

4.0 HAZARD SPECIFIC DISCUSSION

As noted previously, the entire Oak Ridge Reservation was listed as a single entity on the National Priorities List in 1989. In order to facilitate remedial action decision-making, the contaminated areas of the ORR have been divided into the following six areas roughly equivalent to the major hydrologic watersheds:

- East Tennessee Technology Park
- Melton Valley at the Oak Ridge National Laboratory
- Bethel Valley at the Oak Ridge National Laboratory
- Upper East Fork Poplar Creek at the Y-12 National Security Complex
- Bear Creek Valley at the Y-12 National Security Complex
- Chestnut Ridge at the Y-12 National Security Complex

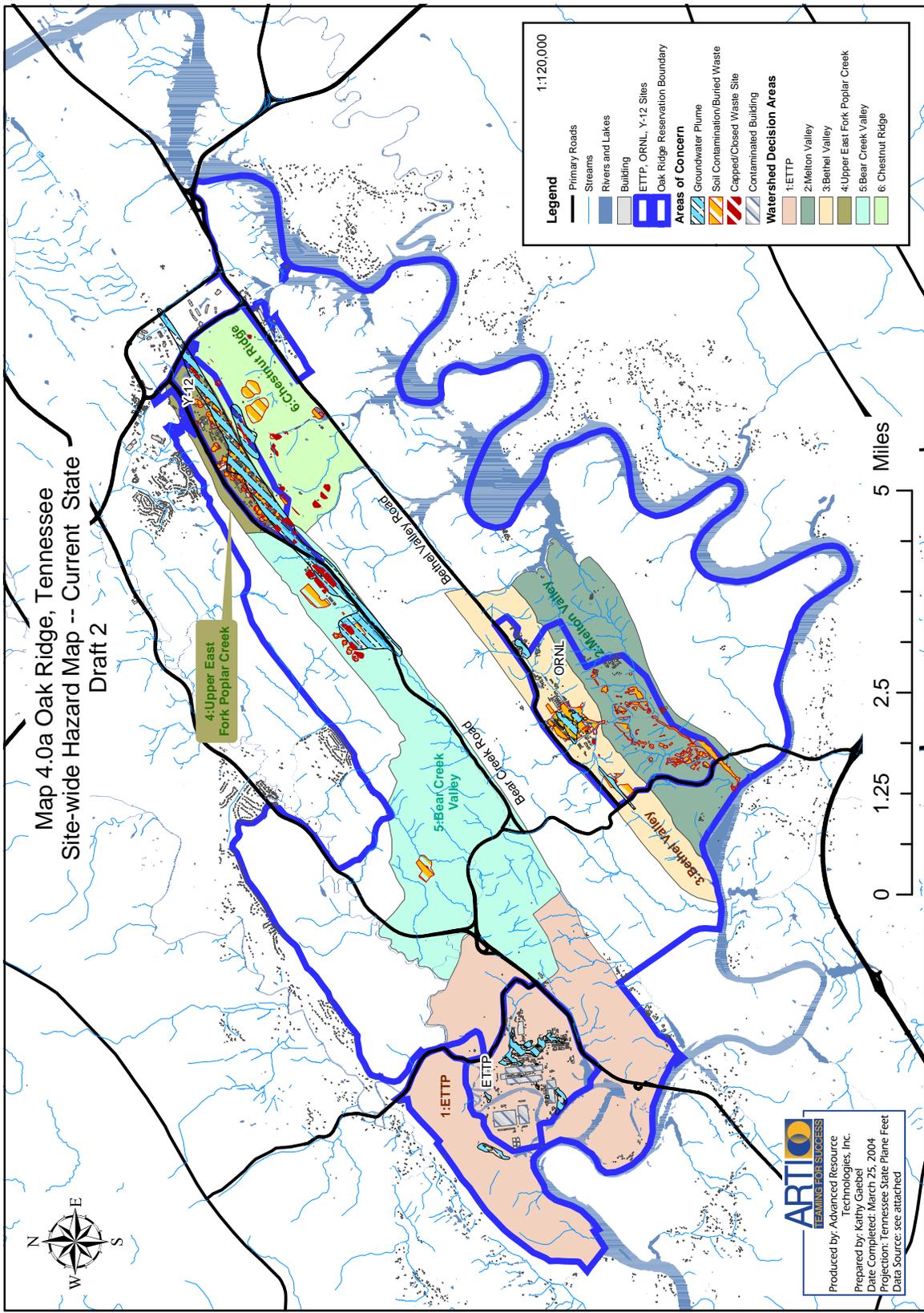
The location of each of these watersheds was shown previously in Figure 1.1. Figures 4.0a and 4.0b also depict these six hazard areas under current and RBES conditions, respectively. Each of these watersheds is discussed in the following sections as a distinct hazard area. Records of Decision have been issued under CERCLA for Melton Valley, Bethel Valley, Bear Creek Valley, part of Upper East Fork Poplar Creek, and part of the East Tennessee Technology Park; and decisions are under development for the remainder of the East Tennessee Technology Park and Upper East Fork Poplar Creek. Additional CERCLA decisions are planned for Chestnut Ridge and for additional actions in Bear Creek Valley. Subsequent CERCLA decisions will determine any additional requirements for groundwater protection and long-term land use controls in each of the watersheds. These hazard areas are discussed in the following sections.

4.1 Hazard Area 1 - East Tennessee Technology Park

The East Tennessee Technology Park is located near the northwest corner of the ORR, in Roane County, Tennessee. ETTP covers an area of approximately 5000 acres; however, only approximately 2200 acres are considered to be potentially impacted by site operations. For purposes of remedial action planning, this potentially impacted area has been subdivided into two areas: Zone 1 consists of approximately 1400 acres located immediately outside the boundaries of the main industrial complex; and Zone 2 consists of the main industrial complex, with an area of about 800 acres. The remaining 2800 acres, located outside of Zone 1 and 2, is referred to as the “footprint reduction area”. This area is thought to be unimpacted by site operations, and no remedial actions are currently planned for this area.

Since construction, many operations have been conducted at the ETTP. Enrichment by the S-50 thermal diffusion process took place from 1944-1945. This process proved ineffective and was discontinued. From 1945-1964, the site was a gaseous diffusion enrichment facility for weapons-grade uranium. From 1965-1985, the site produced commercial grade uranium using uranium hexafluoride as feed. A centrifuge enrichment process was operated from the 1960s until 1985. The ETTP also contains many support buildings, including laboratories, maintenance shops, garages, holding ponds/cooling towers, warehouses, disposal areas, power and utilities, waste treatment plants, and decontamination facilities. The site is partially bordered by the

Map 4.0a Oak Ridge, Tennessee
Site-wide Hazard Map -- Current State
Draft 2



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Legend

- Primary Roads
- Streams
- Rivers and Lakes
- Building
- ETTP, ORNL, Y-12 Sites
- Oak Ridge Reservation Boundary

Areas of Concern

- Groundwater Plume
- Soil Contamination/Buried Waste
- Capped/Closed Waste Site
- Contaminated Building

Watershed Decision Areas

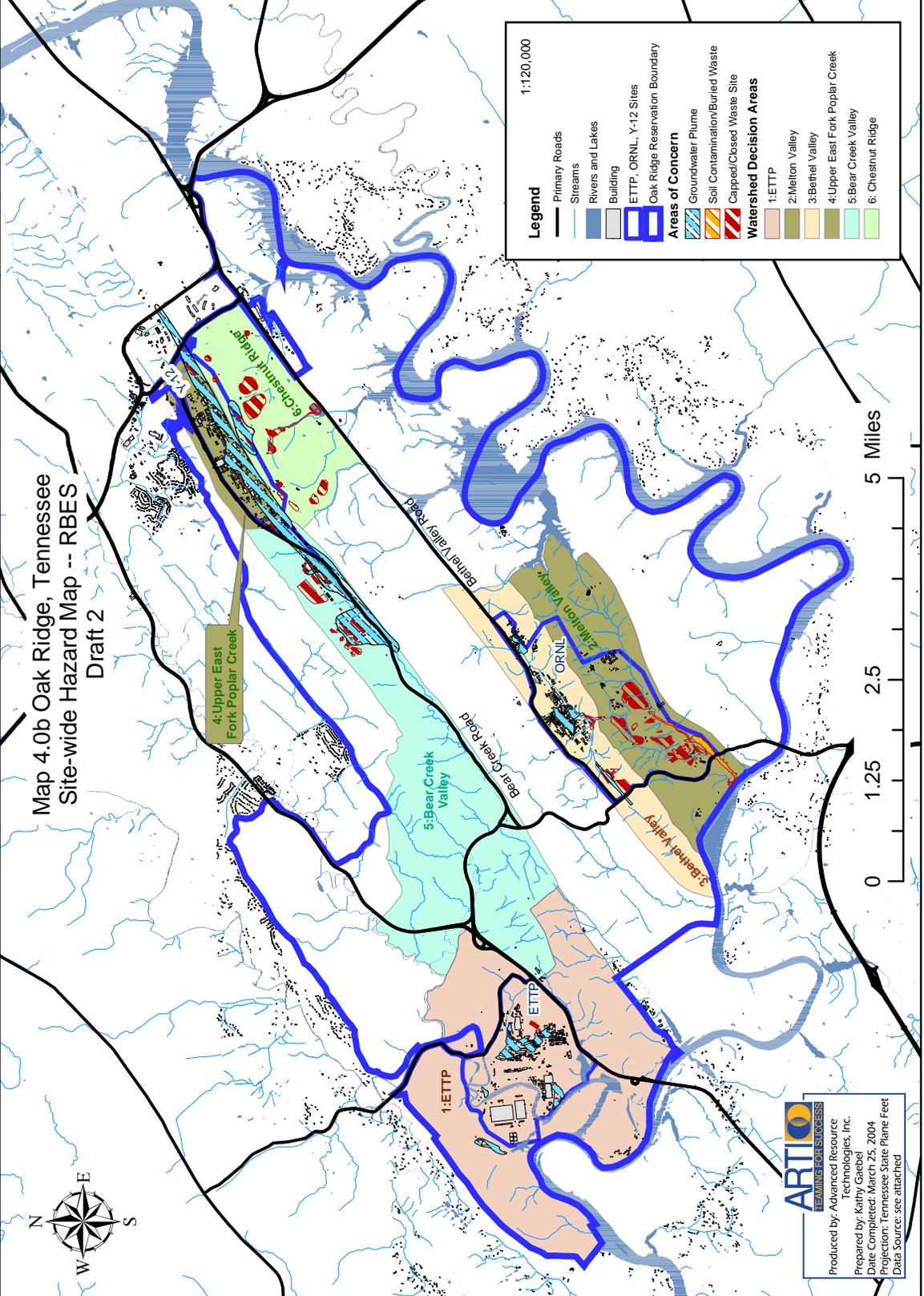
- 1:ETTP
- 2:Melton Valley
- 3:Beethel Valley
- 4:Upper East Fork Poplar Creek
- 5:Upper East Fork Poplar Creek
- 6:Chestnut Ridge



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Map 4.0b Oak Ridge, Tennessee
 Site-wide Hazard Map -- RBES
 Draft 2



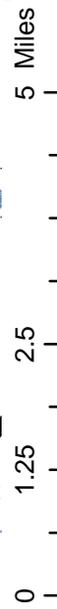
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Legend

- Primary Roads
- Streams
- Rivers and Lakes
- Building
- ETPP, ORNL, Y-12 Sites
- Oak Ridge Reservation Boundary
- Groundwater Plume
- Soil Contamination/Buried Waste
- Capped/Closed Waste Site

Watershed Decision Areas

- 1:ETPP
- 2:Melton Valley
- 3:Bethel Valley
- 4:Upper East Fork Poplar Creek
- 5: Bear Creek Valley
- 6: Chestnut Ridge



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Clinch River and its tributary Poplar Creek. Groundwater flows into Mitchell Branch, Poplar Creek, and the Clinch River.

Remedial actions at ETTP are being conducted under three CERCLA decision documents. A ROD was issued in November 2002 for remediation of contaminated soil within Zone 1 (i.e., areas outside the main plant)(DOE 2002a). A second ROD is currently under development for remediation of contaminated soil and structures within Zone 2 (i.e., the main plant area). And a third ROD is also currently under development to address site-wide groundwater contamination and ecological impacts for all media (soils, sediment, and surface water).

Remediation criteria for soils in Zone 1 were derived to limit potential risk to a future site worker not to exceed 1×10^{-5} excess lifetime cancer risk (ELCR) for individual carcinogens (with adjustments based on cost considerations where justified) and a cumulative risk of 1×10^{-4} ELCR from all contaminants (excluding radium and thorium, for which a non-risk-based alternative concentration limit was selected). Risk from noncarcinogenic contaminants of concern (COCs) was limited not to exceed a Hazard Quotient of 1 for individual COCs and a Hazard Index of 3 from all COCs combined. These values are summarized in Table 4-1.

Table 4-1. Soil Remediation Criteria from the ETTP Zone 1 ROD

Principal COC in Soil	Selected Remediation Concentration-Average
Carcinogens	
Cesium-137	2 pCi/g
Radium-226+D	5 pCi/g *
Thorium-232+D	5 pCi/g *
Neptunium-237	5 pCi/g
Uranium-234	700 pCi/g
Uranium-235	8 pCi/g
Uranium-238	50 pCi/g
PCBs	10 mg/kg
Noncarcinogens	
Arsenic	300 mg/kg
Beryllium	2000 mg/kg
Mercury	600 mg/kg

*Criteria for the Radium-226+D and Thorium-232+D decay series are non-risk-based values, set at 5 pCi/g above site-specific background concentrations. All other criteria are risk-based concentrations for the protection of a hypothetical future worker, and include any contributions from background.

An exposure unit approach is used, which establishes an average remediation level across an exposure unit that will not be exceeded and a maximum remediation level not to be exceeded at any location. Contaminated soil in each exposure unit will be remediated so that the residual concentration averaged across the exposure unit will be at or below the corresponding average remediation level, and the maximum contaminant concentration found at any location will be at or below the corresponding maximum remediation level. In addition to the remediation levels for

individual contaminants of concern, the cumulative risk to the future worker from all contaminants (excluding the radium and thorium decay series, which use non-risk-based criteria) may not exceed 1×10^{-4} ELCR and $HI \leq 3$.

Decision documents for remediation of soils and structures in Zone 2 and for remedial actions to address site-wide groundwater and surface water contamination and ecological impacts are in early stages of development. While these decisions have yet to be completed, they are being developed using a similar risk-based approach, with target risks similar to those used for Zone 1.

ETTP Current State:

Under current state conditions, the major contaminant sources at the ETTP are:

- Hundreds of aging facilities have become contaminated with radioactive and hazardous substances, including uranium, PCBs and heavy metals, during operations.
- There are approximately 4,700 full uranium hexafluoride cylinders, 1,100 empty cylinders, and 980 cylinder heels stored in six locations. The UF_6 cylinders are stored outside and are subject to deterioration due to exposure to the elements.
- Soil contamination has occurred from past operations and disposal activities. Contaminants in soils and burial grounds include uranium and other radionuclides, organics, and heavy metals at levels that pose an unacceptable risk.
- There are known contaminated groundwater plumes resulting from the soil contamination and buried wastes.
- Legacy waste is stored in several different locations in both inside and outside storage areas in thousands of containers.
- Waste has been buried on-site in several burial grounds.
- Ponds that collect drainage from the site prior to discharge have contaminated sediments.

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For Zone 1, characterization data were available to warrant remediation of soil, scrap, and buried materials only in a few discrete areas, based on potential risk to a future industrial worker; these included known areas of contaminated soil in the K-895 Cylinder Destruct Facility area and Powerhouse Area, Blair Quarry, contaminated scrap material and debris in the K-770 Area, and the K-710 sludge beds and Imhoff tanks. Contaminants of concern primarily include radionuclides (primarily uranium), with PCBs contributing significantly only in one exposure unit. For other areas of Zone 1, a dynamic verification strategy was adopted to collect additional characterization data to determine any additional remediation needs. Risk-based remedial action needs for Zone 2 soils and site-wide decisions to address groundwater contamination and ecological impacts have yet to be determined.

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Life-Cycle Baseline Plan for ETTP:

The following remedial actions are planned to be completed by 2008 in the current baseline for ETTP:

- Nearly 500 facilities covering about 15 million ft² will be demolished unless the title is transferred to the Community Reuse Organization of East Tennessee for reindustrialization (approximately 25 of the 500 facilities are currently targeted for possible title transfer).
- The existing inventory of approximately 6,800 UF₆ cylinders will be dispositioned. Full and partially filled cylinders will be shipped to the site(s) of the future conversion facility, while the empty cylinders will be directly disposed of at the Nevada Test Site.
- Scrap metal and debris in two scrap yards will be removed for disposal.
- Soil exceeding risk-based cleanup levels for industrial use will be excavated to a maximum depth of 10 ft, and sources of groundwater contamination will be excavated for disposal at ORR or offsite disposal facilities.
- Following the removal of key contaminant sources, assumed groundwater actions at ETPP primarily include alternate concentration limits or monitored natural attenuation.
- Legacy waste (~26,000 yd³) will be disposed at both ORR (CERCLA waste) and offsite disposal facilities (non-CERCLA wastes and mixed waste).
- The K-1070-B and K-1070-C/D burial grounds will be excavated for disposal at ORR or offsite disposal facilities.
- Pond sediments exceeding risk-based remediation levels will be excavated for disposal at ORR or offsite disposal facilities.
- Institutional controls will be maintained in perpetuity to prohibit disturbance of soils at a depth greater than 10 ft below ground surface and to prohibit onsite use of groundwater.

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Risk-Based End State Vision for ETPP:

Current baseline plans for ETPP are designed to support the planned end use of this site as a commercial industrial park with minimal or no continuing DOE presence. Remediation criteria have been (Zone 1 ROD) and continue to be (Zone 2 and groundwater RODs) derived to achieve an acceptably low level of risk to the future industrial worker. In most cases, therefore, the actions planned under the current baseline are considered to be entirely consistent with remedial actions designed solely on the basis of the risk-based end state. Only two potential variances have been identified to date:

- While a final decision will not be made until the ETPP Zone 2 ROD is completed, the current baseline plan calls for the K-1070-B and K-1070-C/D burial grounds to be excavated for disposal at ORR or offsite disposal facilities. This remedy is assumed to be most consistent with the desired end use of the ETPP site as an unrestricted commercial industrial park. However, it may be possible to achieve an equally protective remedy, potentially at lower cost, for the K-1070-C/D burial grounds for an alternative that involves excavation of wastes and contaminated soil above risk-based remediation criteria for industrial use to a depth of 10 ft and leaving deeper wastes in place beneath a clean soil cover. Containment alternatives for K-1070-B are considered more difficult, as buried waste materials are thought to sit in the saturated zone. Since the K-1070-C/D burial grounds contain classified materials, consideration of security requirements required for implementation of all alternatives must be included in the comparative analysis of alternatives.

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- The great majority of buildings currently remaining at ETPP will be demolished during the site closure process. Only those buildings which have a specific identified future use by private industry will remain, with titles transferred to CROET. These remaining buildings may contain residual radiological contamination on building surfaces (walls, floors, structural beams, etc) that may require decontamination to levels sufficiently protective for future occupants. Current cleanup operations at ETPP are based on surface radioactivity limits specified in DOE Order 5400.5, Table IV-1, which are not risk- or dose-based. Under the RBES, dose-based criteria will be derived specifically for the radionuclides of concern in designated buildings based on the designated future use scenarios for each building. These criteria will be derived to limit the potential radiation dose and health risk to future building occupants to levels that are determined to be protective and consistent with DOE policy to reduce exposures as low as reasonably achievable (ALARA). Dose-based surface activity criteria would be applied primarily for those buildings where attainment of the 5400.5 criteria would be particularly difficult with respect to increased costs and risks to decontamination works that are not commensurate with reductions in residual exposure. Implementation of dose-based criteria for surface contamination for these buildings at ETPP will significantly reduce potential risks to decontamination workers, while still limiting risks to public health and the environment to acceptably low levels.

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Maps of the ETPP site under current and RBES conditions are provided in Figures 4.1a1 and 4.1b1. Conceptual site models under current state and RBES conditions are illustrated in Figures 4.1a2 and 4.1b2, respectively.

Under both the baseline and RBES remediation scenarios for ETPP, contaminated buildings, soils and other materials exceeding risk-based criteria for future industrial use will be removed from the site for off-site disposal. Baseline and RBES scenarios vary only with respect to the management of buried wastes in a small portion of the site and the criteria selected for decontamination of building surfaces. Thus, Figure 4.1b2 indicates primary sources to be removed above-grade, while some below-grade waste may remain onsite. In either case, a long-term stewardship program will ensure the continuing protectiveness of the remedy, including continuing surveillance and maintenance. Groundwater monitoring wells will require periodic maintenance and replacement at longer (~ 30-year) intervals. Since contaminants will remain on site above levels suitable for unlimited use and unrestricted exposure, a statutory review will be conducted at least every five years to ensure that the remedy continues to be protective of human health and the environment.

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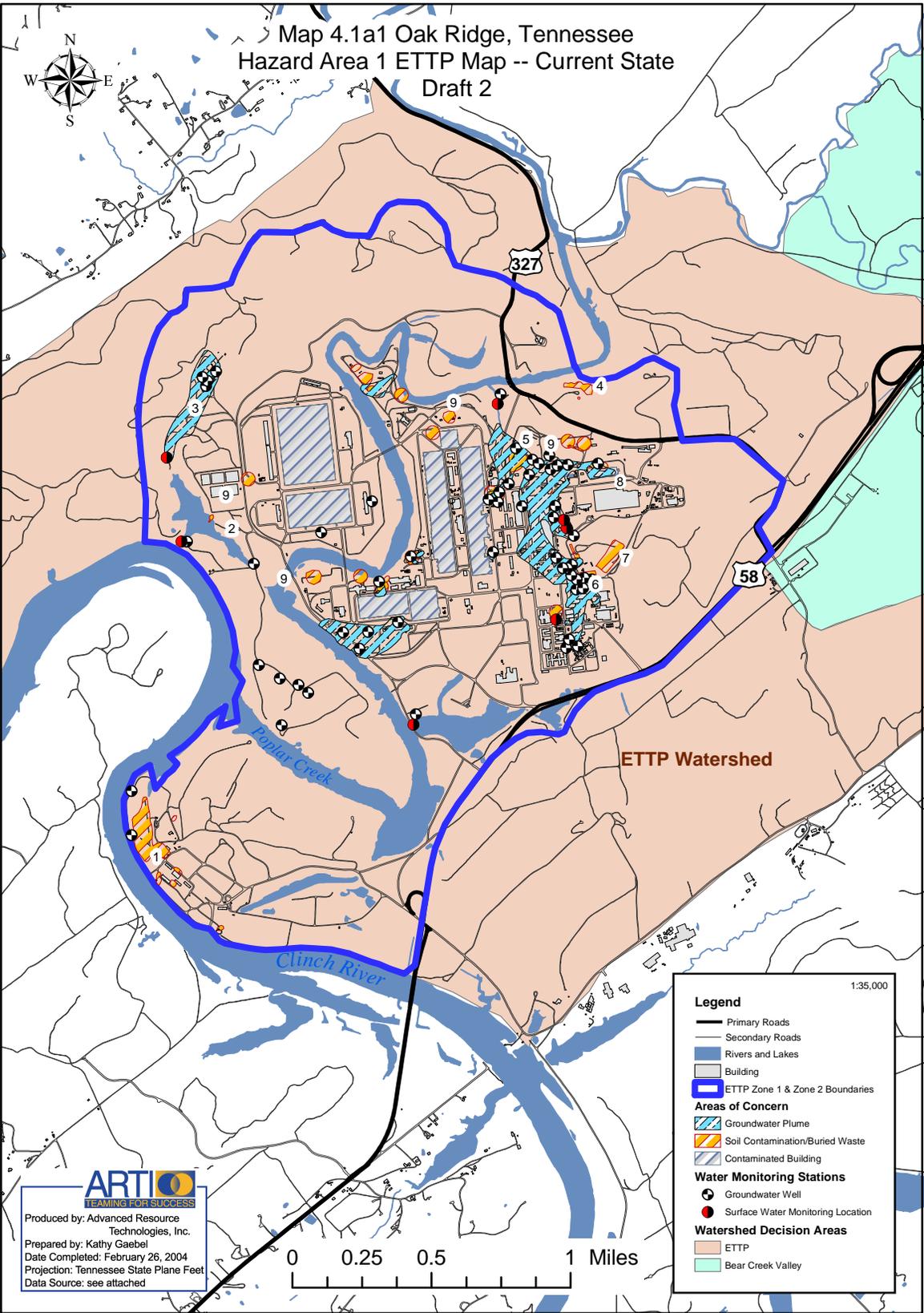
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Future ownership of the ETPP site is less clearly defined than that for other areas of the ORR. ETPP has no continuing DOE mission, and DOE intends to transfer ownership of ETPP facilities to the private sector for development as a commercial industrial park. However, this vision is dependent on the availability of sufficient private sector enterprises with interest in developing this site. It is possible that portions of the site may not be successfully developed for commercial industrial use and DOE may retain ownership of such parcels for the longer term. Nevertheless, the RBES vision for ETPP calls for commercial development of the entire site. Institutional controls required under the selected remedy (e.g., no disturbance of soils below 10 ft bgs, no groundwater use, industrial land use) will be incorporated in the deed for all transferred properties.

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Map 4.1a1 Oak Ridge, Tennessee
 Hazard Area 1 ETPP Map -- Current State
 Draft 2



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Legend

- Primary Roads
- Secondary Roads
- Rivers and Lakes
- Building
- ETPP Zone 1 & Zone 2 Boundaries

Areas of Concern

- Groundwater Plume
- Soil Contamination/Buried Waste
- Contaminated Building

Water Monitoring Stations

- Groundwater Well
- Surface Water Monitoring Location

Watershed Decision Areas

- ETPP
- Bear Creek Valley

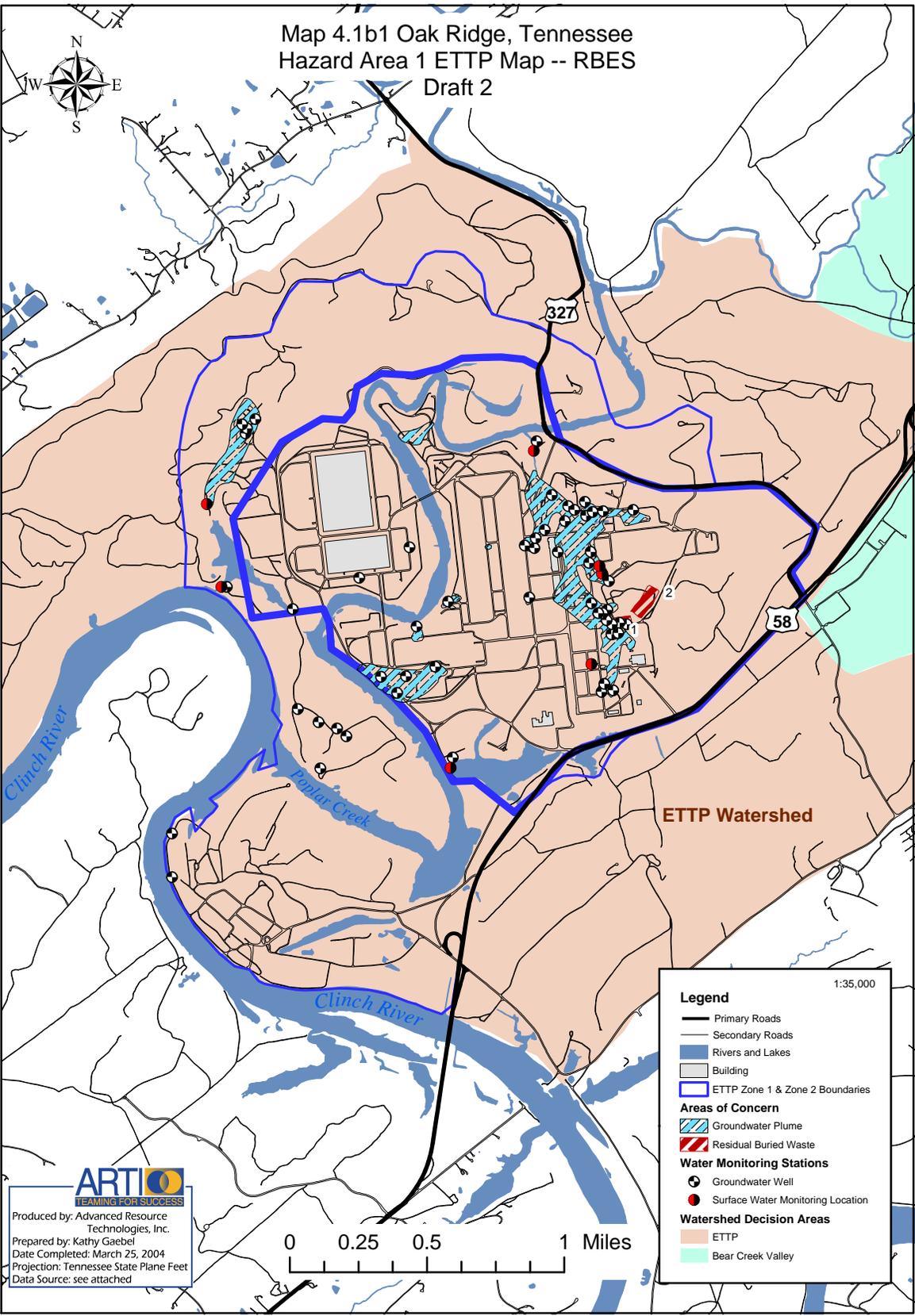
Figure 4.1a1 Continued

Notes for ETPP current state map:

1. Powerhouse Area Scrap and Contaminated Soils (Zone 1) – includes K-770 Scrap Yard, K-710 sludge beds and Imhoff tanks, and contaminated soils in the Powerhouse area, identified to contain contaminants of concern above risk-based remediation levels for industrial use.
2. Contaminated soil at the K-895 Cylinder Destruct Facility, located in the K-901 Area (Zone 1) – characterization data indicate the presence of radionuclides of concern above risk-based remediation levels for industrial use.
3. K-1070-A Waste Burial Ground (Zone 1) - remediation of K-1070-A burial ground completed FY2003; groundwater plume remains, which will be addressed as part of the ETPP site-wide groundwater ROD.
4. Blair Road Quarry, located in the K-901 area (Zone 1) – a 2-acre site where historical burning and burial of miscellaneous material occurred; characterization data indicate levels of contaminants of concern above risk-based remediation levels for industrial use.
5. K-1070-B Waste Burial Ground (Zone 2) – six unlined trenches used for disposal of a wide variety of wastes from the early 1950s until 1976; this disposal area was created by filling in the topographic low at the confluence of the original streambeds of Mitchell Branch and a tributary flowing from the south.
6. K-1070-C Waste Burial Ground (Zone 2) – two unlined trenches used for disposal of ETPP wastes during 1975-1976; used as a maintenance equipment storage yard since completion of landfill operations.
7. K-1070-D Waste Burial Ground (Zone 2) – includes three large trenches used for disposal of low-level radioactive waste and nonradioactive wastes, 10 pits used for disposal of liquid and solid hazardous wastes, three former earthen diked storage areas used for storage of containerized solvents and waste oils, and two landfarm areas; disposal operations took place from 1976 to 1988. Under a ROD issued in 1997, waste materials in the one of the disposal pits (G-Pit) were excavated and treated for off-site disposal and the pit was backfilled with a concrete mix, flowable fill material.
8. Mitchell Branch Area (Zone 2) – Mitchell Branch flows across the northeast portion of the ETPP main industrial area into Poplar Creek; groundwater contamination in the Mitchell Branch subwatershed includes numerous radioactive and chemical contaminants of concern.
9. UF₆ Cylinder Yards – approximately 6800 cylinders of uranium hexafluoride (4700 full cylinders, 1100 empty cylinders, and 980 heels) are currently stored in five outdoor storage yards throughout the ETPP site.

In addition to the hazards identified above, the ETPP site contains approximately 500 buildings and facilities, many of which contain radiological and/or chemical contamination associated with historical process operations, and an extensive infrastructure of deteriorating pipelines and other utilities. Many of these buildings contain residual contamination from previous operations, including radioactive materials on building surfaces, and PCBs; note that only the large uranium enrichment buildings are specifically marked as contaminated in Figure 4.1a1, but many other facilities also contain contamination to varying degrees.

Map 4.1b1 Oak Ridge, Tennessee
 Hazard Area 1 ETPP Map -- RBES
 Draft 2



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Legend

- Primary Roads
- Secondary Roads
- Rivers and Lakes
- Building
- ETPP Zone 1 & Zone 2 Boundaries

Areas of Concern

- ▨ Groundwater Plume
- ▨ Residual Buried Waste

Water Monitoring Stations

- Groundwater Well
- Surface Water Monitoring Location

Watershed Decision Areas

- ETPP
- Bear Creek Valley

Figure 4.1b1 Continued

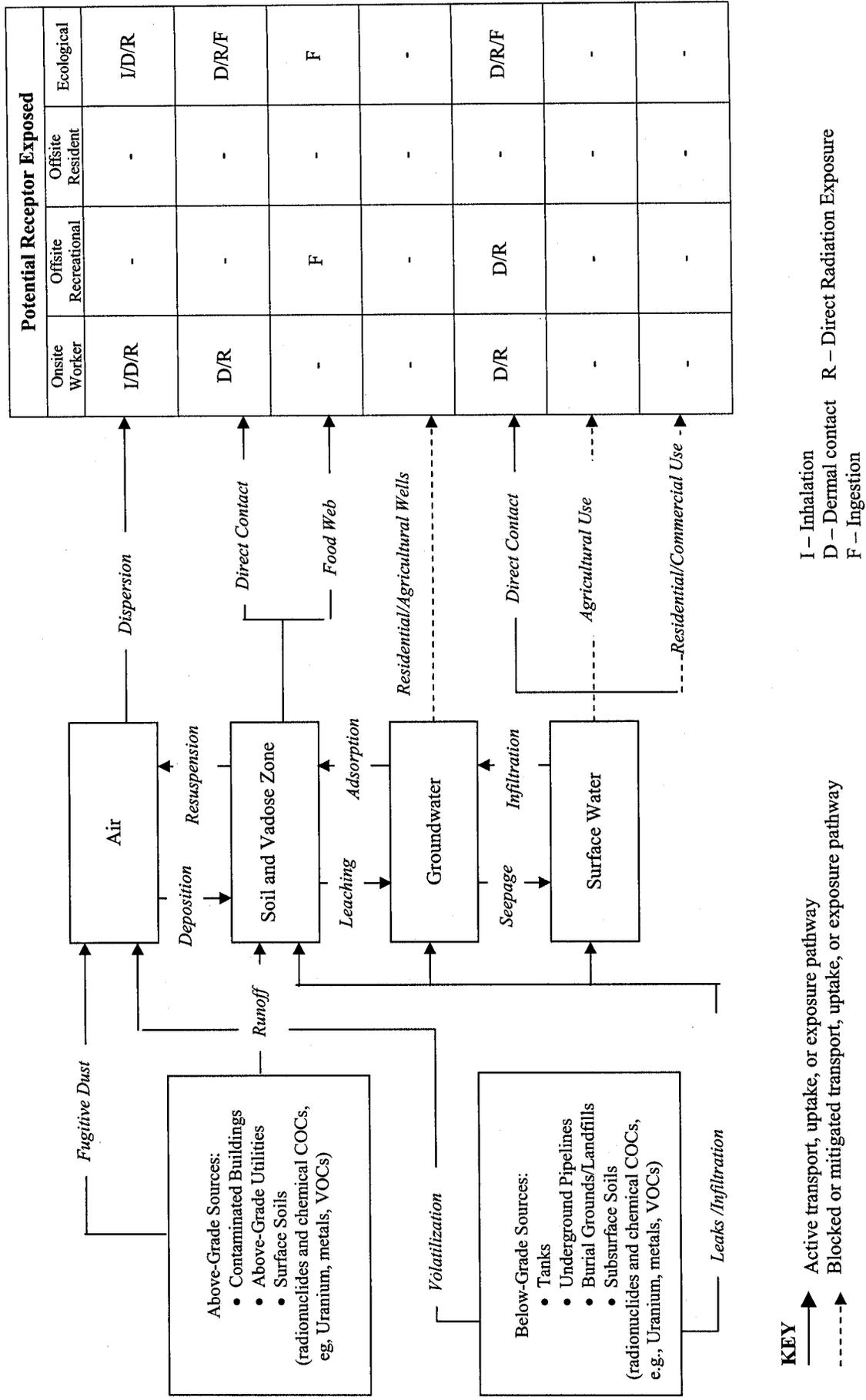
Notes for ETPP RBES map:

1. K-1070-C Waste Burial Ground – Current baseline calls for complete excavation of K-1070-C burial ground; RBES calls for partial excavation and backfill with clean soil.
2. K-1070-D Waste Burial Ground – Current baseline calls for complete excavation of K-1070-D burial ground; RBES calls for partial excavation and backfill with clean soil.

All other hazards shown in Figure 4.1a1 are expected to be removed to risk-based levels for protection of the industrial worker under both current baseline and RBES scenarios to support the desired end use as a commercial industrial park. Potential ecological risks have not yet been fully evaluated in CERCLA decision documents to date but will be addressed in a future decision document.

Under both the current baseline and RBES conditions, uncertainty remains as to which buildings will be demolished and which will remain; in either case, only those buildings which have a specific identified future use by private industry will remain, with title transferred to CROET. With respect to any buildings that may remain at ETPP, the baseline and RBES scenarios differ only in the decontamination criteria to be used; under the current baseline, buildings would be decontaminated to surface activity concentration limits specified in DOE Order 5400.5, whereas the RBES would adopt dose-based concentration limits for residual surface activity, consistent with current DOE and NRC guidance.

Figure 4.1a2, Conceptual Site Model - Hazard Area 1, ETTP - Current State



KEY

- Active transport, uptake, or exposure pathway
- - - - - Blocked or mitigated transport, uptake, or exposure pathway

- I - Inhalation
- D - Dermal contact
- R - Direct Radiation Exposure
- F - Ingestion

Figure 4.1a2, Conceptual Site Model - Hazard Area 1, ETPP - Current State

Narrative:

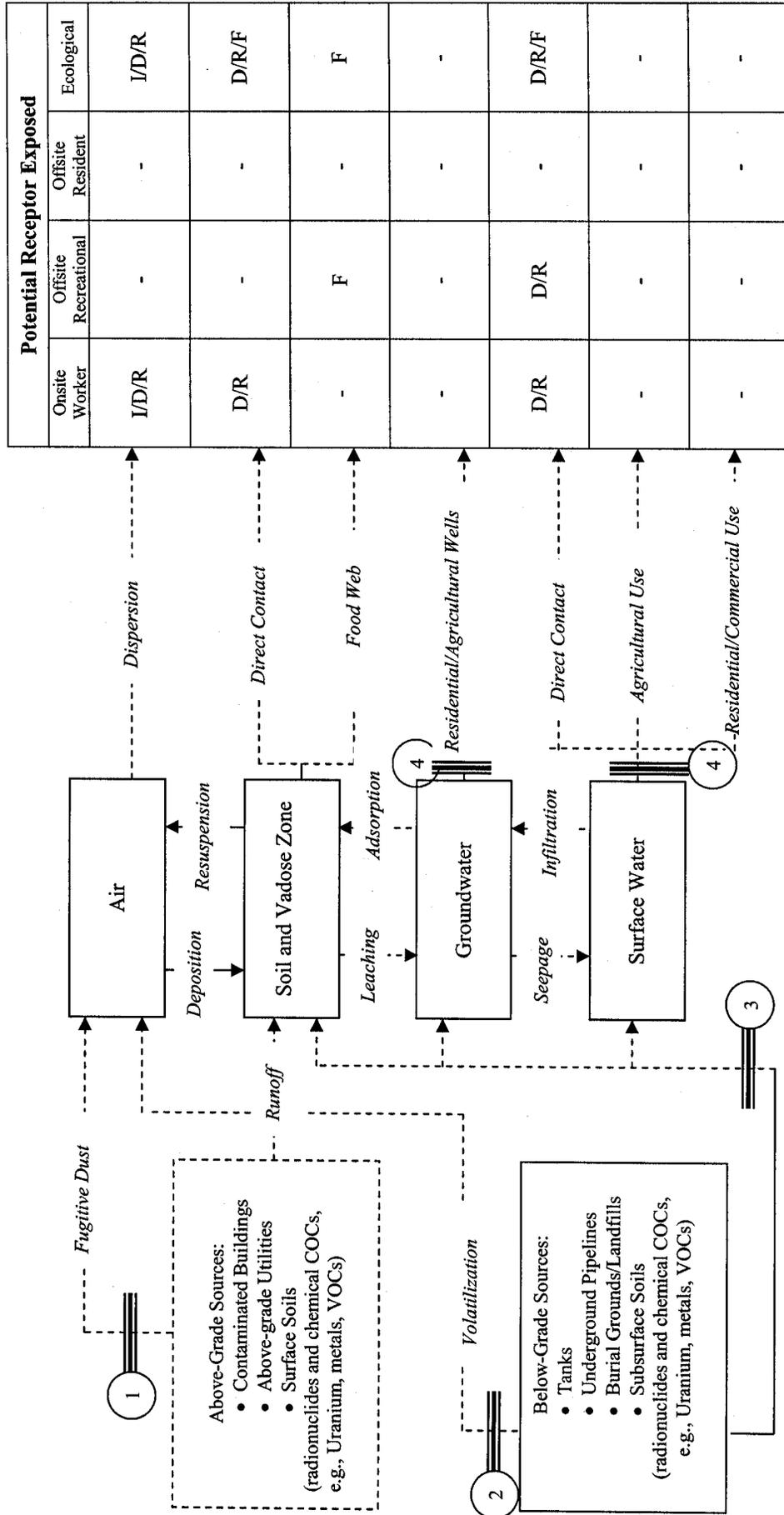
Contaminant Sources:

Under current state conditions, numerous buildings, above- and below-grade pipelines and other utilities, tanks, soils and waste burial grounds contain contaminants of concern in concentrations above site remediation levels. Contaminants of concern include radionuclides (primarily uranium), metals, VOCs, and PCBs.

Current State Exposure Pathways and Receptors:

Under current conditions, potentially complete exposure pathways for onsite workers include: inhalation of particulates or volatiles; and direct exposure to radiation in soils, buildings/structures, waste and surface water. Potentially complete exposure pathways to off-site recreationists include direct contact with surface water and ingestion of fish. Ecological receptors potentially may be exposed to contaminants in air, soil, surface water and the food chain. No potentially complete exposure pathways to offsite residents have been identified. There is no current use of groundwater or surface water at ETPP for residential, commercial, or agricultural purposes.

Figure 4.1b2, Conceptual Site Model – Hazard Area 1, ETTP – RBES



KEY

- ▲ Active transport, uptake, or exposure pathway
- - - Blocked or mitigated transport, uptake, or exposure pathway
- ≡ Engineered barrier or administrative control – sequentially numbered

I – Inhalation
D – Dermal contact
R – Direct Radiation Exposure
F – Ingestion

Figure 4.1b2, Conceptual Site Model – Hazard Area 1, ETTP – RBES

Narrative:

Contaminant Sources:

Under both current life-cycle baseline and Risk-Based End State conditions, ETTP will be released from DOE control for reuse as a commercial industrial park. All buildings, pipelines and other utilities, soils, and other sources containing contaminants above remediation criteria for industrial use will be removed for offsite disposal. Residual contamination below the risk-based remediation criteria will remain in soils, sediments, surface water and groundwater, that will preclude unrestricted use of the site but will not pose unacceptable risk to future receptors under the selected industrial land use. Institutional controls will include restrictions on future groundwater use.

Risk-Based End State Barriers/Interventions:

The steps taken to mitigate or remove these hazards are as follows:

1. Contaminated buildings, utilities and soils above risk-based remediation criteria will be removed for offsite waste disposal. Only those buildings selected for commercial industrial use will remain onsite, with title transferred from DOE to CROET. Residual contaminant levels will be below levels of concern for fugitive dust emissions.
2. Contamination above risk-based remediation levels in tanks, below-grade pipelines and utilities, and soils will be contained and/or removed for offsite disposal, eliminating potential for airborne emissions. Buried wastes would be excavated for offsite disposal under the current baseline plan, but would be contained in place by capping under the RBES. Residual contamination levels also will be below levels of concern for direct radiation exposure.
3. Remediation of contamination above risk-based remediation levels in tanks, below-grade pipelines and utilities, soils, and buried waste also will eliminate potential for continuing releases to surface water or groundwater. Residual contamination levels also will be below levels of concern for direct radiation exposure.
4. Future land use is restricted to industrial use, with prohibitions on groundwater and surface water use. Long-term stewardship and institutional controls will ensure continuing protectiveness of the remedy. Surveillance and maintenance will include monitoring of surface water and groundwater, with periodic maintenance and replacement of groundwater wells and ongoing maintenance of capped areas as required.