0.14	0.46	0.04	3.95	0.23	97	13.3	0.04	4.57	97	14.4	X*	11.7	9973	0 / 57	No	35,888	0 / 57	No	99,732	0 / 57	--	--
Radionuclides																									
Cesium-137	4 / 34	pCi/g	-0.074	0.252	-0.074	0.226	0.07	0.435	0.063	0.206	0.372	0.435	0.111	L*	0.246	0.92	0 / 34	No	1.23	0 / 34	No	9.2	0 / 34	--	--
Europium-152	1 / 1	pCi/g	--	--	0.614	0.614	0.614	0.614	--	0.614	0.614	0.614	--	D	--	0.44	1 / 1	--	0.59	1 / 1	--	4.4	0 / 1	--	--
Neptunium-237	0 / 34	pCi/g	-0.034	0.054	-0.034	0.006	9.3E-04	0.054	0.019	--	--	--	--	N	0.012	2.74	0 / 34	No	3.72	0 / 34	No	27.4	0 / 34	--	--
Potassium-40	34 / 34	pCi/g	--	--	9.05	16.2	15.2	28.3	4.54	9.05	16.2	28.3	4.54	L	17.6	2.85	**34 / 34**	**Yes**	3.85	**34 / 34**	**Yes**	28.5	0 / 34	32.1	0 / 34
Radium-226	34 / 34	pCi/g	--	--	0.295	1.02	1.04	1.49	0.236	0.295	1.02	1.49	0.236	N	1.08	0.27	**34 / 34**	**Yes**	0.36	**33 / 34**	**Yes**	2.7	0 / 34	1.25	**5 / 34**
Technetium-99	1 / 34	pCi/g	-2.07	6.44	-2.07	1.43	1.14	6.44	1.9	0.3	0.3	0.3	--	N	1.98	813	0 / 34	No	1354	0 / 34	No	8132	0 / 34	--	--
Thorium-228	34 / 34	pCi/g	--	--	0.521	1.33	1.39	1.8	0.259	0.521	1.33	1.8	0.259	N	1.41	21.0	0 / 34	No	34.9	0 / 34	No	210	0 / 34	1.86	0 / 34
Thorium-230	34 / 34	pCi/g	--	--	0.696	1.2	1.19	1.76	0.277	0.696	1.2	1.76	0.277	N	1.28	31.4	0 / 34	No	52.5	0 / 34	No	314	0 / 34	1.2	**17 / 34**
Thorium-232	34 / 34	pCi/g	--	--	0.35	1.3	1.31	1.79	0.285	0.35	1.3	1.79	0.285	N	1.39	27.6	0 / 34	No	46.3	0 / 34	No	276	0 / 34	1.95	0 / 34

Table 15. ETTP Zone 1 DVS soil summary statistics for K-1007 Group (0 to 2 ft) - continued

Constituent	Frequency of detection	Units	Non-detect reporting limits[a]		Detected																					
			Min	Max	Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Min	Mean	Max	S.D.	Dist.	UCL 95	Adult RL	Detected freq. > adult RL	UCL95 > adult RL?	Child RL	Detected freq. > child RL	UCL95 > child RL?	Max RL	Detected freq. > max RL?	Back-ground	Detected freq. > bkgd
Thorium-234	1 / 34	pCi/g	-0.698	3.45	-0.698	1.18	1.13	3.45	1.02	1.4	1.4	1.4	--	N	1.48	20.5	0 / 34	No	27.5	0 / 34	No	205	0 / 34	--	--
Uranium-234	34 / 34	pCi/g	--	--	0.731	1.46	1.39	2.82	0.449	0.731	1.46	2.82	0.449	N	1.59	40.4	0 / 34	No	67.7	0 / 34	No	404	0 / 34	--	--
Uranium-235	21 / 34	pCi/g	0.033	0.109	0.033	0.136	0.107	0.537	0.107	0.073	0.175	0.537	0.124	L*	0.159	39.3	0 / 34	No	66.0	0 / 34	No	393	0 / 34	--	--
Uranium-238	34 / 34	pCi/g	--	--	0.574	1.22	1.18	1.71	0.264	0.574	1.22	1.71	0.264	N	1.29	12.3	0 / 34	No	17.9	0 / 34	No	123	0 / 34	1.47	7 / 34

[a] One-half of the reporting limits shown are used as proxy values for organics and inorganics. The reporting limits shown are used as proxy values for non-detect radionuclides.
[b] This summary statistic is calculated using both detects and non-detects. The Kaplan-Meier mean and standard deviation are reported for Kaplan-Meier UCL95.
Background values are from Table 4 from *Soil Background Supplemental Data Set for the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2105&D1).
Dist. = distribution. Distribution flags are defined as:
D = UCL95 is not calculated with fewer than five samples.
G = gamma; UCL95 is calculated using the adjusted or unadjusted gamma as described in ProUCL.
L = lognormal; UCL95 is calculated using Land's statistic or Chebyshev minimum variance unbiased estimator.
N = normal; UCL95 is calculated using t statistic.
O = no detected results to calculate some summary statistics.
X = neither normal, lognormal, nor gamma; UCL95 is calculated using a nonparametric bootstrap or the nonparametric Chebyshev inequality method.
DVS = Dynamic Verification Strategy.
ETTP = East Tennessee Technology Park.
mg/kg = milligrams per kilogram.
pCi/g = picocuries per gram.
RL = remediation level. Recreational RL is the smaller of the adult and child RL. Max RL is 10 times the recreational RL.
S.D. = standard deviation.
UCL95 = upper confidence limit on the mean concentration with 95% confidence.
-- = Not applicable, not available or insufficient data to calculate the statistic.
* Kaplan-Meier estimates of the overall mean, standard deviation, and UCL95 are shown for chemicals with both non-detects and at least two detects.

Table 16. ETTP Zone 1 DVS Soil summary statistics for K-1007 Group (2 to 10 ft)

Constituent	Frequency of detection	Units	Non-detect reporting limits[a]		Detected																				
			Min	Max	Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Min	Mean	Max	S.D.	Dist.	UCL 95	Adult RL	Detected freq. > adult RL	UCL95 > adult RL?	Child RL	Detected freq. > child RL	UCL95 > child RL?	Max RL	Detected freq. > max RL?	Back-ground	Detected freq. > bkgd
K-1007 Group (2 to 10 ft)																									
Metals																									
Aluminum	54 / 54	mg/kg	--	--	2200	14,509	14,000	32,000	5666	2200	14,509	32,000	5666	G	16,000	415,514	0 / 54	No	181,199	0 / 54	No	1.8E+06	0 / 54	40,300	0 / 54
Antimony	50 / 54	mg/kg	0.007	0.17	0.004	0.108	0.055	0.75	0.136	0.008	0.115	0.75	0.141	L*	0.162	98.2	0 / 54	No	38.9	0 / 54	No	389	0 / 54	1.52	0 / 54
Arsenic	54 / 54	mg/kg	--	--	2.3	6.47	5.55	19	3.21	2.3	6.47	19	3.21	L	7.25	1.83	**54 / 54**	**Yes**	7.2	**17 / 54**	**Yes**	18.3	**1 / 54**	15.0	**1 / 54**
Barium	54 / 54	mg/kg	--	--	35	80.9	66	461	64.6	35	80.9	461	64.6	X	119	33,960	0 / 54	No	13,531	0 / 54	No	135,309	0 / 54	125	**6 / 54**
Beryllium	54 / 54	mg/kg	--	--	0.3	1.07	0.93	3.3	0.597	0.3	1.07	3.3	0.597	L	1.21	2.67	**2 / 54**	No	2.88	**2 / 54**	No	26.7	0 / 54	2.2	**2 / 54**
Cadmium	54 / 54	mg/kg	--	--	0.16	1.63	1.5	5.4	0.912	0.16	1.63	5.4	0.912	G	1.87	93.8	0 / 54	No	163	0 / 54	No	938	0 / 54	0.22	**52 / 54**
Chromium	54 / 54	mg/kg	--	--	5.5	20.7	20	36	6.36	5.5	20.7	36	6.36	N	22.2	737,019	0 / 54	No	291,411	0 / 54	No	2.9E+06	0 / 54	44.9	0 / 54
Cobalt	54 / 54	mg/kg	--	--	2.3	14.6	13	41.3	7.5	2.3	14.6	41.3	7.5	L	16.8	141	0 / 54	No	57.3	0 / 54	No	573	0 / 54	42	0 / 54
Copper	54 / 54	mg/kg	--	--	4.8	24.6	20	270	35.8	4.8	24.6	270	35.8	X	45.8	19,654	0 / 54	No	7771	0 / 54	No	77,710	0 / 54	22.5	**20 / 54**
Lead	54 / 54	mg/kg	--	--	5.5	33.9	22.5	260	42.4	5.5	33.9	260	42.4	X	59.0	--	--	--	--	--	--	11,000	0 / 54	37.9	**8 / 54**
Lithium	54 / 54	mg/kg	--	--	3.3	14.9	11	74	12.5	3.3	14.9	74	12.5	X	22.3	983	0 / 54	No	389	0 / 54	No	3886	0 / 54	48.9	**2 / 54**
Mercury	52 / 54	mg/kg	0.002	0.003	8.7E-04	0.067	0.052	0.46	0.07	8.7E-04	0.07	0.46	0.071	X*	0.109	147	0 / 54	No	58.3	0 / 54	No	583	0 / 54	0.17	**2 / 54**
Molybdenum	47 / 54	mg/kg	0.13	0.62	0.065	0.636	0.515	2.1	0.418	0.22	0.694	2.1	0.421	G*	0.763	2457	0 / 54	No	971	0 / 54	No	9714	0 / 54	--	--
Nickel	54 / 54	mg/kg	--	--	5.8	18.2	16.5	42	9.04	5.8	18.2	42	9.04	L	21.0	9827	0 / 54	No	3885	0 / 54	No	38,855	0 / 54	26.1	**9 / 54**
Phosphorous	5 / 5	mg/kg	--	--	210	443	406	725	189	210	443	725	189	N	623	9.83	**5 / 5**	**Yes**	3.89	**5 / 5**	**Yes**	38.9	**5 / 5**	--	--
Silver	20 / 54	mg/kg	0.018	0.64	0.009	0.155	0.069	0.91	0.172	0.073	0.281	0.91	0.236	L*	0.175	2457	0 / 54	No	971	0 / 54	No	9714	0 / 54	0.6	**3 / 54**
Uranium	54 / 54	mg/kg	--	--	0.39	1.28	1.25	2.6	0.571	0.39	1.28	2.6	0.571	L	1.46	295	0 / 54	No	117	0 / 54	No	1166	0 / 54	--	--
Polychlorinated biphenyls																									
PCB-1248	1 / 45	mg/kg	0.019	0.047	0.01	0.025	0.02	0.39	0.056	0.39	0.39	0.39	--	X	0.061	0.36	**1 / 45**	No	3.7	0 / 45	No	3.6	0 / 45	--	--
PCB-1254	4 / 45	mg/kg	0.019	0.047	0.01	0.051	0.02	0.9	0.148	0.019	0.379	0.9	0.413	X*	0.162	0.36	**2 / 45**	No	3.7	0 / 45	No	3.6	0 / 45	--	--
PCB-1260	15 / 45	mg/kg	0.019	0.089	0.005	0.044	0.016	0.78	0.118	0.005	0.107	0.78	0.195	X*	0.123	0.36	**1 / 45**	No	3.7	0 / 45	No	3.6	0 / 45	--	--
Polychlorinated biphenyl	3 / 19	mg/kg	0.019	0.087	0.01	0.116	0.011	1.7	0.375	0.019	0.636	1.7	0.925	X*	0.576	0.36	**1 / 19**	**Yes**	3.7	0 / 19	No	3.6	0 / 19	--	--
Semivolatile organics																									
Benz(*a*)anthracene	24 / 49	mg/kg	0.38	0.47	0.019	0.178	0.205	1.9	0.295	0.019	0.25	1.9	0.404	X*	0.378	1.06	**1 / 49**	No	10.4	0 / 49	No	10.6	0 / 49	--	--
Benzo(*a*)pyrene	26 / 49	mg/kg	0.38	0.47	0.015	0.157	0.2	1.5	0.24	0.015	0.201	1.5	0.313	X*	0.322	0.11	**11 / 49**	**Yes**	1.04	**1 / 49**	No	1.1	**1 / 49**	--	--
Benzo(*b*)fluoranthene	25 / 49	mg/kg	0.38	0.47	0.024	0.216	0.21	1.9	0.312	0.024	0.299	1.9	0.415	X*	0.427	1.06	**1 / 49**	No	10.4	0 / 49	No	10.6	0 / 49	--	--
Benzo(*k*)fluoranthene	19 / 49	mg/kg	0.33	0.47	0.025	0.132	0.2	0.76	0.132	0.025	0.165	0.76	0.184	X*	0.241	10.6	0 / 49	No	104	0 / 49	No	106	0 / 49	--	--
Chrysene	21 / 49	mg/kg	0.38	0.47	0.019	0.187	0.205	1.6	0.253	0.019	0.254	1.6	0.361	X*	0.37	106	0 / 49	No	1043	0 / 49	No	1063	0 / 49	--	--
Dibenz(*a,h*)anthracene	5 / 48	mg/kg	0.33	0.47	0.034	0.071	0.205	0.235	0.051	0.034	0.071	0.17	0.056	X*	0.181	0.11	**1 / 48**	Yes	1.04	0 / 48	No	1.1	0 / 48	--	--
Dibenzofuran	8 / 49	mg/kg	0.33	0.47	0.024	0.101	0.2	0.55	0.088	0.024	0.149	0.55	0.173	X*	0.212	1965	0 / 49	No	777	0 / 49	No	7771	0 / 49	--	--
Fluoranthene	24 / 49	mg/kg	0.38	0.47	0.019	0.319	0.21	4.6	0.704	0.019	0.519	4.6	0.981	X*	0.772	13,298	0 / 49	No	47,851	0 / 49	No	132,976	0 / 49	--	--
Indeno(*1,2,3-cd*)pyrene	13 / 49	mg/kg	0.33	0.47	0.042	0.117	0.2	0.47	0.074	0.042	0.138	0.47	0.114	X*	0.195	1.06	0 / 49	No	10.4	0 / 49	No	10.6	0 / 49	--	--
Naphthalene	15 / 81	mg/kg	0.005	0.46	0.002	0.06	0.165	0.62	0.119	0.019	0.197	0.62	0.216	X*	0.126	665	0 / 81	No	2389	0 / 81	No	6646	0 / 81	--	--
Pyrene	21 / 49	mg/kg	0.33	0.47	0.031	0.286	0.205	3.1	0.519	0.031	0.489	3.1	0.758	X*	0.625	9973	0 / 49	No	35,888	0 / 49	No	99,732	0 / 49	--	--
Radionuclides																									
Americium-241	2 / 2	pCi/g	--	--	0.056	0.078	0.078	0.101	0.032	0.056	0.078	0.101	0.032	D	--	21.9	0 / 2	--	34.5	0 / 2	--	219	0 / 2	--	--
Cesium-134	0 / 8	pCi/g	-0.179	0.522	-0.179	0.089	0.023	0.522	0.251	--	--	--	--	N	0.257	0.33	0 / 8	No	0.44	0 / 8	No	3.3	0 / 8	--	--
Cesium-137	0 / 19	pCi/g	-0.117	0.127	-0.117	-0.013	-0.018	0.127	0.059	--	--	--	--	N	0.011	0.92	0 / 19	No	1.23	0 / 19	No	9.2	0 / 19	--	--
Neptunium-237	0 / 13	pCi/g	-0.017	0.03	-0.017	0.007	0.009	0.03	0.015	--	--	--	--	N	0.014	2.74	0 / 13	No	3.72	0 / 13	No	27.4	0 / 13	--	--
Potassium-40	19 / 19	pCi/g	--	--	6.49	20.2	19.3	42.2	9.0	6.49	20.2	42.2	9.0	N	23.7	2.85	**19 / 19**	**Yes**	3.85	**19 / 19**	**Yes**	28.5	**2 / 19**	32.1	**2 / 19**
Radium-226	19 / 19	pCi/g	--	--	0.846	1.24	1.09	2.06	0.344	0.846	1.24	2.06	0.344	L	1.39	0.27	**19 / 19**	**Yes**	0.36	**19 / 19**	**Yes**	2.7	0 / 19	1.25	**6 / 19**
Technetium-99	0 / 19	pCi/g	-0.308	4.12	-0.308	2.14	2.58	4.12	1.48	--	--	--	--	N	2.73	813	0 / 19	No	1354	0 / 19	No	8132	0 / 19	--	--
Thorium-228	13 / 13	pCi/g	--	--	1.16	1.67	1.74	2.08	0.255	1.16	1.67	2.08	0.255	N	1.79	21.0	0 / 13	No	34.9	0 / 13	No	210	0 / 13	1.86	**2 / 13**
Thorium-230	13 / 13	pCi/g	--	--	0.95	1.51	1.2	3.2	0.619	0.95	1.51	3.2	0.619	L	1.84	31.4	0 / 13	No	52.5	0 / 13	No	314	0 / 13	1.2	**6 / 13**

Table 16. ETTP Zone 1 DVS Soil summary statistics for K-1007 Group (2 to 10 ft) - continued

Constituent	Frequency of detection	Units	Non-detect reporting limits[a]		Detected																				
			Min	Max	Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Min	Mean	Max	S.D.	Dist.	UCL 95	Adult RL	Detected freq. > adult RL	UCL95 > adult RL?	Child RL	Detected freq. > child RL	UCL95 > child RL?	Max RL	Detected freq. > max RL?	Back-ground	Detected freq. > bkgd
Thorium-232	13 / 13	pCi/g	--	--	1.12	1.65	1.73	2.09	0.266	1.12	1.65	2.09	0.266	N	1.78	27.6	0 / 13	No	46.3	0 / 13	No	276	0 / 13	1.95	1 / 13
Thorium-234	1 / 19	pCi/g	-2	3.86	-2	1.59	1.64	4.17	1.39	4.17	4.17	4.17	--	N	2.14	20.5	0 / 19	No	27.5	0 / 19	No	205	0 / 19	--	--
Uranium-234	19 / 19	pCi/g	--	--	0.927	1.57	1.52	2.52	0.525	0.927	1.57	2.52	0.525	L	1.82	40.4	0 / 19	No	67.7	0 / 19	No	404	0 / 19	--	--
Uranium-235	12 / 19	pCi/g	0.023	0.126	0.023	0.12	0.117	0.3	0.056	0.072	0.147	0.3	0.057	N*	0.144	39.3	0 / 19	No	66.0	0 / 19	No	393	0 / 19	--	--
Uranium-238	19 / 19	pCi/g	--	--	0.825	1.48	1.47	2.19	0.388	0.825	1.48	2.19	0.388	N	1.63	12.3	0 / 19	No	17.9	0 / 19	No	123	0 / 19	1.47	9 / 19

[a] One-half of the reporting limits shown are used as proxy values for organics and inorganics. The reporting limits shown are used as proxy values for non-detect radionuclides.
[b] This summary statistic is calculated using both detects and non-detects. The Kaplan-Meier mean and standard deviation are reported for Kaplan-Meier UCL95.
Background values are from Table 4 from *Soil Background Supplemental Data Set for the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2105&D1).
Dist. = distribution. Distribution flags are defined as:
D = UCL95 is not calculated with fewer than five samples.
G = gamma; UCL95 is calculated using the adjusted or unadjusted gamma as described in ProUCL.
L = lognormal; UCL95 is calculated using Land's statistic or Chebyshev minimum variance unbiased estimator.
N = normal; UCL95 is calculated using t statistic.
X = neither normal, lognormal, nor gamma; UCL95 is calculated using a nonparametric bootstrap or the nonparametric Chebyshev inequality method.
DVS = Dynamic Verification Strategy.
ETTP = East Tennessee Technology Park.
mg/kg = milligrams per kilogram.
pCi/g = picocuries per gram.
RL = remediation level. Recreational RL is the smaller of the adult and child RL. Max RL is 10 times the recreational RL.
S.D. = standard deviation.
UCL95 = upper confidence limit on the mean concentration with 95% confidence.
-- = Not applicable, not available or insufficient data to calculate the statistic.
* Kaplan-Meier estimates of the overall mean, standard deviation, and UCL95 are shown for chemicals with both non-detects and at least two detects.

Table 17. ETTP Zone 1 DVS Soil summary statistics for K-1007 Group (> 10 ft)

Constituent	Frequency of Detection	Units	Non-detect reporting limits[a] Min	Non-detect reporting limits[a] Max	Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Detected Min	Detected Mean	Detected Max	Detected S.D.	Dist.	UCL 95	Adult RL	Detected freq. > adult RL	UCL95 > adult RL?	Child RL	Detected freq. > child RL	UCL95 > child RL?	Max RL	Detected freq. > max RL?	Back-ground	Detected freq. > bkgd
K-1007 Group (> 10 ft)																									
Semivolatile Organics																									
Naphthalene	3 / 6	mg/kg	0.005	0.006	0.002	0.003	0.003	0.004	7.3E-04	0.002	0.003	0.004	9.0E-04	N*	0.004	665	0 / 6	No	2389	0 / 6	No	6646	0 / 6	–	–

[a] One-half of the reporting limits shown are used as proxy values for organics and inorganics. The reporting limits shown are used as proxy values for non-detect radionuclides.
[b] This summary statistic is calculated using both detects and non-detects. The Kaplan-Meier mean and standard deviation are reported for Kaplan-Meier UCL95.
Background values are from Table 4 from *Soil Background Supplemental Data Set for the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2105&D1).
Dist. = distribution. Distribution flags are defined as:
N = normal; UCL95 is calculated using t statistic.
DVS = Dynamic Verification Strategy.
ETTP = East Tennessee Technology Park.
mg/kg = milligrams per kilogram.
RL = remediation level. Recreational RL is the smaller of the adult and child RL. Max RL is 10 times the recreational RL.
S.D. = standard deviation.
UCL95 = upper confidence limit on the mean concentration with 95% confidence.
– = Not applicable, not available or insufficient data to calculate the statistic.
* Kaplan-Meier estimates of the overall mean, standard deviation, and UCL95 are shown for chemicals with both non-detects and at least two detects.

Table 18. ETTP Zone 1 DVS soil summary statistics for Powerhouse Group (0 to 2 ft)

Constituent	Frequency of detection	Units	Non-detect reporting limits[a]		Detected																					
			Min	Max	Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Min	Mean	Max	S.D.	Dist.	UCL 95	Adult RL	Detected freq. > adult RL	UCL95 > adult RL?	Child RL	Detected freq. > child RL	UCL95 > child RL?	Max RL	Detected freq. > max RL?	Back-ground	Detected freq. > bkgd
Powerhouse Group (0 to 2 ft)																										
Metals																										
Aluminum	266 / 266	mg/kg	--	--	1700	10,550	10,000	27,000	4440	1700	10,550	27,000	4440	X	11,737	415,514	0 / 266	No	181,199	0 / 266	No	1.8E+06	0 / 266	40,300	0 / 266
Antimony	248 / 259	mg/kg	0.002	0.434	0.001	0.315	0.119	5.8	0.797	0.006	0.326	5.8	0.814	X*	0.531	98.2	0 / 259	No	38.9	0 / 259	No	389	0 / 259	1.52	13 / 259
Arsenic	265 / 266	mg/kg	0.39	0.39	0.195	13.2	8.55	210	16.3	1.8	13.3	210	16.3	X*	17.6	1.83	264 / 266	Yes	7.2	172 / 266	Yes	18.3	45 / 266	15.0	61 / 266
Barium	266 / 266	mg/kg	--	--	9.4	85.1	67	420	63.3	9.4	85.1	420	63.3	X	102	33,960	0 / 266	No	13,531	0 / 266	No	135,309	0 / 266	125	34 / 266
Beryllium	271 / 272	mg/kg	1	1	0.17	0.646	0.565	3	0.32	0.17	0.647	3	0.321	L*	0.674	2.67	1 / 272	No	2.88	1 / 272	No	26.7	0 / 272	2.2	1 / 272
Cadmium	264 / 266	mg/kg	0.045	0.05	0.023	1.57	1.3	18	1.77	0.039	1.58	18	1.78	X*	2.04	93.8	0 / 266	No	163	0 / 266	No	938	0 / 266	0.22	235 / 266
Chromium	266 / 266	mg/kg	--	--	3.9	19.0	16	310	20.9	3.9	19.0	310	20.9	X	24.5	737,019	0 / 266	No	291,411	0 / 266	No	2.9E+06	0 / 266	44.9	4 / 266
Cobalt	266 / 266	mg/kg	--	--	0.53	9.82	8.05	64	7.62	0.53	9.82	64	7.62	L	10.6	141	0 / 266	No	57.3	1 / 266	No	573	0 / 266	42	3 / 266
Copper	266 / 266	mg/kg	--	--	2.9	35.3	14	1600	117	2.9	35.3	1600	117	X	66.6	19,654	0 / 266	No	7771	0 / 266	No	77,710	0 / 266	22.5	70 / 266
Lead	266 / 266	mg/kg	--	--	3.4	120	23.3	15,000	942	3.4	120	15,000	942	X	372	--	--	--	--	--	--	11,000	1 / 266	37.9	66 / 266
Lithium	261 / 261	mg/kg	--	--	2.5	10.8	8.1	100	10.4	2.5	10.8	100	10.4	X	13.6	983	0 / 261	No	389	0 / 261	No	3886	0 / 261	48.9	4 / 261
Mercury	234 / 266	mg/kg	7.8E-04	0.15	3.9E-04	0.133	0.08	4.3	0.286	0.015	0.147	4.3	0.303	X*	0.21	147	0 / 266	No	58.3	0 / 266	No	583	0 / 266	0.17	44 / 266
Molybdenum	195 / 261	mg/kg	0.16	1.7	0.08	1.34	0.85	22	1.92	0.19	1.61	22	2.16	X*	1.87	2457	0 / 261	No	971	0 / 261	No	9714	0 / 261	--	--
Nickel	266 / 266	mg/kg	--	--	2.6	25.4	11.3	2000	124	2.6	25.4	2000	124	X	58.6	9827	0 / 266	No	3885	0 / 266	No	38,855	0 / 266	26.1	44 / 266
Phosphorous	2 / 2	mg/kg	--	--	321	402	402	482	114	321	402	482	114	D	--	9.83	2 / 2	--	3.89	2 / 2	--	38.9	2 / 2	--	--
Silver	98 / 266	mg/kg	0.043	1.3	0.022	0.319	0.123	30	1.89	0.061	0.719	30	3.09	X*	0.827	2457	0 / 266	No	971	0 / 266	No	9714	0 / 266	0.6	12 / 266
Uranium	267 / 267	mg/kg	--	--	0.18	1.5	1.2	13	1.21	0.18	1.5	13	1.21	X	1.82	295	0 / 267	No	117	0 / 267	No	1166	0 / 267	--	--
Polychlorinated biphenyls																										
PCB-1248	3 / 255	mg/kg	0.004	7.3	0.002	0.024	0.01	3.65	0.016	0.022	0.131	0.262	0.121	X*	0.029	0.36	0 / 255	No	3.7	0 / 255	No	3.6	0 / 255	--	--
PCB-1254	26 / 255	mg/kg	0.004	7.3	0.002	0.026	0.01	3.65	0.108	0.005	0.185	1.1	0.299	X*	0.057	0.36	3 / 255	No	3.7	0 / 255	No	3.6	0 / 255	--	--
PCB-1260	95 / 255	mg/kg	0.004	7.3	0.002	0.083	0.011	6.2	0.423	0.005	0.204	6.2	0.679	X*	0.199	0.36	10 / 255	No	3.7	1 / 255	No	3.6	1 / 255	--	--
Polychlorinated biphenyl	99 / 251	mg/kg	0.004	0.35	0.002	0.216	0.011	30	1.94	0.005	0.531	30	3.08	X*	0.752	0.36	10 / 251	Yes	3.7	2 / 251	No	3.6	2 / 251	--	--
Semivolatile organics																										
Benz(*a*)anthracene	95 / 175	mg/kg	0.348	1.47	0.017	3.26	0.205	210	19.2	0.017	5.92	210	25.9	X*	9.62	1.06	18 / 175	Yes	10.4	7 / 175	No	10.6	7 / 175	--	--
Benzo(*a*)pyrene	95 / 174	mg/kg	0.039	1.47	0.016	2.53	0.205	160	14.7	0.016	4.55	160	19.7	X*	7.4	0.11	54 / 174	Yes	1.04	19 / 174	Yes	1.1	18 / 174	--	--
Benzo(*b*)fluoranthene	97 / 175	mg/kg	0.35	1.47	0.022	4.23	0.205	270	24.6	0.022	7.54	270	32.8	X*	12.4	1.06	22 / 175	Yes	10.4	8 / 175	Yes	10.6	8 / 175	--	--
Benzo(*k*)fluoranthene	75 / 175	mg/kg	0.348	1.47	0.021	1.48	0.205	71	7.4	0.021	3.27	71	11.1	X*	3.93	10.6	5 / 175	No	104	0 / 175	No	106	0 / 175	--	--
Chrysene	86 / 175	mg/kg	0.35	1.47	0.013	2.77	0.205	160	15.5	0.013	5.5	160	21.9	X*	7.9	106	2 / 175	No	1043	0 / 175	No	1063	0 / 175	--	--
Dibenz(*a,h*)anthracene	19 / 170	mg/kg	0.039	1.47	0.02	0.452	0.205	19	1.92	0.029	2.99	19	5.19	X*	1.12	0.11	17 / 170	Yes	1.04	7 / 170	Yes	1.1	6 / 170	--	--
Dibenzofuran	48 / 175	mg/kg	0.348	1.47	0.019	0.652	0.205	48	3.77	0.019	2.08	48	7.08	X*	1.91	1965	0 / 175	No	777	0 / 175	No	7771	0 / 175	--	--
Fluoranthene	103 / 175	mg/kg	0.35	0.46	0.021	8.52	0.205	770	61.5	0.021	14.4	770	80.0	X*	28.9	13,298	0 / 175	No	47,851	0 / 175	No	132,976	0 / 175	--	--
Indeno(*1,2,3-cd*)pyrene	52 / 174	mg/kg	0.348	1.47	0.045	1.1	0.205	46	5.14	0.045	3.29	46	9.11	X*	2.81	1.06	15 / 174	Yes	10.4	4 / 174	No	10.6	4 / 174	--	--
Naphthalene	78 / 218	mg/kg	0.005	1.47	0.002	1.69	0.195	250	17.0	0.016	4.66	250	28.3	X*	6.74	665	0 / 218	No	2389	0 / 218	No	6646	0 / 218	--	--
Pyrene	96 / 175	mg/kg	0.35	0.46	0.014	5.52	0.205	420	34.9	0.014	10.0	420	46.9	X*	17.1	9973	0 / 175	No	35,888	0 / 175	No	99,732	0 / 175	--	--
Radionuclides																										
Americium-241	0 / 4	pCi/g	-0.004	0.008	-0.004	0.003	0.004	0.008	0.006	--	--	--	--	O	--	21.9	0 / 4	--	34.5	0 / 4	--	219	0 / 4	--	--
Cesium-134	0 / 4	pCi/g	-0.004	0.071	-0.004	0.029	0.024	0.071	0.032	--	--	--	--	O	--	0.33	0 / 4	--	0.44	0 / 4	--	3.3	0 / 4	--	--
Cesium-137	35 / 94	pCi/g	-0.129	0.397	-0.129	0.19	0.156	5.1	0.545	0.019	0.46	5.1	0.835	X*	0.439	0.92	2 / 94	No	1.23	1 / 94	No	9.2	0 / 94	--	--
Europium-152	0 / 1	pCi/g	1.23	1.23	1.23	1.23	1.23	1.23	--	--	--	--	--	O	--	0.44	0 / 1	--	0.59	0 / 1	--	4.4	0 / 1	--	--
Europium-155	0 / 2	pCi/g	0.459	0.61	0.459	0.535	0.535	0.61	0.107	--	--	--	--	O	--	18.6	0 / 2	--	25	0 / 2	--	186	0 / 2	--	--
Neptunium-237	5 / 84	pCi/g	-0.074	0.103	-0.074	0.117	0.007	0.199	0.011	0.115	0.153	0.199	0.031	L*	0.12	2.74	0 / 84	No	3.72	0 / 84	No	27.4	0 / 84	--	--
Potassium-40	78 / 84	pCi/g	2.37	4.97	2.37	11.1	9.6	35.4	6.24	2.62	11.7	35.4	6.1	L*	12.6	2.85	77 / 84	Yes	3.85	77 / 84	Yes	28.5	2 / 84	32.1	1 / 84
Radium-226	65 / 68	pCi/g	0.045	0.4	0.045	0.946	0.84	3.47	0.539	0.26	0.977	3.47	0.535	X*	1.23	0.27	64 / 68	Yes	0.36	63 / 68	Yes	2.7	2 / 68	1.25	9 / 68
Sodium-22	1 / 1	pCi/g	--	--	0.18	0.18	0.18	0.18	--	0.18	0.18	0.18	--	D	--	0.23	0 / 1	--	0.3	0 / 1	--	2.3	0 / 1	--	--
Technetium-99	4 / 92	pCi/g	-5.07	5.51	-5.07	1.42	0.953	27.3	2.81	1.05	9.5	27.3	12.3	X*	2.9	813	0 / 92	No	1354	0 / 92	No	8132	0 / 92	--	--

Table 18. ETTP Zone 1 DVS soil summary statistics for Powerhouse Group (0 to 2 ft) - continued

Constituent	Frequency of detection	Units	Non-detect reporting limits[a]		Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Detected				Dist.	UCL 95	Adult RL	Detected freq. > adult RL	UCL95 > adult RL?	Child RL	Detected freq. > child RL	UCL95 > child RL?	Max RL	Detected freq. > max RL?	Back-ground	Detected freq. > bkgd
			Min	Max						Min	Mean	Max	S.D.												
Thorium-228	89 / 92	pCi/g	0.046	0.513	0.046	1.2	1.17	3.17	0.49	0.388	1.22	3.17	0.479	X*	1.42	21.0	0 / 92	No	34.9	0 / 92	No	210	0 / 92	1.86	**7 / 92**
Thorium-230	89 / 92	pCi/g	0.273	0.39	0.273	1.45	1.15	6.8	1.08	0.522	1.48	6.8	1.09	X*	1.94	31.4	0 / 92	No	52.5	0 / 92	No	314	0 / 92	1.2	**43 / 92**
Thorium-232	91 / 92	pCi/g	0.079	0.079	0.079	1.18	1.12	3.17	0.496	0.246	1.19	3.17	0.492	X*	1.4	27.6	0 / 92	No	46.3	0 / 92	No	276	0 / 92	1.95	**5 / 92**
Thorium-234	15 / 92	pCi/g	-2.77	3.21	-2.77	1.25	1.16	19.7	2.69	0.569	4.62	19.7	5.74	X*	2.52	20.5	0 / 92	No	27.5	0 / 92	No	205	0 / 92	--	--
Uranium-234	71 / 71	pCi/g	--	--	0.565	1.75	1.26	15.8	1.98	0.565	1.75	15.8	1.98	X	2.77	40.4	0 / 71	No	67.7	0 / 71	No	404	0 / 71	--	--
Uranium-235	42 / 90	pCi/g	-0.401	1.18	-0.401	0.114	0.079	1.18	0.126	0.047	0.184	0.812	0.157	L*	0.123	39.3	0 / 90	No	66.0	0 / 90	No	393	0 / 90	--	--
Uranium-238	94 / 94	pCi/g	--	--	0.471	1.92	1.19	21.1	2.85	0.471	1.92	21.1	2.85	X	3.2	12.3	**2 / 94**	No	17.9	**1 / 94**	No	123	0 / 94	1.47	**24 / 94**

[a] One-half of the reporting limits shown are used as proxy values for organics and inorganics. The reporting limits shown are used as proxy values for non-detect radionuclides.
[b] This summary statistic is calculated using both detects and non-detects. The Kaplan-Meier mean and standard deviation are reported for Kaplan-Meier UCL95.
Background values are from Table 4 from *Soil Background Supplemental Data Set for the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2105&D1).
Dist. = distribution. Distribution flags are defined as:
D = UCL95 is not calculated with fewer than 5 samples.
L = lognormal; UCL95 is calculated using Land's statistic or Chebyshev minimum variance unbiased estimator.
O = no detected results to calculate some summary statistics.
X = neither normal, lognormal, nor gamma; UCL95 is calculated using a nonparametric bootstrap or the nonparametric Chebyshev inequality method.
DVS = Dynamic Verification Strategy.
ETTP = East Tennessee Technology Park.
mg/kg = milligrams per kilogram.
pCi/g = picocuries per gram.
RL = Remediation level. Recreational RL is the smaller of the adult and child RL. Max RL is 10 times the recreational RL.
S.D. = standard deviation.
UCL95 = upper confidence limit on the mean concentration with 95% confidence.
-- = Not applicable, not available or insufficient data to calculate the statistic.
* Kaplan-Meier estimates of the overall mean, standard deviation, and UCL95 are shown for chemicals with both non-detects and at least two detects.

Table 19. ETTP Zone 1 DVS Soil summary statistics for Powerhouse Group (2 to 10 ft)

Constituent	Frequency of detection	Units	Non-detect reporting limits[a] Min	Non-detect reporting limits[a] Max	Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Detected Min	Detected Mean	Detected Max	Detected S.D.	Dist.	UCL 95	Adult RL	Detected freq. > adult RL	UCL95 > adult RL?	Child RL	Detected freq. > child RL	UCL95 > child RL?	Max RL	Detected freq. > max RL?	Background	Detected freq. > bkgd
Powerhouse Group (2 to 10 ft)																									
Metals																									
Aluminum	74 / 74	mg/kg	--	--	2400	12,192	12,000	25,900	4706	2400	12,192	25,900	4706	X	14,576	415,514	0 / 74	No	181,199	0 / 74	No	1.8E+06	0 / 74	40,300	0 / 74
Antimony	68 / 68	mg/kg	--	--	0.008	0.09	0.068	0.28	0.068	0.008	0.09	0.28	0.068	L	0.115	98.2	0 / 68	No	38.9	0 / 68	No	389	0 / 68	1.52	0 / 68
Arsenic	74 / 74	mg/kg	--	--	1.6	10.7	7.55	84	12.8	1.6	10.7	84	12.8	X	17.1	1.83	**73 / 74**	**Yes**	7.2	**40 / 74**	**Yes**	18.3	**7 / 74**	15.0	**10 / 74**
Barium	74 / 74	mg/kg	--	--	18	69.7	63	210	39.9	18	69.7	210	39.9	L	78.4	33,960	0 / 74	No	13,531	0 / 74	No	135,309	0 / 74	125	**5 / 74**
Beryllium	74 / 74	mg/kg	--	--	0.2	0.591	0.52	1.5	0.265	0.2	0.591	1.5	0.265	L	0.643	2.67	0 / 74	No	2.88	0 / 74	No	26.7	0 / 74	2.2	0 / 74
Cadmium	72 / 74	mg/kg	0.036	0.053	0.018	1.13	1.1	3	0.759	0.044	1.16	3	0.753	X*	1.51	93.8	0 / 74	No	163	0 / 74	No	938	0 / 74	0.22	**62 / 74**
Chromium	74 / 74	mg/kg	--	--	5.5	16.8	16	33	6.0	5.5	16.8	33	6.0	G	18.0	737,019	0 / 74	No	291,411	0 / 74	No	2.9E+06	0 / 74	44.9	0 / 74
Cobalt	74 / 74	mg/kg	--	--	0.97	9.33	8	44	6.9	0.97	9.33	44	6.9	L	11.3	141	0 / 74	No	57.3	0 / 74	No	573	0 / 74	42	**1 / 74**
Copper	74 / 74	mg/kg	--	--	3.6	13.4	12	39	7.46	3.6	13.4	39	7.46	L	14.9	19,654	0 / 74	No	7771	0 / 74	No	77,710	0 / 74	22.5	**9 / 74**
Lead	74 / 74	mg/kg	--	--	0.65	23.9	17.5	250	30.8	0.65	23.9	250	30.8	X	39.4	--	--	--	--	--	--	11,000	0 / 74	37.9	**6 / 74**
Lithium	74 / 74	mg/kg	--	--	2.9	9.08	7.15	46	6.38	2.9	9.08	46	6.38	X	12.3	983	0 / 74	No	389	0 / 74	No	3886	0 / 74	48.9	0 / 74
Mercury	67 / 74	mg/kg	0.04	0.11	0.002	0.181	0.06	7.1	0.828	0.002	0.196	7.1	0.875	X*	0.604	147	0 / 74	No	58.3	0 / 74	No	583	0 / 74	0.17	**4 / 74**
Molybdenum	49 / 74	mg/kg	0.16	1.6	0.08	0.884	0.61	3.4	0.692	0.15	1.08	3.4	0.755	X*	1.25	2457	0 / 74	No	971	0 / 74	No	9714	0 / 74	--	--
Nickel	74 / 74	mg/kg	--	--	3.2	11.1	9.55	47	7.02	3.2	11.1	47	7.02	X	14.7	9827	0 / 74	No	3885	0 / 74	No	38,855	0 / 74	26.1	**2 / 74**
Silver	33 / 74	mg/kg	0.007	0.62	0.004	0.139	0.118	0.86	0.143	0.046	0.229	0.86	0.165	X*	0.216	2457	0 / 74	No	971	0 / 74	No	9714	0 / 74	0.6	**1 / 74**
Uranium	74 / 74	mg/kg	--	--	0.35	1.16	1	4.8	0.624	0.35	1.16	4.8	0.624	X	1.48	295	0 / 74	No	117	0 / 74	No	1166	0 / 74	--	--
Polychlorinated biphenyls																									
PCB-1248	0 / 73	mg/kg	0.004	0.2	0.002	0.014	0.01	0.1	0.016	--	--	--	--	O	--	0.36	0 / 73	--	3.7	0 / 73	--	3.6	0 / 73	--	--
PCB-1254	5 / 73	mg/kg	0.004	0.2	0.002	0.038	0.01	0.96	0.132	0.013	0.379	0.96	0.402	X*	0.114	0.36	**2 / 73**	No	3.7	0 / 73	No	3.6	0 / 73	--	--
PCB-1260	12 / 73	mg/kg	0.004	0.082	0.002	0.084	0.01	2.3	0.343	0.009	0.458	2.3	0.775	X*	0.267	0.36	**3 / 73**	No	3.7	0 / 73	No	3.6	0 / 73	--	--
Polychlorinated biphenyl	16 / 73	mg/kg	0.004	0.024	0.002	0.112	0.01	2.8	0.426	0.009	0.471	2.8	0.842	X*	0.337	0.36	**4 / 73**	No	3.7	0 / 73	No	3.6	0 / 73	--	--
Semivolatile organics																									
Benz(*a*)anthracene	19 / 57	mg/kg	0.041	0.49	0.021	1.02	0.2	28	4.21	0.021	2.88	28	7.11	X*	3.51	1.06	**5 / 57**	**Yes**	10.4	**2 / 57**	No	10.6	**2 / 57**	--	--
Benzo(*a*)pyrene	21 / 57	mg/kg	0.041	0.49	0.017	0.899	0.2	23	3.53	0.017	2.32	23	5.68	X*	2.99	0.11	**9 / 57**	**Yes**	1.04	**6 / 57**	**Yes**	1.1	**6 / 57**	--	--
Benzo(*b*)fluoranthene	21 / 57	mg/kg	0.041	0.49	0.021	1.32	0.2	32	4.99	0.029	3.43	32	7.98	X*	4.28	1.06	**6 / 57**	**Yes**	10.4	**2 / 57**	No	10.6	**2 / 57**	--	--
Benzo(*k*)fluoranthene	11 / 57	mg/kg	0.041	0.49	0.021	0.618	0.205	15	2.31	0.032	2.88	15	4.84	X*	2.02	10.6	**1 / 57**	No	104	0 / 57	No	106	0 / 57	--	--
Chrysene	17 / 57	mg/kg	0.041	0.49	0.02	0.867	0.2	22	3.4	0.02	2.68	22	6.01	X*	2.89	106	0 / 57	No	1043	0 / 57	No	1063	0 / 57	--	--
Dibenz(*a,h*)anthracene	4 / 57	mg/kg	0.041	0.87	0.021	0.334	0.205	3.1	0.386	0.26	1.19	3.1	1.33	X*	0.594	0.11	**4 / 57**	**Yes**	1.04	**2 / 57**	No	1.1	**1 / 57**	--	--
Dibenzofuran	11 / 57	mg/kg	0.35	0.49	0.023	0.236	0.205	5	0.718	0.023	0.809	5	1.57	X*	0.689	1965	0 / 57	No	777	0 / 57	No	7771	0 / 57	--	--
Fluoranthene	23 / 57	mg/kg	0.34	0.49	0.016	2.07	0.2	67	9.58	0.016	4.98	67	14.9	X*	7.73	13,298	0 / 57	No	47,851	0 / 57	No	132,976	0 / 57	--	--
Indeno(*1,2,3-cd*)pyrene	10 / 57	mg/kg	0.041	0.49	0.021	0.378	0.205	10	1.42	0.052	1.83	10	3.15	X*	1.24	1.06	**4 / 57**	**Yes**	10.4	0 / 57	No	10.6	0 / 57	--	--
Naphthalene	22 / 92	mg/kg	0.005	0.49	0.002	0.281	0.153	14	1.52	0.005	1.11	14	3.03	X*	0.989	665	0 / 92	No	2389	0 / 92	No	6646	0 / 92	--	--
Pyrene	19 / 57	mg/kg	0.041	0.49	0.021	1.53	0.205	42	6.28	0.031	4.38	42	10.6	X*	5.25	9973	0 / 57	No	35,888	0 / 57	No	99,732	0 / 57	--	--
Radionuclides																									
Americium-241	0 / 1	pCi/g	0.063	0.063	0.063	0.063	0.063	0.063	--	--	--	--	--	O	--	21.9	0 / 1	--	34.5	0 / 1	--	219	0 / 1	--	--
Cesium-137	1 / 37	pCi/g	-0.155	0.235	-0.155	0.037	0.025	0.677	0.133	0.677	0.677	0.677	--	L	0.124	0.92	0 / 37	No	1.23	0 / 37	No	9.2	0 / 37	--	--
Europium-152	0 / 2	pCi/g	0.988	1.31	0.988	1.15	1.15	1.31	0.228	--	--	--	--	O	--	0.44	0 / 2	--	0.59	0 / 2	--	4.4	0 / 2	--	--
Manganese-54	1 / 1	pCi/g	--	--	0.159	0.159	0.159	0.159	--	0.159	0.159	0.159	--	D	--	0.6	0 / 1	--	0.81	0 / 1	--	6	0 / 1	--	--
Neptunium-237	2 / 37	pCi/g	-0.101	0.071	-0.101	0.111	0.011	0.132	0.004	0.11	0.121	0.132	0.016	N*	0.112	2.74	0 / 37	No	3.72	0 / 37	No	27.4	0 / 37	--	--
Potassium-40	37 / 37	pCi/g	--	--	4.78	12.6	11	34.7	6.3	4.78	12.6	34.7	6.3	L	14.7	2.85	**37 / 37**	**Yes**	3.85	**37 / 37**	**Yes**	28.5	**1 / 37**	32.1	**1 / 37**
Radium-226	30 / 30	pCi/g	--	--	0.269	1.69	1.03	6.5	1.68	0.269	1.69	6.5	1.68	X	3.03	0.27	**29 / 30**	**Yes**	0.36	**29 / 30**	**Yes**	2.7	**5 / 30**	1.25	**9 / 30**
Technetium-99	1 / 37	pCi/g	-1.71	7.35	-1.71	1.69	1.37	7.35	2.18	2.12	2.12	2.12	--	N	2.3	813	0 / 37	No	1354	0 / 37	No	8132	0 / 37	--	--
Thorium-228	37 / 37	pCi/g	--	--	0.64	1.58	1.49	3.51	0.643	0.64	1.58	3.51	0.643	L	1.78	21.0	0 / 37	No	34.9	0 / 37	No	210	0 / 37	1.86	**6 / 37**
Thorium-230	37 / 37	pCi/g	--	--	0.501	1.86	1.11	7.61	1.91	0.501	1.86	7.61	1.91	X	3.23	31.4	0 / 37	No	52.5	0 / 37	No	314	0 / 37	1.2	**13 / 37**
Thorium-232	37 / 37	pCi/g	--	--	0.675	1.55	1.41	3.62	0.664	0.675	1.55	3.62	0.664	L	1.73	27.6	0 / 37	No	46.3	0 / 37	No	276	0 / 37	1.95	**6 / 37**

Table 19. ETTP Zone 1 DVS Soil summary statistics for Powerhouse Group (2 to 10 ft) - continued

Constituent	Frequency of detection	Units	Non-detect reporting limits[a]		Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Detected				Dist.	UCL 95	Adult RL	Detected freq. > adult RL	UCL95 > adult RL?	Child RL	Detected freq. > child RL	UCL95 > child RL?	Max RL	Detected freq. > max RL?	Back-ground	Detected freq. > bkgd
			Min	Max						Min	Mean	Max	S.D.												
Thorium-234	6 / 37	pCi/g	-1.44	3.98	-1.44	1.73	1.4	6.35	1.17	1.32	3.8	6.35	1.99	L*	1.91	20.5	0 / 37	No	27.5	0 / 37	No	205	0 / 37	--	--
Uranium-234	33 / 33	pCi/g	--	--	0.828	1.99	1.33	8.05	1.75	0.828	1.99	8.05	1.75	X	3.32	40.4	0 / 33	No	67.7	0 / 33	No	404	0 / 33	--	--
Uranium-235	21 / 37	pCi/g	-0.151	0.4	-0.151	0.188	0.127	0.788	0.169	0.066	0.277	0.788	0.181	L*	0.245	39.3	0 / 37	No	66.0	0 / 37	No	393	0 / 37	--	--
Uranium-238	37 / 37	pCi/g	--	--	0.806	1.87	1.19	8.04	1.75	0.806	1.87	8.04	1.75	X	3.12	12.3	0 / 37	No	17.9	0 / 37	No	123	0 / 37	1.47	12 / 37

[a] One-half of the reporting limits shown are used as proxy values for organics and inorganics. The reporting limits shown are used as proxy values for non-detect radionuclides.
[b] This summary statistic is calculated using both detects and non-detects. The Kaplan-Meier mean and standard deviation are reported for Kaplan-Meier UCL95.
Background values are from Table 4 from *Soil Background Supplemental Data Set for the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2105&D1).
Dist. = distribution. Distribution flags are defined as:
D = UCL95 is not calculated with fewer than 5 samples.
G = gamma; UCL95 is calculated using the adjusted or unadjusted gamma as described in ProUCL.
L = lognormal; UCL95 is calculated using Land's statistic or Chebyshev minimum variance unbiased estimator.
N = normal; UCL95 is calculated using t statistic.
O = no detected results to calculate some summary statistics.
X = neither normal, lognormal, nor gamma; UCL95 is calculated using a nonparametric bootstrap or the nonparametric Chebyshev inequality method.
DVS = Dynamic Verification Strategy.
ETTP = East Tennessee Technology Park.
mg/kg = milligrams per kilogram.
pCi/g = picocuries per gram.
RL = remediation level. Recreational RL is the smaller of the adult and child RL. Max RL is 10 times the recreational RL.
S.D. = standard deviation.
UCL95 = upper confidence limit on the mean concentration with 95% confidence.
-- = Not applicable, not available or insufficient data to calculate the statistic.
* Kaplan-Meier estimates of the overall mean, standard deviation, and UCL95 are shown for chemicals with both non-detects and at least two detects.

Table 20. ETTP Zone 1 DVS soil summary statistics for Powerhouse Group (> 10 ft)

Constituent	Frequency of detection	Units	Non-detect reporting limits[a]		Detected																						
			Min	Max	Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Min	Mean	Max	S.D.	Dist.	UCL 95	Adult RL	Detected freq. > adult RL	UCL95 > adult RL?	Child RL	Detected freq. > child RL	UCL95 > child RL?	Max RL	Detected freq. > max RL?	Back-ground	Detected freq. > bkgd
Powerhouse Group (> 10 ft)																											
Metals																											
Aluminum	12 / 12	mg/kg	--	--	5900	21,125	20,200	45,400	9059	5900	21,125	45,400	9059	G	27,838	415,514	0 / 12	No	181,199	0 / 12	No	1.8E+06	0 / 12	40,300	1 / 12
Antimony	12 / 12	mg/kg	--	--	0.079	0.46	0.37	1.2	0.328	0.079	0.46	1.2	0.328	N	0.63	98.2	0 / 12	No	38.9	0 / 12	No	389	0 / 12	1.52	0 / 12
Arsenic	12 / 12	mg/kg	--	--	5.9	24.8	17.1	87.6	23.0	5.9	24.8	87.6	23.0	L	42.4	1.83	**12 / 12**	**Yes**	7.2	**10 / 12**	**Yes**	18.3	**4 / 12**	15.0	**10 / 12**
Barium	12 / 12	mg/kg	--	--	23	59.3	49.2	110	28.1	23	59.3	110	28.1	N	73.9	33,960	0 / 12	No	13,531	0 / 12	No	135,309	0 / 12	125	0 / 12
Beryllium	12 / 12	mg/kg	--	--	0.44	1.56	0.875	6.2	1.66	0.44	1.56	6.2	1.66	L	2.78	2.67	**2 / 12**	**Yes**	2.88	**2 / 12**	No	26.7	0 / 12	2.2	**2 / 12**
Cadmium	11 / 12	mg/kg	0.036	0.036	0.018	0.431	0.21	1.1	0.4	0.051	0.466	1.1	0.42	L*	1.65	93.8	0 / 12	No	163	0 / 12	No	938	0 / 12	0.22	**6 / 12**
Chromium	12 / 12	mg/kg	--	--	8.8	16.0	15.6	26.3	5.18	8.8	16.0	26.3	5.18	N	18.6	737,019	0 / 12	No	291,411	0 / 12	No	2.9E+06	0 / 12	44.9	0 / 12
Cobalt	12 / 12	mg/kg	--	--	4.1	22.9	13.1	67	21.6	4.1	22.9	67	21.6	L	44.9	141	0 / 12	No	57.3	**2 / 12**	No	573	0 / 12	42	**2 / 12**
Copper	12 / 12	mg/kg	--	--	5.7	64.0	23.8	239	80.9	5.7	64.0	239	80.9	L	201	19,654	0 / 12	No	7771	0 / 12	No	77,710	0 / 12	22.5	**6 / 12**
Lead	12 / 12	mg/kg	--	--	6.9	50.5	47.9	128	34.5	6.9	50.5	128	34.5	N	68.4	--	--	--	--	--	--	11,000	0 / 12	37.9	**8 / 12**
Lithium	12 / 12	mg/kg	--	--	4.6	33.7	31.7	60.6	17.2	4.6	33.7	60.6	17.2	N	42.6	983	0 / 12	No	389	0 / 12	No	3886	0 / 12	48.9	**2 / 12**
Mercury	11 / 12	mg/kg	0.037	0.037	0.013	0.098	0.094	0.24	0.061	0.013	0.106	0.24	0.06	N*	0.131	147	0 / 12	No	58.3	0 / 12	No	583	0 / 12	0.17	**1 / 12**
Molybdenum	10 / 12	mg/kg	0.74	1.2	0.37	3.63	1.55	17.5	4.48	1.2	4.11	17.5	5.02	L*	6.96	2457	0 / 12	No	971	0 / 12	No	9714	0 / 12	--	--
Nickel	12 / 12	mg/kg	--	--	5.4	30.4	19.3	75.5	26.0	5.4	30.4	75.5	26.0	L	69.2	9827	0 / 12	No	3885	0 / 12	No	38,855	0 / 12	26.1	**5 / 12**
Silver	10 / 12	mg/kg	0.12	0.12	0.06	0.151	0.125	0.32	0.064	0.1	0.16	0.32	0.069	N*	0.186	2457	0 / 12	No	971	0 / 12	No	9714	0 / 12	0.6	0 / 12
Uranium	12 / 12	mg/kg	--	--	0.3	3.45	2.8	9.8	2.41	0.3	3.45	9.8	2.41	G	5.54	295	0 / 12	No	117	0 / 12	No	1166	0 / 12	--	--
Polychlorinated biphenyls																											
PCB-1248	0 / 1	mg/kg	0.024	0.024	0.012	0.012	0.012	0.012	--	--	--	--	--	O	--	0.36	0 / 1	--	3.7	0 / 1	--	3.6	0 / 1	--	--
PCB-1254	0 / 1	mg/kg	0.024	0.024	0.012	0.012	0.012	0.012	--	--	--	--	--	O	--	0.36	0 / 1	--	3.7	0 / 1	--	3.6	0 / 1	--	--
PCB-1260	0 / 1	mg/kg	0.024	0.024	0.012	0.012	0.012	0.012	--	--	--	--	--	O	--	0.36	0 / 1	--	3.7	0 / 1	--	3.6	0 / 1	--	--
Polychlorinated biphenyl	0 / 1	mg/kg	0.024	0.024	0.012	0.012	0.012	0.012	--	--	--	--	--	O	--	0.36	0 / 1	--	3.7	0 / 1	--	3.6	0 / 1	--	--
Semivolatile organics																											
Benz(*a*)anthracene	0 / 12	mg/kg	0.39	0.53	0.195	0.225	0.223	0.265	0.021	--	--	--	--	O	--	1.06	0 / 12	--	10.4	0 / 12	--	10.6	0 / 12	--	--
Benzo(*a*)pyrene	0 / 12	mg/kg	0.39	0.53	0.195	0.225	0.223	0.265	0.021	--	--	--	--	O	--	0.11	0 / 12	--	1.04	0 / 12	--	1.1	0 / 12	--	--
Benzo(*b*)fluoranthene	0 / 12	mg/kg	0.39	0.53	0.195	0.225	0.223	0.265	0.021	--	--	--	--	O	--	1.06	0 / 12	--	10.4	0 / 12	--	10.6	0 / 12	--	--
Benzo(*k*)fluoranthene	0 / 12	mg/kg	0.39	0.53	0.195	0.225	0.223	0.265	0.021	--	--	--	--	O	--	10.6	0 / 12	--	104	0 / 12	--	106	0 / 12	--	--
Chrysene	0 / 12	mg/kg	0.39	0.53	0.195	0.225	0.223	0.265	0.021	--	--	--	--	O	--	106	0 / 12	--	1043	0 / 12	--	1063	0 / 12	--	--
Dibenz(*a,h*)anthracene	0 / 12	mg/kg	0.39	0.53	0.195	0.225	0.223	0.265	0.021	--	--	--	--	O	--	0.11	0 / 12	--	1.04	0 / 12	--	1.1	0 / 12	--	--
Dibenzofuran	0 / 12	mg/kg	0.39	0.53	0.195	0.225	0.223	0.265	0.021	--	--	--	--	O	--	1965	0 / 12	--	777	0 / 12	--	7771	0 / 12	--	--
Fluoranthene	0 / 12	mg/kg	0.39	0.53	0.195	0.225	0.223	0.265	0.021	--	--	--	--	O	--	13,298	0 / 12	--	47,851	0 / 12	--	132,976	0 / 12	--	--
Indeno(*1,2,3-cd*)pyrene	0 / 12	mg/kg	0.39	0.53	0.195	0.225	0.223	0.265	0.021	--	--	--	--	O	--	1.06	0 / 12	--	10.4	0 / 12	--	10.6	0 / 12	--	--
Naphthalene	0 / 17	mg/kg	0.005	0.53	0.003	0.16	0.215	0.265	0.106	--	--	--	--	O	--	665	0 / 17	--	2389	0 / 17	--	6646	0 / 17	--	--
Pyrene	0 / 12	mg/kg	0.39	0.53	0.195	0.225	0.223	0.265	0.021	--	--	--	--	O	--	9973	0 / 12	--	35,888	0 / 12	--	99,732	0 / 12	--	--

Table 20. ETTP Zone 1 DVS soil summary statistics for Powerhouse Group (> 10 ft) - continued

Constituent	Frequency of detection	Units	Non-detect reporting limits[a]		Detected																				
			Min	Max	Min[b]	Mean[b]	Median[b]	Max[b]	S.D.[b]	Min	Mean	Max	S.D.	Dist.	UCL 95	Adult RL	Detected freq. > adult RL	UCL95 > adult RL?	Child RL	Detected freq. > child RL	UCL95 > child RL?	Max RL	Detected freq. > max RL?	Back-ground	Detected freq. > bkgd
Volatile organics																									
Naphthalene	0 / 1	mg/kg	0.006	0.006	0.003	0.003	0.003	0.003	--	--	--	--	--	O	--	665	0 / 1	--	2389	0 / 1	--	6646	0 / 1	--	--

[a] One-half of the reporting limits shown are used as proxy values for organics and inorganics. The reporting limits shown are used as proxy values for non-detect radionuclides.
[b] This summary statistic is calculated using both detects and non-detects. The Kaplan-Meier mean and standard deviation are reported for Kaplan-Meier UCL95.
Background values are from Table 4 from *Soil Background Supplemental Data Set for the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2105&D1).
Dist. = distribution. Distribution flags are defined as:
G = gamma; UCL95 is calculated using the adjusted or unadjusted gamma as described in ProUCL.
L = lognormal; UCL95 is calculated using Land's statistic or Chebyshev minimum variance unbiased estimator.
N = normal; UCL95 is calculated using t statistic.
O = no detected results to calculate some summary statistics.
DVS = Dynamic Verification Strategy.
ETTP = East Tennessee Technology Park.
mg/kg = milligrams per kilogram.
RL = remediation level. Recreational RL is the smaller of the adult and child RL. Max RL is 10 times the recreational RL.
S.D. = standard deviation.
UCL95 = upper confidence limit on the mean concentration with 95% confidence.
-- = Not applicable, not available or insufficient data to calculate the statistic.
* Kaplan-Meier estimates of the overall mean, standard deviation, and UCL95 are shown for chemicals with both non-detects and at least two detects.

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APPENDIX C

SURFACE WATER EVALUATION

SURFACE WATER DECISION

The surface water Remedial Action Objectives (RAOs) are to prevent contaminant migration from soils and groundwater to adjacent surface water bodies in order to meet applicable or relevant and appropriate requirements (ARARs) [Tennessee ambient water quality criteria (AWQC)] in surface water, protect the aquatic environment, and protect recreational receptors.

The *Sitewide RI/FS* does not identify the soil in Zone 1 to be a source of surface water contamination. In order to verify that this analysis is still valid and to meet the surface water RAOs, the following activities were performed:

- Compared the storm water characterization data from 2005 to present against applicable AWQC and 4% of the DOE Order 5400.5 Derived Concentration Guide (DCG) (4% of the DCGs equates to drinking water levels), as an initial screening, to identify potential impacts of Zone 1 soils and groundwater on surface water discharges. The radiological screening criteria chosen were deliberately conservative in order to identify discharge areas that should be evaluated in more depth and to fulfill the as low as reasonably achievable objective within DOE Order 5400.5.

- Compared exceedances of the screening level criteria to surface water background data and sample results in the receiving waters of the respective ponds or river.

- Evaluated analytical results at the subwatershed level to determine the potential for legacy contribution of contaminants.

Data screening included the deletion of chlorine from the evaluation since chlorine is not listed as a legacy contaminant. The metals data was corrected to account for water hardness in accordance with AWQC.

The following water bodies (Fig. C-1) receiving storm drain discharges were evaluated:

- Oxbow Lake
- Beaver Dam Ponds in K-720 area
- Clinch River
- K-1007-P Ponds
- K-901-A Pond
- K-720 Slough

Since each of the water bodies drains distinct watersheds with different operations and, therefore, has different potential contaminants of concern, each of the water bodies is discussed in the following sections.

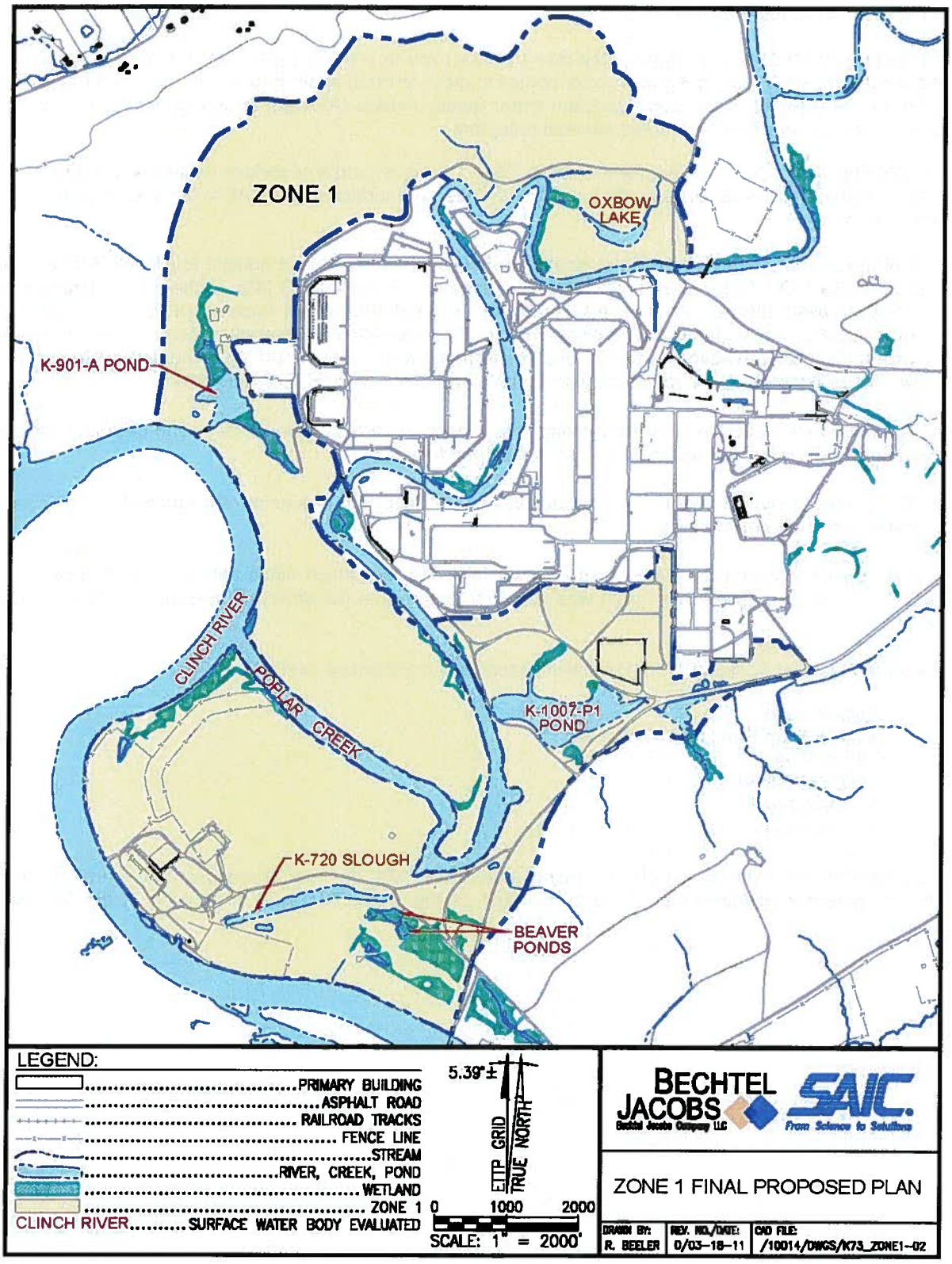


Fig. C-1. Zone 1 surface water bodies evaluated.

Oxbow Lake Surface Water

Oxbow Lake is on the north side of Zone 1 (Fig. C-1) and is comprised of two water bodies--a small pond to the north and a much larger pond to the south. Prior to ETTP site development, the two water bodies appear to have been joined as a cutoff meander of Poplar Creek. During site development and road construction, the northeast corner was back filled to create the two separate water bodies. Currently, both water bodies discharge into Poplar Creek through culvert pipes installed underneath gravel roads. There are no storm drains that discharge into either of the water bodies and, based upon a review of historical records, the area does not appear to have been heavily industrialized but was used for soil borrow and fill.

Due to the larger size of the southern water body and the similar industrial activities within the overall watershed, three surface water and sediment samples were collected from the southern water body to represent the water quality for Oxbow Lake. The eastern, middle, and western sample locations are shown in Fig. C-2 with blue diamond symbols.

The surface water samples were collected from the midpoint of the water column. The sediment samples were collected from the upper 1 foot of sediment using a grab sampling device.

Fig. C-2. Oxbow Lake Sample locations.

The sample results for the three water samples were below the AWQC as well as 4% of the DCG values for radiological constituents.

Beaver Ponds Surface Water

The two Beaver Ponds (Fig. C-1) located on the southern side of Zone 1 were formed in the 1980s and 1990s as beavers established dams and back waters in areas that were previously marshy wetlands.

The north pond is adjacent to an area that was historically used to store fly ash. The fly ash pile was covered in the 1990s. The pond to the south does not receive runoff from the fly ash pile. Neither of the ponds received storm water outfall discharges, so the evaluation focused on the water and sediment quality within the ponds.

Three sampling points selected to evaluate the Beaver Ponds are noted in Fig. C-3 with blue diamond symbols. Due to the proximity of the fly ash pile area, two surface water samples and two sediment samples were collected from the northern pond. Additionally, one surface water sample and one sediment sample were collected from the southern pond.

Fig. C-3. Beaver Pond Sampling Locations.

The sample results for the three water samples were below the AWQC as well as the 4% of the DCG values for radiological constituents.

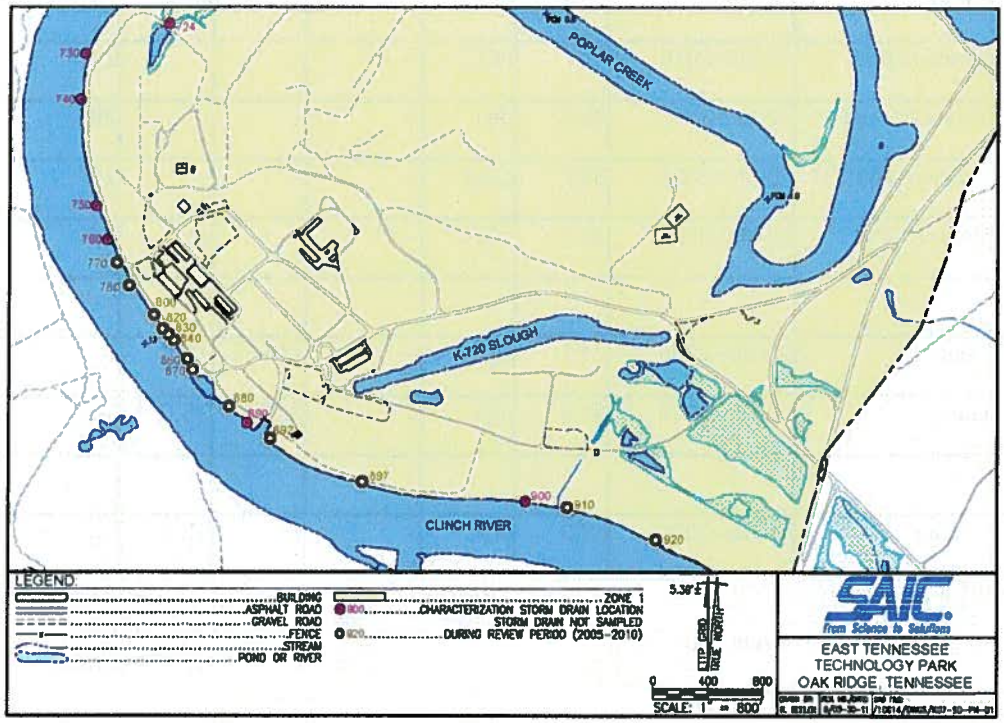
Clinch River Surface Water

There are 20 storm drains (Fig. C-4) that drain directly into the Clinch River from the western edge of Zone 1 in the Powerhouse Area. Many of these storm water outfalls are culverts that run underneath perimeter roadways adjacent to the Clinch River.

The historical industrial activities in this area included:

- K-700 Powerhouse facility and associated buildings that generated electrical power for the gaseous diffusion process buildings and support facilities at ETTP. The primary powerhouse facilities were demolished in the 1990s with additional buildings demolished in recent years
- K-708-F coal storage yard for the powerhouse plant
- K-770 scrap metal yards which included both radiological non-radiological scrap

A significant CERCLA action has been recently completed that removed the scrap metal and remediated the soil in the northwestern part of the Powerhouse Area.



Clinch River Storm Drain Outfalls

red = characterization outfall; brown = outfall not sampled In 2005 – 2010

Fig. C-4. Clinch River Storm Drain Discharges.

The storm water sampling characterization results from 2005 until the present for these outfalls were compared against screening level criteria with the parameters at each outfall that exceeded these levels in Table C-1.

Table C-1: Clinch River Storm Drain Outfalls that Exceeded Screening Level Criteria

Storm Drain Outfall						Fish & Aquatic		
	Constituent	Date	Result	Units	DWS	CCC	CMC	4% DCG
724	Lead	14-Jan-2008	5.99	ug/L	5	3.62	95.0	--
	Uranium-233/234	28-Nov-2005	77.3	pCi/L	--	--	--	20
	Uranium-233/234	01-Mar-2007	65	pCi/L	--	--	--	20
	Uranium-233/234	12-Mar-2010	45.1	pCi/L	--	--	--	20
	Uranium-238	28-Nov-2005	59.8	pCi/L	--	--	--	24
	Uranium-238	01-Mar-2007	50.8	pCi/L	--	--	--	24
	Uranium-238	12-Mar-2010	37.7	pCi/L	--	--	--	24
760	Total Uranium	12-Apr-2007	38.7	ug/L	--	--	--	20
	Uranium-233/234	20-Mar-2006	38.7	pCi/L	--	--	--	20
	Uranium-238	20-Mar-2006	24.3	pCi/L	--	--	--	24
890	Copper	28-Nov-2005	21.7	ug/L	--	11.9	18.5	--
	Lead	28-Nov-2005	21.9	ug/L	5	3.62	93.0	--
900	Copper	16-Nov-2005	17.3	ug/L	--	11.9	18.5	--

DWS = domestic water supply

CCC = criterion continuous concentration

CMC = criterion maximum concentration

DCG = derived concentration guideline from DOE Order 5400.5

To evaluate the potential impact that the storm water discharges had to the Clinch River, an evaluation of the surface water in the Clinch River was conducted. The Clinch River is contained within the Watts Bar Reservoir which is currently classed by the state of Tennessee as impaired in the 303(d) list for mercury, polychlorinated biphenyls, and chlordane. As noted in Table C-1, none of the results that exceeded the AWCQ were for parameters in the impaired category. The results noted were primarily for radiological parameters in the areas where the legacy scrap yard was located that has now been removed along with

contaminated soil. A few metals were exceeded from drainage areas where the coal storage yard was located.

The evaluation of the surface water results for the metal concentrations from storm water outfalls shown in Table C-1 indicate that all the results are below water quality based limits based on Clinch River mixing zone calculations. The mixing zone calculations were performed utilizing spreadsheets provided by the Tennessee Department of Environment and Conservation Division of Water Pollution Control National Pollutant Discharge Elimination System (NPDES) Permitting Section for NPDES permit limit calculations.

The radiological parameters that were exceeded in the storm water discharge screening level evaluation were reviewed at the downstream surface water sampling location Clinch River Kilometer 16 (CRK 16) as noted in Fig. C-5. The results of the in stream sum of fractions calculation for the radiological constituent DCGs are well below the 4% drinking water comparisons and therefore are deemed to not have an impact on the receiving water.

It should also be noted that there was not a measureable difference between the upstream CRK 23 monitoring site in comparison to the downstream CRK 16 location. Both CRK 23 and CRK 16 are long term monitoring sites that were established to specifically compare the water quality of the Clinch River above and below ETTP storm water discharges.

In summary, the surface water results for the direct discharge storm drains to the Clinch River do not indicate additional remedial actions are warranted in this watershed. An action to conduct monitoring for radionuclides and metals at CRK-16 is recommended on at least an annual basis.

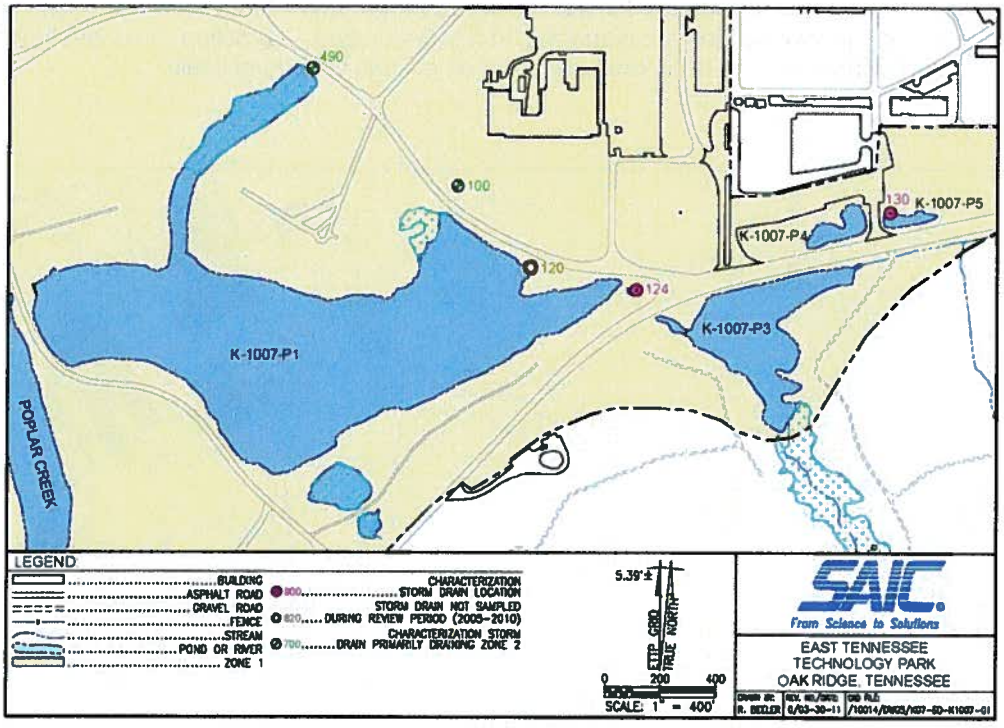
Fig. C-5. Clinch River Surface Water Sampling Locations.

K-1007-P Ponds Surface Water

There are five storm drains (Fig. C-6) that discharge into the K-1007-P Ponds. The K-1007-Ponds were formed in 1944 and 1945 during the construction of Burchfield Road and the weir that was located across a backwater that discharged into Poplar Creek. The four ponds are all interconnected and flow through the P-1 Pond. All of these ponds are considered to be waters of the State of Tennessee.

The ponds drain office buildings and parking lots in Zone 1. However, the upper reaches of storm drain networks for outfalls 100 and 490 also collect storm water from industrial areas within Zone 2. The Zone 2 operations include activities such as laboratories, the southern end of Building K-25, the Building K-29s slab, and the centrifuge building complex.

The K-1007-P ponds were the subject of a recent CERCLA removal action that has been completed to address PCB contamination that impacted the fish in the ponds.



K-1007-P Ponds Storm Drain Outfalls

red = characterization outfall; brown = outfall not sampled in 2005 – 2010; green = outfall primarily drains Zone 2

Fig. C-6. Clinch River Storm Drain Discharges.

The storm water sampling results for the outfalls that discharge to the K-1007-P Ponds were compared against screening level criteria with the parameters at each outfall that exceeded these levels noted in Table C-2.

Table C-2: K-1007-P Pond Storm Drain Outfalls that exceeded screening criteria

Storm Drain Outfall					Fish & Aquatic		Recreation
	Constituent	Date	Result	Units	CCC	CMC	OOC
100	Arsenic	22-Oct-2007	16.4	ug/L	150	340	10
	Cadmium	22-Oct-2007	1.04	ug/L	0.29	2.58	–
	Copper	07-Apr-2005	20.8	ug/L	11.1	17.1	–
	Lead	13-Apr-2005	4.9	ug/L	3.32	85.1	–
	Mercury	12-Dec-2006	0.071	ug/L	0.77	1.4	0.051
	Mercury	07-Apr-2005	0.11	ug/L	0.77	1.4	0.051
	Mercury	13-Apr-2005	0.073	ug/L	0.77	1.4	0.051
	Mercury	16-Mar-2005	0.22	ug/L	0.77	1.4	0.051
	Thallium	22-Oct-2007	13.6	ug/L	–	–	0.47
	Zinc	13-Apr-2005	166	ug/L	147	145	–
	PCB-1254	13-Apr-2005	0.1	ug/L	0.014	–	6.4E-04
	(pH)	29-Mar-2005	6.3	Std Units	6.5 to 9	6.5 to 9	6 to 9
	(pH)	04-Apr-2005	6.3	Std Units	6.5 to 9	6.5 to 9	6 to 9
	(pH)	02-May-2005	6.4	Std Units	6.5 to 9	6.5 to 9	6 to 9
124	Arsenic	02-Jan-2008	10.9	ug/L	150	340	10
	Cadmium	02-Jan-2008	1.09	ug/L	0.29	2.58	–
	Selenium	02-Jan-2008	32.4	ug/L	5	20	–
	Thallium	02-Jan-2008	9.15	ug/L	–	–	0.47
	(pH)	22-Aug-2007	6.4	Std Units	6.5 to 9	6.5 to 9	6 to 9
130	Arsenic	30-Oct-2007	19.9	ug/L	150	340	10
	Cadmium	30-Oct-2007	1.49	ug/L	0.29	2.58	–
	Thallium	30-Oct-2007	23.3	ug/L	–	–	0.47
490	Arsenic	30-Oct-2007	18.4	ug/L	150	340	10
	Cadmium	30-Oct-2007	1.2	ug/L	0.29	2.58	–

	Cadmium	18-Feb-2009	2.4	ug/L	0.29	2.58	–
	Lead	18-Feb-2009	5.7	ug/L	3.32	85.1	–
	Thallium	30-Oct-2007	18.9	ug/L	–	–	0.47
	Benzo(b) fluoranthene	06-Oct-2005	0.7	ug/L	–	–	0.18
	Chrysene	06-Oct-2005	0.6	ug/L	–	–	0.18

CCC = criterion continuous concentration	Rec. = Recreation
CMC = criterion maximum concentration	OOC = organisms only criteria

The parameters that were exceeded in the storm water discharge screening level evaluation were evaluated at the K-1007-P1 pond discharge point to the offsite Poplar Creek receiving water to determine if the storm drain discharges were impacting the receiving water ponds.

The results of the evaluation are summarized below:

- Arsenic, cadmium, copper, lead, mercury, zinc, benzo(b)fluroanthene, chrysene, and selenium were not detected in K-1007-P ponds at levels that exceeded AWQC.
- There was one of twelve thallium results in calendar year 2006 that exceeded AWQC. However, thallium is not a contaminant of historical concern at ETTP, and the nine subsequent sampling events have all been non-detect measurements
- PCBs were detected in only one of thirty-one results at levels greater than AWQC, and this was the only result that was detectable. As previously noted, a CERCLA removal action has been completed for K-1007-P1 Pond to address PCBs in fish which is the primary receptor of concern. Therefore, no further actions are warranted as the PCBs within the pond will continue to be evaluated in post CERLCA action monitoring requirements.

In summary, the surface water results from the K-1007-P1 surface water indicate that the discharges from the storm drains into the K-1007-P1 Pond do not indicate additional remedial actions are warranted in this watershed. An action to monitor the surface water at the K-1007-P1 discharge point to Poplar Creek is recommended an at least an annual basis for PCBs and metals.

K-901-A Pond Surface Water

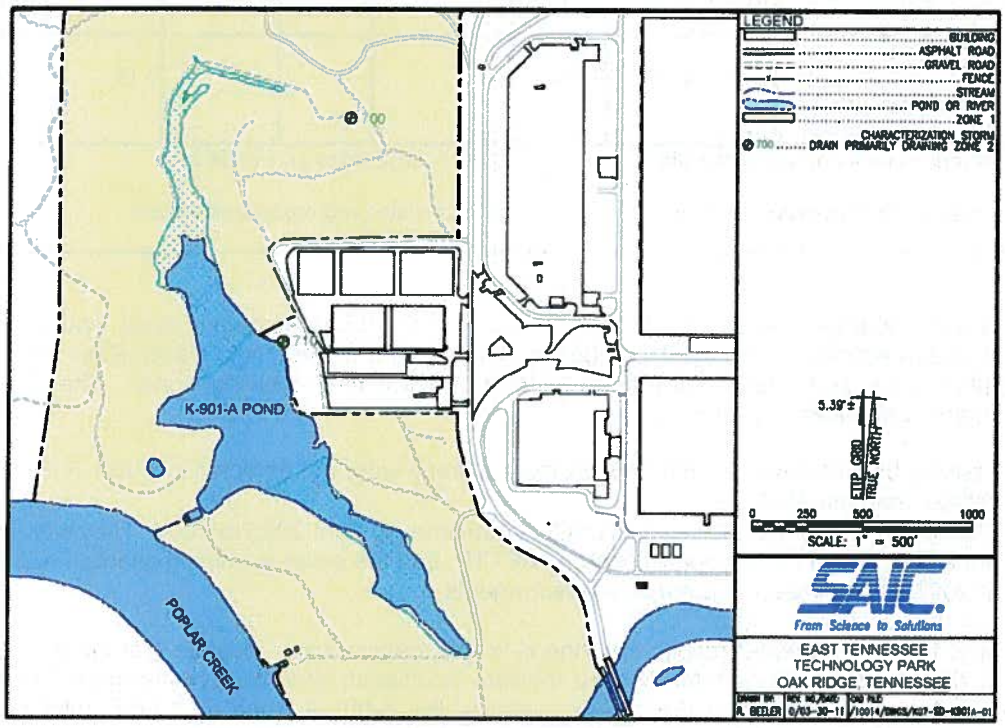
There are two storm drains (Fig. C-7) that discharge into the K-901-A Pond. The K-901-A-Pond was formed in the 1960s by the construction of a dam across the mouth of a seasonally flooded marshy embayment of the Watts Bar reservoir. The pond discharges to the Clinch River upstream of Clinch River monitoring site CRK 16, and the pond is considered to be a water of the State of Tennessee. An area in the southeast section of the pond identified as the K-895 facility was used for the deactivation and disposal of compressed gas cylinders.

The two storm drains that discharge into the pond collect water from mostly wooded areas within Zone 1. However, the upper reaches of storm drain networks for outfalls 700 and 710 also collect storm water from industrial areas within Zone 2. The Zone 2 operations include activities such as:

- the northwest sides of Building K-33 which is currently undergoing demolition. Historically the K-33 recirculation cooling water was discharged through storm drain 700 and into the K-901-A pond
- a switchyard on the west side of Building K-33
- a current commercial radioactive waste treatment facility

- the K-1065 RCRA permitted waste storage complex.

The K-901-A Ponds was the subject of a CERCLA action in the 1990s to remove undesirable fish and to remove cylinders and debris.



K-901-A Pond Storm Drain Outfalls

brown = outfall not sampled in 2005 – 2010; green = outfall primarily drains Zone 2

Fig. C-7. K-901-A Ponds.

The storm water sampling results for the outfalls that discharge to the K-1007-P Ponds were compared against screening level criteria with the parameters at each outfall that exceeded these levels noted in Table C-3.

Table C-3: K-901-A Pond Storm Drain Outfalls that exceeded screening criteria

Storm Drain Outfall					Fish & Aquatic		Recreation	
	Constituent	Date	Result	Units	CCC	CMC	OOC	WOC
710	Arsenic	22-Oct-2007	15.2	ug/L	150	340	10	10
	Thallium	22-Oct-2007	10.1	ug/L	–	–	0.47	0.24
	Benzo(a)pyrene	09-Feb-2010	0.213	ug/L	–	–	0.18	0.038
	Benzo(b) fluoranthene	09-Feb-2010	0.564	ug/L	–	–	0.18	0.038

CCC = criterion continuous concentration

CMC = criterion maximum concentration

OOC = organisms only criteria

WOC = water and organisms criteria

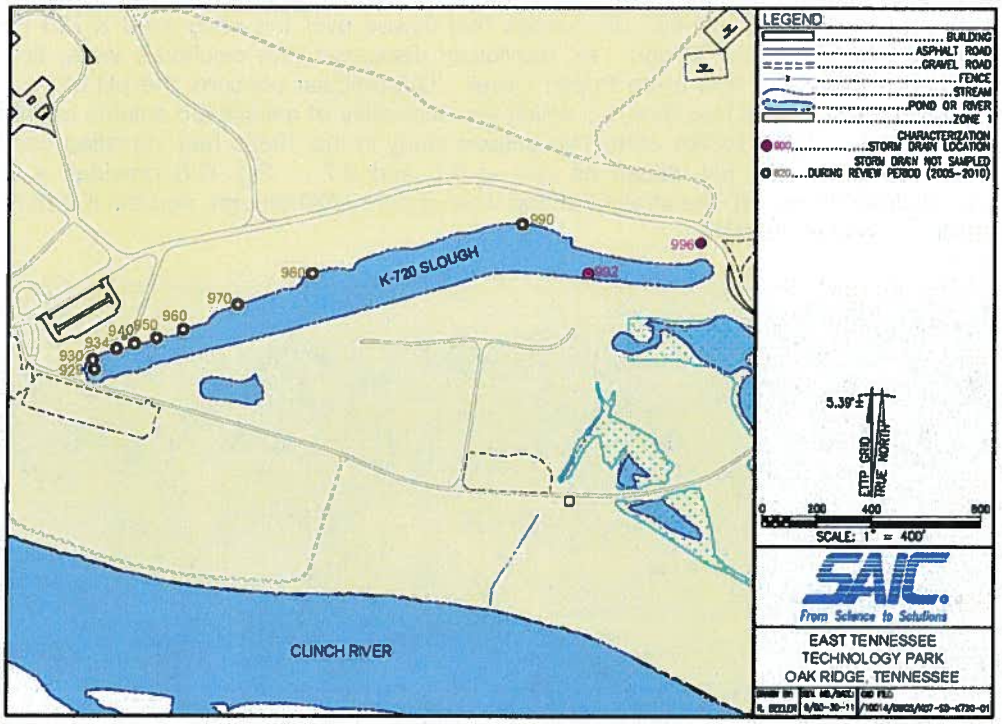
The parameters that were exceeded in the storm water discharge screening level evaluation at storm drain 710 were evaluated at the K-901-A pond discharge point to the offsite Clinch River receiving water to determine if the storm drain discharges were impacting the receiving pond. The results of the evaluation are summarized as follows:

- Arsenic, benzo(a)pyrene, and benzo(b)fluroanthene were not detected in K-901-A Pond at levels greater than the AWQC.
- Thallium was detected above the AWQC three times in from 2005 to 2007. However, thallium is not a contaminant of historical concern at ETTP, and the seven sampling events since the middle of 2007 have all been non-detect measurements

In summary, the surface water results from the K-901-A surface water indicate that the discharges from the storm drains into the K-901-A Pond do indicate additional remedial actions are warranted in this watershed. An action to monitor the surface water at the K-901-A Pond discharge point to the Clinch River is recommended an at least an annual basis for PCBs and metals.

K-720 Slough

There are twelve storm drains (Fig. C-8) that discharge into the K-720 Slough. It should be noted that numerous site documents such as the NPDES permitting history and the site facility maps also refer to the K-720 Slough as the K-702-A discharge flume. Eleven of the storm drains in this watershed collect storm water from small drainage areas along the railroad tracks that are north of the slough. A twelfth storm drain identified as SD-992 drains a large area south of the slough that includes the K-720 Fly Ash Pile.



K-720 Slough Storm Drain Outfalls

red = characterization outfall; brown = outfall not sampled in 2005 – 2010,

Fig. C-8. K-720 Slough.

The K-720 Slough was the "discharge flume" for water used in the K-700 Powerhouse facility boilers that was discharged at elevated temperatures into the slough. The water naturally cooled as it traveled through the slough and was then discharged to Poplar Creek through a box culvert underneath a road crossing.

In addition to the K-720 Slough discharge point, an ash sluice mixture from the powerhouse operations was also discharged to an area immediately south of the western edge of the K-720 Slough. The area where the ash was discharged was separated from the K-720 Slough by an earthen berm that was constructed along the south side of the slough that is still in place today. The only discharge point through the earthen berm is SD-992.

SD-992 collects water from three sources at a combined mixing zone prior to discharging through the earthen berm. Flow from the east flows through beaver dams and a rip rap ditch to the SD-992 storm water mixing zone. Flow from the south drains sections of the beaver pond backwater and the eastern side of the covered K-720 Fly Ash Pile. Flow from the west flows from the historical sluice pond through an extended wet weather conveyance to the SD-992 mixing zone.

The sluiced water consisted of both fly ash and bottom ash. The ash was pushed away from the sluice with a dozer on an as-needed basis and was spread and piled across the acreage south of the K-720 Slough. The dozer operations resulted in the formation of a small pond at the outlet of the discharge pipe which was located at the northwest corner of the overall fly ash pile area. In addition to the waste fly ash,

the adjacent footprint was used to stockpile coal during the operation period of the electricity producing powerhouse. In the 1970s, the area was used to stockpile coal for the steam plant.

In the early 1990s during the negotiation period for the ETTP NPDES storm drain permit, an area of concern was identified for the SD-992 discharges that flowed over the uncovered K-720 Fly Ash Pile through SD-992 into the K-720 Slough. As previously discussed, the discharge water flows into the slough and then continues to flow on to Poplar Creek. Of particular concern, the pH of the discharges were consistently measured at less than 4.0 which was indicative of associated soluble metals that were also being discharged. The RCRA corrective actions study in the 1980s had identified water samples back in the water shed with pH values as low as 2.6 and 2.7. Fig. C-8 provides a view of the Powerhouse facilities to the left, the straight ahead view of the K-720 Slough, and the K-720 Fly Ash Pile and fly ash sluice pond to the right.

Fig. C-8. Powerhouse, K-720 slough, sluice pond, and K-720 fly ash pile.

To address the pH and metals concern, numerous corrective actions were completed in the 1990s. These actions were originally proposed as a CERCLA Interim Record of Decision but after consultation with TDEC and EPA, it was decided to proceed as a Clean Water Act corrective action. These corrective actions were conducted as an implementation step of the NPDES permit issued in 1992 in combination with a NPDES storm water construction permit.

The notable corrective actions that started in the early 1990s were as follows in the general order the actions occurred:

- Flattened the slopes on the K-720 Fly Ash Pile to reduce erosion
- Modified the drainage pathways
- Applied lime on several occasions
    - 20 tons / acre in August 1992
    - 30 tons / acre of agricultural lime in January 1993
    - 14 tons total of hydrated lime in January 1993
    - 12 tons total of hydrated lime in March 1993 followed by an additional 8 tons total in June. The hydrated lime was discharged from a pneumatic tanker truck
    - Applied 20 tons / acre of lime to the temporary coal storage yard
- Initiated the following action in 1994 and completed them in 1996 in conjunction with excavating soil for the installation of a water treatment lagoon at the onsite drinking water facility
    - Established a soil cover of 1.5 to 2 feet over the K-720 Fly Ash Pile
    - applied lime at a rate of 30 tons / acre
    - applied sewage sludge over the area at a rate of 20 tons / acre
    - mixed the sewage and lime into the top 6 inches of the soil fill material that was generated from the water plant lagoon excavation and construction project
    - maintained erosion controls until the area vegetation was sufficient to prevent runoff concerns
- Constructed a modified collection system in late 1996, immediately south of SD-992. This action installed catch basins and culverts as a replacement for open ditches to reduce storm water runoff contact with the ash pile and to reduce the seepage pathways for lower pH water.
- Installed additional rip rap in drainage ditch pathways in response to a pH reading of 3.3 NPDES noncompliance in August 2007, to help neutralize the acidic pH seeps. Additional modifications to the storm water discharge path were also completed in an effort to minimize storm water runoff contact time with the fly ash
- Applied 75 tons of lime to the drainage watershed in September 2010 in response to a pH measurement of 6.0, which is a value at the lower acceptable limit of the current NPDES permit

The storm water sampling results for the outfalls that discharge to the K-720 Slough were compared against screening level criteria with the parameters at each outfall that exceeded the levels noted in Table C-4.

Table C-4. K-720 Slough storm water results that exceed screening criteria

Storm Drain Outfall					Fish & Aquatic		Recreation	
	Constituent	Date	Result	Units	CCC	CMC	OOC	WOC
992	Arsenic	27-Apr-2005	24.7	ug/L	150	340	10	10
	Arsenic	02-Jan-2008	16	ug/L	150	340	10	10
	Arsenic	12-Mar-2010	14.2	ug/L	150	340	10	10
	Cadmium	02-Jan-2008	2.74	ug/L	0.25	2	–	–
	Selenium	02-Jan-2008	72.9	ug/L	5	20	–	–
	Thallium	02-Jan-2008	7.41	ug/L	–	–	0.47	0.24
	(pH)	04-Jan-2006	5.9	Std Units	6.5 to 9	6.5 to 9	6 to 9	6 to 9

	(pH)	06-Feb-2006	6.1	Std Units	6.5 to 9	6.5 to 9	6 to 9	6 to 9
	(pH)	06-Mar-2006	6.1	Std Units	6.5 to 9	6.5 to 9	6 to 9	6 to 9
	(pH)	06-Apr-2006	6.4	Std Units	6.5 to 9	6.5 to 9	6 to 9	6 to 9
	(pH)	05-Mar-2007	6.3	Std Units	6.5 to 9	6.5 to 9	6 to 9	6 to 9
	(pH)	09-Apr-2007	6.4	Std Units	6.5 to 9	6.5 to 9	6 to 9	6 to 9
	(pH)	20-Jun-2007	6.2	Std Units	6.5 to 9	6.5 to 9	6 to 9	6 to 9
	(pH)	16-Jan-2008	6.4	Std Units	6.5 to 9	6.5 to 9	6 to 9	6 to 9
	(pH)	05-Feb-2008	6.2	Std Units	6.5 to 9	6.5 to 9	6 to 9	6 to 9
	(pH)	04-Feb-2009	6	Std Units	6.5 to 9	6.5 to 9	6 to 9	6 to 9
	(pH)	06-Apr-2009	6.4	Std Units	6.5 to 9	6.5 to 9	6 to 9	6 to 9
	(pH)	10-Nov-2009	6.3	Std Units	6.5 to 9	6.5 to 9	6 to 9	6 to 9
	(pH)	07-Dec-2009	6.4	Std Units	6.5 to 9	6.5 to 9	6 to 9	6 to 9
	(pH)	11-Jan-2010	6.3	Std Units	6.5 to 9	6.5 to 9	6 to 9	6 to 9
	(pH)	04-Mar-2010	6.2	Std Units	6.5 to 9	6.5 to 9	6 to 9	6 to 9
	(pH)	26-Apr-2010	6	Std Units	6.5 to 9	6.5 to 9	6 to 9	6 to 9
	(pH)	30-Aug-2007	3.3	Std Units	6.5 to 9	6.5 to 9	6 to 9	6 to 9

CCC = criterion continuous concentration	OOC = organisms only criteria
CMC = criterion maximum concentration	WOC = water and organisms criteria

The parameters that were exceeded in the storm water discharge screening level evaluation were only detected at storm drain 992. These parameters were evaluated at the K-720 Slough discharge point which is in direct hydraulic communication with Poplar Creek and therefore a water of the State of Tennessee. The results of the K-720 Slough surface water data evaluation are below:

- Arsenic, cadmium, selenium, thallium and pH did not exceed AWQC

Although the SD-992 discharges do not represent an immediate impact on the receiving waters, this is due to the significant corrective actions that have occurred since the 1990s to maintain pH and metal concentrations at acceptable discharge levels. Based upon this background information, walk downs and sampling investigations were conducted of the K-720 Fly Ash Pile drainage area to assess the condition of the vegetative cover and the discharge areas. A summary of this walk down indicates the following:

- The vast majority of the soil cover that was installed in the 1990s is still in place and has good vegetation across the cover.
- There is a seep area downstream from the beaver ponds east of the SD-992 collection point that has been measured with pH levels as low as 5.1

- The wet weather conveyance that drains the north side of the K-720 Fly Ash Pile discharges water into the SD-992 mixing zone with pH values as low as 4.2 in measurements collected in 2011. The water that flows through the wet weather conveyance is frequently discolored with white cloudy discharges as well as red iron discoloration
- The K-720 Fly Ash Pile vegetation cover along the northwest side immediately adjacent to the wet weather conveyance has either eroded or was not completely covered during the actions in the 1990s. This has resulted in surface water runoff in direct contact with the fly ash at the edge of the pile. Additionally, this creates an extended area with seeps coming directly from the fly ash material into the surface water runoff.

Based upon the extensive history of this site, the recent walk down, and water quality investigations, a remedial alternatives evaluation was conducted.

REMEDIAL ALTERNATIVES

The following four remedial alternatives were evaluated:

1. No action and no land use controls
2. An action for monitoring and land use controls
3. An action for additional cover material, rework the storm water runoff discharge pathways, monitoring, and land use controls
4. Remove the fly ash pile, vegetate the area, establish new contoured storm water runoff discharge pathways

Alternative 1 – No Action

No additional remediation is performed for the protection of surface water, and no land use controls are required. All of the area will be suitable for unrestricted industrial use to a depth of ten feet.

Alternative 2 – Land Use Controls

The soil vegetative cover that currently exists will remain in place and land use controls will require maintenance of the cover over the remediated fly ash material to minimize storm water contact with the fly ash. Any future use also will minimize direct seep discharges into water bodies. The effectiveness of the land use controls will be evaluated periodically by monitoring at the surface water discharge point at SD-992 into the K-720 slough for metals and pH.

Alternative 3 – Remediation and Land Use Controls

The soil vegetative cover that currently exists will remain in place and land use controls will require maintenance, as in Alternative 2. In addition, the soil cover will be extended to areas that have eroded or were not adequately covered during corrective actions in the 1990s, and storm water discharge pathways will be reworked in selected areas to minimize direct seep discharges into water bodies. Any future use also will minimize direct seep discharges into water bodies. The effectiveness of the land use controls will be evaluated periodically by monitoring at the surface water discharge point at SD-992 into the K-720 slough for metals and pH.

Alternative 4 – Removal

The fly ash material will be excavated and disposed in an appropriate land fill; a soil vegetative cover will be established; and discharge pathways will be established to minimize erosion. Land use controls and monitoring will not be needed.

EVALUATION OF ALTERNATIVES

The evaluation of the four alternatives against the CERCLA criteria is summarized in Table C-5 and discussed below.

Threshold Criteria

Alternative 1 does not satisfy the threshold criteria. Alternative 2 is marginal over the long term. Alternatives 3 and 4 meet the threshold criteria.

Balancing Criteria

Alternative 1 is not effective, and Alternative 2 is only marginally effective because the soil cover is not in place in some areas which exposes the surface water to low pH and elevated metal concentration discharges. This creates the potential need for additional long term maintenance actions.

Alternatives 3 and 4 are both protective over the long term. Alternative 4 has some short term impacts due to the excavation and trucking activities.

All the alternatives are easy to implement.

Alternative 4 has significant capital costs in comparison to the other three alternatives.

NEPA

Alternatives 1 and 2 have no cumulative impacts. Alternatives 3 and 4 have minor additional transportation impacts due to waste disposal in Alternative 4 and bringing in clean fill in Alternatives 3 and 4.

PREFERRED ALTERNATIVE

Based on the available information, DOE believes that the preferred alternative, Alternative 3, meets the threshold criteria and provides the best balance of tradeoffs between the four alternatives considered. This alternative recognizes that land use controls will be needed.

The preferred alternative was evaluated against seven of the nine CERCLA evaluation criteria. Consistent with DOE policy, NEPA values were incorporated into this evaluation. In summary, the preferred alternative provides protection of surface water receptors.

Table C-5: Comparative analysis of alternatives for the K-720 fly ash pile

Criteria	Alternative 1: No Action	Alternative 2: Land Use Controls	Alternative 3: Remediation and Land Use Controls	Alternative 4: Removal
Overall protection of human health and the environment	Does not protect surface water discharge receptors	Limited protection over long term	Is protective	Is protective
Compliance with ARARs	No ARARs for a no action alternative	Does not meet all ARARs over long term	Meets all ARARs	Meets all ARARs
Long-term effectiveness and permanence	Does not provide any long-term effectiveness and permanence	Provides limited long-term effectiveness and permanence	Provides long-term effectiveness and permanence	Provides long-term effectiveness and permanence
Reduction of toxicity, mobility, or volume through treatment	No treatment, so no reduction. Without land use controls, toxicity and mobility of metals could increase	Current vegetative cover does provide limited long term protection	Improved cover and storm water runoff controls will further reduce metals and low pH discharges	Excavation removes the fly ash source
Short-term effectiveness	No short-term impacts	Surface water discharges should not degrade over the short term	Improved vegetative cover will be effective with limited impact on local environment; wetland may be impacted in the short-term but will be improved in the long-term	Minor excavations will have a minimal short-term impact on local environment
Implementability	No implementability issues	No implementability issues	Easy to implement with standard soil field techniques	Easy to implement with standard excavation techniques
Cost (escalated)	None	Capital: $0 Annual O&M: $23,000 Present value: $375,400	Capital: $95,000 Annual O&M: $21,000 Present value: $398,000	Capital: $1,540,000 Annual O&M: $0 Present value: $1,540,000
NEPA-cumulative impacts	None	No loss of significant habitat	Minor transportation additions for bringing in soil cover and lime. No loss of significant habitat.	Minor transportation additions for fly ash waste disposal and then bringing in clean fill material. No loss of significant habitat.

ARAR = applicable or relevant and appropriate requirements

NEPA = National Environmental Policy Act

O&M = operations & maintenance

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