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Focused Feasibility Study for Water Management for the Disposal of CERCLA Waste on the Oak Ridge Reservation, Oak Ridge, Tennessee

PRO-2-SERVE

contributed to the preparation of this document and should not be considered an eligible contractor for its review.

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Focused Feasibility Study for Water Management for the Disposal of CERCLA Waste on the Oak Ridge Reservation, Oak Ridge, Tennessee

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Office of Environmental Management

URS | CH2M Oak Ridge LLC
Safely Delivering the Department of Energy's Vision
for the East Tennessee Technology Park Mission
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ACRONYMS

AWQC	ambient water quality criteria
ARARs	applicable or relevant and appropriate requirements
BCBG	Bear Creek Burial Grounds
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COCs	contaminants of concern
CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
EMDF	Environmental Management Disposal Facility
EMWMF	Environmental Management Waste Management Facility
EPA	U.S. Environmental Protection Agency
FR	Federal Register
GAC	granular activated carbon
HDPE	high-density polyethylene
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
O&M	operations and maintenance
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OF200 MTF	Outfall 200 Mercury Treatment Facility
PWTC	Process Water Treatment Complex
RCRA	Resource Conservation and Recovery Act
TBC	to be considered
TDEC	Tennessee Department of Environment and Conservation
UEFPC	Upper East Fork Poplar Creek
WAC	waste acceptance criteria
WETF	West End Treatment Facility
Y-12	Y-12 National Security Complex

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EXECUTIVE SUMMARY

The purpose of this focused feasibility study is to evaluate options and recommend a solution for the management of leachate and contact water (landfill water) generated from the on-site disposal of Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) waste from the Oak Ridge Reservation and associated sites. The waste has been disposed at the Environmental Management Waste Management Facility (EMWMF) and will be disposed in the future at the proposed Environmental Management Disposal Facility (EMDF).

Currently, contact water from EMWMF is discharged to Bear Creek if it meets the approved discharge limits that are based on the fish and aquatic life criterion maximum concentration ambient water quality criteria. If the contact water does not meet the discharge limits, it is conditioned to meet the discharge limits or transferred by tanker truck to the Process Water Treatment Complex (PWTC) at the Oak Ridge National Laboratory for treatment and disposal. Leachate is transferred by tanker truck to PWTC for treatment and disposal

The alternatives evaluated are:

- Alternative 1: No Action
- Alternative 2: Managed Discharge
- Alternative 3: Treat at EMWMF/EMDF
- Alternative 4: Treat at the Process Waste Treatment Complex at the Oak Ridge National Laboratory
- Alternative 5: Treat at the West End Treatment Facility at the Y-12 National Security Complex
- Alternative 6: Treat at Outfall 200 at the Y-12 National Security Complex

The recommended alternative is managed discharge (as long as the ambient water quality criteria are met without treatment) and then treatment when the ambient water quality criteria will not be met without treatment. For the purposes of this focused feasibility study and the follow-on CERCLA decision documents, the recommended alternative is a combination of Alternatives 2 and 3. This alternative will meet remedial action objectives immediately, will be protective, will comply with applicable or relevant and appropriate requirements, will be effective in the long-term, and will provide the most flexibility to manage uncertain, future contaminant concentrations and flow rates. However, when the need for treatment arises, the location of the treatment facility will be determined based upon the conditions at that time.

The recommended alternative provides a solution for the management of landfill water and supersedes any previous decisions.

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1. INTRODUCTION

1.1 PURPOSE

The purpose of this focused feasibility study is to evaluate options and recommend a solution for the management of landfill leachate and contact water (landfill water) generated from the on-site disposal of Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) waste from the Oak Ridge Reservation (ORR) and associated sites. This CERCLA waste is currently being disposed at the Environmental Management Waste Management Facility (EMWMF) and will be disposed in the future at the proposed on-site Environmental Management Disposal Facility (EMDF). EMWMF is located in the Bear Creek watershed. EMDF is planned to be constructed adjacent to EMWMF in the same watershed. The recommended alternative will provide both short-term and long-term solutions for the management of landfill water generated during operation of the disposal facilities and during post-closure. This solution will supersede any previous decisions (*Addendum to Remedial Design Report for Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste, Oak Ridge, Tennessee* [DOE/OR/01-1873&D2/A1/R2]) for landfill water management. During the planning process for the proposed EMDF, the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the Tennessee Department of Environment and Conservation (TDEC) agreed to evaluate the management of landfill water in a focused feasibility study and then to integrate the recommendation into the decision-making documents for EMDF and EMWMF.

This is a focused feasibility study because it only addresses the management of landfill water generated from EMWMF and the proposed EMDF. The recommendation from this focused feasibility study will be included in the *Remedial Investigation/Feasibility Study for Comprehensive Environmental Response, Compensation, and Liability Act Oak Ridge Reservation Waste Disposal, Oak Ridge Tennessee* (DOE/OR/01-2535&D3) currently being prepared for the proposed EMDF and in other appropriate CERCLA decision-making documents. The appropriate CERCLA decision-making documents are applied to each alternative (Sect. 3.3, Description of Alternatives).

Because the focused feasibility study is focused only on landfill water management from engineered facilities, the hydrogeology of the site, soils information, and ecological information is not included in this focused feasibility study. This information is contained in the *Remedial Investigation/Feasibility Study for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste* (DOE/OR/02-1637&D2 and DOE/OR/02-1637&D2/A1) and DOE/OR/01-2535&D3.

1.2 ORGANIZATION OF THE STUDY

This focused feasibility study consists of six chapters and supporting appendices.

- Chapter 1, "Introduction," describes the purpose of the study and site conditions.
- Chapter 2, "Remedial Action Objectives," presents the objectives of the study and an introduction to the applicable or relevant and appropriate requirements (ARARs).
- Chapter 3, "Development and Description of Alternatives," summarizes the assemblage of representative process options into alternatives to meet the remedial action objectives and describes each alternative.

- Chapter 4, “Analysis of Alternatives,” evaluates the ability of the alternatives and no action to achieve the evaluation criteria and to meet the remedial action objectives, and summarizes the alternative evaluations as compared to no action.
- Chapter 5, “Recommended Alternative,” presents the recommended alternative.
- Chapter 6, “References,” provides full citations for documents used in the preparation of this study and cited in the main text.

The appendices provide supporting data and additional information, including:

- Appendix A, “Bear Creek Burial Grounds Evaluation,” is an evaluation of Bear Creek Burial Grounds (BCBG) as a scope element.
- Appendix B, “Contact Water and Leachate Flow Rate,” describes the development of flow rates.
- Appendix C, “Explanation of How the Key Contaminants of Concern Were Developed,” provides an explanation of the key contaminants of concern (COCs).
- Appendix D, “Applicable or Relevant and Appropriate Requirements,” is a complete set of proposed ARARs.
- Appendix E, “Mercury Concentration in Environmental Management Disposal Facility Leachate,” is a projection of mercury concentration in EMDF leachate.
- Appendix F, “Leachate and Contact Water Waste Determination,” is a discussion of waste determination for leachate and contact water.
- Appendix G, “Zero Discharge,” evaluates the feasibility of zero discharge of landfill water.
- Appendix H, “Water Storage Requirements,” develops the amount of water storage required.
- Appendix I, “Basis of Cost Estimates,” presents the basis of the cost estimates.

1.3 SITE DESCRIPTION

The approximately 33,000-acre DOE ORR is located within and adjacent to the city limits of Oak Ridge, Tennessee in Roane and Anderson counties (Fig. 1). The ORR is bounded to the east and north by the developed portion of the city of Oak Ridge. The three major industrial, research, and production facilities originally constructed as part of the World War II-era Manhattan Project and currently managed by DOE are the East Tennessee Technology Park, the Oak Ridge National Laboratory (ORNL), and the Y-12 National Security Complex (Y-12).

Historic nuclear research and national defense-related operations on the ORR have led to the contamination of soil, surface water, sediment, groundwater, and buildings and have resulted in burial of material at various sites on the ORR. Because of these contaminant releases, ORR was placed on the EPA National Priorities List established under CERCLA (54 *Federal Register* [FR] 48184, November 21, 1989). DOE, TDEC, and EPA signed the *Federal Facility Agreement for the Oak Ridge Reservation* (DOE/OR-1014) that describes how CERCLA remediation activities are performed on the ORR.

The Bear Creek watershed (Fig. 2) contains closed and active waste disposal facilities, including EMWMF and BCBG, and is the proposed location for EMDF. Bear Creek is administratively classified for fish and aquatic life, recreation, livestock watering and wildlife, and irrigation uses (TDEC 1200-04-04). Bear Creek is designated by TDEC as an impacted stream due to nitrates (TDEC 2014a, *Year 2012 303(d) List*), contains cadmium and mercury concentrations that exceed Tennessee ambient water quality criteria (AWQC), and is adversely affected by polychlorinated biphenyls and uranium (TDEC 2014b). The *Record of Decision for the Phase I Activities in Bear Creek Valley at the Oak Ridge Y-12 Plant, Oak Ridge*, *Tennessee* (DOE/OR/01-1750&D4) establishes protectiveness and cleanup levels for the Bear Creek watershed and specifies remedial actions for the S-3 Site, the Oil Landfarm Area (Oil Landfarm Soil Containment Pad, Boneyard/Burnyard, and North Tributary-3), and the Disposal Area Remedial Action Facility.

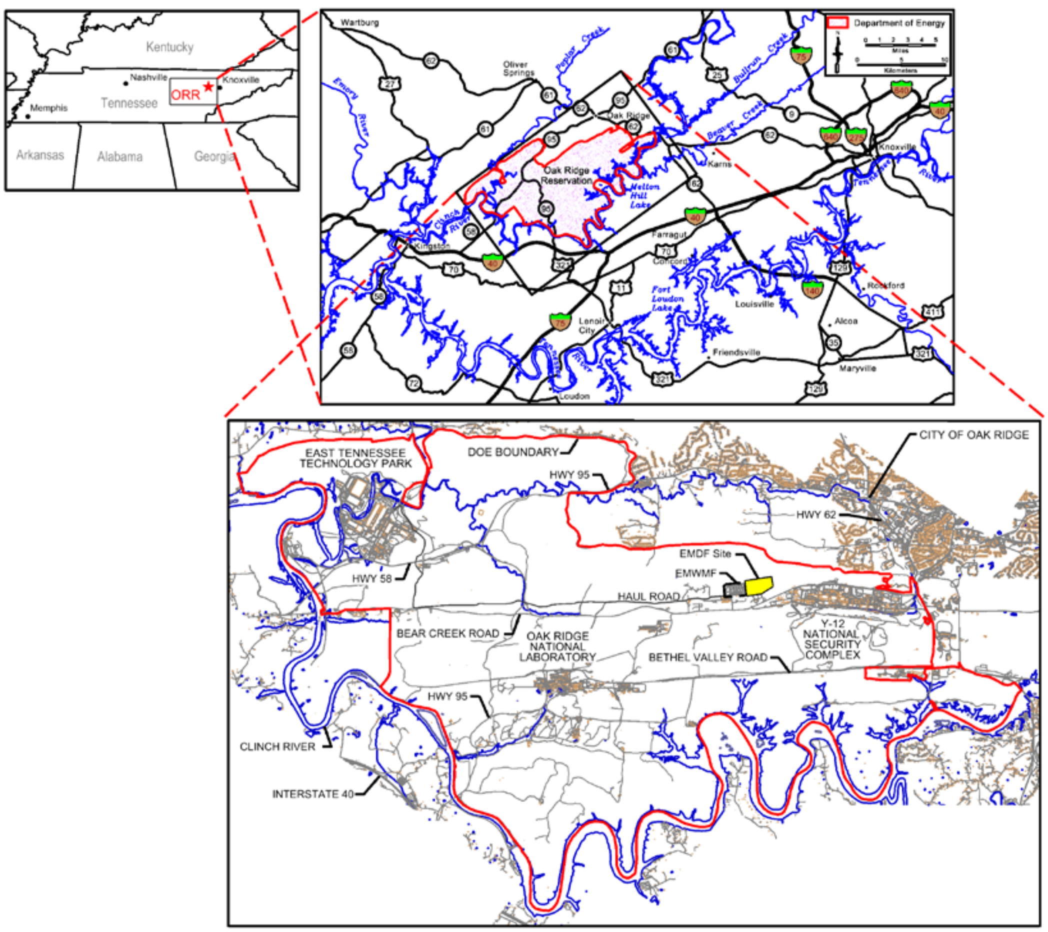

Fig. 1. Oak Ridge Reservation.

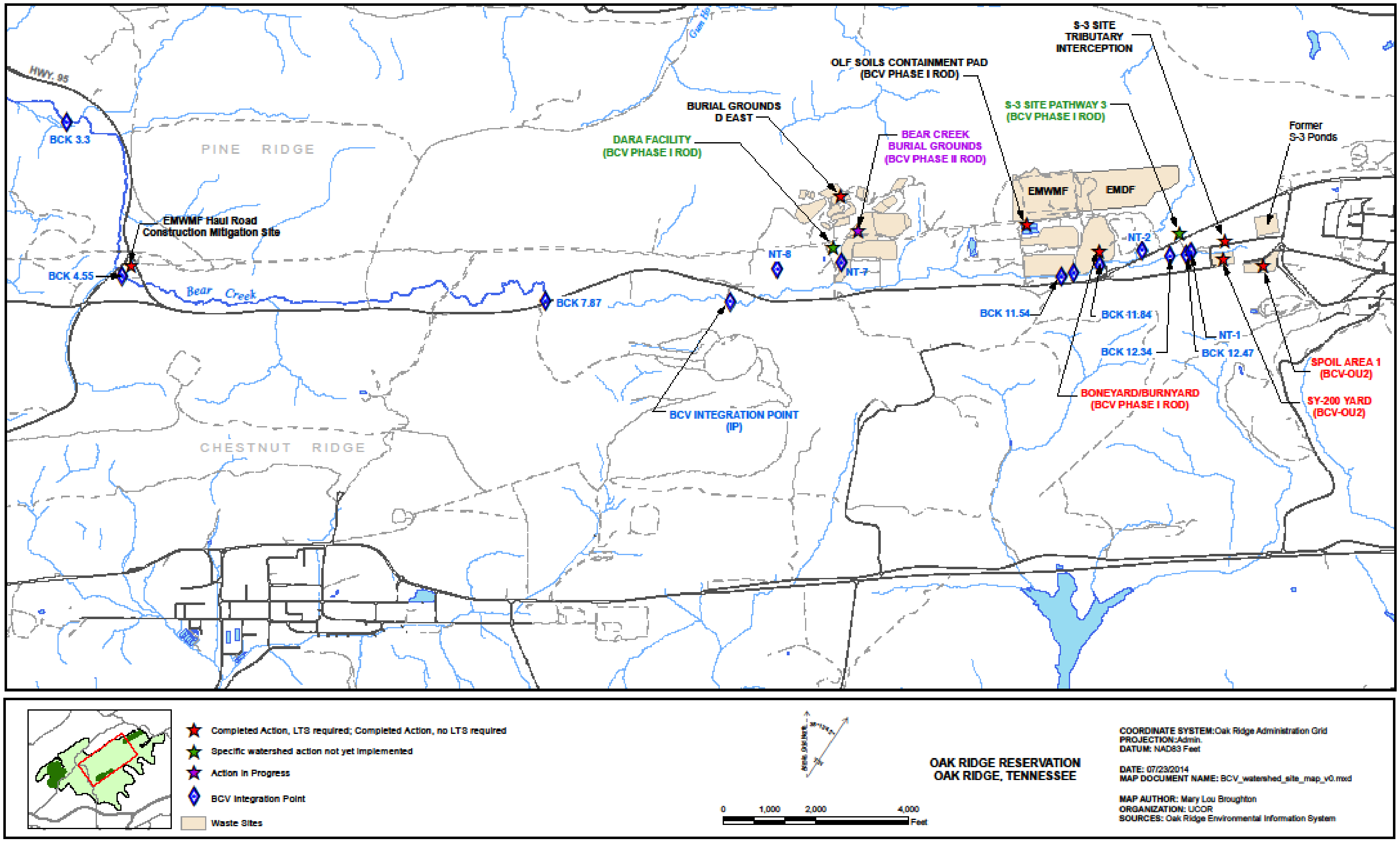

Fig. 2. Bear Creek watershed.

The *Record of Decision for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste, Oak Ridge, Tennessee* (DOE/OR/01-1791&D3) presents the selected remedy for the disposal of waste generated from CERCLA cleanup activities performed by DOE on the ORR and associated sites. This remedy is the design, construction, operation, and closure of EMWMF located in the Bear Creek watershed on the ORR. Following approval of the Record of Decision, three Explanation of Significant Differences were prepared to:

- Add classified waste to the description of waste approved for disposal in EMWMF (DOE/OR/01-1905&D2, *Explanation of Significant Difference from the Remedy in the Record of Decision for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste, Oak Ridge, Tennessee*)
- Construct a dedicated haul road for the transportation of waste from the East Tennessee Technology Park to EMWMF (DOE/OR/01-2194&D2, *Explanation of Significant Difference from the Remedy in the Record of Decision for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste, Oak Ridge, Tennessee*)
- Construct Cell 6 to expand EMWMF (DOE/OR/01-2426&D2, *Explanation of Significant Difference from the Remedy in the Record of Decision for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste, Oak Ridge, Tennessee*)

EMWMF began operations in 2002 and currently is receiving radioactive, hazardous, and mixed wastes from CERCLA actions on ORR and associated sites. EMWMF consists of six disposal cells with a total capacity of 2.2 million cubic yards (Fig. 3). The scope of the cleanup program has increased since the original waste estimates, and another on-site disposal facility, EMDF, is proposed to provide additional waste disposal capacity. The proposed EMDF is expected to consist of six cells with a total capacity of 2.5 million cubic yards (DOE/OR/01-2535&D3) (Fig. 4).

Fig. 3. Environmental Management Waste Management Facility.

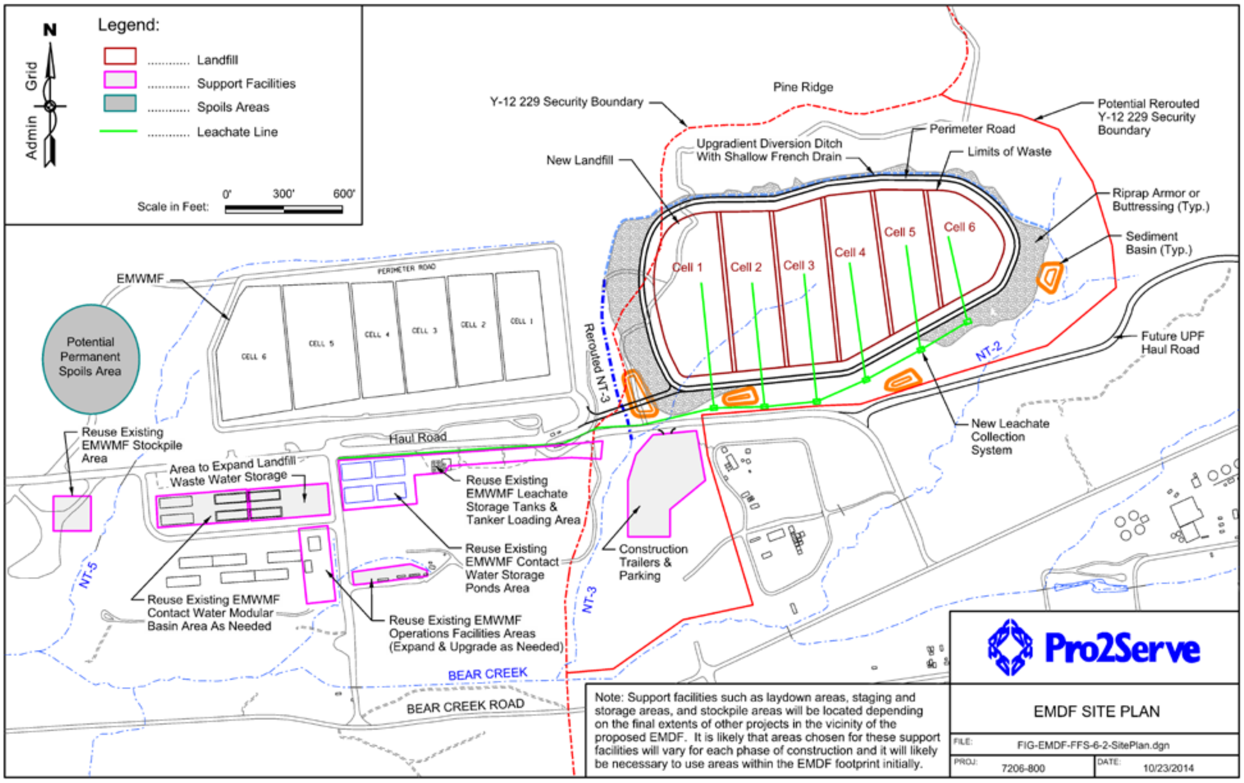

Fig. 4. Proposed EMDF.

1.4 SITE ECOLOGY

Site ecology is described in the *Remedial Investigation/Feasibility Study for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste* (DOE/OR-02-1637&D2 and DOE/OR/02-1637&D2/A1) and the *Remedial Investigation/Feasibility Study for Comprehensive Environmental Response, Compensation, and Liability Act Oak Ridge Reservation Waste Disposal, Oak Ridge Reservation* (DOE/OR/01-2535&D3). The area surrounding EMWMF and proposed EMDF has been strongly influenced by anthropogenic structures and industrial activities. Most of the area is covered with grass and engineered structures, such as the EMWMF disposal cells. As a result, this area provides little habitat for terrestrial vertebrates. The likelihood of the existence of federal or state-listed species in this area is low.

Bear Creek and the north tributaries are the dominant aquatic features in the area. Bear Creek has both gaining and losing stretches, with periods of zero flow in the summer months.

1.5 EVALUATION OF THE BEAR CREEK BURIAL GROUNDS FOR INCLUSION IN THE FOCUSED FEASIBILITY STUDY

BCBG was evaluated to determine if it will be feasible to include management of BCBG leachate in the scope of this focused feasibility study. BCBG is a former waste disposal area for radiologically- and chemically-contaminated waste generated primarily at Y-12. BCBG consists of several waste disposal units designated as BCBG Unit-A, -B,-C, -D, -E, -J, and Walk-in Pits. Each waste disposal unit consists of a series of trenches used for disposal of liquid and solid wastes. The primary wastes disposed in BCBG were uranium, potentially reactive and explosive waste, organic compounds, polychlorinated biphenyls, acids, metals, and other radionuclides.

Similar to EMWMF and proposed EMDF, BCBG also is in the Bear Creek watershed and is close to the location of EMWMF and proposed EMDF. Some of the BCBG leachate is collected and adequately processed for release at the Y-12 Groundwater Treatment Facility. However, other sources not currently captured have a negative impact on Bear Creek water quality. Therefore, DOE, EPA, and TDEC agreed to consider the inclusion of BCBG leachate management in this focused feasibility study.

An evaluation of historical information, documented feasibility studies, and remedial effectiveness reports indicate that BCBG leachate is not appropriate for inclusion in this focused feasibility study. Key reasons for this conclusion are:

- The flow rate of contaminated surface water nearest to BCBG seeps is far greater than what is expected for the combined EMWMF and EMDF landfill water volumes.
- The contaminants are not consistent with those at EMWMF and EMDF.
- No CERCLA remedial decision has been made for the remediation of BCBG.
- The leachate contains Resource Conservation and Recovery Act (RCRA)-listed hazardous waste.
- The larger flow rate and the different contaminants will greatly increase the cost for the EMWMF/EMDF landfill water treatment alternative.

Appendix A provides further details for evaluating the inclusion of BCBG leachate in the scope of this focused feasibility study.

1.6 EMWMF AND EMDF LANDFILL WATER MANAGEMENT OPERATIONS

The scope of this focused feasibility study is the management of EMWMF and EMDF landfill water. The definitions of leachate and contact water follow (UCOR-4135/R1, *Environmental Management Waste Management Facility (EMWMF) Operation Plan, Oak Ridge, Tennessee*), and Fig. 5 illustrates how landfill water is managed:

- Contact water—Contact water is precipitation that falls into an active EMWMF cell, comes in direct contact with waste, is pumped to the contact water tanks from the liner, and does not infiltrate into the leachate collection system. Because contact water contacts the waste, it potentially is contaminated.
- Leachate—Leachate is precipitation that falls into an active cell, infiltrates through the waste, infiltrates through the liner, is collected by the leachate collection system, and is pumped to the leachate storage tanks. Because leachate contacts the waste, it potentially is contaminated. Leachate does not include any liquid wastes, because these are specifically prohibited in accordance with the *Attainment Plan for Risk/Toxicity-Based Waste Acceptance Criteria at the Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-1909&D3).

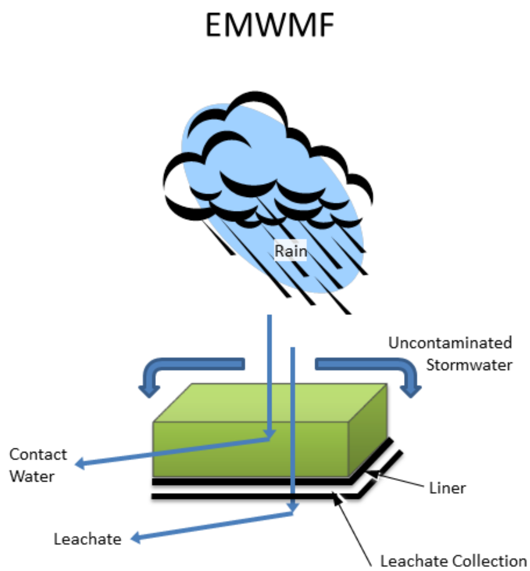

Fig. 5. Water management at EMWMF.

The volume of landfill water is minimized by shedding and diversion of stormwater to the extent possible through landfill design and operating characteristics. Stormwater is precipitation that does not fall into an active cell, does not encounter waste, and does not become contaminated. Therefore, stormwater is not included in this focused feasibility study.

Currently, EMWMF contact water is collected in catchments in each disposal cell and pumped to the contact water ponds and contact water tanks. The contact water is sampled and analyzed to determine if the discharge limits contained in DOE/OR/01-1873&D2/A1/R2 are met. If the discharge limits are met, then the contact water is pumped into the Sediment Basin and discharged to North Tributary-5 of Bear Creek. If the discharge limits are not met due to elevated concentrations of hexavalent chromium, the contact water is conditioned to meet the discharge limits (for hexavalent chrome) or transferred by tanker truck to the Process Water Treatment Complex (PWTC) at ORNL for treatment and disposal.

EMWMF leachate is collected by the leachate underdrain, pumped to the leachate storage tanks and loading stations, and transferred by tanker truck to PWTC for treatment and disposal. EMDF landfill water will be collected and stored, treated, and/or disposed in accordance with the recommendation of this focused feasibility study. The capacities of the EMWMF contact water catchments, ponds, and tanks and the leachate storage tanks are in Table 1. This capacity is inadequate for operation of the combined EMWMF and EMDF, and an additional 500,000 gal of storage will be needed when EMDF begins operation.

Table 1. Contact water and leachate storage capacity at EMWMF

Location	Normal maximum capacity (gallons)	Subtotal (gallons)	Remarks
Cell 5 catchment	3,400,000		
Cell 6 catchment	2,400,000		Reserve capacity until Cell 6 opens.
		5,800,000	
CWP #1	482,300		
CWP #2	492,300		
CWP #3	404,600		
CWP #4	425,000		
		1,804,200	
CWT A	235,000		
CWT B	235,000		
CWT C	235,000		
CWP D	235,000		
		940,000	
Leachate Storage Tanks	240,000		Total of 8 leachate storage tanks.
		240,000	
Total		**8,784,200**	

CWP = contact water pond
CWT = contact water tank

The EMDF approach to landfill water collection may differ from EMWMF. A low permeability material in the catchment areas (referred to as "windows") is being considered to allow contact water to percolate quickly into the leachate collection system, thus allowing collection and management as one stream. However, the EMDF approach to landfill water collection will not be finalized until design. EMDF will utilize the existing EMWMF water storage and transfer systems, along with additional water storage tanks.

1.7 EMWMF AND EMDF LANDFILL WATER QUALITY

DOE, EPA, and TDEC agreed to evaluate the management of landfill water from EMWMF and EMDF in a focused feasibility study and to integrate the recommendation into the CERCLA decision-making documents for EMDF and, if appropriate, for EMWMF.

COCs for EMWMF were identified initially from the COCs listed for the ORR CERCLA remediation sites that were to send waste to EMWMF for disposal. Contaminants shown through calculations to be a risk were included as COCs to reduce or eliminate their exposure to humans and release to the environment. Waste acceptance criteria (WAC) for EMWMF limit the COCs and/or their concentration that may be placed in EMWMF. Additionally, a list of contaminants known to or that can potentially migrate into the environment was established for surface water and groundwater sampling on the ORR.

The COCs for EMWMF landfill water were developed from the EMWMF WAC list and the list of contaminants for ORR surface water and groundwater monitoring. EMWMF COCs are contained in the *Sampling and Analysis Plan/Quality Assurance Project Plan for Environmental Monitoring at the Environmental Management Waste Management Facility* (UCOR-4156) and in Appendix C of this focused feasibility study. These COCs apply to both EMWMF and EMDF for this focused feasibility study.

Because of the different contaminants at the East Tennessee Technology Park, ORNL, and Y-12, the variability in waste lots and associated waste contaminants over time, the presence of unexpected contaminants, and the mobility of the disposed contaminants, the contaminants in EMWMF landfill water have varied over time. As shown in Appendix C, at times in the past, specific contaminants have appeared for a short time, but are not currently in the landfill water. It is expected that this situation will continue in the future so that the contaminants in the landfill water will vary over time and for varying periods of time (Fig. 6).

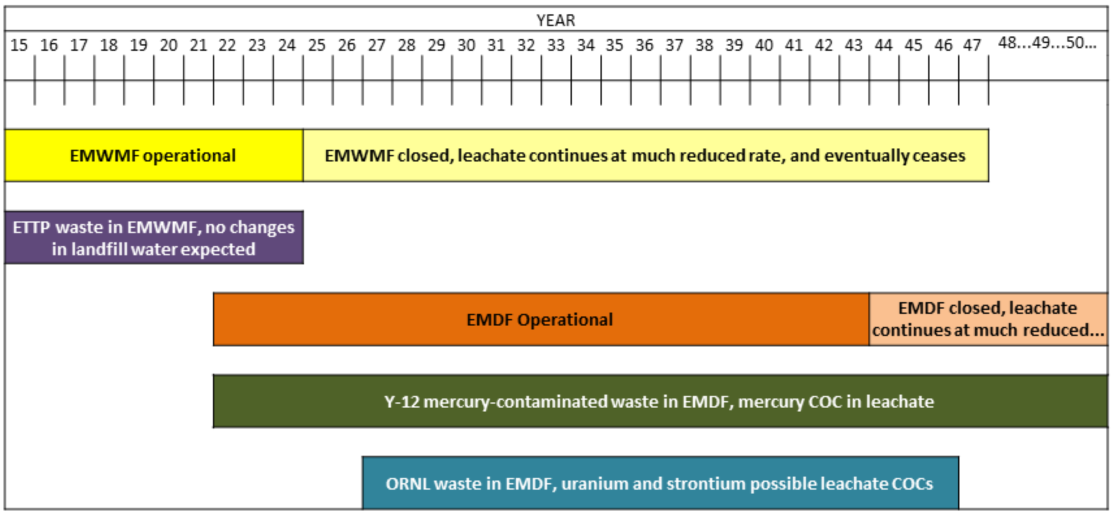

Fig. 6. Contaminants of concern requiring treatment vary over time.

However, to identify the key COCs for this focused feasibility study, all of the COCs were screened against their abundance in EMWMF waste lots, their mobility, and regulatory concern/risk (Appendix C). Based on this screening, the key COCs were determined upon which this focused feasibility study is based. Table 2 lists the key COCs, their minimum, average, and maximum concentrations in leachate and contact water observed over the past two years at EMWMF, and a comparison to AWQC. Two years of data were selected to ensure the current contaminants and concentrations are evaluated. EMWMF and EMDF will periodically evaluate the full suite of contaminants that might be present in the landfill water. Based on the results, COCs and/or treatment options will be adjusted accordingly. Due to the uncertainty in the contaminants to be treated over time, the ability of the alternatives in this focused feasibility study to adapt quickly and easily to changing treatment requirements will be a key criterion of the evaluation.

Comparison of the actual data from EMWMF to AWQC is based on a running annual average. By comparing the average concentrations to the AWQC (Table 2), those key COCs exceeding AWQC are mercury from EMDF and cadmium and pesticides from EMWMF. The concentration of mercury in EMDF landfill water does not use the concentration from EMWMF, but uses a concentration derived from the analysis described in Appendix E. The presence of pesticides is a result of their use at DOE facilities for their intended purposes (pest control), and not from the disposal of waste products from DOE operations. In addition, the detection limits for pesticides are at or above AWQC. Therefore, the TDEC Required Reporting Limits [TDEC 0400-40-03-.05(8)] are appropriate and are used.

The concentrations in Table 2 are used in this focused feasibility study, and their application to each alternative is discussed in Sect. 3.3. The concentrations of the key COCs in landfill water will change over time due to the wide range of contaminants in debris and soil at the East Tennessee Technology

Park, ORNL, and Y-12. Therefore, the ability to adapt quickly and easily to changes is an important consideration in the evaluation of alternatives.

Based on a combination of process knowledge, historical analytical data, approved EMWMF waste lots and disposal records, and physical characteristics, EMWMF leachate and contact water are shown to be neither listed nor characteristic hazardous waste under RCRA. Appendix F provides a detailed determination. EMDF landfill water is not expected to be RCRA-hazardous due to the expected concentration of mercury (Appendix E).

Table 2. Key contaminants of concern

Contaminant type	Contaminant	Units	Minimum	Maximum	Average (contact water)[a]	Average (leachate)[a]	AWQC Fish and Aquatic Life CMC[b]	AWQC Fish and Aquatic Life CCC[b]	AWQC recreation[b]	Required reporting limit[b]
Metal	Arsenic, Total + Dissolved	ug/L	0.15	3.6	2.1	1.97	340	150	10	1
Metal	Cadmium, Total + Dissolved	ug/L	0.08	0.332	0.351	0.356	2.2*	0.27*	NA	1
Metal	Chromium, Total + Dissolved	ug/L	0.3	16.7	6.74	1.92	625*	81*	NA	1
Metal	Copper, Total + Dissolved	ug/L	0.41	5	3.11	2.39	15*	9.9*	NA	1
Metal	Lead, Total + Dissolved	ug/L	0.36	4.53	1.077	1.13	73*	2.8*	NA	1
Metal	Mercury, Total + Dissolved (EMWMF)	ug/L	0.065	0.22	0.077	0.079	1.4	0.77	0.051	0.2
Metal	Mercury, Total + Dissolved (EMWMF lower detection limit)[c]	ug/L	0.02	0.072	0.03	0.03	1.4	0.77	0.051	0.2
Metal	Mercury, Total + Dissolved (EMDF)[d]	ug/L	NA	NA	NA	1.0	1.4	0.77	0.051	0.2
Metal	Nickel, Total + Dissolved	ug/L	0.56	15	6.25	5.1	515*	57*	4600	10
Metal	Uranium	ug/L	2.01	388	6.37	6.01	0	0	0	0
Other	Cyanide	ug/L	1.84	14.9	2.05	2.01	22	5.2	140	NA
Pesticide	4,4'-DDD	ug/L	0.011	0.0767	0.018	0.018	NA	NA	0.0031	0.1
Pesticide	4,4'-DDE	ug/L	0.0125	0.293	0.057	0.018	NA	NA	0.0022	0.1
Pesticide	4,4'-DDT	ug/L	0.013	0.05	0.018	0.019	1.1	0.001	0.0022	0.1
Pesticide	Aldrin	ug/L	0.011	0.04	0.017	0.018	3	NA	0.0005	0.5
Pesticide	beta-BHC	ug/L	0.0104	0.289	0.03	0.018	NA	NA	0.17	0.5
Pesticide	Dieldrin	ug/L	0.011	0.02	0.018	0.018	0.24	0.056	0.00054	0.05
Radiological	Iodine-129	pCi/L	0.39	12.8	2.03	2.104	NA	NA	NA	NA
Radiological	Strontium-90	pCi/L	1.31	471	2.77	17.1	NA	NA	NA	NA
Radiological	Technetium-99	pCi/L	4.11	983	17.4	7.85	NA	NA	NA	NA
Radiological	Tritium	pCi/L	337	9234.86	419	873	NA	NA	NA	NA
Radiological	Uranium-233/234	pCi/L	0.65	362	44.5	36	NA	NA	NA	NA
Radiological	Uranium-235/236	pCi/L	0.26	27.4	3.42	2.5	NA	NA	NA	NA
Radiological	Uranium-238	pCi/L	0.3	156.2	1.86	2.13	NA	NA	NA	NA

[a]Non-detects are replaced by a surrogate value: non-radiological surrogate is one-half the detection limit and radiological surrogate is the minimum detectable activity.

[b]TN0400-040-03-.03, Criteria for Water Uses

[c]The detection limit was lowered for appropriate comparison to the AWQC.

[d]Mercury from EMDF leachate was estimated. See Appendix E.

Table 2. Key contaminants of concern (cont.)

CCC = Criterion Continuous Concentration
CMC = Criterion Maximum Concentration
EMDF = Environmental Management Disposal Facility
NA = not applicable
WAC = waste acceptance criteria
*Hardness corrected value based on average hardness of 112 mg/L in the NT-05 receiving stream

Additional Water Quality Parameters to be Monitored

Hardness, as CaCO3, mg/l	Because toxicity of some metals is directly related
Nitrogen, Nitrate total (as N)	Nutrients, important to monitor health of the stream
Nitrogen, total (as N)	Nutrients, important to monitor health of the stream
Phosphorus, total (as P)	Nutrients, important to monitor health of the stream
total dissolved solids (TDS) or Conductivity	Routine performance to determine if a pulse is moving through the system
Total Organic Carbon	Indicates the presence of volatile organic compounds or semi-volatile organic compounds
TSS = total dissolved solids	Indicates the potential to transport adsorbed metals, affects benthics.
Whole Effluent Toxicity, both Acute and Chronic	Minimum - semi-annual, or upon major change in waste characteristics; at least one sample during Sept - Nov low flow period.
Ammonia Nitrogen, Total as N	Ubiquitous nature in most leachate streams
Stream flow	Required to calculate mixing in stream if upset conditions occur
Wastewater Flow	Required to calculate mixing in stream

1.8 FLOW RATES

The quantity of landfill water will vary over the EMWMF and EMDF life cycle, illustrated in Fig. 7. Initially, landfill water will be generated from EMWMF operations, then from the combined operation of EMWMF and EMDF, then from EMDF operation, and finally following closure. In order to address this uncertain and varying flow rate, the period of time when EMWMF and EMDF operations overlap is used in this focused feasibility study because this period represents the maximum estimated flow rates. Therefore, the design flow rate for this focused feasibility study is based on relatively high anticipated flows during years 3 and 4 when EMWMF Cells 5 and 6 and EMDF Cell 1 are open. Various rainfall events were modeled to predict the flow rate of landfill water, and the predictions were compared to historical data. Table 3 summarizes the flow rates from the model for the peak day, average month, wettest month, and maximum month rainfall events. A detailed description of the flow rate calculations is in Appendix B.

For the purposes of this focused feasibility study, the average flow rate is 30 gal per minute (gpm) (average month in Table 3), and the maximum flow rate is 60 gpm (maximum month in Table 3). The landfill water flow rate will vary over the life of the two facilities as rainfall varies, disposal cells are opened and closed, and during post-closure. The flow rate during post-closure will only be leachate and may be less than one gpm. Therefore, the uncertainty of flow rates and the ability to adapt to varying flow rates is considered in the evaluation of alternatives.

Table 3. Landfill water flow rates

Active cell	Active cell area (acres)	Peak day (gal per minute)	Average month (gal per minute)	Wettest month (gal per minute)	Maximum month (gal per minute)
EMWMF Cell 5	6.0	572	10	12	20
EMWMF Cell 6	5.3	501	10	11	20
EMDF Cell 1	6.2	756	10	12	20
TOTALS	17.5	1839	30	35	60

1.9 ADDITIONAL WATER STORAGE

Additional water storage capacity is required to store the expected landfill water volumes from EMWMF and EMDF. The current EMWMF storage capacity is adequate to store EMWMF landfill water prior to EMDF operations.

The water storage capacity was calculated based upon a 100-year, 24-hour design storm that occurs when three cells are open—two EMWMF cells (Cells 5 and 6) and EMDF Cell 1. The details for the water storage capacity calculations are in Appendix H.

1.10 ESTIMATED TIMELINE

The expected timeline for the operation, closure, and post-closure periods for EMWMF and EMDF is in Fig. 7. In the first two years, only EMWMF is in operation; in years 3 and 4, both EMWMF and EMDF are in operation; for the next 23 years, only EMDF is in operation and EMWMF is closed; finally, both facilities are closed. EMWMF and EMDF each have a 30-year period of long-term stewardship per the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA/540/G-89/004) for the purpose of this focused feasibility study. The *Remedial Investigation/Feasibility Study for*

Comprehensive Environmental Response, Compensation, and Liability Act Oak Ridge Reservation Waste Disposal, Oak Ridge Reservation (DOE/OR/01-2535&D3) assumes that landfill water only will be generated from EMDF for ten years following closure, at which time the landfill will be dewatered. However, the 30-year period of long-term stewardship is still used for the purposes of this focused feasibility study.

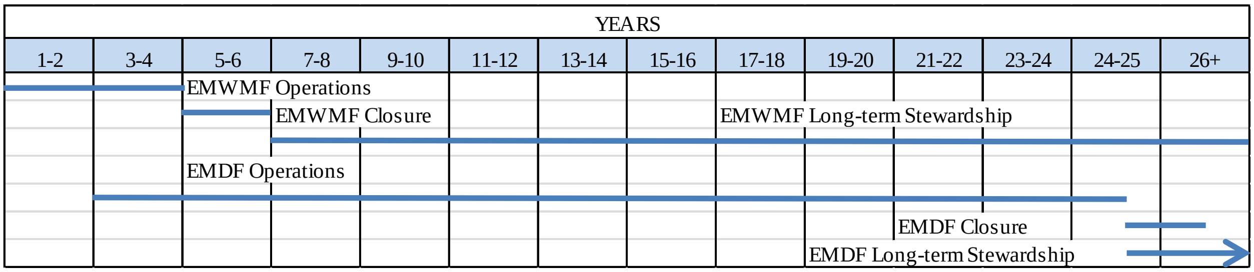

Fig. 7. Timeline.

1.11 PROBLEM SUMMARY

As discussed previously, landfill water will be generated as a result of land disposal of CERCLA waste in EMWMF and EMDF that may contain concentrations of key COCs that exceed AWQC. The problem encompasses the determination of a safe and environmentally sound approach for management of this landfill water. The approach must be protective of human health and the environment, implementable, adaptable, cost effective, and meet AWQC.

The options and alternatives identified and evaluated must have a common basis for development and comparison purposes. The following parameters define the basis for the identification, development, and evaluation of the alternatives.

- The average flow rate is 30 gpm, and the maximum flow rate is 60 gpm.
- The design storm is 100 years, 24 hours.
- The primary contaminants potentially requiring treatment are mercury and cadmium, but additional contaminants that may require treatment are likely over the operating period, due to changes in waste disposed at EMWMF and EMDF over time.
- EMWMF leachate and contact water are neither listed nor characteristic RCRA hazardous waste.
- EMDF landfill water is not expected to be listed or characteristic RCRA hazardous waste.

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2. REMEDIAL ACTION OBJECTIVES

2.1 ANTICIPATED FUTURE LAND USE

EMWMF and EMDF are located in the Bear Creek watershed, entirely within the ORR, where public access is restricted. Because Y-12 is an active production and special nuclear materials management facility, additional security and access limitations apply.

Reasonably anticipated future uses of land are an important consideration in determining remediation levels and extent of remediation. Consistent with EPA guidance in *Land Use in the CERCLA Remedy Selection Process* (EPA 9355.7-04), DOE solicited input on potential future land use from EPA and TDEC, local land-use planning authorities, and the public during the ORR watershed-level remedial investigation and feasibility study development. The ORR Site-Specific Advisory Board recommended the area in which EMWMF is located and where EMDF is proposed be used for waste management. The selected remedy in DOE/OR/01-1750&D4 is consistent with this recommendation.

2.2 REMEDIAL ACTION OBJECTIVES

Remedial action objectives are site-specific goals developed from the purpose and scope of remedial actions. CERCLA guidance defines remedial action objectives as "medium-specific or operable unit-specific goals for protecting human health and the environment" (EPA/540/G-89/004). According to the National Oil and Hazardous Substances Pollution Contingency Plan, [40 *Code of Federal Regulations* (*CFR*) 300.430[e][2][i])] remedial action objectives should specify the media and contaminants of concern, potential exposure pathways, and remediation goals. Because EMWMF and the EMDF remedial actions provide for the disposition of various waste types derived from a wide range of sources and activities, establishing specific cleanup goals is not appropriate. Instead, these goals will be developed at the project-specific level during future CERCLA remedial decisions.

Since the scope of this focused feasibility study is limited to evaluating alternatives for the management of landfill water, the remedial action objective is to:

- Meet AWQC

This remedial action objective is consistent with the overall remedial action objectives for EMWMF and EMDF.

2.3 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

CERCLA Section 121 and 40 *CFR* 300.430(f)(1)(ii)(B) specify that remedial actions for cleanup of hazardous substances must attain or have waived ARARs under federal or more stringent state environmental laws. Applicable requirements are "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site" (40 *CFR* 300.5). Relevant and appropriate requirements are "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting law that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a

CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site" (40 *CFR* 300.5). Pursuant to EPA guidance, where EPA has delegated to the State of Tennessee the authority to implement a federal program, the Tennessee regulations replace the equivalent federal requirements as the potential ARARs.

CERCLA on-site remedial response actions must comply only with the substantive requirements of a regulation and not the administrative requirements to obtain federal, state, or local permits [CERCLA Section 121(e)]. To ensure that CERCLA response actions proceed as rapidly as possible, EPA has reaffirmed this position in the final National Oil and Hazardous Substances Pollution Contingency Plan (NCP) [55 FR 8756, March 8, 1990]. Substantive requirements pertain directly to the actions or conditions at a site, while administrative requirements facilitate their implementation (e.g., approval of or consultation with administrative bodies, documentation, permit issuance, reporting, record keeping, and enforcement).

The NCP at 40 CFR 300.400(e)(1) defines "on-site" as meaning "the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for the implementation of the response action." CERCLA Sect. 104(d)(4) (as discussed further in the preamble to the final NCP, 55 FR 8690) states where two or more noncontiguous facilities are reasonably related on the basis of geography, or on the basis of the threat or potential threat to the public health or welfare or the environment, these related facilities may be treated as one for the purpose of conducting response actions. Section 104(d)(4) allows the lead agency to manage waste transferred between such noncontiguous facilities without having to obtain a permit (i.e., manage as "on-site" waste). This approach was proposed and agreed to by all signatories to the *Federal Facility Agreement for the Oak Ridge Reservation* (DOE/OR-1104) for EMWMF, was acknowledged and documented in the *Record of Decision for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act of 1980 Waste* (DOE/OR/01-1791&D3, and was reaffirmed in DOE/OR-01-2161&D2). This agreement serves as the basis for designating waste treatment, storage, and disposal facilities on the ORR as "on-site" facilities not subject to the CERCLA Off-site Rule (40 *CFR* 300.440) when accepting wastes from CERCLA on-site response actions.

ARARs include those federal and state regulations that are designed to protect the environment. ARARs do not include occupational safety regulations. EPA requires compliance with occupational and worker protection standards in Section 300.150 of the NCP, independent of the ARARs process. Therefore, neither the regulations promulgated by the U.S. Occupational Safety and Health Agency nor DOE Orders related to occupational safety are addressed or included as ARARs.

There are three categories of ARARs:

- Location-specific—Location-specific ARARs establish restrictions on permissible concentrations of hazardous substances or establish requirements for how activities will be conducted because they are in special locations, e.g., wetlands, floodplains, critical habitats, historic districts, or streams.
- Chemical-specific—Chemical-specific ARARs provide health- or risk-based concentration limits or discharge limitations in various environmental media, i.e., surface water, groundwater, soil, or air, for specific hazardous substances, pollutants, or contaminants.
- Action-specific—Action-specific ARARs include operation, performance, and design requirements or limitations based on waste types, media, and removal activities.

In addition to ARARs, 40 *CFR* 300.400(g)(3) states that federal or state nonpromulgated advisories or guidance may be identified as "to be considered" (TBC) guidance for contaminants, conditions, and/or actions at the site. TBC guidance includes non-promulgated criteria, advisories, guidance, and proposed standards. TBC guidance are not ARARs because they are neither promulgated nor enforceable. TBC guidance may be used to interpret ARARs and to determine preliminary remediation goals when ARARs do not exist for particular contaminants or are not sufficiently protective to develop cleanup goals.

DOE Orders are neither ARARs nor TBC guidance. DOE Orders are not ARARs because they are not promulgated. In some cases, DOE Orders may contain requirements promulgated by other federal agencies that are potential ARARs, and these requirements should be identified through the ARARs process.

With regard to the use of any Nuclear Regulatory Commission (NRC) requirements as ARARs at DOE environmental restoration sites, DOE is legally exempt from these low-level radioactive regulations (unless the particular facility is an NRC-licensed facility). Under the Atomic Energy Act of 1954, a single agency, the Atomic Energy Commission, had responsibility for the development and production of nuclear weapons and for both the development and the safe regulation of the civilian uses of nuclear materials. Under the Energy Reorganization Act of 1974, this function was split between two separate and unique agencies—NRC and DOE. DOE has responsibility for the development and production of nuclear weapons, promotion of nuclear power, and other energy-related work, as well as the regulation of defense nuclear facilities, and NRC has responsibility for the development and the safe regulation of civilian uses of nuclear materials.

NRC has promulgated its own regulations governing the facilities and activities it oversees and licenses. These regulations are legally applicable only to NRC-licensed facilities or activities. Similarly, DOE is legally responsible for the management of nuclear materials at its facilities and is responsible for developing its own set of Orders in carrying out its statutory responsibilities under the Atomic Energy Act. Tennessee specifically exempts DOE and its contractors or subcontractors from its NRC-equivalent regulations in TDEC 0400-20-10-.06 and NRC exempts DOE from its definition of a "person" subject to its regulations in 10 CFR 20.1003. EPA's ARARs Guidance, *CERCLA Compliance with Other Laws Manual: Part II* (EPA/540/G-89/009, OSWER 9234.1-02, August, 1989) recognizes DOE's unique role. The manual states that "most of DOE's operations are exempt from NRC's licensing and regulatory requirements" and DOE's requirements for "radioactive waste management are spelled out in a series of internal DOE Orders…issued under the Atomic Energy Act [that] have the same force for DOE facilities or 'within DOE' as does a regulation."

NRC regulations and the TDEC rule equivalents (NRC/TDEC) are also not relevant and appropriate based on the preamble to the final rule establishing the NCP (55 FR 8744, March 8, 1990): "EPA believes it is reasonable to consider the existence of waivers, exemptions, and variances under other laws because generally there are environmental or technical reasons for such provisions…These provisions are generally incorporated into national regulations because there are specific circumstances where compliance with a requirement may be inappropriate for technical reasons or unnecessary to protect human health and the environment." Since DOE is specifically exempted from NRC regulations and the TDEC rule equivalents and has equivalent requirements in its internal Orders, it is per EPA's own language, inappropriate and unnecessary to cite these as relevant and appropriate requirements.

TDEC regulations [TDEC 0400-45-01-.04(55)] allow for a "locational running annual average" defined as the "average of sample analytical results for samples taken at a particular monitoring location during the previous four calendar quarters," and compliance with the set limits will be based on this running annual average. Per EPA guidance (EPA/PB85-227049, *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses* and EPA-820-B-95-001, *Water Quality Guidance for the Great Lakes System: Supplementary Information Document [SID]*), a suitable averaging period is appropriate because the concentration of a pollutant can be above AWQC without causing an unacceptable effect if (a) the magnitudes and durations of the excursions above the

AWQC are appropriately limited and (b) there are compensating periods of time during which the concentration is below the AWQC. EPA also notes that an allowable frequency for exceeding the criteria is incorporated into its criteria because it is not necessary for concentrations to be below criteria at all times to protect aquatic ecosystems. Finally, EPA says that it is not generally possible to ensure that criteria are never exceeded.

The ARARs for this focused feasibility study are in Appendix D.

CERCLA Section 121(d) provides that, under certain circumstances, an ARAR may be waived. The six statutory waivers are:

- Interim measures
- Equivalent standard of performance
- Greater risk to health and the environment
- Technical impracticability
- Inconsistent application of state standard
- Fund-balancing

3. DEVELOPMENT AND DESCRIPTION OF ALTERNATIVES

3.1 PURPOSE

This chapter summarizes the screening of remediation technologies and process options and the development of remedial alternatives for the management of landfill water from EMWMF and EMDF. In accordance with CERCLA [40 *CFR* 300.430(1)], the goal of this focused feasibility study is to develop and evaluate remedial alternatives that eliminate, reduce, or control risks to human health and the environment. The NCP provides recommendations for developing remedial action alternatives, including:

- Use of treatment to address the principal threats posted by a site, wherever practicable.
- Use of engineering controls (e.g., containment) for waste that poses a relatively low, long-term threat for which treatment is impracticable.
- Implementation of a combination of actions, as appropriate, to achieve protection of human health and the environment. For example, in appropriate site situations, treatment of principal threats is combined with engineering and institutional controls for treatment of residuals and untreated waste.
- Use of institutional controls to supplement engineering controls for short- and long-term management to prevent or limit exposures to hazardous substances.
- Selection of an innovative technology when the technology offers the potential for comparable or better treatment performance or implementability than other technologies, fewer adverse impacts than other technologies, or lower costs than demonstrated technologies for similar levels of performance.
- Restoration of environmental media (e.g., groundwater) to their beneficial uses wherever practicable and within a reasonable time frame given the particular circumstances of the site. When restoration of groundwater to beneficial uses is not practicable, EPA expects remedial action to prevent further migration of the contaminant plume, prevent exposure to contaminated groundwater, and evaluate further risk reduction.

Because this focused feasibility study focuses on the management of landfill water generated from EMWMF and EMDF, the range of alternatives is focused on water management actions. Therefore, the range of technology types and process options applicable to this study is limited to those pertinent to the management of landfill water from EMWMF and EMDF. The primary problem addressed in this study is ensuring that the landfill water discharge meets the ARARs. Existing land use controls are effective in preventing unacceptable risks to current receptors, and EMWMF and EMDF are expected to remain under DOE control in perpetuity. Therefore, land use controls are expected to be useful tools to be used in conjunction with other technology options, for consideration in the technology screening.

3.2 IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS

Remedial action objectives are met through implementation of general response actions, alone or in combination. General response actions are categories of actions intended to protect human and ecological receptors from exposure to contamination in sources or environmental media, e.g., groundwater and surface water. Technology types are identified for each general response action that are appropriate for the media, contaminants, and location being considered. Next, process options are identified and evaluated to select representative process options for each technology type. Process options are broad categories of technologies that, alone or in combination, are used to satisfy the remedial action objectives. These representative process options are retained for alternative development.

As specified in EPA guidance (EPA/540/G-89/004), two screening steps typically are taken to reduce the number of technology types and process options associated with each general response action. Initially, each process option is screened for technical applicability against the following criteria:

- Applicability to the type and combination of contaminants
- Applicability to the site physical conditions

Process options that are not technically applicable to the site or to the contaminants are eliminated from further consideration. In the second screening step, the retained process options are evaluated more closely against the following criteria to select one or more options to represent each technology type.

- Effectiveness—Effectiveness considers the potential effectiveness of process options in handling the estimated areas or volumes of media and meeting the remediation goals identified in the remedial action objectives; the potential impacts to human health and the environment during the construction and implementation phases; and how proven and reliable the process is with respect to the contaminants and conditions at the site.
- Implementability—Implementability encompasses both the technical and administrative feasibility of implementing a technology process. Technical implementability is an initial screen to eliminate those that are clearly ineffective or unworkable at the site. Administrative implementability considers the ability to obtain necessary permits for off-site actions; the decision-making process; the availability of treatment, storage, and disposal services (including capacity); and the availability of necessary equipment and skilled workers to implement the technology.
- Cost—Cost plays a limited role in the screening of process options. Relative capital, operations, and maintenance (O&M) costs are used rather than detailed estimates. At this stage in the process, the cost analysis is based on engineering judgment, and each process option is evaluated as to whether costs are high, low, or medium relative to other process options.

Because this is a focused feasibility study evaluating how to manage landfill water, the two screening steps were combined, and the range of general response actions, technology types, and process options was limited to those pertinent to the management of landfill water. The general response actions identified for management of EMWMF and EMDF landfill water are:

- No action
- Monitoring
- Water treatment
- Zero discharge

The no action general response action involves the free release of untreated landfill water to the environment, while other general response actions involve providing health and environmental protection from the potential impacts of contaminated landfill water. Each of the general response actions was evaluated with respect to the evaluation criteria and a determination was made to either retain for further evaluation or reject from further consideration. The results of the evaluation are in Table 4.

Zero discharge was not retained because of the relatively high volume of landfill water generated at EMWMF and EMDF that makes evaporation impractical. The greater volume is a result of maintaining the large working faces necessary to minimize the amount of clean fill used and provide sufficient space for the concurrent disposal of differing waste streams. Reuse of the generated landfill water for dust control is confined to the working cells only. Use outside of the cells results in the potential to spread contamination. Therefore, reuse requires maintaining two separate systems for dust control and adds additional cost. Appendix G contains additional discussion of the zero discharge general response action.

In the development and evaluation of the alternatives, an adaptive management approach is used to make a decision based on existing information, monitoring and evaluating data during operation, and modifying the landfill water management system as appropriate over time (Everett and Ebert, *Production and Operations Management: Concepts, Models, and Behavior*; Holling, C. S., *Adaptive Environmental Assessment and Management*; National Research Council 2003, *Environmental Cleanup at Navy Facilities: Adaptive Site Management*; and National Research Council 2004 *Adaptive Management for Water Resources Project Planning*). This approach is a decision process that promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Adaptive management acknowledges uncertainty and makes use of management interventions and follow-up monitoring to promote understanding and improve decision making through an iterative process. In this case, uncertainties associated with future COCs is addressed by allowing for flexibility in construction and operations. Additional processing capability or modified operations will be implemented to address COCs that are not anticipated during initial design.

Table 4. Evaluation of process options

General response action	Technology type	Process option	Description	Technical applicability	Effectiveness	Implementability	Cost	Retained
No action	None	None	No additional action	Not applicable	Not effective	Easy to implement	No cost	Retain as required by the National Contingency Plan
Monitoring	Monitoring	Managed discharge	Discharge if AWQC met	Applicable	Effective if AWQC met	Easy to implement	Low	Retain
Water treatment	*In situ*	Constructed wetlands	Construct wetlands to treat water	Applicable	May meet discharge limits; perhaps useful for polishing	Will convert mercury to methyl mercury; will have to be constructed	Low	Not retained
	Treat at EMWMF/EMDF site	Water treatment facility	Construct new treatment facility	Applicable	Effective	Easy to implement	Medium	Retain
	Treat elsewhere on ORR	ORNL PWTC	Transport to ORNL PWTC for treatment by truck or pipeline	Applicable	Effective	WAC do not accept mercury, so WAC will have to be revised; harder to implement due to trucking or pipeline; may need expansion of storage facilities and future modification of treatment processes for additional COCs	Medium	Retain

Table 4. Evaluation of process options (cont.)

Water treatment	Treat elsewhere on ORR	Y-12 WETF	Transport to Y-12 WETF for treatment by truck or pipeline	Applicable	Effective	Meets WAC; harder to implement due to trucking or pipeline and work in Y-12; treatment plant expansion required	Medium	Retain
		Outfall 200 treatment system	Transport to Outfall 200 treatment system by truck or pipeline	Applicable; addresses mercury	Effective for mercury; may require modification for other COCs	Easy to implement; treatment facility proposed but not built; discharges into another watershed	Low	Retain
	Off-site	Existing facility	Use an existing off-site treatment facility and transport by truck or pipeline	Applicable	Not effective	No facility available	Not applicable	Not retained
		New facility	Construct a new off-site treatment facility and transport by truck or pipeline	Applicable	Effective	Difficult due to new construction and transporting to new facility	High	Not retained
Zero discharge	Reuse of water	Reuse of water	Reuse leachate and contact water	Applicable	Not effective	Use of contaminated water unacceptable; treatment prior to reuse is not cost effective	High	Not retained
	Evaporation	Evaporation	Evaporate leachate and contact water	Applicable	Not effective due to inadequate evaporation rate	Easy to implement	Low	Not retained

AWQC = ambient water quality criteria
COCs = contaminants of concern
EMDF = Environmental Management Disposal Facility
EMWMF = Environmental Management Waste Management Facility
ORNL = Oak Ridge National Laboratory
ORR = Oak Ridge Reservation
PWTC = Process Water Treatment Complex
WETF = West End Treatment Facility
Y-12 = Y-12 National Security Complex

The general response actions, technology types, and representative process options retained for alternative development are in Table 5.

Table 5. Retained representative process options

General response action	Technology type	Representative process option (s)
No action	None	No action
Manage at EMWMF/EMDF site	Managed discharge	Managed discharge
	Treatment facility	Treatment facility
Manage elsewhere on ORR	ORNL PWTC	ORNL PWTC
	Y-12 WETF	Y-12 WETF
	Outfall 200	Outfall 200

The specific process options used to implement the action can change and may not be selected until the design phase. The specific process options selected as representative are considered to represent similar performance and cost to those that will actually be implemented.

3.3 DESCRIPTION OF ALTERNATIVES

3.3.1 Introduction

This section presents the description of the alternatives to manage the landfill water from EMWMF and the EMDF. The general response actions and representative process options selected in the preceding section were used to develop a range of alternatives. The purpose of a range of alternatives is to present the decision-makers with technical and economic options for implementation. While the representative process options provide a basis for developing alternatives, the specific process options used to implement the action can change and may not be selected until the design phase. The following six alternatives were assembled from the retained representative process options:

- Alternative 1: No Action. In Alternative 1, landfill water is not collected and flows freely from EMWMF and EMDF into groundwater and/or surface water.
- Alternative 2: Managed Discharge. In Alternative 2, landfill water is sampled and discharged to Bear Creek without treatment.
- Alternative 3: Treat at EMWMF/EMDF. In Alternative 3, landfill water is treated at the EMWMF/EMDF site prior to discharge to Bear Creek.
- Alternative 4: Treat at PWTC. In Alternative 4, the landfill water is transported by truck or pipeline to the existing, on-site treatment facility (PWTC) at ORNL. PWTC will require modifications.
- Alternative 5: Treat at West End Treatment Facility (WETF). In Alternative 5, the landfill water is transported by truck or pipeline to the existing, on-site treatment facility (WETF) at Y-12. WETF will require modifications.
- Alternative 6: Treat at Outfall 200 Mercury Treatment Facility (OF200 MTF). In Alternative 6, the landfill water is transported by truck or pipeline to the planned, on-site treatment facility (OF200 MTF) at Y-12.

Following are descriptions of the alternatives in sufficient detail to support their analysis in Chap.4. Specific technologies, other than those described here, may be substituted once the alternative is selected and subsequent detailed design is underway.

3.3.2 Alternative 1: No Action

Summary: As required by the NCP, the no action alternative provides a comparative baseline against which other alternatives are evaluated. The no action alternative does not initiate any remedial action, normally assumes that present security measures and land use controls to limit access and use are not maintained, and eliminates short- and long-term monitoring. Operation of the existing EMWMF landfill water collection system will be terminated, and landfill water will be discharged without management. EMDF will not include a landfill water collection system and landfill water will flow freely from both landfills. The landfill water will not be expected to meet AWQC at all times. No implementation is required and there are no costs associated with this alternative.

Time frame for implementation: This alternative can be implemented immediately.

3.3.3 Alternative 2: Managed Discharge

Summary: Alternative 2 consists of collecting the landfill water from EMWMF and EMDF in tanks and ponds. Landfill water will be transferred to the existing EMWMF sediment basin for discharge to Bear Creek. Figure 8 illustrates the process flow diagram for this alternative.

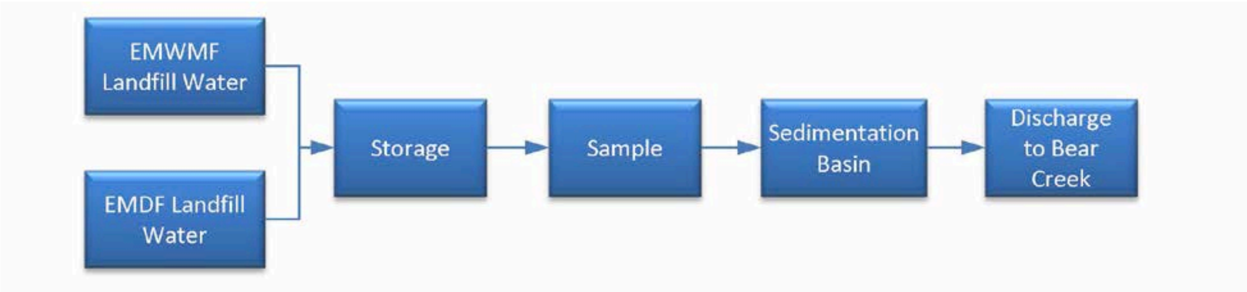

Fig. 8. Alternative 2: process flow diagram.

Details: Contact water at EMWMF will be collected within the existing in-cell catchments, then pumped to the existing EMWMF contact water ponds and tanks. Leachate will be collected in sumps from both EMWMF and EMDF leachate collection systems, then transferred to the EMWMF leachate storage tanks or to above ground EMDF ponds and tanks. The existing EMWMF and EMDF site layout with water management features is in Fig. 9.

From the water storage locations, the landfill water will then pass through a flow proportional sampler that collects representative samples and measures flow rates. The design flow rate is 60 gpm.

This process can be operated on either a batch or continuous basis. Samples will be collected from a continuous, flow proportional sampler during release. The quality of the landfill water will be determined on the basis of a running annual average. In accordance with TDEC regulations and EPA guidance, a running annual average is appropriate because the concentration of a pollutant can be above AWQC without causing a detrimental effect if (a) the magnitudes and durations of the excursions above the AWQC are appropriately limited and (b) there are compensating periods of time during which the concentration is below AWQC. If collected data indicate the water consistently meets AWQC, then larger volumes of water and higher flow rates may be continuously released. For temporary exceedances of AWQC, there will be the ability to retain landfill water for conditioning or transport to an on-site treatment facility.

As shown in Table 2, the landfill water meets AWQC except for the following:

- Pesticides—The presence of pesticides in landfill water is a result of use at DOE facilities for their intended purposes (pest control), and not from the disposal of waste products from DOE operations. In addition, the detection limits for pesticides are at or above the AWQC. Therefore, the TDEC Required Reporting Limits [TDEC 0400-40-03-.05(8)] are appropriate for comparison purposes.
- Cadmium—Managed discharge will operate on a batch basis, so the criterion maximum concentration for fish and aquatic life [TDEC 0400-40-03-.03(3)(g)] is appropriate for comparison purposes.
- Mercury—The historic mercury concentrations in EMWMF landfill water do not meet all AWQC; however, the more recent data with the appropriate detection limits generally does. The landfill water from EMDF may not meet recreational AWQC for mercury once mercury-containing material is placed in the landfill. The ORR Waste Generating Forecast estimates that more of the Y-12 potential mercury-containing waste will be disposed within EMDF, resulting in leachate that is estimated to be above the recreational AWQC for mercury. Depending upon when the remediation work involving mercury takes place, EMDF landfill water may meet recreational AWQC for some period of time.

The landfill water also will be analyzed for the indicator parameters, e.g., nutrients, dissolved solids, total suspended solids, and total organic carbon. Total organic carbon will be used as an indicator of organic compounds. An increasing trend will trigger additional evaluation of the potential for increased organic compounds in the landfill water. The indicator parameters are not EMWMF or EMDF key COCs, but will be used to ensure the landfill water can be discharged without additional impairment of Bear Creek.

Support Activities: No additional support facilities will be required to implement managed discharge. Managed discharge of both EMWMF and EMDF landfill water will be performed with the existing EMWMF water management staff. No additional resources will be needed.

Monitoring and Land Use Controls: EMWMF and EMDF are expected to remain within the control of DOE indefinitely with existing access restrictions and land use controls.

One sample per week will be collected for the indicator parameters. The key COCs will be compared to AWQC on the basis of a running annual average. In addition, a sample will be collected every two years for the full suite of COCs.

Current EMWMF monitoring is described in UCOR-4156. This document includes the environmental monitoring required for this alternative, but will require revision.

Monitoring and managed discharge will continue following completion of the EMWMF final cover. Contact water will no longer be generated. Leachate volumes are anticipated to be reduced, and the sampling frequency will reduce to one sample a month. A new flow proportional sampler will be installed at completion of the final cover to ensure representative samples are collected.

Time frame for implementation: This alternative can be implemented immediately.

Uncertainties: There is uncertainty in the future concentrations of the key COCs in landfill water over time because of the different contaminants at the East Tennessee Technology Park, ORNL, and Y-12; the variability in waste lots and associated contaminants over time; the presence of unexpected contaminants; and the mobility of the disposed contaminants. As shown in Appendix C, at times in the past, specific contaminants have required treatment for a short time, but do not currently require treatment. It is expected that this situation will continue in the future so that the contaminants requiring treatment will vary over time and for varying periods of time. The ability to adapt to changes in key COCs, COC concentrations, and fluctuating flow rate is considered in the subsequent evaluation of this alternative.

Although current concentrations of key COCs in Table 2 indicate this alternative will be successful for EMWMF, there is the potential for increases in the EMWMF key COCs above AWQC.

The indicator parameters also may change based on potential changes in waste characteristics, changes in field measurements, or total organic carbon indicating a change in the landfill water characteristics, and/or the results of the biennial sampling results. The nutrient loading, total suspended solids, and/or total dissolved solids sample results may require additional management controls to reduce these to acceptable levels. These management controls, if required, will be implemented at the EMWMF/EMDF site and will not require transport for treatment elsewhere on the ORR.

Documents: To implement this alternative, the EMWMF record of decision and implementing documents, including UCOR-4156, will have to be revised. The EMDF remedial investigation/feasibility study, proposed plan, and record of decision will have to be approved. A remedial action work plan/remedial design report and completion document will have to be prepared.

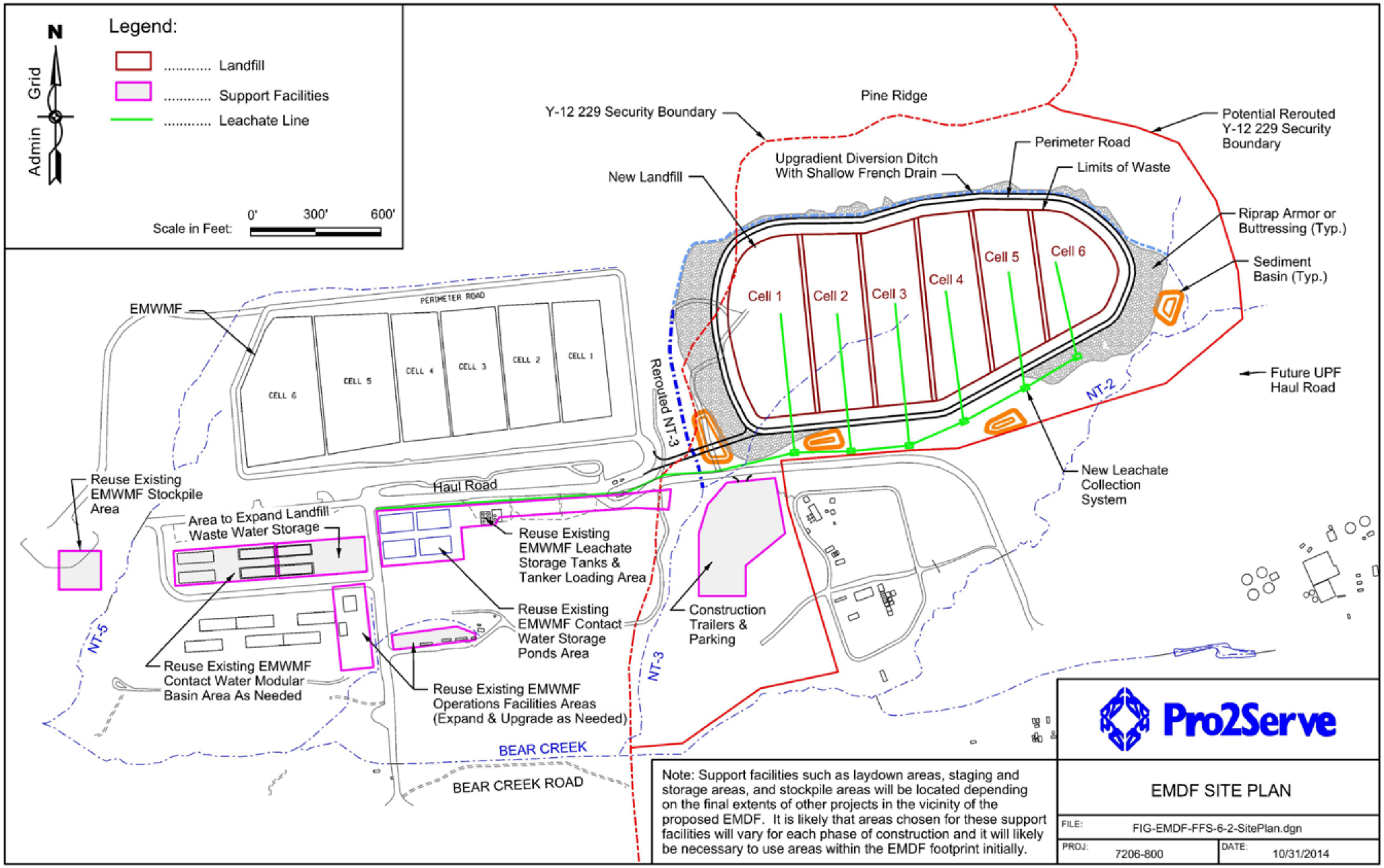

Fig. 9. Alternative 2: site plan.

3.3.4 Alternative 3: Treat at EMWMF/EMDF

Summary: Alternative 3 consists of construction of a new treatment system at the EMWMF/EMDF site to treat landfill water from EMWMF and EMDF. The landfill water will be collected in tanks and basins, then transferred at a constant flow rate to the modular treatment system. Centrally located tanks and ponds will be used to collect and store landfill water for transfer at a constant flow rate to the treatment system. Following treatment, the effluent will be discharged to the existing EMWMF Sediment Basin prior to discharge to Bear Creek. The effluent will pass through a flow proportional sampler at which the flow is measured and samples collected for analysis. Figure 10 illustrates the process flow diagram for this alternative.

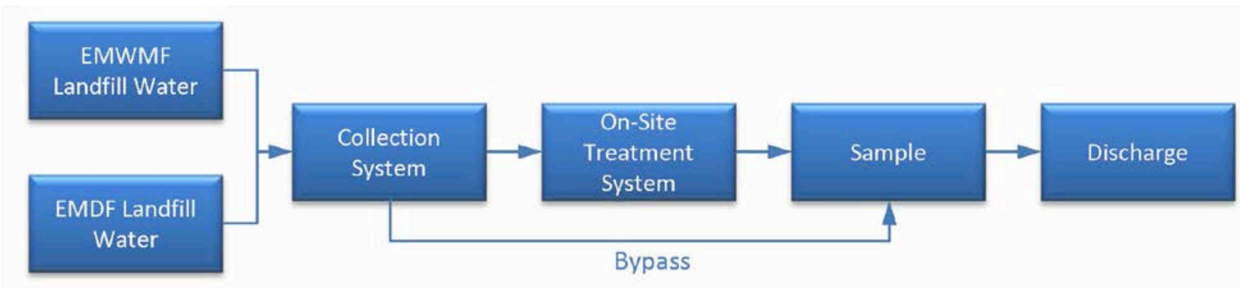

Fig. 10. Alternative 3: process flow diagram.

Details: Construction of a new treatment system at the EMWMF/EMDF location will provide treatment to remove mercury and cadmium from the EMDF and EMWMF landfill water. Cadmium currently does not consistently meet the continuous flow AWQC, and mercury is projected to exceed AWQC in the EMDF landfill water (Table 2).

The treatment system will occupy an area of approximately 3100 square feet and be located south of EMWMF and immediately east of the existing modular collection tanks (Fig. 11). A weather structure will be utilized to provide weather protection of the treatment system. The treatment system will be a manufactured unit.

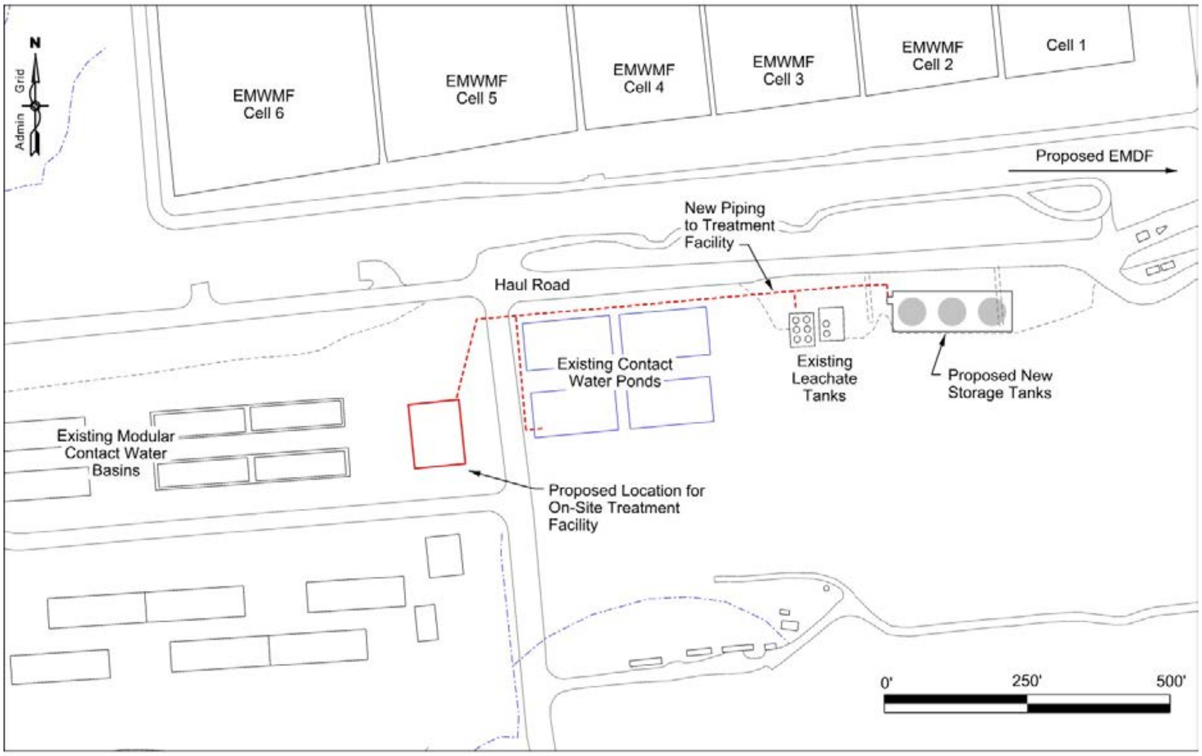

Fig. 11. Alternative 3: location of the treatment system.

The design flow of 60 gpm was used for sizing the treatment system. If storm flow above the design storm rates occurs that exceeds the storage capacity, the stormwater will be released through a bypass pipeline without active management. If this occurs, the surrounding streams will also be flowing at high levels, minimizing any potential impacts from this release.

Preliminary process equipment will be selected based on the COC characteristics and best available technology for treatment of mercury and cadmium. The treatment system will be designed to meet AWQC.

A treatability study will be performed as part of this alternative to ensure the appropriate process equipment is identified and installed.

Secondary waste may include spent cartridge filters, spent granular carbon, clarifier settled solids (blowdown), carbon column backwash, and liquid from spent carbon dewatering. The spent filters and carbon will be dewatered, packaged, and placed in EMWMF or EMDF. The blowdown, backwash return, and dewatering liquid will be transferred to the existing contact water ponds where suspended solids will settle until dredging of the basin is necessary to maintain design capacity. The solids from dredging will be dewatered, packaged, and placed in EMWMF or EMDF.

Following treatment, the running annual average landfill water characteristics will be compared to the AWQC. In accordance with TDEC regulations and EPA guidance, a running annual average is appropriate because the concentration of a pollutant can be above AWQC without causing an unacceptable effect if (a) the magnitudes and durations of the excursions above the AWQC are appropriately limited and (b) there are compensating periods of time during which the concentration is below AWQC.

Following treatment, the effluent will meet AWQC, except for pesticides. The presence of pesticides in landfill waters is a result of use at DOE facilities for their intended purposes (pest control), and not from the disposal of waste products from DOE operations. In addition, the detection limits for pesticides are at or above the AWQC. Therefore, the Required Reporting Limits are appropriate and are used.

The landfill water discharge will also be analyzed for indicator parameters, e.g., nutrients, dissolved solids, total suspended solids, and total organic carbon. Total organic carbon will be used as an indicator of organic compounds. An increasing trend will trigger additional evaluation of the potential for increased organic compounds in the landfill water. The other analyses are not EMWMF or EMDF key COCs, but will be used to ensure the landfill water can be discharged into Bear Creek without additional impairment of the stream.

Support activities: The treatment system will be installed near EMWMF in a central location. Site preparation of the treatment system will require minor excavation, including 750 square feet of free space to add process equipment, if needed, per the adaptive management approach. Utility requirements will include electrical power for pumping systems, an air compressor, mechanical equipment, lighting, and instrumentation; and process water for fire protection and cleaning. Support activities will be needed to construct the weather structure, and provide connection between the alarm systems and emergency transponders for high-level alarms and similar alerts.

Operating the treatment system will require trained chemical operators and an operations supervisor to oversee the processing activities.

Secondary solid waste, such as exhausted activated carbon and personal protective equipment, will be disposed at EMWMF or EMDF. Secondary landfill water liquids will be transferred to the collection system basins.

The EMWMF/EMDF operating contractor will provide support functions (operations management, engineering, health and safety, environmental management, human resources, payroll, accounting, etc.) Sanitary services and change facilities will be available for employees in the existing EMWMF office complex.

Monitoring and land use controls: EMWMF and EMDF are expected to remain within the control of DOE indefinitely with existing access restrictions and land use controls.

One sample per week will be collected for the indicator parameters. The sample will be collected using a flow proportional sampler. Compliance with AWQC (Table 2) will be based on a running annual average. An additional monthly sample will be collected to monitor the influent water quality. Samples will be collected every two years for the full suite of COCs.

Monitoring will continue following completion of the EMWMF and EMDF final covers. Contact water will no longer be generated at EMWMF. Leachate volumes will be reduced, and the sampling frequency will be reduced to one sample a month. New flow proportional samplers will be installed at completion of the final covers to ensure representative samples are collected. Following closure and construction of the final covers, the treatment system will be operated on a batch basis when sufficient landfill water has accumulated to justify running the plant.

Time frame for implementation: Construction of the treatment system will be concurrent with EMDF construction, with operations planned to begin in mid to late 2022.

Uncertainties: There is uncertainty in the future concentrations of the key COCs in landfill water over time because of the different contaminants at the East Tennessee Technology Park, ORNL, and Y-12; the variability in waste lots and associated contaminants over time; the presence of unexpected contaminants; and the mobility of the disposed contaminants. As shown in Appendix C, at times in the past, specific contaminants have required treatment for a short time, but do not currently require treatment. It is expected that this situation will continue in the future so that the contaminants requiring treatment will vary over time and for varying periods of time. There also is uncertainty in the flow rate due to rainfall variation, the number of open disposal cells, and the number of closed cells. Therefore, the treatment system will be constructed using a modular design that can be modified, as needed. The adaptive management approach is used where likely additional contaminants are identified and potential additional processing capability is identified in advance.

A manufactured unit will be used. These systems are readily available. By using a manufactured unit, the treatment system can adapt quickly and easily to varying concentrations of key COCs and flow rates. The ability to adapt to changes in key COCs, COC concentrations, and fluctuating flow rate is considered in the subsequent evaluation of this alternative.

The indicator parameters also may change based on potential changes in waste characteristics, changes in field measurements or total organic carbon indicating a change in the landfill water characteristics, and/or the results of the biennial sampling results. The nutrient loading, total suspended solids, and/or total dissolved solids sample results may require additional management controls to reduce these to acceptable levels. These controls will be implemented at EMWMF and will not require additional treatment unit operations.

Documents: To implement this alternative, the EMDF remedial investigation/feasibility study, proposed plan, and record of decision have to be approved. A remedial action work plan/remedial design report will be completed that includes the specific design for the treatment system. A completion report will be required to document the as-built conditions. The EMWMF record of decision and implementing documents, including UCOR-4156, will have to be revised.

3.3.5 Alternative 4: Treat at Process Waste Treatment Complex

3.3.5.1 Common Components

Summary: In Alternative 4, the landfill water from EMWMF and EMDF are transferred to the existing, on-site ORNL PWTC for treatment prior to discharge into White Oak Creek. Landfill water can be transferred to PWTC by either pipeline (Alternative 4a) or trucking (Alternative 4b). Figure 12 illustrates the process flow diagram for this alternative.

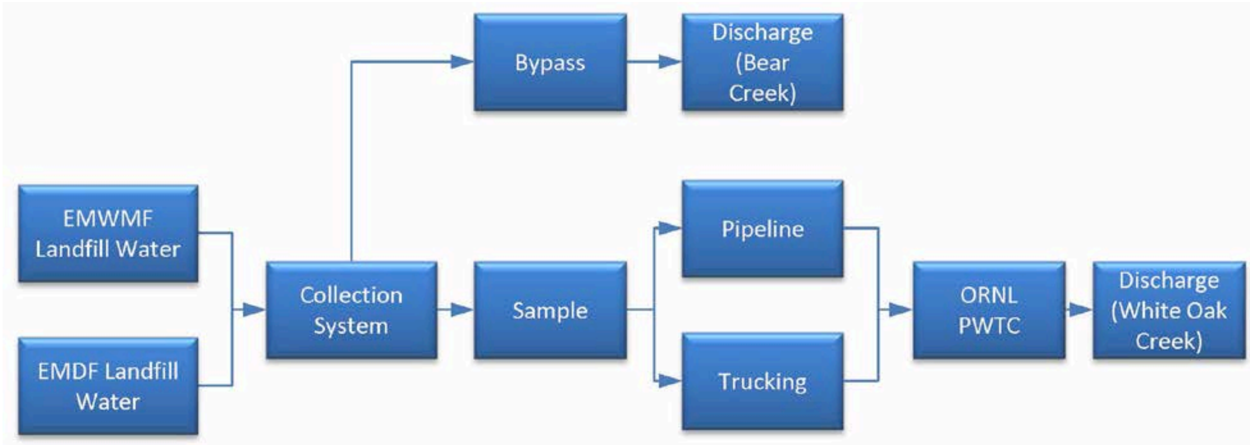

Fig. 12. Alternative 4: process flow diagram.

Background: The entire ORR is on the CERCLA National Priorities List due to legacy contamination. The ORNL PWTC is located on the ORR and is an on-site treatment facility primarily used to treat waters arising from the ORNL facilities and environmental management actions. PWTC treats the existing EMWMF leachate and batches of EMWMF contact water that do not meet the current EMWMF discharge limits (DOE/OR/01-1873&D2/A1/R2). These landfill waters are currently trucked to the ORNL PWTC.

The NCP at 40 *CFR* 300.400(e)(1) defines "on-site" as meaning "the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for the implementation of the response action." CERCLA Sect. 104(d)(4) (as discussed further in the preamble to the final NCP, 55 FR 8690) states where two or more noncontiguous facilities are reasonably related on the basis of geography, or on the basis of the threat or potential threat to the public health or welfare or the environment, these related facilities may be treated as one for the purpose of conducting response actions. Section 104(d)(4) allows the lead agency to manage waste transferred between such noncontiguous facilities without having to obtain a permit (i.e., manage as "on-site" waste).

This approach was proposed and agreed to by all signatories to the *Federal Facility Agreement for the Oak Ridge Reservation* for EMWMF, was acknowledged and documented in DOE/OR/01-1791&D3, and was reaffirmed in DOE/OR-01-2161&D2. This agreement serves as the basis for designating waste treatment, storage, and disposal facilities on the ORR as "on-site" facilities not subject to the CERCLA Off-Site Rule (40 *CFR* 300.440) when accepting wastes from CERCLA on-site response actions.

EMWMF landfill water rarely requires processing prior to treatment at PWTC. However, EMDF landfill water is projected to contain elevated concentrations of mercury. Pretreatment for mercury will be required for PWTC to accept the additional landfill water. Since PWTC—Bldg. 3608—has been operating since 1990 in support of ORNL operations, any upgrades or modernization to support ORNL operations will be performed by the operating contractor and not by EMWMF or EMDF. Only upgrades needed to process the landfill water are included in this alternative.

Details: Contact water at EMWMF will be collected within the existing in-cell catchments, and then pumped to the existing EMWMF contact water ponds and tanks. Leachate will be collected in sumps from both the EMWMF and EMDF leachate collection systems and then transferred to the EMWMF leachate storage tanks or to above-ground EMDF collection tanks. The average flow rate is 30 gpm, an 18 gpm increase over the current yearly average for EMWMF leachate volume of approximately 12 gpm.

The maximum flow rate is 60 gpm, approximately one-third of the current PWTC flow rate. Figure 4 illustrates the existing EMWMF and EMDF site layout with water management features.

From the water storage locations, the landfill water will be pumped through a pipeline or to a truck for transport to the ORNL PWTC. As the landfill water is collected, it will flow through a flow proportional sampler at which the flow will be measured and samples will be collected for analysis and verification that the PWTC WAC are met. If the quantity of landfill water exceeds the storage capacity, the water will bypass treatment and be discharged to Bear Creek to prevent uncontrolled overflow of the storage system. The storage capacity design is based on a 100-year, 24-hour storm. Water storage will be constructed. As has happened in the past, maintenance or water storage limitations at Bldg. 3608 will require landfill water storage at EMWMF/EMDF instead of continuous transfer to PWTC.

As shown in Table 6, the landfill water meets the WAC, except for mercury. Elevated levels of mercury above the current PWTC will require additional pretreatment prior to treatment at the PWTC.

Based on the design flow of 60 gpm from landfill water and the current ORNL landfill water demand, there is sufficient capacity at PWTC to accommodate the landfill water in the non-radiological treatment system, but not in the radiological treatment system. If radiological treatment of the landfill water were required, pretreatment at EMWMF/EMDF will be required.

Sampling to verify compliance with the WAC (Table 6) will be performed at EMWMF/EMDF using a flow proportional sampler. Additional sampling will be performed for the Bldg. 3608 filter cake waste to determine if this still meets the Nevada National Security Site WAC.

Table 6. Alternative 4: waste characteristics and waste acceptance criteria

Contaminant Type	Contaminant	Units	Minimum	Maximum	Average (contact water)[a]	Average (leachate)[a]	PWTC WAC[b] (Bldg. 3544 - radiological)	PWTC WAC[b] (Bldg. 3608 - non-radiological)
Metal	Arsenic, Total + Dissolved	ug/L	0.15	3.6	2.1	1.97	4000	4000
Metal	Cadmium, Total + Dissolved	ug/L	0.08	0.332	0.351	0.356	300	10
Metal	Chromium, Total + Dissolved	ug/L	0.3	16.7	6.74	1.92	NA	NA
Metal	Copper, Total + Dissolved	ug/L	0.41	5	3.11	2.39	2500	100
Metal	Lead, Total + Dissolved	ug/L	0.36	4.53	1.077	1.13	30,000	30,000
Metal	Mercury, Total + Dissolved (EMWMF)	ug/L	0.065	0.22	0.077	0.079	0[c]	0[c]
Metal	Mercury, Total + Dissolved (EMWMF lower detection limit)[d]	ug/L					0[c]	0[c]
Metal	Mercury, Total + Dissolved (EMDF)[e]	ug/L	NA	NA	NA	1.0	0[c]	0[c]
Metal	Nickel, Total + Dissolved	ug/L	0.56	15	6.25	5.1	65,000	11,000
Metal	Uranium	ug/L	2.01	388	6.37	6.01	NA	NA
Other	Cyanide	ug/L	1.84	14.9	2.05	2.01	200	200
Pesticide	4,4'-DDD	ug/L	0.011	0.0767	0.018	0.018	NA	NA
Pesticide	4,4'-DDE	ug/L	0.0125	0.293	0.057	0.018	NA	NA
Pesticide	4,4'-DDT	ug/L	0.013	0.05	0.018	0.019	NA	NA
Pesticide	Aldrin	ug/L	0.011	0.04	0.017	0.018	NA	NA
Pesticide	beta-BHC	ug/L	0.0104	0.289	0.03	0.018	NA	NA
Pesticide	Dieldrin	ug/L	0.011	0.02	0.018	0.018	NA	NA
Radiological	Iodine-129	pCi/L	0.39	12.8	2.03	2.104	NA	NA
Radiological	Strontium-90	pCi/L	1.31	471	2.77	17.1	10,000B q/L	NA
Radiological	Technetium-99	pCi/L	4.11	983	17.4	7.85	NA	NA
Radiological	Tritium	pCi/L	337	9234.86	419	873	NA	NA
Radiological	Uranium-233/234	pCi/L	0.65	362	44.5	36	NA	NA
Radiological	Uranium-235/236	pCi/L	0.26	27.4	3.42	2.5	NA	NA
Radiological	Uranium-238	pCi/L	0.3	156.2	1.86	2.13	NA	NA

[a] Non-detects are replaced by a surrogate value: non-radiological surrogate is one-half the detection limit and radiological surrogate is the minimum detectable activity.
[b] *Waste Acceptance Criteria for Liquid Waste Systems Operated by Liquid and Gaseous Waste Operations at Oak Ridge National Laboratory, Rev 9*
[c] Treatment process being modified to accept mercury. Waiver to WAC required.
[d] The detection limit was lowered for appropriate comparison to the AWQC.
[e] Mercury from EMDF leachate was estimated. See Appendix E.
NA = not applicable

The PWTC consists of two influent streams—radiological and non-radiological (Fig. 13). The treatment steps for the radiological influent (PWTC 3544) are:

- Chemical precipitation and clarification for removal of metals and radioisotopes, and reducing hardness
- Filtration for the removal of particulate matter
- Ion exchange for the removal of strontium, cesium, and other radioisotopes
- Zeolite ion exchange for the removal of cesium

The effluent from this treatment system is combined with the non-radiological influent for further treatment (PWTC 3608) as follows:

- Air stripping for the removal of volatile organic compounds
- Activated carbon for particulate removal and adsorption for removal of semi-volatile organics and heavy metals, including mercury
- pH adjustment
- Discharge

Approximately 10% of the existing influent flow volume is expected to contain heavy metals. This flow is routed to a separate holding tank where it is batch treated by chemical precipitation and clarification prior to combining with the other PWTC 3608 influent. Following treatment, the treated effluent is discharged into White Oak Creek under a National Pollutant Discharge Elimination System (NPDES) permit.

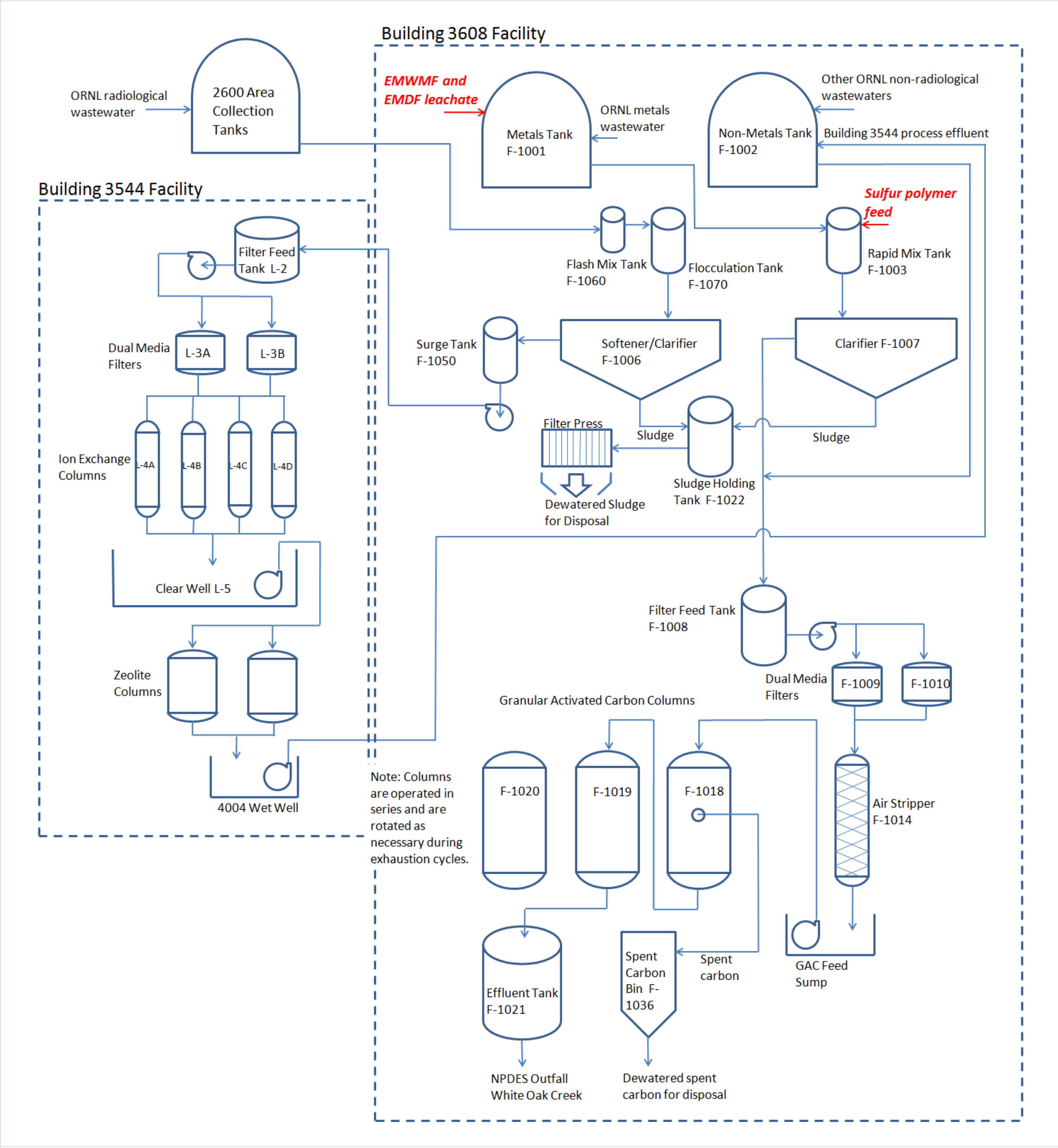

Fig. 13. Alternative 4: PWTC process flow diagram.

Prior to accepting new wastewater for treatment at PWTC, the waste generator must ensure the wastewater meets the WAC (WM-LWS-WAC/R9, *Waste Acceptance Criteria for Liquid Waste Systems Operated by Liquid and Gaseous Waste Operations at Oak Ridge National Laboratory*). In limited situations, wastewaters containing mercury can be accepted at the PWTC, but even then, only with an approved variance request. Therefore, a variance request will have to be issued and approved to allow for the treatment of mercury-containing landfill water. Longer-term treatment of mercury-containing landfill water will require a NPDES permit modification

Support activities: Landfill water will be transferred to PWTC by either pipeline (Alternative 4a) or truck (Alternative 4b). Support activities will be needed to construct additional loading and unloading stations, connect to utilities, and provide connection between the alarm systems and emergency transponders for high-level alarms and similar alerts. Operation of the PWTC will use the existing trained and qualified chemical operators.

Monitoring and land use controls: EMWMF, EMDF, and PWTC are expected to remain within the control of DOE indefinitely with existing access restrictions and land use controls.

One sample will be collected using a flow proportional sampler for every 140,000 gal to ensure compliance with PWTC WAC (Table 6). The number of samples is estimated at 72 per year, based on current and projected landfill water generation rates.

Monitoring will continue following completion of the EMWMF and EMDF final covers. Contact water will no longer be generated at EMWMF. Leachate volumes will be reduced, and the sampling frequency will be reduced to one sample a month. New flow proportional samplers will be installed at completion of the final covers to ensure representative samples continue to be collected.

Time frame for implementation: The time frame for obtaining a short-term variance to allow receipt of mercury-containing landfill water is uncertain, but must be in place at the start of EMDF operations. Additionally, the PWTC NPDES permit will need to be renegotiated prior to long-term acceptance of landfill water. Because the mercury concentration in landfill water is estimated and uncertain, additional modifications and upgrades to PWTC will be required to ensure NPDES permit compliance. Construction of the pipeline, if selected, and the additional modifications and upgrades will be concurrent with EMDF construction, with operations planned to begin in mid to late 2022.

Uncertainties: There is uncertainty in the future concentrations of the key COCs in landfill water over time because of the different contaminants at the East Tennessee Technology Park, ORNL, and Y-12; the variability in waste lots and associated contaminants over time; the presence of unexpected contaminants; and the mobility of the disposed contaminants. As shown in Appendix C, at times in the past, specific contaminants have required treatment for a short time, but do not currently require treatment. It is expected that this situation will continue in the future so that the contaminants requiring treatment will vary over time and for varying periods.

Since the concentration of mercury in EMDF landfill water is estimated and uncertain, the actual concentration may exceed the ability of the PWTC to reduce it sufficiently to meet the discharge permit limits. If the mercury levels are sustained at high levels, and/or are projected to result in effluent that exceeds the NPDES permit, then this water cannot be treated at the PWTC without pre-treatment. Because of space limitations at the PWTC, this is expected to take place at the EMWMF/EMDF site.

There also is uncertainty in the flow rate due to rainfall variation, the number of open disposal cells, and the number of closed cells. The combined flow from EMDF and EMWMF, the ability to adapt to changes in key COCs, COC concentrations, and fluctuating flow rate are considered in the subsequent evaluation of this alternative.

There are no unit operations for uranium removal at PWTC, so landfill water with uranium isotopes cannot be accepted at this time. Additional treatment facilities will be needed at the EMWMF/EMDF site if high levels of uranium or other radionuclides in landfill water are encountered in the future.

The PWTC 3608 processing system was constructed in 1989 and shows signs of deterioration from 25 years of operation. Recently, the dual media filters F-1009 and F-1010 have experienced corrosion problems and have been removed from service. The sulfuric acid feed tank was also recently replaced because of corrosion. Routine maintenance and component replacement will continue, as necessary, to continue operations, although it may be more cost effective in the near future to provide a new treatment facility at another ORNL location to replace both Bldgs. 3608 and 3544.

When EMDF begins operations in 2022, PWTC will be 32 years old, well beyond its design life. A future replacement facility is expected to replace the PWTC at a nearby location. The replacement facility is expected to be as or more capable as PWTC for water treatment. Replacement of PWTC will require modifications to the truck unloading stations or to the pipeline.

The condition of the PWTC, however, is not a consequence of EMWMF/EMDF landfill water processing. This focused feasibility study assumes PWTC (or a replacement facility) will be required for future ORNL ongoing treatment needs and will be available for the duration of EMWMF/EMDF landfill operations and for post-closure leachate processing.

While it is assumed that PWTC will bear the costs of any required replacements or upgrades, this is an area of uncertainty.

Documents: To implement this alternative, the EMDF remedial investigation/feasibility study, proposed plan, and record of decision have to be completed, and a short-term variance to the PWTC WAC obtained, as necessary. The NPDES permit will require modification to incorporate the design modification changes to the influent stream and required facility modifications.

A remedial action work plan/remedial design report will be completed that includes the specific design. A completion report will be required to document the as-built conditions.

The EMWMF record of decision and implementing documents, including UCOR-4156, may have to be revised.

3.3.5.2 Alternative 4a: Pipeline Transport to PWTC

Summary: A pipeline will be constructed to transport landfill water from EMWMF/EMDF to PWTC. This pipeline will consist of double-walled, welded, high-density polyethylene (HDPE) piping and will follow existing disturbed areas, such as Haul Road and the power line easement, where possible.

Details: Approximately 4.8 miles of buried pressurized pipe will be installed between EMWMF/EMDF and PWTC. The pipeline will be double-walled 4-in. (SDR 11) HDPE pipe with a single lift station and leak detection sensors in the annular space. The primary pipe will be contained within a secondary HDPE pipe with leak detection sensors. The leak detection sensors will be electronic low-point leak detection stations set approximately 5000 feet apart that will communicate wirelessly to a main receiver. The pipeline lift station will receive landfill water from the water storage facilities currently provided at EMWMF and the additional tanks provided for EMDF leachate.

The pipeline will follow the existing Haul Road west from EMWMF, turning south at Reeves Road, and joining the power line easement that crosses over Chestnut Ridge (Fig. 14). The pipeline will exit the power line easement alongside Bethel Valley Road, then turn south at First Street, turning east near the 2600 tanks. The pipeline will follow First Street within ORNL to avoid the congestion of utilities that typically exists within the ORNL main campus footprint. This route is anticipated to have minimal impact to the environment or ORNL operations. There will be two above-ground segments of the pipeline at the crossings for Bear Creek and White Oak Creek. The creek crossings will utilize the existing bridges at these locations.

The pump station will be located at the beginning of the pipeline near to the existing EMWMF contact water storage areas. The pump station will consist of a prefabricated metal structure over a wet well with a primary transfer pump and secondary back-up pump. The pumps will be sized based on the design flow rate of 60 gal per minute and the required head to overcome elevation changes to clear Chestnut Ridge and friction losses along the entire length of the pipeline. Power will be run from existing infrastructure at the EMWMF/EMDF site, and an emergency generator will be provided to maintain operations during prolonged power outages.

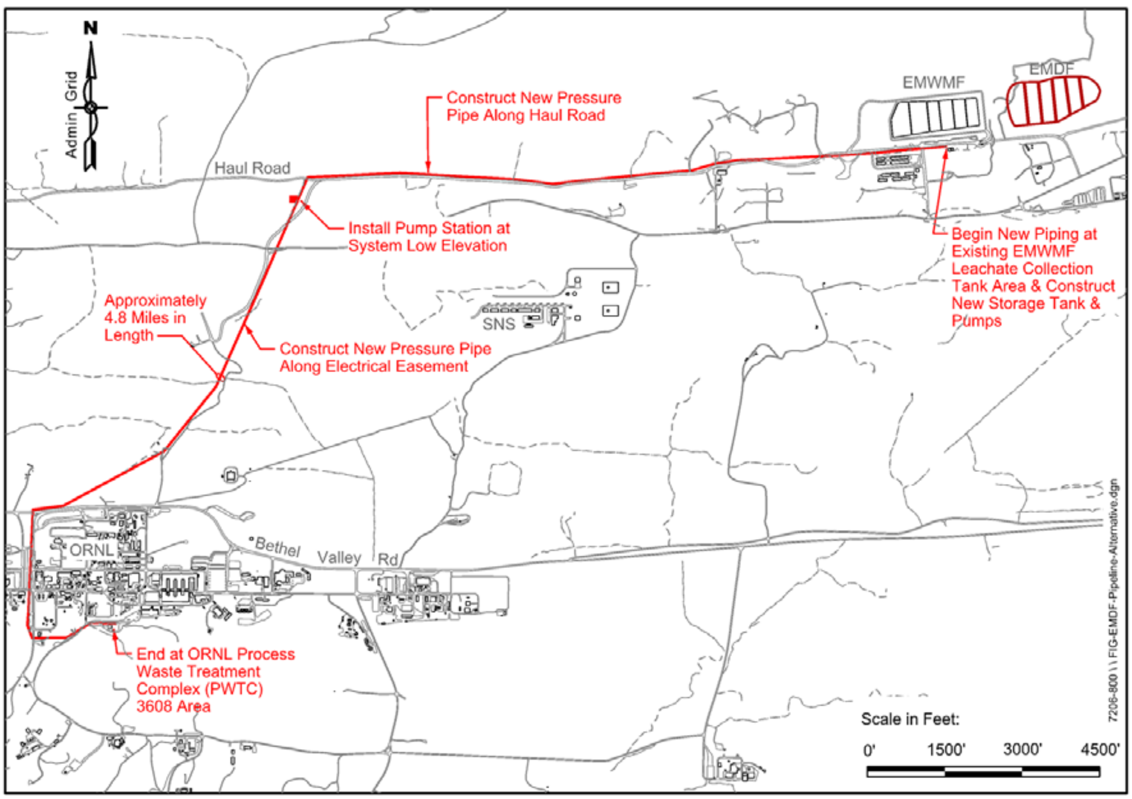

Fig. 14. Alternative 4a: route of pipeline to PWTC.

Support activities: Additional utility support will be required at ORNL to ensure utilities and structures are identified, moved, or protected during construction activities. Electrical power will be required to the pump stations. Leak detection alarms will be required, along with telemetry to alert operators of potential alarms or leaks. Additional storage will be required for the landfill water at the EMWMF/EMDF site to retain the design stormwater and to provide a consistent flow of water to the lift station.

Monitoring and land use controls: The ORR will remain within the control of DOE indefinitely with existing access restrictions and land use controls. Additional monitoring of the pipeline will be performed to verify safe and efficient operating conditions.

Time frame for implementation: Construction of the pipeline will be concurrent with EMDF construction, with operations planned to begin in mid- to late-2022.

Uncertainties: The following uncertainties are associated with the pipeline:

- Potential route deviations within ORNL due to structures, utilities, or similar obstructions that cannot be moved or avoided
- Potential route deviations outside of ORNL due to potential ecological impacts
- Construction delays within the ORNL main campus due to conflicts with the existing operations
- Construction delays within the power line easement due to the proximity to electrical lines
- Additional lift stations may be required if the planned lift station cannot be placed at the planned location
- Potential soil contamination along the pipeline route may cause delays and increased cost for disposal

Documents: An environmental survey of the pipeline route will be required.

3.3.5.3 Alternative 4b: Truck transport to PWTC

Summary: The landfill water will be trucked to PWTC using the existing fleet of government-furnished, 5000-gal capacity tanker trailers and tractors, plus an additional two tankers. The route will be the same as the current route taken by EMWMF tanker trucks and is shown in Fig 15.

Details: The trucks typically haul 4500 gal per load. For the higher precipitation season of approximately three months, trucks will haul landfill water seven days per week for a regular 10-hour day shift. During the remaining nine months of the year, trucks are expected to haul landfill water four days per week, day shift only, as is the current practice. However, if higher precipitation volumes occur during winter, then the seven-day-per-week schedule may need to be extended for up to six months to empty the storage system.

The two existing EMWMF leachate loading stations are required to process up to 20 shipments per 10-hour shift and a third loading station is required, as a contingency, should water collected at the EMWMF contact water ponds or tanks require off-site treatment. The existing 4-in. portable pumps will be used to transfer the contact water to the loading station. Connections exist for the portable pump to each tank, and hoses will connect the pump discharge to the loading arm pipe at the new station.

The new loading station, located centrally to the contact water tanks, includes a pull-through spill containment slab similar to that at the current West Loading Station, but with both long sides curbed. The containment slab will be 60-ft long with a sump for collection of rainwater and spill/leaks. The sump will have an automatic submersible pump that will pump back to any of the four tanks via a new underground pipe network.

The existing West Loading Station will be refurbished to add a loading platform and new articulating loading arm of similar design to the existing East Loading Station. The only change to the East Loading Station is an upgrade to a higher capacity leachate transfer/loading pump.

A second, accessible tanker unloading station or bay will be required at the PWTC to allow two tankers to be simultaneously unloaded. The unloading station will consist of a pull-through concrete containment slab with a sump to collect and transfer rainwater or spills into the treatment system and a gravity discharge pipe header to allow for emptying the tanker into the main collection sump at Bldg. 3608. To create space for the new unloading station, a long retaining wall will be demolished, and excavation into a hillside with potentially contaminated soil will be performed. The retaining wall will be re-constructed. The excavated soil will require characterization to determine the appropriate disposal pathway, expected to be the ORR landfill.

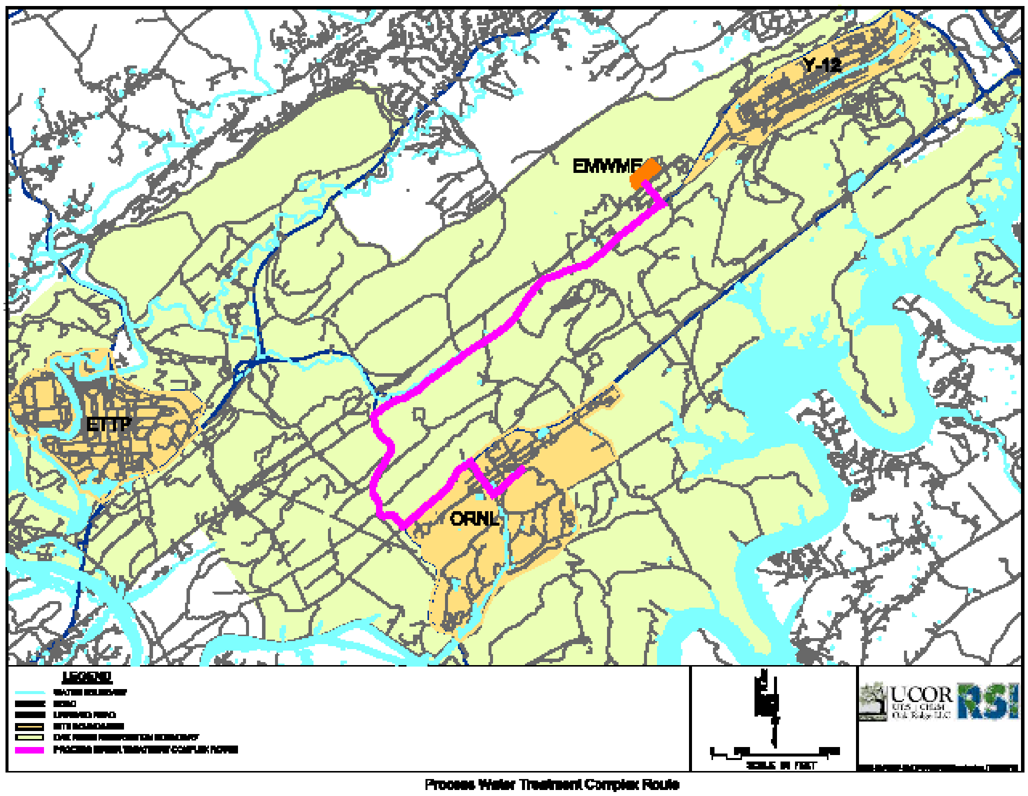

Fig. 15. Alternative 4b: truck route to the PWTC.

Support activities: Piping is required to connect the EMDF storage tanks and load-out pump to the new loading station near the existing ModuTanks®[1]. Additional support activities are required to procure two additional tankers, train drivers, and maintain the ORR roadways. Tractors to transport the leachate tankers will be leased.

The PWTC personnel will be required to support a seven-days/week shipping schedule for up to six months per year. In addition, a second tanker unloading station or bay is required at the PWTC.

Monitoring and land use controls: The ORR will remain within the control of DOE indefinitely with existing access restrictions and land use controls. No additional monitoring is required over what is required for Alternative 4.

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[1] Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

Time frame for implementation: Construction of the additional support structures will be concurrent with EMDF construction, with operations planned to begin in mid- to late-2022.

Uncertainties: Low levels of contamination are present in the soil that must be removed to undertake the infrastructure modifications at PWTC. While this soil is expected to be suitable for disposition at the ORR landfill, if higher levels of contamination are found, additional worker protection may be needed. In addition, more stringent packaging and handling may be necessary for waste disposal at an alternate location. The future cost and availability of fuel may be a factor in the execution of this alternative.

The truck route to PWTC (Fig. 15) may be altered due to safety and security issues, as has occurred recently. This change may result in significant inefficiencies and cost increases.

Documents: No additional documentation is required in addition to the Alternative 4 documents.

3.3.6 Alternative 5: Treat at WETF

3.3.6.1 Common Components

Summary: In Alternative 5, the landfill water from EMWMF and EMDF are transferred to the existing, on-site Y-12 WETF for treatment prior to discharge into Upper East Fork Poplar Creek (UEFPC). Landfill water can be transferred by either pipeline (Alternative 5a) or trucking (Alternative 5b). Figure 16 illustrates the process flow diagram for this alternative.

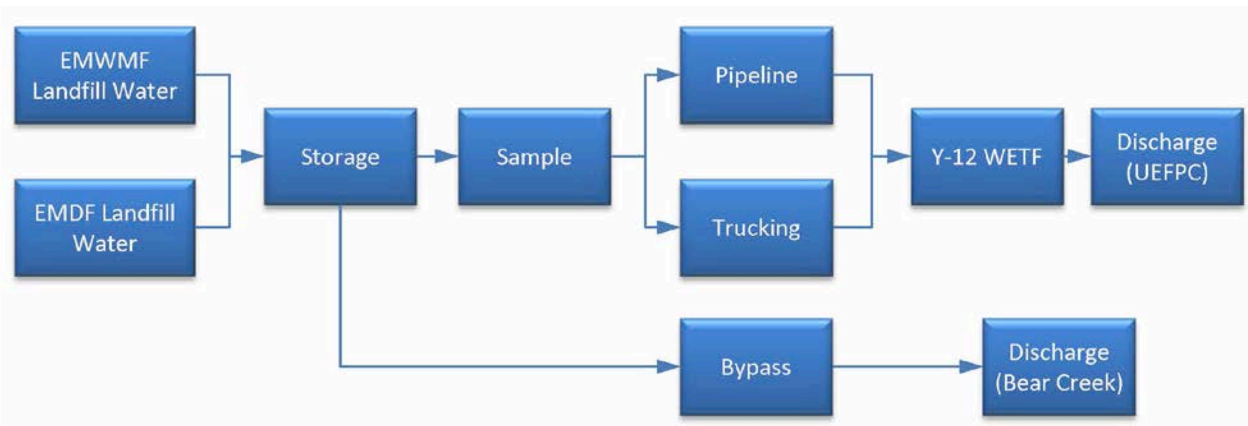

Fig. 16. Alternative 5: process flow diagram.

Background: The entire ORR is on the CERCLA National Priorities List due to legacy contamination. The Y-12 WETF is located on the ORR and is an on-site water treatment facility primarily to treat waters collected from BCBG. CERCLA remedial actions conducted on-site, as defined by 40 *CFR* 300.5, must comply with the ARARs, but not procedural or administrative requirements.

The NCP at 40 *CFR* 300.400(e)(1) defines "on-site" as meaning "the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for the implementation of the response action." CERCLA Sect. 104(d)(4) (as discussed further in the preamble to the final NCP, 55 FR 8690) states where two or more noncontiguous facilities are reasonably related on the basis of geography, or on the basis of the threat or potential threat to the public health or welfare or the environment, these related facilities may be treated as one for the purpose of conducting response actions.

Section 104(d)(4) allows the lead agency to manage waste transferred between such noncontiguous facilities without having to obtain a permit (i.e., manage as “on-site” waste). This approach was proposed and agreed to by all signatories to the *Federal Facility Agreement for the Oak Ridge Reservation* for EMWMF, was acknowledged and documented in DOE/OR/01-1791&D3, and was reaffirmed in the DOE/OR-01-2161&D2. This agreement serves as the basis for designating waste treatment, storage, and disposal facilities on the ORR as “on-site” facilities not subject to the CERCLA Off-Site Rule (40 *CFR* 300.440) when accepting wastes from CERCLA on-site response actions. Section 104(d)(4) allows the lead agency to manage waste transferred between such noncontiguous facilities without having to obtain a permit (i.e., manage as “on-site” waste).

Details: EMWMF/EMDF landfill water will be pumped to sumps, tanks, and/or basins for storage. The average flow rate is 30 gpm, and the peak flow rate is 60 gpm. From storage, the landfill water will be pumped through a pipeline (alternative 5a) or to a tanker (alternative 5b) for transport to the Y-12 WETF. The water will flow through a flow proportional sampler at which the flow will be measured and samples will be collected for analysis and verification that the WETF WAC (MS/COT-141016, *Criteria for Landfill Waters to be Treated at the Y-12 Liquid Waste Management Services: Profile No.: WW-01*) are met. Compliance with the WAC will be based on a running annual average. If the quantity of water exceeds the storage capacity, the water will bypass treatment and be discharged to Bear Creek to prevent uncontrolled overflow of the storage system. The storage capacity design will be based on a 100-year, 24-hour storm. Water storage will be constructed or upgraded to be RCRA-compliant.

Based on the evaluation of leachate and contact water characterization data in Table 2 as compared to the BCBG waters (Appendix A), EMWMF/EMDF landfill water is expected to meet the WAC. However, the treatment capacity of WETF is 30 gpm, sufficient to treat the BCBG water, but not able to accommodate the addition of the 60 gpm design flow. Therefore, additional treatment capacity will be required at this location, identical to the EMWMF-/EMDF-based treatment system described in Alternative 3 because the complexity and cost of modifying WETF for the additional flow will be cost prohibitive. Therefore, a separate treatment system will be built at a location in the WETF proximity. Construction of a new treatment system will provide treatment to remove mercury and cadmium from the landfill water, as needed, to meet the discharge limits. However, additional complexity is introduced into the construction and operations at this location, due to its location within the Y-12 security perimeter.

The expanded treatment system will occupy an area of approximately 3100 square feet. Space is limited at WETF, and a preliminary location was selected west of the existing facility in a currently forested area.

The design flow of 60 gpm was used for sizing unit operations. If storm flow above the design storm rates occurs that exceeds the processing and storage capacity, the stormwater will be released without active management. If this occurs, the surrounding streams will also be experiencing peak flow rates, minimizing any potential impacts from this release.

Preliminary process equipment was selected based on the pollutant characteristics and best available technology for treatment of mercury and cadmium. The water treatment system will be designed to achieve a performance objective for the removal of cadmium and mercury concentrations in landfill water to below the PWTC discharge limits. The water storage used for EMDF leachate will be constructed or upgraded to be RCRA-compliant.

A treatability study will be performed as part of this alternative to ensure the appropriate process equipment is identified and installed.

The treated effluent will be discharged into UEFPC under the NPDES permit.

Support activities: Site preparation of the expanded treatment system will require tree removal, excavation, and grading for site development, including 750 square feet of free space to add process equipment, if needed, per the adaptive management approach. Utility requirements will include electrical power for pumping systems, an air compressor, mechanical equipment, lighting, and instrumentation; and process water for fire protection and cleaning. A weather structure will be utilized to provide weather protection of the treatment system.

Landfill water will be transferred by either pipeline (Alternative 5a) or truck (Alternative 5b). Support activities will be needed to construct additional loading stations, connect to utilities, and provide connection between the alarm systems and emergency transponders for high-level alarms and similar alerts.

Modifications/repairs to the existing 500,000-gal storage tanks located near WETF will be required to provide temporary storage prior to treatment. Additional unloading stations and pumped transfer systems are also required to move the water to the storage tanks, then to the treatment system.

Operating the system will require trained chemical operators and an operations supervisor to oversee the processing activities. Operators will be required for cartridge filter change-out operations, unloading and dewatering spent granular carbon, loading fresh granular carbon, landfill water sampling, collecting operating data, and routine maintenance activities.

Secondary solid waste, such as exhausted activated carbon and personal protective equipment, will be disposed at EMWMF or EMDF. Secondary landfill water liquids will be transferred to a holding tank or basin to allow suspended solids to settle. Water from the holding tank or basin will be recycled to the plant feed system, and the sludge will be transferred to existing WETF sludge holding tanks for future processing and disposal. These secondary wastes will be characterized prior to disposal to verify they meet the WAC.

The WETF operating contractor will provide support functions (operations management, engineering, radiation protection, health and safety, environmental management, human resources, payroll, accounting, etc.) Sanitary services and change facilities will be available for employees in the existing WETF office complex.

Monitoring and land use controls: EMWMF, EMDF, and WETF are expected to remain within the control of DOE indefinitely with existing access restrictions and land use controls.

One sample will be collected for the key COCs for every 140,000 gal to ensure compliance with the WETF WAC. The number of samples is estimated at 72 per year. The sample will be collected using a flow proportional sampler. Compliance with the WAC will be based on a running annual average. Samples will be collected every two years for the full suite of COCs.

Monitoring will continue following completion of the EMWMF and EMDF final covers. Contact water will no longer be generated at EMWMF. Leachate volumes will be reduced, and the sampling frequency will be reduced to one sample a month. New flow proportional samplers will be installed at completion of the final covers to ensure representative samples are collected.

Time frame for implementation: Construction of the expanded treatment system will be concurrent with EMDF construction, with operations planned to begin in mid- to late-2022.

Uncertainties: There is uncertainty in the future concentrations of the key COCs in landfill water over time because of the different contaminants at the East Tennessee Technology Park, ORNL, and Y-12; the variability in waste lots and associated contaminants over time; the presence of unexpected contaminants; and the mobility of the disposed contaminants. As shown in Appendix C, at times in the past, specific contaminants have required treatment for a short time, but do not currently require treatment. It is expected that this situation will continue in the future so that the contaminants requiring treatment will vary over time and for varying periods. There also is uncertainty in the flow rate due to rainfall variation, the number of open disposal cells, and the number of closed cells. The ability to adapt to changes in concentration and fluctuations in flow rate is considered in the subsequent evaluation of this alternative.

The WETF area is congested with minimal free space to expand the treatment system. The selected area has not been thoroughly evaluated and may not be suitable. Additional locations within WETF are expected to require demolition of existing structures and tanks to be suitable.

There is the potential for significant construction delays because of the location within the Y-12 security perimeter.

Process improvements for this alternative may include future expansion or refurbishment of the WETF storage facilities to contain the entire flow volume resulting from EMWMF and EMDF.

Documents: To implement this alternative, the EMDF remedial investigation/feasibility study, proposed plan, and record of decision have to be completed. A remedial action work plan/remedial design report will need to be completed that includes the specific design for the treatment facility. A completion report will be required to document the as-built conditions.

EMWMF record of decision and implementing documents, including UCOR-4156, may have to be revised.

3.3.6.2 Alternative 5a: Pipeline transport to WETF

Summary: A pipeline will be constructed to transport landfill water from EMWMF/EMDF to WETF. This pipeline will consist of welded HDPE piping and will follow existing disturbed areas, such as Haul Road, where possible.

Details: Approximately 4400 feet of buried pressurized pipe will be installed between the EMWMF/EMDF site and WETF. The pipeline will be 4-in. (SDR 11) HDPE pipe with a single lift station and leak detection sensors. This primary pipe will be contained within a secondary HDPE pipe with leak detection sensors. The leak detection sensors will be electronic low-point leak detection stations set approximately 2000 feet apart that would communicate wirelessly to a main receiver.

For ease of installation, the pipeline route follows the Haul Road and Bear Creek Road, as much as possible (Fig. 17). The pipeline route enters WETF from the north.

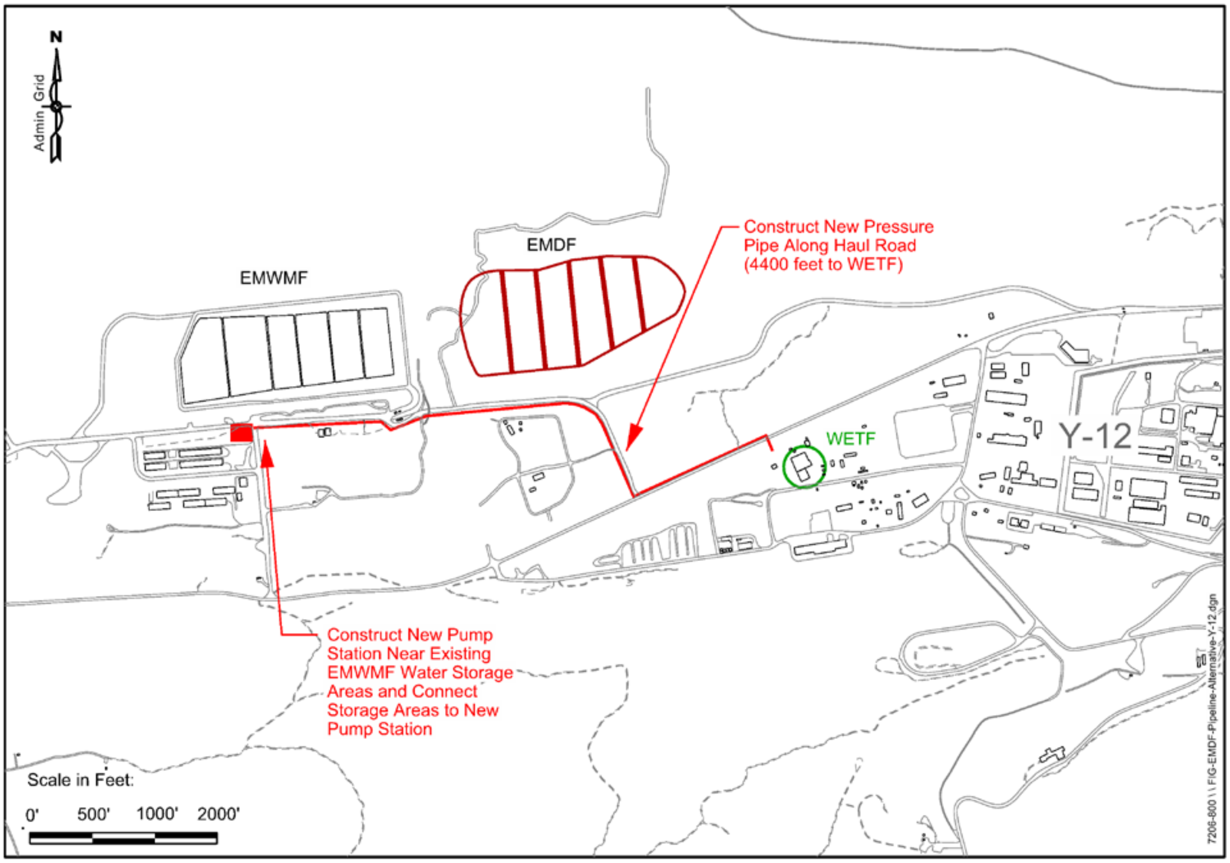

Fig. 17. Alternative 5a: route of pipeline to WETF.

No additional storage is included in this alternative, but additional storage will be required for EMDF construction.

The pipeline will be buried and pressurized with a pump station located near the EMWMF contact water storage tanks and ponds. A pressurized system eliminates the need for large, deep excavations required for a gravity flow system over the varying terrain. Locating the pump station at the beginning of the pipeline near the EMWMF contact water storage areas and making the entire system pressure driven allows for more flexibility when installing the pipe. Minimizing the working footprint along Haul Road will lessen the impact to hauling operations, including the Uranium Processing Facility construction traffic.

No bridges are crossed, but North Tributary-2 and North Tributary-3 are crossed. For tributary crossings, the pipeline will be buried next to or in the shoulder of Haul Road, while still maintaining the required burial depth when crossing culverts.

Support activities: Additional utility support will be required at Y-12 to ensure utilities and structures are identified, moved, or protected during construction activities. Electrical power will be required to the pump stations. Leak detection alarms will be required, along with telemetry to alert operators of potential leaks. Additional storage will be required for the landfill water at the EMWMF/EMDF site to retain the design stormwater and to provide a consistent flow of water for the pipeline.

Monitoring and land use controls: The ORR will remain within the control of DOE indefinitely with existing access restrictions and land use controls. Additional monitoring of the pipeline will be performed to verify operating conditions.

Time frame for implementation: Construction of the pipeline will be concurrent with EMDF construction, with operations planned to begin in mid- to late-2022.

Uncertainties: The following uncertainties are associated with the pipeline:

- Potential route deviations within Y-12 because of ecological concerns, structures, utilities, or similar items that cannot be moved or avoided.
- Slower construction rate than planned within Y-12 because of potential conflicts with the existing infrastructure.
- Slower construction rate within Y-12 due to the increased security requirements.
- Additional lift stations may be required if the lift station cannot be placed as planned.
- There is potential for underground contamination to be present along the pipeline route. This contamination will need to be addressed sufficiently for construction purposes.

Documents: An environmental survey of the pipeline route will be required.

3.3.6.3 Alternative 5b. Truck transport to WETF

Summary: The landfill water will be trucked to WETF using the existing fleet of government-furnished, 5000-gal capacity tanker trailers and tractors, plus an additional two tankers. The route will be along Haul Road to Bear Creek Road, then through the existing WETF access road to the facility (Fig. 18).

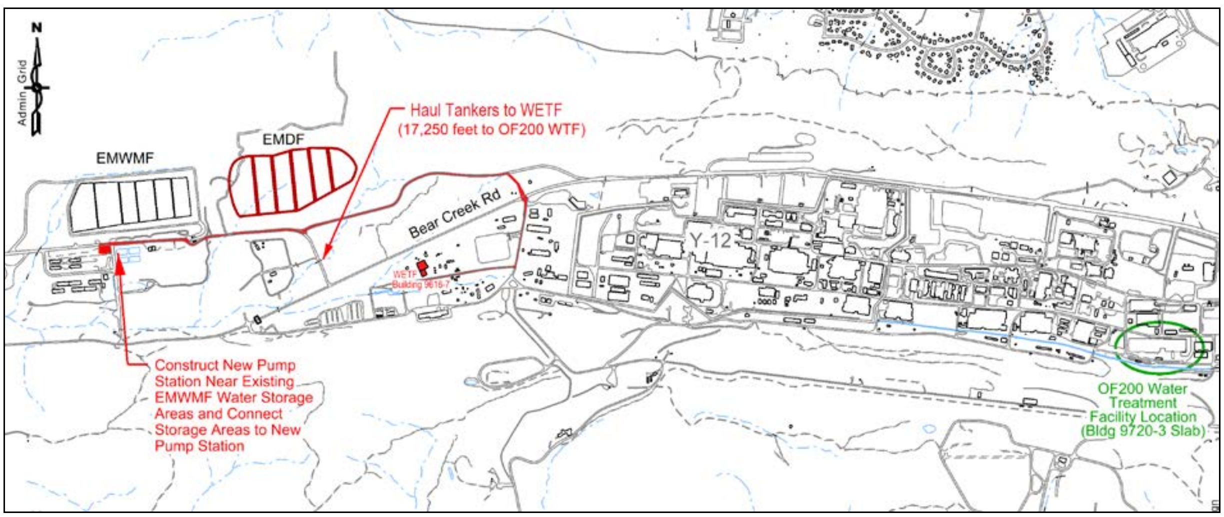

Fig. 18. Alternative 5b: truck route to WETF.

Details: The existing 5000-gal capacity tanker trucks typically haul 4500 gal per load. For the higher precipitation season of approximately three months, trucks will haul landfill water seven days per week during a regular day shift. During the remaining nine months of the year, trucks will haul landfill water four days per week, day shift only, as is the current practice.

Two efficient loading stations are required to process up to 20 shipments per 10-hour shift. A new loading station will be required at the EMWMF contact water tanks (the four ModuTanks®) to ship the EMWMF landfill contact water. The existing 4-in. Wacker portable pumps will be used to transfer the contact water to the loading station. Hook-ups exist for the hose connection of a portable pump to each ModuTank® and hoses will be used to connect the pump discharge to the loading arm pipe at the new station.

The new station includes a pull-through spill containment slab similar to that at the current West Loading Station, but with both long sides curbed. The containment slab will be 60-ft long with a sump for collection of rainwater and spill/leaks. The sump will have an automatic submersible pump that will pump back to any of the four ModuTanks® via new 2-in. underground pipe network.

The existing West Loading Station will be refurbished to add a SafeRack® loading platform and new articulating loading arm of similar design to the existing East Loading Station. The only change to the East Loading Station will be an upgrade to a higher capacity leachate transfer/loading pump.

No new landfill water storage will be required at WETF. However, two of the existing 500,000-gal storage tanks will need to be available for receiving the water. There also will need to be two new unloading stations, unloading pumps and equipment, and pumps to transport the water from the 500,000-gal tanks to WETF. Landfill water storage will be maintained at the EMWMF/EMDF site due to the proximity to WETF.

Support activities: Piping will be required to connect the EMDF storage tanks and load-out pump to the new loading station. Additional support activities will be required to procure an additional tanker, train drivers, and maintain the ORR roadways.

Additional landfill water storage will be required at the EMWMF/EMDF site to provide a consistent flow of water for the trucking operation. Operations staff will provide sufficient workers to ship from two stations at the same time.

Monitoring and land use controls: The ORR will remain within the control of DOE indefinitely with existing access restrictions and land use controls. No additional monitoring is required over what is required for Alternative 5.

Time frame for implementation: Construction of the additional support structures will be concurrent with EMDF construction, with operations planned to begin in mid- to late-2022.

Uncertainties: The space for additional tanker unloading stations will be limited and may have low-levels of contamination in the soil that must be removed prior to construction. The future cost and availability of fuel may be a factor in the execution of this alternative.

The schedule impacts caused by entering and exiting the Y-12 security portal are not determined, but have been significant in the past.

The truck route to WETF (Fig. 19) may be altered due to safety and security issues. This change may result in significant inefficiencies and cost increases.

Documents: No additional documentation is required in addition to the Alternative 5 documents.

3.3.7 Alternative 6: Treat at Outfall 200 MTF

3.3.7.1 Common Components

Summary: In Alternative 6, the landfill water from EMWMF and EMDF will be transferred to the proposed ORR on-site OF200 MTF for treatment prior to discharge into UEFPC. Landfill water will be transferred to OF200 MTF by either pipeline (Alternative 6a) or trucking (Alternative 6b). The proposed OF200 MTF will be capable of treating 3000 gpm of UEFPC surface water (95^{th} percentile of the projected UEFPC stream flow) and discharging effluent at < 200 ppt mercury. The conceptual design for OF200 MTF includes coarse solids (grit) removal, chemical co-precipitation/clarification, and multi-media filtration. Figure 19 illustrates the process flow diagram for this alternative. Storage capacity for the landfill water will be provided at the EMWMF/EMDF site until these waters are transferred to the proposed OF200 MTF.

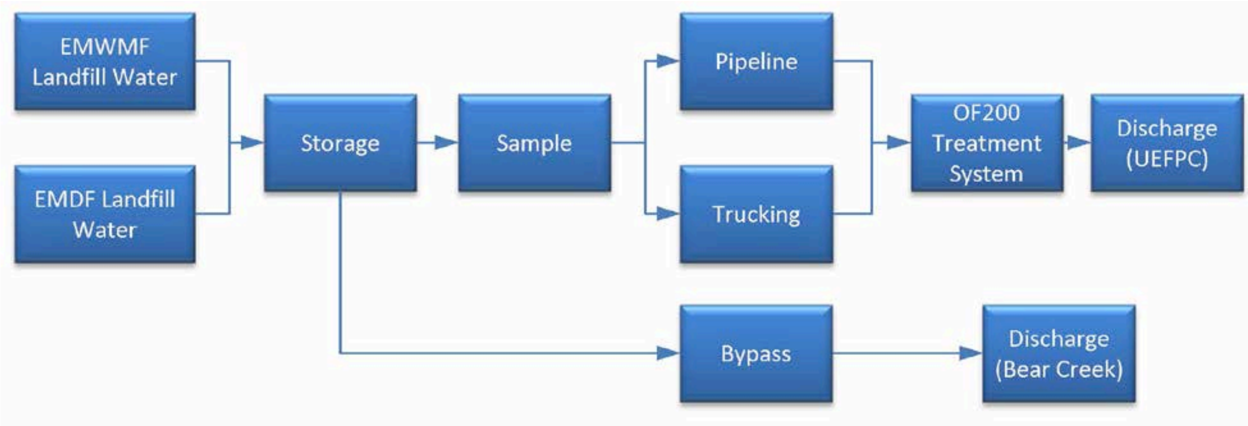

Fig. 19. Alternative 6: process flow diagram.

OF200 MTF will be designed to remove mercury from UEFPC surface water. While the OF200 MTF design may be effective for removal of other COCs in addition to mercury, treatment system performance for other contaminants has not been evaluated to date. The system will be designed to accommodate the addition of polishing (with granular activated carbon [GAC]), and/or stormwater retention, as required in the future by the adaptive management process.

Background: The proposed OF200 MTF will be an on-site water treatment facility located on the Y-12 footprint of the ORR. OF200 MTF is currently being evaluated as a potential on-site water treatment facility for UEFPC. While not yet in place, this treatment facility, if ultimately approved and constructed, will be designed to reduce the amount of mercury discharged into UEFPC.

CERCLA remedial actions conducted on-site, as defined by 40 *CFR* 300.5, must comply with the ARARs, but not procedural or administrative requirements. The NCP at 40 *CFR* 300.400(e)(1) defines “on-site” as meaning “the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for the implementation of the response action.” CERCLA Sect. 104(d)(4) (as discussed further in the preamble to the final NCP, 55 FR 8690) states where two or more noncontiguous facilities are reasonably related on the basis of geography, or on the basis of the threat or potential threat to the public health or welfare or the environment, these related facilities may be treated as one for the purpose of conducting response actions. Section 104(d)(4) allows the lead agency to manage waste transferred between such noncontiguous facilities without having to obtain a permit (i.e., manage as “on-site” waste).

Section 104(d)(4) allows the lead agency to manage waste transferred between such noncontiguous facilities without having to obtain a permit (i.e., manage as "on-site" waste). This approach was proposed and agreed to by all signatories to the *Federal Facility Agreement for the Oak Ridge Reservation* for EMWMF, was acknowledged and documented in DOE/OR/01-1791&D3, and was reaffirmed in DOE/OR-01-2161&D2. This agreement serves as the basis for designating waste treatment, storage, and disposal facilities on the ORR as "on-site" facilities not subject to the CERCLA Off-Site Rule (40 *CFR* 300.440) when accepting wastes from CERCLA on-site response actions.

Details: The landfill water from EMWMF and EMDF will be pumped to sumps, tanks, and/or basins for storage. The average flow rate will be 30 gpm, and the peak flow rate will be 60 gpm. From storage, the water will be pumped through a pipeline (alternative 6a) or to a truck (alternative 6b) for transport to OF200 MTF. The landfill water will flow through a flow proportional sampler at which the flow will be measured, and samples will be collected for analysis and verification that the water can be treated at OF200 MTF. If the quantity of water exceeds the storage capacity, the water will bypass treatment and discharge to Bear Creek to prevent uncontrolled overflow of the storage system. The storage capacity design will be based on a 100-year, 24-hour storm. Water storage will be constructed or upgraded to be RCRA-compliant.

Based on the evaluation of leachate and contact water characterization data in Table 2, the landfill water may be able to be treated at the proposed OF200 MTF. If selected, a treatability study will be performed as part of this alternative to determine whether contaminants other than mercury, such as cadmium and radionuclides, will be removed by the proposed OF200 MTF. The treatability study will evaluate removal of both the current COCs requiring treatment (mercury and cadmium) and potential contaminants that may require treatment in the future (e.g., hexavalent chromium and uranium-238). The results of the treatability study will be used to develop the criteria to determine whether landfill water can be accepted at OF200 MTF.

The *Remedial Design Work Plan for the Outfall 200 Mercury Treatment Facility at the Y-12 National Security Complex, Oak Ridge, Tennessee* (DOE/OR/01-2599&D2) describes the conceptual design for the water treatment facility planned to reduce the release of mercury from OF200 into UEFPC at Y-12. The proposed OF200 MTF is currently being evaluated, and if selected, will be documented in an Amendment to the selected remedy from the *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee* (DOE/OR/01-1951&D3) and *Explanation of Significant Differences for the Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee* (DOE/OR/01-2539&D2). The conceptual design information presented below is summarized from DOE/OR/01-2599&D2.

The current plans show the OF200 MTF will be constructed near Outfall 200 (Fig. 20). However, the location is expected to change in the near future to an area with a treatment capacity of 3000 gpm (4.3 million gal per day) of influent UEFPC surface water.

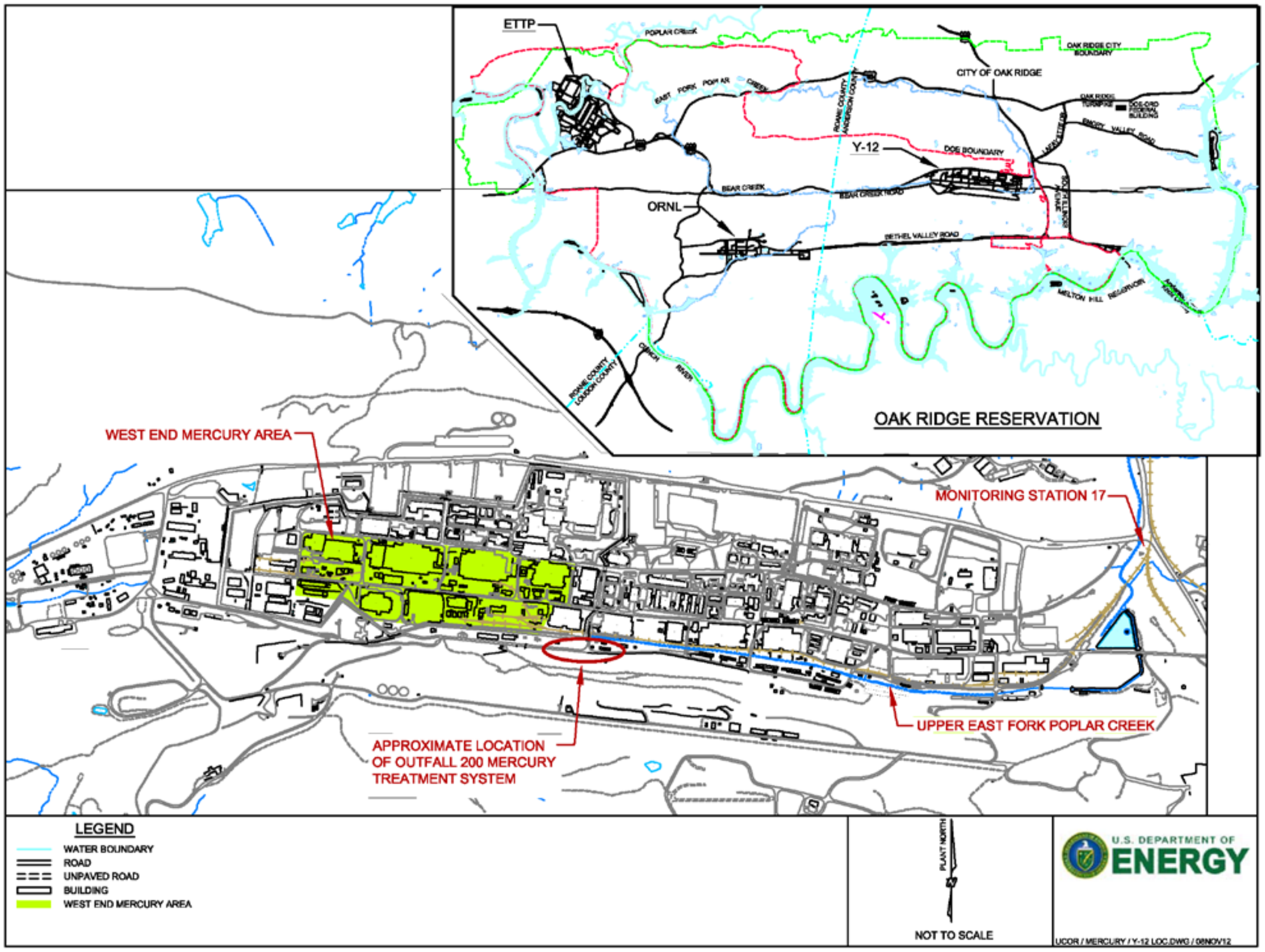

Fig. 20. Proposed location of the Outfall 200 MTF.

As described in DOE/OR/01-2599&D2, water flowing from Outfall 200 will be diverted into the inlet channel of the head works through an intake structure with an adjustable weir and continue through a manual bar screen, grit removal, grit classification and dewatering, and pump station. Water that has completed the grit removal process will be pumped through the base flow pump station to an equalization tank prior to further treatment. OF200 MTF will include two parallel treatment trains to provide the design treatment capacity and will include the following sequential unit operations:

- Headworks/intake structure, with manually cleaned bar screen, and overflow diversion to UEFPC
- Vortex-grit chamber for grit removal under base flow conditions (up to 3000 gpm), and grit classifier/washer
- pH control and dechlorination system—reaction tank for pH adjustment and dechlorination, as needed
- Chemical precipitation tanks—including a sulfide-functional polymer addition system and reaction tank, followed by a ferric chloride coagulant addition system and reaction tank
- Inclined plate clarifiers for solids removal, with rapid mix and flocculation chambers
- Sludge thickening and dewatering—sludge from the clarifiers will go to a sludge thickening tank and then to a filter press for dewatering. The resulting filter cake will be sent for disposal, while the filtrate will go to a backwash tank and then recycled back into the influent stream

- Multimedia filtration—liquid effluent from the clarifiers will go to a tank for pH adjustment and then to a multi-media filtration tank, prior to discharge of the treated effluent back to UEFPC
- Equalization, effluent, and backwash holding tanks

The OF200 MTF process flow diagram is in Fig. 21.

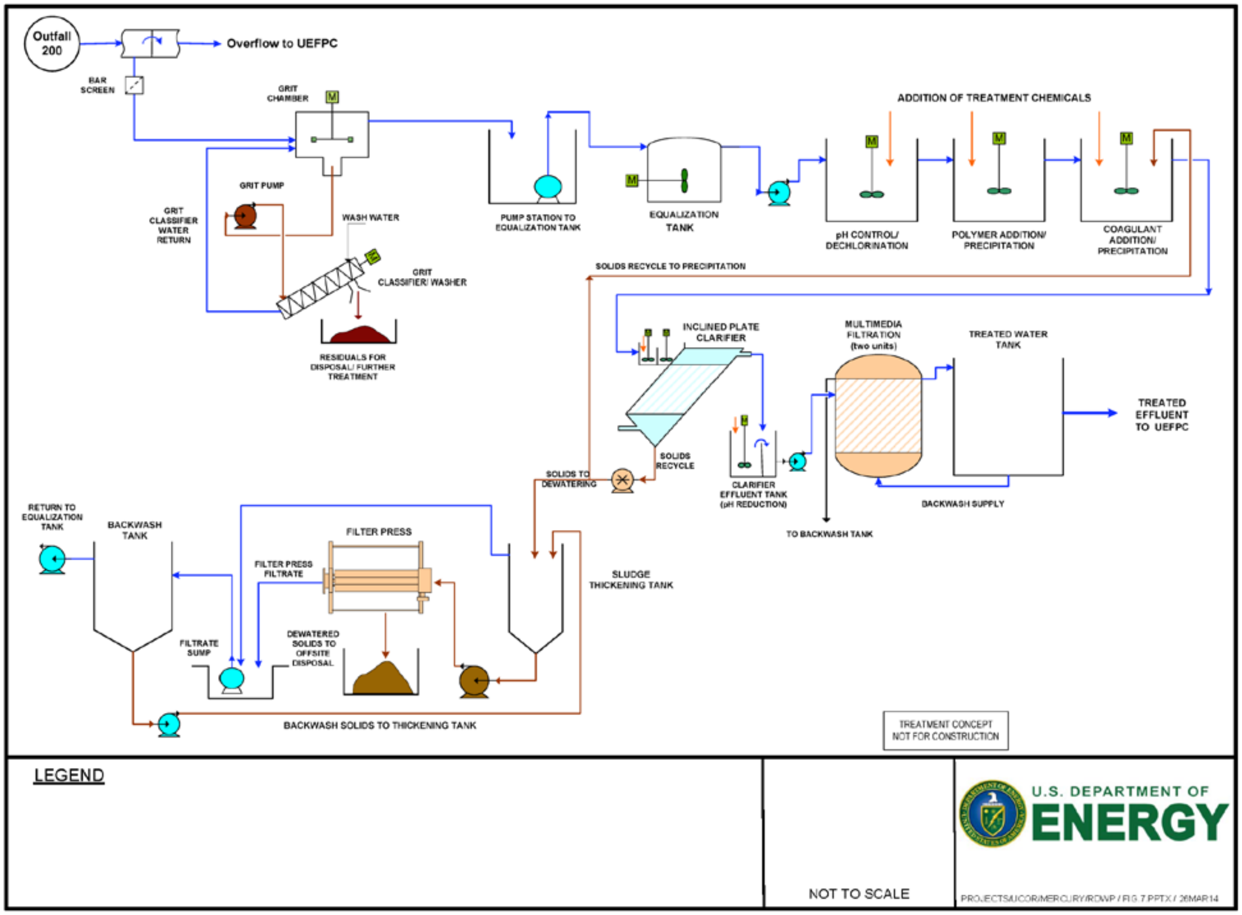

Fig. 21. Proposed Outfall 200 MTF process flow diagram.

The proposed OF200 MTF is only planned to accept the influent from UEFPC. If the OF200 MTF alternative is selected, design modifications will be required to convey the landfill water to OF200 MTF by either pipeline (Alternative 6a) or trucking (Alternative 6b).

Operation of the OF200 MTF will continue until mercury source areas at the West End Mercury Area have been remediated and mercury levels in discharges from Outfall 200 have declined to levels that no longer require treatment, estimated at 30 years.

Support activities: Landfill water will be transferred to OF200 MTF by either pipeline (Alternative 6a) or truck (Alternative 6b). Support activities will be needed to construct additional loading and unloading stations, connect to utilities, and provide connection between the alarm systems and emergency transponders for high-level alarms and similar alerts. The additional 60 gpm of wastewater will not be expected to require any additional trained and qualified chemical operators over what is already estimated (DOE/OR/01-2599&D2). Depending on the COCs in the water, pre-treatment (e.g., ion exchange) may be appropriate to enhance the treatment effectiveness and/or minimize impacts to the facility operations. Pretreatment is expected to increase the operating costs for this facility; however, the increase will depend on the type of pretreatment and the volume of water requiring treatment.

The predominant solid waste streams generated by the proposed OF200 MTF treatment operations are estimated to include grit material from the grit removal system (estimated at 1,300,000 lb/year), filter cake from the filter press (estimated at 440,000 lb/year), and spent media from the multi-media filters (estimated at 44,000 lb/year) (DOE/OR/01-2660&D1, *Focused Feasibility Study for Supplemental Mercury Abatement Actions Under the Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee*). All wastes will be sent for appropriate on-site or off-site disposal as sanitary/industrial waste, RCRA-regulated hazardous waste, low-level radioactive waste, or mixed waste, as suitable (DOE/OR/01-2599&D2).

Monitoring and land use controls: EMWMF, EMDF, and OF200 MTF are expected to remain within the control of DOE indefinitely with existing access restrictions and land use controls.

New surface water monitoring requirements at the proposed OF200 MTF will evaluate the effectiveness of the treatment system operations (DOE/OR/01-2599&D2). This effluent monitoring will be additional to the monitoring currently required by the *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee* and *Explanation of Significant Differences for the Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area, Oak Ridge, Tennessee*.

Time frame for implementation: The current schedule for the proposed OF200 MTF is for construction to start in 2017, with the treatment system expected to be operational in 2021. This time frame will result in the ability to treat EMDF landfill water when this begins to be generated in mid- to late-2022. However, the proposed OF200 MTF will not be available to treat EMWMF landfill water until 2021.

Uncertainties: There is uncertainty in the future concentrations of the key COCs in landfill water over time because of the different contaminants at the East Tennessee Technology Park, ORNL, and Y-12; the variability in waste lots and associated contaminants over time; the presence of unexpected contaminants; and the mobility of the disposed contaminants. As shown in Appendix C, at times in the past, specific contaminants have required treatment for a short time, but do not currently require treatment. It is expected that this situation will continue in the future so that the contaminants requiring treatment will vary over time and for varying periods. There also is uncertainty in the flow rate due to rainfall variation, the number of open disposal cells, and the number of closed cells.

The proposed OF200 MTF will be designed to treat mercury in UEFPC surface water. While other waters may be effectively treated and other contaminants potentially may be removed, no evaluation has been conducted to determine if additional contaminant removal will be successful. Treatability studies will be conducted for this alternative to determine effectiveness at removing additional EMWMF/EMDF contaminants, such as cadmium and uranium-238.

There is a possibility that the landfill water will require pretreatment or may not be accepted at OF200 MTF because COCs present will deleteriously impact the OF200 MTF. Pretreatment of the landfill water may be required either at the proposed OF200 MTF site or at the EMWMF/EMDF site if the contaminants are not effectively removed by the proposed OF200 MTF. Pretreatment will require additional construction and operating costs. Space for pretreatment facilities may not be available at the OF200 MTF site, in which case the pretreatment facilities will have to be located at the EMWMF/EMDF site. Pretreated water may be transported to OF200 MTF, or directly discharged, depending on the treatment.

If radiological COCs require treatment in the future, pretreatment also may be required to ensure that the OF200 MTF safety basis remains as non-radiological. If the radiological constituents are not removed before the wastewaters enter the OF200 MTF, the safety basis may change, requiring additional changes to treatment, documentation and work control, and potential changes to the waste disposal pathway. These changes are expected to result in increased startup and operating costs. In addition, the addition of radiological COCs may result in a change in the secondary waste disposal pathway.

OF200 MTF will be designed to accommodate the addition of polishing (with GAC), and/or stormwater retention, as required in the future by the adaptive management process.

The proposed OF200 MTF is currently in the planning process and is planned to be operational in 2021. If landfill water requires treatment during this time frame, an alternative treatment system will be necessary. In addition, delays in completion of OF200 MTF will increase the potential that an alternative treatment system will be required prior to availability of the OF200 MTF.

Operation of the OF200 MTF will continue until mercury source areas at the West End Mercury Area have been remediated and mercury levels in discharges from Outfall 200 have declined to levels that no longer require treatment, estimated at 30 years. This duration may be incompatible with the time needed to treat landfill water.

Documents: To implement this alternative, the remedial investigation/feasibility study, proposed plan, and record of decision for proposed EMDF have to be completed, and the proposed OF200 MTF CERCLA documents must be revised and approved to include the EMDF/EMWMF landfill water as a treatment stream. A remedial action work plan/remedial design report will be completed that includes the specific design for conveyance support. A completion report will be required to document the as-built conditions. EMWMF record of decision and implementing documents, including UCOR-4156, may have to be revised. The division of scope between EMWMF, EMDF, and OF200 MTF CERCLA documents will have to be determined.

3.3.7.2 Alternative 6a: Pipeline transport to Outfall 200 MTF

Summary: A pipeline will be constructed to transport landfill water from EMWMF/EMDF to OF200 MTF. This pipeline will consist of welded HDPE piping and will follow existing disturbed areas, such as Haul Road, where possible.

Details: Approximately 4400 feet of buried pressurized pipe will be installed between the EMWMF/EMDF site and OF200 MTF. The pipeline will be 4-in. (SDR 11) HDPE pipe with a single lift station and leak detection sensors. This primary pipe will be contained within a secondary HDPE pipe with leak detection sensors. The leak detection sensors will be electronic low-point leak detection stations set approximately 2000 feet apart that would communicate wirelessly to a main receiver.

For ease of installation, the pipeline route will follow Haul Road and Bear Creek Road as much as possible (Fig. 22).

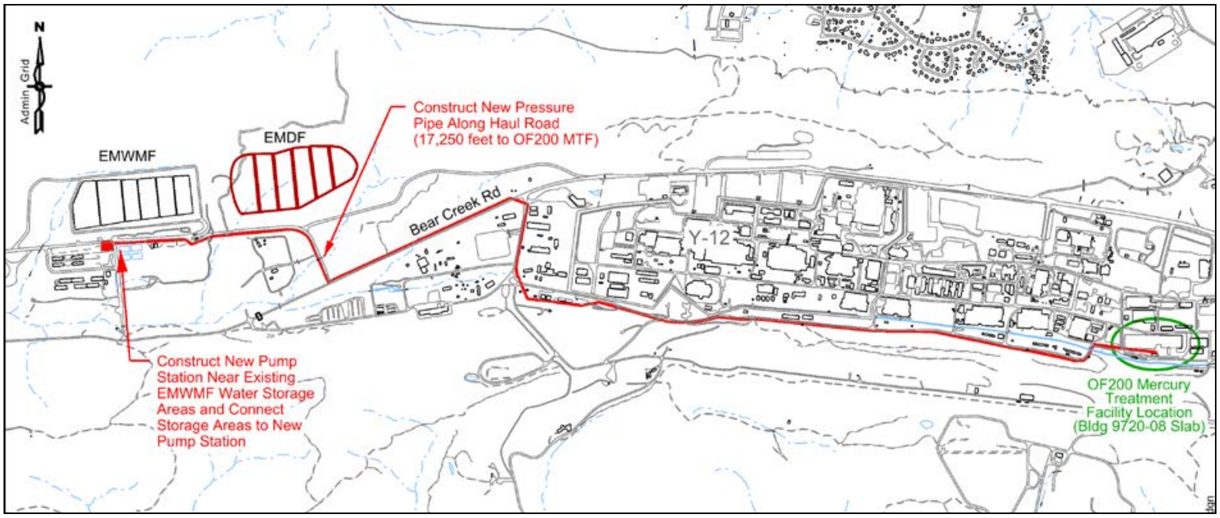

Fig. 22. Alternative 6a: route of pipeline to the Outfall 200 MTF.

No additional storage is included in this alternative, but additional storage will be required for the proposed EMDF construction.

The pipeline will be buried and pressurized with a pump station located near the EMWMF contact water storage tanks and ponds. A pressurized system eliminate the need for large, deep excavations required for a gravity flow system over the varying terrain. Locating the pump station at the beginning of the pipeline near the EMWMF contact water storage areas and making the entire system pressure driven allows for more flexibility when installing the pipe. Minimizing the working footprint along Haul Road will lessen the impact to hauling operations, including the Uranium Processing Facility construction traffic.

No bridges are crossed, but North Tributary-2 and North Tributary-3 are crossed. For tributary crossings, the pipeline will be buried next to or in the shoulder of Haul Road, while still maintaining the required burial depth when crossing culverts.

Support activities: Additional utility support will be required at Y-12 to ensure utilities and structures are identified, moved, or protected during construction activities. Electrical power will be required to the pump stations. Leak detection alarms will be required, along with telemetry to alert operators of potential leaks. Additional storage will be required for the landfill water at the EMWMF/EMDF site to retain the design stormwater and to provide a consistent flow of water for the pipeline.

Monitoring and land use controls: EMWMF, EMDF, and OF200 MTF are expected to remain within the control of DOE indefinitely with existing access restrictions and land use controls.

Additional monitoring of the pipeline will be performed to verify operating conditions.

Time frame for implementation: Construction of the pipeline will be concurrent with EMDF construction, with operations planned to begin in mid- to late-2022.

Uncertainties: The following uncertainties are associated with the pipeline:

- Potential route deviations within Y-12 because of ecological concerns, structures, utilities, or similar items that cannot be moved or avoided.

- Slower construction rate than planned within Y-12 because of potential conflicts with the existing infrastructure.
- Slower construction rate within Y-12 due to the increased security requirements.
- Additional lift stations may be required if the lift station cannot be placed as planned.
- There is potential for underground contamination to be present along the pipeline route. This contamination will need to be addressed sufficiently for construction purposes.

Documents: An environmental survey of the pipeline route will be required.

3.3.7.3 Alternative 6b. Truck transport to OF200 MTF

Summary: The landfill water will be trucked to OF200 MTF using the existing fleet of government-furnished, 5000-gal capacity tanker trailers and tractors, plus an additional two tankers. The route will be along Haul Road to Bear Creek Road (Fig. 23). Similar to Alternative 6a, the tankers will discharge to a holding tank.

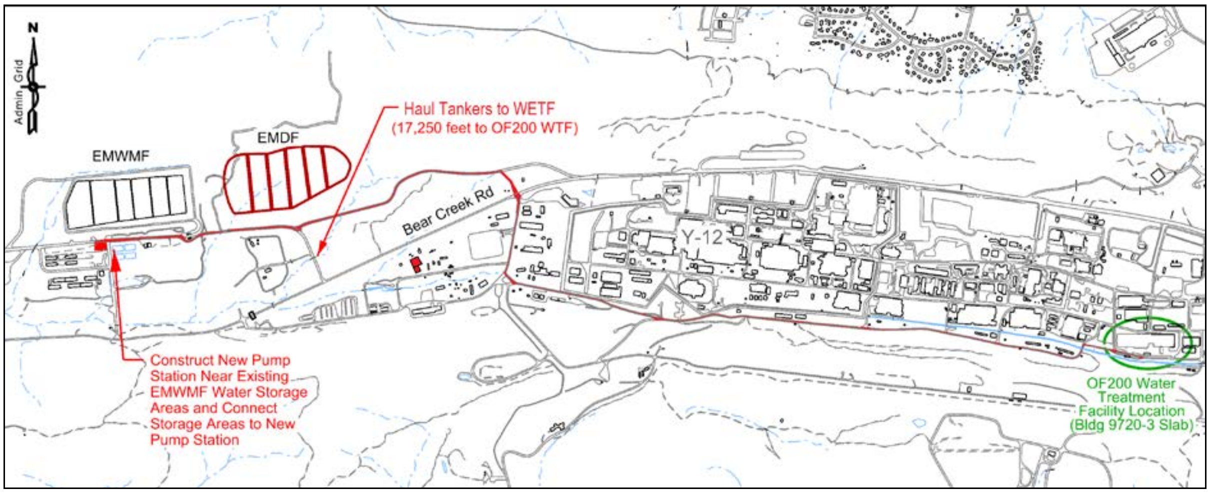

Fig. 23. Alternative 6b: truck route to Outfall 200 MTF.

Details: The existing 5000-gal capacity tanker trucks typically haul 4500 gal per load. For the higher precipitation season of approximately three months, trucks will haul landfill water seven days per week during a regular day shift. During the remaining nine months of the year, trucks will haul landfill water four days per week, day shift only, as is the current practice.

Two efficient loading stations are required to process up to 20 shipments per 10-hour shift. A new loading station will be required at the EMWMF contact water tanks (the four ModuTanks®) to ship the EMWMF contact water. The existing 4-in. Wacker portable pumps will be used to transfer the contact water to the loading station. Hook-ups exist for the hose connection of a portable pump to each ModuTank® and hoses will be used to connect the pump discharge to the loading arm pipe at the new station.

The new station includes a pull-through spill containment slab similar to that at the current West Loading Station, but with both long sides curbed. The containment slab will be 60-ft long with a sump for collection of rainwater and spill/leaks. The sump will have an automatic submersible pump that will pump back to any of the four ModuTanks® via new 2-in. underground pipe network.

The existing West Loading Station will be refurbished to add a SafeRack® loading platform and new articulating loading arm of similar design to the existing East Loading Station. The only change to the East Loading Station is an upgrade to a higher capacity leachate transfer/loading pump.

No new landfill water storage is required at WETF. Landfill water storage will be maintained at the EMWMF/EMDF location due to the proximity to OF200 MTF.

Support activities: Piping is required to connect the EMDF storage tanks and load-out pump to the new loading station. Additional support activities are required to procure an additional tanker, train drivers, and maintain the ORR roadways.

Additional landfill water storage will be required at the EMWMF/EMDF location to provide a consistent flow of water for the trucking operation. Operations staff will provide sufficient workers to ship from two stations at the same time.

Monitoring and land use controls: EMWMF, EMDF, and OF200 MTF are expected to remain within the control of DOE indefinitely with existing access restrictions and land use controls. No additional monitoring is required over what is required for Alternative 6.

Time-frame for implementation: Construction of the additional support structures will be concurrent with EMDF construction, with operations planned to begin in mid- to late-2022.

Uncertainties: The space for additional tanker unloading stations is limited and soil may have low levels of contamination that must be removed prior to construction. The future cost and availability of fuel may be a factor in the execution of this alternative.

The schedule impacts caused by entering and exiting the Y-12 security portal are not determined, but have been significant in the past.

The truck route to OF200 MTF (Fig. 23) may be altered due to safety and security issues. This change may result in significant inefficiencies and cost increases.

Documents: No additional documentation is required in addition to the Alternative 6 documents.

4. ANALYSIS OF ALTERNATIVES

4.1 INTRODUCTION

This chapter presents the detailed analyses of the alternatives for the management of landfill water generated from EMWMF and EMDF. The analysis of alternatives provides the basis for recommending an alternative. Section 4.2 describes the evaluation criteria, Sect. 4.3 is an in-depth analysis for each alternative that provides the basis of alternative selection, and Sect. 4.4 is a comparative analysis of the alternatives.

4.2 EVALUATION CRITERIA

CERCLA, Section 121, as amended, specifies statutory requirements for remedial actions. These requirements include protection of human health and the environment, compliance with ARARs, a preference for permanent solutions that incorporate treatment as a principal element to the maximum extent practicable, and cost effectiveness. To assess whether alternatives meet these requirements, the following nine criteria (EPA/540/G-89/004**)** are identified in the NCP (40 *CFR* 300.430) that must be evaluated for each alternative [Section 300.430(e)(9)(iii)].

- Threshold Criteria
  - Overall Protection of Human Health and the Environment
  - Compliance with ARARs
- Balancing Criteria
  - Long-Term Effectiveness and Permanence
  - Reduction of Toxicity, Mobility, or Volume Through Treatment
  - Short-Term Effectiveness
  - Implementability
  - Cost
- Modifying Criteria
  - State Acceptance
  - Community Acceptance

The first two criteria are the threshold criteria that relate directly to statutory findings that must be documented in the record of decision. The next five criteria, the primary balancing criteria, address the performance of the alternative and verify that the alternative is realistic. The last two modifying criteria are not addressed in the current analyses because they rely on stakeholder participation and feedback on the recommended alternative.

In addition to these evaluation criteria prescribed under CERCLA, DOE policy directs that the substantive elements of analysis required under the National Environmental Policy Act (NEPA) be incorporated into CERCLA decision documents (DOE 1994, *Secretarial Policy Statement on National Environmental Policy Act*). Elements common to both CERCLA and NEPA include protectiveness, compliance with ARARs, long-term effectiveness and permanence, short-term effectiveness, and cost. Additional NEPA values that are not specifically included in the CERCLA criteria include socioeconomic impacts, environmental justice, irreversible and irretrievable commitment of resources, and cumulative impacts.

Additionally, current EPA policy (EPA 542-R-12-002, *Methodology for Understanding and Reducing a Project's Environmental Footprint*) is to incorporate sustainability principles into the remedial decision-making process by considering all environmental effects of remedy implementation and incorporating options to maximize net environmental benefit of cleanup actions. The processes used for remediation also use a lot of water and energy and can create problems with emissions to air and water. To limit such collateral damage from remediation, EPA is adopting and promoting greener remediation practices. The core elements to be considered are energy requirements for treatment technologies, air emissions, water requirements and impacts, land and ecosystem impacts, material consumption and waste generation, and long-term stewardship.

Because both the landfill water flow and potential COCs are expected to be variable over time, the adaptability of each alternative to address these uncertainties was also added as an evaluation criterion.

Below are summaries of the factors that comprise the nine CERCLA criteria, a brief discussion on the integration of NEPA and green remediation with the CERCLA analysis, and a brief discussion of adaptability.

- **Criterion 1: Overall Protection of Human Health and the Environment.** This evaluation criterion assesses whether the alternative achieves and maintains adequate protection of human health and the environment in accordance with the remedial action objectives. Because the scope of this criterion is broad, it also reflects the discussions of the subsequent criteria, including long-term effectiveness and permanence and short-term effectiveness. This criterion evaluates how site risks associated with each exposure pathway will be eliminated, reduced, or mitigated through treatment, engineering controls, or land use controls. This criterion also evaluates impacts to the site environment resulting from the action itself.
- **Criterion 2: Compliance with ARARs.** This evaluation criterion addresses compliance with promulgated federal and state environmental requirements that are legally applicable or relevant and appropriate. If an alternative cannot meet a requirement, a waiver under CERCLA might be appropriate and a basis for justifying the waiver is presented. ARARs consist of two sets of requirements—those that are applicable and those that are relevant and appropriate. If there are no standards that address the proposed action or COCs, nonpromulgated advisories, criteria, or guidance developed by EPA, other federal agencies, or states may be designated as TBC guidance.

  Appendix D contains all potential ARARs for the scope of this study.
- **Criterion 3: Long-Term Effectiveness and Permanence.** This evaluation criterion evaluates the extent to which an alternative achieves an overall reduction in risk to human health and the environment after the remedial action objectives are met. The criterion also considers the degree to which the alternative provides sufficient long-term controls and reliability to prevent exposures that exceed protective levels for human and environmental receptors. The principal factors addressed by this criterion include the magnitude of residual risk, the adequacy and reliability of controls to address such risk, and the uncertainties associated with these factors. This criterion also evaluates the potential long-term environmental effects of the alternative. The evaluation of adequacy and reliability of controls assesses the effectiveness of any treatment, containment, or land use controls that are part of the alternative. Factors considered include performance characteristics, maintenance requirements, and expected durability. Information and data from past performance and similar technology applications may be appropriately incorporated into the evaluation. Land use controls are considered if they potentially improve the effectiveness of engineering controls.
- **Criterion 4: Reduction of Toxicity, Mobility, or Volume Through Treatment.** This evaluation criterion reflects the statutory preference that remedial alternatives contain a principal component that substantially reduces toxicity, mobility, or volume of hazardous substances through treatment. The

evaluation of alternatives against this criterion considers the extent to which alternative technologies can effectively and permanently fix, transform, immobilize, or reduce the volume of contaminants.

- **Criterion 5: Short-Term Effectiveness.** This evaluation criterion addresses the effects on human health and the environment posed by the construction and implementation of the alternative. Both the potential impacts and associated mitigative measures are examined for protectiveness of the community, remediation workers, and environmental receptors during remedial activities. Potential short-term risks to the public include inhalation of contaminants that might be released during construction and implementation of the alternative. Potential short-term risks to workers include direct contact and exposure during construction, waste handling, and transportation; physical injury or death during construction and transportation activities; and airborne contamination during soil removal. Alternative analyses also include a description of mitigative measures, such as engineering and land use controls, expected to minimize potential risks to the public and workers. This criterion also evaluates impacts on environmental media and potentially sensitive resources. Short-term environmental effects and mitigation measures are qualitatively assessed.

- **Criterion 6: Implementability.** This evaluation criterion examines the technical and administrative factors affecting implementation of an alternative and considers the availability of services and materials required during implementation. Technical factors to be assessed include the ease and reliability of construction and operations, the prospects for implementing any needed future actions, and the adequacy of monitoring systems to detect failures. Administrative factors include permitting and coordination requirements between the lead agency (DOE) and regulatory agencies (EPA and TDEC). Service and material considerations include treatment, storage, or disposal capacities; equipment and operator availability; and applicability or development requirements for prospective technologies.

  Technical feasibility considers the performance history of the technologies in direct applications or the expected performance for similar applications. Also addressed are uncertainties associated with construction, operation, and performance monitoring.

  The evaluation of administrative feasibility addresses actions required to coordinate with regulatory agencies in establishing the framework for compliance with substantive technical requirements. The NCP requires that the evaluation of the relative administrative feasibility of each alternative include "…activities needed to coordinate with other offices and agencies and the ability and time required to obtain any necessary approvals and permits from other agencies (for off-site actions). CERCLA, Sect. 121(e), stipulates that no federal, state, or local permit shall be required for the portion of any removal or remedial action conducted entirely on site." An action must satisfy the substantive requirements of any permits that would otherwise be required. The availability of services and materials is addressed by analyzing the material components of the proposed technologies and then determining the locations and quantities of those materials. Process operations are reviewed to identify any special services, operator skills, or training needed for ready implementation of the process.

- **Criterion 7: Cost.** A cost estimate is included for each alternative. The estimate is based on feasibility-level scoping and is intended to facilitate evaluation of the alternative. The estimate has an expected accuracy of +50 to -30 percent for the scope of action. All estimates have been escalated using DOE-approved annual rates and a schedule for the various activities based on similar project experience. Typical cost estimating contingencies are not included in the estimate.

  The cost estimate is divided into capital, and O&M costs. Capital costs are defined as those expenditures required to initiate and install an alternative. These are short-term costs and exclude costs required to maintain the action throughout the project's lifetime. O&M costs are long-term costs required to maintain the action throughout the project's lifetime. These costs occur after construction and installation are completed.

Appendix H contains additional information on the cost estimates and the major assumptions used to develop those estimates.

- **Criterion 8: State Acceptance.** State acceptance of alternatives will be evaluated in the proposed plan issued for public comment. Therefore, this criterion is not necessary for this focused feasibility study.

- **Criterion 9: Community Acceptance.** Community acceptance of alternatives will be evaluated when the proposed plan is issued for public comment. Therefore, this criterion is not necessary for this focused feasibility study.

- **NEPA Considerations.** DOE policy (DOE 1994) directs that the substantive elements of analysis required under NEPA be incorporated into CERCLA decision documents. This process provides decision-makers with a wider range of environmental and social concerns than those specifically delineated under CERCLA. The CERCLA evaluation criteria are directly applicable to the consideration of environmental and social impacts, as listed below:

  — Compliance with ARARs addresses the NEPA requirement for consideration of applicable laws and guidelines, including cultural and historical resources

  — Long-term effectiveness and permanence addresses the NEPA requirement for consideration of long-term impacts on human health and the environment, including emissions to air and water

  — Short-term effectiveness addresses the NEPA requirement for consideration of short-term impacts on human health and the environment, noise, air, transportation, and short-term emissions to air and water

  — Cost is a consideration under both NEPA and CERCLA

Other NEPA values not normally considered in a CERCLA focused feasibility study include the following:

- Aesthetic effects
- Socioeconomic impacts
- Environmental justice
- Irreversible and irretrievable commitments of resources
- Cumulative impacts

These values are not key differentiators among the alternatives, except for the irreversible and irretrievable commitments of resources.

- **Green remediation considerations.** EPA policy (EPA 542-R-12-002) is to incorporate sustainability principles into the remedial decision-making process. The CERCLA evaluation criteria are directly applicable to the following core elements, as listed below:

  — Overall protection of human health and the environment addresses the core element of land and ecosystem impacts.

  — Implementability addresses the core element of long-term stewardship by evaluating the impacts of the alternatives on operations and maintenance. Implementability also addresses the core element of air emissions in the evaluation of the trucking option.

  — Compliance with ARARs addresses the core element of water impacts by evaluating compliance with AWQC.

— The discussion of process options (Sect. 3.2) already addresses water requirements in terms of reusing water.

The core values not normally considered in a CERCLA feasibility study are the following:

- Energy required
- Material consumption and waste generation

These are similar to the irreversible and irretrievable commitment of resources discussed above with the NEPA values, so another criterion against which each alternative is evaluated is the irreversible and irretrievable commitment of resources.

- **Adaptability.** There is uncertainty in the future concentrations of the key COCs in landfill water over time because of the different contaminants at the East Tennessee Technology Park, ORNL, and Y-12; the variability in waste lots and associated contaminants over time; the presence of unexpected contaminants; and the mobility of the disposed contaminants. As shown in Appendix C, at times in the past, specific contaminants have required treatment for a short time, but do not currently require treatment. This situation is expected to continue in the future so that the contaminants requiring treatment will vary over time and for varying periods. There also is uncertainty in the flow rate due to rainfall variation, the number of open disposal cells, and the number of closed cells. Therefore, a key criterion in evaluating the alternatives is the ability to adapt to changes in COCs and flow rate.

4.3 INDIVIDUAL ANALYSIS OF ALTERNATIVES

4.3.1 Alternative 1: No Action

Evaluation of the No Action alternative is required under CERCLA [40 *CFR* 300.430(e)(6)] to provide a baseline for comparison with the action alternatives. Under this No Action alternative, no response action will be taken for the management of landfill water. The existing landfill water collection system at EMWMF will be abandoned, no collection system will be constructed at EMDF, no monitoring will be performed, present security measures and land use controls to limit access and use will not maintained, and landfill water will flow freely from EMWMF and EMDF into groundwater and/or surface water.

Overall Protection of Human Health and the Environment (Alternative 1)

The No Action alternative will not be protective of human health and the environment, will not meet the remedial action objective to comply with AWQC, and will not be effective. No action will be taken to attain AWQC in surface water, and contaminant releases in excess of AWQC are possible.

Compliance with ARARs (Alternative 1)

Compliance with ARARs applies only to actions taken under CERCLA authority. Since the No Action alternative includes no response actions to manage landfill water, there are no ARARs associated with this alternative.

Long-Term Effectiveness and Permanence (1)

The No Action alternative will not be effective in the long-term and is unacceptable since no remedial action will be taken to mitigate contaminant releases from the contact water and leachate. Contaminant releases to surface water and groundwater will continue.

Reduction of Toxicity, Mobility, or Volume Through Treatment (Alternative 1)

Implementation of the No Action alternative will not meet the CERCLA preference for treatment to reduce toxicity, mobility, or volume of contaminants.

Short-Term Effectiveness (Alternative 1)

Since the No Action alternative involves no construction, there will be no short-term risks to workers or the community and no short-term environmental impacts.

Implementability (Alternative 1)

No implementation activities will be required for the No Action alternative. Therefore, this alternative is inherently implementable. However, it may be difficult to obtain acceptance from the regulators and the public.

Cost (Alternative 1)

There are no costs associated with the No Action alternative. The No Action alternative can result in fines under the Clean Water Act if AWQC are not maintained.

Irretrievable Commitment of Resources (Alternative 1)

There will be no commitment of resources under the No Action alternative. However, the release of contaminants will continue to degrade the water quality of Bear Creek.

Adaptability (Alternative 1)

Since no action is being taken to manage the discharge of landfill water, the No Action alternative can address fluctuating flows and varying COCs.

4.3.2 Alternative 2: Managed Discharge

In Alternative 2, the landfill water (until mercury or other key COCs concentrations exceed applicable AWQC) will discharge to Bear Creek without treatment.

Overall Protection of Human Health and the Environment (Alternative 2)

Protection of Human Health and the Environment. The Managed Discharge alternative will be protective of human health and the environment for the batch discharge of landfill water that meets AWQC. Bear Creek already exceeds AWQC for cadmium and mercury (TDEC 2014a). The landfill water from EMWMF may contain cadmium at concentrations above the criterion continuous concentration AWQC, but below the criterion maximum concentration AWQC applicable to batch discharges. To meet AWQC, the release of EMWMF landfill water must be performed on a batch basis only. If the mercury concentration in the proposed EMDF leachate exceeds AWQC, managed discharge will not be protective of human health and the environment and cannot be performed. Therefore, the Managed Discharge alternative will be protective of human health and the environment for the batch discharge of landfill water when AWQC are met prior to batch discharge.

Effectiveness. The Managed Discharge alternative will be effective for the discharge of landfill water when the concentrations of the key COCs are below the criterion maximum concentration AWQC applicable to batch discharges. The Managed Discharge alternative will not be effective for the discharge of EMDF landfill water when the mercury or other key COCs exceed AWQC.

Impact to Site Environment. The Managed Discharge alternative will have no impact to the site environment because there will be no new construction. Existing facilities and equipment will be used, and no upgrade will be necessary. While a batch discharge meets the criterion maximum concentration AWQC, additional quantities of cadmium are still discharged into Bear Creek.

Compliance with ARARs (Alternative 2)

Compliance with ARARs. The Managed Discharge alternative will comply with all chemical-specific, location-specific, and action-specific ARARs, unless and until the AWQC for mercury or other key COCs is exceeded in landfill water.

ARAR Waivers. No ARAR waivers will be required.

Long-Term Effectiveness and Permanence (Alternative 2)

Effectiveness. The Managed Discharge alternative will be effective for the long-term because direct discharge without treatment will only be performed for landfill water that meets AWQC.

Permanence. EMWMF and EMDF are expected to remain within the control of DOE indefinitely with existing access restrictions and land use controls. There is uncertainty associated with the quality of the landfill water in the future, as remediation continues at ORNL and Y-12 with different COCs and as contaminants continue to leach in unpredictable concentrations. If the concentrations of COCs in the future exceed AWQC, then the Managed Discharge alternative will no longer be effective.

Reduction of Toxicity, Mobility, or Volume Through Treatment (Alternative 2)

The Managed Discharge alternative will not meet the CERCLA preference for treatment to reduce toxicity, mobility, or volume of contaminants.

Short-Term Effectiveness (Alternative 2)

Since the Managed Discharge alternative involves no construction, there will be no short-term risk to workers, the community, and the environment. Since EMDF will not be operational for several years, the only short-term discharge is EMWMF landfill water. During this time, the Managed Discharge alternative will be effective by discharging only landfill water that meets AWQC.

Implementability (Alternative 2)

Technical Feasibility. The Managed Discharge alternative will be technically feasible. For EMWMF landfill water, existing facilities and equipment will be used and no upgrade will be necessary. EMDF will require leachate collection and storage systems, which are routinely used and easily implemented.

Administrative Feasibility. The Managed Discharge alternative will be administratively easy to implement. EMWMF record of decision and implementing documents will be revised to include appropriate ARARs for the discharge of landfill water into Bear Creek and to include the discharge of cadmium at the criterion maximum concentration. EMDF remedial investigation/feasibility study, proposed plan, and record of decision will have to be approved. A remedial action work plan and a completion document will be required.

Availability of Services and Materials. The few services and materials required for implementation of the Managed Discharge alternative will be readily available.

Cost (Alternative 2)

Capital Cost. There is no capital cost for Alternative 2.

O&M Cost. The annual O&M cost for Alternative 2 is estimated at approximately $613,000 per year during EMWMF operation and closure. Offsetting this annual O&M cost is the current annual cost of approximately $500,000 to transport EMWMF leachate to PWTC for treatment.

Present Worth. The present worth of Alternative 2 is estimated at approximately $3,600,000. The basis for the cost estimate is in Appendix I.

Irretrievable Commitment of Resources (Alternative 2)

The Managed Discharge alternative has no irretrievable commitment of resources.

Adaptability

There is no ability to manage contaminants above AWQC. Additional treatment will be required, either through existing or acquired treatment facilities.

4.3.3 Alternative 3: Treat at EMWMF/EMDF

In Alternative 3, a new treatment facility will be constructed and operated for the treatment of landfill water at the EMWMF/EMDF site prior to discharge to Bear Creek.

Overall Protection of Human Health and the Environment (Alternative 3)

Protection of Human Health and the Environment. Alternative 3 will be protective of human health and the environment because landfill water will be treated to meet AWQC. The remedial action objectives will be met as soon as the treatment system is built and operational. Construction time is estimated to be approximately one year. Treatment technologies for removal of mercury and cadmium are well demonstrated, reliable, effective, readily available, and easily implemented. If the landfill water composition changes and additional contaminants must be addressed, the treatment system can be modified easily due to its modular design to include the necessary unit operations. Sampling treatment system influent and effluent verifies performance and identifies changes in the characteristics of the landfill water. On the rare occasions that untreated landfill water bypasses the treatment system and discharges directly into Bear Creek, the overall protection of human health and the environment will not be affected because Bear Creek will be experiencing peak flow rates.

Effectiveness. Alternative 3 will be effective because the concentrations of cadmium and mercury will be reduced to AWQC . Treatment technologies for removal of mercury and cadmium are well demonstrated, reliable, effective, readily available, and easily implemented. If the landfill water composition changes and additional contaminants must be addressed, the treatment system can be modified easily to include the necessary unit operations.

Impact to Site Environment. Alternative 3 will have minimal impact to the site environment. Even though a treatment system will be constructed, the site previously has been impacted by waste disposal operations, and site preparation will require only minor excavation. On the rare occasions untreated landfill water bypasses the treatment system and discharges directly into Bear Creek, the overall protection of human health and the environment will not likely to be affected because Bear Creek will be experiencing peak flow rates.

Compliance with ARARs (Alternative 3)

Compliance with ARARs. Alternative 3 will comply with all chemical-specific, location-specific, and action-specific ARARs. Cadmium and mercury concentrations will be reduced to AWQC through the treatment of landfill water. Since cadmium will be reduced through treatment in this alternative, the lower criterion continuous concentration cadmium concentration will be met. Treatment technologies for removal of mercury and cadmium are well demonstrated, reliable, readily available, and easily implemented. Sampling treatment system effluent verifies performance and identifies changes in the characteristics of the leachate and contact water. If landfill water composition changes and additional contaminants must be addressed, the treatment system can be modified easily due to its modular design to include the necessary unit operations.

ARAR Waivers. No ARAR waivers are required.

Long-Term Effectiveness and Permanence (Alternative 3)

Effectiveness. Alternative 3 will be effective for the long-term because the treatment system will provide processing equipment with a design life that matches the anticipated landfill operations schedule with continued post-closure operations until landfill water no longer requires treatment or is no longer generated. Since treatment technologies for removal of mercury and cadmium are well demonstrated, reliable, effective, readily available, and easily implemented, the treatment system can be maintained, and components can be replaced with normal procedures. Sampling treatment system influent and effluent will verify performance and identify changes in the characteristics of the leachate and contact water. If landfill water composition changes, and additional contaminants must be addressed, the treatment system can be modified easily due to its modular design to include the necessary unit operations.

Permanence. Alternative 3 will be a permanent action. EMWMF and EMDF are expected to remain within the control of DOE indefinitely with existing access restrictions and land use controls. The treatment system at the EMWMF/EMDF site provides processing equipment with a design life that matches the anticipated landfill operations schedule with continued post-closure operations until leachate no longer requires treatment or is no longer generated. Since treatment technologies for removal of mercury and cadmium are well demonstrated, reliable, effective, readily available, and easily implemented, the treatment system can be maintained, and components can be replaced with normal procedures. If landfill water composition changes and additional contaminants must be addressed, the treatment system can be modified easily due to its modular design to include the necessary unit operations.

Reduction of Toxicity, Mobility, or Volume Through Treatment (Alternative 3)

Alternative 3 reduces the concentrations of cadmium and mercury to AWQC through treatment of landfill water. Treatment of landfill water concentrates the mercury and cadmium into a small, residual waste form for disposal.

Short-Term Effectiveness (Alternative 3)

The treatment of landfill water at the EMWMF/EMDF site will require construction activities with the associated risk of industrial accidents. DOE safety policies, procedures, and worker training reduce the potential for and mitigate the consequences of such incidents. This alternative will have minimal short-term impacts to the surrounding community and the environment.

Implementability (Alternative 3)

Technical Feasibility. Alternative 3 will be technically easy to implement because the treatment technologies for removal of cadmium and mercury are well demonstrated, reliable, effective, readily available, and easy to construct using standard equipment and techniques. DOE has implemented similar projects at ORNL, Y-12, and the East Tennessee Technology Park for landfill water treatment and has access to experienced engineering and project management resources for landfill water treatment projects. The treatment system will be designed for ease of expansion if additional COCs are encountered. The time required to respond to additional COCs will be minimized through monitoring of leachate and contact water and through contingency planning that includes evaluation of waste planned for disposal.

Administrative Feasibility. Alternative 3 will be administratively easy to implement. The remedial investigation/feasibility study, proposed plan, and record of decision for EMDF have to be approved. A remedial action work plan/remedial design report that includes the specific treatment system design, and a completion document that contains the as-built conditions are required. All of these documents are conventional CERCLA documents for which DOE has extensive experience.

Availability of Services and Materials. The services and materials for Alternative 3 are readily available. The treatment technologies for removal of cadmium and mercury are well demonstrated, reliable, effective, readily available, and easy to construct using standard equipment and techniques. DOE has implemented similar projects at ORNL, Y-12, and the East Tennessee Technology Park for landfill water treatment and has access to experienced engineering and project management resources for landfill water treatment projects.

Cost (Alternative 3)

Capital Cost. The capital cost of Alternative 3 is estimated at approximately $3,900,000.

O&M Cost. The annual O&M cost of Alternative 3 is estimated at approximately $950,000 per year during EMDF operation and closure and $137,000 during post-closure.

Present Worth. The present worth of Alternative 3 is estimated at approximately $25,300,000. The basis for the cost estimate is in Appendix I.

Irretrievable Commitment of Resources (Alternative 3)

In Alternative 3, there will be minimal irretrievable commitment of resources. The treatment system will be small, so the energy requirements are not excessive. The footprint of the treatment system is in an area already dedicated to waste management, so there will be minimal environmental impacts.

Adaptability (Alternative 3)

The treatment system will be designed to quickly implement different treatment units, if required by changes in COCs above or below discharge limits or due to long-term changes in flow rates. Flow rates above the design flow rate during storms will bypass the treatment system; however, dilution by precipitation and floodwaters will minimize the impact to the environment. If higher flow rates are continuous, then the treatment system will be easily expanded. Lower flow rates normally will be treated in batches, requiring no changes to the treatment system. If lower flow rates are continuous, then the treatment system will be easily reduced in size.

4.3.4 Alternative 4: Treat at PWTC

In Alternative 4, the landfill water will be transferred by truck or pipeline to the existing, on-site PWTC at ORNL for treatment prior to discharge into White Oak Creek.

Overall Protection of Human Health and the Environment (Alternative 4)

Protection of Human Health and the Environment. Alternative 4 is protective of human health and the environment because the remedial action objective for landfill water from EMWMF and EMDF will be met by treatment at PWTC prior to discharge to White Oak Creek. The treatment technologies used at PWTC and the pre-treatment required for mercury are effective for the landfill water. Sampling the landfill water prior to shipping to PWTC will verify compliance with WAC and identify changes in the characteristics of the landfill water. If the landfill water becomes radiologically contaminated with constituents other than those currently treated at PWTC, the complexity and cost of retrofitting PWTC radiological treatment system will be significant. The response to the need for additional treatment capability will require time to obtain additional funds and to design, construct, and deploy the additional processing equipment. If the landfill water is transported by truck to PWTC, then there will be risk to the drivers and the public associated with the potential for roadway transport incidents.

The pipeline option is protective of human health and the environment because it will transfer hazardous landfill water in an engineered system with secondary containment, instrumentation, controls, and leak detection capability. The utilization of pipelines is a well-established technology with standards codes and specifications for designing, constructing, and testing a pipeline system. As with any pipeline, there will be inherent minor risk associated with pipeline failure from a manmade event or natural phenomena, e.g., fire, earthquake, freeze damage. Since the pipeline route will follow the existing Haul Road and power line easement, there will be minimal additional environmental impacts. Environmental surveys will be required prior to construction to evaluate impacts to wetlands and rare and endangered species.

This alternative will reduce the flow of water into Bear Creek that may be detrimental to aquatic life. On rare occasions that storm events necessitate the bypass of untreated landfill water directly into Bear Creek, the overall impact to protection of human health and the environment will be minimal because Bear Creek will be at high flow conditions.

Effectiveness. The treatment technologies used at PWTC and the pre-treatment required for mercury will be effective for the landfill water. Sampling the landfill water prior to transferring to PWTC will verify compliance with WAC and identify changes in the characteristics of the landfill water. If the landfill water becomes radiologically contaminated with constituents other than those currently treated at PWTC, the complexity and cost of retrofitting PWTC radiological treatment system will be significant. The PWTC does not have unit operations for other radiological constituents, and. additional treatment capability will require time to obtain additional funds, design, and deploy the new equipment.

Either transporting the landfill water by truck or transferring by pipeline will be effective for moving landfill water to PWTC for treatment. Both methods have some level of inherent risk associated with potential spills.

Truck transportation of landfill water has been performed successfully for over ten years. However, due to the increased quantity of water to be transported, there is uncertainty in the availability of trucks, the availability of drivers, and the travel time during bad weather. Increase truck transportation will also require additional PWTC support for unloading tankers.

Impacts to Site Environment. Alternative 4 will have minimal impacts to the site environment. Since the pipeline route follows the existing Haul Road and power line easement for most of the route, minimal additional environmental impacts are anticipated. However, an environmental survey will be required prior to construction. This alternative will reduce the flow of water in Bear Creek and may be detrimental to aquatic life. On the rare occasions that untreated landfill water bypasses the treatment system and is discharged directly into Bear Creek, the overall protection of human health and the environment will be minimal. In order to install the additional landfill water offloading stations at PWTC, soil will have to be excavated that has low levels of contamination.

Compliance with ARARs (Alternative 4)

Compliance with ARARs. Alternative 4 will comply with all chemical-specific, location-specific, and action-specific ARARs. Treatment of landfill water at PWTC is compliant with ARARs. The WAC and the NPDES permit will have to be revised. The treatment technologies used at PWTC and the pre-treatment for mercury are effective for the landfill water. Sampling landfill water prior to transporting it to PWTC will verify compliance with WAC and identify changes in the characteristics of the landfill water. The pipeline will be constructed to appropriate engineering standards and will have secondary containment and leak detection capability.

ARAR Waivers. No ARAR waivers are required.

Long-Term Effectiveness and Permanence (Alternative 4)

Effectiveness. Alternative 4 will be effective in the long-term. Treatment of landfill water at PWTC will be effective for long-term operation and compliant performance. Sampling landfill water prior to transporting it to PWTC will verify compliance with WAC and identify changes in the characteristics of the landfill water due to the differing predominant contaminants at the East Tennessee Technology Park, ORNL, and Y-12. If additional contaminants are introduced into the landfill water, PWTC modifications can be performed as necessary to meet processing needs, although modifications to remove additional radiological constituents will be complex and costly. Significant PWTC modifications can result in impaired treatment effectiveness and performance for the time necessary to provide the required treatment capability. The age of PWTC and the possibility of its replacement may have short-term impacts during future construction, but will still be effective once replaced or upgraded.

Transporting the contact and leachate by tanker truck to PWTC will not be an effective long-term option. The utilization of trucks has been practiced successfully for over ten years. However, the expected increase and fluctuation in landfill water flow will introduce uncertainty in the availability of trucks and drivers, and increase the potential for transport incidents.

The pipeline will be effective because it will provide an engineered, automated, and well-contained system for transferring landfill water to the PWTC. Buried HDPE piping has a long service life and can be designed and installed to last well beyond the period of performance for EMWMF and EMDF.

Permanence. The EMWMF and EMDF site and ORNL are expected to remain within the control of DOE indefinitely with existing access restrictions and land use controls. The facilities and equipment at PWTC are aging, show signs of deterioration, and may require major upgrades or replacement in the future. However, the ORNL demand for wastewater treatment and availability of the PWTC for landfill water treatment is projected to continue for the life cycle of EMWMF and EMDF operational needs.

Support of CERCLA water treatment is not a mission for ORNL, so there is a chance in the future that PWTC or an equivalent facility will be unavailable. If additional contaminants are introduced into the landfill water, PWTC modifications can be performed as necessary to meet processing needs, although modifications to remove additional radiological constituents will be complex and costly.

Transporting the landfill water by tanker truck to PWTC will not be an effective long-term option. The utilization of trucks has been practiced successfully for over ten years. However, the fluctuation in landfill water flow will introduce uncertainty in the availability of trucks and drivers and increase the potential for transport incidents. The pipeline will be effective because it will provide an engineered, automated, and well-contained system for transferring landfill water to PWTC. Buried HDPE piping has a long service life and can be designed and installed to last well beyond the period of performance for EMWMF and EMDF.

Reduction of Toxicity, Mobility, or Volume Through Treatment (Alternative 4)

Alternative 4 will reduce the concentrations of cadmium and mercury to acceptable levels through treatment of landfill water prior to discharge to White Oak Creek. Treatment of landfill water will concentrate the mercury and cadmium into a small, residual waste form for disposal.

Short-Term Effectiveness (Alternative 4)

The operation of PWTC will have minimal short-term impacts to remediation workers, the surrounding community, and the environment. The PWTC currently accepts and processes EMWMF leachate effectively and safely. Truck transport is currently used to deliver the leachate to PWTC for treatment and is being performed effectively and safely. Construction of the pipeline will have short-term environmental impacts, but by following the existing duct bank and power line easement, the impacts are minimized. DOE safety policies, procedures, and worker training reduce the potential for and mitigate the consequences of such incidents. Alternative 4 will reduce the flow of water in Bear Creek and may be detrimental to aquatic life. In order to install the additional landfill water offloading stations at PWTC, soil will have to be excavated that has low levels of contamination that will require additional worker protection.

Implementability (Alternative 4)

Technical Feasibility. Alternative 4 will be technically feasible and simple to implement. Upgrades at PWTC to install the additional landfill water offloading stations are easy to construct, and the slightly contaminated soil should be disposed at the ORR landfill. However, if the landfill water becomes radiologically contaminated with constituents other than those currently treated at the PWTC, implementability will be impaired by the need to obtain additional funds, complete design activities, and perform construction within an existing footprint, while maintaining operational capability for continued landfill water processing. The PWTC does not currently accept uranium.

The construction activities required to modify PWTC to accept the landfill water are minor, and the additional risk of a construction accident is not significant. Operational risk for landfill water treatment is no greater than what is currently experienced during PWTC ongoing operations.

Construction of the pipeline will use conventional construction techniques. However, there is likely to be interference from existing underground utilities and potentially contaminated soil that will complicate construction of the pipeline. The utilization of trucks has been practiced successfully for over ten years. However, the expected fluctuation in landfill water flow will introduce uncertainty in the availability of trucks and drivers and increase the potential for transport incidents.

Administrative Feasibility. Alternative 4 will be administratively easy to implement. The remedial investigation/feasibility study, proposed plan, and record of decision for EMDF will have to be approved. A remedial action work plan/remedial design report that includes the specific treatment facility design and a completion document that contains the as-built conditions will be required. All of these documents are conventional CERCLA documents for which DOE has extensive experience. The WAC will have to be revised to accept mercury, or a waiver will have to be obtained to accept landfill water containing mercury. If additional contaminants appear in the leachate and contact water in the future, then the WAC will require further revision before the new contaminants can be accepted on a permanent basis.

Availability of Services and Materials. Expansion of the facilities to receive the landfill water and construction of the pipeline will use conventional construction techniques. The additional trucks and drivers that will be needed are available, but the varying demand complicates access to them.

Cost (Alternative 4)

- Trucking Option (Alternative 4a):
  - **Capital Cost.** The capital cost of Alternative 4a is estimated at approximately $10,200,000.
  - **O&M Cost.** The annual O&M cost of Alternative 4a is estimated at approximately $3,000,000 during EMDF operation and closure, and $180,000 during post-closure.
  - **Present Worth.** The present worth of Alternative 4a is estimated at approximately $70,400,000. The basis for the cost estimate is in Appendix I.
- Pipeline Option (Alternative 4b):
  - **Capital Cost.** The capital cost of Alternative 4b is estimated at approximately $15,700,000.
  - **O&M Cost.** The annual O&M cost of Alternative 4b is estimated at approximately $1,200,000 during EMDF operations and closure, and $137,000 during post-closure.
  - **Present Worth.** The present worth of Alternative 4b is estimated at approximately $41,600,000. The basis for the cost estimate is in Appendix I.

Irretrievable Commitment of Resources (Alternative 4)

In Alternative 4, there will be minimal irretrievable commitment of resources. PWTC is an existing facility, and the additional flow is minimal. Therefore, the incremental energy and chemical requirements for treatment will be minimal. The route of the pipeline is in an area already used as a haul road and power line easement, so there will be minimal environmental impacts. Transporting leachate and contact water by truck will consume more energy in fuel than the pipeline option.

Adaptability (Alternative 4)

PWTC is not readily adaptable to changing flow rates and COCs.

4.3.5 Alternative 5: Treat at WETF

In Alternative 5, the landfill water will be transported by truck or pipeline to the expanded, on-site WETF at Y-12 for treatment prior to discharge into UEFPC.

Overall Protection of Human Health and the Environment (Alternative 5)

Protection of Human Health and the Environment. Alternative 5 will be protective of human health and the environment and will meet the remedial action objective by treatment at WETF prior to discharge to UEFPC. The treatment technologies used at WETF following expansion will be effective for the landfill water. Sampling the landfill water prior to transporting to WETF will verify compliance with WAC and identify changes in the characteristics of the landfill water. If the landfill water becomes contaminated with constituents other than those currently treated, or if the flow rate changes, the expanded WETF can be modified with some constraints due to construction inside Y-12.

The utilization of trucks has been practiced successfully for over ten years. However, the expected increase in landfill water flow will introduce uncertainty in the availability of trucks and drivers, and the increase the potential for transport incidents.

The pipeline will be effective because it will provide an engineered, automated, and well-contained system for transferring landfill water to the WETF. Buried HDPE piping has a long service life and can be designed and installed to last well beyond the period of performance for EMWMF and EMDF. As with any pipeline, there will be inherent risk associated with pipeline failure from a manmade event or natural phenomena, e.g., fire, earthquake, freeze damage. The pipeline will include secondary containment and leak detection thus minimizing the potential for releases to the environment. Since the pipeline route will be in land already used for industrial uses, there will be minimal environmental impact from pipeline installation.

Effectiveness. Alternative 5 will be effective because the treatment technologies used at WETF following expansion will be effective for the landfill water. Sampling the landfill water prior to shipping to WETF will verify compliance with WAC and identify changes in the characteristics of the landfill water. If the landfill water becomes contaminated with constituents other than those currently treated, or the flow rate changes, the new WETF can be modified with some constraints due to construction inside Y-12.

Impacts to Site Environment. Alternative 5 will have minimal impacts to the site environment because the WETF site currently is used for landfill water treatment and is located in a heavily industrialized area. If untreated landfill water must bypass the treatment facility due to storm events, the impact to human health and the environment will be minimal because the heavy rain will contribute to high flow in UEFPC. This alternative will reduce the flow into Bear Creek, which may be detrimental to aquatic life.

Compliance with ARARs (Alternative 5)

Compliance with ARARs. Alternative 5 will comply with all chemical-specific, location-specific, and action-specific ARARs. Sampling landfill water prior to transporting to WETF will verify compliance with WAC and identify changes in the characteristics of the landfill water. The treatment technologies that will be used at WETF following expansion will be effective for the landfill water. Sampling landfill water prior to transporting it to WETF verifies compliance with WAC and identifies changes in the characteristics of the leachate and contact water. The pipeline will have secondary containment and leak detection.

ARAR Waivers. No ARAR waivers are required.

Long-Term Effectiveness and Permanence (Alternative 5)

Effectiveness. Alternative 5 will be effective for the long-term. The treatment technologies that will be used at the WETF following expansion will be effective for the landfill water. Transferring landfill water to the WETF by truck or pipeline will be effective because both practices are commonly used and well demonstrated. The utilization of trucks has been practiced successfully for over ten years at EMWMF. However, the expected increase in landfill water flow and variability will increase the potential for health and environmental impacts from transport incidents. In addition, there is uncertainty and inefficiency associated with the security checks of the tractor-trailer rigs entering Y-12 and the impact of these checks on turn-around time. The pipeline will be effective because it will provide an engineered, automated, and well-contained system for transferring landfill water to the WETF.

Permanence. The treatment technologies used at the new WETF treatment system will provide a permanent solution for landfill water with current characteristics. The EMWMF and EMDF site and WETF are expected to remain within the control of DOE indefinitely with existing access restrictions and land use controls. The facilities and equipment at the WETF will require routine maintenance and replacement; however, the Y-12 demand for landfill water treatment and availability of the WETF for landfill water treatment is projected to continue for the life cycle of EMWMF and EMDF operational needs. If the landfill water becomes contaminated with constituents other than those currently treated at WETF, or if the flow rate changes, the treatment facility can be modified with some constraints due to construction inside Y-12.

Transporting the landfill water by tanker truck to the WETF will not be an effective long-term option. The utilization of trucks has been practiced successfully for over ten years; however, the access issues at Y-12 will delay transportation events and the expected increase in landfill water flow will increase the potential for transport incidents. The pipeline will be effective because it will provide a permanent engineered, automated, and well-contained system for transferring landfill water to the WETF. Buried HDPE piping has a long service life and can be designed and installed to last well beyond the period of performance for EMWMF and EMDF.

Reduction of Toxicity, Mobility, or Volume Through Treatment (Alternative 5)

Alternative 5 will reduce the concentrations of cadmium and mercury to acceptable levels through treatment of landfill water prior to discharge to UEFPC. Treatment of landfill water concentrates the mercury and cadmium into a small, residual waste form for disposal.

Short-Term Effectiveness (Alternative 5)

The treatment of landfill water at WETF will require construction activities with the associated risk of industrial accidents. DOE safety policies, procedures, and worker training will reduce the potential for and mitigate the consequences of such incidents. Site preparation will require tree removal, minor excavation and grading, and installation of a concrete foundation. Utilities will have to be extended to new facilities. This alternative will have minimal short-term impacts to the surrounding community and the environment due to location within an existing DOE industrialized area. Construction of the pipeline has minimal short-term impacts because it is in an existing industrial area.

Implementability (Alternative 5)

Technical Feasibility. Although treatment technologies are available and well demonstrated, Alternative 5 will be technically difficult to implement because land for expansion is limited, significant site preparation activities will be required, and construction inside Y-12 will be complicated due to site security requirements. The selected area has not been thoroughly evaluated and may not be suitable, and alternate locations within WETF will require demolition of existing structures. The potential for significant construction delays will be high because of the location within the Y-12 security perimeter. If the landfill water becomes contaminated with constituents other than those currently treated at WETF, or if the flow rate changes, the treatment facility can be modified with constraints due to construction inside Y-12.

Pipeline installation is a common practice and easily implementable, but construction inside Y-12 will complicate construction activities due to security requirements. Installation of the pipeline will also be likely to encounter contaminated soil resulting in project delays and increased cost. Transporting the leachate and contact water via truck will be complex and inhibited by the congested industrial area and access requirements for Y-12.

Administrative Feasibility. Alternative 5 will be administratively easy to implement. The remedial investigation/feasibility study, proposed plan, and record of decision for proposed EMDF will have to be approved. A remedial action work plan/remedial design report that includes the specific treatment facility design and a completion document that contains the as-built conditions will be required. All of these documents are conventional CERCLA documents for which DOE has extensive experience.

Cost (Alternative 5)

- Trucking Option (Alternative 5a):
  - **Capital Cost.** The capital cost of Alternative 5a is estimated at approximately $8,500,000.
  - **O&M Cost.** The annual O&M cost of Alternative 5a is estimated at approximately $3,000,000 during EMDF operation and closure, and $360,000 during post-closure.
  - **Present Worth.** The present worth of Alternative 5a is estimated at approximately $68,700,000.
- Pipeline Option (Alternative 5b):
  - **Capital Cost.** The capital cost of Alternative 5b is estimated at approximately $7,800,000.
  - **O&M Cost.** The annual O&M cost of Alternative 5b is estimated at approximately $1,200,000 during EMDF operations and closure, and $1,600,000 during post-closure.
  - **Present Worth.** The present worth of Alternative 5b is estimated at approximately $33,800,000.

The basis for the cost estimate is in Appendix I.

Irretrievable Commitment of Resources (Alternative 5)

In Alternative 5, there will be minimal irretrievable commitment of resources. The treatment facility will be small, so the energy requirements will not be excessive. The footprint of the treatment facility and the route of the pipeline are in areas already dedicated to waste management and industrial uses, so there will be minimal impact to the environment. Transporting landfill water by truck will consume more energy in fuel than the pipeline option.

Adaptability (Alternative 5)

The expanded treatment facility will be designed to quickly implement different treatment units if required by changes in COCs above or below discharge limits or due to long-term changes in flow rates. However, it will be difficult to implement changes at Y-12. Flow rates above the design flow rate during storms will bypass the treatment facility; however, dilution by precipitation and floodwaters will minimize the impact to the environment.

4.3.6 Alternative 6: Treat at Outfall 200 MTF

In Alternative 6, the landfill water will be transferred by truck or pipeline to the planned, on-site treatment facility at Outfall 200 at Y-12 for treatment prior to discharge into UEFPC.

Overall Protection of Human Health and the Environment (Alternative 6)

Protection of Human Health and the Environment. Alternative 6 will be protective of human health and the environment because the remedial action objective for landfill water from EMWMF and EMDF will be met by treatment at OF200 MTF and possible pre-treatment prior to discharge to UEFPC. The treatment technologies planned at OF200 MTF are effective for the landfill water mercury concentration, and pre-treatment will be effective for other COCs as they appear. Sampling the landfill water prior to shipping to OF200 MTF will verify compatibility with OF200 MTF capability and identify changes in the characteristics of the landfill water. If the landfill water becomes contaminated with COCs other than mercury, the complexity and cost of retrofitting OF200 MTF will be significant. Until treatability studies are performed, the ability to treat cadmium is not known and the ability to treat other COCs is not known. If pre-treatment is required, the pre-treatment facility may have to be constructed and operated at the EMWMF/EMDF site due to limited space at the OF200 MTF site. This alternative will reduce the flow of water into Bear Creek that may be detrimental to aquatic life.

If the landfill water is transported by truck to OF200 MTF, there will be risk to the drivers and the public associated with the potential for roadway transport incidents.

The pipeline option is protective of human health and the environment because it will transfer hazardous landfill water in an engineered system with secondary containment, instrumentation, controls, and leak detection capability. The utilization of pipelines is a well-established technology with standards codes, and specifications for designing, constructing, and testing a pipeline system. As with any pipeline, there will be inherent minor risk associated with pipeline failure from a manmade event or natural phenomena, e.g., fire, earthquake, freeze damage. Since the pipeline route will follow the existing Haul Road, there will be minimal additional environmental impacts. Environmental surveys will be required prior to construction to evaluate impacts to wetlands and rare and endangered species.

On the rare occasions that storm events necessitate the bypass of untreated landfill water directly into Bear Creek, the overall impact to protection of human health and the environment will be minimal because Bear Creek will be at high flow conditions.

Effectiveness. OF200 MTF will be effective for the landfill water mercury concentration. However, OF200 MTF does not have the capability to treat radionuclides and may not have the capability to treat COCs other than mercury. Until treatability studies are performed, the ability of OF200 MTF to treat other COCs is not known. Sampling the landfill water prior to transferring to OF200 MTF will verify compatibility with OF200 MTF capability and identify changes in the characteristics of the landfill water. If the landfill water becomes contaminated with constituents other than mercury, the complexity and cost of pre-treatment will be significant. OF200 MTF does not have unit operations for radiological constituents and may not be able to treat COCs other than mercury, and pre-treatment capability will require time to obtain additional funds, design, and deploy the new equipment.

Either transporting the landfill water by truck or transferring by pipeline will be effective for moving landfill water to OF200 MTF. Both methods have some level of inherent risk associated with potential spills.

The utilization of trucks has been practiced successfully for over ten years. However, due to the increased quantity of water to be transported, there is uncertainty in the availability of trucks, the availability of drivers, and the travel time during bad weather.

Impacts to Site Environment. Alternative 6 will have minimal impacts to the site environment. An environmental survey will be required prior to construction of the pipeline. This alternative will reduce the flow of water in Bear Creek and may be detrimental to aquatic life. On the rare occasions that untreated landfill water bypasses the treatment facility and is discharged directly into Bear Creek, the overall protection of human health and the environment will be minimal.

Compliance with ARARs (Alternative 6)

Compliance with ARARs. Alternative 6 will comply with all location-specific and action-specific ARARs. Treatment of landfill water at OF200 MTF may be compliant with ARARs, but an interim waiver for mercury is being considered. The treatment technologies used at Outfall 200 are effective for the landfill water mercury concentration and with pre-treatment will be effective for other COCs. Until the treatability studies are performed, the ability of OF200 MTF to treat other COCs is not known. Sampling landfill water prior to transporting it to Outfall 200 will verify compatibility with OF200 MTF capability and identify changes in the characteristics of the landfill water. The pipeline will be constructed to appropriate engineering standards and will have secondary containment and leak detection capability.

ARAR Waivers. The mercury discharge limits for OF200 MTF are still being negotiated. An interim waiver from ARARs for mercury is being considered.

Long-Term Effectiveness and Permanence (Alternative 6)

Effectiveness. Alternative 6 will be effective in the long-term. Treatment of landfill water at OF200 MTF will be effective for long-term operation and compliant performance. Pre-treatment facilities will be required for radiological contaminants and possibly non-radiological contaminants. Sampling landfill water prior to transporting it to Outfall 200 will verify compatibility with OF200 MTF capability and identify changes in the characteristics of the landfill water due to the differing predominant contaminants at the East Tennessee Technology Park, ORNL, and Y-12. If additional contaminants are introduced into the landfill water, OF200 MTF modifications can be performed as necessary to meet processing needs, although modifications to remove additional constituents will be complex and costly. Significant OF200 MTF modifications can result in impaired treatment effectiveness and performance for the time necessary to provide the required treatment capability.

Transporting the landfill water by tanker truck to OF200 MTF will not be an effective long-term option. The utilization of trucks has been practiced successfully for over ten years. However, the expected increase and fluctuation in landfill water flow will introduce uncertainty in the availability of trucks and drivers and increase the potential for transport incidents.

The pipeline will be effective because it will provide an engineered, automated, and well-contained system for transferring landfill water to OF200 MTF. Buried HDPE piping has a long service life and can be designed and installed to last well beyond the period of performance for EMWMF and EMDF.

Permanence. The EMWMF and EMDF site and Y-12 are expected to remain within the control of DOE indefinitely with existing access restrictions and land use controls. If additional contaminants are introduced into the landfill water, OF200 MTF modifications can be performed as necessary to meet processing needs, although modifications to remove additional radiological constituents will be complex and costly.

Transporting the landfill water by tanker truck to OF200 MTF will not be an effective long-term option. The utilization of trucks has been practiced successfully for over ten years. However, the fluctuation in landfill water flow will introduce uncertainty in the availability of trucks and drivers and increase the potential for transport incidents. The pipeline will be effective because it will provide an engineered, automated, and well-contained system for transferring landfill water to OF200 MTF. Buried HDPE piping has a long service life and can be designed and installed to last well beyond the period of performance for EMWMF and EMDF.

Reduction of Toxicity, Mobility, or Volume Through Treatment (Alternative 6)

Alternative 6 will reduce the concentrations of cadmium and mercury through treatment of landfill water prior to discharge to UEFPC. Until the treatability studies are performed, the ability of OF200 MTF to treat other COCs will not be known. OF200 MTF is not currently designed for the removal of radionuclides. Treatment of landfill water will concentrate the mercury and cadmium into a small, residual waste form for disposal.

Short-Term Effectiveness (Alternative 6)

The operation of OF200 MTF will have minimal short-term impacts to remediation workers, the surrounding community, and the environment. Truck transport is currently used to deliver the leachate to PWTC for treatment and is being performed effectively and safely. Construction of the pipeline will have short-term environmental impacts. DOE safety policies, procedures, and worker training reduce the potential for and mitigate the consequences of such incidents. Alternative 6 will reduce the flow of water in Bear Creek and may be detrimental to aquatic life.

Implementability (Alternative 6)

Technical Feasibility. Alternative 6 will be technically feasible and simple to implement. Upgrades at Outfall 200 to install the additional landfill water offloading stations are easy to construct. Treatability studies are simple to perform, and if pre-treatment facilities are required, their construction is technically feasible and simple to implement. If the landfill water becomes contaminated with constituents other than those currently treated at OF200 MTF, implementability will be impaired by the need to obtain additional funds, complete design activities, and perform construction within an existing footprint, while maintaining operational capability for continued landfill water processing.

If the landfill water requires treatment for radiological contaminants, the planned method of disposal of secondary waste from OF200 MTF will have to change, the safety basis will have to be revised, and the cost of operation will increase.

The construction activities required to modify OF200 MTF to accept the leachate and contact water are minor, and the additional risk of a construction accident is not significant. If the pre-treatment facilities have to be located at the EMWMF/EMDF site, the cost of implementation increases and the complexity of operation increases.

Construction of the pipeline will use conventional construction techniques. However, there is likely to be interference from existing underground utilities and potentially contaminated soil that will complicate construction of the pipeline. The utilization of trucks has been practiced successfully for over ten years. However, the expected fluctuation in landfill water flow will introduce uncertainty in the availability of trucks and drivers and increase the potential for transport incidents.

Administrative Feasibility. Alternative 6 will be administratively easy to implement. The remedial investigation/feasibility study, proposed plan, and record of decision for EMDF will have to be approved. A remedial action work plan/remedial design report that includes the specific design and a completion document that contains the as-built conditions will be required. All of these documents are conventional CERCLA documents for which DOE has extensive experience. The separation of scope among EMWMF, EMDF, and OF200 MTF CERCLA documents will have to be determined. If the landfill water requires treatment for radiological contaminants, then the safety basis will have to be revised.

Availability of Services and Materials. Expansion of the facilities to receive the landfill water and construction of the pipeline will use conventional construction techniques. The additional trucks and drivers that will be needed are available, but the varying demand complicates access to them.

Cost (Alternative 6)

- Trucking Option (Alternative 6a):
  - **Capital Cost.** The capital cost of Alternative 6a is estimated at approximately $4,100,000.
  - **O&M Cost.** The annual O&M cost of Alternative 6a is estimated at approximately $2,100,000 during EMDF operation and closure, and $194,000 during post-closure.
  - **Present Worth.** The present worth of Alternative 6a is estimated at approximately $44,600,000.
- Pipeline Option (Alternative 6b):
  - **Capital Cost.** The capital cost of Alternative 6b is estimated at approximately $7,600,000.
  - **O&M Cost.** The annual O&M cost of Alternative 6b is estimated at approximately $325,000 during EMDF operations and closure, and $120,000 during post-closure.
  - **Present Worth.** The present worth of Alternative 6b is estimated at approximately $15,300,000.

The basis for the cost estimate is in Appendix I.

Irretrievable Commitment of Resources (Alternative 6)

In Alternative 6, there will be minimal irretrievable commitment of resources. OF200 MTF is a planned facility for a much larger flow, and the additional flow is minimal. Therefore, the incremental energy and chemical requirements for treatment will be minimal. There will be minimal environmental impacts. Transporting leachate and contact water by truck will consume more energy in fuel than the pipeline option.

Adaptability (Alternative 6)

OF200 MTF is not currently approved. It is currently planned to treat only water from UEFPC to reduce mercury below 200 ng/L. Addition of landfill water will require changes to the OF200 MTF decision documents. The current schedule shows the system in place prior to start of EMDF waste receipt and prior to generation of leachate water requiring treatment for mercury. However, there is uncertainty in the schedule.

Changes in flow rates will be readily handled. However, OF200 MTF is planned only to treat water for mercury. Treatability studies will be required if this alternative is selected to determine if landfill water will be effectively treated at OF200 MTF, with the potential that not all COCs will be adequately treated. If not, pre-treatment may be required, either at the EMWMF/EMDF site or at OF200 MTF at additional cost. Unanticipated changes in landfill water COCs beyond those evaluated in the treatability studies may require additional studies. Pre-treatment scope and costs may be equivalent to Alternative 3.

4.4 COMPARATIVE ANALYSIS OF ALTERNATIVES

4.4.1 Introduction

A comparative analysis was performed for the alternatives to develop the basis for selecting a recommended alternative. Both threshold criteria and the primary balancing criteria were considered in the analysis. The following threshold criteria reflect key statutory mandates of CERCLA that must be satisfied by an alternative for it to be eligible for selection.

- Overall Protection of Human Health and the Environment
- Compliance with ARARs

The following primary balancing criteria were used to compare the relative advantages and disadvantages of the alternatives to determine the most appropriate remedy.

- Long-Term Effectiveness and Permanence
- Reduction of Toxicity, Mobility, or Volume Through Treatment
- Short-Term Effectiveness
- Implementability
- Adaptability
- Cost

A comparison of these six criteria forms the basis of the comparative analysis. The first three balancing criteria address the statutory preference for treatment as a principal element of the remedy. Together with the last three criteria, these form the basis for determining the general feasibility of each alternative and for determining whether costs are proportional to the overall effectiveness.

The two modifying criteria—state acceptance and community acceptance—will not be evaluated until the public has had the opportunity to comment on the proposed plan. Therefore, these criteria were not formally evaluated in this focused feasibility study.

Finally, irreversible and irretrievable commitment of resources was evaluated.

4.4.2 Threshold Criteria

4.4.2.1 Introduction

The threshold criteria consist of two of the nine criteria that must be satisfied by the selected alternative. These criteria are important because they reflect the key statutory mandates of CERCLA. If an alternative does not satisfy both of these criteria, it is not eligible to be selected as a remedy. CERCLA Sect.121(d) provides that, under certain circumstances, an ARAR may be waived. The following includes a discussion of the degree to which the six alternatives satisfy the two threshold criteria.

4.4.2.2 Overall Protection of Human Health and the Environment

The No Action alternative will not protect human health and the environment because no action will be taken to prevent the release of cadmium and mercury in the landfill water.

Alternatives 2 through 6 will protect human health and the environment. Alternative 2, Managed Discharge, will be protective because it applies only to landfill water that meets AWQC. However, Alternative 2 will be the least robust alternative because the landfill water will not be treated, cadmium will be discharged at the higher criterion maximum AWQC concentration applicable to batch discharges, EMDF leachate may be excluded if mercury concentrations exceed AWQC, and changes in COC concentrations in the future cannot be addressed. Alternatives 3, 4, 5, and 6 will involve treatment of the landfill water and can accommodate changes to COC concentrations in the future. However, the expansion that will be required for Alternative 5 will be very difficult due to limited space and the complications of working inside Y-12. Alternative 6 currently does not address any COC except mercury. Until the treatability studies are completed, the ability to treat other COCs will not be known. Alternatives 4, 5, and 6 will require the landfill water to be transported to PWTC, WETF, and OF200, respectively, by either truck or pipeline. Both of these transportation methods will be effective, but involve risk associated with the potential for transport incident or pipeline failure. In addition, Alternatives 4, 5, and 6 will divert water flow from Bear Creek, which may be detrimental to aquatic life. The pipeline will be effective and will be protective due to the double containment and leak detection.

4.4.2.3 Compliance with ARARs

Alternatives 2 through 6 will meet the action-specific, chemical-specific, and location-specific ARARs. Alternative 2, Managed Discharge, will be compliant with ARARs because it applies only to landfill water that meets AWQC. Alternative 2 will meet the higher criterion maximum AWQC concentration for cadmium applicable to batch discharges, while Alternative 3 will meet the lower criterion continuous AWQC concentration for cadmium. Alternative 6 may not meet the mercury AWQC. Alternative 6 may require an ARAR waiver for the mercury discharge limit. In Alternative 4, the PWTC WAC do not accept mercury-contaminated landfill water, so pre-treatment will be required. The WAC will have to be revised or a waiver approved to be able to accept the landfill water, and a revision to the NPDES permit may be required. Alternatives 3, 4, 5, and 6 will accommodate changes to COC concentrations and the need to provide additional treatment processes and continue compliance with ARARs. Alternative 3 will be the easiest to modify to address additional treatment because it will be designed in a modular fashion with expansion in mind. PWTC and OF200 are slightly more difficult unless a COC not currently addressed, such as uranium, needs to be treated. WETF will be very difficult to expand due to limited space and complications of working inside Y-12.

4.4.2.4 Summary

The No Action alternative will not meet the threshold criteria and cannot be considered for selection. Alternative 2, Managed Discharge, will satisfy both criteria because it only applies to landfill water that meets AWQC and involves no risks from industrial accidents or construction activities. However, Alternative 2 will not be applicable to landfill water if mercury or other key COCs concentrations exceed AWQC. Alternative 5, Treatment at WETF, will be protective, but includes risks associated with potential release of untreated landfill water during pipeline transfer or truck transport, along with the risk of construction accidents. Alternative 3, Treatment at EMWMF/EMDF, has the lowest risk of untreated landfill water release, but includes risk from construction incidents. Alternative 4, Treatment at PWTC, has the lowest risk of construction accidents, but includes risks associated with truck and pipeline transfers. Alternative 6, Treatment at OF200 MTF, will satisfy both criteria, but the need for and amount of pre-treatment required for any COC (except mercury) is not known, and the need for an interim ARAR waiver for mercury is a possibility. The ability to adapt to changing COCs is less than Alternative 3 because a treatability study will have to be performed for each COC.

4.4.3 Balancing Criteria

4.4.3.1 Long-Term Effectiveness and Permanence

Alternative 2, Managed Discharge, will be effective only for landfill water that meets AWQC without treatment. Therefore, it is less likely to be effective in the long-term due to the potential for additional contaminants. Alternatives 3, 4, 5, and 6 will all be effective in the long-term because treatment systems will be provided that are designed and maintained for long-term operation. Alternatives 3, 4, and 6 will be the easiest to modify to accommodate changes in the concentrations of COCs in the future because they will be designed in a modular fashion with modification in mind. Alternatives 3, 4, and 6 are sited at locations fully under the control of the DOE Environmental Management Program, and there are no competing priorities for the utilization of the site. Alternative 5 will be the most difficult to modify after initial expansion due to limited space and construction inside Y-12. PWTC in Alternative 4 is an old plant and may have to be upgraded or replaced. In addition, uncertainties associated with the future contaminants in EMDF leachate may require additional modifications at PWTC, e.g., uranium removal is not currently provided. OF200 MTF in Alternative 6 is designed only for mercury, so treatability studies will have to be performed, and pre-treatment facilities may have to be constructed.

4.4.3.2 Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternative 1, No Action, will not include treatment and will not satisfy this criterion. This criterion does not apply to Alternative 2, Managed Discharge, because it involves only landfill water that meets AWQC and does not include treatment. Alternatives 3, 4, 5, and 6 include treatment, thus reducing toxicity of the landfill water.

4.4.3.3 Short-Term Effectiveness

Alternatives 2 through 6 will satisfy the short-term effectiveness criterion. Alternative 2, Managed Discharge, will be immediately effective for landfill water that meets AWQC and can be discharged without treatment. Alternatives 3 and 5 will involve construction of treatment facilities, but will be effective upon treatment system startup. Alternative 6, Treatment at OF200 MTF, will involve construction of a treatment facility, but will be effective for mercury upon treatment system startup. Alternative 4, Treatment at the PWTC, will be effective immediately for EMWMF landfill water because it is a current, ongoing process.

4.4.3.4 Implementability

Alternative 1, No Action will not satisfy this criterion because nothing will be implemented to address the problem. Alternatives 2 through 6 will be technically feasible to implement and will be performed using standard construction equipment and techniques. Services and materials required for implementation of all action alternatives will be readily available. Alternative 2, Managed Discharge, will be the easiest to implement because existing facilities will be used, and a treatment system will not be required. Alternative 5, Treatment at WETF, will be the most difficult to implement because land for expansion will be limited, significant site preparation activities will be required, and construction inside Y-12 will be complicated due to site security requirements. Alternatives 3 and 6 will not be difficult to implement, but will involve design and construction of a treatment system. Alternative 6 will require treatability studies for any COC, except mercury, and may require the construction of pre-treatment facilities. Alternative 4 will utilize the existing PWTC with modifications and pre-treatment, but will also require continued trucking or construction of a pipeline to move the landfill water to the site. If additional contaminants appear in the leachate in the future, Alternatives 3 and 6 will have the greatest flexibility to implement additional processing capability.

Alternatives 2 through 6 will equally satisfy the need for administrative implementability. All of the required planning documents are conventional CERCLA documents with which DOE has extensive experience. Alternatives 4 and 5 will require additional revisions or waiver requirements for the respective facility WAC. Alternative 6 may require an ARAR waiver for the discharge of mercury.

4.4.3.5 Adaptability

Alternative 1, No Action will not satisfy this criterion because nothing will be implemented to address uncertainties. Alternative 2 will address uncertain flow rates, but will not address uncertainties in future COCs above AWQC. Alternative 3 will have the most flexibility to address uncertainties in flow and future COCs through use of a modular approach for treatment to allow treatment units to be added, modified, or removed as the landfill water contaminants change.

Alternative 5 will take a similar modular treatment approach, but the pipeline and/or trucking options reduce the flexibility of the treatment system by dictating the volume of water transported. Because the system is not currently operational, there are uncertainties in the schedule.

Alternative 4 will manage uncertainties up to the point where the WAC is exceeded. If this occurs, then pre-treatment will be required at the EMWMF/EMDF site. Upgrades are planned for this treatment facility; however, treatment is not assumed to be negatively impacted while upgrades are completed.

Significant uncertainties are associated with Alternative 6 because the treatment system is currently planned only for mercury removal. There is uncertainty in whether additional treatment will be needed for other COCs and where additional treatment will be located if required. Because the system is not currently operational, there are uncertainties in the schedule.

4.4.3.6 Cost

Cost estimates are used in the CERCLA evaluation process to eliminate alternatives that are significantly more expensive than competing alternatives without offering commensurate increases in performance or overall protection of human health and the environment. The cost estimates are preliminary estimates with an intended accuracy range of +50 to -30 percent. Final costs will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, final scope, final schedule, final engineering design, and other variables. Table 7 presents the estimated capital, annual O&M, and total present value costs for each alternative. Alternative 4 with trucking will be the most expensive alternative with a present value of $70,400,000. Alternative 2 will be the least expensive alternative with a present value of $3,600,000.

4.4.4 Irreversible and Irretrievable Commitment of Resources

None of the action alternatives will have significant irreversible and irretrievable commitment of resources. Alternative 2, Managed Discharge, will have the least because there will be no treatment system involved. Alternatives 3, 4, 5, and 6 will be similar because they all will require landfill water treatment systems and associated energy requirements. The use of trucks or pipelines to transport the leachate and contact water for Alternatives 4, 5, and 6 will increase energy needs. Alternatives 4, 5, and 6 will remove the landfill water from Bear Creek with possible impacts to aquatic organisms in Bear Creek.

4.4.5 Comparative Analysis Summary

Results of the comparative analysis of alternatives are summarized in Table 7. Each of the alternatives is assigned a numeric rating for each of the criteria evaluated to assist the comparative analysis. Numeric ratings are semi-quantitative in that, while based on objective factors and data, they incorporate some degree of subjectivity as to the relative impact of the factors and data. The ratings are:

- 0 – not applicable
- 1 – Worst/Least
- 2 – Worse/Less
- 3 – Average/Neutral
- 4 – Better/More
- 5 – Best/Most

Table 7. Comparative analysis of alternatives

Criteria	Alternative								
	Alternative 1: No Action	Alternative 2: Managed Discharge	Alternative 3: Treat at EMWMF/EMDF	Alternative 4a: Treat at ORNL PWTC		Alternative 5: Treat at Y-12 WETF		Alternative 6: Treat at Outfall 200	
				Alternative 4: Truck	Alternative 4b: Pipeline	Alternative 5a: Truck	Alternative 5b: Pipeline	Alternative 6a: Truck	Alternative 6b: Pipeline
Overall Protection of Human Health and the Environment	Not protective	Protective of human health and the environment; AWQC met; cadmium discharged at higher criterion maximum AWQC; EMDF leachate may not meet AWQC for mercury; cannot address future COC changes	Protective of human health and the environment; cadmium discharged at lower criterion continuous AWQC; easiest to address future COC changes due to modular design	Protective of human health and the environment; COCs are treated; minor risk due to potential for trucking incidents; potential impact to Bear Creek aquatic life	Protective of human health and the environment; COCs are treated; easy to address future COC changes; minimal risk due to the potential for pipeline failure; potential impact to Bear Creek aquatic life	Protective of human health and the environment; COCs are treated; minor risk due to the potential for trucking incidents; potential impact to Bear Creek aquatic life	Protective of human health and the environment; COCs are treated; difficult to address future COC changes due to limited space and working inside Y-12; minimal risk due to the potential for pipeline failure; potential impact to Bear Creek aquatic life	Protective of human health and the environment; not certain all COCs are treated; minor risk due to the potential for trucking incidents; potential impact to Bear Creek aquatic life	Protective of human health and the environment; not certain all COCs are treated; minimal risk due to the potential for pipeline failure; potential impact to Bear Creek aquatic life
Rating	1	3	5	4	4	2	2	2	2
Compliance with ARARs	Not applicable	Meets all ARARs for landfill water that meets AWQC without treatment; meets higher criterion maximum AWQC for cadmium; may not meet mercury AWQC for EMDF leachate	Meets all ARARs; meets lower criterion continuous AWQC for cadmium	Meets all ARARs; PWTC WAC and NPDES permit will have to be revised to accept mercury	Meets all ARARs; PWTC WAC and NPDES permit will have to be revised to accept mercury	Meets all ARARs	Meets all ARARs	Not currently planned to meet Recreational AWQC; interim waiver for mercury AWQC being considered	Not currently planned to meet Recreational AWQC; interim waiver for mercury AWQC being considered
Rating	0	3	5	4	4	4	4	2	2
Long-Term Effectiveness and Permanence	Not effective	Effective as long as COCs meet AWQC without treatment	Treatment system designed for long-term operations and treatment effectiveness; able to address future COC changes due to modular design	Treatment system designed for long-term operations and treatment effectiveness; long-term use of trucking involves risk; upgrade or replacement to address future COC changes difficult	Treatment system designed for long-term operations and treatment effectiveness; minimal risk from long-term use of pipeline; upgrade or replacement to address future COC changes difficult	Treatment system designed for long-term operations and treatment effectiveness; long-term use of trucks involves risk; difficult to address future COC changes due to limited space and working inside Y-12	Treatment system designed for long-term operations and treatment effectiveness; difficult to address future COC changes due to limited space and working inside Y-12; minimal risk from long-term use of pipeline	Treatment system designed for long-term operations and treatment effectiveness; only designed for mercury; long-term use of trucks involves risk; difficult to address future COC changes due to limited space and working inside Y-12	Treatment system designed for long-term operations and treatment effectiveness; only designed for mercury; difficult to address future COC changes due to limited space and working inside Y-12; minimal risk from long-term use of pipeline
Rating	1	3	5	4	4	2	2	2	2

Table 7. Comparative analysis of alternatives (cont.)

Criteria	Alternative								
	Alternative 1: No Action	Alternative 2: Managed Discharge	Alternative 3: Treat at EMWMF/EMDF	Alternative 4a: Treat at ORNL PWTC		Alternative 5: Treat at Y-12 WETF		Alternative 6: Treat at Outfall 200	
				Alternative 4: Truck	Alternative 4b: Pipeline	Alternative 5a: Truck	Alternative 5b: Pipeline	Alternative 6a: Truck	Alternative 6b: Pipeline
Reduction of Toxicity, Mobility, or Volume Through Treatment	No treatment; therefore, no reduction	No treatment; therefore, no reduction	Reduction of toxicity through treatment	Reduction of toxicity through treatment	Reduction of toxicity through treatment	Reduction of toxicity through treatment	Reduction of toxicity through treatment	Reduction of toxicity through treatment	Reduction of toxicity through treatment
Rating	1	1	4	3	3	3	3	3	3
Short-Term Effectiveness	No short-term impacts	Minor short-term impacts; uses existing facilities; standard construction risks to workers	Minimal short-term impacts due to construction activities; in existing waste management area; standard construction risks to workers	Minor short-term impacts due to construction activities; plant expansion in heavily industrialized area; standard construction risks to workers	Minor short-term impacts due to construction activities; plant expansion in heavily industrialized area; pipeline construction; standard construction risks to workers	Minor short-term impacts due to expansion in industrial area; standard construction risks to workers	Minor short-term impacts due to expansion in industrial area; pipeline construction; standard construction risks to workers	Minor short-term impacts due to construction activities; standard construction risks to workers	Minor short-term impacts due to construction activities; pipeline construction; standard construction risks to workers
Rating	2	5	4	3	3	3	3	3	3
Implementability	No action; therefore, no implementability issues	Technically and administratively feasible; materials and services available; uses existing facilities; EMWMF and EMDF CERCLA documents	Technically and administratively feasible; materials and services available; design and construction required to implement treatment; easy to implement process changes to address future COCs; EMWMF and EMDF CERCLA documents	Technically and administratively feasible; materials and services available; minor modifications and pretreatment required to implement; WAC and NPDES permit will have to be revised to accept mercury; difficult to implement process changes to address future COCs; inherent risk associated with trucking; EMWMF/EMDF CERCLA documents	Technically and administratively feasible; materials and services available; minor modifications and pretreatment required to implement; WAC and NPDES permit will have to be revised to accept mercury; difficult to implement process changes to address future COCs; inherent risk associated with pipeline construction and operation; EMWMF/EMDF CERCLA documents	Technically and administratively feasible; materials and services available; complex design and construction required to implement treatment; inherent risk associated with trucking; difficult to implement process changes to address future COCs due to limited space and working in Y-12; EMWMF/EMDF CERCLA documents	Technically and administratively feasible; materials and services available; complex design and construction required to implement treatment; minimal risk associated with pipeline transfers; difficult to implement process changes to address future COCs due to limited space and working in Y-12; EMWMF/EMDF CERCLA documents	Technically and administratively feasible; materials and services available; inherent risk associated with trucking; difficult to implement process changes to address future COCs due to limited space and working in Y-12; EMWMF/EMDF and OF200 MTF CERCLA documents	Technically and administratively feasible; materials and services available; minimal risk associated with pipeline transfers; difficult to implement process changes to address future COCs due to limited space and working in Y-12 EMWMF/EMDF and OF200 MTF CERCLA documents
Rating	0	5	4	3	3	2	2	2	2

Table 7. Comparative analysis of alternatives (cont.)

Criteria	Alternative								
	Alternative 1: No Action	Alternative 2: Managed Discharge	Alternative 3: Treat at EMWMF/EMDF	Alternative 4: Treat at ORNL PWTC		Alternative 5: Treat at Y-12 WETF		Alternative 6: Treat at Outfall 200	
				Alternative 4a: Truck	Alternative 4b: Pipeline	Alternative 5a: Truck	Alternative 5b: Pipeline	Alternative 6a: Truck	Alternative 6b: Pipeline
Adaptability	No action; therefore, no adaptability issues	Not adaptable is COC concentrations exceed AWQC	Modular treatment system adaptable	Uncertainty with WAC and difficult to implement process changes to address future COCs; Potential for pretreatment at landfills	Uncertainty with WAC and difficult to implement process changes to address future COCs; Potential for pretreatment at landfills	Uncertainty with WAC, difficult to implement process changes to address future COCs; Potential for pretreatment at landfills	Uncertainty with WAC, difficult to implement process changes to address future COCs; Potential for pretreatment at landfills	Uncertainty with treatment for all COCs; potential for pretreatment at landfills; uncertainty with timing	Uncertainty with treatment for all COCs; potential for pretreatment at landfills; uncertainty with timing
Rating	0	1	5	4	4	3	3	2	2
Cost ($million)	None	Capital = $0 O&M = $0.6/year during EMWMF operation and closure O&M = $0/year during post-closure Present Value = $3.6	Capital = $3.9 O&M = $1.0/year during EMDF operation and closure O&M = $0.3/year during post-closure Present Value = $25.3	Capital = $10.2 O&M = $3.0/year during EMDF operation and closure O&M = $0.4/year during post-closure Present Value = $70.4	Capital = $15.7 O&M = $1.2/year during EMDF operation and closure O&M = $0.3/year during post-closure Present Value = $41.6	Capital = $8.5 O&M = $3.0/year during EMDF operation and closure O&M = $0.4/year during post-closure Present Value = $68.7	Capital = $7.8 O&M = $1.2/year during EMDF operation and closure O&M = $0.3/year during post-closure Present Value = $33.8	Capital = $4.1 O&M = $2.1/year during EMDF operation and closure O&M = $0.2/year during post-closure Present Value = $44.6	Capital = $7.6 O&M = $0.3/year during EMDF operation and closure O&M = $0.1/year during post-closure Present Value = $15.3
Rating	0	5	3	2	3	1	3	5	5
Irreversible and Irretrievable Commitment of Resources	None	Minor	Moderate due to facility and energy requirements	Minor facility modifications; moderate energy requirements for trucking; removes water from Bear Creek	Minor facility modifications; moderate construction and energy requirements for pipeline; removes water from Bear Creek	Moderate due to facility and energy requirements for trucking; removes water from Bear Creek	Moderate due to facility and energy requirements for pipeline; removes water from Bear Creek	Moderate due to energy requirements for trucking; removes water from Bear Creek	Low due to energy requirements for pipeline; removes water from Bear Creek
Rating	0	5	4	1	3	2	3	3	4

ARARs = applicable or relevant and appropriate requirements
AWQC = ambient water quality criteria
COC = contaminants of concern
EMDF = Environmental Management Disposal Facility
EMWMF = Environmental Management Waste Management Facility
O&M = operations & maintenance
ORNL = Oak Ridge National Laboratory
PWTC = Process Water Treatment Complex
Y-12 = Y-12 National Security Complex
WETF = West End Treatment Facility

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5. RECOMMENDED ALTERNATIVE

An alternative is recommended in this focused feasibility study so that it can be implemented for EMWMF in advance of the EMDF proposed plan and record of decision. Based on the evaluation of the alternatives, the following can be eliminated from further consideration:

- Alternative 1: No action. The No Action alternative will not meet the threshold criteria and cannot be selected.
- Alternative 4a: Treat at PWTC and transport by truck. Alternative 4a is difficult to implement and has a high present value.
- Alternative 5a: Treat at WETF and transport by truck. Alternative 5a is difficult to implement and has a high present value.
- Alternative 6a: Treat at OF200 MTF and transport by truck. Alternative 6a is difficult to implement and has a high present value.

This focused feasibility study assumes that water quality will vary over time. Therefore, adaptability to manage changes in future landfill water quality is the key criterion in determining the recommended alternative. Table 8 provides a comparison of the remaining alternatives for adaptability, along with the major assumptions and cost.

Table 8. Analysis of alternatives for future water quality changes

Alternative	Summary evaluation	Capital cost/present value ($million)
2 - Managed Discharge	Alternative can be implemented immediately for no additional capital cost, but has no ability to adapt to changing COCs.	$0/$3.6
3 - Treat at EMWMF/EMDF	Alternative does not have to be implemented until the concentrations of COCs exceed AWQC. Easily adapts to changing COCs.	$3.9/$25.3
4b - Treat at PWTC, transport by pipeline	Immediate capital costs required for the pipeline and a delayed capital cost required for pre-treatment. This alternative is less adaptable than Alternative 3.	$15.7/$41.6
5b - Treat at WETF, transport by pipeline	Immediate capital costs required for the pipeline and a treatment system at WETF. The new WETF treatment system is identical to the treatment system needed for Alternative 3.	$7.8/$33.8
6b - Treat at OF200 MTF, transport by pipeline	Immediate capital costs required for the pipeline and a delayed capital cost required for pre-treatment. This alternative is less adaptable than Alternative 3.	$7.6/$15.3

The recommended alternative is a combination of Alternative 2, Managed Discharge, and Alternative 3, Treat at EMWMF/EMDF. Since the landfill water from EMWMF currently meets the AWQC without treatment, Alternative 2, is recommended to be implemented immediately. When EMDF is constructed and operational, mercury is likely to exceed AWQC eventually in the landfill water and require treatment. Alternative 3 is recommended for landfill water treatment due to advantages in effectiveness, flexibility, cost, adaptability, and reduced risk and because of the broader capability to react to any key COC that exceeds AWQC. This recommended alternative will meet remedial action objectives immediately, will be protective, will comply with ARARs, will be effective in the long-term, will reduce the toxicity of contaminants, will be the easiest to implement, will be the best for accommodating future changes in COC concentrations and flow rates, and will be the least in cost. Alternative 3 also avoids the inherent risk associated with transferring landfill water to another treatment facility by truck or pipeline. Additionally, immediate implementation of this recommended alternative will prevent the current expenditure of approximately $500,000 per year to transport EMWMF leachate to PWTC for treatment. While Alternative 6 is similar to Alternative 3, it was not selected because the need for and amount of pre-treatment required for any COC, except mercury, is not known. The ability to adapt to changing COCs is less than Alternative 3 because a treatability study will have to be performed for each COC.

In order to implement the recommended alternative, the EMWMF record of decision (DOE/OR/01-1791&D3) will need to be revised followed by revision and approval of appropriate implementing documents. This will enable Alternative 2 to be implemented quickly. Then, the remedial investigation/feasibility study, proposed plan, and record of decision for EMDF need to be finalized for implementation of Alternative 3. The recommended alternative in the EMDF record of decision should be managed discharge and treatment when needed. For the basis of planning and estimating costs, Alternative 3 should be assumed as the treatment alternative. However, the record of decision should be clear that the final location of the treatment system might be elsewhere based on the economics and logistical concerns at the time of final design.

6. REFERENCES

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APPENDIX A.
BEAR CREEK BURIAL GROUNDS EVALUATION

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Bear Creek Burial Grounds Analysis

A feasibility study is being conducted to determine the optimum approach for managing wastewater generated as a consequence of hazardous/radioactive landfill operations located on the U.S. Department of Energy (DOE) Oak Ridge Reservation (ORR) west of the Y-12 National Security Complex (Y-12). There are several major landfills currently located or planned for this area. The Environmental Management Waste Management Facility (EMWMF) is currently operating to provide disposal services for contaminated waste materials being generated as a consequence of ORR demolition and remediation projects. An additional facility to be constructed adjacent to EMWMF for the same purpose, the Environmental Management Disposal Facility (EMDF), will also require water management capability. The Bear Creek Burial Grounds (BCBG) is a disposal area that is no longer operating, but has been used in the past to dispose of hazardous and radioactive materials, and currently generates leachate for collection and treatment. There are additional uncontrolled releases of dissolved uranium from BCBG that must be considered for collection and treatment. This analysis is being performed to evaluate the feasibility of a combined solution that addresses all wastewater sources from EMWMF, future EMDF, and BCBG.

EMDF will be located in the same vicinity as the existing EMWMF and is expected to produce leachate that is similar in composition to EMWMF, with the notable exception of mercury that will be present at higher concentration in EMDF leachate. The proximity of EMDF will be close enough to allow for shared infrastructure for leachate collection and management. Consequently, a combined wastewater management solution for these two facilities is considered feasible and appropriate. EMWMF currently transports leachate to the Oak Ridge National Laboratory Process Waste Treatment Complex (PWTC) by tanker where it is combined with other wastewaters for processing and discharge to White Oak Creek via an existing permitted outfall. Contact water, generated separately at EMWMF and consisting of stormwater that comes into contact with waste materials at the working face of the landfill, is collected and analyzed to verify discharge criteria are met prior to release to a stormwater retention basin. Contact water exceeding discharge criteria is transported to the PWTC for treatment and discharge

BCBG is located west of EMWMF at a distance of roughly 3000 ft (Fig. A.1) and was historically used for disposal of radiologically- and chemically-contaminated wastes generated primarily by Y-12 operations. The source and type of waste materials disposed at BCBG are significantly different from those being disposed or planned for disposal at EMWMF and EMDF. BCBG consist of several principal waste disposal units designated as BCBG Unit-A, -B, -C, -D, -E, -J, and Walk-in Pits. Each waste disposal unit consists of a series of trenches used for disposal of liquid and solid wastes. Contamination in these disposal units include depleted uranium, shock-sensitive acids (e.g., picric acid), chromic acid, various organic solvents, polychlorinated biphenyls (PCBs), beryllium, chromium, thorium, and other radionuclides (DOE/OR/01-2382&D1, *Focused Feasibility Study for the Bear Creek Burial Grounds at the Y-12 National Security Complex*).

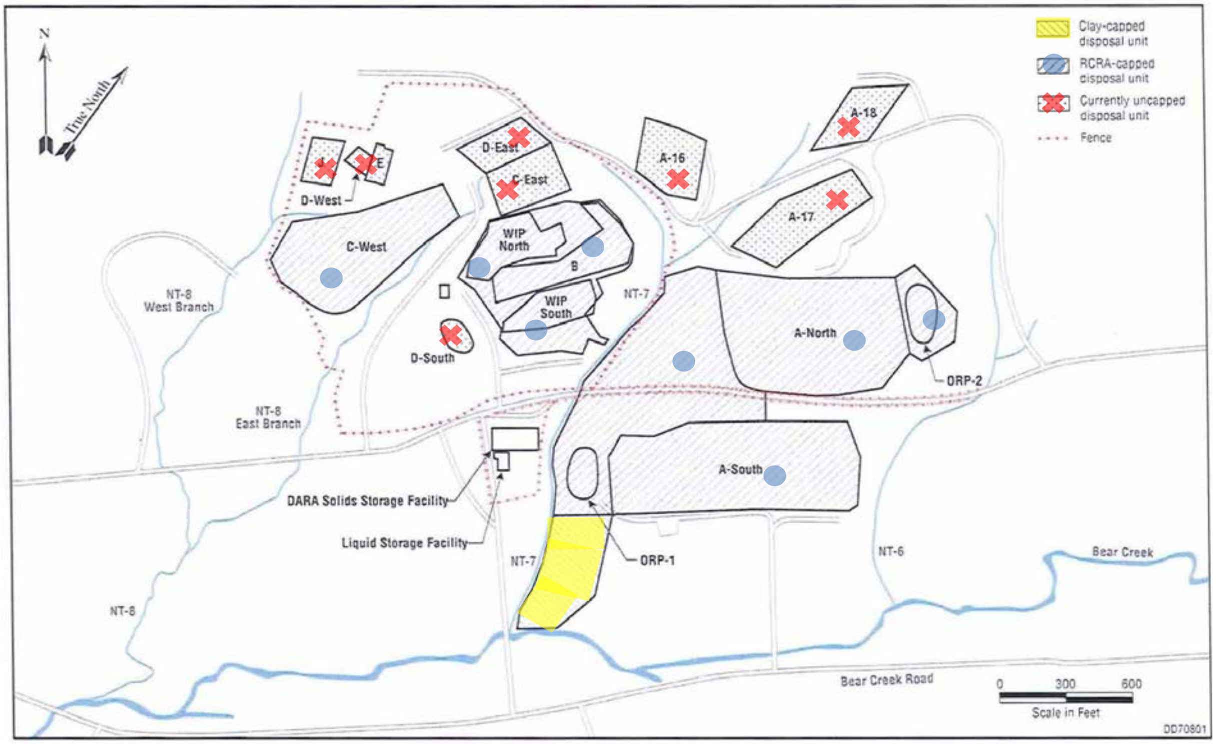


Fig. A.1. BCBG Waste Disposal Unit locations.

Disposal activities at BCBG ended in 1993, and several of the BCBG waste units have been closed under requirements of the Resource Conservation and Recovery Act (RCRA), including construction of multilayer caps. In 1989, a leachate collection system was installed in the North Tributary (NT)-7 catchment to intercept seepage from Unit A-North. A second leachate collection system was installed in the NT-8 catchment in 1993 to collect water from several seeps in this area. These leachate collection systems and associated storage comprise the Leachate Storage Facility (LSF). Collected leachate at the LSF is currently transported by tanker to the Y-12 Groundwater Treatment Facility (GWTF) for treatment and discharge through a permitted outfall. It has been determined; however, that there are additional uncontrolled releases of contaminated water from BCBG that contribute significant releases of dissolved uranium and other contaminants to surface water at NT-8 (DOE/OR/01-2638, *2014 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee*).

As seen in the figure, several BCBG disposal units have not yet been remediated or capped. A Focused Feasibility Study (FFS) was written in 2008 (DOE/OR/01-2382&D1) to address remediation of these BCBG disposal units under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). A future Record of Decision (ROD) is planned to develop a tri-party agreement regarding the approach for remediation of this area. Due to current issues associated with water-borne uranium being released from BCBG into NT-8, this analysis considers the feasibility of incorporating the management of BCBG-contaminated water along with EMWMF/EMDF wastewater.

Existing BCBG Leachate

The existing BCBG water collection and storage system for contaminated groundwater, the LSF, (see Fig. A.2) was built as part of the RCRA closure activities at BCBG. Leachate is collected from two locations at BCBG:

- BCBG NT-7: The leachate gravity flows from the burial grounds north of Tributary 7 into a holding tank and is pumped into the LSF.
- BCBG NT-8: The leachate gravity flows from underground Seeps 3 and 4 of C-West Burial Ground, Seep 2 of C-East Burial Ground, and the underground slope of C-West into a holding tank and is pumped into the LSF.

The LSF provides a gravity separator and storage tanks. The leachate collected from Tributary 7 area is primarily contaminated with depleted uranium, PCBs, VOCs, and iron whereas Tributary 8 area leachate contains depleted uranium, PCBs, volatile organic compounds (VOCs), lithium, iron, and moderately high sediment levels. The leachate carries the RCRA Hazard Code F039 waste (Y/ER-188, *Focused Feasibility Study Report for the Bear Creek Burial Grounds Leachate Collection System Project at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee*).

Fig. A.2. Leachate Storage Facility.

GWTF (see Fig. A.3) receives tanker trucks from the LSF and also receives wastewater from the East Chestnut Ridge Waste Pile in 300-gal bulk containers for processing. Other contaminated groundwater seeps or other wastewaters appropriate to this treatment system may also be treated at this facility. After treatment, the water is discharged to Upper East Fork Poplar Creek through a National Pollution Discharge System permit. The facility operates 4 days a week, 10 hours per day. Contaminants of concern (COCs) include uranium-235 and -238, technetium-99, PCBs, VOCs, and beryllium. Unit operations include air stripping and activated carbon columns to remove contaminants. It operates at a nominal 25 gal per minute (gal/min) and an average of 2.1 million (M) gallons is treated annually, depending on rainfall. A continuous treatment of this volume would result in an average of 3 to 4 gal/min flow rate.

Fig. A.3. GWTF located in Bldg. 9616-7.

Bear Creek Uranium Flux Issue

Uranium contamination is a primary concern in Bear Creek. Uranium migration continues to be an issue, as noted in a review of past Remedial Effectiveness Reports (RERs) and specifically the most recent RER (DOE/OR/01-2638). See Table A.1 for a summary of uranium flux in Bear Creek over time as given in the 2014 RER. More recently (2009 and later), the flux has increased more dramatically. The uranium measured at Bear Creek Kilometer (BCK) 9.2 in Zone 2 (see Fig. A.5) currently exceeds the ROD goal of 34 kg/year by about a factor of four. As shown in Fig. A.1, three tributaries (NT-6, NT-7, and NT-8) drain the BCBG area and flow into Bear Creek. NT-8 contributes heavily to the uranium flux migrating into Zone 2, at up to approximately half the total flux passing BCK 9.2. As noted in the RER, the NT-7 uranium flux of 1 to 2 kg per year in recent years has not been very significant, and NT-6 is not mentioned as a notable contributing factor to the contaminant load of Bear Creek. This information is corroborated by the fact that NT-7 is now mostly an engineered ditch with an existing groundwater seepage collection system, and that groundwater flow tends to flow towards the southwest and away from NT-6.

Table A.1. Uranium flux at flow-paced monitoring locations in BCV watershed (Table 4.7 from 2014 RER)

Fiscal year	BCK 9.2	SS-6	NT-8	BCK 11.54	NT-3	BCK 12.34	Average rainfall (in.)
2001	88.7	17.2	--	--	79.9	24.5	45.9
2002	**120.2**	13.1	--	158.2	**62.8**	25.4	52.7
2003	**165.4**	12.3	--	87.0	**4.6**	**44.3**	73.7
2004	**115.0**	9.5	--	45.8	1.2	**27.3**	56.4
2005	**115.4**	11.1	--	39.8	4.1	**40.3**	58.9
2006	**68.5**	--	--	25.2	1.7	21.3	46.4
2007	**59.5**	--	--	12.6	--[a]	15.8	36.8
2008	**73.2**	--	27.9	15.9	--[a]	23.0	49.3
2009	**147.7**	11.6	43.3d	27.2	--[a]	**32.9**	62.5
2010	**118.9**	9.9	61.0	32.5	**14.5**	**33.9**	55.8
2011	**108.7**	9.1	40	36.7	**16.3**	**37.8**	59.2
2012	**114.9**	9.2	43.3	45.4	**13.6**	**32.9**	61.75
2013	**122.3**	9.5	64.0	47.6	**22.3**	**40.3**	63.73
ROD Goals:	*34*				*4.3*	*27.2*	

Bold values indicate the *Record of Decision for the Phase 1 Activities in Bear Creek Valley at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee* (DOE/OR/01-1750&D4) goal for uranium flux has not been met**.**
[a]Goal attained; flux monitoring discontinued in FY2007 and reinstituted in FY2010.
BCK = Bear Creek kilometer
BCV = Bear Creek Valley
DOE = U.S. Department of Energy
FY = fiscal year
NT = North Tributary
ROD = Record of Decision
SS = surface spring
Y-12 = Y-12 National Security Complex

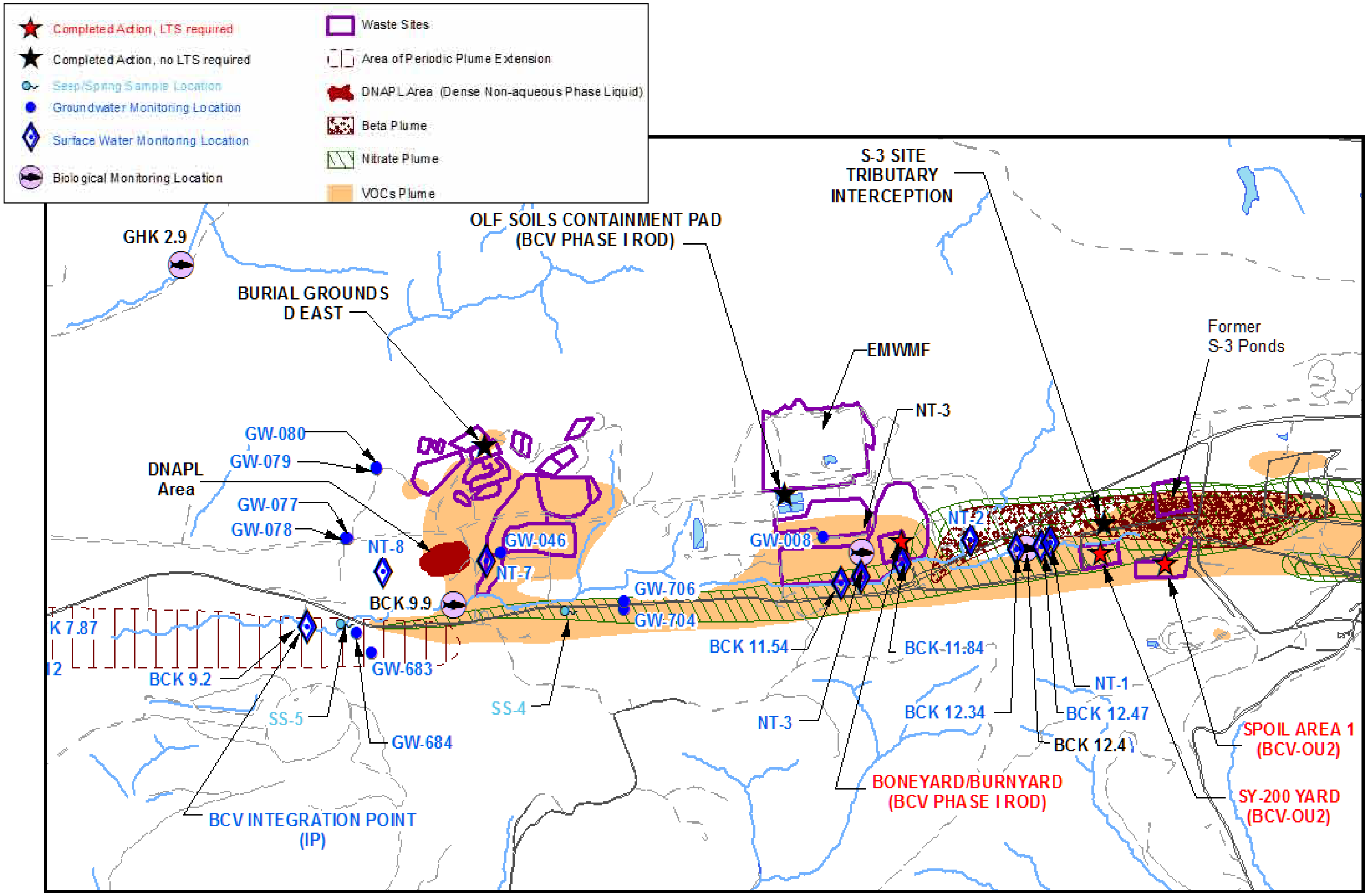


Fig. A.4. Bear Creek Valley points of interest in Zones 2 and 3—integration point BCK 9.2 and BCK 11.84; NT-3; NT-8 (portion of Fig 4.1 from 2014 RER).

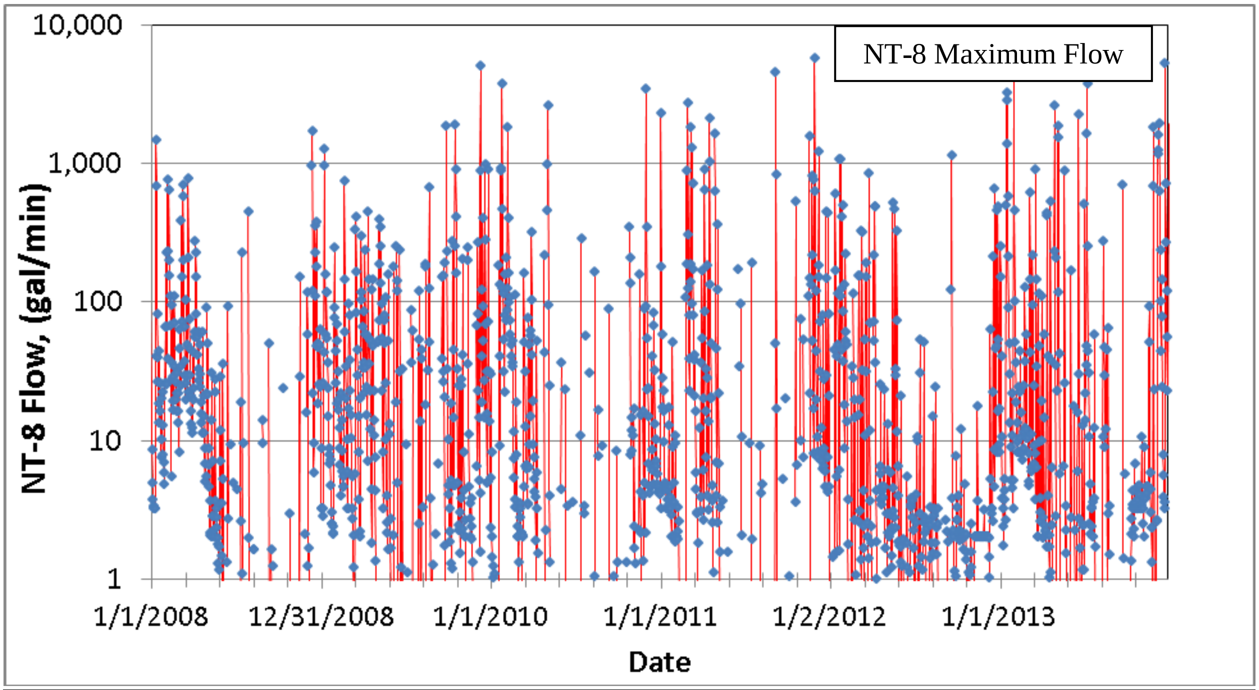
Per the 2008 BCBG FFS, tributaries NT-6, -7, and -8 are usually dry during the periods in the late summer and early fall. Base flow in each stream reaches a maximum between December and April, and peak storm flow for each tributary ranges from 900 to 27,000 gal/min. A more recent examination of flow in NT-8 alone indicates a wet season base flow of about 10 gal/min.[1] Figure A.5 provides graphics of current NT-8 maximum and base flows. The NT-8 flow is measured from the RER monitoring flume just past the point in NT-8 where east and west branches merge to form a single stream channel. Figure A.5 demonstrates the highly variable flow rates that occur at the NT-8 flume. As seen in the top graph of Fig. A.5, flow rates have exceeded 1000 gpm, with rates over 5000 gpm on record. The bottom graph in Fig. A.5 clearly demonstrates that the creek is often dry during summer months. If NT-8 was targeted for treatment to reduce the Bear Creek uranium flux, a complex collection system and large equalization tanks would be required to provide a constant flow for processing. To reduce the flow to a more manageable rate, further investigation of the source of the existing contaminant issues at BCBG was completed, and is discussed in the following section.

Proposed Collection of Additional BCBG Wastewater

As described above, NT-8 appears to contribute a significant portion of the uranium flux in Bear Creek. Additional sampling data and field investigation has been performed at the BCBG area since the issuance of the 2008 BCBG FFS. The FY2008 RER identified the need to install a continuous flow monitoring station in NT-8, since the ungauged uranium input at BCK 9.2 was increasing and uranium flux attributable to NT-8 had not been quantified since the Bear Creek Valley Remedial Investigation (DOE/OR/01-1455/V1–V4&D1, *Report on the Remedial Investigation of Bear Creek Valley at the Oak Ridge Y-12 Plant*, *Oak Ridge*, *Tennessee*). The FY2009 RER reported that a new monitoring station demonstrated that NT-8 was contributing high levels of uranium to the watershed. As part of the FY2011 RER, a recommended action was identified to document the discharge of contaminants along NT-8 in order to determine where contaminants were entering the stream. Uranium, VOCs, and PCBs were listed as being of greatest concern. A secondary recommendation of the FY2011 RER was to review the engineering design, operational records, and system performance of the existing non-CERCLA groundwater seepage collection system in the NT-8 headwaters (associated with BCBG D-West). The secondary recommendation was deferred, but the investigation of NT-8 surface water was carried out and the results discussed in the FY2012 RER. Ten transects were examined along NT-8, starting from the NT-8 RER monitoring flume and moving north towards the buried waste. It was determined that the eastern branch of NT-8 was the principal source of uranium, with the highest concentrations occurring near the intersection of the fence line and the eastern branch of NT-8 (near C-West). Historical data collected from the area indicated dissolved uranium-238 concentrations at this location were as high as 1230 pCi/L. The eastern branch of NT-8 was also determined to be a significant source of PCBs. VOCs were highest near the confluence of the eastern and western branches of NT-8.

Knowledgeable subject matter experts have suggested that an interceptor trench located perpendicular to NT-8 East branch (see Fig. A.6) along the fence line could capture groundwater that likely contains some of the highest uranium concentrations, prior to its combining with surface water in NT-8. This interceptor trench would be 8- to 10-ft deep and entail a French drain collection system with a downgradient slurry wall barrier along the fence line next to C-West. The trench would include a cap to shed stormwater and would connect with the existing LSF collection system.

[1]Data for BCK 9.2 and NT-8 flow, taken from Oak Ridge Environmental Information System (OREIS), April 2014.



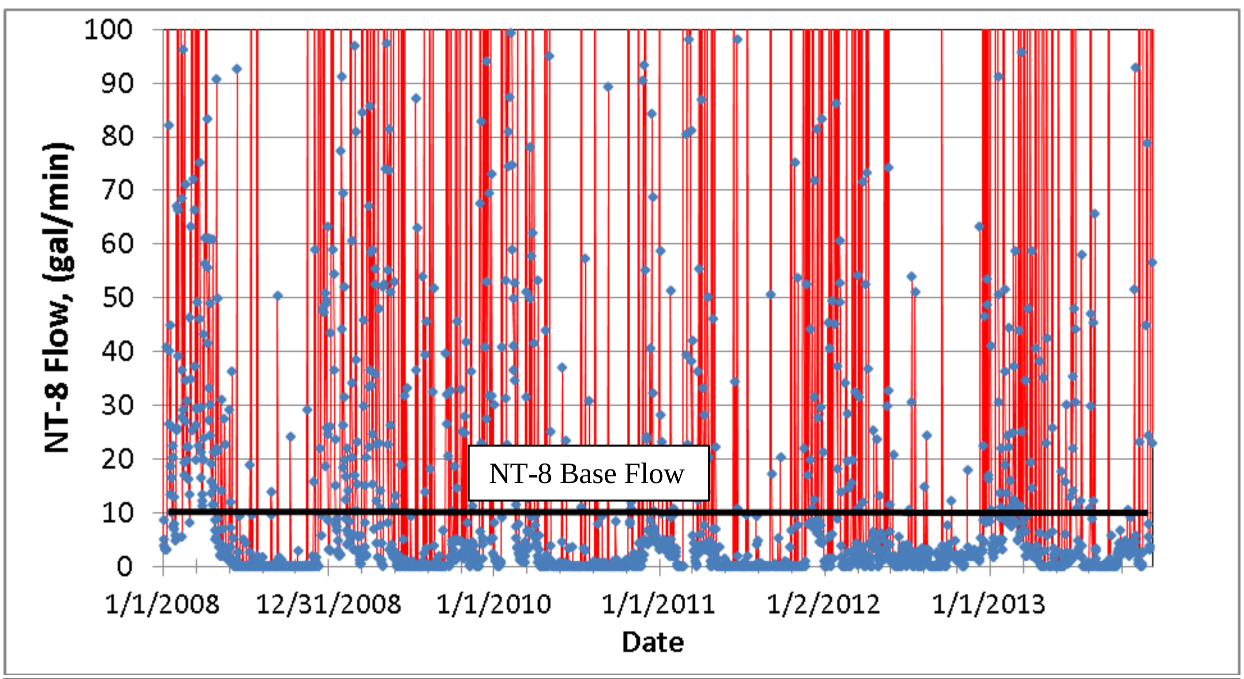


Fig. A.5. OREIS sampling location BC-NT8 (NT-8 continuous flow monitoring flume)—maximum and base flows.

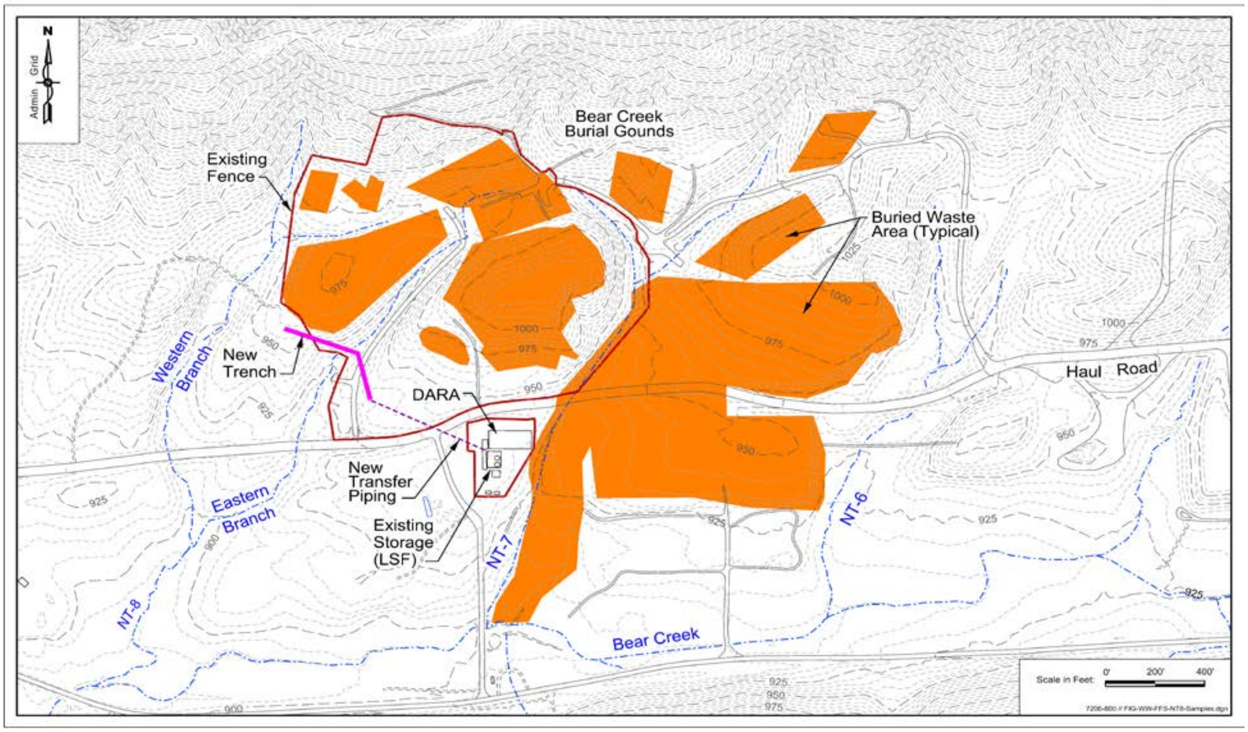


Fig. A.6. Proposed interceptor trench at BCBG.

This approach to collecting BCBG wastewater for treatment, however, would require additional data and engineering to evaluate the feasibility and cost. Data gaps include information that would require somewhat extensive investigation, for example:

- Depth to bedrock in order to determine collection trench size
- Flow information to determine collection trench dimensions, collection pipe size, the need for a booter pump, and storage needs
- Potential modifications to the existing GWTF to manage higher volumes of water
- More specific contaminant information (e.g., dissolved versus particle-bound contaminants)

Management of Additional BCBG Wastewater

Collecting the intercepted groundwater prior to combining with surface water would greatly reduce the volume of water to be treated and the associated cost of water management systems. Based on an anticipated continuous flow of less than 10 gal/min, this intercepted groundwater flow could be managed by incorporating it with the existing LSF collection system. It could be transferred to and treated at the GWTF along with the current BCBG leachate, or could be stored at the LSF and considered for incorporation into the EMWMF/EMDF water management FFS alternatives.

Connecting this intercepted groundwater flow to the existing LSF collection system would be straight forward. Transfer (currently trucking) to the existing GWTF and frequency of batch treatment operations would increase, but the combined flow would not likely exceed the current system treatment capacity. The COCs are the same as those currently managed by the GWTF. Considering drainage areas and speaking with subject matter experts, the NT-8 interceptor trench would probably double the flow that is currently being collected at the LSF. The current system focuses on collection of seeps instead of a continuous trench that would be required for protecting the eastern branch of NT-8. However, as previously discussed, the design flow of the GWTF is nearly a factor of ten higher than the current average flow processed by the system. Treating the additional flow would result in more frequent trucking/transfer and batch treatment campaigns.

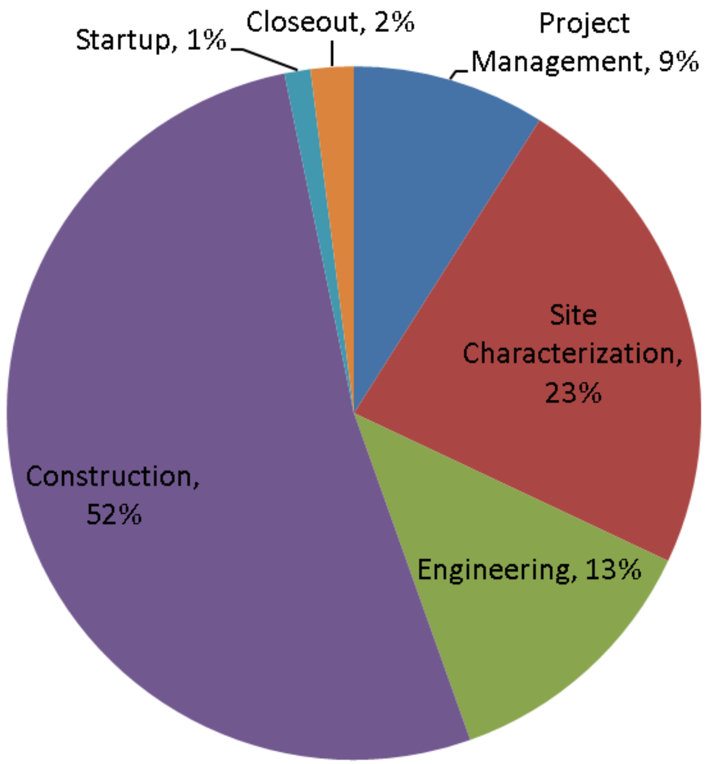
Although the anticipated flow collected by this trench system would be manageable within an EMWMF/EMDF wastewater analysis, contaminants must also be considered, and would necessarily need to be a subset of those contaminants that will be managed under the EMWMF/EMDF water management alternative. PCBs, F039-listed solvents, and uranium are the main COCs for BCBG. Uranium is also an expected COC for the EMWMF/EMDF; however, PCBs and F039-listed solvents have not been identified as COCs. Treatment of PCBs and F039-listed solvents would require additional RCRA considerations (requirements in terms of design and construction), and would greatly increase the cost of secondary waste disposal. Due to the F039-listed components, the secondary wastes from the EMWMF/EMDF leachate treatment system would also be listed with this constituent. Consequently, the secondary wastes would require additional processing and disposal at an off-site disposal facility as a mixed RCRA/radioactive waste material, and could not be considered for return to either disposal facility since neither facility accepts listed wastes. The existing GWTF currently manages these constituents and there would be no need to alter current disposal practices. It would therefore be advantageous to collect, transfer, and treat the NT-8 intercept trench water along with the current BCBG leachate stream at the GWTF.

Rough Order-of-magnitude (ROM) costs for the management of BCBG wastewater as proposed, via an interceptor trench, incorporating a slurry wall and cap, have been determined. These costs are summarized in Table A.2. Additional costs have not been delineated, but are noted as applicable.

Table 2. Cost of proposed methods for capture of BCBG contaminated water management

Proposed method	ROM cost	Issues
Interceptor trench, slurry wall, cap, collect and treat with existing BCBG leachate stream at GWTF	• $1.4 M (interceptor trench, slurry wall, cap) • Additional cost to tie into existing BCBG leachate collection at LSF • Additional transfer/operations costs at GWTF	• Data gaps remain
Interceptor trench, slurry wall, cap, collect and manage with EMWMF/EMDF stream	• $1.4 M (interceptor trench, slurry wall, cap) • Additional cost to tie into existing BCBG leachate collection at LSF • Additional cost to transfer/tie into EMWMF/EMDF treatment • Additional capital costs for increased design flow and COC treatment • Additional permitting and operating costs for management of combined wastewater as F039-listed waste (projected to be a high cost)	• Data gaps remain • COCs outside of envelope of those to be treated for EMWMF/EMDF

As shown in Table A.2, treatment by the currently utilized method (e.g., collection within the LSF system, trucking to the GWTF for treatment) would be a more cost effective solution as opposed to combining the management of the waters with EMWMF/EMDF waters. Details of the cost estimate for the interceptor trench, slurry wall, and cap are given in Fig. A.7.



WBS	WBS Description	Cost
1.1	Project Management	$110,959.68
1.2	Site Characterization	$284,472.00
1.3	Engineering	$155,218.73
1.4	Construction	$645,117.33
1.5	Startup	$14,923.81
1.6	Closeout	$24,816.35
	Subtotal	$1,235,507.90
	Contingency - 30% of construction	$132,913.67
	Total Estimated Cost	**$1,368,421.57**

Fig. A.7. Detailed cost information for interceptor trench, slurry wall, and cap for BCBG.

<u>Conclusions</u>

This analysis indicates that the solution to address wastewater sources from EMWMF, future EMDF, and BCBG involves combined processing of EMWMF and EMDF wastewaters and treatment of BCBG wastewater separately. While the projected volume of BCBG wastewater to be treated would be capable of being managed within a future EMWMF/EMDF alternative, the list of COCs for BCBG wastewater precludes treatment with the EMWMF/EMDF wastewater. Listed F039 solvents and PCBs are not contaminants identified as requiring treatment for the EMWMF/EMDF wastewater. Additional equipment and operating costs to treat BCBG wastewater in combination with EMWMF/EMDF wastewater are projected to be much greater than the cost of processing BCBG wastewater at GWTF. Additionally, the wastewater would require transport by truck (or pipeline) from the LSF to a location for incorporation into a “new” EMWMF/EMDF option. Negative impacts, such as increased capital cost, increased complexity in terms of contaminants requiring treatment, and increased waste disposal costs are identified by incorporating a BCBG leachate waste stream into the EMWMF/EMDF wastewater management analysis.

A preferred solution would involve constructing an additional trench at BCBG to intercept contaminated groundwater entering NT-8 and transfer it to the existing LSF. The flow of the collected water would be within the existing capacity of the GWTF that currently processes leachate collected at the LSF. Additionally, the COCs to be addressed are the same as those currently managed by GWTF.

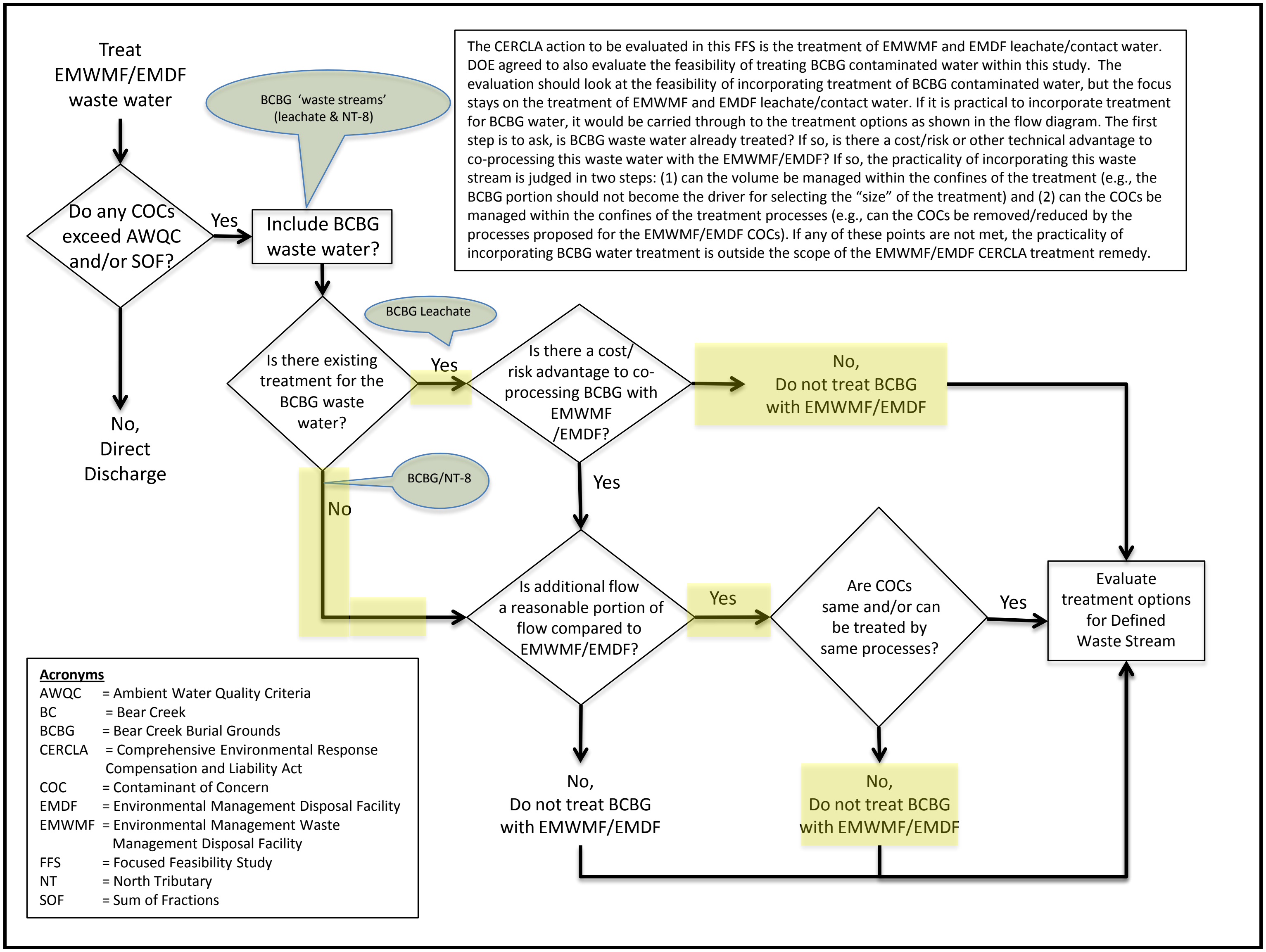


Fig. A.8. Flow sheet for determining the scope of the EMWMF/EMDF FFS.

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APPENDIX B.
CONTACT WATER AND LEACHATE FLOW RATE

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B.1 General Approach

The flow rates used in the Focused Feasibility Study (FFS) were calculated with input from the Environmental Management Waste Management Facility (EMWMF) HELP model, the historical flow rate data, and the existing water balance that takes into account interim storage in tanks and ponds and the effect of varying water transfer rates. The historical data and HELP model output are useful in pointing to a range of values that are worth considering, but do not provide the precision required to calculate the future processing rates. Therefore, the water input was determined from a combination of HELP and historical data. The water balance was then used to evaluate the impact from changing storage volumes, transfer rates, and storm recurrence intervals to evaluate the risk of spillage from the system of storage units. The water storage requirement is provided in Appendix H.

B.2 Considerations When Using HELP Model Analysis Validated Against Historical Data to Establish Water Processing Rates

HELP Model Limitations:

It is difficult to model all variations in cover conditions that are possible during active cell operations. The enhanced operational cover and large areas with compacted, low permeability clay above waste that still shed water into the active cells likely result in more rainfall becoming contact water than HELP would forecast.

HELP modeling does not usually attempt to account for the large, multi-day, storm events that generated a tremendous amount of water. A good example is the 8.66 inches of rain that fell over the Labor Day weekend in 2011. That storm exceeded the 100-year, 24-hour storm by 2.16 inches. Another example is the 9.54 inches of rain that fell between February 14–16, 2003, exceeding the 100-year, 24-hour storm by slightly over 3 inches.

HELP does not account for storage of stormwater runoff (i.e., contact water) nor does it accurately account for the delay/damping of the peak leachate generation as the water percolates through the waste mass and into the collection system.

Comparison of HELP model predictions of leachate and contact water quantities to the measured volumes provides inconclusive results. Leachate predictions are generally more accurate than contact water and typically are higher than actual quantities. Contact water appears to be under-predicted by HELP, except for the larger storms (such as the 100-year, 24-hour storm) where the model significantly over-predicts the volume.

The EMWMF HELP modeling scenarios assume that as cells reach their final waste placement grades, the cells are quickly placed into a cover situation that diverts most of the precipitation out of the cell to the stormwater collection system. Although progress is being made, EMWMF has not been able to fully establish this cover to match the model's aggressive assumptions, resulting in contact water volumes that typically exceed the model-predicted values.

Actual Data Limitations:

Actual data can be misleading because measured values are only recorded when someone is on-site to do so. Thus, amounts of rainfall and leachate generated often represent the net total for a 3-day period (or more if a holiday weekend is involved).

When comparing to predicted quantities of leachate or contact water, the actual values are substantially influenced by storage and infrequent closures of the Leachate Collection System valves. This has the effect of reducing or damping the daily volumes to levels the existing water management system can accommodate.

Water inputs and outputs to leachate storage tanks, contact water ponds, and contact water tanks are monitored daily with good precision; however, the water level changes in the catchments is only monitored weekly or subsequent to large storm events. While there is no true daily record of contact water input to the catchments, the measured output from the catchments is recorded. The output volume is essentially equal to the input volume minus the fraction that evaporates or infiltrates the leachate system. As a result and as shown in Table B.1, leachate volumes are lower than the HELP model predicts, and contact water volumes are higher than the HELP model predicts.

Table B.1. Actual vs. HELP model leachate quantities (2004–2009)

Peak day generation rate	
Actual volume (gal/day)	56,300
Projected volume - rainfall adjusted (gal/day)	62,532
Percentage of actual to projected (%)	90
Average month generation rate	
Actual volume (gal/mon)	166,294
Projected volume - rainfall adjusted (gal/mon)	320,698
Percentage of actual to projected (%)	52
Wettest month generation rate	
Actual volume (gal/mon)	412,600
Projected volume (gal/mon)	549,300
Percentage of actual to projected (%)	75

Table B.2. Actual vs. HELP model contact water quantities (2004–2009)
(Note: In this analysis all stormwater runoff is included with contact water.)

Peak day generation rate	
Actual volume (gal/day)	490,000
Projected volume - rainfall adjusted (gal/day)	1,516,859
Percentage of actual to projected (%)	32
Average month generation rate	
Actual volume (gal/mon)	593,409
Projected volume - rainfall adjusted (gal/mon)	837,200
Percentage of actual to projected (%)	71
Wettest month generation rate	
Actual volume (gal/mon)	2,101,400
Projected volume (gal/mon)	995,000
Percentage of actual to projected (%)	211

Flow Rate Estimates

The following likely situations were evaluated for the Cell 6 Remedial Design Report (RDR) and are used in the FFS flow rate calculations.

Table B.3. Landfill situation descriptions used in Cell 6 RDR HELP model calculation

Situation	Landfill layer descriptions
A—New cell	New cell with minimum waste plus water catchment
B1—Working face with 10-ft layer of waste	10-ft waste at K = 5.0 × 10E-4 cm/s
B2—Working face with 30-ft layer of waste	30-ft waste at K = 5.0 × 10E-4 cm/s
C1—Operational cover with 40-ft layer of waste	0.25-in. Posi-shell cover at K = 5.8 × 10E-6 cm/s 1-ft operational cover at K = 5.0 × 10E-6 cm/s 40 ft of waste at K = 5.0 × 10E-4 cm/s
C2—Operational cover with 70-ft layer of waste	0.25-in. Posi-shell cover at K = 5.8 × 10E-6 cm/s 1-ft operational cover at K = 5.0 × 10E-6 cm/s 70 ft of waste at K = 5.0 × 10E-4 cm/s

The EMWMF Help model was then used with the above scenarios to develop leachate and contact water generation rates.

Table B.4. Leachate and contact water generation rates from EMWMF HELP Model average for Cells 1–6 from prior analyses (Cell 6 RDR HELP calculation)

Cell	Peak day (CF/Ac/day)		Average month (CF/Ac/day)		Wettest month (CF/Ac/day)		Max month (CF/Ac/day)	
Situation	Leachate	CW	Leachate	CW	Leachate	CW	Leachate	CW
A	1,198	22,311	44	255	78	288	127	473
B1	1,235	17,175	212	76	305	76	501	125
B2	1,234	17,175	212	76	313	76	514	125
C1	480	22,719	14	328	44	374	72	615
C2	487	22,719	14	328	44	374	72	615

Peak day data based on 100-yr, 24-hr storm of 6.5 in.
Average month data based on 100 years of HELP model synthetically generated data
Wettest month data based on 5.72-in. rain
Max month data based on 9.39 in. of rain (avg. of highest single month rain over period)
Ac = acre
CF = cubic feet
CW = contact water

These data were then used to simulate the conditions where EMWMF Cells 5 and 6 were open concurrently with Environmental Management Disposal Facility Cell 1, the base case for the FFS evaluations.

Table B.5. Base case modeling scenario

	Cell area	Peak day (CF/day)		Average month (CF/day)		Wettest month (CF/day)		Max month (CF/day)	
Active cells/condition	(acres)	Leachate	CW	Leachate	CW	Leachate	CW	Leachate	CW
EMWMF Cell 5 Situation B2	6.0	7,404	103,050	1,272	456	1,878	456	3,084	750
EMWMF Cell 6 Situation B2	5.3	6,479	90,169	1,113	399	1,643	399	2,699	656
EMDF Cell 1 Situation A	6.2	7,440	138,551	273	1,584	484	1,788	789	2,937
Totals	17.5	21,322	331,770	2,658	2,439	4,006	2,643	6,571	4,344
Converting to gal/day		159,489	2,481,640	19,884	18,240	29,962	19,773	49,152	32,490
Converting to gal/min		111	1,723	14	13	21	14	34	23
leachate + CW gal/min			**1,834**		**26**		**35**		**57**

CF = cubic feet
CW = contact water

The resulting flow rates were then used in the FFS as follows:

- Average flow rate was rounded to 30 gpm

Maximum month flow rate was rounded to 60 gpm and was used as the design basis in the FFS as a conservative measure, given the uncertainty in the flow rates.

APPENDIX C.
EXPLANATION OF HOW THE KEY CONTAMINANTS OF CONCERN WERE DEVELOPED

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C.1 METHODOLOGY

The Environmental Management Waste Management Facility (EMWF) approach taken was to first compile the available data, then to qualitatively evaluate these for abundance in the waste lots, mobility in the EMWMF and surrounding environment, and regulatory and other risk. Following compilation and initial evaluation, the key contaminants of concern (COCs) were selected. The last two years of data were analyzed to determine which of the current analytes would require treatment if a system was installed at this time. Additional evaluation was performed on the key COCs to determine trends and evaluate which COCs may require treatment at a future date as facilities with different characteristics are demolished.

The following information was considered as part of this process:

- Free liquids are not allowed to be disposed at EMWMF.
- No listed waste has been or is projected to be disposed at EMWMF. Therefore, no degreasers/solvents are expected, such as trichloroethene (TCE) and tetrachloroethene (PCE). Instead, these materials are present as a result of intended use associated with the facilities that have been demolished and disposed at EMWMF, or as residual amounts in soil or debris from previous, remediated leaks or spills. Therefore, these materials may be present in minor amounts, rather than as primary contaminants.
- Wastes disposed at EMWMF must meet Land Disposal Restrictions, minimizing the concentrations available to potentially leach into water.
- Metals typically require a low pH environment to dissolve and be transported in water. Both the geologic environment and the disposed waste (primarily building debris) at EMWMF are carbonate-rich with historically higher pH levels. Therefore, many metals are not expected to dissolve and be transported in either the surface or groundwater.

C.2 DATA COMPILATION

The (over 11 years of) leachate and contact water analytical data was compiled. These analytical data included COCs and additional analytical data obtained by analyzing EMWMF wastewater for analytical suites instead of for COCs identified in the waste lots. The contact water analytical data are in Attachment 1 to this appendix and the leachate data are in Attachment 2. As shown in these attachments, the number of analytes routinely detected is much less than the analytes that are analyzed.

C.3 DATA EVALUATION

Following data compilation, the analytes were reviewed to evaluate abundance in the waste lots disposed at EMWMF, the contaminant mobility in water, the regulatory concern and/or risk, and other factors.

C.3.1 Analyte Abundance in EMWMF Waste

To determine the abundance in the waste, the number of waste lots with each analyte was compared against the number of waste lots where the analyte was detected during characterization. This comparison also determined that EMWMF was analyzing for many analytes not characterized in the waste. The abundance is provided per analyte in Attachment 3, the COC winnowing table. Analytes not characterized in the waste are indicated with a dash in the abundance table.

There have been 170 waste lots disposed to date at EMWMF. Analytes detected in waste in 0–50 waste lots were designated as low abundance. Analytes detected in 50–100 waste lots were designated as moderate abundance. Analytes detected in over 100 of the waste lots were designated as high abundance.

C.3.2 Mobility

Analytes were next evaluated for mobility in water. The mobility class for the common organic analytes was derived from Applied Hydrogeology (C. W. Fetter, 1994, *Applied Hydrogeology*, Prentice-Hall, Upper Saddle River, New Jersey). The analytes specifically listed are highlighted in Attachment 3. For the remaining analytes not listed in Fetter, the following mobility class was assigned based upon the chemical properties:

Table C.1. Assigned mobility class for analyte families

Suffix	Assigned mobility	Suffix	Assigned mobility
-hexane	L	-nitrile	H
-ketone	M	-phenol	H
-benzene	H	-chlor	L
-ethene	M	-naphthalene	L
-ethane	H	-amine	L
-chloride	H		

H = high
L = low
M = moderate

Asbestos has not been seen in leachate or contact water and was assigned a low mobility due to its physical properties.

Several metals are not expected to be mobile within the cell or within the geologic setting because of the concrete in the waste cell and the carbonate-rich geologic environment. However, metals such as barium and cadmium are mobile in the environment and are designated as such. Chromium has a dual mobility designation. Chrome III has a low mobility, but Chrome VI is highly mobile.

C.3.3 Regulatory Concern/Risk

Several analytes are of greater concern because of their carcinogenic risk and/or an underlying regulatory concern. These analytes were assigned a low, moderate, or high rating based on the level of concern.

Mercury, cadmium, and nitrogen compounds (including ammonia) are of high concern because of the potential harm to the ecosystem. Pesticides are also of high concern because the potential harm to the ecosystem. In addition, certain mobile radionuclides are of high concern because of the mobility combined with the persistence in the environment and the potential harm to the ecosystem.

The assigned ratings are found in Attachment 3.

C.4 SELECTION OF KEY COCS

Based upon the preceding evaluation, the key COCs were identified (Table C.2) as analytes that present in the wastewater and are abundant in the waste, mobile in the local environment, and of high risk or regulatory concern. Additional water quality parameters will be monitored based on the Tennessee Department of Environment and Conservation (TDEC) Water Pollution Control experience in assessing industrial wastewater and recognizing reasonable potential impacts to streams in this geographical region. For example, Total Organic Carbon (TOC) will be monitored to indicate the presence of volatile organic compounds and semivolatile organic compounds. Additional analyses would be triggered if higher levels of TOCs are seen.

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Table C.2 Key COCs and summary statistics for 2011–2013

Analysis type	Analyte	No. of analyses	No. of detected results	Detection frequency	Units	Min.	Max.	Project quantitation limit (MDA)	CMC AWQC TDEC Fish and Aquatic Life (batch)	CCC AWQC TDEC Fish and Aquatic Life (continuous)	TDEC AWQC recreation	96% of the DCGs	Max above FAL batch?	Max above FAL cont?	Max above recreation?	Max above DCGs?
METAL	Arsenic, Tot + Diss	169	24	14.2%	ug/L	0.15	3.6	5	340	150	10		No	No	No	-
METAL	Cadmium, Tot + Diss	169	34	20.1%	ug/L	0.08	0.332	5	2.2*	0.27*	-		No	Yes	-	-
METAL	Chromium, Tot + Diss	201	119	59.2%	ug/L	0.3	16.7	5	625*	81*	-		No	No	-	-
METAL	Copper, Tot + Diss	169	88	52.1%	ug/L	0.41	5	5	15*	9.9*	-		No	No	-	-
METAL	Lead, Tot + Diss	201	22	10.9%	ug/L	0.36	4.53	5	73*	2.8*	-		No	Yes	-	-
METAL	Mercury, Tot + Diss	188	7	3.7%	ug/L	0.065	0.22	5	1.4	0.77	0.051		No	No	Yes	-
METAL	Nickel, Tot + Diss	196	136	69.4%	ug/L	0.56	15	5	515*	57*	4600		No	No	No	-
METAL	Uranium	194	185	95.4%	ug/L	2.01	388	5	-	-	-		-	-	-	-
Other	Cyanide	303	14	4.6%	ug/L	1.84	14.9	5	22	5.2	140		No	Yes	No	-
Other	Dissolved Solids	41**	41	100.0%	mg/L	125	1410	2.5	-	-	-		-	-	-	-
Other	Suspended Solids	48**	27	56.3%	mg/L	1.15	1400	2.5	-	-	-		-	-	-	-
Other	Total Organic Carbon (TOC)	42**	41	97.6%	mg/L	0.86	12.1	1	-	-	-		-	-	-	-
PPCB	4,4'-DDD	318	23	7.2%	ug/L	0.011	0.0767	5	-	-	0.0031		-	-	Yes	-
PPCB	4,4'-DDE	318	26	8.2%	ug/L	0.0125	0.293	5	-	-	0.0022		-	-	Yes	-
PPCB	4,4'-DDT	312	6	1.9%	ug/L	0.013	0.05	5	1.1	0.001	0.0022		No	Yes	Yes	-
PPCB	Aldrin	307	7	2.3%	ug/L	0.011	0.04	5	3	-	0.0005		No	-	Yes	-
PPCB	beta-BHC	311	101	32.5%	ug/L	0.0104	0.289	5	-	-	0.17		-	-	No	-
PPCB	Dieldrin	324	8	2.5%	ug/L	0.011	0.02	5	0.24	0.056	0.00054		-	-	-	-
RAD	Iodine-129	347	15	4.3%	ug/L	0.39	12.8	5	0	0	0		-	-	-	-
RAD	Strontium-90	350	266	76.0%	ug/L	1.31	471	5	0	0	0		-	-	-	-
RAD	Technetium-99	347	307	88.5%	ug/L	4.11	983	5	0	0	0		-	-	-	-
RAD	Tritium	347	249	71.8%	ug/L	337	9234.86	5	0	0	0		-	-	-	-
RAD	Uranium-233/234	347	344	99.1%	ug/L	0.65	362	5	0	0	0		-	-	-	-
RAD	Uranium-235/236	347	301	86.7%	ug/L	0.26	27.4	5	0	0	0		-	-	-	-
RAD	Uranium-238	347	339	97.7%	ug/L	0.3	156.2	5	0	0	0		-	-	-	-

* Hardness corrected value based on average hardness of 112 mg/L in the North Tributary-05 receiving stream

** Historical data only available for leachate

Additional Water Quality Parameters

Other	Hardness, as CaCO3, mg/l	Because toxicity of some metals is directly related
Other	Nitrogen, Nitrate total (as N)	Nutrients, important to monitor health of the stream
Other	Nitrogen, total (as N)	Nutrients, important to monitor health of the stream
Other	Phosphorus, total (as P)	Nutrients, important to monitor health of the stream
Other	TDS or conductivity	Routine performance to determine if a pulse is moving through the system
Other	Total Organic Carbon	Indicates the presence of volatile organic compounds or semivolatile organic compounds
Other	TSS	Indicates the potential to transport adsorbed metals, affects benthics
Other	Whole effluent toxicity, both acute and chronic	Minimum - semi-annual, or upon major change in waste characteristics; at least one sample during Sept.–Nov. low-flow period.
Other	Ammonia Nitrogen, Total as N	Ubiquitous nature in most leachate streams
Other	Stream flow	Required to calculate mixing in stream if upset conditions occur
Other	Wastewater Flow	Required to calculate mixing in stream

AWQC = ambient water quality criteria
CCC = criterion continuous concentration
CMC = criterion maximum concentration
DCG = derived concentration guidelines
FAL = fish and aquatic life
MDA = minimum detectable activity
PPCB = pesticides and polychlorinated biphenyls
RAD = radiological
TDS = total dissolved solids
TSS = total suspended solids

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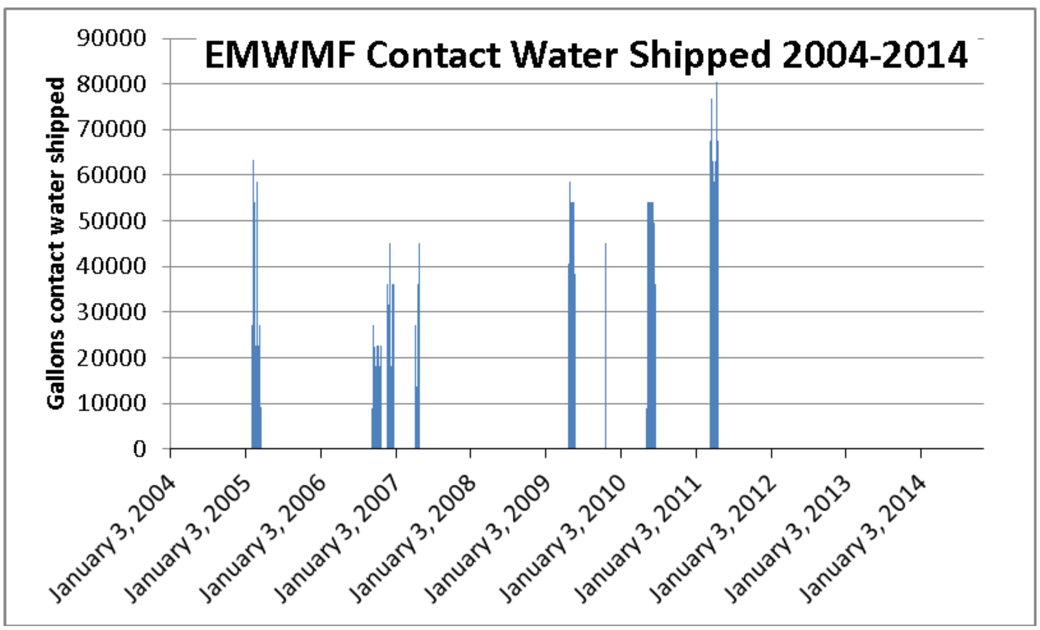
C.4.1 Additional Analysis

Each of the key COCs was evaluated over the EMWMF operating history to determine the trends. The data range from 2005 to 2014 was selected as the most complete, representative data set to evaluate and provides ten years of data. Contact water and leachate are graphed separately for each analyte, with the same axes for each analyte to facilitate the comparison between leachate and contact water. The following data were not filtered to show only the water released. Instead, all available analyses were used, including those from water that were treated.

The following table and graph shows the water volumes that have been treated in the past ten years. As shown, no contact water has been shipped for treatment since April 2011.

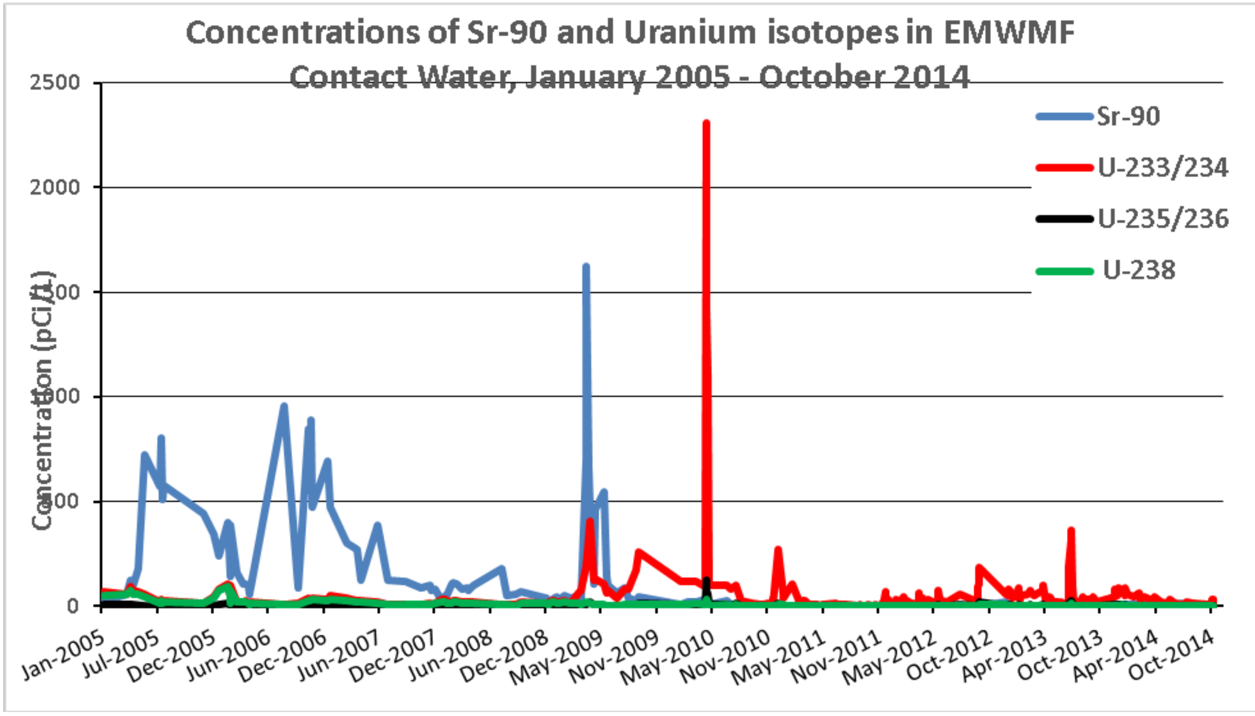
Table C.3 EMWMF contact water volume shipped by year (2004 to present)

Year	Months	Contact water shipped for treatment (gal)
2005	Jan–Mar	660,262
2006	Sep–Dec	831,187
2007	April	274,621
2009	April–May October	724,056 121,823
2010	May–June	1,191,035
2011	March–April	1,187,119
Total (2004–2014)		4,990,103



As shown in the following sections, concentrations of certain contaminants in contact water have changed over time, particularly as the origin of the waste received has changed. This is particularly noticeable in uranium (U) isotopes and strontium (Sr)as the origin of the waste has changed from the Y-12 National Security Complex (Y-12) to the Oak Ridge National Laboratory (ORNL) to the East Tennessee

Technology Park (ETTP). The following figure reflects these changes over time and indicates the changes expected to be seen as the origin of the waste changes in the future.



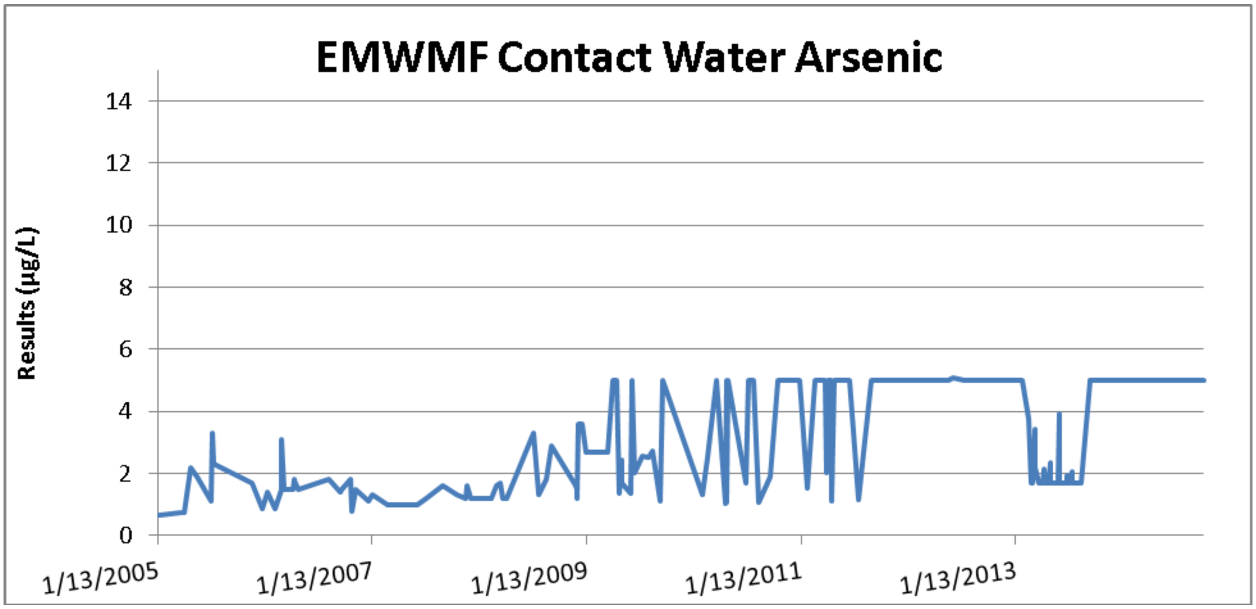
	2002–2006	2007–2010	2011–2014
Y-12	Boneyard/Burnyard		Old Salvage Yard, Biology Complex, Alpha 5
ORNL	Melton Valley closure soil and sediment, main plant surface impoundments	University of Tennessee-Battelle Bldg. 3026, 2000 complex	2000 complex, including slabs and soils
ETTP	K1070A burial ground, main facilities	K-25, Zone 1 and 2, Poplar Creek process facilities	K-33, K-25
Other	David Witherspoon 901	David Witherspoon 1630	

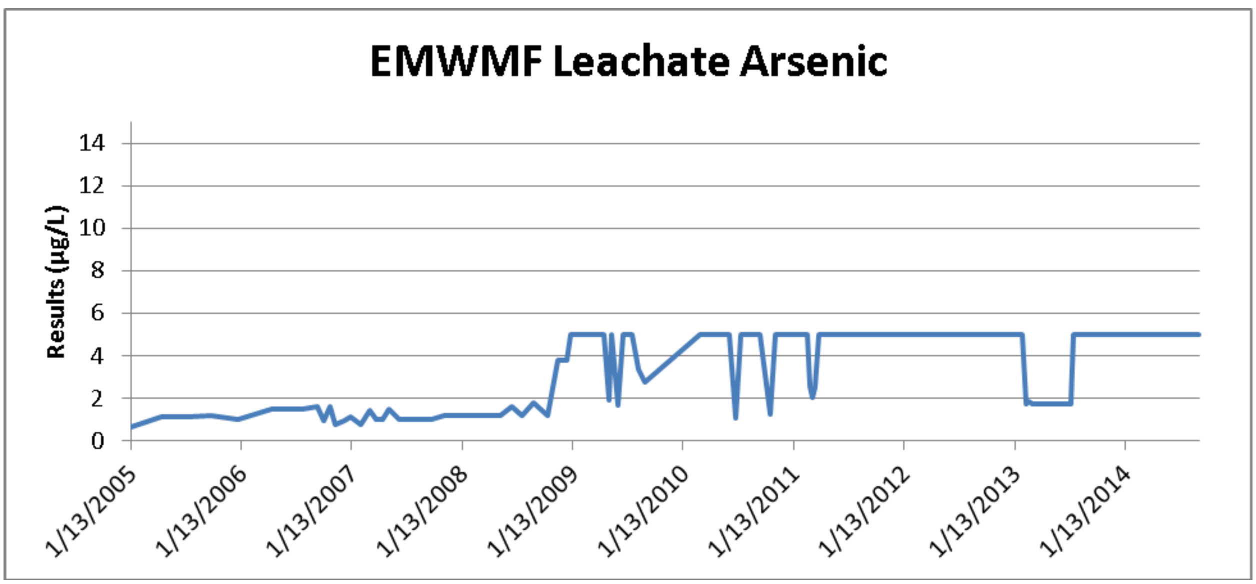
As shown above, prior to 2010, strontium was more prevalent in the contact water, representing the waste streams from Y-12 and ORNL. After 2010, U-233/234 is the prevalent radionuclide, representing a change in waste streams to primarily those originating at ETTP. U-235/236 is also more common in contact water prior to 2007, representing the portion of waste received from Y-12 and the Boneyard/Burnyard.

Arsenic

Low levels of arsenic are detected in both the contact water and leachate. When detected, arsenic is well below the project quantitation level (PQL) of 5 ug/L. Arsenic is not expected to require treatment

Recreational ambient water quality criteria (AWQC) – 10 ug/L Criterion maximum concentration (CMC) – 340 ug/L Criterion continuous concentration (CCC) – 150 ug/L





Cadmium

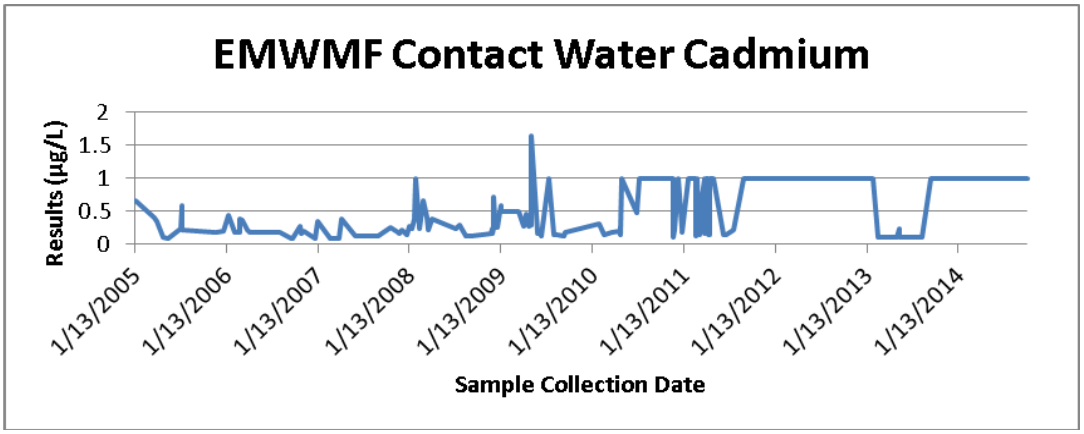
Cadmium was detected in about 20% of the leachate and contact water samples. Leachate typically contains lower cadmium than contact water. There have been no results higher than the CMC, but there are several instances, particularly in 2009, when results were higher than the CCC. The recent PQL is higher than what is required to demonstrate compliance with the CCC, but historical results occasionally exceed this value. Cadmium treatment is expected if continuous discharge is implemented.

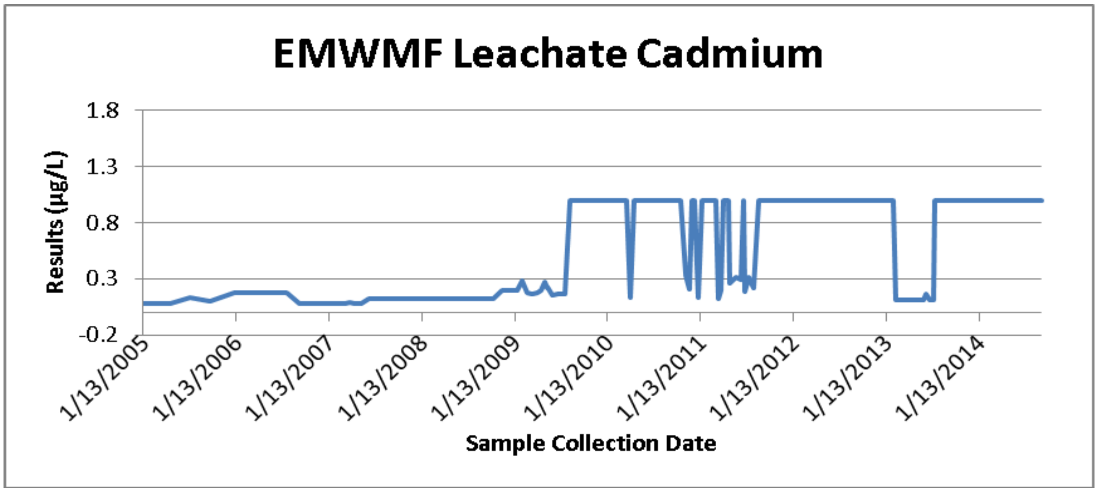
Recreational AWQC – n/a
Hardness corrected CMC – 2.2 ug/L
Hardness corrected CCC – 0.27 ug/L

Cadmium CW summary	No. samples	Detected	Min. detect (ug/L)	Max. detect (ug/L)
Total (Unfilt)	115	78	0.08	1
Dissolved (Filt)	216	36	0.105	1.65
Total	331	114		

CW = contact water

The highest value of 1.65 ug/L was a filtered sample collected on 5/13/2009 from Contact Water Pond (CWP) 2. However, this sample may not be representative of the actual water quality. The next highest sample result was 1.0 ug/L from an unfiltered sample collected from CWP 3 on 4/14/11, indicating that the highest result may not be representative of the actual water quality. The filtered sample collected from CWP 2 had a result of 0.28 ug/L. The comparison of filtered vs. unfiltered results does not show a consistent trend. For some pairs, filtered and unfiltered results are the same; for others, the filtered results are slightly higher; and for others, the unfiltered results are slightly higher. However, almost all are in the 0.1 to 0.2 ug/L range.

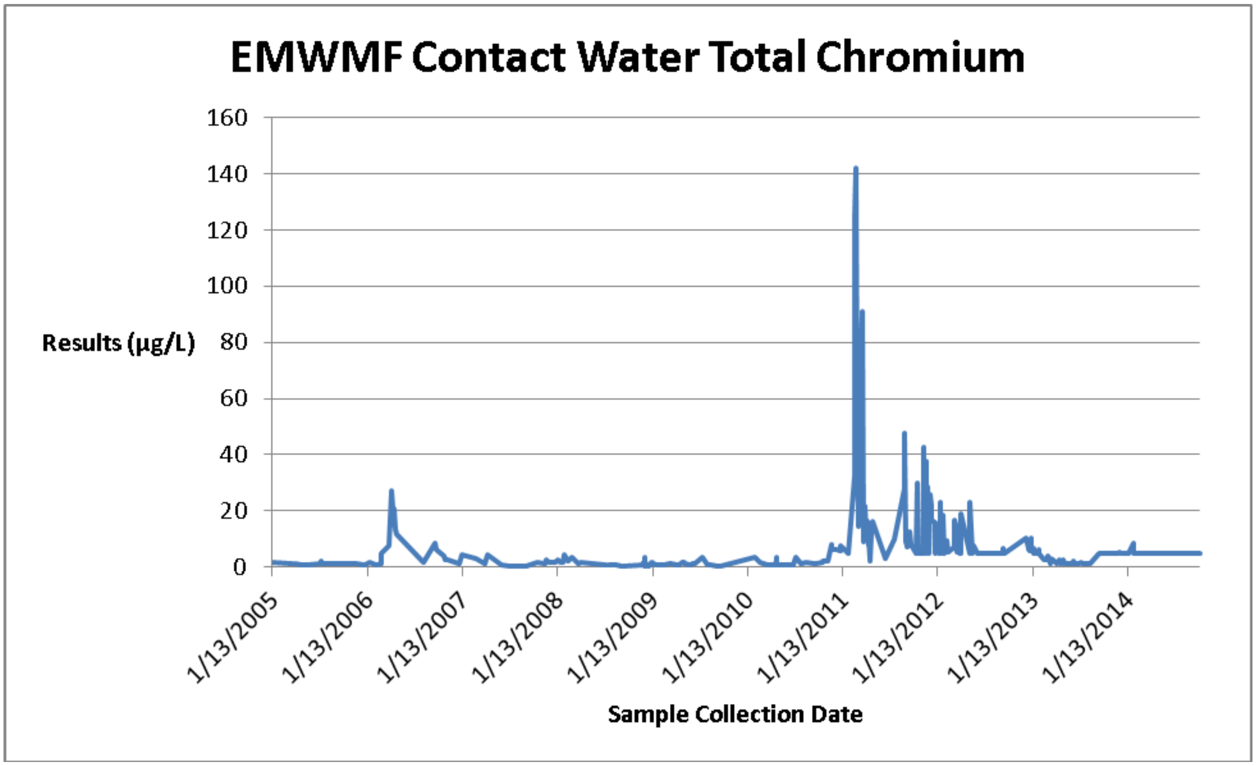


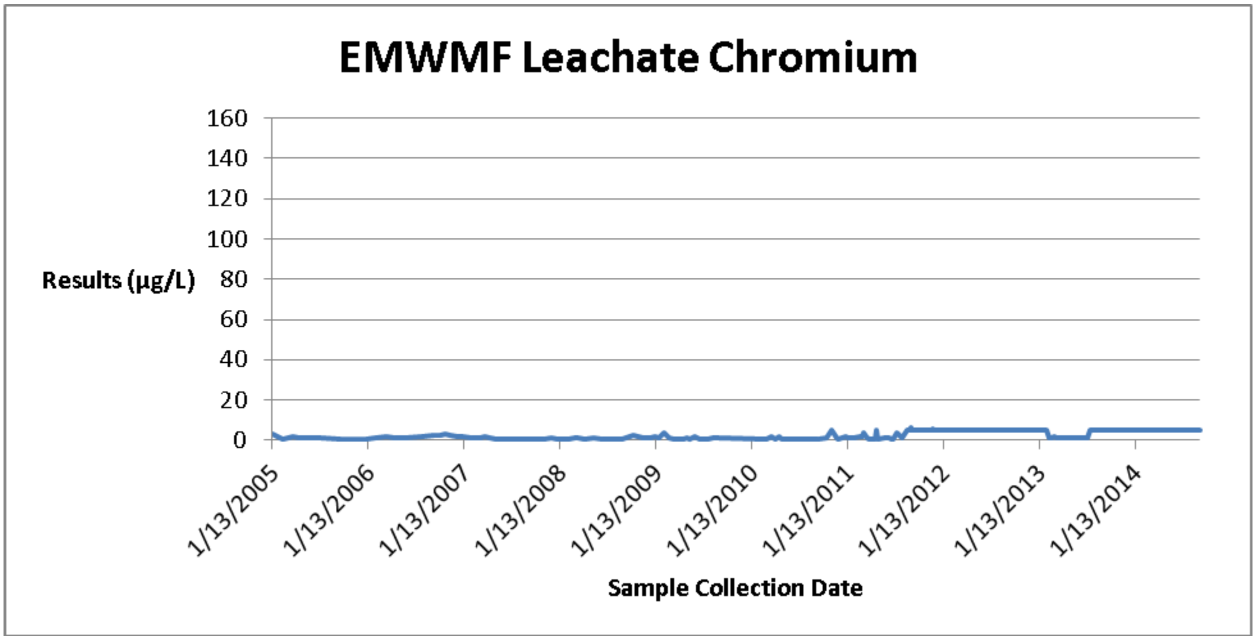


Chromium (total)

Recreational AWQC – n/a Hardness corrected CMC – 625 ug/L Hardness corrected CCC – 81 ug/L

Historically, about 60% of the results have been detects. Total chrome has not been above either AWQC.





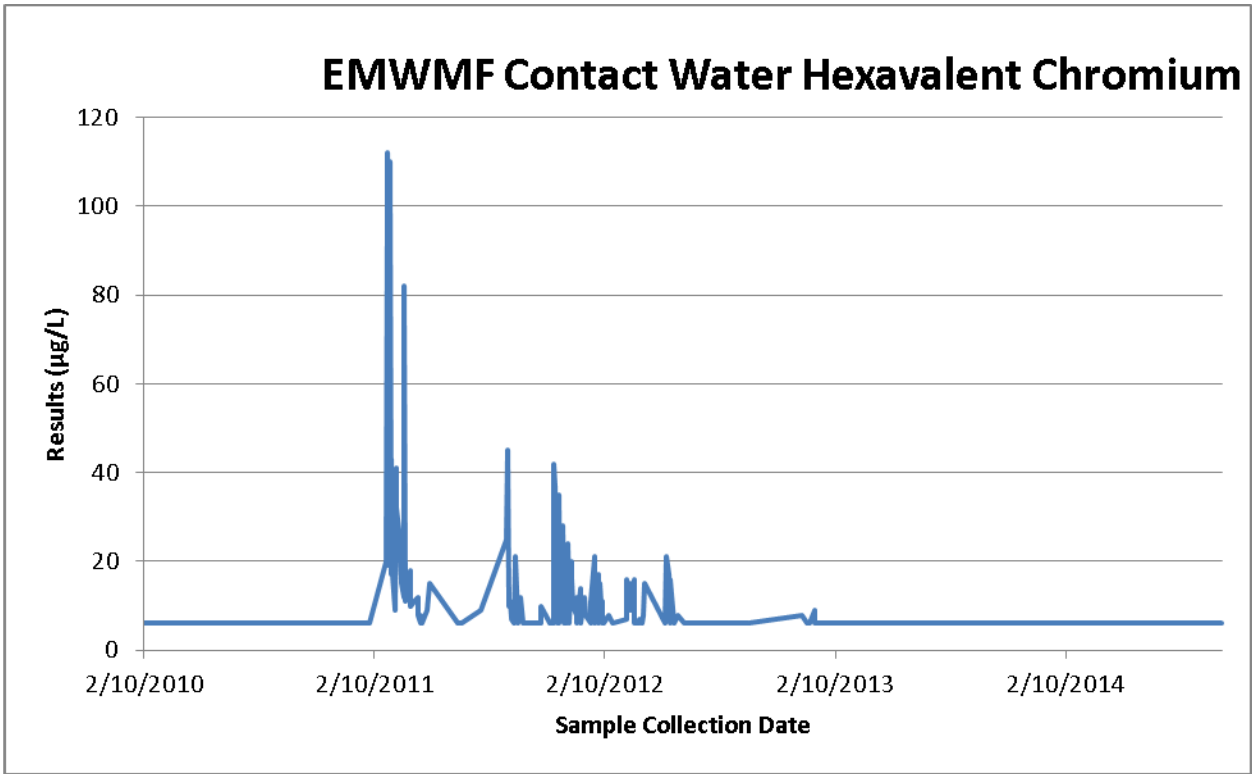
Hexavalent Chrome

Recreational AWQC – n/a CMC – 16 ug/L CMC – n/a

Historically, about 60% of the results have been detects. Total chrome has not been above either AWQC. Only contact water is analyzed for hexavalent chrome (Cr-VI) because this analysis is not required to prove compliance with the Liquid and Gaseous Waste Operations/Process Waste Treatment Complex waste acceptance criteria.

As shown in the graph below, hexavalent chrome was an issue in contact water between March 2011 and May 2012. Water with Cr-VI results higher than the AWQC of 16 ug/L were retained in the contact water ponds and tanks, and the Cr-VI was reduced to levels below 16 ug/L prior to release. Additional samples were collected to monitor the reduction and verify water was acceptable for release, resulting in the stair step pattern on the graph.

The Cr-VI was thought to result from disposal of K-33 debris at EMWMF during this time frame. A similar rise in Cr-VI levels was anticipated and has been seen for the ongoing K-31 demolition debris disposal (not shown). However, the EMWMF operations staff strives to place suspect debris in areas that are not impacted by accumulations of contact water to minimize the possibility of hexavalent chromium impacts, and maintains the capacity to reduce contact water when required.



Copper

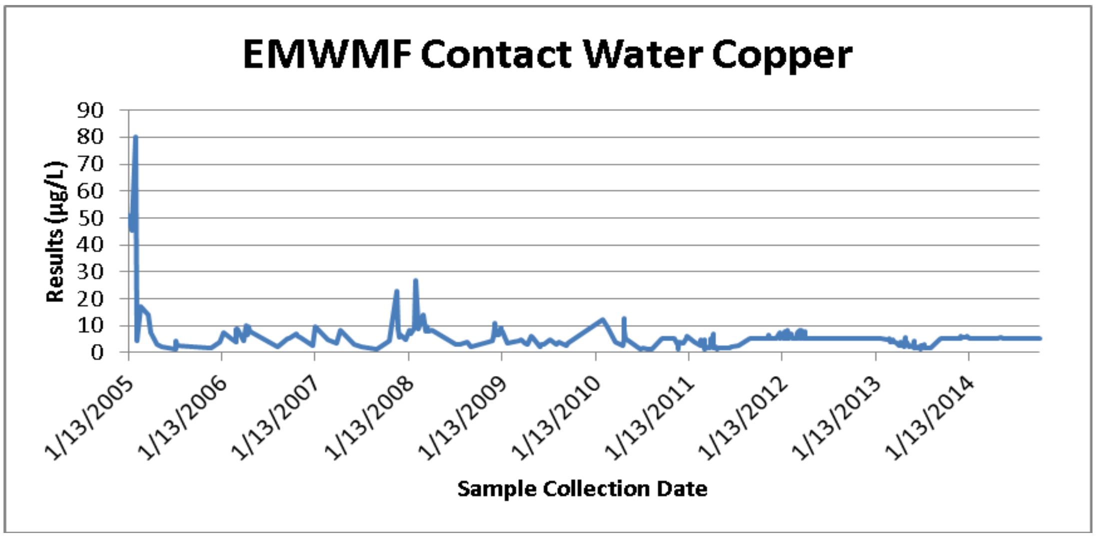
Historically, about 52% of the results have been detects. Higher copper levels were more prevalent in the past, with results above the CMC in February to March 2005, and again in November 2007 and February 2008. Since that time, there have been no results above the CMC. There have been no results above the CCC since May 2010. However, several results approached that amount in 2012.

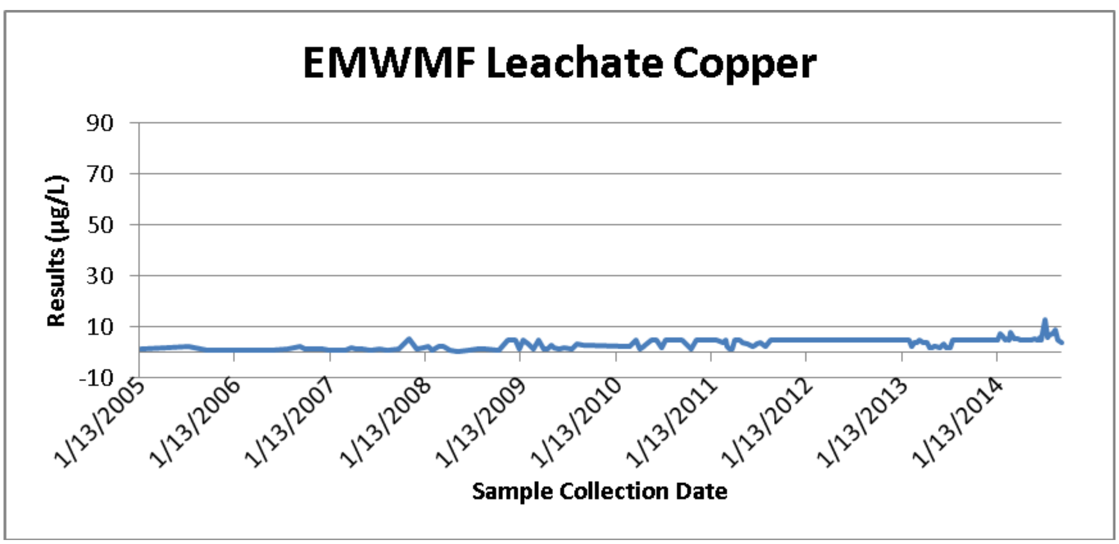
Recreational AWQC – n/a
Hardness corrected CMC – 15 ug/L
Hardness corrected CCC – 9.9 ug/L

Copper CW Summary	No. Samples	Detected	Min. detect (ug/L)	Max. detect (ug/L)
Total (Unfilt)	150	130	1	80.2
Dissolved (Filt)	221	123	1	36.5
Total	371	253		

CW = contact water

Leachate contains lower concentrations of copper. The highest result was 12.8 on July 14, 2014. This value was below the CMC, but exceeded the CCC. There was no concurrent elevation in contact water. The potential for copper treatment will be considered as a contingency in the future if continuous discharge is implemented.

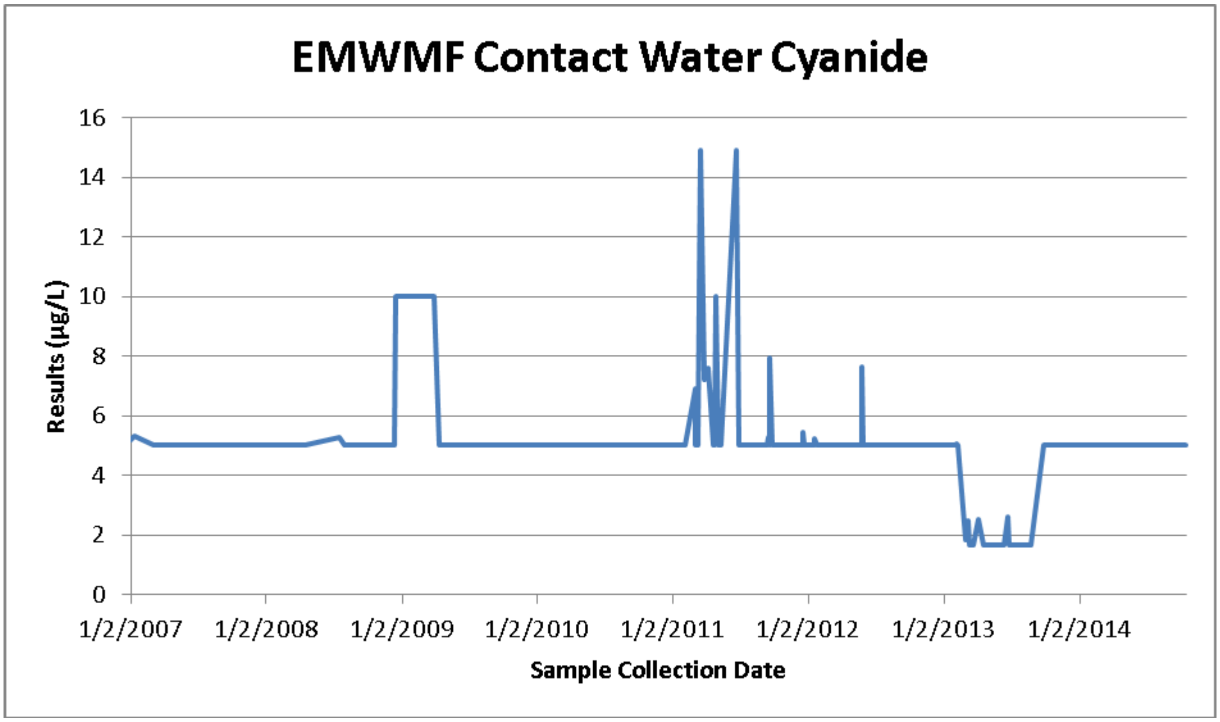


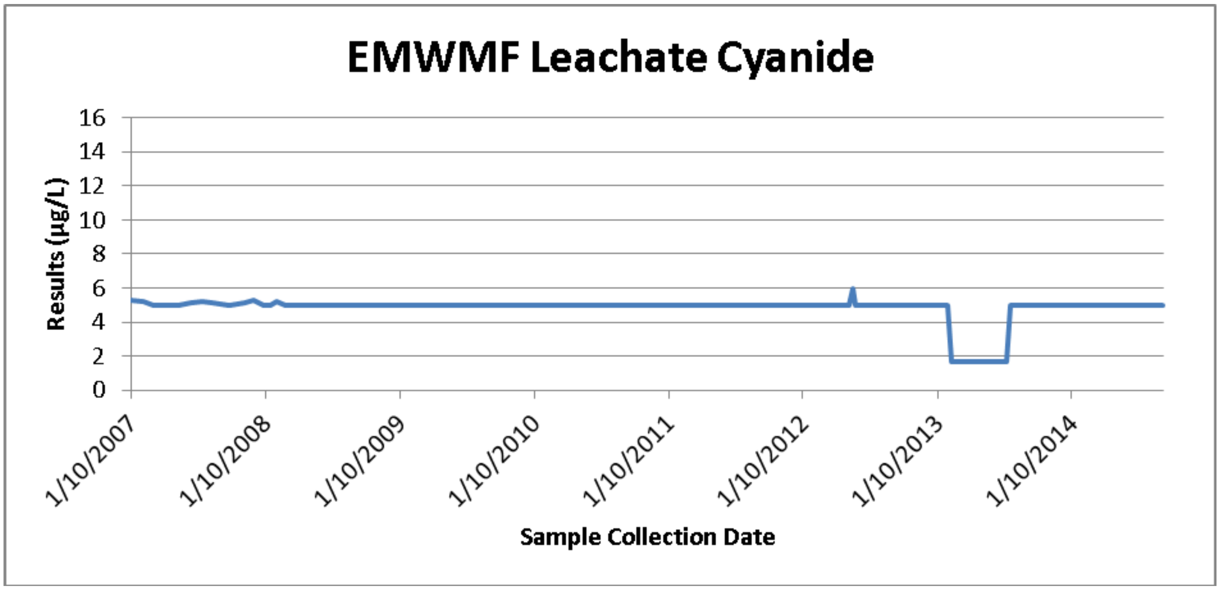


Cyanide

Recreational AWQC – 140 ug/L CMC – 22 ug/L CCC – 5.2 ug/L

Historically, about 5% of the results have been detects. Results are well below the CMC. Most results have been below detection limits, but there were several results above the CCC during the period March 2011 to September 2011. One additional result exceeded the CCC in May 2012. The potential for cyanide treatment will be considered as a contingency if continuous discharge is implemented.



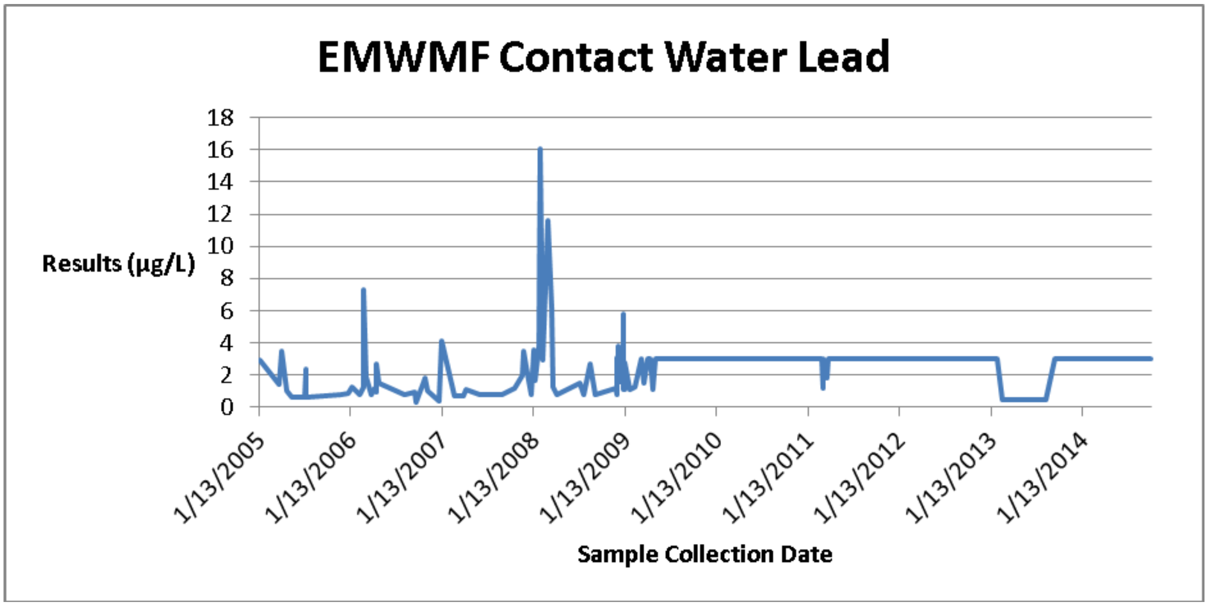


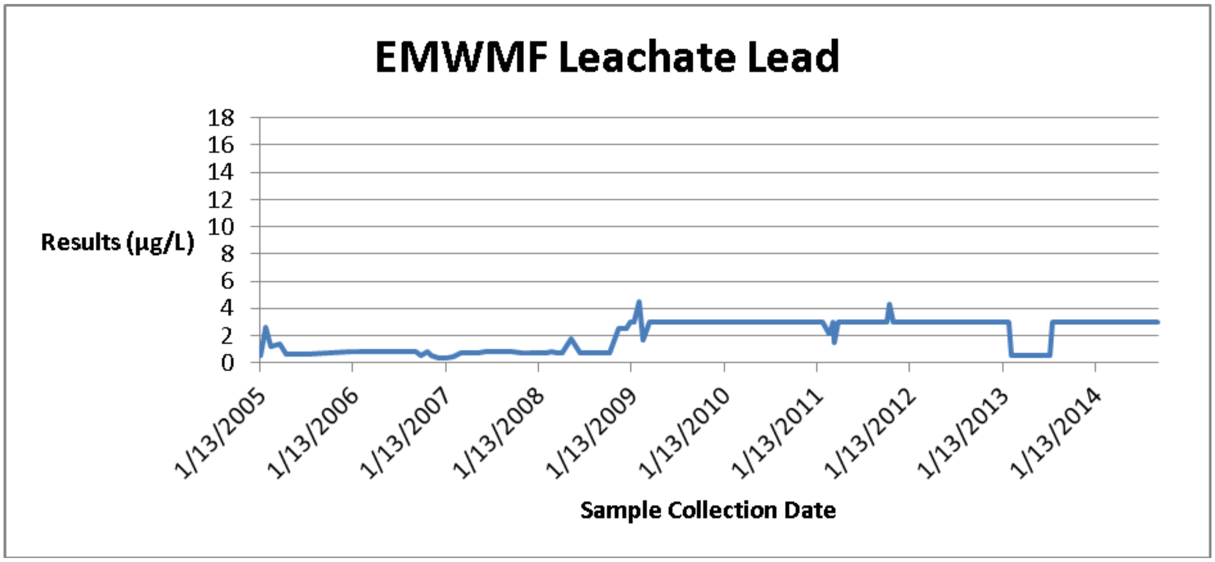
Lead

Recreational AWQC – n/a
Hardness corrected CMC – 73 ug/L
Hardness corrected CCC – 2.8 ug/L

Historically, about 11% of the results have been detects. Results are below the CMC, but several have been above the CCC in the past. The highest contact water results were in February and March 2008.

Since March 2009, no detected result has been above the CCC, although the detection limit was usually set at 3 ug/l. However, the lack of results above 3 ug/L and lack of results above the lower detection limits in early 2013 demonstrate that recent contact water met the hardness corrected CCC. The highest leachate value was 4.53 in February 2009, which is above the CCC. The potential for lead treatment will be considered as a contingency in the future if continuous discharge is implemented.





Mercury

Historically, about 11% of the results have been detects. Results are below the CMC, but several have been above the CCC in the past. The highest contact water results were in February and March 2008. Historically, about 4% of the results have been detects and many of the other results are B qualified, indicating that the results may be suspect. However, the recreational AWQC was not a discharge criterion and the detection limit was not low enough to determine if it can be met.

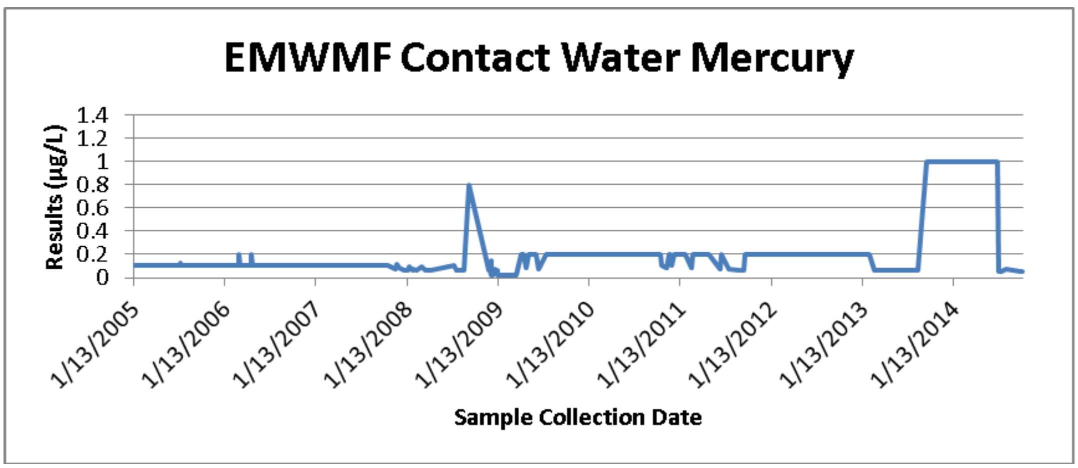
Recreational AWQC – 0.051 ug/L
CMC – 1.4 ug/L
CCC – 0.77 ug/L

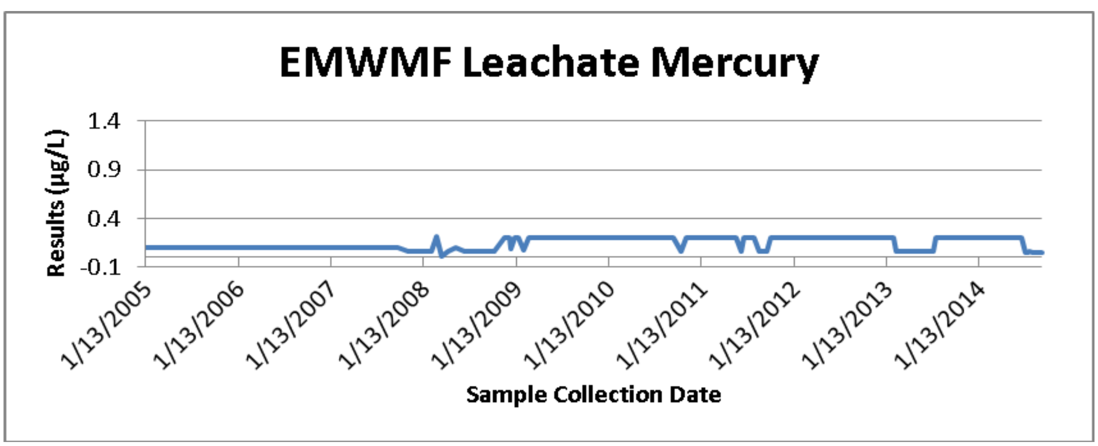
Mercury CW Summary	No. Samples	Detected	Min. detect (ug/L)	Max. detect (ug/L)
Total (Unfilt)	127	32	0.021	0.8
Dissolved (Filt)	201	9	0.02	0.109
Total	331	114		

CW = contact water

The highest detected result was 0.8 on Sept 15, 2008. This result was B qualified, indicating the result may not be accurate.

The results from filtered and unfiltered pairs show filtered sample results in a pair are generally slightly less than the total sample results. This indicates that mercury is present in both the dissolved and undissolved state. Mercury treatment is expected to be required because of the low recreational AWQC that will need to be met after implementation of this Focused Feasibility Study (FFS), and because the Environmental Management Disposal Facility is expected to receive more mercury-contaminated waste.

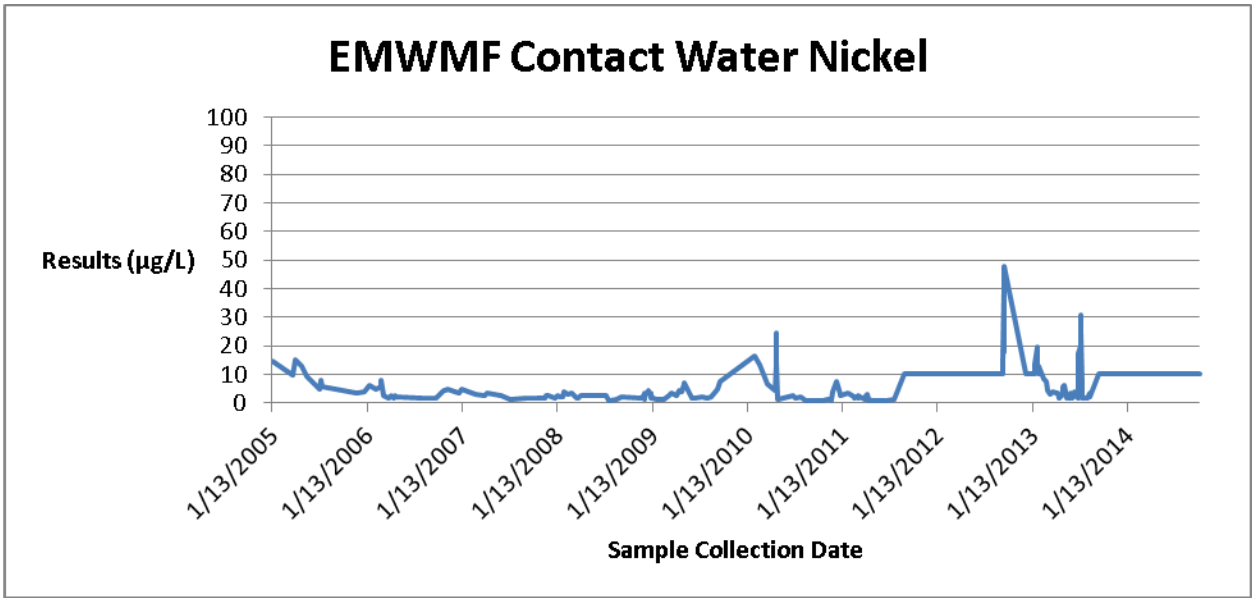


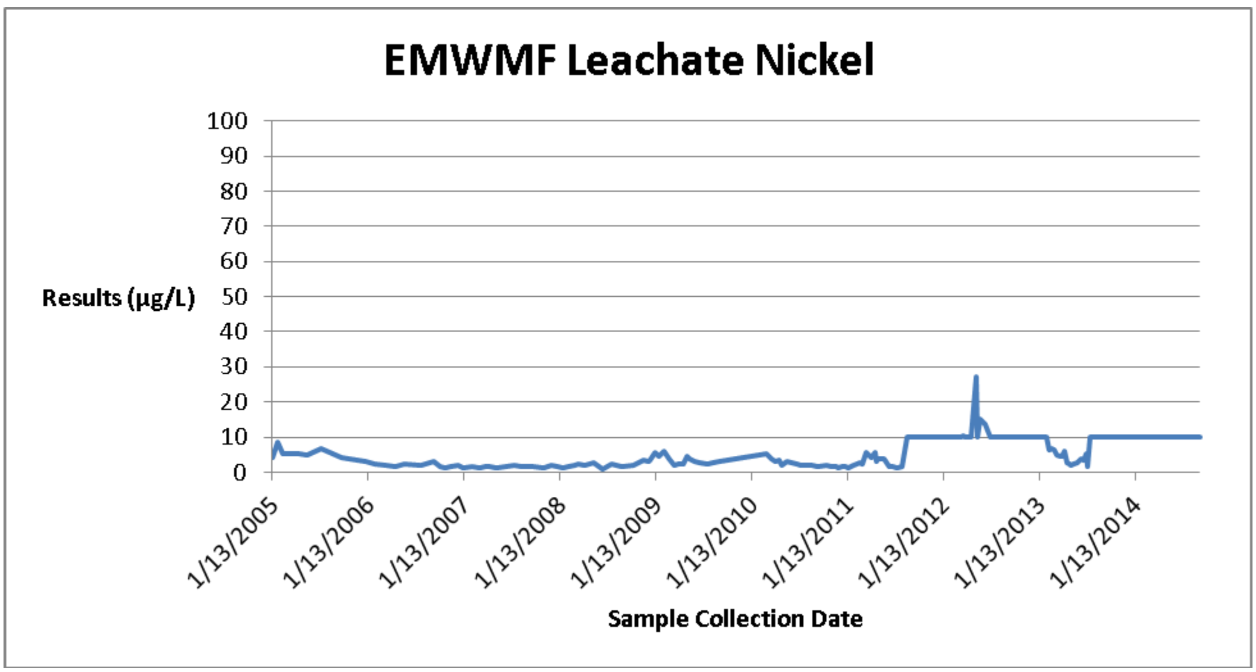


Nickel

Recreational AWQC – 4,600 ug/L Hardness corrected CMC – 515 ug/L Hardness corrected CCC – 57 ug/L

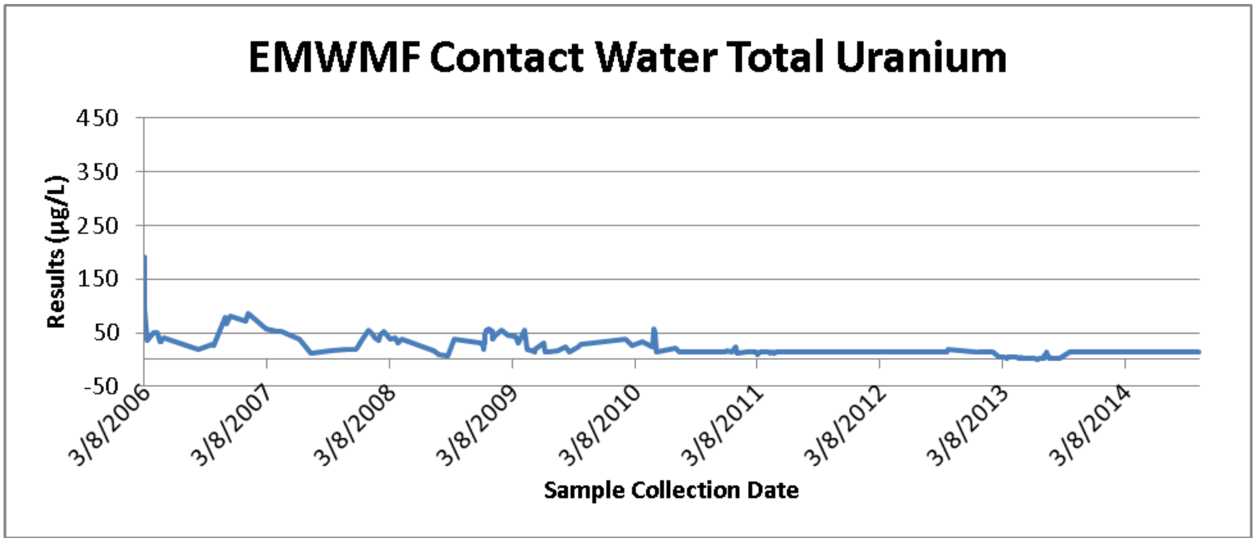
Historically, about 70% of the results have been detects. Results are well below the CMC and CCC. The two highest results occurred in September 2012 and were well below the CCC, with the highest result (48 ug/L) on September 25, 2012.

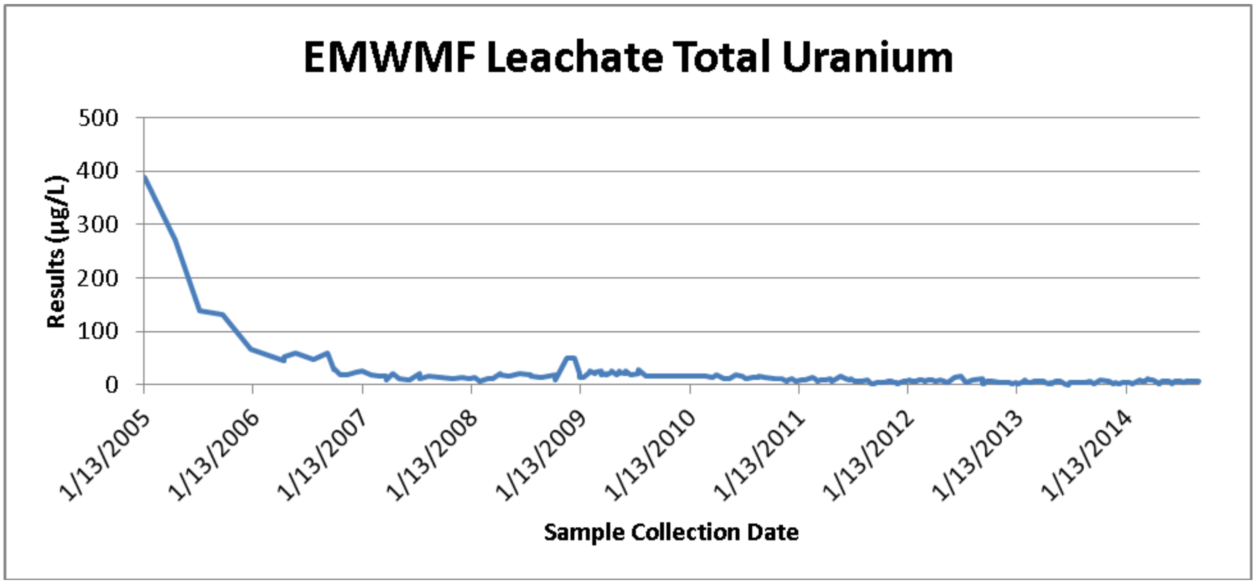




Uranium

AWQC are established for the uranium radionuclides present within EMWMF waste, but not for uranium as a metal. Total uranium is monitored in conjunction with the radionuclide analyses to show trends. There were higher levels of total uranium in the leachate early in the EMWMF history, followed by a declining trend with lower results since 2007. A similar trend can be inferred from the contact water data. However, there are no total uranium contact water results available from 2005 or earlier to evaluate.



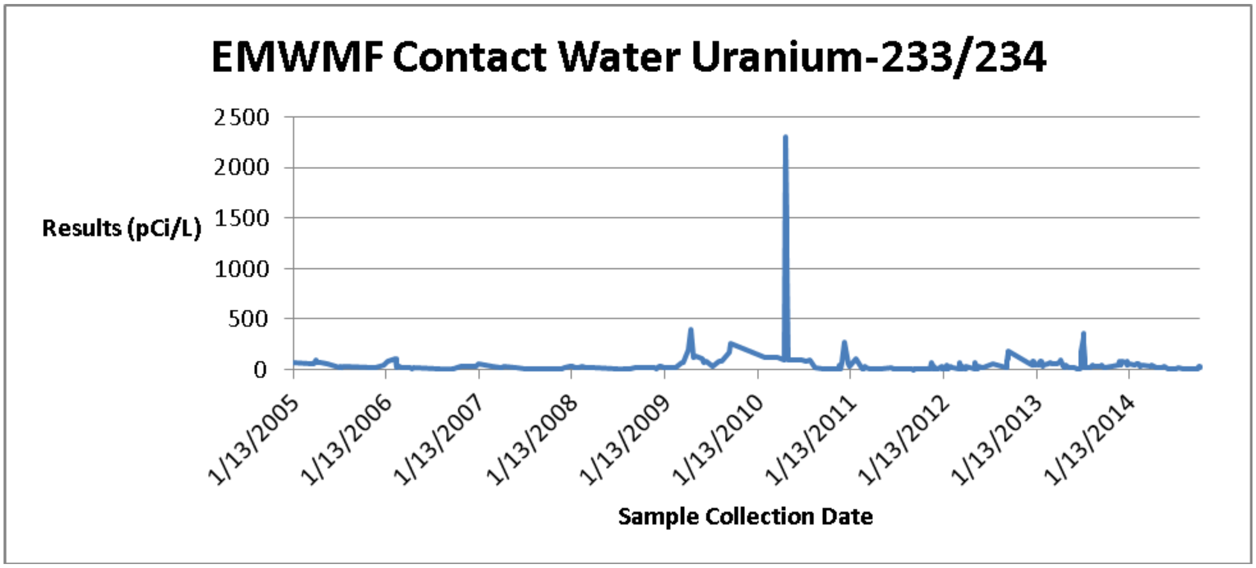


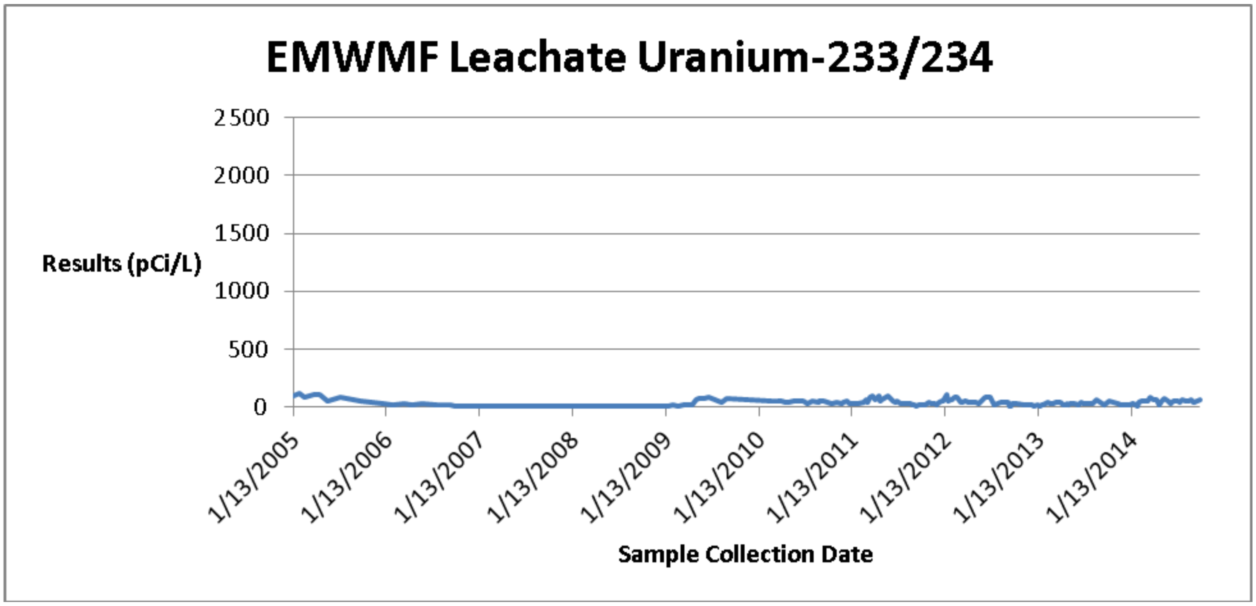
Uranium 233/234

Current criterion – 480 pCi/L

There have been no recent results above the current criterion, but there were several results above this criterion in CWPs 1, 2, and 4 in May 2010. Leachate did not show a similar rise in activity at that time, and generally has lower results.

The potential for uranium 233/234 treatment will be considered as a contingency in the future.

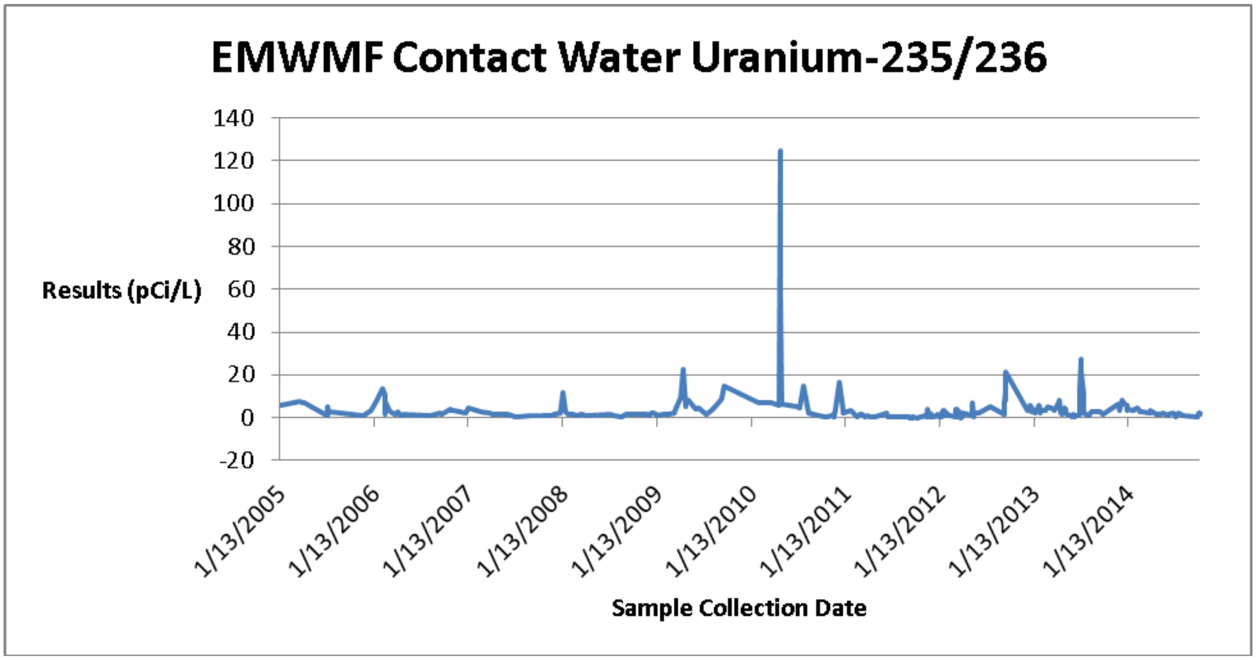


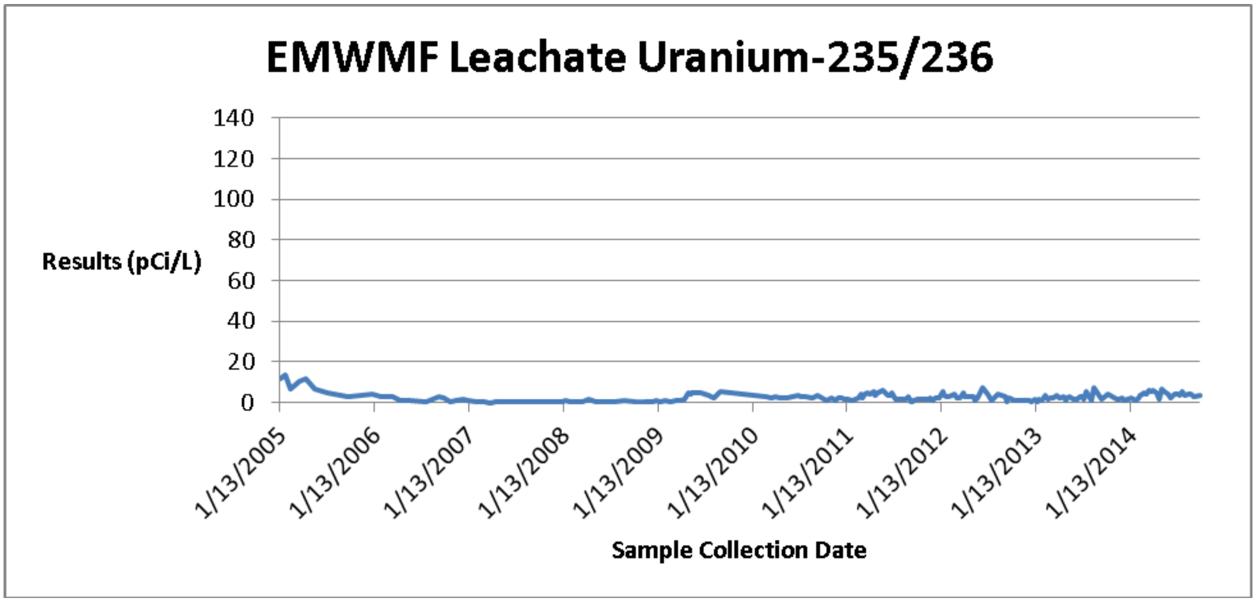


Uranium 235/236

Current criterion – 480 pCi/L

There have been no results above that criterion. The highest result observed was in May 2010, concurrent with the elevated U-233/234 results. Leachate did not show a similar rise in activity at that time, and generally has lower, more consistent results.

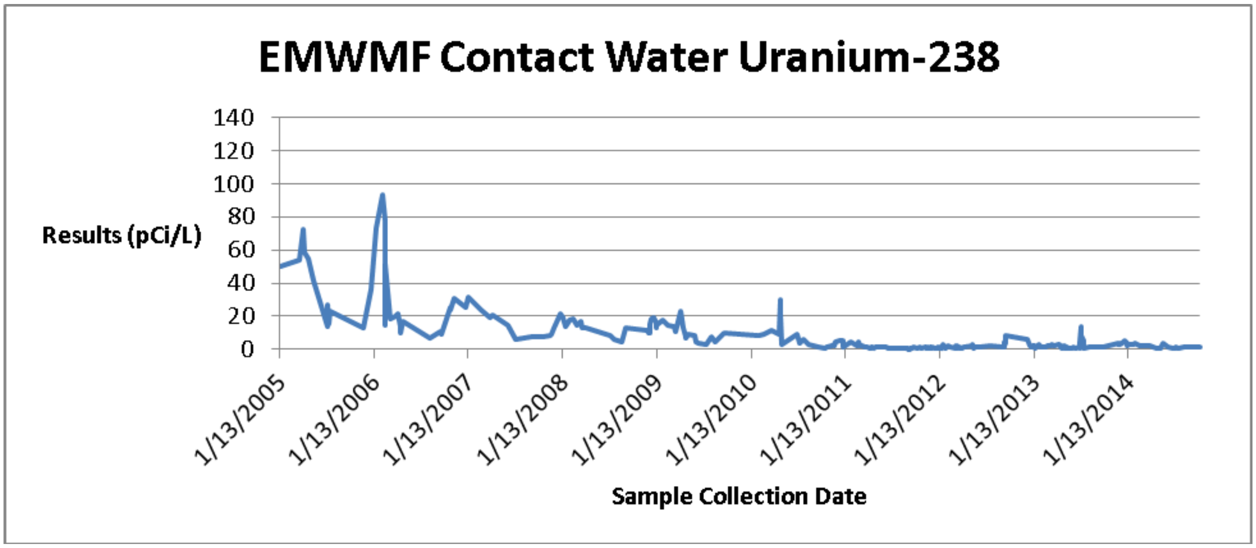


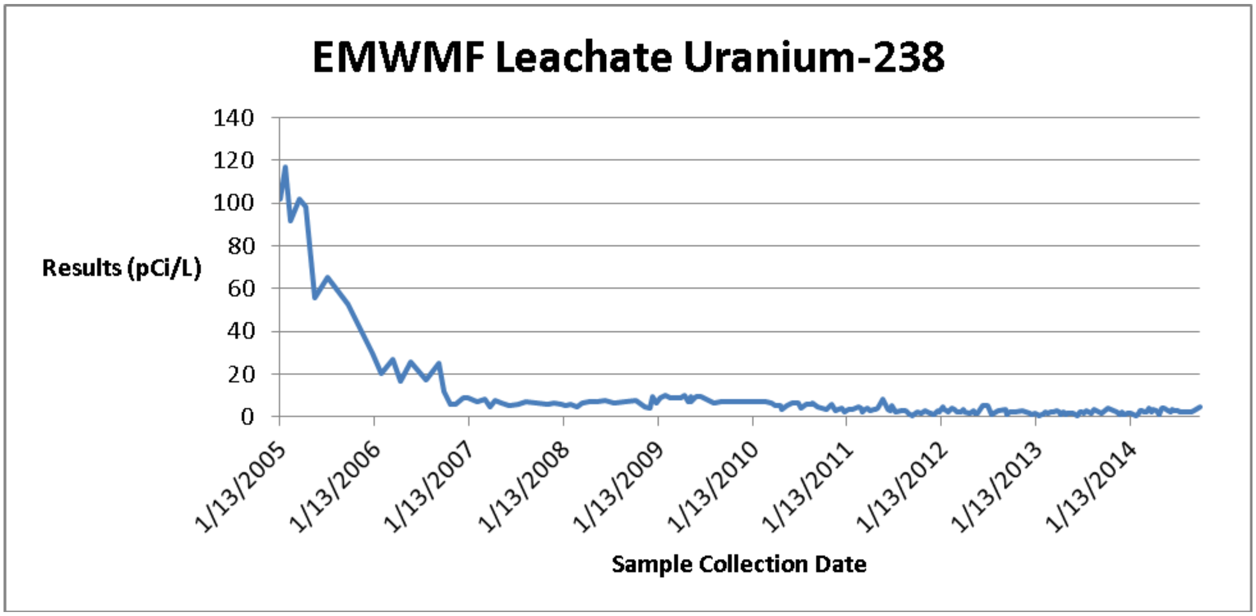


Uranium 238

Current criterion – 576 pCi/L

There have been no results above that criterion in the last ten years. The highest result observed was in leachate in 2005 (117 pCi/L). Contact water showed elevated readings at that time, but not as consistently. The leachate and contact water trends for total uranium and U-238 are very similar, indicating U-238 is likely the basis of the total uranium results.

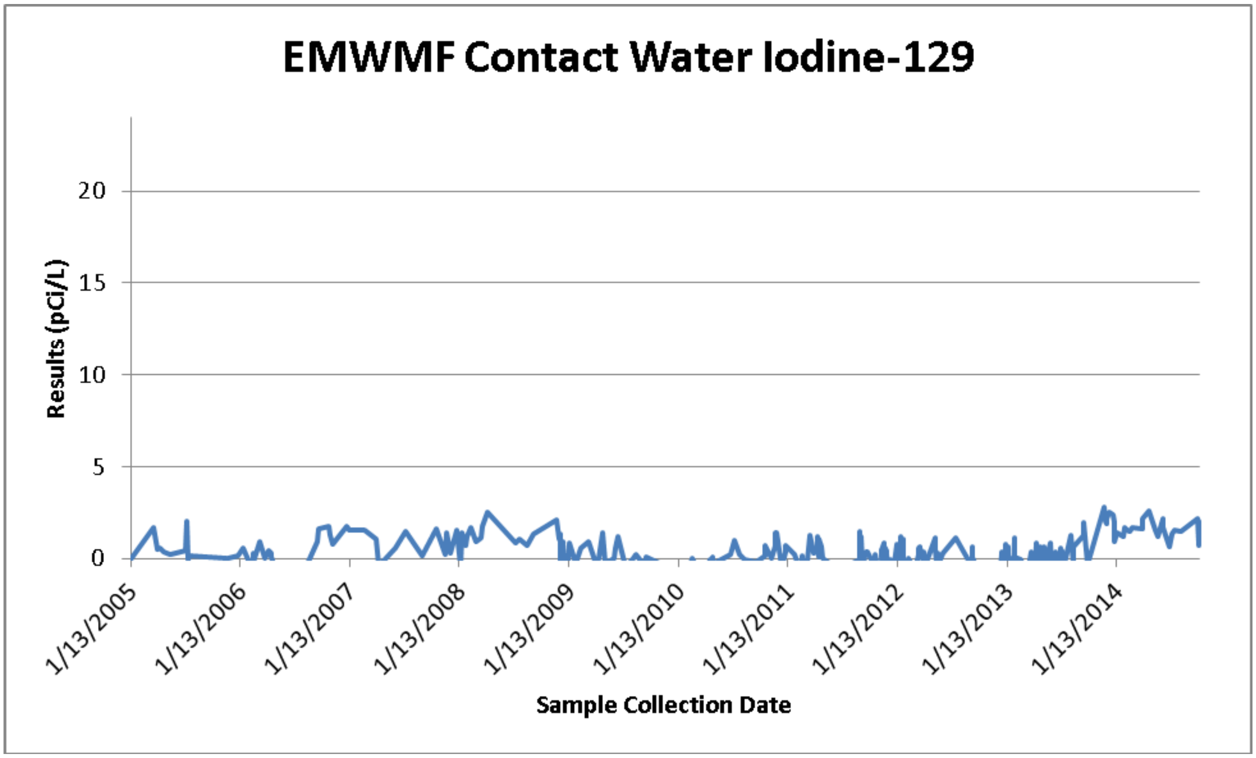


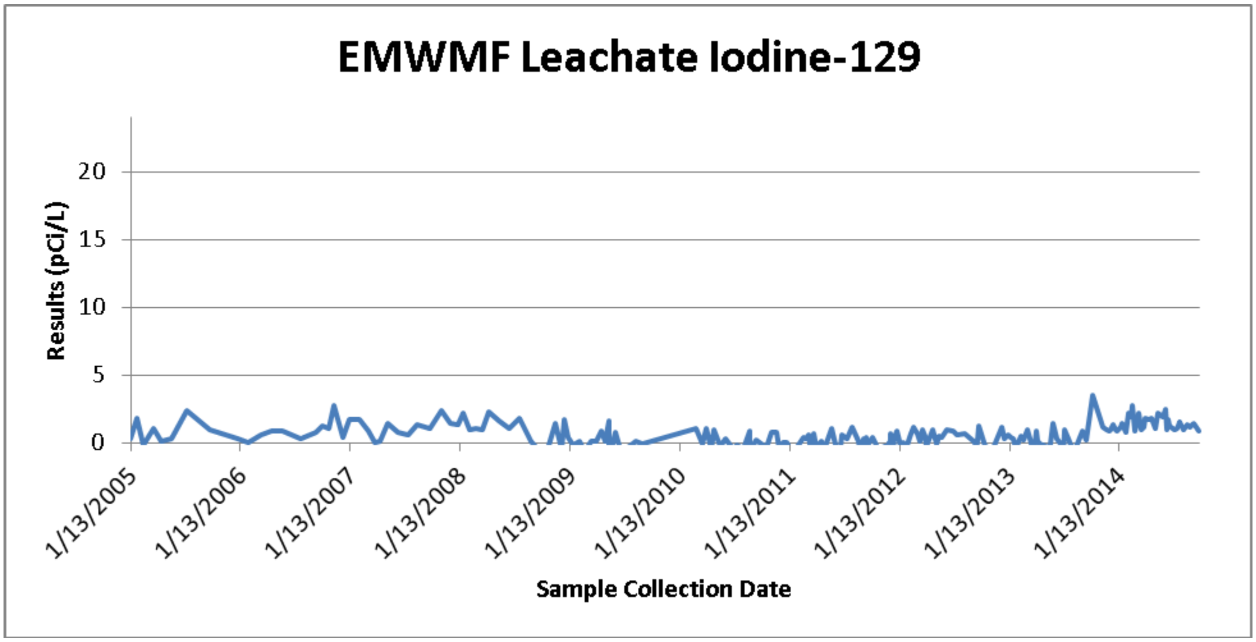


Iodine-129

Current criterion – 480 pCi/L

Neither contact water nor leachate results have been above 5 pCi/L in the last ten years. The ranges in the graphs below were reduced to 1/20th of the current criterion (24 pCi/L) to show the variation in the results over time.

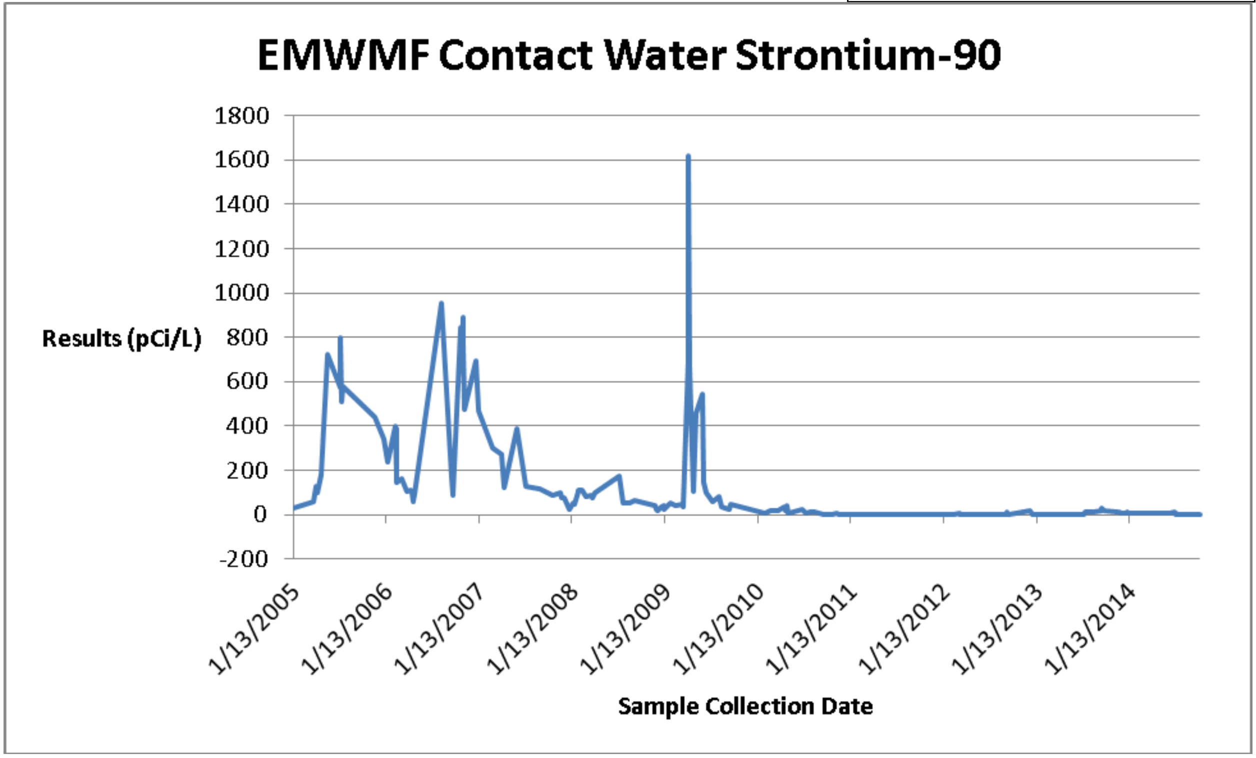


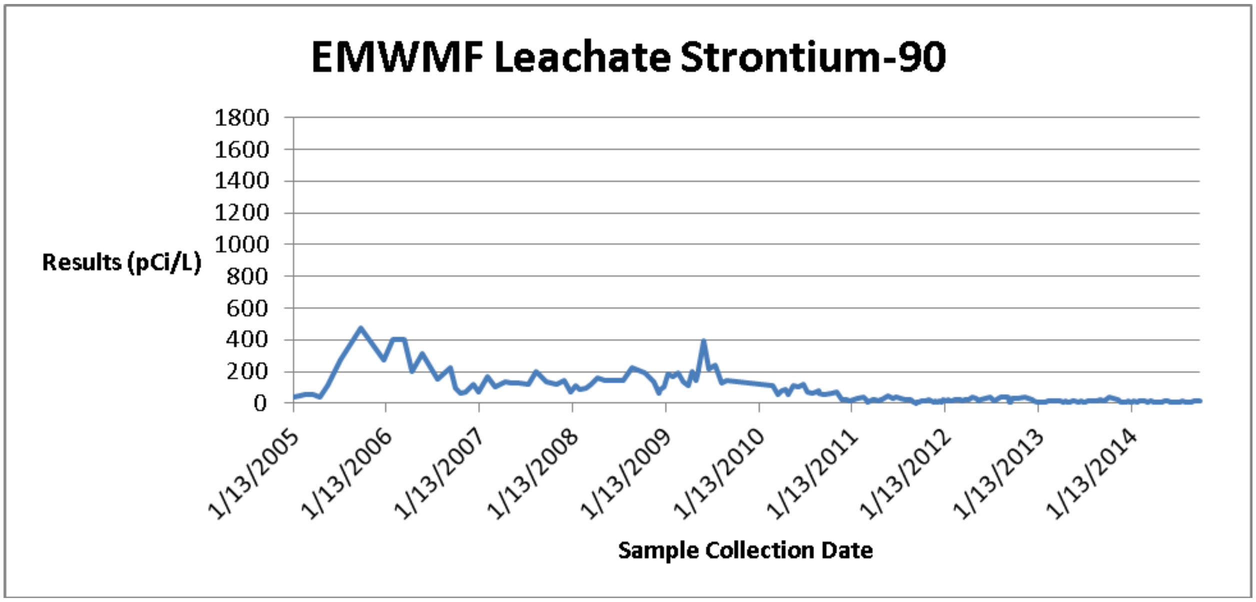


Strontium-90

Contact water results have approached this value in 2006 and 2007, and exceeded it in April 2009 (1620 pCi/L). Leachate showed a similar but muted trend, and has not approached the current criterion. Because of the higher activities in the past, the potential for Sr-90 treatment will be considered as a contingency in the future.

Current criterion – 960 pCi/L

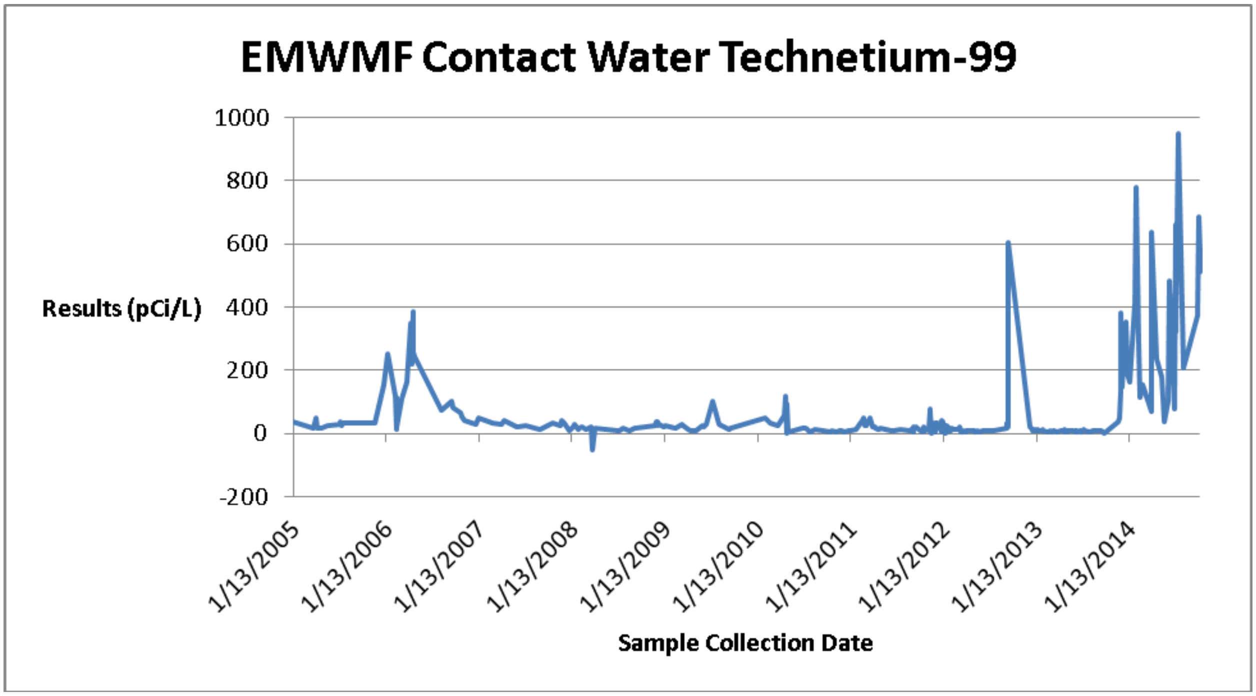


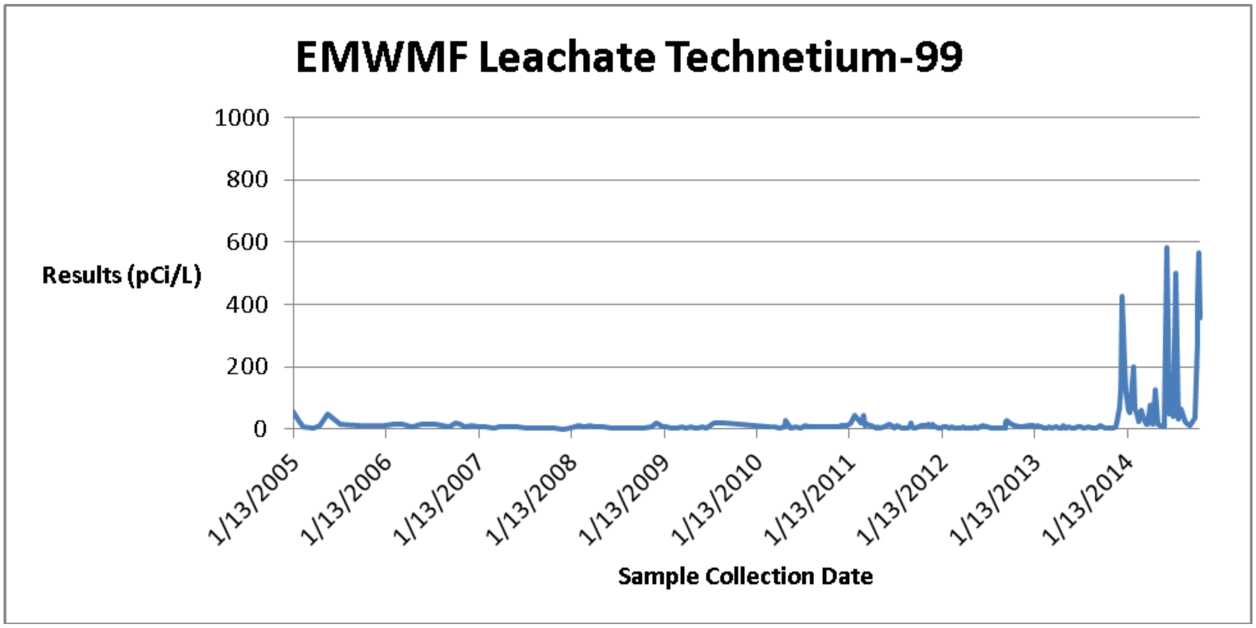


Technetium-99

Neither contact water nor leachate results are within an order of magnitude of this value within the last ten years. The results show the impact of the recent higher sum-of-fraction waste from K-25 on both the contact water and leachate. However, neither wastewater stream required treatment.

Current criterion – 96,000 pCi/L

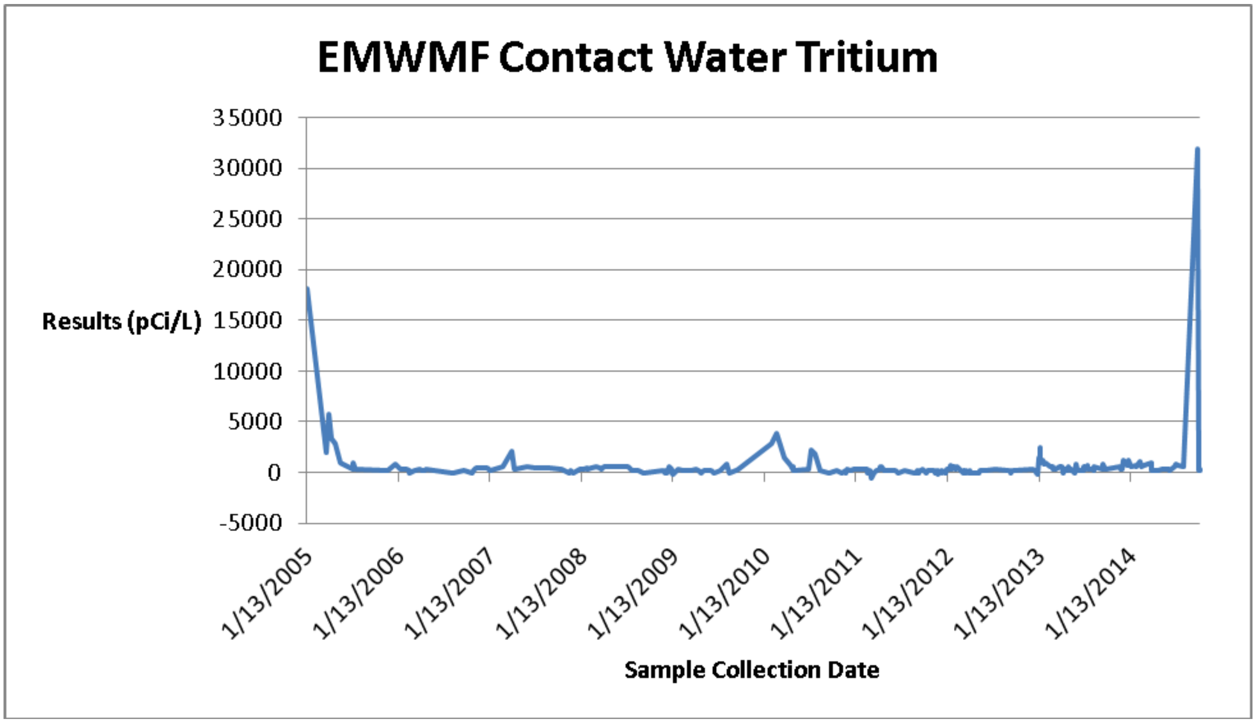


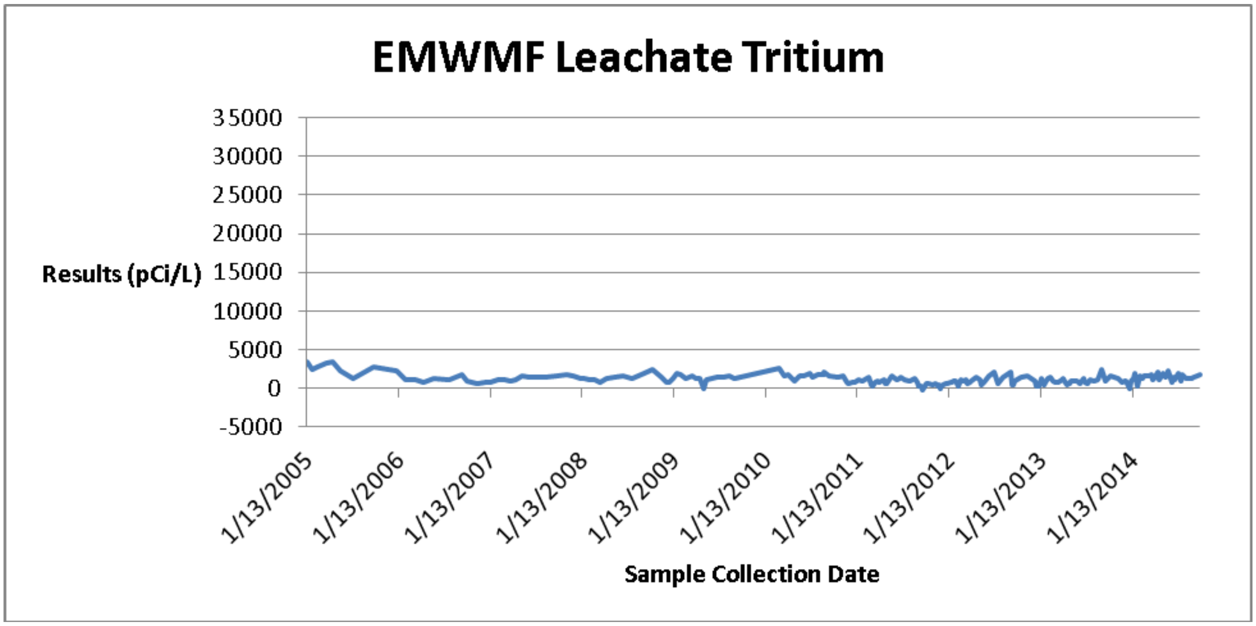


Tritium

Neither contact water nor leachate results have been close to this value over the last ten years. One result in October 2014 was approximately 32,000 pCi/L. However, this result is questionable because the results immediately before this result was below 1000 pCi/L and the result four days later was below 200 pCi/L. Because tritium behaves like water, a high spike in concentration, followed immediately by a decline, is unlikely.

Current criterion – 1,920,000 pCi/L





C.4.2 Pesticides

The proposed AWQC for EMWMF include the following pesticides:

- 4,4'-DDD
- 4,4'-DDE
- 4,4'-DDT
- Aldrin
- beta-BHC
- Dieldrin

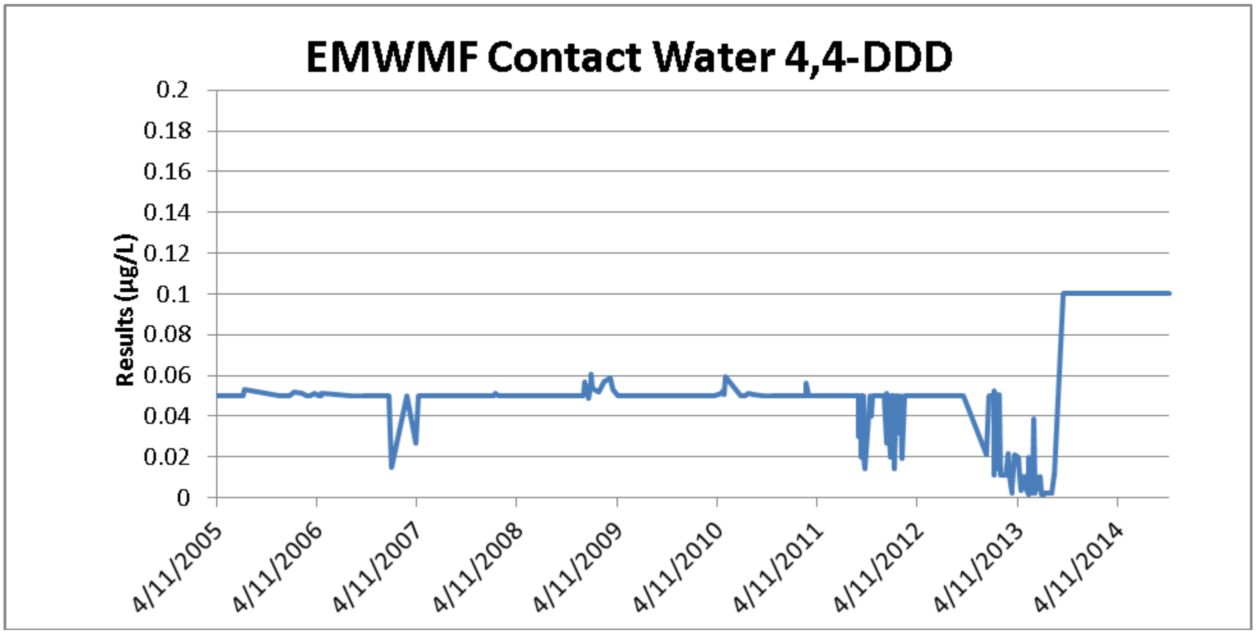
Significant quantities of these materials were not present in incoming waste lots disposed at EMWMF and were not identified as site-related contaminants. Instead, these materials are present as a result of intended use associated with the facilities that have been demolished and disposed at EMWMF, or as residual amounts in soil or debris from previous, remediated leaks or spills.

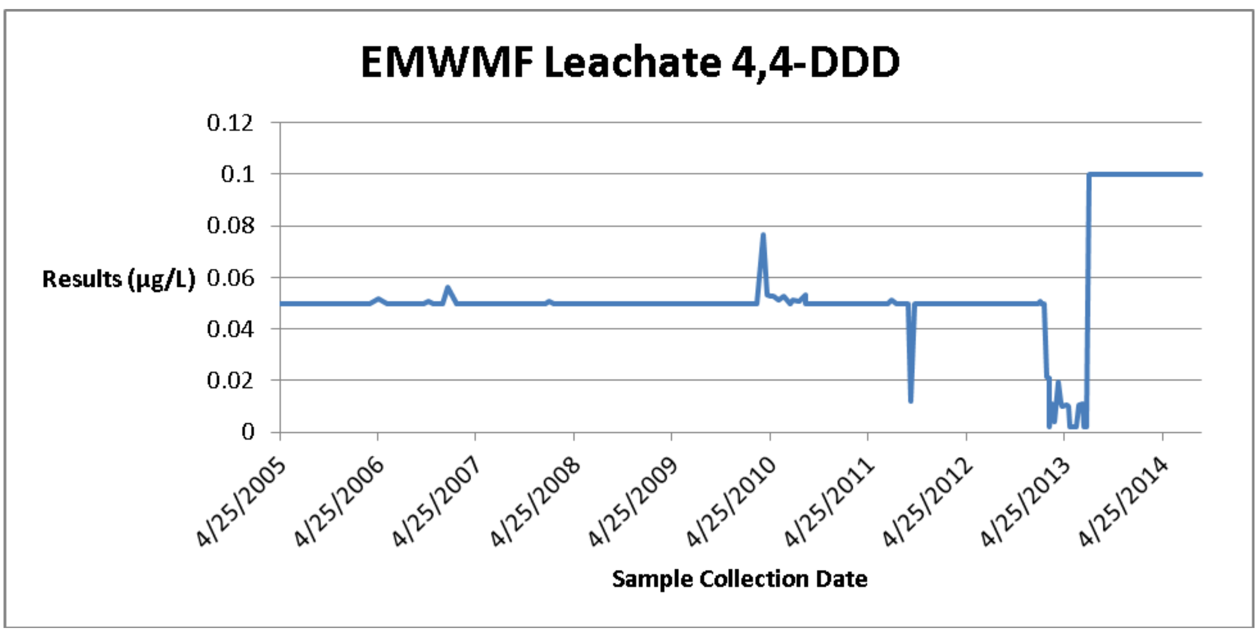
The contact water and leachate have been tested for these compounds for over 11 years at the detection limits, at or below the TDEC Rule 1200-04-03-.05-required method detection limits (RDLs). These results were lower than the applicable TDEC Fish and Aquatic Life discharge limits required for EMWMF. Almost all results have been non-detects. A few beta-BHC results were detected around April 2011 and the last quarter of calendar year 2011, but these were all below the RDL of 0.5 ug/l. A very small number of 4-4'-DDE results were above the RDL of 0.1 ug/l around the January 2013 time frame. Based on the presence of only residual amounts of these compounds in the waste, and that none of these were principle contaminants in the disposed waste, the required reporting limits are acceptable detection limits for these compounds.

4,4-DDD

Most of the variation in the graphs below are the result of changes in detection limits; however, there was one result greater than the AWQC and above the detection limit—0.051 ug/l on December 20, 2011. Samples were analyzed with lower detection limits, mostly lower than the AWQC, in late April through mid-August 2013. All results during this period were non-detects.

Recreational AWQC – 0.0031 ug/L CMC – n/a CMC – n/a RDL – 0.1 ug/L

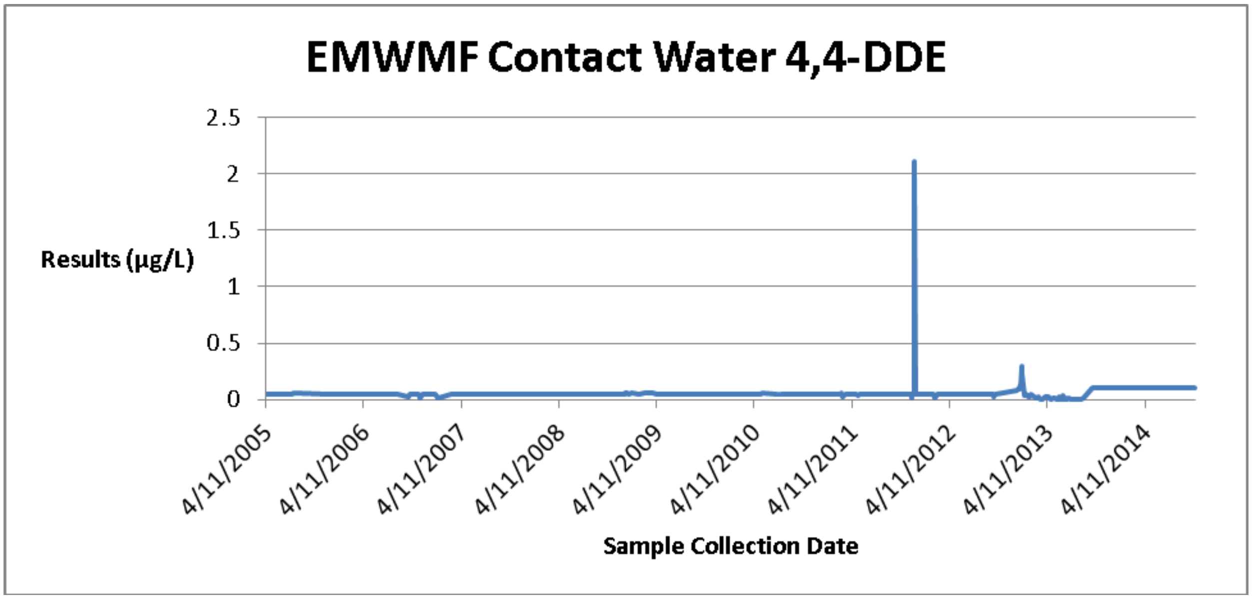


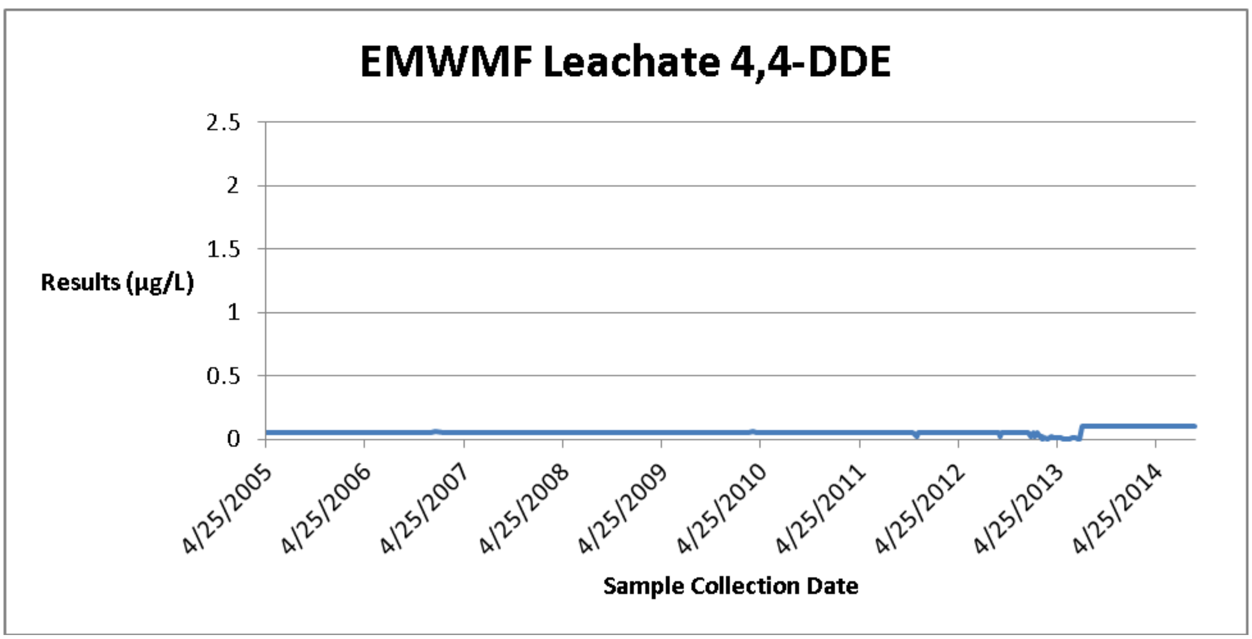


4,4-DDE

Most of the variation in the graphs below are the result of changes in detection limits; however, there was one result greater than the AWQC and above the detection limit—0.055 ug/l on March 2, 2011. Samples analyzed in December 2011 and January 2012 were mostly non-detects at the detection limit of 0.05. However, two samples had results of 2.11 and 1.96 ug/L. These results are suspect as these are orders of magnitude higher than the other, concurrent results. Samples were analyzed with lower detection limits, mostly lower than the AWQC, in late April through mid-August 2013. All results during this period were non-detects.

Recreational AWQC – 0.0022 ug/L CMC – n/a CMC – n/a RDL – 0.1 ug/L

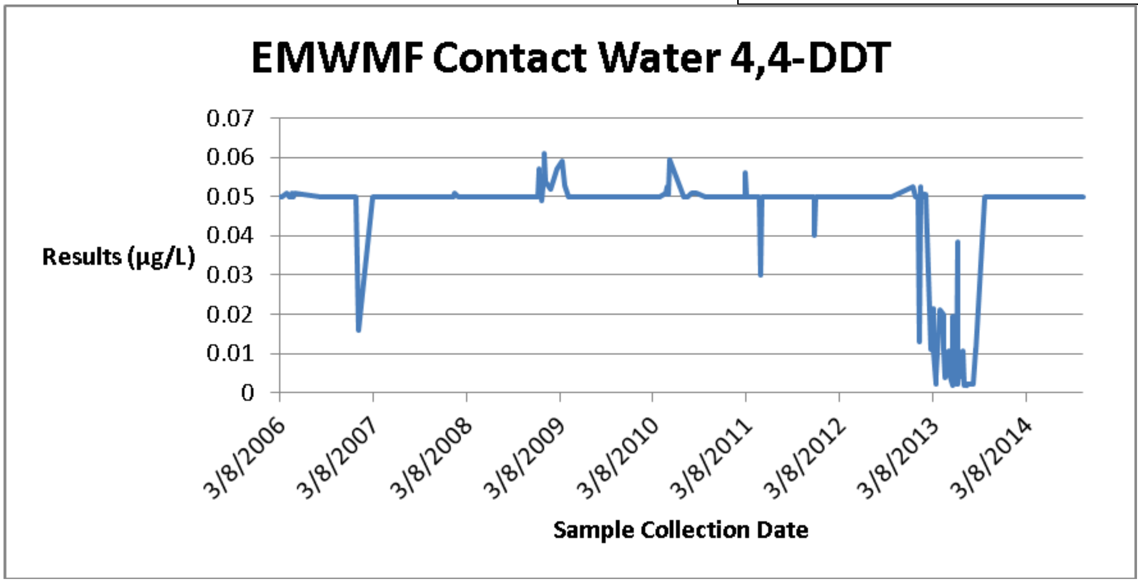


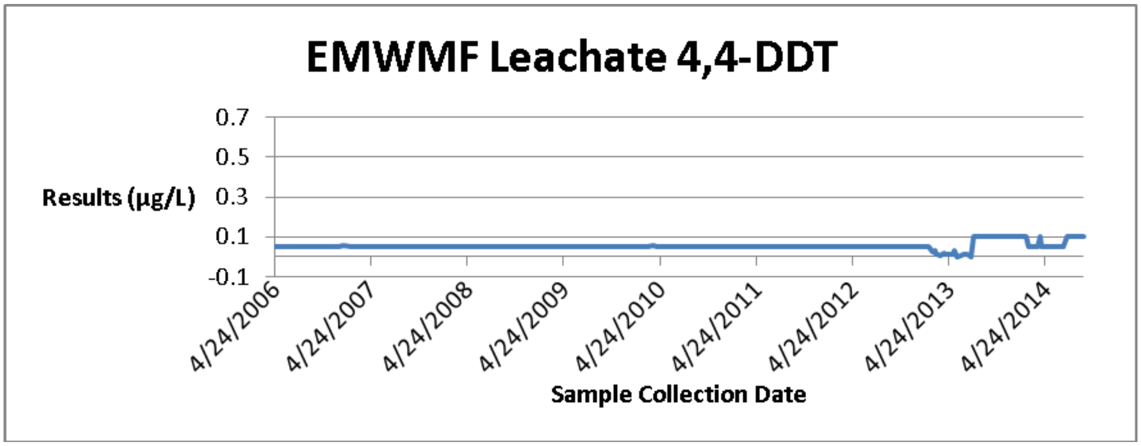


4,4-DDT

Most of the variation in the graphs below are the result of changes in detection limits, as only 2% of the results have been detected, although these have all been below the detection limit. However, from June 2014 on, the detection limit has been around 0.002 ug/L.

Recreational AWQC – 0.0022 ug/L
CMC – 1.1 ug/L
CMC – 0.001 ug/L
RDL – 0.1 ug/L

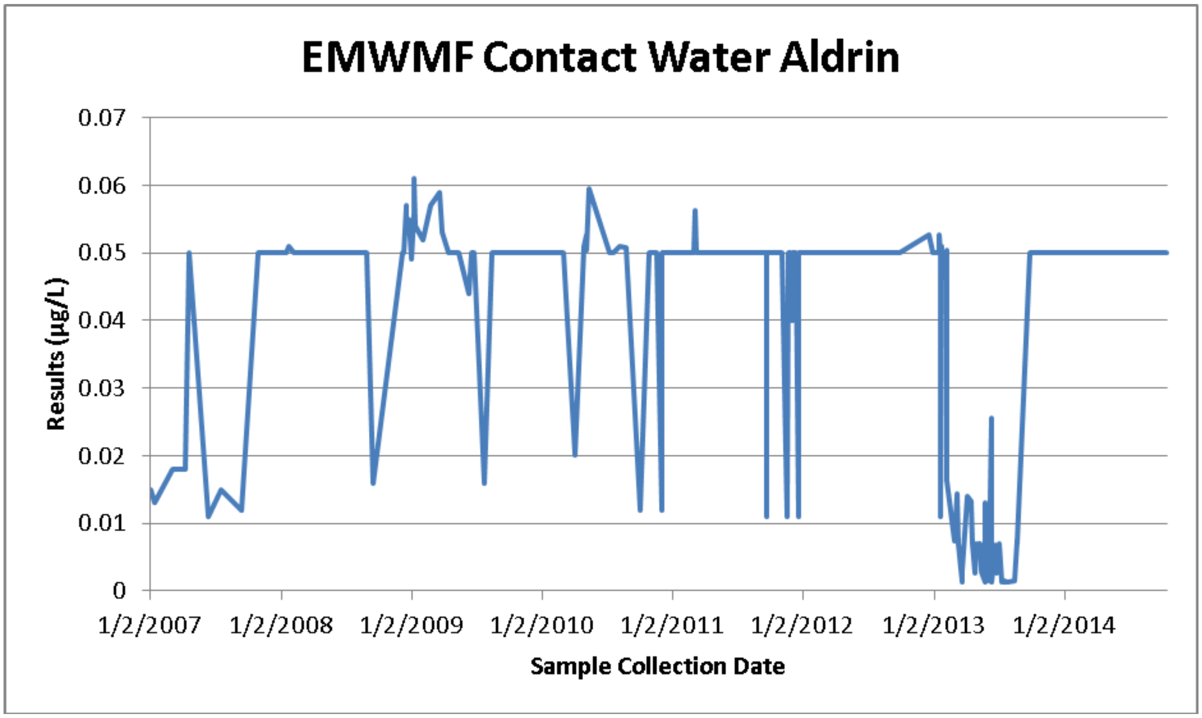


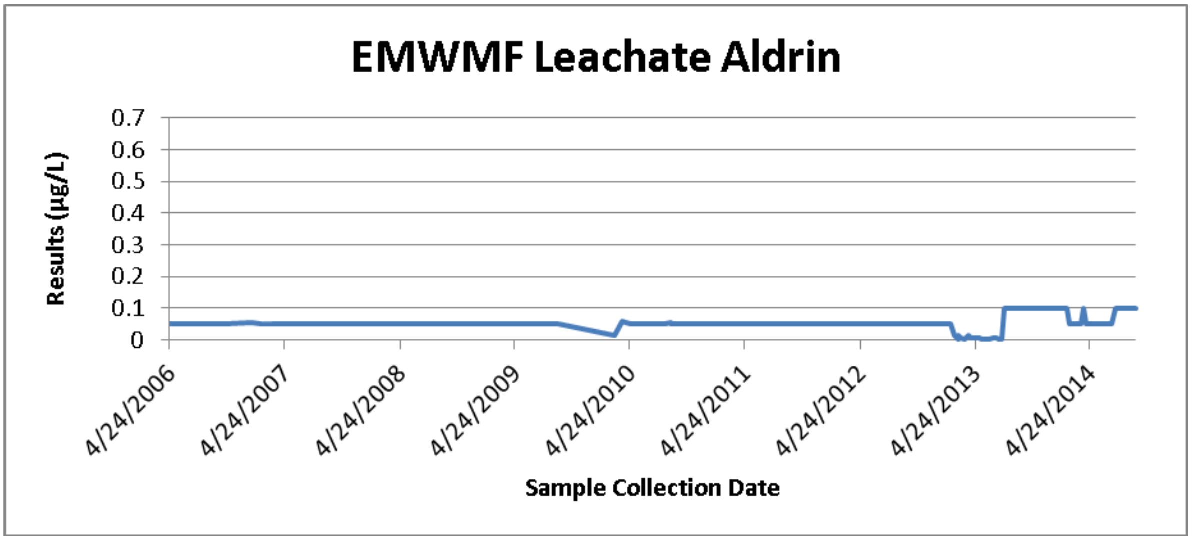


Aldrin

Most of the variation in the graphs below are the result of changes in detection limits, as only 2% of the results have been detected, although these have all been below the specified detection limit. However, from June 2014 on, the detection limit has been around 0.002 ug/L

Recreational AWQC – 0.0005 ug/L CMC – 3 ug/L CMC – 0.001 ug/L RDL – 0.5 ug/L

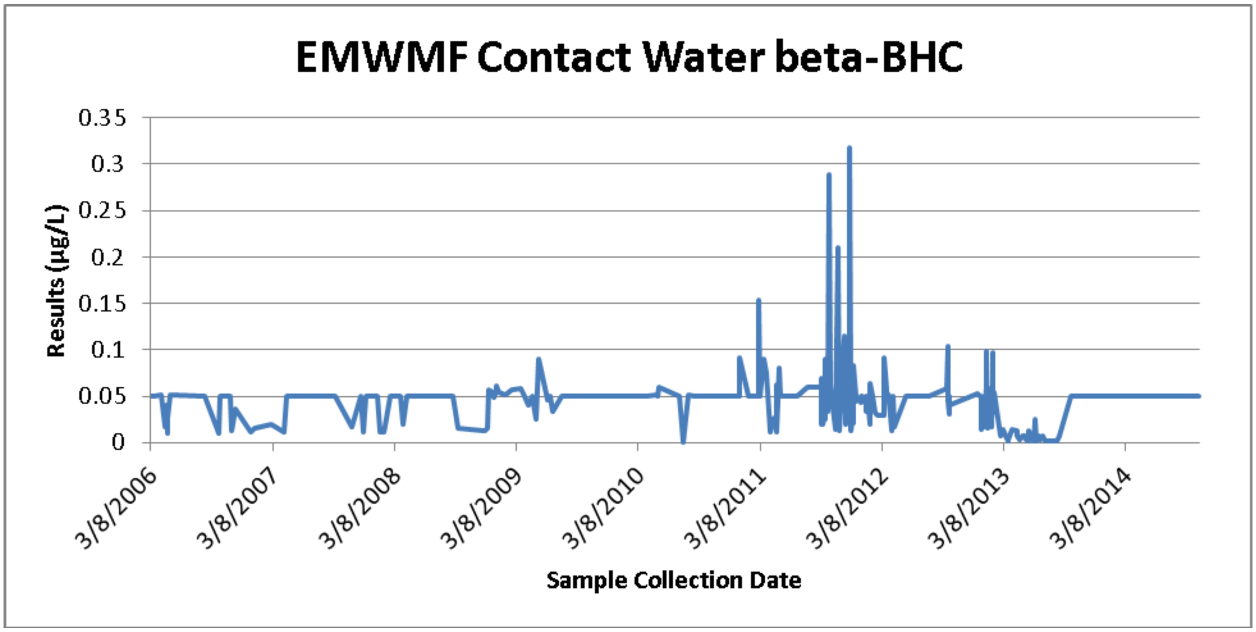


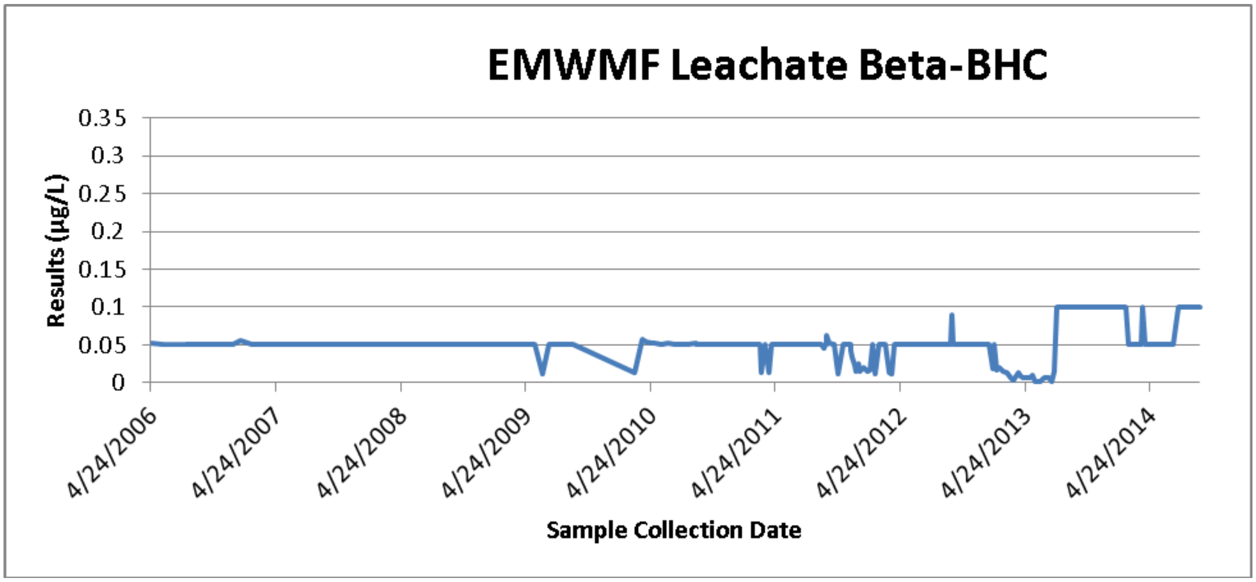


Beta BHC

There have been three instances in ten years, all within the same timeframe, when results were higher than the AWQC: September 29, 2011 (0.289 ug/L); October 26, 2011 (2.1 ug/L); and December 1, 2011 (0.318 ug/L). All other results are below the recreational AWQC and are mostly non-detects.

Recreational AWQC – 0.17 ug/L CMC – n/a CMC – n/a RDL – 0.5 ug/L (gamma BHC)

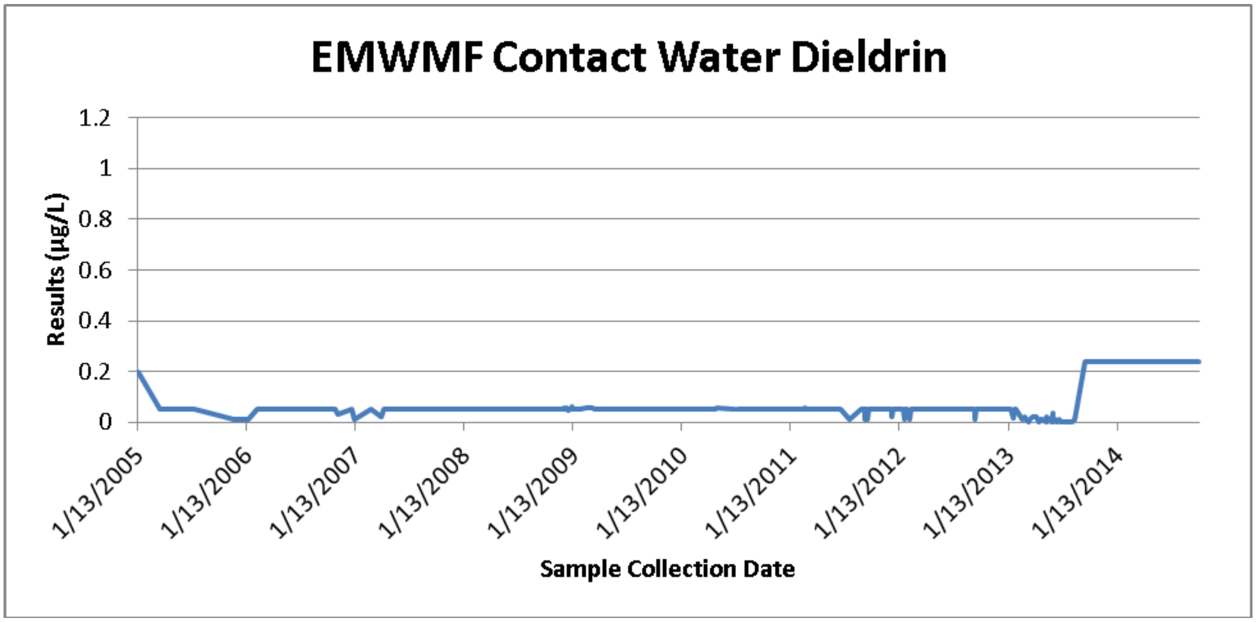


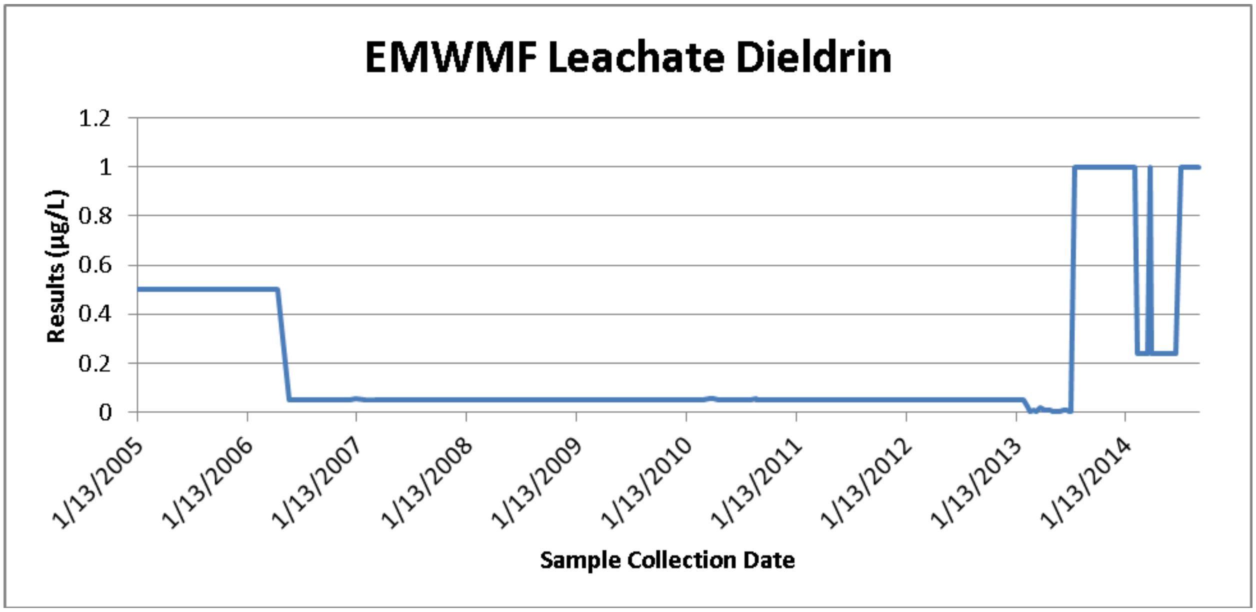


Dieldrin

The variation in the graphs below is the result of changes in detection limits, as only 2.5% of the results have been detected, all below the detection limit. The detection limit from May 2013 to mid-August 2013 was about 0.002 ug/L. All results during this period were non-detects.

Recreational AWQC – 0.00054 ug/L CMC – 0.2 ug/L CMC – 0.056 ug/L RDL – 0.05 ug/L





C.5 Summary

Based on the evaluation of the last two years of data, the COCs considered to require treatment for the FFS are mercury and cadmium if future operations rely on continuous release of wastewater to Bear Creek. Neither COC is currently expected to require treatment if there is batch release of waste water to Bear Creek.

Additional COCs that would have required treatment in the past under the FFS AWQC are:

- Copper
- Cyanide
- Lead
- U-238
- Sr-90

The potential that treatment may be required for these additional COCs will be considered during evaluation of the alternatives to determine if these could be effectively treated with minimal changes/upgrades.

Hexavalent chrome is anticipated to be reduced in the contact water ponds/tanks when this occurs.

As stated in Sect. C.4.2, pesticides are present in the waste because of their intended use at the facilities disposed at EMWMF. These are present in minor concentrations in the contact water and leachate. Therefore, the RDL will be used as the future detection limit. Concentrations are anticipated to be below these levels.

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APPENDIX C.
Attachment 1—Contact Water Data

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Analysis type	Code	Analyte	No. of analyses	No. of detected results	Detection frequency	Units	Min.	Max.	Project quantitation limit (MDA)	CMC AWQC TDEC Fish and Aquatic Life (batch)	CCC AWQC TDEC Fish and Aquatic Life (continuous)	TDEC AWQC recreation	96% of the DCGs	Max above FAL batch?	Max above FAL cont?	Max above recreation?	Max above DCGs?
HERB	2	2,4-D	2	0	0.0%	ug/L	.	.	0.5	-	-	-		-	-	-	-
HERB	2	Silvex	22	3	13.6%	ug/L	0.016	0.05	0.5	-	-	-		-	-	-	-
METAL	2	Aluminum	104	97	93.3%	ug/L	34.7	2490	50	-	-	-		-	-	-	-
METAL	2	Antimony	124	54	43.5%	ug/L	0.76	10.2	6	-	-	640		-	-	No	-
METAL	1	Arsenic	105	54	51.4%	ug/L	0.75	3.3	5	340	150	10		No	No	No	-
METAL	2	Barium	121	121	100.0%	ug/L	20.4	108	5	-	-	-		-	-	-	-
METAL	2	Beryllium	103	31	30.1%	ug/L	0.02	0.29	1	-	-	-		-	-	-	-
METAL	2	Boron	104	102	98.1%	ug/L	16.9	727	10	-	-	-		-	-	-	-
METAL	1	Cadmium	105	64	61.0%	ug/L	0.08	1	1	2.014	0.25	-		No	Yes	-	-
METAL	2	Calcium	104	104	100.0%	ug/L	18500	226000	250	-	-	-		-	-	-	-
METAL	1	Chromium	126	112	88.9%	ug/L	0.35	16.7	5	570	74	-		No	No	-	-
METAL	1	Chromium, hexavalent	202	93	46.0%	ug/L	6	112	6								
METAL	2	Cobalt	77	30	39.0%	ug/L	0.13	3.7	5	-	-	-		-	-	-	-
METAL	2	Copper	111	105	94.6%	ug/L	1.15	50.9	5	13	9	-		Yes	Yes	-	-
METAL	2	Hafnium	5	0	0.0%	ug/L			50	-	-	-		-	-	-	-
METAL	2	Iron	104	99	95.2%	ug/L	6.64	2490	50	-	-	-		-	-	-	-
METAL	1	Lead	121	61	50.4%	ug/L	0.64	6.2	3	64.581	2.5	-		No	Yes	-	-
METAL	2	Lithium	88	77	87.5%	ug/L	2.76	274	10	-	-	-		-	-	-	-
METAL	2	Magnesium	104	103	99.0%	ug/L	3760	33200	50	-	-	-		-	-	-	-
METAL	2	Manganese	104	101	97.1%	ug/L	0.734	736	5	-	-	-		-	-	-	-
METAL	1	Mercury	121	31	25.6%	ug/L	0.021	0.2	0.2	1.4	0.77	0.051		No	No	Yes	-
METAL	2	Molybdenum	78	77	98.7%	ug/L	1.5	24	5	-	-	-		-	-	-	-
METAL	1	Nickel	111	107	96.4%	ug/L	0.662	33.5	10	468.23	52	4600		No	No	No	-
METAL	2	Phosphorous	37	37	100.0%	ug/L	11	658	20	-	-	-		-	-	-	-
METAL	2	Potassium	104	103	99.0%	ug/L	938	7120	500	-	-	-		-	-	-	-
METAL	1	Selenium	270	56	20.7%	ug/L	0.24	8.1	5	20	5	-		No	Yes	-	-
METAL	1	Silver	105	4	3.8%	ug/L	0.22	0.47	1	3.217	-	-		No	-	-	-
METAL	2	Sodium	104	98	94.2%	ug/L	2890	31100	250	-	-	-		-	-	-	-
METAL	2	Strontium	119	118	99.2%	ug/L	40	625	50	-	-	-		-	-	-	-
METAL	1	Thallium	103	4	3.9%	ug/L	0.56	4.2	3	-	-	0.47		-	-	Yes	-
METAL	2	Tin	119	6	5.0%	ug/L	0.312	6.1	50	-	-	-		-	-	-	-
METAL	2	Titanium	67	60	89.6%	ug/L	0.19	19	5	-	-	-		-	-	-	-
METAL	1	Uranium	78	65	83.3%	ug/L	11.2	877	15	-	-	-		-	-	-	-
METAL	2	Vanadium	119	76	63.9%	ug/L	0.18	9.97	20	-	-	-		-	-	-	-
METAL	1	Zinc	112	102	91.1%	ug/L	2.7	187	10	117.18	120	-		Yes	Yes	No	-
METAL	2	Zirconium	10	9	90.0%	ug/L	0.736	2.77	50	-	-	-		-	-	-	-
Other	2	Asbestos	173	0	0.0%	fibers/L	.	.	200,000					-	-	-	-
Other	2	Chloride	2	2	100.0%	mg/L	15.1	17.4	0.1	-	-	-		-	-	-	-
Other	1	Cyanide	211	13	6.2%	ug/L	1.84	14.9	5	22	5.2	140		No	Yes	No	-
Other	2	Fluoride	2	2	100.0%	mg/L	0.5	0.59	0.05	-	-	-		-	-	-	-
Other	2	Nitrate	1	0	0.0%	mg/L	.	.	0.1	-	-	-		-	-	-	-

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Other	2	Suspended Solids	13	13	100.0%	mg/L	3.6	33.4	2.5	-	-	-		-	-	-	-
Other	2	Total Organic Carbon (TOC)	1	1	100.0%	mg/L	5.3	5.3	1	-	-	-		-	-	-	-
PPCB	1	4,4'-DDD	236	23	9.7%	ug/L	0.011	0.051	0.1	-	-	0.0031		-	-	Yes	-
PPCB	1	4,4'-DDE	236	25	10.6%	ug/L	0.01	0.293	0.1	-	-	0.0022		-	-	Yes	-
PPCB	1	4,4'-DDT	226	5	2.2%	ug/L	0.013	0.05	0.05	1.1	0.001	0.0022		No	Yes	Yes	-
PPCB	1	Aldrin	211	20	9.5%	ug/L	0.011	0.044	0.05	3	-	0.0005		No	-	Yes	-
PPCB	1	alpha-BHC	216	2	0.9%	ug/L	0.011	0.02	0.05	-	-	0.049		-	-	No	-
PPCB	2	alpha-Chlordane	238	3	1.3%	ug/L	0.01	0.023	0.05	-	-	-		-	-	-	-
PPCB	1	beta-BHC	226	97	42.9%	ug/L	0.001	0.289	0.05	-	-	0.17		-	-	Yes	-
PPCB	2	Chlordane	183	0	0.0%	ug/L	.	.	0.1	2.4	0.0043	0.0081		-	-	-	-
PPCB	2	delta-BHC	216	4	1.9%	ug/L	0.013	0.0372	0.05	-	-	-		-	-	-	-
PPCB	2	Dieldrin	273	15	5.5%	ug/L	0.001	0.03	0.24	0.24	0.056	0.00054		No	No	Yes	-
PPCB	1	Endosulfan I	211	12	5.7%	ug/L	0.011	0.026	0.05	0.22	0.056	89		No	No	No	-
PPCB	1	Endosulfan II	226	6	2.7%	ug/L	0.011	0.028	0.05	0.22	0.056	89		No	No	No	-
PPCB	1	Endosulfan sulfate	216	5	2.3%	ug/L	0.01	0.031	0.05	-	-	89		-	-	No	-
PPCB	1	Endrin	228	3	1.3%	ug/L	0.015	0.027	0.05	0.086	0.036	0.06		No	No	No	-
PPCB	1	Endrin aldehyde	236	1	0.4%	ug/L	0.012	0.012	0.05	-	-	0.3		-	-	No	-
PPCB	2	Endrin ketone	184	0	0.0%	ug/L	.	.	0.05	-	-	-		-	-	-	-
PPCB	2	gamma-Chlordane	238	11	4.6%	ug/L	0.011	0.045	0.05	-	-	-		-	-	-	-
PPCB	1	Heptachlor	186	7	3.8%	ug/L	0.011	0.015	0.05	0.52	0.0038	0.00079		No	Yes	Yes	-
PPCB	1	Heptachlor epoxide	228	8	3.5%	ug/L	0.011	0.0241	0.05	0.52	0.0038	0.00039		No	Yes	Yes	-
PPCB	1	Lindane	28	0	0.0%	ug/L	.	.	0.05	0.95	-	1.8		-	-	-	-
PPCB	2	Methoxychlor	212	21	9.9%	ug/L	0.011	0.05	0.05	-	-	-		No	-	No	-
PPCB	1	PCB-1016	269	0	0.0%	ug/L	.	.	0.5	0.5	-	0.00064		-	-	-	-
PPCB	1	PCB-1221	258	0	0.0%	ug/L	.	.	0.5	0.5	-	0.00064		-	-	-	-
PPCB	1	PCB-1232	258	0	0.0%	ug/L	.	.	0.5	0.5	-	0.00064		-	-	-	-
PPCB	1	PCB-1242	269	0	0.0%	ug/L	.	.	0.5	0.5	-	0.00064		-	-	-	-
PPCB	1	PCB-1248	258	0	0.0%	ug/L	.	.	0.5	0.5	-	0.00064		-	-	-	-
PPCB	1	PCB-1254	269	22	8.2%	ug/L	0.0434	0.34	0.5	0.5	-	0.00064		No	-	Yes	-
PPCB	1	PCB-1260	269	6	2.2%	ug/L	0.0151	0.14	0.5	0.5	-	0.00064		No	-	Yes	-
PPCB	1	PCB-1262	224	0	0.0%	ug/L	.	.	0.5	0.5	-	0.00064		-	-	-	-
PPCB	1	PCB-1268	226	0	0.0%	ug/L	.	.	0.5	0.5	-	0.00064		-	-	-	-
PPCB	1	Polychlorinated biphenyl	12	0	0.0%	ug/L	.	.	0.5	-	0.014	0.00064		-	-	-	-
PPCB		Toxaphene	2	0	0.0%	ug/L	.	.	5								
RAD	2	Actinium-227	107	7	6.5%	pCi/L	0.18	0.62	1.5				9.6	-	-	-	No
RAD	2	Alpha activity	62	60	96.8%	pCi/L	11.7	3,160					.	-	-	-	-
RAD	2	Aluminum-26	31	0	0.0%	pCi/L	.	.	10				9,600	-	-	-	-
RAD	1	Americium-241	273	17	6.2%	pCi/L	0.18	1.23	1				28.8	-	-	-	No
RAD	2	Americium-243	71	13	18.3%	pCi/L	0.19	0.5	1				28.8	-	-	-	No
RAD	1	Beta activity	62	59	95.2%	pCi/L	11.1	2,160	5				.	-	-	-	-
RAD		Californium-252	58	0	0.0%	pCi/L	-	-	10				96	-	-	-	-

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RAD	1	Carbon-14	274	28	10.2%	pCi/L	12.43	103.37	50				67,200				No
RAD	1	Cesium-137	272	13	4.8%	pCi/L	2.85	11.47	10				2,880	-	-	-	No
RAD	1	Chlorine-36	263	69	26.2%	pCi/L	2.03	302.36	50				48,000	-	-	-	No
RAD	1	Cobalt-60	239	1	0.4%	pCi/L	11.8	11.8	10				4,800	-	-	-	No
RAD	2	Curium-242	76	0	0.0%	pCi/L	.	.	10				960	-	-	-	-
RAD	2	Curium-243/244	76	3	3.9%	pCi/L	0.47	1.43	1				48	-	-	-	No
RAD	1	Curium-245	230	36	15.7%	pCi/L	0.18	0.83	1				28.8	-	-	-	No
RAD	1	Curium-246	230	36	15.7%	pCi/L	0.18	0.83	1				28.8	-	-	-	No
RAD	1	Curium-247	230	5	2.2%	pCi/L	0.23	0.94	1				28.8	-	-	-	No
RAD	2	Curium-248	104	12	11.5%	pCi/L	0.16	1.48	2				7.68	-	-	-	No
RAD	2	Europium-152	238	1	0.4%	pCi/L	26	26	10				19,200	-	-	-	No
RAD	2	Europium-154	238	0	0.0%	pCi/L	.	.	10				19,200	-	-	-	-
RAD	2	Europium-155	79	2	2.5%	pCi/L	3.9	6.21	10				96,000	-	-	-	No
RAD	1	Iodine-129	275	13	4.7%	pCi/L	0.65	5.15	5				480	-	-	-	No
RAD	2	Lead-210	185	17	9.2%	pCi/L	0.67	2.91	1				28.8	-	-	-	No
RAD	2	Neptunium-237	273	27	9.9%	pCi/L	0.12	4.2	1				28.8	-	-	-	No
RAD	2	Nickel-63	220	6	2.7%	pCi/L	24.8	78.7	7200				288,000	-	-	-	No
RAD	2	Plutonium-236	71	0	0.0%	pCi/L	.	.	1				96	-	-	-	-
RAD	2	Plutonium-238	242	5	2.1%	pCi/L	0.17	5.35	1				38.4	-	-	-	No
RAD	1	Plutonium-239/240	273	13	4.8%	pCi/L	0.13	3.84	1				28.8	-	-	-	No
RAD	2	Plutonium-241	222	1	0.5%	pCi/L	30	30	48				1,920	-	-	-	No
RAD	1	Plutonium-242	230	53	23.0%	pCi/L	0.09	1.58	1				28.8	-	-	-	No
RAD	2	Plutonium-244	71	0	0.0%	pCi/L	.	.	1				28.8	-	-	-	-
RAD	1	Potassium-40	233	31	13.3%	pCi/L	15.29	79.2	10				6,720	-	-	-	-
RAD	2	Protactinium-231	3	0	0.0%	pCi/L	.	.	300				9.6	-	-	-	-
RAD	2	Protactinium-234m	263	259	98.5%	pCi/L	0.3	637.6	100				67,200	-	-	-	No
RAD	1	Radium-226	261	68	26.1%	pCi/L	0.08	1.21	1				96	-	-	-	No
RAD	1	Radium-228	261	39	14.9%	pCi/L	0.57	83.1	1				96	-	-	-	No
RAD	1	Strontium-90	281	202	71.9%	pCi/L	1.31	953	4				960	-	-	-	No
RAD	1	Technetium-99	274	257	93.8%	pCi/L	3.98	4,840	10				96,000	-	-	-	No
RAD	2	Thorium-227	73	3	4.1%	pCi/L	0.18	0.62	1.5				3,840	-	-	-	No
RAD	1	Thorium-228	267	10	3.7%	pCi/L	0.17	0.55	1				384	-	-	-	No
RAD	1	Thorium-229	217	8	3.7%	pCi/L	0.09	1.48	9.6				38.4	-	-	-	No
RAD	1	Thorium-230	267	164	61.4%	pCi/L	0.15	3.08	1				288	-	-	-	No
RAD	1	Thorium-232	267	30	11.2%	pCi/L	0.13	0.85	1				48	-	-	-	No
RAD	1	Thorium-234	230	226	98.3%	pCi/L	0.3	93.1	240				9,600	-	-	-	No
RAD	1	Tritium	274	133	48.5%	pCi/L	283.13	7285.12	300				1,920,000	-	-	-	No
RAD	2	Uranium-232	71	9	12.7%	pCi/L	0.21	0.82	1				96	-	-	-	No
RAD	1	Uranium-233/234	274	267	97.4%	pCi/L	0.65	529.8	1				480	-	-	-	Yes
RAD	1	Uranium-235/236	273	242	88.6%	pCi/L	0.26	55.7	1				576	-	-	-	No
RAD	1	Uranium-236	6	5	83.3%	pCi/L	11.74	37.62	1				480	-	-	-	No

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RAD	1	Uranium-238	275	267	97.1%	pCi/L	0.3	749.6	1				576	-	-	-	Yes
RAD	2	Yttrium-90	233	152	65.2%	pCi/L	1.31	953	4				9,600	-	-	-	No
SVOA	2	1,2,4-Trichlorobenzene	247	0	0.0%	ug/L	.	.	10	-	-	70	-	-	-	-	-
SVOA	2	1,2-Dichlorobenzene	247	0	0.0%	ug/L	.	.	10	-	-	1300	-	-	-	-	-
SVOA	2	1,3-Dichlorobenzene	247	0	0.0%	ug/L	.	.	10	-	-	960	-	-	-	-	-
SVOA	2	1,4-Dichlorobenzene	249	1	0.4%	ug/L	1	1	10	-	-	190	-	-	-	No	-
SVOA	2	2,3,4,6-Tetrachlorophenol	229	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	2,4,5-Trichlorophenol	2	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	2,4,6-Trichlorophenol	2	0	0.0%	ug/L	.	.	10	-	-	24	-	-	-	-	-
SVOA	2	2,4-Dimethylphenol	225	23	10.2%	ug/L	2.03	7.27	10	-	-	850	-	-	-	No	-
SVOA	2	2,4-Dinitrophenol	225	0	0.0%	ug/L	.	.	25	-	-	5300	-	-	-	-	-
SVOA	2	2-Methylnaphthalene	235	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	2-Methylphenol	227	11	4.8%	ug/L	2.02	3.39	10	-	-	-	-	-	-	-	-
SVOA	2	3- and 4- Methylphenol	185	41	22.2%	ug/L	2.02	22	10	-	-	-	-	-	-	-	-
SVOA	2	4-Chloro-3-methylphenol	215	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	4-Methylphenol	14	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	Acenaphthene	273	3	1.1%	ug/L	0.165	0.328	10	-	-	990	-	-	-	No	-
SVOA	2	Acenaphthylene	220	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	Acetophenone	205	2	1.0%	ug/L	2.05	4	10	-	-	-	-	-	-	-	-
SVOA	2	Anthracene	225	16	7.1%	ug/L	0.183	3.44	10	-	-	40000	-	-	-	No	-
SVOA	2	Benz(a)anthracene	225	0	0.0%	ug/L	.	.	10	-	-	0.18	-	-	-	-	-
SVOA	2	Benzenemethanol	215	0	0.0%	ug/L	.	.	20	-	-	-	-	-	-	-	-
SVOA	2	Benzidine	96	0	0.0%	ug/L	.	.	50	-	-	0.002	-	-	-	-	-
SVOA	1	Benzo(a)pyrene	225	0	0.0%	ug/L	.	.	10	-	-	0.18	-	-	-	-	-
SVOA	2	Benzo(b)fluoranthene	225	0	0.0%	ug/L	.	.	10	-	-	0.18	-	-	-	-	-
SVOA	2	Benzo(ghi)perylene	225	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	Benzo(k)fluoranthene	225	0	0.0%	ug/L	.	.	10	-	-	0.18	-	-	-	-	-
SVOA	1	Benzoic acid	235	61	26.0%	ug/L	0.5	76.9	50	-	-	-	-	-	-	-	-
SVOA	1	Bis(2-ethylhexyl)phthalate	225	20	8.9%	ug/L	0.5	11	10	-	-	22	-	-	-	No	-
SVOA	2	Butyl benzyl phthalate	225	0	0.0%	ug/L	.	.	10	-	-	1900	-	-	-	-	-
SVOA	2	Carbazole	265	3	1.1%	ug/L	0.274	0.55	10	-	-	-	-	-	-	-	-
SVOA	2	Chrysene	225	0	0.0%	ug/L	.	.	10	-	-	0.18	-	-	-	-	-
SVOA	1	Dibenz(a,h)anthracene	225	0	0.0%	ug/L	.	.	10	-	-	0.18	-	-	-	-	-
SVOA	2	Dibenzofuran	225	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
		Dieldrin	1	0	0.0%	ug/L		.	0.24							-	
SVOA	1	Diethyl phthalate	225	9	4.0%	ug/L	0.5	2.02	10	-	-	44000	-	-	-	No	-
SVOA	1	Dimethyl phthalate	225	1	0.4%	ug/L	2.61	2.61	10	-	-	1100000	-	-	-	No	-
SVOA	1	Di-n-butyl phthalate	269	24	8.9%	ug/L	0.5	11	10	-	-	4500	-	-	-	No	-
SVOA	2	Di-n-octylphthalate	225	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA		Diphenylamine	26	0	0.0%	ug/L	.	.								-	
SVOA	2	Fluoranthene	225	5	2.2%	ug/L	0.172	0.265	10	-	-	140	-	-	-	No	-

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SVOA	2	Fluorene	225	2	0.9%	ug/L	0.2	0.242	10	-	-	5300	-	-	-	No	-
SVOA	2	Hexachlorobenzene	150	0	0.0%	ug/L	.	.	10	-	-	0.0029	-	-	-	-	-
SVOA	2	Hexachlorobutadiene	215	0	0.0%	ug/L	.	.	10	-	-	180	-	-	-	-	-
SVOA		Hexachloroethane	29	0	0.0%	ug/L	.	.	10							-	
SVOA	1	Indeno(1,2,3-cd)pyrene	225	0	0.0%	ug/L	.	.	10	-	-	0.18	-	-	-	-	-
SVOA	2	Isophorone	225	0	0.0%	ug/L	.	.	10	-	-	9600	-	-	-	-	-
SVOA		m+p Methylphenol	39	1	2.6%	ug/L	2.35	2.35	10							-	
SVOA	2	Naphthalene	265	6	2.3%	ug/L	0.242	4.88	10	-	-	-	-	-	-	-	-
SVOA	2	Nitrobenzene	2	0	0.0%	ug/L	.	.	10	-	-	690	-	-	-	-	-
SVOA	1	Pentachlorophenol	227	2	0.9%	ug/L	8.94	12.9	10	19	15	30	-	No	No	No	-
SVOA	2	Phenanthrene	225	6	2.7%	ug/L	0.195	2.27	10	-	-	-	-	-	-	No	-
SVOA	1	Phenol	229	43	18.8%	ug/L	2.31	18.7	10	-	-	1700000	-	-	-	No	-
SVOA	2	Pyrene	225	0	0.0%	ug/L	.	.	10	-	-	4000	-	-	-	-	-
SVOA	2	Pyridine	2	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA		(1,1-Dimethylethyl)benzene	27	0	0.0%	ug/L	.	.									
SVOA		(1-Methylpropyl)benzene	27	0	0.0%	ug/L	.	.									
VOA	2	1,1,1-Trichloroethane	211	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	1,1,2,2-Tetrachloroethane	16	0	0.0%	ug/L	.	.	5	-	-	40	-	-	-	-	-
VOA	2	1,1,2-Trichloroethane	185	0	0.0%	ug/L	.	.	5	-	-	160	-	-	-	-	-
VOA	2	1,1-Dichloroethane	211	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	1,1-Dichloroethene	191	0	0.0%	ug/L	.	.	5	-	-	7100	-	-	-	-	-
		1,2,3-Trimethylbenzene	13	0	0.0%	ug/L	.	.									
VOA	2	1,2,4-Trimethylbenzene	202	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	1,2-Dichloroethane	18	0	0.0%	ug/L	.	.	5	-	-	370	-	-	-	-	-
VOA	2	1,2-Dichloroethene	10	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	1,2-Dichloropropane	16	0	0.0%	ug/L	.	.	5	-	-	150	-	-	-	-	-
VOA	2	1,2-Dimethylbenzene	239	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	1,3,5-Trimethylbenzene	202	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA		1,3-Dimethylbenzene	24	0	0.0%	ug/L	.	.									
VOA	2	1-Methyl-4-(1-methylethyl)benzene	27	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	1	2-Butanone	228	3	1.3%	ug/L	2	6	10	-	-	-	-	-	-	-	-
VOA	2	2-Hexanone	217	1	0.5%	ug/L	2	2	10	-	-	-	-	-	-	-	-
VOA	2	4-Methyl-2-pentanone	253	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
VOA	1	Acetone	268	98	36.6%	ug/L	1	64.3	10	-	-	-	-	-	-	-	-
VOA	2	Acrylonitrile	149	0	0.0%	ug/L	.	.	20	-	-	2.5	-	-	-	No	-
VOA	2	Benzene	255	1	0.4%	ug/L	1.26	1.26	71	-	-	510	-	-	-	-	-
VOA	2	Bromodichloromethane	16	0	0.0%	ug/L	.	.	5					-	-	-	-
VOA	2	Bromoform	42	0	0.0%	ug/L	.	.	5	-	-	1400	-	-	-	-	-
VOA	2	Bromomethane	16	0	0.0%	ug/L	.	.	10					-	-	-	-
VOA	2	Carbon disulfide	226	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	1	Carbon tetrachloride	271	0	0.0%	ug/L	.	.	5	-	-	16	-	-	-	-	-

Analysis type	Code	Analyte	No. of analyses	No. of detected results	Detection frequency	Units	Min.	Max.	Project quantitation limit (MDA)	CMC AWQC TDEC Fish and Aquatic Life (batch)	CCC AWQC TDEC Fish and Aquatic Life (continuous)	TDEC AWQC recreation	96% of the DCGs	Max above FAL batch?	Max above FAL cont?	Max above recreation?	Max above DCGs?
VOA	2	Chlorobenzene	250	0	0.0%	ug/L	.	.	5	-	-	1600	-	-	-	-	-
VOA	2	Chloroethane	211	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
VOA	1	Chloroform	271	0	0.0%	ug/L	.	.	5	-	-	4700	-	-	-	-	-
VOA	2	Chloromethane	25	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
VOA	2	cis-1,2-Dichloroethene	211	1	0.5%	ug/L	0.31	0.31	5	-	-	-	-	-	-	-	-
VOA	2	cis-1,3-Dichloropropene	16	0	0.0%	ug/L	.	.	5					-	-	-	-
VOA	2	Cumene	217	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	Dibromochloromethane	16	0	0.0%	ug/L	.	.	5	-	-	170	-	-	-	-	-
VOA	2	Ethylbenzene	217	0	0.0%	ug/L	.	.	5	-	-	2100	-	-	-	-	-
VOA	1	Hexane	14	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
		M + P Xylene	41	0	0.0%	ug/L	.	.	5								
VOA	2	Methanol	148	3	2.0%	ug/L	440	1330	5	-	-	-	-	-	-	-	-
VOA	2	Methylcyclohexane	99	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	1	Methylene chloride	226	1	0.4%	ug/L	1.68	1.68	5	-	-	5900	-	-	-	Yes	-
VOA	2	Propylbenzene	176	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	1	Propylene glycol	150	5	3.3%	mg/L	11.3	31.6	20	-	-	-	-	-	-	-	-
VOA	2	Styrene	186	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	1	Tetrachloroethene	275	1	0.4%	ug/L	2	2	5	-	-	33	-	-	-	No	-
VOA	1	Toluene	273	1	0.4%	ug/L	1	1	5	-	-	15000	-	-	-	-	-
VOA	2	Total Xylene	241	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	trans-1,2-Dichloroethene	16	0	0.0%	ug/L	.	.	5					-	-	-	-
VOA	2	trans-1,3-Dichloropropene	16	0	0.0%	ug/L	.	.	5					-	-	-	-
VOA	1	Trichloroethene	275	1	0.4%	ug/L	0.33	0.33	5	-	-	300	-	-	-	-	-
VOA	1	Vinyl chloride	213	0	0.0%	ug/L	.	.	5	-	-	24		-	-	-	-

AWQC = ambient water quality criteria
CCC = criterion continuous concentration
CMC = criterion maximum concentration
DCG = derived concentration guidelines
FAL = fish and aquatic life
MDA = minimum detectable activity
PPCB = pesticides and polychlorinated biphenyls
RAD = radiological
SVOA = semivolatile organic analysis
TDS = total dissolved solids
TSS = total suspended solids
VOA = volatile organic analysis

APPENDIX C.
Attachment 2—Leachate Data

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Analysis type	Code	Analyte	No. of analyses	No. of detected results	Detection frequency	Units	Min.	Max.	Project quantitation limit (MDA)	CMC AWQC TDEC Fish and Aquatic Life (batch)	CCC AWQC TDEC Fish and Aquatic Life (continuous)	TDEC AWQC recreation	96% of the DCGs	Max above FAL batch?	Max above FAL cont?	Max above recreation?	Max above DCGs?
HERB	2	2,4,5-T	34	0	0.0%	ug/L	.	.	0.5	-	-	-		-	-	-	-
HERB	2	2,4-D	34	3	8.8%	ug/L	0.052	0.33	0.5	-	-	-		-	-	-	-
HERB	2	Silvex	134	2	1.5%	ug/L	0.174	0.386	0.5	-	-	-		-	-	-	-
METAL	2	Aluminum	182	169	92.9%	ug/L	21	2370	50	-	-	-		-	-	-	-
METAL	2	Antimony	194	21	10.8%	ug/L	0.62	3	6	-	-	640		-	-	No	-
METAL	1	Arsenic	164	23	14.0%	ug/L	0.15	3.6	5	340	150	10		No	No	No	-
METAL	2	Barium	196	195	99.5%	ug/L	29.5	137	5	-	-	-		-	-	-	-
METAL	2	Beryllium	162	11	6.8%	ug/L	0.02	0.12	1	-	-	-		-	-	-	-
METAL	2	Boron	182	181	99.5%	ug/L	25	1110	10	-	-	-		-	-	-	-
METAL	1	Cadmium	164	33	20.1%	ug/L	0.08	0.332	1	2.014	0.25	-		No	Yes	-	-
METAL	2	Calcium	182	182	100.0%	ug/L	30800	308000	250	-	-	-		-	-	-	-
METAL	1	Chromium	196	115	58.7%	ug/L	0.3	6.37	5	570	74	-		No	No	-	-
METAL	2	Cobalt	162	47	29.0%	ug/L	0.1	4.4	5	-	-	-		-	-	-	-
METAL	2	Copper	162	85	52.5%	ug/L	0.41	5	5	13	9	-		No	No	-	-
METAL	2	Hafnium	90	0	0.0%	ug/L	.	.	50	-	-	-		-	-	-	-
METAL	2	Iron	182	158	86.8%	ug/L	11.4	2390	50	-	-	-		-	-	-	-
METAL	1	Lead	196	21	10.7%	ug/L	0.36	4.53	3	64.581	2.5	-		No	Yes	-	-
METAL	2	Lithium	168	81	48.2%	ug/L	0.62	21.2	10	-	-	-		-	-	-	-
METAL	2	Magnesium	182	182	100.0%	ug/L	4730	38700	50	-	-	-		-	-	-	-
METAL	2	Manganese	182	182	100.0%	ug/L	0.87	1300	5	-	-	-		-	-	-	-
METAL	1	Mercury	183	7	3.8%	ug/L	0.065	0.22	0.2	1.4	0.77	0.051		No	No	Yes	-
METAL	2	Molybdenum	150	101	67.3%	ug/L	0.91	6.81	5	-	-	-		-	-	-	-
METAL	1	Nickel	191	132	69.1%	ug/L	0.56	15	10	468.23	52	4600		No	No	No	-
METAL	2	Phosphorous	135	101	74.8%	ug/L	12.7	74.2	20	-	-	-		-	-	-	-
METAL	2	Potassium	182	182	100.0%	ug/L	1600	10800	250	-	-	-		-	-	-	-
METAL	1	Selenium	196	21	10.7%	ug/L	0.48	4.46	5	20	5	-		No	-	-	-
METAL	1	Silver	171	2	1.2%	ug/L	0.15	0.24	1	3.217	-	-		-	-	-	-
METAL	2	Sodium	182	182	100.0%	ug/L	4380	72300	250	-	-	-		-	-	-	-
METAL	2	Strontium	194	194	100.0%	ug/L	80.7	886	5	-	-	-		-	-	-	-
METAL	1	Thallium	170	4	2.4%	ug/L	1.4	**2.02**	2	-	-	0.47		-	-	Yes	-
METAL	2	Tin	194	12	6.2%	ug/L	0.25	8.4	50	-	-	-		-	-	-	-
METAL	2	Titanium	146	86	58.9%	ug/L	0.259	40.1	5	-	-	-		-	-	-	-
METAL	1	Uranium	189	184	97.4%	ug/L	2.01	**388**	4	-	-	-		-	-	-	-
METAL	2	Vanadium	194	124	63.9%	ug/L	0.17	25.8	10	-	-	-		-	-	-	-
METAL	1	Zinc	182	126	69.2%	ug/L	0.53	97.5	10	117.18	120	-		No	No	-	-
METAL	2	Zirconium	126	28	22.2%	ug/L	0.81	5.21	50	-	-	-		-	-	-	-
Other	2	asbestos				fibers			200,000					-	-	-	-
Other	2	Bicarbonate EPA-310.1	38	38	100.0%	mg/L	113	318	na	-	-	-		-	-	-	-
Other	2	Carbonate EPA-310.1	38	0	0.0%	mg/L	.	.	na	-	-	-		-	-	-	-
Other	2	Chloride	41	41	100.0%	mg/L	4.25	36.6	0.1	-	-	-		-	-	-	-
Other	1	Cyanide	149	1	0.7%	ug/L	5.97	5.97	5	22	5.2	140		No	Yes	No	-

Analysis type	Code	Analyte	No. of analyses	No. of detected results	Detection frequency	Units	Min.	Max.	Project quantitation limit (MDA)	CMC AWQC TDEC Fish and Aquatic Life (batch)	CCC AWQC TDEC Fish and Aquatic Life (continuous)	TDEC AWQC recreation	96% of the DCGs	Max above FAL batch?	Max above FAL cont?	Max above recreation?	Max above DCGs?
Other	2	Dissolved Solids	41	41	100.0%	mg/L	125	1410	2.5	-	-	-		-	-	-	-
Other	2	Fluoride	40	38	95.0%	mg/L	0.13	0.57	0.05	-	-	-		-	-	-	-
Other	2	Nitrite as Nitrogen	1	1	100.0%	mg/L	1.1	1.1	0.1	-	-	-		-	-	-	-
Other	2	Sulfate	40	40	100.0%	mg/L	37.4	518		-	-	-		-	-	-	-
Other	2	Suspended Solids	48	27	56.3%	mg/L	1.15	1400	2.5	-	-	-		-	-	-	-
Other	2	Total Organic Carbon (TOC)	42	41	97.6%	mg/L	0.86	12.1	1	-	-	-		-	-	-	-
PPCB	1	4,4'-DDD	164	2	1.2%	ug/L	0.012	0.0767	0.1	-	-	0.0031		-	-	Yes	-
PPCB	1	4,4'-DDE	164	4	2.4%	ug/L	0.016	0.02	0.1	-	-	0.0022		-	-	Yes	-
PPCB	1	4,4'-DDT	158	2	1.3%	ug/L	0.0284	0.0288	0.05	1.1	0.001	0.0022		No	Yes	Yes	-
PPCB	1	Aldrin	153	1	0.7%	ug/L	0.014	0.014	0.05	3	-	0.0005		No	-	Yes	-
PPCB	1	alpha-BHC	156	12	7.7%	ug/L	0.00653	0.046	0.05	-	-	0.049		-	-	No	-
PPCB	2	alpha-Chlordane	165	0	0.0%	ug/L	.	.	0.05	-	-	-		-	-	-	-
PPCB	1	beta-BHC	157	28	17.8%	ug/L	0.0104	0.09	0.05	-	-	0.17		-	-	No	-
PPCB	2	Chlordane	15	0	0.0%	ug/L	.	.	0.1	2.4	0.0043	0.0081		-	-	-	-
PPCB	2	delta-BHC	156	1	0.6%	ug/L	0.0153	0.0153	0.05	-	-	-		-	-	-	-
PPCB	2	Dieldrin	170	0	0.0%	ug/L	.	.	0.24	0.24	0.056	0.00054		-	-	-	-
PPCB	1	Endosulfan I	149	3	2.0%	ug/L	0.011	0.014	0.05	0.22	0.056	89		No	No	No	-
PPCB	1	Endosulfan II	158	0	0.0%	ug/L	.	.	0.05	0.22	0.056	89		-	-	-	-
PPCB	1	Endosulfan sulfate	154	5	3.2%	ug/L	0.014	0.035	0.05	-	-	89		-	-	-	-
PPCB	1	Endrin	158	1	0.6%	ug/L	0.0155	0.0155	0.05	0.086	0.036	0.06		No	No	No	-
PPCB	1	Endrin aldehyde	164	3	1.8%	ug/L	0.011	0.031	0.05	-	-	0.3		-	-	No	-
PPCB	2	Endrin ketone	136	1	0.7%	ug/L	0.027	0.027	0.05	-	-	-		-	-	-	-
PPCB	2	gamma-Chlordane	165	4	2.4%	ug/L	0.012	0.019	0.05	-	-	-		-	-	-	-
PPCB	1	Heptachlor	137	0	0.0%	ug/L	.	.	0.05	0.52	0.0038	0.00079		-	-	-	-
PPCB	1	Heptachlor epoxide	158	4	2.5%	ug/L	0.00705	0.0184	0.05	0.52	0.0038	0.00039		No	Yes	Yes	-
PPCB	1	Lindane	50	1	2.0%	ug/L	0.027	0.027	0.05	0.95	-	1.8		No	-	No	-
PPCB	2	Methoxychlor	152	7	4.6%	ug/L	0.011	0.015	0.05	-	-	-		-	-	-	-
PPCB	1	PCB-1016	171	0	0.0%	ug/L	.	.	0.5	0.5	-	0.00064		-	-	-	-
PPCB	1	PCB-1221	161	0	0.0%	ug/L	.	.	0.5	0.5	-	0.00064		-	-	-	-
PPCB	1	PCB-1232	161	0	0.0%	ug/L	.	.	0.5	0.5	-	0.00064		-	-	-	-
PPCB	1	PCB-1242	191	1	0.5%	ug/L	0.276	0.276	0.5	0.5	-	0.00064		No	-	Yes	-
PPCB	1	PCB-1248	161	0	0.0%	ug/L	.	.	0.5	0.5	-	0.00064		-	-	-	-
PPCB	1	PCB-1254	191	1	0.5%	ug/L	0.19	0.19	0.5	0.5	-	0.00064		No	-	Yes	-
PPCB	1	PCB-1260	191	0	0.0%	ug/L	.	.	0.5	0.5	-	0.00064		-	-	-	-
PPCB	1	PCB-1262	147	0	0.0%	ug/L	.	.	0.5	0.5	-	0.00064		-	-	-	-
PPCB	1	PCB-1268	148	0	0.0%	ug/L	.	.	0.5	0.5	-	0.00064		-	-	-	-
PPCB	1	PCBs-Total								-	0.014	0.00064		-	-	-	-
RAD	2	Actinium-225	38	3	7.9%	pCi/L	0.18	1.43	24				960	-	-	-	No
RAD	2	Actinium-227	190	17	8.9%	pCi/L	0.18	0.98	1.3				9.6	-	-	-	No
RAD	2	Alpha activity	46	43	93.5%	pCi/L	5.7	**350.82**	5				.	-	-	-	-
RAD	2	Aluminum-26	150	0	0.0%	pCi/L	.	.	10				9,600	-	-	-	-

Analysis type	Code	Analyte	No. of analyses	No. of detected results	Detection frequency	Units	Min.	Max.	Project quantitation limit (MDA)	CMC AWQC TDEC Fish and Aquatic Life (batch)	CCC AWQC TDEC Fish and Aquatic Life (continuous)	TDEC AWQC recreation	96% of the DCGs	Max above FAL batch?	Max above FAL cont?	Max above recreation?	Max above DCGs?
RAD	2	Americium-243	162	30	18.5%	pCi/L	0.12	0.59	1				28.8	-	-	-	No
RAD	2	Antimony-126	45	0	0.0%	pCi/L	.	.	480				NA	-	-	-	-
RAD	2	Barium-133	27	0	0.0%	pCi/L	.	.	30				NA	-	-	-	-
RAD	1	Beta activity	46	44	95.7%	pCi/L	2.94	1240	5				.	-	-	-	No
RAD	2	Bismuth-207	45	0	0.0%	pCi/L	.	.	720				28,800	-	-	-	-
RAD	2	Californium-249	40	2	5.0%	pCi/L	0.12	0.31	1				28.8	-	-	-	No
RAD	2	Californium-250	40	0	0.0%	pCi/L	.	.	16.8				67.2	-	-	-	-
RAD	2	Californium-251	40	1	2.5%	pCi/L	0.39	0.39	0.072				28.8	-	-	-	No
RAD	2	Californium-252	147	0	0.0%	pCi/L	.	.	10				96	-	-	-	-
RAD	1	Carbon-14	193	10	5.2%	pCi/L	14.3	77.1	50				67,200	-	-	-	No
RAD	2	Cesium-135	45	0	0.0%	pCi/L	.	.	480				19,200	-	-	-	-
RAD	1	Cesium-137	195	1	0.5%	pCi/L	3.1	3.1	10				2,880	-	-	-	No
RAD	1	Chlorine-36	190	70	36.8%	pCi/L	2.51	75.72	50				48,000	-	-	-	No
RAD	1	Cobalt-60	171	2	1.2%	pCi/L	7.59	7.75	10				4,800	-	-	-	No
RAD	2	Curium-242	164	0	0.0%	pCi/L	.	.	10				960	-	-	-	-
RAD	2	Curium-243/244	168	3	1.8%	pCi/L	0.11	0.29	1				48	-	-	-	No
RAD	1	Curium-245	162	39	24.1%	pCi/L	0.12	0.62	1				28.8	-	-	-	No
RAD	1	Curium-246	162	39	24.1%	pCi/L	0.12	0.62	1				28.8	-	-	-	No
RAD	1	Curium-247	162	3	1.9%	pCi/L	0.25	0.51	1				28.8	-	-	-	No
RAD	2	Curium-248	190	14	7.4%	pCi/L	0.04	0.56	2				7.68	-	-	-	No
RAD	2	Europium-152	171	0	0.0%	pCi/L	.	.	10				19,200	-	-	-	-
RAD	2	Europium-154	171	0	0.0%	pCi/L	.	.	10				19,200	-	-	-	-
RAD	2	Europium-155	171	0	0.0%	pCi/L	.	.	10				96,000	-	-	-	-
RAD	1	Iodine-129	193	15	7.8%	pCi/L	0.39	12.8	5				480	-	-	-	No
RAD	2	Lead-210	141	20	14.2%	pCi/L	0.63	1.61	1				28.8	-	-	-	No
RAD	2	Lead-212	45	0	0.0%	pCi/L	.	.	72				2,880	-	-	-	-
RAD	2	Neptunium-237	193	17	8.8%	pCi/L	0.14	0.92	1				28.8	-	-	-	No
RAD	2	Nickel-59	40	0	0.0%	pCi/L	.	.	16800				672,000	-	-	-	-
RAD	2	Nickel-63	162	9	5.6%	pCi/L	18.6	60.14	7200				288,000	-	-	-	No
RAD	2	Niobium-93m	37	5	13.5%	pCi/L	56.63	1610	7200				288,000	-	-	-	No
RAD	2	Niobium-94	45	1	2.2%	pCi/L	4.36	4.36	720				28,800	-	-	-	No
RAD	2	Plutonium-236	149	1	0.7%	pCi/L	0.33	0.33	1				96	-	-	-	No
RAD	2	Plutonium-238	174	2	1.1%	pCi/L	0.15	0.25	1				38.4	-	-	-	No
RAD	1	Plutonium-239/240	193	7	3.6%	pCi/L	0.17	0.45	1				28.8	-	-	-	No
RAD	2	Plutonium-241	160	1	0.6%	pCi/L	30	30	48				1,920	-	-	-	No
RAD	1	Plutonium-242	160	42	26.3%	pCi/L	0.09	2.26	1				28.8	-	-	-	No
RAD	2	Plutonium-244	160	3	1.9%	pCi/L	0.16	0.54	1				28.8	-	-	-	No
RAD	2	Polonium-210	38	4	10.5%	pCi/L	0.28	0.57	2				76.8	-	-	-	No
RAD	1	Potassium-40	159	21	13.2%	pCi/L	28.3	183	10				6,720	-	-	-	No
RAD	2	Protactinium-231	30	0	0.0%	pCi/L	.	.	300				9.6	-	-	-	-
RAD	2	Protactinium-234m	190	187	98.4%	pCi/L	0.68	156.2	100				67,200	-	-	-	No

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RAD	2	Radium-223	45	2	4.4%	pCi/L	0.2	0.22	0.8				NA	-	-	-	-
RAD	2	Radium-225	45	2	4.4%	pCi/L	0.18	0.29	0.5				NA	-	-	-	-
RAD	1	Radium-226	178	20	11.2%	pCi/L	0.08	1.1	1				96	-	-	-	No
RAD	1	Radium-228	178	39	21.9%	pCi/L	0.52	9.11	1				96	-	-	-	No
RAD	2	Silver-108m	27	0	0.0%	pCi/L	.	.	30				NA	-	-	-	-
RAD	2	Strontium-89	39	0	0.0%	pCi/L	.	.	4				NA	-	-	-	-
RAD	1	Strontium-90	196	191	97.4%	pCi/L	2.94	471	4				960	-	-	-	No
RAD	1	Technetium-99	193	162	83.9%	pCi/L	4.11	983	10				96,000	-	-	-	No
RAD	2	Thorium-227	165	13	7.9%	pCi/L	0.18	0.48	1.5				3,840	-	-	-	No
RAD	1	Thorium-228	191	8	4.2%	pCi/L	0.17	2.91	1				384	-	-	-	No
RAD	1	Thorium-229	160	7	4.4%	pCi/L	0.12	17.7	9.6				38.4	-	-	-	No
RAD	1	Thorium-230	191	115	60.2%	pCi/L	0.14	74.49	1				288	-	-	-	No
RAD	1	Thorium-232	191	25	13.1%	pCi/L	0.16	5.57	1				48	-	-	-	No
RAD	1	Thorium-234	160	134	83.8%	pCi/L	0.68	140	240				9,600	-	-	-	No
RAD	2	Tin-126	38	0	0.0%	pCi/L	.	.	192				7,680	-	-	-	-
RAD	1	Tritium	193	181	93.8%	pCi/L	339	9234.86	300				1,920,000	-	-	-	No
RAD	2	Uranium-232	166	5	3.0%	pCi/L	0.29	0.76	1				96	-	-	-	No
RAD	1	Uranium-233/234	193	191	99.0%	pCi/L	3.92	127.7	1				480	-	-	-	No
RAD	1	Uranium-235/236	193	171	88.6%	pCi/L	0.29	20.21	1				576	-	-	-	No
RAD	1	Uranium-236	12	9	75.0%	pCi/L	0.72	8.18	1				480	-	-	-	No
RAD	1	Uranium-238	193	189	97.9%	pCi/L	0.68	156.2	1				576	-	-	-	No
RAD	2	Yttrium-90	160	158	98.8%	pCi/L	5.74	471	2				9,600	-	-	-	No
SVOA	2	1,2,4-Trichlorobenzene	161	0	0.0%	ug/L	0	0	10	-	-	70	-	No	No	No	-
SVOA	2	1,2-Dichlorobenzene	161	0	0.0%	ug/L	.	.	10	-	-	1300	-	-	-	Yes	-
SVOA	2	1,3-Dichlorobenzene	161	0	0.0%	ug/L	.	.	10	-	-	960	-	-	-	Yes	-
SVOA	2	1,4-Dichlorobenzene	161	0	0.0%	ug/L	.	.	10	-	-	190	-	-	-	Yes	-
SVOA	2	2,3,4,6-Tetrachlorophenol	150	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	2,4,5-Trichlorophenol	47	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	2,4,6-Trichlorophenol	35	0	0.0%	ug/L	.	.	10	-	-	24	-	-	-	Yes	-
SVOA	2	2,4-Dimethylphenol	154	0	0.0%	ug/L	.	.	10	-	-	850	-	-	-	-	-
SVOA	2	2,4-Dinitrophenol	155	0	0.0%	ug/L	.	.	25	-	-	5300	-	-	-	-	-
SVOA	2	2-Chloronaphthalene	39	0	0.0%	ug/L	.	.	10	-	-	1600	-	-	-	Yes	-
SVOA	2	2-Chlorophenol	47	0	0.0%	ug/L	.	.	10	-	-	150	-	-	-	Yes	-
SVOA	2	2-Methyl-4,6-dinitrophenol	47	0	0.0%	ug/L	.	.	10	-	-	280	-	-	-	Yes	-
SVOA	2	2-Methylnaphthalene	154	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	2-Methylphenol	154	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	2-Nitrobenzenamine	39	0	0.0%	ug/L	.	.	50	-	-	-	-	-	-	-	-
SVOA	2	2-Nitrophenol	35	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	3- and 4- Methylphenol	125	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	3,3'-Dichlorobenzidine	38	0	0.0%	ug/L	.	.	1	-	-	0.28	-	-	-	Yes	-
SVOA	2	4-Chloro-3-methylphenol	151	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-

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SVOA	2	4-Methylphenol	14	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	4-Nitrobenzenamine	38	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	4-Nitrophenol	27	0	0.0%	ug/L	.	.	25	-	-	-	-	-	-	-	-
SVOA	2	Acenaphthene	196	0	0.0%	ug/L	.	.	10	-	-	990	-	-	-	-	-
SVOA	2	Acenaphthylene	146	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	Acetophenone	146	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	Anthracene	159	0	0.0%	ug/L	.	.	10	-	-	40000	-	-	-	-	-
SVOA	2	Benz(a)anthracene	158	0	0.0%	ug/L	.	.	10	-	-	0.18	-	-	-	-	-
SVOA	2	Benzenemethanol	146	0	0.0%	ug/L	.	.	20	-	-	-	-	-	-	-	-
SVOA	2	Benzidine	121	0	0.0%	ug/L	.	.	50	-	-	0.002	-	-	-	-	-
SVOA	1	Benzo(a)pyrene	158	1	0.6%	ug/L	0.6	0.6	10	-	-	0.18	-	-	-	Yes	-
SVOA	2	Benzo(b)fluoranthene	158	0	0.0%	ug/L	.	.	10	-	-	0.18	-	-	-	-	-
SVOA	2	Benzo(ghi)perylene	147	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	Benzo(k)fluoranthene	158	0	0.0%	ug/L	.	.	10	-	-	0.18	-	-	-	-	-
SVOA	1	Benzoic acid	153	9	5.9%	ug/L	0.6	5.68	50	-	-	-		-	-	-	-
SVOA	1	Bis(2-ethylhexyl)phthalate	159	22	13.8%	ug/L	0.5	15	10	-	-	22	-	-	-	No	-
SVOA	2	Butyl benzyl phthalate	147	0	0.0%	ug/L	.	.	10	-	-	1900	-	-	-	-	-
SVOA	2	Carbazole	194	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	Chrysene	147	0	0.0%	ug/L	.	.	10	-	-	0.18	-	-	-	-	-
SVOA	1	Dibenz(a,h)anthracene	158	2	1.3%	ug/L	0.18	0.7	10	-	-	0.18	-	-	-	Yes	-
SVOA	2	Dibenzofuran	147	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	1	Diethyl phthalate	147	1	0.7%	ug/L	0.5	0.5	10	-	-	44000	-	-	-	No	-
SVOA	1	Dimethyl phthalate	147	1	0.7%	ug/L	1	1	10	-	-	1100000	-	-	-	No	-
SVOA	1	Di-n-butyl phthalate	194	11	5.7%	ug/L	0.8	2	10	-	-	4500	-	-	-	No	-
SVOA	2	Di-n-octylphthalate	149	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	Fluoranthene	159	0	0.0%	ug/L	.	.	10	-	-	140	-	-	-	-	-
SVOA	2	Fluorene	159	0	0.0%	ug/L	.	.	10	-	-	5300	-	-	-	-	-
SVOA	2	Hexachlorobenzene	105	0	0.0%	ug/L	.	.	10	-	-	0.0029	-	-	-	-	-
SVOA	2	Hexachlorobutadiene	143	0	0.0%	ug/L	.	.	10	-	-	180	-	-	-	-	-
SVOA	1	Indeno(1,2,3-cd)pyrene	158	1	0.6%	ug/L	0.6	0.6	10	-	-	0.18	-	-	-	Yes	-
SVOA	2	Isophorone	159	0	0.0%	ug/L	.	.	10	-	-	9600	-	-	-	-	-
SVOA	2	Naphthalene	196	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	2	Nitrobenzene	27	0	0.0%	ug/L	.	.	10	-	-	690	-	-	-	Yes	-
SVOA	2	N-Nitroso-di-n-propylamine	39	0	0.0%	ug/L	.	.	10	-	-	5.1	-	-	-	Yes	-
SVOA	2	N-Nitrosodiphenylamine	6	0	0.0%	ug/L	.	.	10	-	-	60	-	-	-	-	-
SVOA	1	Pentachlorophenol	167	21	12.6%	ug/L	0.104	1.75	10	19	15	30	-	No	No	No	-
SVOA	2	Phenanthrene	159	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
SVOA	1	Phenol	168	2	1.2%	ug/L	1	1	10	-	-	1700000	-	-	-	No	-
SVOA	2	Pyrene	147	0	0.0%	ug/L	.	.	10	-	-	4000	-	-	-	-	-
SVOA	2	Pyridine	27	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
VOA	2	1,1,1-Trichloroethane	730	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-

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VOA	2	1,1,2,2-Tetrachloroethane	157	0	0.0%	ug/L	.	.	5	-	-	40	-	-	-	Yes	-
VOA	2	1,1,2-Trichloro-1,2,2-trifluoroethane	118	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	1,1,2-Trichloroethane	673	0	0.0%	ug/L	.	.	5	-	-	160	-	-	-	-	-
VOA	2	1,1-Dichloroethane	730	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	1,1-Dichloroethene	683	0	0.0%	ug/L	.	.	5	-	-	7100	-	-	-	-	-
VOA	2	1,2,4-Trimethylbenzene	640	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	1,2-Dichloroethane	157	0	0.0%	ug/L	.	.	5	-	-	370	-	-	-	Yes	-
VOA	2	1,2-Dichloroethene	125	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	1,2-Dichloropropane	157	0	0.0%	ug/L	.	.	5	-	-	150	-	-	-	Yes	-
VOA	2	1,2-Dimethylbenzene	698	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	1,3,5-Trimethylbenzene	640	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	1-Methyl-4-(1-methylethyl)benzene	623	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	1	2-Butanone (Methyl Ethyl Ketone)	748	12	1.6%	ug/L	2	400	10	-	-	-	-	-	-	-	-
VOA	2	2-Hexanone	749	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
VOA	2	4-Methyl-2-pentanone	785	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
VOA	1	Acetone	819	60	7.3%	ug/L	2	680	10	-	-	-	-	-	-	-	-
VOA	2	Acrylonitrile	517	0	0.0%	ug/L	.	.	20	-	-	2.5	-	-	-	-	-
VOA	2	Benzene	785	0	0.0%	ug/L	.	.	71	-	-	510	-	-	-	-	-
VOA	2	Bromodichloromethane	157	0	0.0%	ug/L	.	.	5					-	-	-	-
VOA	2	Bromoform	218	0	0.0%	ug/L	.	.	5	-	-	1400	-	-	-	-	-
VOA	2	Bromomethane	157	0	0.0%	ug/L	.	.	10					-	-	-	-
VOA	2	Carbon disulfide	749	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	1	Carbon tetrachloride	821	1	0.1%	ug/L	7.3	**7.3**	5	-	-	16	-	-	-	No	-
VOA	2	Chlorobenzene	776	0	0.0%	ug/L	.	.	5	-	-	1600	-	-	-	-	-
VOA	2	Chloroethane	730	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
VOA	1	Chloroform	821	3	0.4%	ug/L	0.51	1.35	5	-	-	4700	-	-	-	No	-
VOA	2	Chloromethane	157	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
VOA	2	cis-1,2-Dichloroethene	730	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	cis-1,3-Dichloropropene	157	0	0.0%	ug/L	.	.	5					-	-	-	-
VOA	2	Cumene	702	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	Dibromochloromethane	157	0	0.0%	ug/L	.	.	5	-	-	170	-	-	-	Yes	-
VOA	2	Ethane	105	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
VOA	2	Ethylbenzene	752	0	0.0%	ug/L	.	.	5	-	-	2100	-	-	-	-	-
VOA	2	Ethylene	105	0	0.0%	ug/L	.	.	10	-	-	-	-	-	-	-	-
VOA	1	Hexane	603	1	0.2%	ug/L	1.22	1.22	10	-	-	-	-	-	-	-	-
VOA	2	Methane	105	10	9.5%	ug/L	1.01	8.15	10	-	-	-	-	-	-	-	-
VOA	2	Methanol	98	2	2.0%	ug/L	820	1800	5	-	-	-	-	-	-	-	-
VOA	2	Methylcyclohexane	752	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	1	Methylene chloride	749	21	2.8%	ug/L	1	**7**	5	-	-	5900	-	-	-	No	-
VOA	2	Propylbenzene	623	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	1	Propylene glycol	93	2	2.2%	mg/L	14.4	15.1	20	-	-	-	-	-	-	-	-

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VOA	2	Styrene	678	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	1	Tetrachloroethene	821	0	0.0%	ug/L	.	.	5	-	-	33	-	-	-	-	-
VOA	1	Toluene	821	4	0.5%	ug/L	0.97	12.8	5	-	-	15000	-	-	-	No	-
VOA	2	Total Xylene	785	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	2	trans-1,2-Dichloroethene	157	0	0.0%	ug/L	.	.	5					-	-	-	-
VOA	2	trans-1,3-Dichloropropene	157	0	0.0%	ug/L	.	.	5					-	-	-	-
VOA	1	Trichloroethene	821	2	0.2%	ug/L	3	**11**	5	-	-	300	-	-	-	No	-
VOA	2	Trimethylbenzene	66	0	0.0%	ug/L	.	.	5	-	-	-	-	-	-	-	-
VOA	1	Vinyl chloride	733	0	0.0%	ug/L	.	.	5	-	-	24		-	-	-	-

AWQC = ambient water quality criteria
CCC = criterion continuous concentration
CMC = criterion maximum concentration
DCG = derived concentration guidelines
FAL = fish and aquatic life
MDA = minimum detectable activity
PPCB = pesticides and polychlorinated biphenyls
RAD = radiological
SVOA = semivolatile organic analysis
TDS = total dissolved solids
TSS = total suspended solids
VOA = volatile organic analysis

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APPENDIX C.
Attachment 3—COC Winnowing Table

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Leachate		CURRENT leachate COC	CURRENT CW COC	CURRENT GW COC	AWQC (B,C,R,M,D)*	WASTE LOT ABUNDANCE (H, M, L)	MOBILITY (H, M, L, I)	REGULATORY CONCERN/ RISK (H, M, L)	NEW COC			COMMENTS
Analysis type	Analyte								Leachate	CW	GW	
DI/FURA	2,3,7,8-Tetrachlorodibenzo-p-dioxin			X	M	-	M	L				
HERB	2,4,5-T/Silvex	X		X	M	L	M	L				Incidental constituent from herbicide use
HERB	2,4-D	X			---	L	M	L				Incidental constituent from herbicide use
METAL	Aluminum	X	X	X	---	-	L	L				Low mobility based on geologic setting
METAL	Antimony	X	X	X	R,M	M	L	L				Low mobility based on geologic setting
METAL	Arsenic	X	X	X	B,C,R,M	-	L	H	X	X		Low mobility based on geologic setting
METAL	Barium	X	X	X	M	H	L	L				Common in geologic setting
METAL	Beryllium	X	X	X	M	-	L	L				Low mobility based on geologic setting
METAL	Boron	X	X	X	---	L	H	L				Low mobility based on geologic setting
METAL	Cadmium	X	X	X	B,C,M	-	L	L	X	X		Low mobility based on geologic setting
METAL	Calcium	X	X	X	---	-	H	H				Water quality concern, but common in EMWMF geologic setting
METAL	Chromium	X	X	X	B,C,M	H	L/H	L/H	X	X	X	Except for Cr VI, low mobility based on geologic setting
METAL	Cobalt	X	X	X	---	-	L	L				Low mobility based on geologic setting
METAL	Copper	X	X	X	B,C,M	-	L	H	X	X		Low mobility based on geologic setting
METAL	Hafnium	X	X	X	M	-	L	L				Low mobility based on geologic setting
METAL	Iron	X	X	X	---	-	L	L				Low mobility based on geologic setting
METAL	Lead	X	X	X	B,C,M	H	L	H	X	X		Low mobility based on geologic setting
METAL	Lithium	X	X	X	---	L	L	L				Low mobility based on geologic setting
METAL	Magnesium	X	X	X	---	-	L	L				Low mobility based on geologic setting
METAL	Manganese	X	X	X	---	M	L	L				Low mobility based on geologic setting
METAL	Mercury	X	X	X	B,C,R,M	L	H	H	X	X	X	Methylated mercury has high mobility
METAL	Molybdenum	X	X	X	---	M	L	L				Low mobility based on geologic setting
METAL	Nickel	X	X	X	B,C,R,M	-	L	L	X	X		Low mobility based on geologic setting
METAL	Phosphorous	X	X	X	---	-	H	L				

Leachate		CURRENT leachate COC	CURRENT CW COC	CURRENT GW COC	AWQC (B,C,R,M,D)*	WASTE LOT ABUNDANCE (H, M, L)	MOBILITY (H, M, L, I)	REGULATORY CONCERN/ RISK (H, M, L)	NEW COC			COMMENTS
Analysis type	Analyte								Leachate	CW	GW	
METAL	Potassium	X	X	X	---	-	H	L				
METAL	Selenium	X	X	X	B,C,M	M	L	L				Low mobility based on geologic setting
METAL	Silver	X	X	X	B	-	L	L				Low mobility based on geologic setting
METAL	Sodium	X	X	X	---	-	H	L				
METAL	Strontium	X	X	X	---	M	L	L				Low mobility based on geologic setting
METAL	Thallium	X	X	X	R,M	-	L	L				Low mobility based on geologic setting
METAL	Tin	X	X	X	---	M	L	L				Low mobility based on geologic setting
METAL	Titanium	X	X	X	---	-	L	L				Low mobility based on geologic setting
METAL	Uranium	X	X	X	M	-	H	L	X	X	X	The radioactive isotopes will be included as COCs
METAL	Vanadium	X	X	X	---	H	L	L				Low mobility based on geologic setting
METAL	Zinc	X	X	X	B,C	-	L	L				Low mobility based on geologic setting
METAL	Zirconium	X	X	X	---	-	L	L				Low mobility based on geologic setting
Other	Ammonia Nitrogen. Total as N					-	H	H	X	X		Generally ubiquitous in leachate
Other	asbestos	X	X		---	-	L	L				Not detected in discharges
Other	Bicarbonate EPA-310.1	X			---	-	H	L				
Other	Carbonate EPA-310.1	X			---	-	H	L				
Other	Chloride	X			---	-	H	L				
Other	Cyanide	X	X	X	B,C,R,M	L	H	H	X	X		
Other	Total Dissolved Solids/Conductivity	X			---	-	H	H	X	X		Daily recommended to evaluate whether discharge changes have occurred (a pulse)
Other	Fluoride	X			---	-	H	L				
Other	Hardness as CaCO3, mg/l					-	-	-	x	x		Required to determine toxicity of the EMWMF some metal COCs
Other	Nitrite as Nitrogen	X			---	-	H	L				
Other	Nitrogen, total (as N)						H	H	x	x		Nutrient which may impact stream health
Other	Nitrogen, Nitrate total (N)					-	H	H	x	x		Nutrient which may impact stream health
Other	Phosphorous, total as P					-	H	H	x	x		Nutrient which may impact stream health
Other	Sulfate	X			---	-	H	-				

Leachate		CURRENT leachate COC	CURRENT CW COC	CURRENT GW COC	AWQC (B,C,R,M,D)*	WASTE LOT ABUNDANCE (H, M, L)	MOBILITY (H, M, L, I)	REGULATORY CONCERN/ RISK (H, M, L)	NEW COC			COMMENTS
Analysis type	Analyte								Leachate	CW	GW	
Other	Total Suspended Solids	X			---	-	H	H	X	X		Transports adsorbed metals/PCBs - affects benthics
Other	Total Organic Carbon (TOC)	X			---	-	L	H	X	X		Instead of multiple VOCs/SVOCs
Other	Whole effluent toxicity - chronic/acute					-	-	H	X	X		Semi-annual or after a major change in waste characteristics. One sample during Sept–Nov low-flow period
PPCB	4,4'-DDD	X	X	X	R	L	I	H	X	X		From incidental use for intended purpose.
PPCB	4,4'-DDE	X	X	X	R	L	I	H	X	X		From incidental use for intended purpose.
PPCB	4,4'-DDT	X	X	X	B,C,R	-	I	H	X	X		From incidental use for intended purpose.
PPCB	Aldrin	X	X	X	B,R	L	I	L	X	X		
PPCB	alpha-BHC	X	X	X	R	L	L	L				
PPCB	alpha-Chlordane	X	X	X	---	-	L	L				
PPCB	beta-BHC	X	X	X	R	L	L	H	X	X		
PPCB	Chlordane	X	X	X	B,C,R,M	L	I	L				
PPCB	delta-BHC	X	X	X	---	L	L	L				
PPCB	Dieldrin	X	X	X	B,C,R	L	I	H	X	X		
PPCB	Endosulfan I	X	X	X	B,C,R	L	L	L				
PPCB	Endosulfan II	X	X	X	B,C,R	L	L	L				
PPCB	Endosulfan sulfate	X	X	X	R	-	I	L				
PPCB	Endrin	X	X	X	B,C,R,M	L	I	L				
PPCB	Endrin aldehyde	X	X	X	R	L	L	L				
PPCB	Endrin ketone	X	X	X	---	L	M	L				
PPCB	gamma-Chlordane	X	X	X	---	-	L	L				
PPCB	Heptachlor	X	X	X	B,C,R,M	L	I	L				
PPCB	Heptachlor epoxide	X	X	X	B,C,R	L	L	L				
PPCB	Lindane	X	X	X	B,R,M	L	L	L				
PPCB	Methoxychlor	X	X	X	M	-	L	L				
PPCB	PCB-1016	X	X	X	B,R,M	-	L	L				
PPCB	PCB-1221	X	X	X	B,R,M	-	L	L				
PPCB	PCB-1232	X	X	X	B,R,M	-	L	L				
PPCB	PCB-1242	X	X	X	B,R,M	-	L	L				
PPCB	PCB-1248	X	X	X	B,R,M	-	L	L				
PPCB	PCB-1254	X	X	X	B,R,M	-	I	L				
PPCB	PCB-1260	X	X	X	B,R,M	-	I	L				
PPCB	PCB-1262	X	X	X	B,R,M	-	L	L				
PPCB	PCB-1268	X	X	X	B,R,M	-	L	L				
PPCB	PCBs-Total	X	X		C,R	-	L	L				
PPCB	Toxaphene			X	M	-	L	L				

Leachate		CURRENT leachate COC	CURRENT CW COC	CURRENT GW COC	AWQC (B,C,R,M,D)*	WASTE LOT ABUNDANCE (H, M, L)	MOBILITY (H, M, L, I)	REGULATORY CONCERN/ RISK (H, M, L)	NEW COC			COMMENTS
Analysis type	Analyte								Leachate	CW	GW	
RAD	Actinium-225	X			D	-	-	-				Minimal detects - no further evaluation
RAD	Actinium-227	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Alpha activity	X	X	X	M	-	-	-				Screening level analysis only
RAD	Aluminum-26	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Americium-241	X	X	X	D	M	L	-				Minimal detects - no further evaluation
RAD	Americium-243	X		X	D	-	-	-				Not in waste lot/detects < 10% of DCG
RAD	Antimony-126	X		X	---	-	-	-				Minimal detects - no further evaluation
RAD	Barium-133	X			---	-	-	-				Minimal detects - no further evaluation
RAD	Beta activity	X	X	X	M	-	-	-				Screening level analysis only
RAD	Bismuth-207	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Californium-249	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Californium-250	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Californium-251	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Californium-252	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Carbon-14	X	X	X	D	L	H	L				Minimal detects - no further evaluation
RAD	Cesium-135	X		X	D	-	H	-				Minimal detects - no further evaluation
RAD	Cesium-137	X	X	X	D	-	H	-				Minimal detects - no further evaluation
RAD	Chlorine-36	X	X	X	D	-	-	-				Minimal detects - no further evaluation
RAD	Cobalt-60	X	X	X	D	-	M	-				Minimal detects - no further evaluation
RAD	Curium-242	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Curium-243/244	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Curium-245	X	X	X	D	-	-	-				Not in waste lot/detects < 10% of DCG
RAD	Curium-246	X	X	X	D	-	-	-				Not in waste lot/detects < 10% of DCG
RAD	Curium-247	X	X	X	D	-	-	-				Minimal detects - no further evaluation

Leachate		CURRENT leachate COC	CURRENT CW COC	CURRENT GW COC	AWQC (B,C,R,M,D)*	WASTE LOT ABUNDANCE (H, M, L)	MOBILITY (H, M, L, I)	REGULATORY CONCERN/ RISK (H, M, L)	NEW COC			COMMENTS
Analysis type	Analyte								Leachate	CW	GW	
RAD	Curium-248	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Europium-152	X	X	X	D	-	-	-				Minimal detects - no further evaluation
RAD	Europium-154	X	X	X	D	-	-	-				Minimal detects - no further evaluation
RAD	Europium-155	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Iodine-129	X	X	X	D	L	H	H	X	X	X	
RAD	Lead-210	X	X	X	D	-	-	-				Minimal detects - no further evaluation
RAD	Lead-212	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Neptunium-237	X	X	X	D	M	H	L				Minimal detects - no further evaluation
RAD	Nickel-59	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Nickel-63	X	X	X	D	-	-	-				Minimal detects - no further evaluation
RAD	Niobium-93m	X			D	-	-	-				Not in waste lot/detects < 10% of DCG
RAD	Niobium-94	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Plutonium-236	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Plutonium-238	X	X	X	D	-	-	-				Minimal detects - no further evaluation
RAD	Plutonium-239/240	X	X	X	D	M	L	L				Minimal detects - no further evaluation
RAD	Plutonium-241	X	X	X	D	-	-	-				Minimal detects - no further evaluation
RAD	Plutonium-242	X	X	X	D	-	-	-				Minimal detects - no further evaluation
RAD	Plutonium-244	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Polonium-210	X			D	-	-	-				Minimal detects - no further evaluation
RAD	Potassium-40	X	X	X	D	-	-	-				Not in waste lot/detects < 10% of DCG
RAD	Protactinium-231	X			D	-	-	-				Minimal detects - no further evaluation
RAD	Protactinium-234m	X	X	X	D	-	-	-				Not in waste lot/detects < 10% of DCG
RAD	Radium-223	X		X	---	-	-	-				Minimal detects - no further evaluation
RAD	Radium-225	X		X	---	-	-	-				Minimal detects - no further evaluation
RAD	Radium-226	X	X	X	D	-	-	-				Not in waste lot/detects < 10% of DCG

Leachate		CURRENT leachate COC	CURRENT CW COC	CURRENT GW COC	AWQC (B,C,R,M,D)*	WASTE LOT ABUNDANCE (H, M, L)	MOBILITY (H, M, L, I)	REGULATORY CONCERN/ RISK (H, M, L)	NEW COC			COMMENTS
Analysis type	Analyte								Leachate	CW	GW	
RAD	Radium-228	X	X	X	D	-	-	-				Not in waste lot/detects < 10% of DCG
RAD	Silver-108m	X			---	-	-	-				Minimal detects - no further evaluation
RAD	Strontium-89	X		X	---	-	H	-				Minimal detects - no further evaluation
RAD	Strontium-90	X	X	X	D,M	-	H	-	X	X	X	
RAD	Technetium-99	X	X	X	D	H	H	H	X	X	X	
RAD	Thorium-227	X		X	D,M	-	-	-				Minimal detects - no further evaluation
RAD	Thorium-228	X	X	X	D	-	-	-				Minimal detects - no further evaluation
RAD	Thorium-229	X	X	X	D	-	-	-				Minimal detects - no further evaluation
RAD	Thorium-230	X	X	X	D	-	-	-				U-234/238 daughter product (COCs)
RAD	Thorium-232	X	X	X	D	-	-	-				Not in waste lot/detects < 12% of DCG
RAD	Thorium-234	X	X	X	D	-	-	-				U-238 daughter/detects < 10% of DCG
RAD	Tin-126	X			D	-	-	-				Minimal detects - no further evaluation
RAD	Total Radium Alpha			X	---	-	-	-				Screening level analysis only
RAD	Tritium	X	X	X	D,M	L	H	H	X	X	X	
RAD	Uranium-232	X		X	D	-	-	-				Minimal detects - no further evaluation
RAD	Uranium-233/234	X	X	X	D	M	H	L	X	X	X	
RAD	Uranium-235/236	X	X	X	D	H	H	-	X	X	X	
RAD	Uranium-236	X	X	X	D	M	H	-				Minimal detects - no further evaluation
RAD	Uranium-238	X	X	X	D	H	H	-	X	X	X	
RAD	Yttrium-90	X	X	X	D	-	-	-				Not in waste lot/detects < 10% of DCG
SVOA	1,2,4-Trichlorobenzene	X	X	X	R,M	L	M	L				
SVOA	1,2-Dichlorobenzene	X	X	X	R,M	L	M	L				
SVOA	1,3-Dichlorobenzene	X	X	X	R	L	M	L				
SVOA	1,4-Dichlorobenzene	X	X	X	R,M	L	L	L				
SVOA	2,3,4,6-Tetrachlorophenol	X	X	X	---	L	H	L				
SVOA	2,4,5-Trichlorophenol	X		X	---	-	H	L				
SVOA	2,4,6-Trichlorophenol	X			R	-	H	L				
SVOA	2,4-Dimethylphenol	X	X	X	R	L	H	L				
SVOA	2,4-Dinitrophenol	X	X	X	R	-	H	L				
SVOA	2-Chloronaphthalene	X		X	R	-	L	L				
SVOA	2-Chlorophenol	X		X	R	-	H	L				
SVOA	2-Methyl-4,6-dinitrophenol	X		X	R	-	H	L				
SVOA	2-Methylnaphthalene	X	X	X	---	L	L	L				

Leachate		CURRENT leachate COC	CURRENT CW COC	CURRENT GW COC	AWQC (B,C,R,M,D)*	WASTE LOT ABUNDANCE (H, M, L)	MOBILITY (H, M, L, I)	REGULATORY CONCERN/ RISK (H, M, L)	NEW COC			COMMENTS
Analysis type	Analyte								Leachate	CW	GW	
SVOA	2-MethylphenoL (*o*-cresol)	X	X	X	---	-	H	L				
SVOA	2-Nitrobenzenamine	X		X	---	-	L	L				
SVOA	2-Nitrophenol	X			---	-	H	L				
SVOA	3- and 4- Methylphenol (*p*-cresol)	X	X	X	---	-	H	L				
SVOA	3,3'-Dichlorobenzidine	X		X	R	-	L	L				
SVOA	4-Chloro-3-methylphenol	X	X	X	---	-	H	L				
SVOA	4-Methylphenol	X	X	X	---	-	H	L				
SVOA	4-Nitrobenzenamine	X			---	-	L	L				
SVOA	4-Nitrophenol	X			---	-	H	L				
SVOA	Acenaphthene	X	X	X	R	L	L	L				
SVOA	Acenaphthylene	X	X	X	---	L	L	L				
SVOA	Acetophenone	X	X	X	---	L	L	L				
SVOA	Anthracene	X	X	X	R	-	I	L				
SVOA	Benz(a)anthracene	X	X	X	R	-	I	L				
SVOA	Benzenemethanol	X	X	X	---	-	L	L				
SVOA	Benzidine	X	X	X	R	L	L	L				Detected in less than five waste lots
SVOA	Benzo(a)pyrene	X	X	X	R,M	-	I	L				
SVOA	Benzo(b)fluoranthene	X	X	X	R	-	I	L				
SVOA	Benzo(ghi)perylene	X	X	X	---	-	L	L				
SVOA	Benzo(k)fluoranthene	X	X	X	R	-	I	L				
SVOA	Benzoic acid	X	X	X	---	L	H	L				
SVOA	Bis(2-ethylhexyl)phthalate	X	X	X	R	-	L	L				
SVOA	Butyl benzyl phthalate	X	X	X	R	-	L	L				
SVOA	Carbazole	X	X	X	---	L	L	L				
SVOA	Chrysene	X	X	X	R	-	I	L				
SVOA	Dibenz(a,h)anthracene	X	X	X	R	-	L	L				
SVOA	Dibenzofuran	X	X	X	---	-	L	L				
SVOA	Diethyl phthalate	X	X	X	R	L	H	L				
SVOA	Dimethyl phthalate	X	X	X	R	L	L	L				
SVOA	Di-n-butyl phthalate	X	X	X	R	L	M	L				
SVOA	Di-n-octylphthalate	X	X	X	---	-	L	L				
SVOA	Diphenylamine			X	---	-	L	L				
SVOA	Fluoranthene	X	X	X	R	-	L	L				
SVOA	Fluorene	X	X	X	R	-	L	L				
SVOA	Hexachlorobenzene	X	X	X	R,M	-	L	L				
SVOA	Hexachlorobutadiene	X	X	X	R	L	L	L				
SVOA	Hexachloroethane			X	---	-	L	L				
SVOA	Indeno(1,2,3-cd)pyrene	X	X	X	R	-	L	L				
SVOA	Isophorone	X	X	X	R	L	H	L				
SVOA	m+p Methylphenol		X	X	---	-	H	L				
SVOA	Naphthalene	X	X	X	---	L	L	L				
SVOA	Nitrobenzene	X			R	-	L	L				
SVOA	N-Nitroso-di-n-propylamine	X		X	R	-	L	L				

Leachate		CURRENT leachate COC	CURRENT CW COC	CURRENT GW COC	AWQC (B,C,R,M,D)*	WASTE LOT ABUNDANCE (H, M, L)	MOBILITY (H, M, L, I)	REGULATORY CONCERN/ RISK (H, M, L)	NEW COC			COMMENTS
Analysis type	Analyte								Leachate	CW	GW	
SVOA	N-Nitrosodiphenylamine	X			R	L	L	L				
SVOA	Pentachlorophenol	X	X	X	B,C,R,M	-	L	L				
SVOA	Phenanthrene	X	X	X	---	-	I	L				
SVOA	Phenol	X	X	X	R	L	H	L				
SVOA	Pyrene	X	X	X	R	-	I	L				
SVOA	Pyridine	X			---	-	L	L				
VOA	(1,1-Dimethylethyl)benzene			X	---	-	H	L				
VOA	(1-Methylpropyl)benzene			X	---	L	H	L				
VOA	1,1,1-Trichloroethane	X	X	X	M	-	M	L				
VOA	1,1,2,2-Tetrachloroethane	X		X	R	-	H	L				
VOA	1,1,2-Trichloro-1,2,2-trifluoroethane	X			---	-	M	L				
VOA	1,1,2-Trichloroethane	X	X	X	R	-	H	L				
VOA	1,1-Dichloroethane	X	X	X	---	-	H	L				
VOA	1,1-Dichloroethene	X	X	X	R,M	-	M	L				
VOA	1,2,3-Trimethylbenzene			X	---	-	H	L				
VOA	1,2,4-Trimethylbenzene	X	X	X	M	L	H	L				
VOA	1,2-Dichloroethane	X		X	R,M	-	H	L				
VOA	1,2-Dichloroethene	X		X	-	-	M	L				
VOA	1,2-Dichloropropane	X		X	R,M	-	H	L				
VOA	1,2-Dimethylbenzene	X	X	X	---	L	H	L				
VOA	1,3,5-Trimethylbenzene	X	X	X	---	L	H	L				
VOA	1-Methyl-4-(1-methylethyl)benzene	X		X	---	L	H	L				
VOA	2-Butanone (Methyl Ethyl Ketone)	X	X	X	---	-	M	L				
VOA	2-Hexanone	X	X	X	---	L	H	L				
VOA	4-Methyl-2-pentanone	X	X	X	---	-	H	L				
VOA	Acetone	X	X	X	---	L	H	L				
VOA	Acrylonitrile	X	X	X	R	-	H	L				
VOA	Benzene	X	X	X	R,M	L	H	L				
VOA	Bromodichloromethane	X		X	---	-	H	L				
VOA	Bromoform	X	X	X	R	L	H	L				
VOA	Bromomethane	X		X	---	-	H	L				
VOA	Carbon disulfide	X	X	X	---	L	M	L				
VOA	Carbon tetrachloride	X	X	X	R,M	L	M	L				
VOA	Chlorobenzene	X	X	X	R	L	M	L				
VOA	Chloroethane	X	X	X	---	-	H	L				
VOA	Chloroform	X	X	X	R	L	H	L				
VOA	Chloromethane	X		X	---	-	H	L				
VOA	cis-1,2-Dichloroethene	X	X	X	M	L	M	L				
VOA	cis-1,3-Dichloropropene	X		X	---	-	H	L				
VOA	Cumene	X	X	X	---	L	H	L				
VOA	Dibromochloromethane	X		X	R	-	H	L				
VOA	Ethane	X			---	-	H	L				
VOA	Ethylbenzene	X	X	X	R,M	L	L	L				
VOA	Ethylene	X			---	-	H	L				

Leachate		CURRENT leachate COC	CURRENT CW COC	CURRENT GW COC	AWQC (B,C,R,M,D)*	WASTE LOT ABUNDANCE (H, M, L)	MOBILITY (H, M, L, I)	REGULATORY CONCERN/ RISK (H, M, L)	NEW COC			COMMENTS
Analysis type	Analyte								Leachate	CW	GW	
VOA	Hexane	X	X	X	---	L	M	L				n-hexane detected in less than five waste lots
VOA	M + P Xylene		X	X	---	-	L	L				
VOA	Methane	X			---	-	H	L				
VOA	Methanol	X	X	X	---	-	H	L				
VOA	Methylcyclohexane	X	X	X	---	L	M	L				
VOA	Methylene chloride	X	X	X	R,M	L	H	L				
VOA	Propylbenzene	X	X	X	---	L	H	L				
VOA	Propylene glycol	X	X	X	---	L	H	L				
VOA	Styrene	X	X	X	M	L	M	L				
VOA	Tetrachloroethene	X	X	X	R,M	L	M	L				
VOA	Toluene	X	X	X	R,M	L	M	L				
VOA	Total Xylene	X	X	X	M	L	M	L				
VOA	trans-1,2-Dichloroethene	X		X	M	L	H	L				
VOA	trans-1,3-Dichloropropene	X		X	---	-	H	L				
VOA	Trichloroethene	X	X	X	R,M	L	M	L				
VOA	Trimethylbenzene	X		X	---	-	H	L				
VOA	Vinyl chloride	X	X	X	R,M	L	H	L				

B AWQC CMC (Batch Discharge)
C AWQC CCC (Continuous Discharge)
D 96% of the DCG (DOE O 5400.5)
H High
I Immobile
L Low
M MCL for GW/Medium
R AWQC Recreation
- Analyte not associated with a Waste Lot
Yellow Mobility class for common organic pollutants from C. W. Fetter (1994) *Applied Hydrogeology*, Prentice-Hall, Upper Saddle River, New Jersey.

AWQC = ambient water quality criteria
CCC = criterion continuous concentration
CMC = criterion maximum concentration
COC = contaminant of concern
CW = contact water
DCG = derived concentration guidelines
GW = groundwater
MCL = maximum contaminant level
MDA = minimum detectable activity
PCB = polychlorinated biphenyl
PPCB =pesticides and PCBs
RAD = radiological
SVOA = semivolatile organic analysis
SVOC = semivolatile organic compound
VOA = volatile organic analysis
VOC = volatile organic compound

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APPENDIX D.
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

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D.1. INTRODUCTION

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) Section 121 and 40 *Code of Federal Regulations* (CFR) 300.430(f)(1)(ii)(B) specify that removal actions for cleanup of hazardous substances must attain or have waived legally applicable or relevant and appropriate requirements (ARARs) under federal or more stringent state environmental laws.

Applicable requirements are “those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site” (40 CFR 300.5). Relevant and appropriate requirements are “those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting law that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site” (40 CFR 300.5). Pursuant to U.S. Environmental Protection Agency (EPA) guidance, where EPA has delegated to the State of Tennessee the authority to implement a federal program, the Tennessee regulations replace the equivalent federal requirements as the potential ARARs.

CERCLA on-site remedial response actions must comply only with the substantive requirements of a regulation and not the administrative requirements to obtain federal, state, or local permits [CERCLA Section 121(e)]. To ensure that CERCLA response actions proceed as rapidly as possible, EPA has reaffirmed this position in the final National Oil and Hazardous Substances Pollution Contingency Plan (NCP) [55 *Federal Register* (FR) 8756, March 8, 1990]. Substantive requirements pertain directly to the actions or conditions at a site, while administrative requirements facilitate their implementation (e.g., approval of or consultation with administrative bodies, documentation, permit issuance, reporting, record keeping, and enforcement).

The NCP at 40 CFR 300.400(e)(1) defines “on-site” as meaning “the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for the implementation of the response action.” CERCLA Sect. 104(d)(4) [as discussed further in the preamble to the final NCP, 55 FR 8690] states where two or more noncontiguous facilities are reasonably related on the basis of geography, or on the basis of the threat or potential threat to the public health or welfare or the environment, these related facilities may be treated as one for the purpose of conducting response actions. Section 104(d)(4) allows the lead agency to manage waste transferred between such noncontiguous facilities without having to obtain a permit [i.e., manage as “on-site” waste]. This approach was proposed and agreed to by all Federal Facility Agreement (FFA) parties for the Oak Ridge Reservation (ORR) Environmental Management Waste Management Facility (EMWMF) project and was acknowledged and documented in the signed EMWMF Record of Decision (ROD) [U.S. Department of Energy (DOE), 1999] and reaffirmed in the East Tennessee Technology Park Zone 2 ROD (DOE, 2005). This agreement serves as the basis for designating waste TSD facilities on the ORR as “on-site” facilities not subject to the CERCLA Off-site Rule (40 CFR 300.440) when accepting wastes from CERCLA on-site response actions.

ARARs include those federal and state regulations that are designed to protect the environment; ARARs do not include occupational safety regulations. EPA requires compliance with occupational and worker protection standards in Section 300.150 of the NCP, independent of the ARARs process. Therefore, neither the regulations promulgated by the U.S. Occupational Safety and Health Agency (OSHA) nor DOE Orders related to occupational safety are addressed or included as ARARs.

In addition to ARARs, 40 CFR 300.400(g)(3) states that federal or state nonpromulgated advisories or guidance may be identified as “to be considered” (TBC) guidance for contaminants, conditions, and/or actions at the site. TBCs include non-promulgated criteria, advisories, guidance, and proposed standards. TBCs are not ARARs because they are neither promulgated nor enforceable. TBCs may be used to interpret ARARs and to determine preliminary remediation goals (PRGs) when ARARs do not exist for particular contaminants or are not sufficiently protective to develop cleanup goals.

This section provides a preliminary identification of potential federal and state chemical-, location-, and action-specific ARARs and TBC guidance for the alternatives proposed under this focused feasibility study (FFS) to manage, treat (if necessary), and dispose of leachate and contact water generated by the Environmental Management Waste Management Facility (EMWMF) and the Environmental Management Disposal Facility (EMDF). Five alternatives are proposed and evaluated in this FFS: Alternative 1 – no action; Alternative 2 – on-site managed discharge; Alternative 3 – on-site treatment at EMWMF/EMDF (if necessary) and discharge to Bear Creek (batch or continuous); Alternative 4 – truck or pipe water to the Process Waste Treatment Complex (PWTC) at Oak Ridge National Laboratory (ORNL), an on-site (on-ORR) wastewater treatment facility for treatment and eventual discharge via a Clean Water Act (CWA) authorized outfall; and Alternative 5 – truck or pipe water to the West End Treatment Facility (WETF) at Y-12, an on-site (on-ORR) wastewater treatment facility for treatment and eventual discharge via a CWA authorized outfall.

Identification of ARARs is an iterative process; the ARARs listed in Table D.1 will be refined and changed as necessary as a remedial alternative is selected and the remedial design is further developed. The requirements listed in Table D.1 are triggered as ARARs if the particular jurisdictional prerequisite for that requirement (listed in Column 3 of the table) is met. For example, although there are wetlands in the project area, if the response action does not result in harm to or loss of these wetlands, then the requirements addressing mitigation of wetlands would not be triggered as ARARs. Final ARARs for the project will be set in the final decision document when the preferred alternative is chosen.

D.2. CHEMICAL-SPECIFIC ARARS

Chemical-specific ARARs provide health-or risk-based concentrations limits or discharge limitations in various environmental media (i.e., surface water, groundwater, soil, and air) for specific hazardous substances, pollutants, or contaminants. Chemical-specific ARARs identified for this action include Tennessee Department of Environment and Conservation (TDEC) ambient water quality criteria (AWQC) for surface waters of the state.

Surface water bodies in Tennessee are assigned use classifications by the Tennessee Water Quality Control Board. Those use classifications are not assigned based on surrounding land uses, and may have no relationship to how the surface water is currently being used. Tennessee surface water use classifications are listed in TDEC 0400-40-04. Bear Creek, near the EMWMF and the proposed EMDF, is classified by the state for Fish and Aquatic Life (FAL), Recreation (REC), Irrigation (IRR), and Livestock Watering and Wildlife (LWW) uses. All other named and unnamed surface waters in the Clinch River Basin, with the exception of wet weather conveyances, which have not been specifically treated, are classified for FAL, REC, LWW, and IRR uses per TDEC 0400-40-04-.09. Each of the use classifications has water quality standards set under TDEC 0400-40-03, although only the FAL and REC uses have specific numeric AWQC set for particular compounds. The REC AWQC are human health criteria and the FAL criteria are set for the protection of aquatic life. Although all of these criteria, both numeric and narrative, are all potential ARARs for any effluent discharges to Bear Creek, the specific criteria that would be applied and enforced as final limits at a point source outfall, should the selected remedy include an on-site water treatment facility at the EMWMF/EMDF, would be negotiated and set in the final decision document for this action and could include any subset of these criteria, as determined by the regulatory authorities. A preliminary subset of key contaminants of concern in the leachate/contact water has been identified and agreed to by the Federal Facility Agreement (FFA) parties; this subset has been used during the development and screening of remedial alternatives under this FFS. AWQC for this subset of contaminants of concern are listed in Table D.2. Other narrative water quality standards are included in Table D.1 as potential action-specific ARARs for on-site wastewater treatment under Alternative 3 (see Sect. D.4).

Although it is possible that there may be air pollutant emissions from the wastewater treatment system under Alternative 3, the amounts are not expected to be large enough to be considered a “major source” or to exceed emission thresholds and offset ratios allowed under Clean Air Act (CAA) regulations. The National Ambient Air Quality Standards (NAAQS) are established as the criteria state and local governments must plan to achieve and thus are not directly enforceable in and of themselves. Under the CAA §110, states are required to promulgate regulations to achieve the NAAQS and these state regulations are then the potential ARARs. The CAA National Emission Standards for Hazardous Air Pollutants (NESHAPs) for various industrial sources that emit one of several pollutants are established in 40 CFR 61. Most of the NESHAPs are neither applicable nor relevant and appropriate to cleanup at CERCLA sites because they regulate particular types of sources that would not be expected to be found at a CERCLA site (EPA, 1989; EPA, 1990; EPA, 1992a). No NESHAPs were identified as ARARs for this particular response action. Air regulations are discussed further as potential action-specific ARARs for Alternative 3 in Sect. D.4.

D.3. LOCATION-SPECIFIC ARARS

Location-specific requirements establish restrictions on permissible concentrations of hazardous substances or establish requirements for how activities will be conducted solely because they will take place in special locations. Several wetlands have been identified within or near the proposed area for siting the water treatment facilities. Potential location-specific ARARs, as listed in Table D.1, include those addressing wetlands, floodplains, aquatic resources, endangered species, migratory birds, and archaeological resources. Selection of a final alternative, as well as final siting of a water treatment facility (under Alternative 3) or selection of a treatment facility, method of water transfer, and final route for a transfer pipeline (if piping is selected under Alternative 4 or 5) will determine which of these are actually triggered as location-specific ARARs. Certainly any construction work within or near Bear Creek or its tributaries will trigger a number of ARARs designed to protect sensitive resources in or near those waters.

D.3.1 Floodplains/wetlands

Activities that affect wetlands are regulated under state and federal law. Impacts to wetlands from siting a new water treatment facility under Alternative 3 will be avoided whenever possible. If impacts were unavoidable, they would be minimized through steps such as project design changes or the implementation of best management practices (BMPs), erosion and sedimentation controls, and site restoration. The extent of wetlands impact will be determined based on a wetlands survey and other detailed design considerations. Compensatory mitigation would be carried out as required by the ARARs if necessary.

If the detailed design footprint of the water treatment plant and auxiliary facilities is within the 100- or 500-year floodplain, or construction activities would impact the floodplain, ARARs regarding impacts on the floodplains would be triggered.

Construction activities are assumed to impact these aquatic resources; mitigation activities are therefore assumed in the on-site treatment alternative.

D.3.2 Aquatic resources

The Fish and Wildlife Coordination Act requires federal agencies to consider the effect of water-related projects on fish and wildlife resources. The provisions of the Act are not legally applicable to those projects or activities carried out in connection with land use and management programs carried out by federal agencies on federal lands under their jurisdiction; however, the provisions may be relevant and appropriate for such activities.

The TDEC Division of Water Pollution Control requires Aquatic Resource Alteration Permits (ARAPs) for alterations of waters of the state, including wetlands. Typical actions that trigger these requirements include the impoundment, diversion, stream relocation, or other control or modifications of any body of water or wetland. General permits are available for wet weather conveyances, minor wetland alterations, minor road crossings, utility line crossings of streams, bank stabilization, sand and gravel dredging, debris removal, culvert maintenance, construction of a new outfall structure, and stream restoration. Since this project will be implemented under CERCLA, activities would be required to meet only the substantive requirements of the ARAP process, including such elements as BMPs and erosion and sedimentation controls.

Construction of a new outfall in Bear Creek, if necessary, will have direct aquatic impacts, triggering a number of location-specific ARARs. Actual design considerations will determine whether and to what extent aquatic impacts will occur.

D.3.3 Endangered, threatened or rare species

The EMWMF/EMDF site is not known to contain plants that are threatened or endangered, in need of management, or species of concern. A biologic and wetlands survey, however, is planned for the on-site disposal alternative for the proposed EMDF, which could discover sensitive species in need of protection in the area. In addition, the Tennessee dace (Phoxinus tennesseensis), which is listed as a “species in need of management” by the state of Tennessee, inhabit certain reaches of Bear Creek and several of its tributaries. Impacts associated with the selected remedy would be considered and mitigated as appropriate in accordance with the Tennessee Nongame and Endangered or Threatened Wildlife Species Conservation Act and associated ARARs, as listed in Table D.1.

Tennessee lists state-specific threatened, endangered, and in-need-of-management animal species in Tennessee Wildlife Resource Conservation Proclamations 00-14 and 00-15. The Tennessee endangered plant species are listed in TDEC 0400-06-02-.04. The TDEC Division of Natural Areas Tennessee Natural Heritage Program Rare Plant List may also be consulted for threatened and special status species.

DOE recently signed a Memorandum of Understanding (MOU) with the DOE and the Fish and Wildlife Service (FWS) regarding implementation of Executive Order 13186 “Responsibilities of Federal Agencies to Protect Migratory Birds” (September 12, 2013). The MOU requires DOE to coordinate with the FWS prior to DOE operations and activities with significant adverse effects on migratory birds and their habitats, and to initiate appropriate actions to avoid or minimize the take of migratory birds. Although the MOU and the consultation it requires might be considered an administrative requirement under CERCLA, DOE will take appropriate actions, as necessary, to avoid or minimize the take of migratory birds as required by Executive Order 13186, which is listed as a TBC in Table D.1, should any migratory birds or their habitats be identified in the project area during implementation of the remedy.

D.3.4 National Environmental Research Park

Approximately 13,600 acres of the ORR have been designated as a DOE National Environmental Research Park to protect biological diversity through the protection of special habitats. The DOE research parks are used to evaluate the environmental consequences of energy use and development as well as strategies to mitigate these effects. They are also used to demonstrate possible environmental and land-use options. Portions of the ORR Research Park are located in the proximity of the Y-12 and ORNL sites. Some Research Park areas need to be protected from all manipulations for definite or indefinite periods of time in order to serve as controls. While execution of the program missions of DOE sites must be ensured, ongoing environmental research projects and protected natural areas must be given careful consideration in any site-use decisions. Under Alternative 4 or 5, if piping is selected as the mode of transport of wastewater to a WWTU, special consideration will need to be given to any research areas along the pipeline route.

D.3.5 Cultural resources

There are no known significant historic or archaeological resources within the EMWMF/EMDF footprint or support facilities area where a water treatment facility and its associated support facilities would be built. No prehistoric sites are known to exist at the area that would be impacted by proposed construction activities. If any such resources (e.g., Native American remains) are discovered or unearthed at any time during site grading or excavation activities, work will be suspended until applicable requirements, as detailed in Table D.1, are met. Several statutes and regulations protect cultural resources, such as Native American artifacts, that may be discovered. If such a discovery is made at any time during project activities, the artifacts or remains must be reasonably protected from disturbance and all activity in the discovery area must cease until the site and artifacts are properly evaluated.

D.4. ACTION-SPECIFIC ARARS

Performance, design, or action-specific requirements set controls or restrictions on particular kinds of activities related to the management of waste and are usually technology- or activity-based standards or limitations depending on the type of waste.

Pursuant to EPA guidance (EPA, 1991), there are no ARARs for a No Action alternative (Alternative 1). All three proposed action alternatives include water monitoring, management, and disposal; site preparation, construction or excavation activities; waste management and disposal; and some level of on-site transportation of potentially hazardous secondary wastes. ARARs for these activities are listed in Table D.1. Alternative 3 also includes on-site (at the EMWMF/EMDF) treatment of leachate/contact water, including construction of a WWTU, with on-site discharge to Bear Creek. Alternative 5 includes similar construction and treatment but at WETF. Additional action-specific ARARs for these two alternatives are listed at the end of Table D.1.

Although the EMWMF and the proposed EMDF are designed to accept RCRA Subtitle C hazardous waste, no RCRA listed hazardous waste has been disposed at EMWMF and all RCRA characteristic waste sent to the EMWMF has been treated to meet RCRA land disposal restrictions (LDRs) prior to transfer. Years of leachate and contact water sampling data indicate none of the water contains RCRA characteristic waste. No RCRA listed waste is expected to be disposed at the proposed EMDF. Estimates of future waste streams at the EMDF, however, indicate there may be enough mercury to cause leachate or contact waters to fail TCLP for hazardous characteristics, which would cause the wastewater stream to be characteristically hazardous.

On-site wastewater treatment units that are part of a wastewater treatment facility subject to regulation under Section 402 or Section 307(b) of the CWA are exempt from the requirements of RCRA Subtitle C for all tank systems, conveyance systems (whether piped or trucked), and ancillary equipment used to store or transport RCRA contaminated water. Therefore, RCRA requirements are not legally applicable to the wastewater treatment facility(ies) under Alternatives 3, 4 and 5, including any tanks/containers and surface impoundments (Alternative 3 and 5), or tanks/trucks or pipelines (Alternative 4 and 5). However, because the EMWMF and the proposed EMDF are designed to meet RCRA hazardous waste facility standards and the EMDF water may be characteristically hazardous, the situation is considered sufficiently similar and "well suited" to a RCRA site to consider certain of the RCRA standards "relevant and appropriate" requirements under the CERCLA ARARs process for this action [see 40 CFR 300.430(g)(2) for a discussion of the "relevant and appropriate" analysis process]. These include the design, construction, operation, and closure/post-closure standards for tanks and surface impoundments. [These ARARs would not apply to the WWTU under Alternative 4, as the ARARs process is considered complete once the waste is turned over to a regulated non-CERCLA facility. The waste does have to meet the WWTU's waste acceptance criteria prior to being transferred to the unit, however.]

RCRA requirements for the characterization, management and disposal of hazardous waste are included in Table D.1 in the event that secondary waste streams (e.g., spent filters) from the management/treatment of wastewater are determined to be hazardous waste. RCRA requirements would be legally applicable to the management of these newly generated hazardous wastes.

Although effluent from RCRA Subtitle C hazardous waste landfills is regulated under the CWA and subject to effluent limits set under 40 CFR 445.11, EPA notes that RCRA Subtitle C landfills that only receive wastes generated by the industrial operations directly associated with the landfill (i.e., "captive landfills") are exempt from these CWA effluent standards for Subtitle C hazardous waste landfills [40 CFR §445.1(e); 65 FR 3008, January 19, 2000]. EMWMF and the proposed EMDF qualify for this exemption, and the proposed WWTU would be part of the landfill complex, thus the §445.11 limits are not triggered as action-specific ARARs for the water treatment alternatives.

The surface water quality standards discussed as chemical-specific ARARs in Section D.2 and listed under both chemical- and action-specific ARARs in Table D.1 will be implemented through the state's action-specific effluent discharge requirements under the CWA. The state requires that point source discharges of wastewaters receive the degree of treatment or effluent reduction necessary to comply with water quality standards and, where appropriate, and that such discharges comply with the "Standard of Performance" as required by TN Water Quality Control Act at TCA §§69-3-101, et seq. For industrial discharges without applicable federal effluent guidelines, best professional judgment must be employed to determine appropriate effluent limitations and standards. As discussed in Section D.2, the specific criteria that would be applied and enforced as final limits, should the selected remedy include an on-site WWTU, would be negotiated and set in the final decision document for this action and could include any subset of these criteria, as determined by the regulatory authorities. The TDEC regulations [TDEC 0400-45-01-.04(55)] allow for a "locational running annual average (LRAA)" defined as the "average of sample analytical results for samples taken at a particular monitoring location during the previous four calendar quarters", and compliance with the set limits will be based on this running annual average. Per EPA guidance (EPA, 2010; EPA, 1995), a suitable averaging period is appropriate because the concentration of a pollutant can be above AWQC without causing an unacceptable effect if (a) the magnitudes and durations of the excursions above the AWQC are appropriately limited and (b) there are compensating periods of time during which the concentration is below the AWQC. EPA also notes that an allowable frequency for exceeding the criteria is incorporated into its criteria because it is not necessary for concentrations to be below criteria at all times in order to adequately protect aquatic ecosystems. And finally, EPA says that it is not generally possible to ensure that criteria are never exceeded.

Per TDEC 0400-40-05-.10(4), effluent discharges are also required to meet the anti-degradation requirements of TDEC 0400-40-03-.06 to ensure that new or increased discharges do not would cause measurable degradation of any parameter that is "unavailable." Unavailable parameters exist where water quality is at, or fails to meet, the levels specified as water quality criteria in TDEC 0400-40-03-.03.

It is possible that there may be air pollutant emissions from the wastewater treatment system under Alternatives 3 and 5, although the amounts are not expected to be large. The RCRA air emission control requirements of 40 CFR 264 Subpart CC [air emission standards for tanks], however, do not apply to a waste management unit(s) that is used solely for on-site treatment or storage of hazardous waste that is generated as the result of implementing remedial activities required under CERCLA authorities [40 CFR 264.1080(b)(5); TDEC 0400-12-01-.32(a)(2)(v)]. On-site remediation and treatment of contaminated water using air strippers is also an exempted air contaminant source under TDEC regulations provided the emissions are no more than 5 tons per year of any regulated pollutant that is not a hazardous air pollutant and less than 1000 pounds per year of each hazardous air pollutant [TDEC 1200-03-09-.04(4)(d)(24)]. If Alternative 3 or 5 is selected, the air regulations and available exemptions will be reexamined as ARARs as facility design is further developed and refined.

Per EPA regulation and guidance, reporting and recordkeeping requirements, as well as requirements related to training, inspections, contingency planning, test procedures, and sampling methods are considered administrative requirements, not substantive environmental protection standards, therefore are not ARARs [40 CFR 300.5; EPA, 1992b, pg. 2; Preamble to the Final NCP, 55 *FR* 8756, March 8, 1990; EPA, 1988, pg. 1-11]. Although these requirements will be met as mandated by internal DOE and company policy and procedures and will be completed in accordance with those procedures and CERCLA requirements and guidance, and documented in project files, they are not listed as ARARs on Table D.1.

D.5. REFERENCES

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EPA, 1988. *CERCLA Compliance with Other Laws Manual, Part I*, EPA/540/G-89/006, OSWER Directive 9234.1-01, August 8, 1988.

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EPA, 1992a. "ARARs Fact Sheet: Compliance with the Clean Air Act and Associated Air Quality Requirements," EPA Publication 9234.2-22FS, September, 1992.

EPA, 1992b. "Guide to Management of Investigation-Derived Wastes," EPA OSWER Directive 9345.3-03FS, January, 1992.

EPA, 1995. *Water Quality Guidance for the Great Lakes System: Supplementary Information Document (SID),* EPA-820-B-95-001, March, 1995.

EPA, 1997. "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination," EPA OSWER Directive 9200.4-18, August, 1997.

EPA, 2010. *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses,* PB85-227049, December, 2010.

Table D.1 ARARs and TBC guidance for water management at the ORR CERCLA EMWMF and the EMDF, Oak Ridge, Tennessee

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 impacts associated with the occupancy and modification of wetlands. Avoid direct and indirect development in a wetland wherever there is a practicable alternative.	DOE actions that involve potential impacts to, or take place within, wetlands—**applicable**	10 CFR 1022.3(c)
	Incorporate wetland protection considerations into its planning, regulatory, and decision-making processes, and shall, to the extent practicable, minimize the destruction, loss, or degradation of wetlands; and; 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 proposed wetland action. Identify, evaluate, and, as appropriate, implement alternative actions that may avoid or mitigate adverse wetland impacts.		10 CFR 1022.3(b) and (d)
	Consider alternatives to the proposed action that avoid adverse impacts and incompatible development in a wetland area, including alternate sites, alternate actions, and no action. DOE shall evaluate measures that mitigate the adverse effects of actions in a wetland including, but not limited to, minimum grading requirements, runoff controls, design and construction constraints, and protection of ecologically-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 D.1 ARARs and TBC guidance for water management at the ORR CERCLA EMWMF and the EMDF, Oak Ridge, Tennessee (cont.)

Action	Requirements	Prerequisite	Citation
Mitigation of state wetlands as defined under TDEC 0400-40-07-.03	If an applicant proposes an activity that would result in an appreciable permanent loss of resource value of wetlands, the applicant must provide mitigation, which results in no overall net loss of resource value. 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. For any mitigation involving the enhancement or preservation of existing wetlands, to the extent practicable, the applicant shall complete the mitigation before any impact occurs to the existing state waters. For any mitigation involving restoration or creation of a wetland, to the extent practicable, the mitigation shall occur either before or simultaneously with impacts to the existing state waters. Mitigation actions for impacts to wetlands are prioritized as listed in TDEC 0400-40-07-.04 (7)(b)(1)(i) – (viii).	Activity that would cause loss of wetlands as defined in TDEC 0400-40-07-.03—**applicable**	TDEC 0400-40-07-.04 (7)(b)
Presence of minor isolated wetlands of less than 0.25 acres – Minor alterations to wetlands	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 isolated wetlands of less than 0.25 acres—**applicable**	*TCA* 69-3-108(l) TDEC 0400-40-07-.01 TDEC ARAP General Permit for Minor Alterations to Wetlands (effective July 1, 2010) (**TBC**)

Table D.1 ARARs and TBC guidance for water management at the ORR CERCLA EMWMF and the EMDF, Oak Ridge, Tennessee (cont.)

Action	Requirements	Prerequisite	Citation
	Floodplains		
Presence of floodplain as defined in 10 CFR 1022.4	Incorporate floodplain management goals into planning, regulatory, and decision-making processes, and, to the extent practicable, reduce the risk of flood loss; minimize the impact of floods on human safety, health, and welfare; restore and preserve natural and beneficial values served by floodplains; require the construction of DOE structures and facilities to be, at a minimum, in accordance with FEMA National Flood Insurance Program building standards; and promote public awareness of flood hazards by providing conspicuous delineations of past and probable flood heights on DOE property that is in an identified floodplain.	DOE actions that involve potential impacts to, or take place within, floodplains—**applicable**	10 CFR 1022.3(a)(1) through (6)
	Undertake a careful evaluation of the potential effects of any proposed floodplain action. Identify, evaluate, and, as appropriate, implement alternative actions that may avoid or mitigate adverse floodplain impacts.		10 CFR 1022.3(b) and (d)
	Avoid, to the extent possible, the long- and short-term adverse impacts associated with the occupancy and modification of floodplains. Avoid direct and indirect development in a floodplain wherever there is a practicable alternative.		10 CFR 1022.3(c)
	Consider alternatives to the proposed action that avoid adverse impacts and incompatible development in the floodplain, including alternate sites, alternate actions, and no action. DOE shall evaluate measures that mitigate the adverse effects of actions in a floodplain including, but not limited to, minimum grading requirements, runoff controls, design and construction constraints, and protection of ecologically-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 11988.		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*)

Table D.1 ARARs and TBC guidance for water management at the ORR CERCLA EMWMF and the EMDF, Oak Ridge, Tennessee (cont.)

Action	Requirements	Prerequisite	Citation
Waters of the state as defined in *TCA* 69-3-103(33) – General permit conditions	Must comply with the [substantive] requirements of the ARAP for erosion and sediment control to prevent pollution of waters of the state. 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 0400-40-03-.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 0400-40-04; • 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. • 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.	Action potentially altering the properties of any waters of the state**—applicable**	*TCA* 69-3-108(l) TDEC 0400-40-07-.01 TDEC ARAP Program conditions common to all General Permits (**TBC)**

Table D.1 ARARs and TBC guidance for water management at the ORR CERCLA EMWMF and the EMDF, Oak Ridge, Tennessee (cont.)

Action	Requirements	Prerequisite	Citation
Waters of the state as defined in *TCA* 69-3-103(33) – Bank stabilization	Bank stabilization activities along state waters must be conducted in accordance with the requirements of the ARAP Program (Rules of the TDEC, Chap. 0400-40-07). The general permit requirements for stream bank stabilization include the following: • The erosion and sedimentation control practices indicated under the TDEC ARAP general conditions apply; in addition, • Stream beds must not be used as transport 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—**applicable**	*TCA* 69-3-108(l) TDEC 0400-40-07-.01 TDEC ARAP General Permit for Bank Stabilization Activities (effective July 1, 2010) (**TBC**)
Waters of the state as defined in *TCA* 69-3-103(33) – Culvert maintenance activities	The maintenance of existing serviceable structures or fills along waters of the state must be conducted in accordance with the requirements of the ARAP Program (Rules of the TDEC, Chap. 0400-40-07). The general permit requirements for maintenance activities include the following: • The erosion and sedimentation control practices indicated under the TDEC ARAP general conditions apply; in addition, • Placement of material for scour protection or repair shall be limited to clean rock, riprap, rock-filled wire baskets or mattresses, or concrete contained by formwork for footing repair. Clean rock can be of various type and sizes depending on application. Clean rock shall not contain fines, soils, or other wastes or contaminants. • Materials used in maintenance activities shall be free of contaminants, including toxic pollutants, hazardous substances, waste metal, construction debris and other wastes as defined by *TCA* 69-3-103-(18).	Maintenance activities affecting waters of the state—**applicable**	*TCA* 69-3-108(l) TDEC 0400-40-07-.01 TDEC ARAP General Permit for Maintenance Activities (effective July 1, 2010) (**TBC**)

Table D.1 ARARs and TBC guidance for water management at the ORR CERCLA EMWMF and the EMDF, Oak Ridge, Tennessee (cont.)

Action	Requirements	Prerequisite	Citation
	• Placement of material shall not impair flow or be conducted in a manner that would permanently disrupt the movement of fish or aquatic life. • Streambeds shall 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. Stream crossings shall be constructed of clean rock and stream flow shall be conveyed in appropriately sized pipe. Crossing shall be constructed so that stream flow is not obstructed. Following construction, all materials used for temporary crossing shall be removed and disturbed stream banks restored and stabilized if needed. • Excavation and fill activities shall be kept to a minimum and shall be separated from flowing waters to the extent practicable and necessary. Activities shall be conducted in the dry to the maximum extent practicable by diverting flow utilizing cofferdams, berms, temporary channels, or pipes. Temporary diversion channels shall be protected by non-erodible material and lined to the expected high water level. • Excavated materials, removed vegetation, construction debris, and other wastes shall be removed to an upland location and properly stabilized or disposed of in such a manner as to prevent reentry into the waterway. • The placement of riprap shall be the minimum necessary to protect the structure or to ensure the safety of the structure. • Sediment shall be prevented from entering waters of the state. Erosion and sediment control measures shall be designed according to the size and slope of the disturbed or drainage areas to detain runoff and trap sediment and shall be properly selected, installed, and maintained in accordance with the manufacturer's specifications and good engineering practices. • Erosion and sediment controls must be in place and functional before earth moving operations begin, and shall be constructed and maintained throughout the construction period. Temporary measures may be removed at the beginning of the work day but replaced at the end of the work day. • Litter, construction debris, and construction chemicals exposed to storm water shall be picked up prior to anticipated storm events, or otherwise prevented from becoming a pollutant source for storm water discharges. After use, silt fences should be removed. • Clearing, grubbing, and other disturbance to riparian vegetation shall be kept to minimum necessary for slope construction and equipment operations. Unnecessary riparian vegetation removal, including trees, is prohibited.		

Table D.1 ARARs and TBC guidance for water management at the ORR CERCLA EMWMF and the EMDF, Oak Ridge, Tennessee (cont.)

Action	Requirements	Prerequisite	Citation
	• Material may not be placed in a location or manner so as to impair surface water flow into or out of any wetland area.		
	• Appropriate steps shall be taken to ensure that petroleum products or other chemical pollutants are prevented from entering waters of the state. All spills shall be reported to the appropriate emergency response agency and to TDEC and all measures taken immediately to prevent pollution of waters of the state, including groundwater.		
Waters of the state as defined as *TCA* 69-3-103 – Wet weather conveyances	Wet-weather conveyances may be altered provided the following conditions are met:	Activities that alter wet-weather conveyances—**applicable**	TDEC 0400-40-07-.04(10)(a) TDEC ARAP General Permit for Alteration of Wet Weather Conveyances (effective July 1, 2010) (**TBC**)
	• The activity must not result in the discharge of waste or other substances that may be harmful to humans or wildlife;		TDEC 0400-40-07-.04(10)(a)(1)
	• Material must not be placed in a location or manner so as to impair surface water flow into or out of any wetland area; and		TDEC 0400-40-07-.04(10)(a)(2)
	• Sediment shall be prevented from entering other waters of the state:		TDEC 0400-40-07-.04(10)(a)(3)
	- Erosion/sediment controls shall be designed according to size and slope of disturbed or drainage areas to detain runoff and trap sediment and shall be properly selected, installed, and maintained in accordance with manufacturer's specifications and good engineering practices.		TDEC 0400-40-07-.04(10)(a)(3)(i)
	- Erosion/sediment control measures must be in place and functional before earthmoving operations begin, and must be constructed and 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.		TDEC 0400-40-07-.04(10)(a)(3)(ii)
	- Checkdams must be utilized where runoff is concentrated. Clean rock, log, sandbag or straw bale checkdams shall be properly constructed to detain runoff and trap sediment. Checkdams or other erosion control devices are not to be constructed in stream. Clean rock can be of various type and size depending on the application and must not contain fines or other wastes or contaminants.		TDEC 0400-40-07-.04(10)(a)(3)(iii)
	• Appropriate steps must be taken to ensure that petroleum products or other chemical pollutants are prevented from entering waters of the state. All spills must be reported to the appropriate emergency management agency and TDEC. In event of spill, measures shall be taken immediately to prevent pollution of waters of the state, including groundwater.		TDEC 0400-40-07-.04(10)(a)(4)

Table D.1 ARARs and TBC guidance for water management at the ORR CERCLA EMWMF and the EMDF, Oak Ridge, Tennessee (cont.)

Action	Requirements	Prerequisite	Citation
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 230 Subpart H
Mitigation of state waters other than wetlands	Must provide mitigation that results in no overall net loss of resource values for any activity that would result in appreciable permanent loss of resource value of a state water. For any mitigation involving relocation or re-creation of a stream segment, to extent practicable must complete mitigation before any impact occurs to existing state waters. Mitigation measures include but are not limited to: restoration of degraded stream reaches and/or riparian zones; new (relocated) stream channels; removal of pollutants from and hydrologic buffering of stormwater runoff; and other measures which have a reasonable likelihood of increasing the resource value of a state water. Mitigation measures or actions should be prioritized in the following order: restoration, enhancement, re-creation, and protection.		TDEC 0400-40-07-.04(7)(a)
	Endangered, threatened, or rare species		
Presence of Tennessee nongame species as defined in *TCA* 70-08-103	May not take (defined as "harass, hunt, capture, kill, or attempt to kill"), possess, transport, export, or process wildlife species. May not knowingly destroy the habitat of such wildlife species. Upon good cause shown and where necessary to protect human health or safety, endangered or threatened species or "in need of management" species may be removed, captured, or destroyed.	Action impacting Tennessee nongame species, including wildlife species that are "in need of management" (as listed in TWRA Proclamations 00-14 and 00-15 as amended by 00-21)**— applicable**	*TCA* 70-8-104(c) TWRA Proclamations 00-14, Section II and 00-15, Section II, as amended by Proclamation 00-21 (**TBC**) *TCA* 70-8-106(e) TWRA Proclamations 00-14 and 00-15, as amended by Proclamation 00-21 (**TBC**)
Presence of Tennessee-listed endangered or rare plant species as listed in TDEC 0400-06-02.04	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(a) TWRA Proclamation 00-15, as amended by Proclamation 00-21 (TBC guidance)

Table D.1 ARARs and TBC guidance for water management at the ORR CERCLA EMWMF and the EMDF, Oak Ridge, Tennessee (cont.)

Action	Requirements	Prerequisite	Citation
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 is 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(a-c) (*Archeological and Historic Preservation Act*) (AHPA) 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 provide immediate telephone notification of the inadvertent discovery, with written confirmation, to the responsible Federal agency official with respect to Federal lands, and, with respect to tribal lands, to the responsible Indian tribe official. Must take reasonable effort to secure and protect the objects discovered, including as appropriate, stabilization or covering. Must consult with Indian tribe likely to be affiliated with the objects to determine further disposition per 43 CFR 10.5. Federal agency officials should coordinate their responsibilities under these regulations with their emergency discovery responsibilities under the NHPA and the AHPA.	Federal agency construction or excavation activities that inadvertently discover such resources on federal lands or under federal control—**applicable**	25 USC 3002(d) (*Native American Graves Protection and Repatriation Act*) (NAGPRA) 43 CFR 10.4(b) through (d) and (f)

Table D.1 ARARs and TBC guidance for water management at the ORR CERCLA EMWMF and the EMDF, Oak Ridge, Tennessee (cont.)

Action	Requirements	Prerequisite	Citation
	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(l) *General Permit No. TNR10-0000* *(*effective May 24, 2011) (TBC guidance)
	• does not violate water quality criteria as stated in TDEC 0400-40-03-.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 0400-40-04;	Storm water discharges from construction activities—**TBC**	*General Permit No. TNR10-0000,* Section 5.3.2
	• 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.		
Activities causing storm water runoff	Shall develop and implement storm water management controls to insure compliance with the terms and conditions of *General Permit No. TNR050000* ("Stormwater Multi-Sector General Permit for Industrial Activities") or any applicable site-specific permit and with TDEC 0400-40-10.03(2)(c).	Storm water discharges associated with industrial activity—**applicable**	*TCA* 69-3-108(l) *General Permit No. TNR05-0000,* Sector K (effective June 1, 2009) (TBC guidance)

Table D.1 ARARs and TBC guidance for water management at the ORR CERCLA EMWMF and the EMDF, Oak Ridge, Tennessee (cont.)

Action	Requirements	Prerequisite	Citation
	Shall develop and maintain a storm water pollution prevention/control plan prepared in accordance with good engineering practices and with the factors outlined in 40 CFR 125.3(d)(2) or (3) as appropriate and any additional requirements listed in Part XI for the particular sector of industrial activity. The plan shall identify potential sources of pollution that may reasonably be expected to affect the quality of storm water discharges associated with industrial activity.	Storm water discharges associated with industrial activity—**TBC**	*General Permit No. TNR050000*,Section 4
	Storm water pollution prevention plans shall include, at a minimum, the items identified in *General Permit No. TNR050000 Sector K.3*, including a description of potential pollution sources, storm water management measures and controls, preventive maintenance, spill prevention and response procedures, and sediment and erosion controls.	Storm water discharges associated with industrial activity at hazardous waste treatment, storage or disposal facilities—**TBC**	*General Permit No. TNR050000 Sector K.3*
	Shall monitor at least annually the identified storm water outfalls in accordance with the monitoring requirements specified in *General Permit No. TNR050000 Sector K.5* and the parameters listed in Table K-1 of *General Permit No. TNR050000 Sector K*, as appropriate. Sampling waivers are available under the conditions specified in *General Permit No. TNR050000 Sector K.5.1.3*.		*General Permit No. TNR050000 Sector K.5*
	Waste characterization and management		
Characterization of solid waste	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 0400-12-01-.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 0400-12-01-.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 0400-12-01-.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 0400-12-01-.03(1)(b)(4)
Characterization of hazardous waste (*e.g., spent filters*)	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 0400-12-01-.06(2)(d)(1)

Table D.1 ARARs and TBC guidance for water management at the ORR CERCLA EMWMF and the EMDF, Oak Ridge, Tennessee (cont.)

Action	Requirements	Prerequisite	Citation
	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 0400-12-01-.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.		40 CFR 268.9(a) TDEC 0400-12-01-.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 0400-12-01-.10(1)(i)(1)
Management of hazardous waste on site (*e.g., spent filters*)	A generator who treats, stores, or disposes of hazardous waste on-site must comply with the applicable [substantive] standards and requirements set forth in 40 CFR parts 264, 265, 266, 268, and 270.	Generation of RCRA hazardous waste for storage, treatment or disposal on-site—**applicable** if secondary wastes are determined to be hazardous	40 CFR 262.10, Note 2 TDEC 0400-12-01-.03(1)(a)(3)
Temporary storage of hazardous waste in containers on-site (*e.g., spent filters*)	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 0400-12-01-.03(4)(e)(2)(i)(I)
	• container is marked with the date upon which each period of accumulation begins; and		40 CFR 262.34(a)(2) TDEC 0400-12-01-.03(4)(e)(2)(ii)
	• container is marked with the words "hazardous waste" or		40 CFR 262.34(a)(3) TDEC 0400-12-01-.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 0400-12-01-.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 0400-12-01-.06(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 0400-12-01-.06(9)(c)
	Keep containers closed during storage, except to add/remove waste.		40 CFR 264.173(a) TDEC 0400-12-01-.06(9)(d)(1)

Table D.1 ARARs and TBC guidance for water management at the ORR CERCLA EMWMF and the EMDF, Oak Ridge, Tennessee (cont.)

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 0400-12-01-.06(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 0400-12-01-.06(9)(f)(3)
Storage of RCRA hazardous waste with free liquids in containers	Area must have a containment system designed and operated in accordance with 40 CFR 264.175(b) as follows:	Storage of RCRA hazardous waste with free liquids or F020, F021, F022, F023, F026 and F027 in containers—**applicable**	40 CFR 264.175(a) and (d) TDEC 0400-12-01-.06(9)(f)(1) – (2)
	• a base must underlie the containers which is free of cracks or gaps and is sufficiently impervious to contain leaks, spills and accumulated precipitation until the collected material is detected and removed;		40 CFR 264.175(b)(1) TDEC 0400-12-01-.06(9)(f)(2)(i)
	• base must be sloped or the containment system must be otherwise designed and operated to drain and remove liquids resulting from leaks, spills or precipitation, unless the containers are elevated or are otherwise protected from contact with accumulated liquids;		40 CFR 264.175(b)(2) TDEC 0400-12-01-.06(9)(f)(2)(ii)
	• must have sufficient capacity to contain 10 percent of the volume of containers or volume of largest container, whichever is greater;		40 CFR 264.175(b)(3) TDEC 0400-12-01-.06(9)(f)(2)(iii)
	• run-on into the system must be prevented unless the collection system has sufficient capacity to contain along with volume required for containers; and		40 CFR 264.175(b)(4) TDEC 0400-12-01-.06(9)(f)(2)(iv)
	• spilled or leaked waste and accumulated precipitation must be removed from the sump or collection area in a timely manner as or necessary to prevent overflow.		40 CFR 264.175(b)(5) TDEC 0400-12-01-.06(9)(f)(2)(v)
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 0400-12-01.06(9)(i)
Characterization and management of universal waste	A large quantity handler of universal waste must manage universal waste in accordance with [substantive requirements of] 40 CFR 273 in a way that prevents releases of any universal waste or component of a universal waste to the environment.	Generation of universal waste [as defined in 40 CFR 273] for disposal—**applicable**	40 CFR 273 TDEC 0400-12-01-.12
	Must label or mark the universal waste to identify the type of universal waste.		40 CFR 273.34 TDEC 0400-12-01-.12(3)(e)

Table D.1 ARARs and TBC guidance for water management at the ORR CERCLA EMWMF and the EMDF, Oak Ridge, Tennessee (cont.)

Action	Requirements	Prerequisite	Citation
	A large quantity handler of universal waste must immediately contain all releases of universal wastes and other residues from universal wastes, and must determine whether any material resulting from the release is hazardous waste, and if so, must manage the hazardous waste in compliance with all applicable requirements.		40 CFR 273.37 TDEC 0400-12-01-.12(3)(h)
Disposal of universal waste	The generator of the universal waste must determine whether the waste exhibits a characteristic of hazardous waste. If it is determined to exhibit such a characteristic, it must be managed in accordance with 40 CFR 260 through 272 [TDEC 0400-1-11-.01 through .10]. If the waste is not hazardous, the generator may manage and dispose of it in any way that is in compliance with applicable federal, state, and local solid waste regulations.	Generation of universal waste [as defined in 40 CFR 273] for disposal—**applicable**	40 CFR 273.33 TDEC 0400-12-01-.12(3)(d)
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 0400-12-01-.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 0400-12-01-.11(3)(c)(2)(i) and (ii)
	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 0400-12-01-.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 them to service.	Release of used oil to the environment**—applicable**	40 CFR 279.22(d) TDEC 0400-12-01.11(3)(c)(4)
	Transportation		
Transportation of hazardous waste on-site	The generator manifesting requirements of 40 CFR 262.20-262.32(b) do not apply. 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 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 0400-12-01-.03(3)(a)(6)
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 0400-1-11-.12(3)(i)].	Off-site shipment of universal waste by a large quantity generator of universal waste—**applicable**	40 CFR 273.38 TDEC 0400-1-11-.12(3)(i)

Table D.1 ARARs and TBC guidance for water management at the ORR CERCLA EMWMF and the EMDF, Oak Ridge, Tennessee (cont.)

Action	Requirements	Prerequisite	Citation
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 0400-1-11-.11(3)(e)
Additional ARARs for Alternatives 3 and 5 – On-site treatment and discharge of leachate/contact water			
Water treatment			
Construction of new outfall structure for discharge of wastewater	Construction, maintenance, repair, rehabilitation or replacement of intake or outfall structures shall be carried out in such a way that work: • Does not violate water quality criteria as stated in TDEC 0400-40-03-.03 including but not limited to prevention of discharges that causes 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 0400-40-04. • Activities in non-navigable streams shall be conducted in the dry; in navigable streams, where impracticable to work in the dry, work may be conducted within the water column. • Shall be located and oriented so as to avoid permanent alteration or damage to the integrity of the stream channel including the opposite stream bank. Alignment of the structure (except for diffusers) should be as parallel to the stream flow as is practicable, with the discharge pointed downstream. Diffusers may be placed perpendicular to stream flow for more complex mixing. • Intake and outfall structures shall be designed to minimize harm and prevent impoundment of normal or base flows. • Velocity dissipation devices shall be placed as needed at discharge locations to provide a non-erosive velocity from the structure. • Activity may not be conducted in a manner that would permanently disrupt the movement of fish and aquatic life. • Material may not be placed in a location or manner so as to impair surface water flow into or out of any wetland area. • Backfill activities must be accomplished in a manner that stabilizes the streambed and banks to prevent erosion. All contours must be returned to pre-project conditions to the extent practicable and completed activities may not disrupt or impound stream flow. • Stream beds must not be used as transportation routes for construction equipment;	Construction of intake and outfall structures in waters of the state—**applicable** to Alternative 3	*TCA* 69-3-108(l) TDEC 0400-40-07-.01 TDEC General Permit for Construction of Intake and Outfall Structures (effective July 1, 2010) (**TBC**)

Table D.1 ARARs and TBC guidance for water management at the ORR CERCLA EMWMF and the EMDF, Oak Ridge, Tennessee (cont.)

Action	Requirements	Prerequisite	Citation
	• 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 work, all materials used for temporary crossing must be removed and disturbed stream banks restored and stabilized. • Materials used in intake and outfall structures must be free of contaminants and wastes as defined by TCA 69-3-103(18). • Clearing, grubbing and other disturbances to riparian vegetation shall be kept to a minimum necessary for slope construction and equipment operations. Unnecessary tree removal is prohibited. • Sediment shall be prevented from entering waters of the state. Erosion and sediment control measures shall be properly selected, installed, and maintained and must be in place and functional before earth moving operations begin. • Litter, construction debris, and construction chemicals exposed to storm water shall be picked up prior to anticipated storm events or otherwise prevented from becoming a pollutant source during storms. • Excavated materials, removed vegetation, construction debris, and other wastes shall be removed to an upland location and properly stabilized or disposed of to prevent reentry into the waterway. • Take appropriate steps to ensure petroleum products or other chemical pollutants are prevented from entering waters of the state. In event of a spill, take immediate measures to prevent pollution of waters of the state.		
Design and installation of a RCRA tank system (tanks and associated piping)	Must prepare an assessment attesting that the tank system design has sufficient structural integrity and is acceptable for the storing/treating of hazardous waste. The assessment must include the information specified in 40 CFR 264.192(a)(1)-(5) [TDEC 0400-12-01-.06(10)(c)(1)-(5)].	Storage of RCRA hazardous waste in a new tank system–**relevant and appropriate** if water is determined to be hazardous	40 CFR 264.192(a) TDEC 0400-12-01-.06(10)(c)(1)
	Prior to use, must ensure that proper handling procedures are adhered to in order to prevent damage to the system during installation.		40 CFR 264.192(b) TDEC 0400-12-01-.06(10)(c)(2)
	Prior to use, must inspect the system for the presence of weld breaks, punctures, scrapes of protective coatings, cracks, corrosion, other structural damage, or inadequate construction/installation. All discrepancies must be remedied before the system is covered, enclosed or placed in use.		40 CFR 264.192(b)(1)-(6) TDEC 0400-12-01-.06(10)(c)(2)(i)-(vi)
	Prior to use, tanks and ancillary equipment must be tested for tightness. If a tank system is found not to be tight, all repairs necessary to remedy the leak(s) must be performed prior to the system being placed into use.		40 CFR 264.192(d) TDEC 0400-12-01-.06(10)(c)(4)

Table D.1 ARARs and TBC guidance for water management at the ORR CERCLA EMWMF and the EMDF, Oak Ridge, Tennessee (cont.)

Action	Requirements	Prerequisite	Citation
	Ancillary equipment (i.e., piping) must be supported and protected against physical damage and excessive stress due to settlement, vibration, expansion, or contraction.		40 CFR 264.192(e) TDEC 0400-12-01-.06(10)(c)(5)
	Must provide the degree of corrosion protection based upon the information in 40 CFR 264.192(a)(3) [TDEC 0400-12-01-.06(10)(c)(1)(iii)] to ensure the integrity of the tank system during use. Installation of field fabricated corrosion protection system must be supervised by an independent corrosion expert.		40 CFR 264.192(f) TDEC 0400-12-01-.06(10)(c)(6)
	Must provide secondary containment in order to prevent release of hazardous waste or constituents into the environment.		40 CFR 264.193(a)(1) TDEC 0400-12-01-.06(10)(d)(1)
	Secondary containment systems must be: • designed, installed, and operated to prevent any migration of wastes or accumulated liquid out of the system to the soil, ground water, or surface water at any time during the use of the tank system;		40 CFR 264.193(b)(1) TDEC 0400-12-01-.06(10)(d)(2)(i)
	• capable of detecting and collecting releases and accumulated liquids until the collected material is removed;		40 CFR 264.193(b)(2) TDEC 0400-12-01-.06(10)(d)(2)(ii)
	• constructed of or lined with materials that are compatible with the wastes to be placed in the tank system and must have sufficient strength and thickness to prevent failure owing to pressure gradients (including static head and external hydrological forces), physical contact with the waste to which it is exposed, climatic conditions, and the stress of daily operation (including stresses from nearby vehicular traffic)		40 CFR 264.193(c)(1) TDEC 0400-12-01-.06(10)(d)(3)(i)
	• placed on a foundation or base capable of providing support to the secondary containment system, resistance to pressure gradients above and below the system, and capable of preventing failure due to settlement, compression, or uplift;		40 CFR 264.193(c)(2) TDEC 0400-12-01-.06(10)(d)(3)(ii)
	• provided with a leak-detection system that is designed and operated so it will detect the failure of either the primary or secondary containment structure or presence of any release of hazardous waste or accumulated liquid in the secondary containment system within 24 hours, or at the earliest practicable time if the owner can demonstrate that existing detection technologies or site conditions will not allow detection of a release within 24 hours; and		40 CFR 264.193(c)(3) TDEC 0400-12-01-.06(10)(d)(3)(iii)

Table D.1 ARARs and TBC guidance for water management at the ORR CERCLA EMWMF and the EMDF, Oak Ridge, Tennessee (cont.)

Action	Requirements	Prerequisite	Citation
	• sloped or otherwise designed or operated to drain and remove liquids resulting from leaks, spills, or precipitation. Spilled or leaked waste and accumulated precipitation must be removed from the secondary containment system within 24 hours, or in as timely a manner as is possible to prevent harm to human health and the environment, if the owner can demonstrate that removal of the released waste or accumulated precipitation cannot be accomplished within 24 hours.		40 CFR 264.193(c)(4) TDEC 0400-12-01-.06(10)(d)(3)(iv)
	The secondary containment for tanks must include one or more of the following devices: • a liner (external to the tank); • a vault; • a double-walled tank; or • an equivalent device as approved by the EPA.		40 CFR 264.193(d)(1-4) TDEC 0400-12-01-.06(10)(d)(4)(i-iv)
	External liner systems must be: • designed and operated to contain 100 percent of the capacity of the largest tank within its boundary;		40 CFR 264.193(e)(1)(i) TDEC 0400-12-01-.06(10)(d)(5)(i)(I)
	• designed or operated to prevent run-on or infiltration of precipitation into the secondary containment system unless the collection system has sufficient excess capacity to contain run-on or infiltration. [Such additional capacity must be sufficient to contain precipitation from a 25 year, 24-hour rainfall event];		40 CFR 264.193(e)(1)(ii) TDEC 0400-12-01-.06(10)(d)(5)(i)(II)
	• free of cracks or gaps; and		40 CFR 264.193(e)(1)(iii) TDEC 0400-12-01-.06(10)(d)(5)(i)(III)
	• designed and installed to surround the tank completely and to cover all surrounding earth likely to come into contact with the waste if the waste is released from the tank(s) (i.e., capable of preventing lateral as well as vertical migration of the waste).		40 CFR 264.193(e)(1)(iv) TDEC 0400-12-01-.06(10)(d)(5)(i)(IV)
	Vault system must be: • designed or operated to contain 100 percent of the capacity of the largest tank within its boundary;		40 CFR 264.193(e)(2)(i) TDEC 0400-12-01-.06(10)(d)(5)(ii)(I)

Table D.1 ARARs and TBC guidance for water management at the ORR CERCLA EMWMF and the EMDF, Oak Ridge, Tennessee (cont.)

Action	Requirements	Prerequisite	Citation
	• designed or operated to prevent run-on or infiltration of precipitation into the secondary containment system unless the collection system has sufficient excess capacity to contain run-on or infiltration. [Such additional capacity must be sufficient to contain precipitation from a 25 year, 24-hour rainfall event];		40 CFR 264.193(e)(2)(ii) TDEC 0400-12-01-.06(10)(d)(5)(ii)(II)
	• constructed of chemical-resistant water stops in all joints (if any);		40 CFR 264.193(e)(2)(iii) TDEC 0400-12-01-.06(10)(d)(5)(ii)(III)
	• provided with an impermeable interior coating or lining that is compatible with the stored waste and that will prevent migration of the waste into the concrete;		40 CFR 264.193(e)(2)(iv) TDEC 0400-12-01-.06(10)(d)(5)(ii)(IV)
	• provided with a means to protect against formation of and ignition of vapors within the vault if the waste being stored or treated meets the definition of ignitable or reactive waste under 40 CFR 261.21 or 261.23; and		40 CFR 264.193(e)(2)(v) TDEC 0400-12-01-.06(10)(d)(5)(ii)(V)
	• provided with an exterior moisture barrier or otherwise designed or operated to prevent migration of moisture into the vault if the vault is subject to hydraulic pressure.		40 CFR 264.193(e)(2)(vi) TDEC 0400-12-01-.06(10)(d)(5)(ii)(VI)
	Double-walled tanks must be: • designed as an integral structure (i.e., an inner tank completely enveloped within and outer shell) so that any release from the inner tank is contained by the outer shell;		40 CFR 264.193(e)(3)(i) TDEC 0400-12-01-.06(10)(d)(5)(iii)(I)
	• protected, if constructed of metal, from both corrosion of the primary tank interior and of the external surface of the outer shell; and		40 CFR 264.193(e)(3)(ii) TDEC 0400-12-01-.06(10)(d)(5)(iii)(II)
	• provided with a built-in continuous leak detection system capable of detecting a release within 24 hours, or at the earliest practicable time.		40 CFR 264.193(e)(3)(iii) TDEC 0400-12-01-.06(10)(d)(5)(iii)(III)
	Ancillary equipment must be provided with secondary containment (e.g., trench, jacketing, double-walled piping) that meets the requirements of 40 CFR 264.193(b) and (c) [TDEC 0400-12-01-.06(10)(d)(2) and (3)] except for:		40 CFR 264.193(f) TDEC 0400-12-01-.06(10)(d)(6)
	• aboveground piping (exclusive of flanges, joints, valves, and other connections) that are visually inspected for leaks on a daily basis;		40 CFR 264.193(f)(1) TDEC 0400-12-01-.06(10)(d)(6)(i)
	• welded flanges, welded joints and welded connections, that are visually inspected for leaks on a daily basis;		40 CFR 264.193(f)(2) TDEC 0400-12-01-.06(10)(d)(6)(ii)
	• seamless or magnetic coupling pumps and seal-less valves, that are visually inspected for leaks on a daily basis; and		40 CFR 264.193(f)(3) TDEC 0400-12-01-.06(10)(d)(6)(iii)

Table D.1 ARARs and TBC guidance for water management at the ORR CERCLA EMWMF and the EMDF, Oak Ridge, Tennessee (cont.)

Action	Requirements	Prerequisite	Citation
	• pressurized aboveground piping systems with automatic shut-off devices (e.g., excess flow check valves, flow metering shutdown devices, loss of pressure actuated shut-off devices) that are visually inspected for leaks on a daily basis.		40 CFR 264.193(f)(4) TDEC 0400-12-01-.06(10)(d)(6)(iv)
Operation of RCRA tank system	Hazardous wastes or treatment reagents must not be placed in the tank system if they could cause the tank, its ancillary equipment or the containment system to rupture, leak, corrode, or otherwise fail.	Storage of RCRA hazardous waste in a new tank system—**relevant and appropriate** if water is determined to be hazardous	40 CFR 264.194(a) TDEC 0400-12-01-.06(10)(e)(1)
	Must use appropriate controls and practices to prevent spills an overflows from the tank or containment system. These include at a minimum:		40 CFR 264.194(b) TDEC 0400-12-01-.06(10)(e)(2)
	• spill prevention controls (e.g., check valves, dry disconnect couplings);		40 CFR 264.194(b)(1) TDEC 0400-12-01-.06(10)(e)(2)(i)
	• overfill prevention controls (e.g., level sensing devices, high level alarms, automatic feed cutoff, or bypass to a standby tank; and		40 CFR 264.194(b)(2) TDEC 0400-12-01-.06(10)(e)(2)(ii)
	• maintenance of sufficient freeboard in uncovered tanks to prevent overtopping by wave or wind action or by precipitation		40 CFR 264.194(b)(3) TDEC 0400-12-01-.06(10)(e)(2)(iii)
	Must comply with the requirements of 40 CFR 264.196 [TDEC 0400-12-01-.06(10)(g)] if a leak or a spill occurs in the tank system.		40 CFR 264.194(c) TDEC 0400-12-01-.06(10)(e)(3)
Control of air emissions from an above-grade RCRA tank system	The requirements of 40 CFR 264 Subpart CC do not apply to a waste management unit that is used solely for on-site treatment or storage of hazardous waste that is generated as a result of implementing remedial activities required under CERCLA authorities.	Storage of RCRA hazardous waste in a new tank system—**relevant and appropriate** if water is determined to be hazardous	40 CFR 264.1080(b)(5) TDEC 0400-12-01-.32(a)(2)(v)
Control of emissions from a WWTU treatment system	On-site remediation and treatment of contaminated water using air strippers is an exempted air contaminant source provided the emissions are no more than 5 tons per year of any regulated pollutant that is not a hazardous air pollutant and less than 1000 pounds per year of each hazardous air pollutant.	Emissions of air pollutants from new air contaminant sources —**applicable**	TDEC 1200-03-09-.04(4)(d)(24)
Design and installation of a RCRA surface impoundment	Must install a liner system consisting of two or more liners and a leachate collection and removal system, constructed in accordance with 40 CFR 264.221(c)(1)-(4) [TDEC 0400-12-01-.06(11)(b)(3)(i)-(iv)].	Storage of RCRA hazardous waste in a new surface impoundment—**relevant and appropriate** if water is determined to be hazardous	40 CFR 264.221(c) TDEC 0400-12-01-.06(11)(b)(3)
	Must implement a leak detection system capable of detecting, collecting and removing leaks of hazardous constituents from all areas of the top liner during the active life and postclosure care period.		40 CFR 264.221(c)(2) TDEC 0400-12-01-.06(11)(b)(3)(ii)
	Must design, construct and maintain dikes with sufficient structural integrity to prevent massive failure.		40 CFR 264.221(h) TDEC 0400-12-01-.06(11)(b)(8)

Table D.1 ARARs and TBC guidance for water management at the ORR CERCLA EMWMF and the EMDF, Oak Ridge, Tennessee (cont.)

Action	Requirements	Prerequisite	Citation
	Alternative design practices to those in 40 CFR 264.221(c) [TDEC 0400-12-01-.06(11)(b)(3)] may be approved by the Regional Administrator.		40 CFR 264.221(d) TDEC 0400-12-01-.06(11)(b)(4)
Operation of RCRA surface impoundment	Design and operate facility to prevent overtopping resulting from normal or abnormal operations; overfilling; wind and wave action; rainfall; run-on; malfunctions of level controllers, alarms and other equipment; and human error.	Storage of RCRA hazardous waste in a new surface impoundment—**relevant and appropriate** if water is determined to be hazardous	40 CFR 264.221(g) TDEC 0400-12-01-.06(11)(b)(7)
	Remove surface impoundment from operation if the dike leaks or if there is a sudden drop in liquid level.		40 CFR 264.227 TDEC 0400-12-01-.06(11)(h)
	Ignitable or reactive waste must not be placed in a surface impoundment unless it is treated so that it is no longer ignitable or reactive or is managed so that it is protected from materials or conditions that may cause it to ignite or react.		40 CFR 264.229 TDEC 0400-12-01-.06(11)(j)
Instream water quality criteria for release of contact water and leachate into Bear Creek tributary	Dissolved oxygen shall not be less than 5.0 mg/l. Substantial or frequent variations in dissolved oxygen levels, including diurnal fluctuations, are undesirable if caused by man-induced conditions. Diurnal fluctuations shall not be substantially different than the fluctuations noted in reference streams in the region. There shall always be sufficient dissolved oxygen present to prevent odors of decomposition and other offensive conditions.	Release of wastewater or effluents into surface water—**applicable** as instream criteria beyond the mixing zone	TDEC 0400-40-03-.03(3)(a) TDEC 0400-40-03-.03(4)(a) TDEC 0400-40-03-.03(5)(a) TDEC 0400-40-03-.03(6)(a)
	The pH value shall not fluctuate more than 1.0 unit over a period of 24 hours and shall not be outside the following ranges: 6.0-9.0.		TDEC 0400-40-03-.03(3)(b) TDEC 0400-40-03-.03(4)(b) TDEC 0400-40-03-.03(5)(b) TDEC 0400-40-03-.03(6)(b)
	The hardness of or the mineral compounds contained in the water shall not impair its use for irrigation or livestock watering and wildlife.		TDEC 0400-40-03-.03(5)(c) TDEC 0400-40-03-.03(6)(c)
	There shall be no distinctly visible solids, scum, foam, oily slick, or the formation of slimes, bottom deposits or sludge banks of such size or character that may be detrimental to fish and aquatic life or recreation or impair its use for irrigation or livestock watering and wildlife.		TDEC 0400-40-03-.03(3)(c) TDEC 0400-40-03-.03(4)(c) TDEC 0400-40-03-.03(5)(d) TDEC 0400-40-03-.03(6)(d)
	There shall be no turbidity, total suspended solids, or color in such amounts or of such character that will materially affect fish and aquatic life or result in any objectionable appearance to the water, considering the nature and location of the water.		TDEC 0400-40-03-.03(3)(d) TDEC 0400-40-03-.03(4)(d)
	The maximum water temperature shall not exceed 3 degrees C relative to an upstream control point. The temperature of the water shall not exceed 30.5 degrees C and the maximum rate of change shall be 2 degrees C per hour. There shall be no abnormal water temperature changes that may affect aquatic life unless caused by natural conditions. The temperature in flowing streams shall be measured at mid-depth. Temperature shall not interfere with its use for irrigation or livestock watering and wildlife purposes.		TDEC 0400-40-03-.03(3)(e) TDEC 0400-40-03-.03(4)(e) TDEC 0400-40-03-.03(5)(e) TDEC 0400-40-03-.03(6)(e)

Table D.1 ARARs and TBC guidance for water management at the ORR CERCLA EMWMF and the EMDF, Oak Ridge, Tennessee (cont.)

Action	Requirements	Prerequisite	Citation
	Waters shall not contain substances that will impart unpalatable flavor to fish or result in noticeable offensive odors in the vicinity of the water or otherwise interfere with fish or aquatic life.		TDEC 0400-40-03-.03(3)(f) TDEC 0400-40-03-.03(4)(g)
	Waters shall not contain substances or combination of substances including disease-causing agents which, by way of either direct exposure or indirect exposure through food chains, may cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction), physical deformations, or restrict or impair growth in fish or aquatic life or their offspring. See Table D.2 for list of criteria for key contaminants of concern.		TDEC 0400-40-03-.03(3)(g)
	Water shall not contain toxic substances that will render the water unsafe or unsuitable for water contact activities including the capture and subsequent consumption of fish and shellfish, or will propose toxic conditions that will adversely affect man, animal, aquatic life, or wildlife. See Table D.2 for list of criteria for key contaminants of concern.		TDEC 0400-40-03-.03(4)(j)
	Water shall not contain other pollutants that will be detrimental to fish or aquatic life, or adversely affect the quality of the waters for recreation, irrigation, or livestock watering and wildlife.		TDEC 0400-40-03-.03(3)(h) TDEC 0400-40-03-.03(4)(k) TDEC 0400-40-03-.03(5)(f) and (g) TDEC 0400-40-03-.03(6)(f) and (g)
	Water shall not contain iron at concentrations that cause toxicity or in such amounts that interfere with habitat due to precipitation or bacteria growth.		TDEC 0400-40-03-.03(3)(i)
	The one-hour and thirty-day average concentrations of ammonia shall not exceed the acute criterion and chronic criteria calculated using the equations given in TDEC 0400-40-03-.03(3)(j).		TDEC 0400-40-03-.03(3)(j)
	Water shall not contain nutrients in concentrations that stimulate aquatic plant and/or algae growth to the extent that aquatic habitat is substantially reduced and/or biological integrity fails to meet regional goals or that the public's recreational uses of the water body or downstream waters are affected. Quality of downstream waters shall not be detrimentally affected. Interpretation of this provision may be made using the document Development of Regionally-based Interpretations of Tennessee's Narrative Nutrient Criterion and/or other scientifically defensible methods.		TDEC 0400-40-03-.03(3)(k) TDEC 0400-40-03-.03(4)(h)
	The concentration of the *e. coli* group shall not exceed 126 per 100 ml as a geometric mean based on a minimum of 5 samples collected as specified in the regulation. The concentration of *e. coli* group in any individual sample shall not exceed 1 per 100 ml.		TDEC 0400-40-03-.03(3)(l) TDEC 0400-40-03-.03(4)(f)

Table D.1 ARARs and TBC guidance for water management at the ORR CERCLA EMWMF and the EMDF, Oak Ridge, Tennessee (cont.)

Action	Requirements	Prerequisite	Citation
	Waters shall not be modified through the addition of pollutants or through physical alteration to the extent that diversity and/or productivity of aquatic biota within the receiving waters are substantially decreased or, in the case of wadeable streams, substantially different from conditions in reference streams in the same ecoregion. The parameters associated with this criterion are the aquatic biota measured. These are response variables.		TDEC 0400-40-03-.03(3)(m)
	Quality of stream habitat shall provide for development of a diverse aquatic community that meets regionally-based biological integrity goals. Types of habitat loss include channel and substrate alterations, rock and gravel removal, stream flow changes, accumulation of silt, precipitation of metals, and removal of riparian vegetation. For wadeable streams, instream habitat within each sub ecoregion shall be generally similar to that found at reference streams. However, streams shall not be assessed as impacted by habitat loss if it has been demonstrated that the biological integrity goal has been met.		TDEC 0400-40-03-.03(3)(n)
	Stream flow shall support fish and aquatic life criteria and recreational use.		TDEC 0400-40-03-.03(3)(o) TDEC 0400-40-03-.03(4)(m)
Antidegradation requirements	Effluent limitations may be required to insure [sic] compliance with the Antidegradation Statement in TDEC 0400-40-03-.06.	Point source discharge(s) of pollutants into waters of the U.S. **—applicable**	TDEC 0400-40-05-.10(4)
	New or increased discharges that would cause measurable degradation of the parameter that is unavailable shall not be authorized. Nor will discharges be authorized if they cause additional loadings of unavailable parameters that are bioaccumulative or that have criteria below current method detection levels.	Waters with "unavailable"[as defined in TDEC 0400-40-03-.06(2)] parameters**—applicable**	TDEC 0400-40-03-.06(2)(a)
	No new or expanded water withdrawals that will cause additional measurable degradation of the unavailable parameter shall be authorized.		TDEC 0400-40-03-.06(2)(b)
	Where one or more of the parameters comprising the habitat criterion are unavailable, activities that cause additional degradation of the unavailable parameter or parameters above the level of de minimis shall not be authorized.		TDEC 0400-40-03-.06(2)(c)
Release of contact water and leachate into Bear Creek tributary	Shall receive the degree of treatment or effluent reduction necessary to comply with water quality standards and, where appropriate, will comply with the "Standard of Performance" as required by TN Water Quality Control Act at TCA §§69-3-101, et seq. For industrial discharges without applicable federal effluent guidelines, best professional judgment should be employed to determine appropriate effluent limitations and standards.	Point source discharge(s) of pollutants into waters of the U.S. **—applicable**	TDEC 0400-40-03-.05(6) TDEC 0400-40-05-.09(1)(b)

Table D.1 ARARs and TBC guidance for water management at the ORR CERCLA EMWMF and the EMDF, Oak Ridge, Tennessee (cont.)

Action	Requirements	Prerequisite	Citation
Non-continuous batch discharges (those discharges which are not continuous as defined in 40 CFR 122.2) of leachate and contact water	Non-continuous discharges shall be particularly described and limited, considering the following factors, as appropriate: • Frequency • Total mass • Maximum rate of discharge of pollutants during the discharge; and • Mass or concentration of specified pollutants	Non-continuous discharge of pollutants to surface waters—**applicable** if water is released on a non-continuous batch basis rather than continuously	40 CFR 122.45(e) TDEC 0400-40-05-.08(1)(n)
Exclusion from 40 CFR 445 effluent discharge standards for RCRA Subtitle C landfills point source category	Pursuant to 40 CFR 445.1(e), RCRA Subtitle C landfills that only receive wastes generated by the industrial operations directly associated with the landfill are exempt from the CWA effluent standards under 40 CFR 445.11.	Point source discharge of wastewater from RCRA Subtitle C landfills [as defined in 40 CFR 445.2(f)] into waters of the U.S.— **applicable**	40 CFR 445.1(e)
Temporary bypass of waste stream	Bypass is prohibited unless: • bypass was unavoidable to prevent loss of life, personal injury, or severe property damage; • there were no feasible alternatives to bypass; condition not satisfied if adequate backup equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance	Bypass, as defined in TDEC 0400-40-05-.02(15), of waste stream—**applicable**	TDEC 0400-40-05-.07(2)(l)
	A bypass that does not cause effluent limitations to be exceeded may be allowed only if the bypass is necessary for essential maintenance to assure efficient operation.		TDEC 0400-40-05-.07(2)(m)
Wastewater transferred by truck or pipeline to on-site on-ORR CWA-authorized WWTU	A user may not introduce into a wastewater facility any pollutant(s) which causes pass through or interference, and wastewater must meet the pretreatment standards and prohibitions [waste acceptance criteria and limits] set by the wastewater facility prior to transfer.	Transfer of contaminated wastewater to a CWA-authorized wastewater facility for treatment **—applicable**	TDEC 0400-40-14-.05(1) – (2) and (4)
Management of water generated from EMWMF landfill	On-site wastewater treatment units that are part of a wastewater treatment facility subject to regulation under Section 402 or Section 307(b) of the CWA are exempt from the requirements of RCRA Subtitle C for all tank systems, conveyance systems (whether piped or trucked), and ancillary equipment used to store or transport RCRA contaminated water.	On-site wastewater treatment units subject to regulation under §402 or §307(b) of the CWA—**applicable** if water is determined to be hazardous	40 CFR 264.1(g)(6) 40 CFR 260.10 40 CFR 270.1(c)(2)(v) TDEC 0400-12-01-.07(1)(b)(4)(iv) 53 FR 34079, September 2, 1988

Table D.1 ARARs and TBC guidance for water management at the ORR CERCLA EMWMF and the EMDF, Oak Ridge, Tennessee (cont.)

Action	Requirements	Prerequisite	Citation
Disposal of wastewaters containing RCRA hazardous constituents	Disposal is not prohibited if the wastes are managed in a treatment system which subsequently discharges to waters of the U.S. under the CWA unless the wastes are subject to a specified method of treatment other than DEACT in 40 CFR 268.40 or are D003 reactive cyanide.	Disposal of RCRA restricted hazardous wastes that are hazardous only because they exhibit a hazardous characteristic and are not otherwise prohibited under 40 CFR 268**—applicable** if water is determined to be hazardous	40 CFR 268.1(c)(4)(i) TDEC 0400-12-01-.10(1)(a)(3)(iv)(I)
Closure performance standard for RCRA hazardous waste management units	Must close the facility in a manner that: • Minimizes the need for further maintenance; and	Closure of a RCRA hazardous waste management unit —**relevant and appropriate** if water is determined to be hazardous	40 CFR 264.111(a) TDEC 0400-12-01-.06(7)(b)(1)
	• Controls, minimizes or eliminates, to the extent necessary to protect human health and environment, post-closure escape of hazardous waste or its decomposition products, hazardous constituents, contaminated run off to ground or surface waters or to the atmosphere.		40 CFR 264.111(b) TDEC 0400-12-01-.06(7)(b)(2)
	• Complies with the substantive closure requirements of 40 CFR 264 for the particular type of facility, including but not limited to the requirements of Sects. 264.178 (container storage area), 264.197 (tanks), 264.310 (landfills), and 264.554 (remediation waste piles).	Hazardous substances left in place that may pose an unreasonable threat to public health, safety, or environment —**relevant and appropriate** water is determined to be hazardous	40 CFR 264.111(c) TDEC 0400-12-01-.06(7)(b)(3)
	During closure periods, all contaminated equipment, structures, and soils must be properly disposed or decontaminated.		40 CFR 264.114 TDEC 0400-12-01-.06(7)(e)
Closure of a RCRA tank system	Must remove or decontaminate all waste residues, contaminated containment system components (liners, etc.) contaminated soils, and structures and equipment contaminated with waste, and manage them as hazardous waste, unless 40 CFR 261.3(d) [TDEC 0400-12-01-.02(1)(c)(4)] applies.	Closure of a hazardous waste tank system—**relevant and appropriate** if water is determined to be hazardous	40 CFR 264.197(a) TDEC 0400-12-01-.06(10)(h)(1)
	If all contents cannot be practicably removed or decontaminated, consider the tank system a landfill and close in accordance with the landfill closure requirements of 40 CFR 264.310 [TDEC 0400-12-01-.06(14)(k).		40 CFR 264.197(b) TDEC 0400-12-01-.06(10)(h)(2)
Closure and post-closure care of a surface impoundment	Must remove or decontaminate all waste residues and contaminated materials; otherwise free liquids must be removed, the remaining wastes stabilized to a bearing capacity sufficient to support final cover, and the facility closed and covered with a final cover designed in accordance with 40 CFR 264.228(a)(2)(iii)(A)-(E) [TDEC 0400-12-01-.06(11)(i)(1)(ii)(III)].	Closure of a hazardous waste surface impoundment—**relevant and appropriate** if water is determined to be hazardous	40 CFR 264.228(a) TDEC 0400-12-01-.06(11)(i)(1)
	If some waste residues or contaminated materials are left in place at final closure, must comply with all post-closure requirements contained in §§264.117 through 264.120 [TDEC 0400-12-01-.06(7)(h) through (k)], including maintenance and monitoring throughout the post-closure period. Must also:		40 CFR 264.228(b) TDEC 0400-12-01-.06(11)(i)(2)

Table D.1 ARARs and TBC guidance for water management at the ORR CERCLA EMWMF and the EMDF, Oak Ridge, Tennessee (cont.)

Action	Requirements	Prerequisite	Citation
	• maintain integrity and effectiveness of final cover, making repairs to the cap as necessary;		40 CFR 264.228(b)(1) TDEC 0400-12-01-.06(11)(i)(2)(i)
	• maintain and monitor leak detection system;		40 CFR 264.228(b)(2) TDEC 0400-12-01-.06(11)(i)(2)(ii)
	• maintain and monitor groundwater monitoring system;		40 CFR 264.228(b)(3) TDEC 0400-12-01-.06(11)(i)(2)(iii)
	• prevent run-on and runoff from eroding or otherwise damaging final cover.		40 CFR 264.228(b)(4) TDEC 0400-12-01-.06(11)(i)(2)(iv)

AHPA = Archeologic and Historic Preservation Act
ARAP = aquatic resource alteration permit
ARAR = applicable or relevant and appropriate requirement
BAT = best available technology
CERCLA = Comprehensive Environmental Response, Compensation and Liability Act of 1980
CFR = *Code of Federal Regulations*
CMBST = combustion
CWA = Clean Water Act of 1974
DEACT = deactivation
DCS = derived concentration standard
DOE = U.S. Department of Energy
EMDF = Environmental Management Disposal Facility
EMWMF = Environmental Management Waste Management Facility
EO = Executive Order
EPA = U.S. Environmental Protection Agency
FEMA = Federal Emergency Management Agency
FWS = U.S. Fish and Wildlife Service
NAGPRA = Native American Graves Protection and Repatriation Act
NHPA = National Historic Preservation Act
NRC = Nuclear Regulatory Commission
ORR = Oak Ridge Reservation
POLYM = polymerization
PPE = personal protective equipment
RCRA = Resource Conservation and Recovery Act of 1976
RORGS = recovery of organics
TBC = to be considered
TCA = *Tennessee Code Annotated*
TDEC = Tennessee Department of Environment and Conservation
T&E = threatened and endangered
TN = Tennessee
TWRA = Tennessee Wildlife Resources Agency
U.S. = United States
USC = *United States Code*
WWTU = wastewater treatment unit

Table D.2 Numeric ambient water quality criteria (AWQC) that are potential chemical-specific ARARs/TBCs for key COCs in EMWMF/EMDF leachate/contact water[a]

Chemical	Fish and Aquatic Life [TDEC 0400-40-03-.03(3)]		Recreation[b] [TDEC 0400-40-03-.03(4)]	Required reporting level[c] [TDEC 0400-40-03-.05(8)]
	Criterion maximum concentration (CMC) (µg/L or ppb)	Criterion continuous concentration (CCC) (µg/L or ppb)	Organisms only (µg/L or ppb)	(RRL) (µg/L or ppb)
Aldrin (c)	3.0		0.00050	0.5
Arsenic (c)			10.0	1.0
Arsenic (III)	340[d]	150[d]		1.0
b-BHC (c)			0.17	
Cadmium	2.0[e]	0.25[e]		1.0
Chromium (III)	570[e]	74[e]		1.0
Chromium (VI)	16[d]	11[d]		10.0
Copper	13[e]	9.0[e]		1.0
Cyanide	22	5.2	140	5.0
4,4’-DDT (b)(c)	1.1	0.001	0.0022	0.1
4,4’-DDE (b)(c)			0.0022	0.1
4,4’-DDD (b)(c)			0.0031	0.1
Dieldrin (b)(c)	0.24	0.056	0.00054	0.05
Lead	65[e]	2.5[e]		1.0
Mercury (b)	1.4[d]	0.77[d]	0.051	0.2
Nickel	470[e]	52[e]	4600	10.0

(b) = bioaccumulative parameter
(c) = carcinogenic parameter

[a] http://www.tn.gov/sos/rules/0400/0400-40/0400-40-03.20131216.pdf.
[b] A 10^{-5} risk level is used for setting TDEC recreational criteria for all carcinogenic pollutants. Recreational criteria for noncarcinogenic chemicals are set using a 10^{-6} risk level. [*Note*: All federal recreational criteria are set at a 10^{-6} risk level].
[c] In cases in which the in-stream AWQC or effluent limits established for an outfall are less than current chemical technological capabilities for analytical detection, compliance with the AWQC or limits will be determined using the higher RRLs, per TDEC 0400-40-03-.05(8).
[d] Criteria are expressed as dissolved.
[e] Criteria are expressed as dissolved and are a function of total hardness (mg/L). Criteria displayed correspond to a total hardness of 100 mg/L.

ARARs = applicable or relevant and appropriate requirements
AWQC = ambient water quality criteria
CCC = criterion continuous concentration
CMC = criterion maximum concentration
COCs = contaminants of concern
EMDF = Environmental Management Disposal Facility
EMWMF = Environmental Management Waste Management Facility
RRL = required reporting level
TBC = to-be-considered [guidance]
TDEC = Tennessee Department of Environment and Conservation

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APPENDIX E.
MERCURY CONCENTRATION IN ENVIRONMENTAL MANAGEMENT DISPOSAL FACILITY LEACHATE

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Predicting Mercury Concentrations in Leachate

Mercury-contaminated building demolition debris and soils resulting from cleanup of Y-12 National Security Complex (Y-12) are assumed to be disposed of in the Environmental Management Disposal Facility (EMDF). Oak Ridge Environmental Management forecasts a total of about 380,000 cubic yards (CY) of debris waste to be disposed from the four large mercury-contaminated buildings at Y-12. The forecasted soils and sediments to be disposed total approximately 100,000 CY. It was assumed in the Integrated Facility Disposition Program (IFDP) that a portion of the debris and soil/sediments would require treatment to meet land disposal restrictions (LDRs) prior to land disposal. The soils/debris portions requiring treatment are those that do not pass the toxicity characteristic leaching procedure (TCLP) testing. This analysis will evaluate the IFDP-assumed quantities and mercury content of waste debris and soil to be disposed of at the future EMDF, and estimate potential mercury concentrations in the landfill leachate.

For debris, LDR treatment was assumed to be macroencapsulation in place, in the landfill. For purposes of this analysis, macroencapsulation is assumed to totally stabilize the mercury, thus no mercury would leach from macroencapsulated debris during active landfill operations following treatment. Prior to treatment, however, the debris may be exposed to precipitation when it is placed in the landfill, and it is likely that some leaching of mercury prior to completion of the macroencapsulation may occur. Due to the short time that debris will be exposed prior to macroencapsulation, it is assumed this resulting contaminated leachate will be addressed similarly to leachate resulting from non-treated mercury waste, as discussed below. Debris that passes TCLP testing is assumed (for purposes of calculating a mercury leachate concentration) to exhibit the same characteristics as low mercury soil waste, since the debris would be surrounded within a soil matrix that would uptake the mercury leached from the debris.

For soils, it is assumed that treatment to meet LDRs would be carried out on the portion of waste that fails TCLP testing. This treatment method is assumed to be sulfur polymer stabilization/solidification (SPSS). URS | CH2M Oak Ridge LLC (UCOR) completed a study in which soils from Y-12 were treated by this method (UCOR-4323 and -4344, *Treatability Study Report for Y-12 Site Mercury Contaminated Soil, Oak Ridge, Tennessee*). The results of that study were used in this analysis to predict partition coefficients (Kd) for treated and untreated mercury-contaminated soils, and thus used to determine potential leachate mercury concentrations.

<u>Mercury Concentrations in Building Debris</u>

A thorough characterization was recently completed on the Alpha-5 Building at Y-12 (DOE-OR/01-2540&D2, *Characterization Report for Alpha 5 Building 9201-5 at the Y-12 National Security Complex, Oak Ridge, Tennessee*). Mercury characterization results are summarized here to give an indication of the expected concentrations in demolition debris that would be disposed of at EMDF.

Data taken from the Alpha-5 characterization report is given in Tables E.1 and E.2 (Tables 23 and 24 from the report). A discussion taken from the report is included as well. The data show that 95% of mercury debris samples with a total mercury concentration of at least 247 mg/kg will exceed the Resource Conservation and Recovery Act (RCRA) limit of 0.2 mg/L in TCLP testing, and 95% of mercury samples with a total mercury concentration of up to 151 mg/kg would not exceed the TCLP RCRA limit. This implies that mercury-contaminated debris with mercury concentrations up to 151 mg/kg may pass TCLP and be placed in the landfill without treatment.

Summary statistics for total mercury concentrations (mg/kg) were developed (DOE-OR/01-2540&D2 and EPA/600/R-07/041, *Statistical Software for Environmental Applications for Data Sets with and without Non-detect Observations*, ProUCL 5.0.00) using core samples from Alpha-5 Building 9201-5 media (concrete floor, ceiling, interior wall, exterior wall, and roof) on floors 1, 1M, 2, 2M, 3, and 4. Kaplan-Meier (KM) estimation methods were used to account for non-detects, and no substitution methods (replacing the non-detect value by the detection limit or ½-detection) were employed. Results are summarized in Table E.3. A description of the derivation of the data follows.

Table E.1. Detected mercury samples exceeding TCLP mercury RCRA limit (Table 23 from DOE/OR/01-2540&D2)

Intrusive (mg/kg)	Number TCLP Samples ≥ 0.2 mg/L	Number Samples ≥ Intrusive	Percent Samples > 0.2 mg/L
0.00438	32	247	13.0
1.01	32	167	19.2
6.77	31	77	40.3
15.5	30	59	50.8
20.5	29	52	55.8
23.3	28	46	60.9
27.9	27	42	64.3
40.3	26	40	65.0
57.6	25	37	67.6
78.6	24	34	70.6
127	22	27	81.5
161	21	25	84
228	20	22	90.9
247	18	19	94.7
727	9	9	100

Table 23 summarizes the number of TCLP and detected intrusive mercury samples at or above each detected intrusive concentration. Table 23 provides the data to create the empirical distribution function shown in Figure 44, which relates the percentage of TCLP samples exceeding 0.2 mg/L for each detected intrusive sample concentration. Table 23 and Figure 44 show that 95% (18 out of 19) of the TCLP mercury samples exceeding the RCRA limit of 0.2 mg/L were also analyzed for total mercury with concentrations at or above 247 mg/kg. All (100%) of the TCLP mercury samples exceeding the RCRA limit of 0.2 mg/L were also analyzed for total mercury with concentrations at or above 727 mg/kg. Ninety-one percent (91%) of the TCLP mercury samples exceeding the RCRA limit of 0.2 mg/L were also analyzed for total mercury with concentrations at or above 228 mg/kg. Based upon this empirical data, there is a 95% probability that an intrusive mercury sample with a mercury concentration of at least 247 mg/kg would also fail the TCLP RCRA limit of 0.2 mg/L.

Table E.2. Detected mercury samples meeting TCLP mercury RCRA limit (Table 24 from DOE/OR/01-2540&D2)

Intrusive (mg/kg)	Number TCLP Samples < 0.2 mg/L	Number Samples ≤ Intrusive	Percent Samples < 0.2 mg/L
0.94	80	80	100.0
6.59	169	170	99.4
14.8	186	188	98.9
20.3	192	195	98.5
23	197	201	98.0
27	200	205	97.6
28.1	201	207	97.1
49.8	203	210	96.7
66.7	205	213	96.2
125	210	220	95.5
151	211	222	95.0
224	213	225	94.7
243	214	228	93.9
542	215	238	90.3
4340	215	247	87.0

Table 24 summarizes the number of TCLP and detected intrusive mercury samples at or below each detected intrusive concentration. Table 24 provides the data to create the empirical distribution function shown in Figure 45, which relates the percentage of TCLP samples below 0.2 mg/L for each detected intrusive sample concentration. Table 24 and Figure 45 show that 95% (211 out of 222) of the TCLP mercury samples below the RCRA limit of 0.2 mg/L were also analyzed for total mercury, with concentrations at or below 151 mg/kg. All (100%) of the TCLP mercury samples below the RCRA limit of 0.2 mg/L were also analyzed for total mercury, with concentrations at or below 0.94 mg/kg. Ninety percent (90%) of the TCLP mercury samples below the RCRA limit of 0.2 mg/L were also analyzed for total mercury, with concentrations at or below 542 mg/kg. Based upon this empirical data, there is a 95% probability that an intrusive mercury sample with a mercury concentration of up to 151 mg/kg would also pass the TCLP RCRA limit of 0.2 mg/L. More data are needed to bring the percentage of samples below 0.2 mg/L to below 87%.

Table E.3. Summary statistics for Alpha-5 (Bldg. 9201-5) total mercury (mg/kg)

Parameter	Result	Units	Comment
Total number of samples	543	Count	
Probability distribution	N/A	None	Data do not fit normal, lognormal, gamma distributions, or other similar distributions
Number of detects	534	Count	
Minimum of detects	0.00438	mg/kg	
Median of detects	1.955	mg/kg	
Maximum of detects	4340	mg/kg	
Mean of detects	63.59	mg/kg	
Standard deviation of detects	325.6	mg/kg	
Coefficient of variation of detects	512%	mg/kg	
95% KM Chebyshev UCL	123	mg/kg	Non-parametric UCL
99% KM Chebyshev UCL	200.5	mg/kg	Non-parametric UCL
95% UTL with 95% coverage	360	mg/kg	Non-parametric UTL
95% UTL with 99% coverage	3170	mg/kg	Non-parametric UTL

UCL = upper confidence limit
UTL = upper tolerance limit

Sample results for 467 of the 543 samples are greater than 0.1 mg/kg. The number of sample results and the range of sample results for floors and media types are presented in Table E.4. For example, 126 sample results were collected from Floor 1-Floor, and the range of sample results is 0.102 mg/kg to 4340 mg/kg. Blank cells, such as Floor 1M Ceiling, indicate no sample results for the floor/media combination. The wide ranges indicate heterogeneity of mercury contamination greater than 0.1 mg/kg for all floors and all media.

Table E.4. Sample results greater than 0.1 mg/kg for Alpha-5 (Bldg. 9201-5) total mercury

Floor	Media					
	Floor	Ceiling	Interior wall	Exterior wall	Roof	Total
	Entries are number of samples and range (minimum to maximum) of sample results (mg/kg)					
1	126 0.102 to 4340	33 0.172 to 101	30 0.128 to 69.4	28 0.115 to 10.5		217 0.102 to 4340
1M	2 0.503 to 0.586		2 2.63 to 5.28			4 0.503 to 5.28
2	56 0.141 to 1130	26 0.101 to 8.09	25 0.296 to 40.3	21 0.186 to 24		128 0.101 to 1130
2M	4 0.409 to 42.6	4 1.49 to 3.85	4 1.32 to 58.1	5 0.973 to 4.1		17 0.409 to 58.1
3	25 0.168 to 1410	21 0.475 to 12.5	23 0.106 to 8.17	16 0.119 to 43.3		85 0.106 to 1410
4	4 0.137 to 0.436	5 1.04 to 3.14		2 0.26 to 0.738		11 0.137 to 3.14
Roof					5 0.109 to 0.637	5 0.109 to 0.637
Total	217 0.102 to 4340	89 0.101 to 101	84 0.106 to 69.4	72 0.115 to 43.3	5 0.109 to 0.637	467 0.101 to 4340

The upper confidence limit (UCL) is the upper boundary (or limit) of the population mean. The KM Chebyshev UCL is based upon Kaplan-Meier estimates using the Chebyshev inequality. The Chebyshev inequality is the sum of the arithmetic average and the weighted standard error of the mean. The Chebyshev inequality does not rely on any underlying probability distribution of the data (e.g., normal, lognormal, gamma). The weighting factor is proportional to the square root of the confidence level, e.g., 95%. The upper tolerance limit (UTL) is a confidence limit on a percentile of the population rather than a confidence limit on the mean. For example, a 95% one-sided UTL for 95% coverage represents the value below which 95% of the population values are expected to fall with 95% confidence. In other words, a 95% UTL with coverage coefficient 95% represents a 95% UCL for the 95th percentile.

Mercury Concentrations in Soils and Sediments

Information about the extent of mercury contamination in soils at Y-12 is very limited, as are data on the specific soil mercury concentrations. Figure E.1 is a map showing areal extent and ranges of mercury concentrations, taken from the *Record of Decision for Phase I Interim Source Control Actions in the Upper East Fork Poplar Creek Characterization Area, Oak Ridge*, *Tennessee* (DOE/OR/01-1951&D3). From the figure, it is assumed that the majority of soils would exhibit a mercury concentration of between 1 and 10 mg/kg.

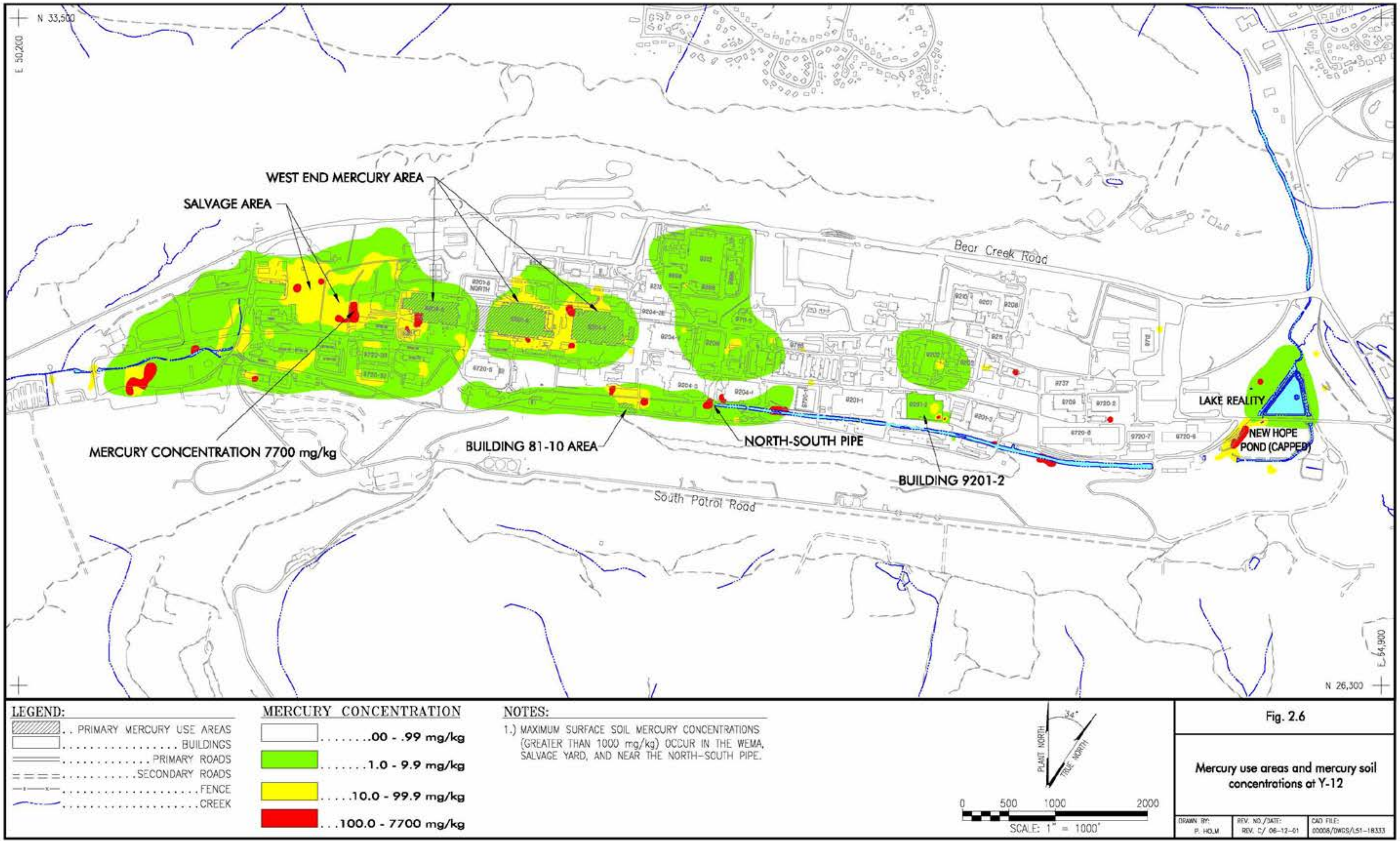

Fig. E.1. Upper East Fork Poplar Creek mercury soils concentrations.

Calculation of Kd

Kds indicate the equilibrium partitioning of a contaminant between the solid phase (in this case, soil) and the liquid phase (in this case leachate). High Kd indicates greater immobility, and low Kd indicates greater mobility in the soil-water environment. Kds were calculated for mercury based on the results of the UCOR soils study (UCOR-4323 and -4344). Kds for untreated soils were also taken from literature, for comparison purposes (EPA/600/R-05/074, *Partition Coefficients for Metals in Surface Water, Soil, and Waste*). Following is a summary of those calculations and results.

A. Calculation of Field Leachate Concentrations

Leachate concentrations measured in the SPLP test are not equivalent to those that would be observed under field conditions because the relative amounts of soil and water used in the SPLP test are completely different from those in a natural soil system. (For a detailed explanation of the issues involved, refer to Appendix C.) For this reason, field leachate concentrations must be calculated for each sample using the SPLP leaching test results and its corresponding measured total soil concentration. The procedure to calculate field leachate concentrations is described below.

1. For each sample, calculate a soil water-partition coefficient (K_d) for each contaminant:

$$K_d = \frac{(C_T M_S - C_{SPLP} V_L)/M_S}{C_{SPLP}} \quad (1)$$

where

K_d = is the soil-water partition coefficient (L/kg)
C_T = the total concentration of the contaminant in the SPLP soil sample (mg/kg)
M_S = the total weight of the soil sample submitted for SPLP analysis (~0.1 kg for inorganic chemicals and semivolatiles, or ~0.025 kg for volatiles)
C_{SPLP} = the concentration of contaminant in the SPLP leachate (mg/L)
V_L = the volume of the SPLP leachate (~2 L for inorganic chemicals and semivolatiles, or ~0.5 L for volatiles)

NOTE: C_{SPLP} in Equation 1 must have units of mg/L

The excerpt above is from a 2013 New Jersey Department of Environmental Protection (NJDEP) Guidance Document (NJDEP 2013, *Development of Site-Specific Impact to Groundwater Soil Remediation Standards Using the Synthetic Precipitation Leaching Procedure*). SPLP is the synthetic precipitation leaching procedure and, in regards to this analysis of potential mercury concentrations, analogous to TCLP, so that $C_{SPLP} = C_{TCLP}$ and the results of the UCOR Soils Study can be substituted into the equation above.

The following is a calculation of Kd values using the UCOR treatability study data (UCOR-4323 and -4344). Three separate vendor laboratories participated in the study: Brookhaven National Laboratory, Energy*Solutions*, and Materials and Energy Corporation. Each lab received spiked soil samples in order to test their treatment methods for immobilization of mercury to meet TCLP testing and allow land disposal of the treated forms. Soil samples were provided to the vendors that had been spiked with elemental mercury to produce mercury concentrations in the soil samples of nominally 2000 mg/kg and nominally 10,000 mg/kg. These mercury spiked soil samples were produced by a single separate lab and then supplied to the 3 vendor labs to perform the testing. The vendor labs then treated the samples with their respective methods of (some form of) sulfur polymer stabilization/solidification (SPSS). Prior to and after testing, the vendor laboratories calculated the total mercury concentrations in the soil samples. These actual measured values were used in the following calculations as the total concentration of the contaminant in the soil sample (C_T). See the previous equation for explanation.

Treated Soils: *Calculating Kd (L/kg) values for treated soils based on UCOR Soils Study data:*

C_T Values:	2,000	10,000	Nominal as Mixed (mg/kg)
BNL	1.91E+03	6.25E+03	Actual as Measured (mg/kg)
ES	1.36E+03	3.73E+03	
M&EC	1.60E+03	8.03E+03	

C_{TCLP} Values:	2,000	10,000	Nominal as Mixed (mg/kg)
BNL	0.0011	0.0013	TCLP (mg/L)
ES	0.00067	0.0233	
M&EC	0.00174	0.00067	

Kd:	2,000	10,000	Nominal as Mixed (mg/kg)
BNL	1.74E+06	4.81E+06	(L/kg)
ES	2.03E+06	1.60E+05	
M&EC	9.18E+05	1.20E+07	
AVERAGE:	3.61E+06	**Mercury Kd for Treated Soils**	

*Note BNL did not report starting soil concentrations, so averages from ES and M&EC used.

Untreated Soils: *Calculating Kd (L/kg) for untreated soils based on UCOR Soils Study data:*

C_T Values:	2,000	10,000	Nominal as Mixed (mg/kg)
BNL	1.91E+03	6.25E+03	Actual as Measured (mg/kg)
ES	2.96E+03	3.48E+03	
M&EC	2.28E+03	1.23E+04	

C_{TCLP} Values:	2,000	10,000	Nominal as Mixed (mg/kg)
BNL	6.5	11.9	TCLP (mg/L)
ES	11.2	6.86	
M&EC	7.71	6.97	

Kd:	2,000	10,000	Nominal as Mixed (mg/kg)
BNL	2.74E+02	5.05E+02	(L/kg)
ES	2.44E+02	4.87E+02	
M&EC	2.75E+02	1.75E+03	
AVERAGE:	5.89E+02	**Mercury Kd for Untreated Soils**	

BNL = Brookhaven National Laboratory
ES = Energy*Solutions*
M&EC = Materials and Energy Corporation

The average values for the treated and untreated soils (highlighted on the previous page) were carried forward for this evaluation. Further research of EPA literature was conducted in order to compare the Kds calculated above to other studies that have been performed. The EPA's 2005 report *Partition Coefficients for Metals in Surface Water, Soil, and Waste* cited mercury Kd values of 1000 L/kg and 3981 L/kg, which would represent untreated waste. Thus multiple Kd values for the untreated waste were examined at various mercury soil concentrations to predict leachate mercury concentrations. The following Kd values are those that were used in this analysis:

- 3.61E+06 L/kg for Treated Soil Waste, as calculated in UCOR Soils Study (see preceding Kd calc)
- 589 L/Kg for Untreated Soil Waste, as calculated in UCOR Soils Study (see preceding Kd calc)
- 1000 L/Kg for Untreated Soil Waste, quoted from reference as value used by EPA in studies (EPA/600/R-05/074).
- 3981 L/Kg for Untreated Waste, soil/water partition coefficient, mean from multiple data sets, per reference (EPA/600/R-05/074).

The following equation was then used to evaluate the potential leachate concentration range of future mercury-contaminated waste.

2. For each sample, substitute the K_d value in the following equation to calculate the estimated field leachate concentration:

$$C_L = \frac{C_T}{K_d + \frac{\theta_w + \theta_a H'}{\rho_b}} \qquad (2)$$

where
ρ_b = bulk density of the soil (1.6 kg/L)
θ_w = soil moisture content (0.23)
θ_a = soil air content (0.18)
H' = the dimensionless Henry's law constant
C_L = field leachate concentration (mg/L).

Equation 2 is a simple rearrangement of the USEPA Soil Screening Guidance soil-water partition equation. It is derived in Appendix C.

From the 2013 NJDEP Guidance Document

Equation Inputs to Estimate Mercury Concentrations in Leachate:

Kd, for treated soils:	3.61E+06	L/kg	
Kd, for untreated soils: ***	(Varied)	L/kg	
Henry's Law Constant for Hg:	0.467	dimensionless	
	total, CY	Volume assumed to require treatment (from IFDP, CD-1)….CY	Volume, no treatment (IFDP, CD-1)…..CY
Total Bldg. Debris Volume	381,854	123,087	258,767
Total Soil Volume	95,574	53,882	41,692

***Vary Kd & Hg concentration:

Untreated Soil

Untreated Soil Hg concentration (mg/kg)	Kd = 589 L/kg	Kd = 1,000 L/kg	Kd = 3,981 L/kg	
	Leachate C_L in ppt	Leachate C_L in ppt	Leachate C_L in ppt	AWQC Hg Limits, ppt
0.01	17	10	3	51 (recreational) 770 (fish/aquatic life, CCC) 1,400 (fish/aquatic life, CMC)
0.1	170	100	25	
1	1,697	1,000	251	
10	16,972	9,998	2,512	
20	33,945	19,996	5,024	
40	67,889	39,992	10,047	
100	169,723	99,980	25,118	
200	339,445	199,961	50,236	

Treated Soil

Treated Soil Hg concentration (mg/kg)	Kd = 3.61e6 L/kg	
	Leachate C_L in ppt	AWQC Hg Limits, ppt
10	3	51 (recreational) 770 (fish/aquatic life, CCC) 1,400 (fish/aquatic life, CMC)
30	8	
100	28	
200	55	
500	139	
1000	277	
6000	1,662	
10000	2,770	

*** Various parameters were modified to better understand potential mercury concentrations in leachate under various circumstances

AWQC = ambient water quality criteria   CCC = Criterion Continuous concentration   CMC = Criterion Maximum Concentration

Graphs have been produced to predict a potential range of mercury concentrations in leachate as a function of the concentration of mercury in untreated and treated soils and varying Kd values. (See Figs. E.2 and E.3).

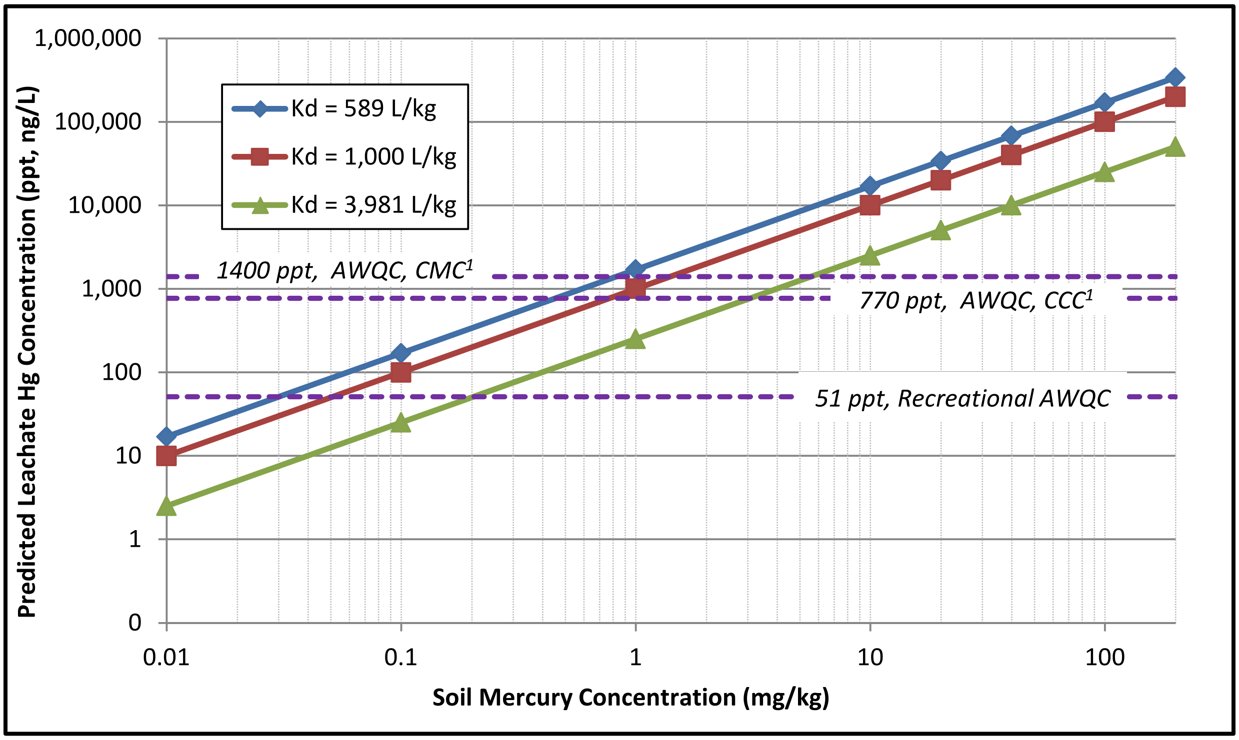

Fig. E.2. Predicted concentration of mercury in leachate given a soil concentration, for various untreated soil Kds.

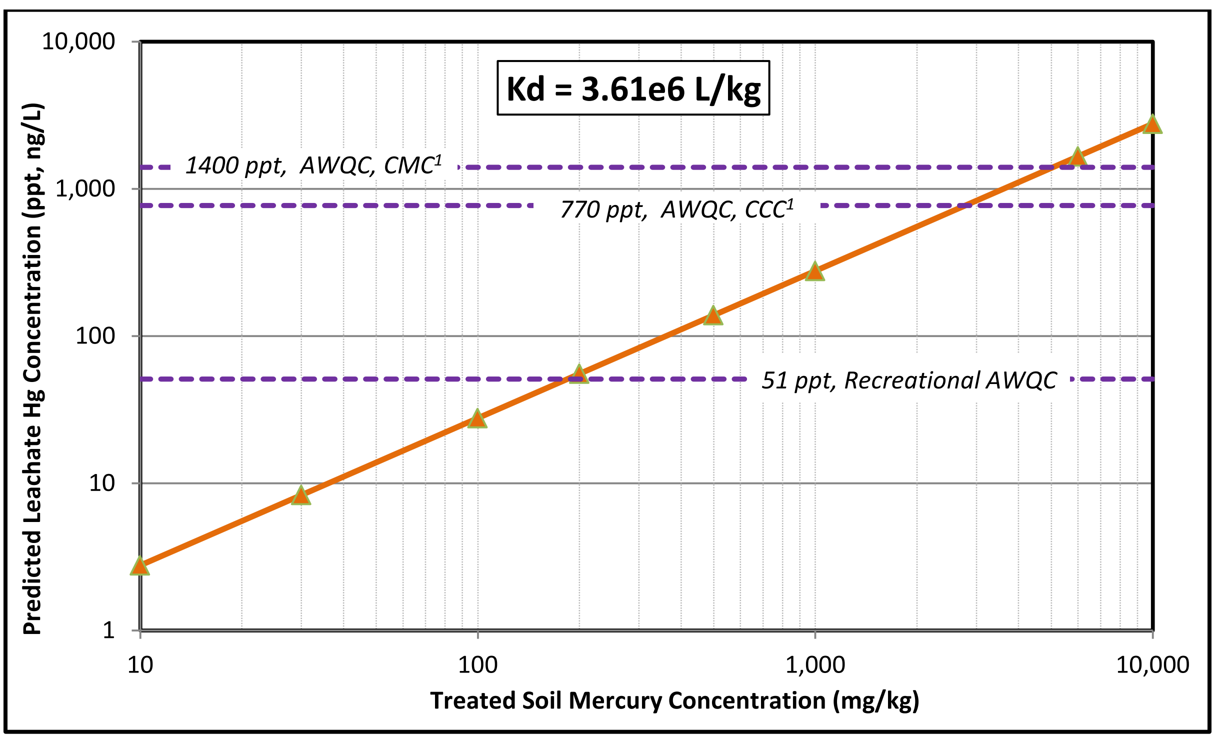

Fig. E.3. Predicted concentration of mercury in leachate given a treated (SPSS) Kd and soil concentration.

[1]CCC = Criterion Continuous Concentration, Fish & Aquatic Life; CMC = Criterion Maximum Concentration, Fish & Aquatic Life

Summary

Debris and soil wastes resulting from the demolition and remediation of Y-12 mercury-contaminated buildings and media will be disposed of in the future EMDF. Some of those wastes will require treatment to meet LDRs. Debris that fails TCLP are assumed to be macroencapsulated in place, in the future landfill; soil wastes that fail TCLP are assumed to be treated by SPSS prior to disposal in the future landfill. No measurable mercury leaching from these treated waste forms is expected during active operations of the landfill.

Untreated soils and debris that pass TCLP will be disposed of in the landfill. Although mercury has naturally high Kds, the amount of mercury-contaminated waste soil and debris expected to be disposed is large enough to result in significant “as-disposed” soil mercury concentrations that may result in measurable mercury concentrations in the leachate (see Fig. E.3). “As-generated” soil/debris mercury concentrations must be adjusted to account for the addition of soil fill, necessary for landfill stability, and the inclusion of other wastes in the landfill resulting in an “as-disposed” mercury concentration. The assumed volume of mercury-contaminated debris and soil to be disposed that will not require treatment to meet LDRs is approximately 300,000 CY. This material will be disposed along with the mercury-containing debris and soil within the first three cells resulting in a final as-disposed volume of approximately 1.25M CY. Consequently, the as-generated mercury concentrations would be reduced by a factor of about four. Assuming the resulting, as-disposed concentration is in the range of 0.03 to 0.25 mg/kg (equivalent to an as-generated waste mercury concentrations corresponding to 0.1 to ~1 mg/kg), leachate concentrations could exceed the 51 ppt ambient water quality criteria (AWQC) for mercury depending on the Kd exhibited (see Fig. E.3). As noted in the Alpha-5 characterization results, mercury concentrations are highly variable, and 95% of debris samples exhibiting mercury concentrations up to 151 mg/kg may pass TCLP. Taking this as an upper bound of the as-generated mercury concentration and assuming the Kds for contaminated debris would be the same as soil, a leachate mercury concentration in the range of 10,000 (highest Kd) to 90,000 ppt (lowest Kd) might be possible. With the uncertainty in volumes of soil/debris to be disposed, and the variability in as-generated mercury concentrations, predictions are highly uncertain. It is expected that leachate concentrations will vary widely for reasons such as variability in rainfall, sequencing of waste volumes, operations procedures, etc. Discussions and technology development activities are ongoing regarding the use of soil additives (for fill soil, landfill liner systems) that could help immobilize the mercury as well, thereby significantly reducing mercury leachate concentrations.

Soils that fail TCLP are assumed to be treated by SPSS. SPSS provides a large measure of protection against leaching, as seen by the very high calculated Kd (3.61e6 L/kg, see Fig. E.4). As-disposed soil mercury concentrations would have to exceed 200 mg/kg to result in leachate concentrations exceeding recreational AWQC. The mercury leached from these waste forms will not likely add significantly to mercury leachate concentrations, since the majority of the soils are expected to exhibit a concentration less than 10 mg/kg (refer to Fig. E.1).

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APPENDIX F.
LEACHATE AND CONTACT WATER WASTE DETERMINATION

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Leachate and Contact Water Waste Determination

This determination has been written to address the regulatory status of leachate and contact water under the Resource Conservation and Recovery Act of 1976 (RCRA).

Approach

Environmental Management Waste Management Facility (EMWMF) Operations has evaluated the regulations of 40 *CFR* 262.11, *Hazardous Waste Determination*, to ensure requirements were met for making a valid characterization decision. A combination of process knowledge, including physical characteristics of leachate and contact water, approved waste lots and disposal records, and historical analytical data, were then evaluated against the requirements of 40 *CFR* 262.11.

Requirements

40 *CFR* 262.11:

A person who generates a solid waste, as defined in 40 *CFR* 261.2, must determine if that waste is a hazardous waste using the following method:

(a) He should first determine if the waste is excluded from regulation under 40 *CFR* 261.4.

(b) He must then determine if the waste is listed as a hazardous waste in Subpart D of 40 *CFR* part 261.

NOTE: Even if the waste is listed, the generator still has an opportunity under 40 *CFR* 260.22 to demonstrate to the Administrator that the waste from his particular facility or operation is not a hazardous waste.

(c) For purposes of compliance with 40 *CFR* part 268, or if the waste is not listed in Subpart D of 40 *CFR* part 261, the generator must then determine whether the waste is identified in Subpart C of 40 *CFR* Part 261 by either:

(1) Testing the waste according to the methods set forth in Subpart C of 40 *CFR* part 261, or according to an equivalent method approved by the Administrator under 40 *CFR* 260.21; or

(2) Applying knowledge of the hazard characteristic of the waste in light of the materials or the processes used.

Process Knowledge

EMWMF Leachate Physical Characteristics

EMWMF leachate and contact water are water-based liquids that are derived from precipitation and application of fire water (potable water) for dust control that flows over and through disposed waste and is collected either in catchments within the disposal cells or by the leachate collection system. There are no impacts to EMWMF leachate and contact water from disposed liquids, as free liquids are prohibited from disposal at EMWMF by the *Attainment Plan for Risk/Toxicity-Based Waste Acceptance Criteria at the Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE/OR/01-1909&D3).

Approved Waste Lots and Disposal Record Information

Based on waste lots approved for disposal at EMWMF, no listed waste has been or is planned to be disposed at EMWMF. Therefore, EMWMF leachate and contact water are not listed waste.

Historical analytical data discussed below are based on analyses performed that include constituents identified as contaminants of concern (COCs) based on characterization information related to waste received. These COCs include all of the constituents identified in 40 *CFR* 261.24.

Historical Analytical Data

Historical EMWMF leachate and contact water data discussed in this waste determination were collected over the first 10 years of operations at EMWMF.

LEACHATE

EMWMF leachate samples were collected after the leachate from each active cell had been commingled in the leachate storage tanks. Leachate has been historically sampled and analyzed at a rate of one sample for every 140,000 gal generated, as well as one sample per calendar quarter for an expanded list of analytes.

Figure F.1 presents a timeline for when EMWMF Operations began managing leachate as each disposal cell came online:

05/2002 to 10/2004	11/2004 to 01/2006	02/2006 to 03/2010	04/2010 to 07/2011	08/2011 to present
Cell 1	Cells 1–2	Cells 1–3	Cells 1–4	Cells 1–5

Fig. F.1. EMWMF leachate generation timeline.

The analyses performed on the leachate include the following U.S. Environmental Protection Agency-approved Methods, as defined in SW-846:

- Method 6010, Inductively Coupled Plasma-Atomic Emission Spectrometry (Metals)
- Method 7470, Mercury in Liquid Waste (Manual Cold-Vapor Technique)
- Method 8081, Organochlorine Pesticides by Gas Chromatography (GC)
- Method 8151, Chlorinated Herbicides by GC Using Methylation or Pentafluorobenzylation Derivatization
- Method 8260, Volatile Organic Compounds by GC/Mass Spectrometry (MS)
- Method 8270, Semivolatile Organic Compounds by GC/MS

CONTACT WATER

Contact water is collected in catchments within the disposal cell, then pumped to collection ponds or above-ground tanks. Each pond or tank is sampled when full; analytical results are compared against release criteria, and discharged to surface waters if the release criteria are met.

As shown in Table F.1, the maximum detected concentration values for toxicity characteristic (TC) constituents in leachate and contact water are well below regulatory levels. In all cases, the project quantitation levels are below the regulatory levels, but are greater that the method detection limits.

Table F.1. Comparison of 10-year leachate and contact water maximum values against 40 *CFR* 261.24 Table 1 regulatory levels

Chemical name	Maximum detected contact water value (mg/L)	Percent of regulatory level	Maximum detected leachate value (mg/L)	Percent of regulatory level	Regulatory level (mg/L)
Arsenic	0.0051	0.10%	0.00383 J	0.08%	5.0
Barium	0.0914	0.09%	0.46 N	0.46%	100.0
Benzene	0.005	1%	ND	N/A	0.5
Cadmium	0.001	0.1%	0.000712 J	0.07%	1.0
Carbon tetrachloride	0.005	0.1%	0.0082	1.64%	0.5
Chlordane	0.000119	0.4%	ND	N/A	0.03
Chlorobenzene	0.005	0.005%	ND	N/A	100.0
Chloroform	0.005	0.08%	0.00135 J	0.02%	6.0
Chromium	0.142	2.84%	0.00637	0.13%	5.0
2-Methylphenol (o-Cresol)	0.0112	0.056%	ND	N/A	200.0
3- and 4-Methylphenol (m-Cresol)	0.022	0.011%	ND	N/A	200.0
4-Methylphenol (p-Cresol)	0.022	0.011%	ND	N/A	200.0
Cresol	Not Applicable, based on 40 *CFR* 261.24, Table 1, Footnote 4.				
2,4-D	ND	N/A	0.00033 J	0.00%	10.0
1,4-Dichlorobenzene	0.0112	0.15%	ND	N/A	7.5
1,2-Dichloroethane	0.005	0.1%	ND	N/A	0.5
1,1-Dichloroethene	0.005	0.7%	ND	N/A	0.7
2,4-Dinitrotoluene	0.01	7.7%	ND	N/A	0.13
Endrin	0.0000595	0.3%	ND	N/A	0.02
Heptachlor	0.0000595	0.74%	ND	0.15%	0.008
Heptachlor epoxide	0.0000595	--	0.000012 J	--	--
Hexachlorobenzene	0.0112	8.6%	ND	N/A	0.13
Hexachlorobutadiene	0.0112	2.2%	ND	N/A	0.5
Hexachloroethane	0.01	0.33%	ND	N/A	3.0
Lead	0.005	0.1%	0.00453	0.09%	5.0
Lindane	0.00000133	0.0003%	0.000027 J	0.01%	0.4
Mercury	0.0002	0.1%	0.00022 *	0.11%	0.2
Methoxychlor	0.0000595	0.0006%	0.000015 J	0.00%	10.0
2-Butanone (MEK)	0.01	0.005%	1.77 D	0.89%	200.0
Nitrobenzene	0.01	0.5%	ND	N/A	2.0
Pentachlorophenol	0.025	0.025%	0.000124	0.00%	100.0
Pyridine	ND	N/A	ND	N/A	5.0
Selenium	0.01	1%	0.00446 J	0.45%	1.0
Silver	0.0025	0.05%	0.0088 N	0.18%	5.0
Tetrachloroethene	0.005	0.7%	ND	N/A	0.7
Toxaphene	ND	N/A	ND	N/A	0.5
Trichloroethene	0.005	1%	0.011	2.20%	0.5
2,4,5-Trichlorophenol	0.01	0.003%	ND	N/A	400.0
2,4,6-Trichlorophenol	0.01	0.5%	ND	N/A	2.0
Silvex	ND	N/A	0.000386 J	0.04%	1.0
Vinyl chloride	0.01	5%	ND	N/A	0.2

* = duplicate analysis not within control limits
D = identified at a secondary dilution factor
N = spike recovery not within control limits
ND = no detected values were identified
J = estimated value, between the project quantitation level and the method detection limit

As discussed above, the individual disposal cells were constructed and put into use sequentially, as necessary. Table F.2 presents the maximum detected values for TC constituents in EMWMF leachate during each phase noted in the timeline. Many TC constituents were not detected during analysis, and other TC constituent concentrations are estimated values. The results indicate that over time, most TC constituents are not present at detectable levels. Concentrations of those constituents that are detectable are estimated. As each EMWMF disposal cell came on line, there have been no notable increases in hazardous constituent concentrations, indicating negligible concentrations of hazardous constituents in leachate from each disposal cell. Therefore, analysis of samples from each disposal cell is not warranted.

Table F.2. Maximum detected values for TC constituents in EMWMF leachate

EPA HW No.	Chemical Name	Cell 1 Maximum Detected Results (05/02 - 10/04) (mg/L)	Qualifier	Cells 1-2 Maximum Detected Results (11/04 - 01/06) (mg/L)	Qualifier	Cells 1-3 Maximum Detected Results (02/06 - 03/10) (mg/L)	Qualifier	Cells 1-4 Maximum Detected Results (04/10 - 07/11) (mg/L)	Qualifier	Cells 1-5 Maximum Detected Results (08/11 - pres.) (mg/L)	Qualifier	Regulatory Level (mg/L)
D004	Arsenic	0.0011	B	0.0012	B	0.00383	J	0.00256	J	ND		5.0
D005	Barium	0.11	J	0.0954	*	0.46	*N	0.0804		0.12		100.0
D018	Benzene	ND		ND		ND		ND		ND		0.5
D006	Cadmium	0.00014	B	0.00013	B	0.000712	J	0.000332	J	0.000216	J	1.0
D019	Carbon tetrachloride	0.0082		ND		ND		ND		ND		0.5
D020	Chlordane	ND		ND		ND		ND		ND		0.0
D021	Chlorobenzene	ND		ND		ND		ND		ND		100.0
D022	Chloroform	0.00051	J	ND		0.00135	J	ND		ND		6.0
D007	Chromium	0.0031	B	0.004	B	0.00389	J	0.00387	J	0.00637		5.0
D023	2-Methylphenol (o-Cresol)	ND		ND		ND		ND		ND		200.0
D024	3- and 4- Methylphenol (m-Cresol)	ND		ND		ND		ND		ND		200.0
D025	4-Methylphenol (p-Cresol)	ND		ND		ND		ND		ND		200.0
D026	Cresol- NO DATA AVAILABLE	No data		No data		No data		No data		No data		200.0
D016	2,4-D	ND		ND		0.00033	J	ND		ND		10.0
D027	1,4-Dichlorobenzene	ND		ND		ND		ND		ND		7.5
D028	1,2-Dichloroethane	ND		ND		ND		ND		ND		0.5
D029	1,1-Dichloroethene	ND		ND		ND		ND		ND		0.7
D030	2,4-Dinitrotoluene	ND		ND		ND		ND		ND		0.13
D012	Endrin	ND		ND		ND		ND		ND		0.02
D031	Heptachlor	ND		ND		ND		ND		ND		0.008
	Heptachlor epoxide	ND		ND		0.000012	J	ND		ND		
D032	Hexachlorobenzene	ND		ND		ND		ND		ND		0.13
D033	Hexachlorobutadiene	ND		ND		ND		ND		ND		0.5
D034	Hexachloroethane	ND		ND		ND		ND		ND		3.0
D008	Lead	0.0023	B	0.0026	B	0.00453		0.00225	J	0.0043	J	5.0
D013	Lindane	ND		ND		ND		ND		0.000027	J	0.4
D009	Mercury	ND		0.0001	B	0.00022	*	0.000066	J	ND		0.2
D014	Methoxychlor	ND		ND		ND		ND		0.000015	J	10.0
D035	2-Butanone (MEK)	0.4		0.004	J	0.00908	J	ND		1.77	D	200.0
D036	Nitrobenzene	ND		ND		ND		ND		ND		2.0
D037	Pentachlorophenol	ND		ND		0.00025	J	0.00175		0.000384	J	100.0
D038	Pyridine	ND		ND		ND		ND		ND		5.0
D010	Selenium	0.0041	*	0.0011	B	0.00446	J	ND		ND		1.0
D011	Silver	0.00024	BJ	0.0088	N	ND		ND		ND		5.0
D039	Tetrachloroethene	ND		ND		ND		ND		ND		0.7
D015	Toxaphene	ND		ND		ND		ND		ND		0.5
D040	Trichloroethene	0.011		ND		ND		ND		ND		0.5
D041	2,4,5-Trichlorophenol	ND		ND		ND		ND		ND		400.0
D042	2,4,6-Trichlorophenol	ND		ND		ND		ND		ND		2.0
D017	Silvex	ND		ND		ND		0.000174	J	0.000386	J	1.0
D043	Vinyl chloride	ND		ND		ND		ND		ND		0.2

* – Duplicate analysis not within control limits
B – Result less than PQL but greater than IDL; analyte found in blank as well as sample
ND – No detected values were found in the database
D – Identified at a secondary dilution factor
J – Estimated value, btw. PQL and MDL
N – Spike recovery not within control limits

Waste Determination

This waste determination demonstrates (through a combination of process knowledge, historical analytical data, approved waste lots and disposal records, and physical characteristics) EMWMF leachate and contact water are neither a listed nor a characteristic hazardous waste under RCRA (see Table F.3). This same waste determination applies to the landfill water from the Environmental Management Disposal Facility.

Table F.3. Summary of 40 *CFR* 261 Subpart C criteria regarding EMWMF leachate

40 *CFR* 261 Subpart C criteria	**EMWMF leachate status**
§ 261.21 Characteristic of ignitability.	
(a) A solid waste exhibits the characteristic of ignitability if a representative sample of the waste has any of the following properties:	
(1) It is a liquid, other than an aqueous solution containing less than 24 percent alcohol by volume and has flash point less than 60°C (140°F), as determined by a Pensky-Martens Closed Cup Tester, using the test method specified in ASTM Standard D 93-79 or D 93-80 (incorporated by reference, see § 260.11), or a Setaflash Closed Cup Tester, using the test method specified in ASTM Standard D 3278-78 (incorporated by reference, see § 260.11).	**Addressed**; EMWMF leachate and contact water are aqueous solutions containing less than 24 percent alcohol by volume.
(2) It is not a liquid and is capable, under standard temperature and pressure, of causing fire through friction, absorption of moisture or spontaneous chemical changes and, when ignited, burns so vigorously and persistently that it creates a hazard.	**Addressed**; EMWMF leachate and contact water are aqueous solutions.
(3) It is an ignitable compressed gas.	**Addressed**; EMWMF leachate and contact water are aqueous solutions.
(4) It is an oxidizer. An oxidizer for the purpose of this subchapter is a substance such as a chlorate, permanganate, inorganic peroxide, or a nitrate, that yields oxygen readily to stimulate the combustion of organic matter (see Note 4). [Note 4: The DOT regulatory definition of an oxidizer was contained in § 173.151 of 49 *CFR*, and the definition of an organic peroxide was contained in paragraph 173.151a. An organic peroxide is a type of oxidizer.]	**Addressed**; EMWMF leachate and contact water are aqueous solutions.
§ 261.22 Characteristic of corrosivity.	
(a) A solid waste exhibits the characteristic of corrosivity if a representative sample of the waste has either of the following properties:	
(1) It is aqueous and has a pH less than or equal to 2 or greater than or equal to 12.5, as determined by a pH meter using Method 9040C in *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, EPA Publication SW-846, as incorporated by reference in § 260.11 of this chapter.	**Addressed**; Numerous field pH measurements range from 5.46 to 10.27. The typical range is 6.8–7.85 with an average of 7.21.
(2) It is a liquid and corrodes steel (SAE 1020) at a rate greater than 6.35 mm (0.250 inch) per year at a test temperature of 55°C (130°F) as determined by Method 1110A in *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, EPA Publication SW-846, and as incorporated by reference in § 260.11 of this chapter.	**Addressed**; The leachate collection system and leachate and contact water transfer systems do not show evidence of excessive corrosion.

40 *CFR* 261 Subpart C criteria	EMWMF leachate status
§ 261.23 Characteristic of reactivity.	
(a) A solid waste exhibits the characteristic of reactivity if a representative sample of the waste has any of the following properties:	
(1) It is normally unstable and readily undergoes violent change without detonating.	**Addressed**; EMWMF leachate and contact water are aqueous solutions.
(2) It reacts violently with water.	**Addressed**; EMWMF leachate and contact water are aqueous solutions.
(3) It forms potentially explosive mixtures with water.	**Addressed**; EMWMF leachate and contact water are aqueous solutions.
(4) When mixed with water, it generates toxic gases, vapors, or fumes in a quantity sufficient to present a danger to human health or the environment.	**Addressed**; EMWMF leachate and contact water are aqueous solutions.
(5) It is a cyanide or sulfide-bearing waste which, when exposed to pH conditions between 2 and 12.5, can generate toxic gases, vapors, or fumes in a quantity sufficient to present a danger to human health or the environment.	**Addressed**; EMWMF leachate and contact water are aqueous solutions. Cyanides and Sulfides have not been identified as COCs in waste received to date at EMWMF and field pH measurements demonstrate that the leachate and contact water pH is greater than 2 and less than 12.5.
(6) It is capable of detonation or explosive reaction if it is subjected to a strong initiating source or if heated under confinement.	**Addressed**; EMWMF leachate and contact water are aqueous solutions.
(7) It is readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure.	**Addressed**; EMWMF leachate and contact water are aqueous solutions.
(8) It is a forbidden explosive as defined in 49 *CFR* 173.54, or is a Division 1.1, 1.2 or 1.3 explosive as defined in 49 *CFR* 173.50 and 173.53.	**Addressed**; EMWMF leachate and contact water are aqueous solutions.
§ 261.24 Toxicity characteristic.	
(a) A solid waste (except manufactured gas plant waste) exhibits the characteristic of toxicity if, using the Toxicity Characteristic Leaching Procedure, test Method 1311 in *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, EPA Publication SW-846, as incorporated by reference in § 260.11 of this chapter, the extract from a representative sample of the waste contains any of the contaminants listed in Table 2 (1) at the concentration equal to or greater than the respective value given in that table. Where the waste contains less than 0.5 percent filterable solids, the waste itself, after filtering using the methodology outlined in Method 1311, is considered to be the extract for the purpose of this section.	**Addressed**; Leachate and contact water samples have not been subjected to the TCLP Prep Method. Please refer to Table F.1 above for a comparison of historical leachate and contact water analytical data (“totals” analyses) against the regulatory levels.

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APPENDIX G.
ZERO DISCHARGE

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Zero Discharge Option for the EMWMF

Thermal processes, which include evaporation, are the only viable options for achieving zero discharge of leachate. This point was made at the Intercontinental Landfill Research Symposium at the Lulea University of Technology in Lulea, Sweden, December 11–13, 2000.

> Thermal processes, particularly evaporation, are the only "treatment" technologies available today that dispose of the water component of water-based waste streams, such as leachate. This technology can reduce the total volume of leachate to less than five percent of the original volume. Leachate evaporation systems generally are economically feasible at sites with an adequate supply of landfill gas (LFG) to evaporate the volume of leachate generated…
>
> The byproduct of these systems is a residual material that usually can be returned to the landfill for disposal…

Table G.1. Summary of selected treatment technologies with application for leachate service

Treatment technology	Advantages	Disadvantages	Residuals
Thermal			
Evaporator	• No liquid effluent • Small footprint • Easy to operate	• Dependent on landfill gas supply for economical operation • Material compatibility	• Solids (minimal) • Flare emissions
Distillation	• Good VOC and Ammonia Removal • Energy Efficient • Small Footprint • High quality effluent	• Operational complexity	• VOC-laden liquid side stream • Concentrate • Air emission from boiler

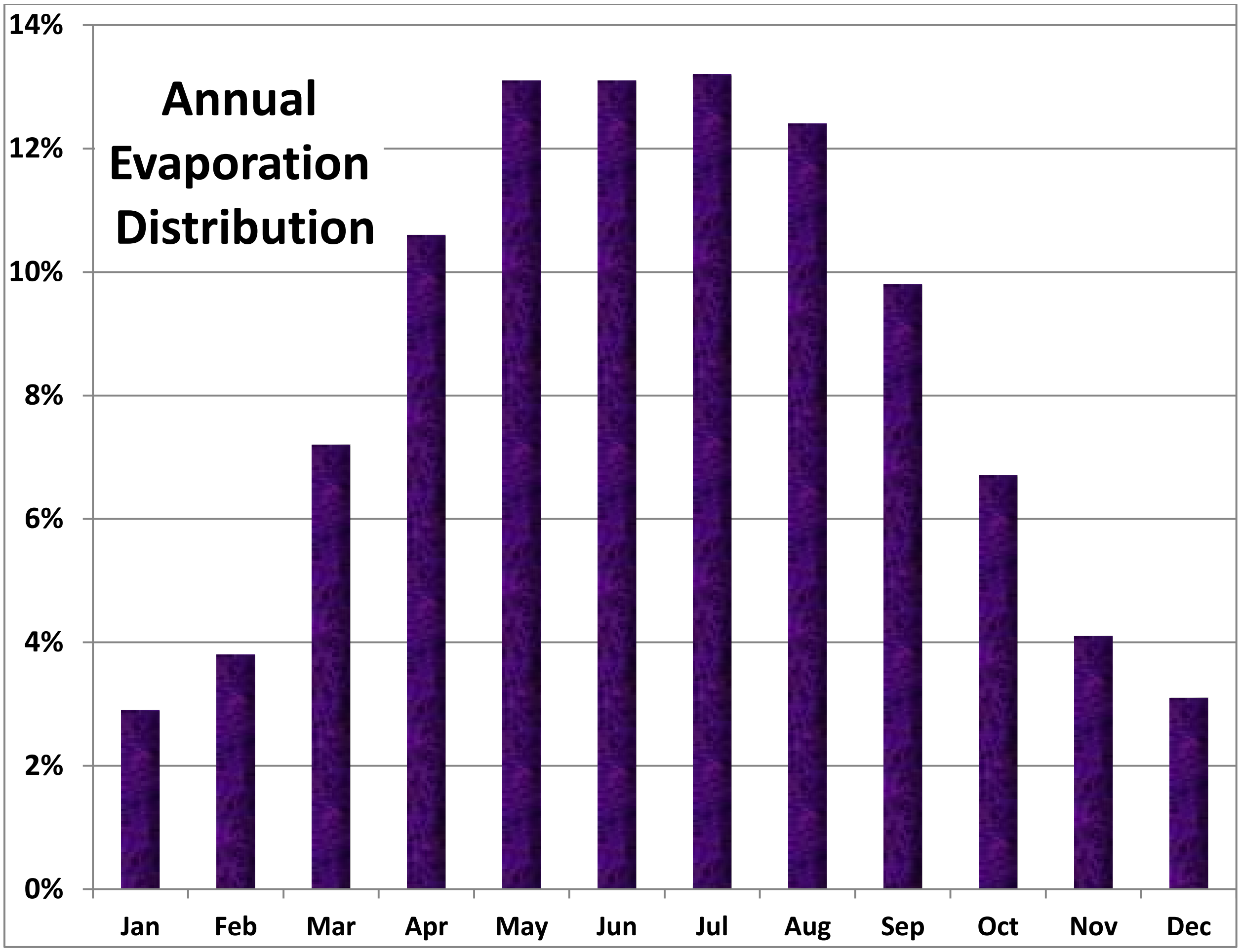
Source: *Leachate Treatment Options for Sanitary Landfills* by J. M. Harris, D. E. Purschwitz, and C. D. Goldsmith, 2000.

VOC = volatile organic compound

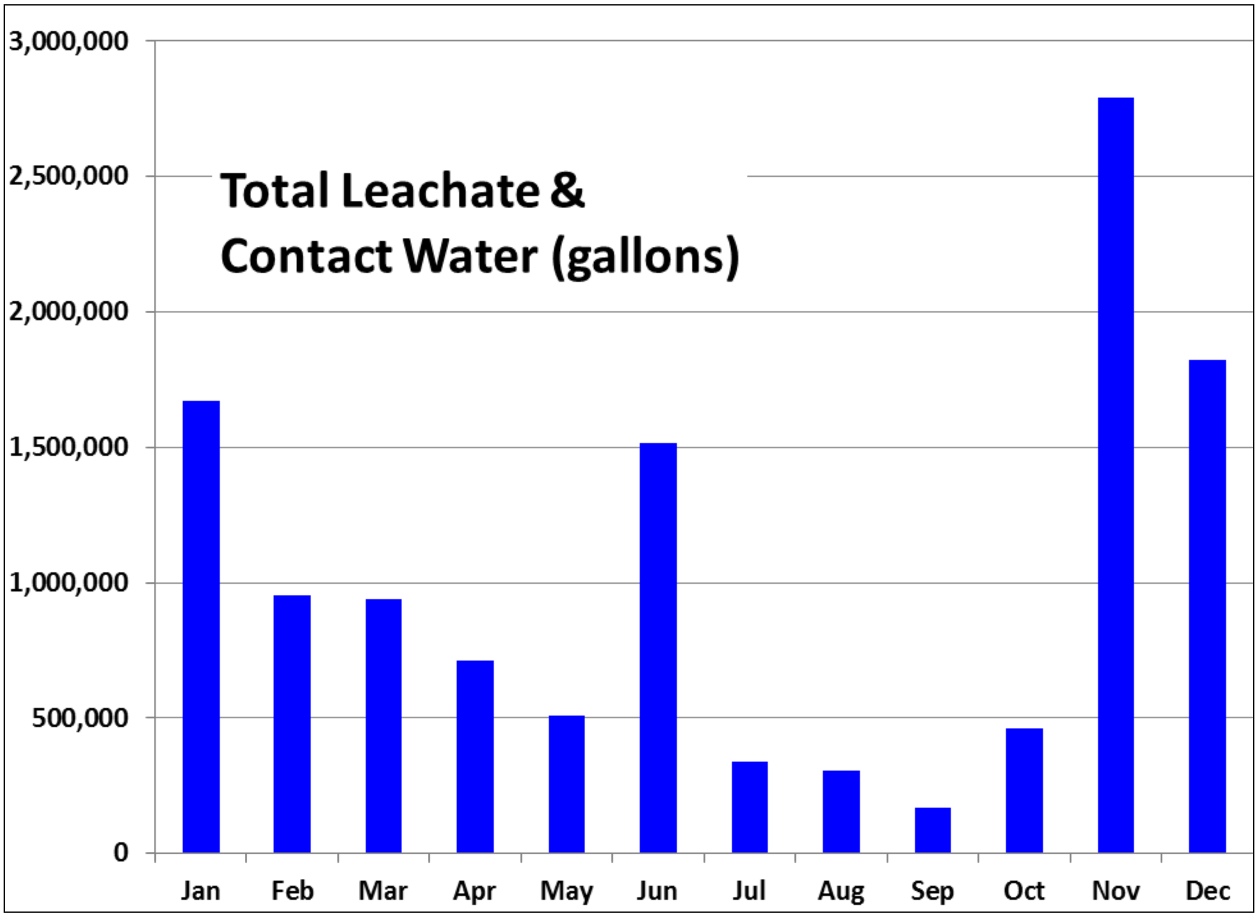
The above limitations were reiterated in the Environmental Research & Education Foundation Regional Summit on Sustainable Solid Waste Practices & Research [for] Managing & Treating Landfill Leachate in Philadelphia, Pennsylvania, October 8–9, 2013:

> …evaporation technology may be attractive due to discharge elimination but site constraints (e.g., availability of LFG or waste heat) may limit its application. (Source: *Leachate Management Decision Making & Available Technologies*, Kevin Torrens, Brown and Caldwell, 2013)

The most influential factors for evaporation are ambient relative humidity, ambient temperature, and the speed of turbulence when mixing the water and air. The Environmental Management Waste Management Facility (EMWMF) is located in a humid subtropical climate zone. Summers are hot and humid, and winters are cool to cold. As illustrated in the following figures, the evaporation potential at EMWMF is at its lowest when the amount of landfill water is at its greatest.



Source: http://knoxcounty.org/stormwater/pdfs/vol2/3-1-8%20Water%20Balance%20Calculations.pdf .



Source: EMWMF operational data for the past 12 months.

Zero discharge of leachate and contact water is not a viable option at the EMWMF for two key reasons:

- There is no landfill gas or waste heat to cost effectively evaporate these waters
- The lowest evaporation potential is present when water generation is greatest

Other factors that render thermal processing unattractive for EMWMF include:

- The droplets of water carried off in the air may have low levels of contaminants, with the potential for depositing contaminants downwind in previously un-impacted areas.
- The process is expected to require several large enclosed structures to prevent immediate precipitation of evaporated water, for which adequate footprint is not readily available.

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APPENDIX H.
WATER STORAGE REQUUIREMENTS

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Environmental Management Waste Management Facility/Environmental Management Disposal Facility's (EMWMF/EMDF's) existing and proposed water handling systems, including water storage features and water processing rates, within this Focused Feasibility Study (FFS) were limited to managing design storm events using conventional stormwater analysis, as is standard industry practice. Conventional analysis uses intensity, aerial distribution of a storm, and a storm's recurrence interval. Intensity is the relationship between the volume of a precipitation event and the duration of the event, and a storm's recurrence interval is the average number of years between storms of a given intensity. High-intensity storm events generally occur at greater intervals, such as 25, 50, to 100 years or more apart.

For this FFS, the National Oceanic and Atmospheric Administration (NOAA) 100-year, 24-hour design storm event for Oak Ridge, Tennessee of 6.85 inches of precipitation was the selected intensity based on the reasonably low daily probability of the event, historical rainfall data at EMWMF, duration of stormwater management at EMWMF/EMDF, and professional judgment. As the design life of the facility increases, the probability of experiencing the design storm event increases; therefore, this risk must be mitigated through properly designed water storage and processing rates.

The design storm event, over an assumed areal distribution, provided a reasonably high volume that is likely to occur, and was used to size a feasible storage capacity within the existing and proposed water handling systems. It is important to note that for these areal distributions analyzed, it is not practical to design a water processing system that will keep up in real-time with the rate of precipitation of the design 100-year, 24-hour storm event or the precipitation resulting from more frequently occurring, lower intensity storm events. Similarly, it is not reasonable to design water storage features that can accommodate all storm events larger than the design event for this large of an areal distribution.

Flood routing and/or bypass of the water handling systems may be expected if a storm event larger than the design storm event occurs or if a high-intensity storm event occurs while stormwater inventory remains in the water storage system.

An appropriate water processing rate for the various FFS alternatives requires that the EMWMF quantify and specify the assumed relationship between the areal distribution and available water storage capacity, as well as identify potential operational constraints that could limit the ability to handle the 100-year, 24-hour design storm event. EMWMF and EMDF are each delineated into six (6) waste placement areas known as cells, and each area is assigned a label of Cell 1 through Cell 6.

For the FFS, EMWMF Cells 1–3 were considered to be in an interim cover state and shedding stormwater that does not contribute to the water handling system at EMWMF. Cells 4–5 are considered open, active waste placement areas, and all stormwater contributes to the water handling system as either leachate or contact water. As landfill progression continues, it is possible that three (3) cells will be considered open and active at any given time, based on demolition strategies observed at the Oak Ridge Reservation (ORR) in the past; however, for this FFS, three (3) open and active cells, the areal distribution used in the analysis varied from approximately 13 to 18 acres, depending on which configuration of cells were open.

The FFS assumes that EMWMF Cells 5 and 6 and EMDF Cell 1 were the three (3) cells open at a given time. The areal distribution was 17.1 acres versus 16.3 acres, if EMDF Cells 1–3 were open. While determining inputs and assumptions to this FFS, we determined that the existing storage capacity at EMWMF would only be utilized by open cells at EMWMF. No in-cell storage is planned for EMDF; therefore, water handling systems and storage would be constructed for the design storm event and assume complete runoff to storage.

To assess the risk of bypassing the existing water management system at EMWMF, a calculation was developed for management called the EMWMF Water Balance Model. This tool accounts for configuration modifications of the facility, including areal distribution and storage capacity increases and decreases while modeling design storm events over the design life of the facility. Using the daily probability of these design storm events occurring, the overall likelihood of a bypass can be quantified to a percent risk. Based on the design life expected of less than 50 years, a risk of less than 10% was considered an acceptable configuration, with little to no bypass volumes expected for the design 100-year, 24-hour storm event. Additionally, EMWMF Operations' continuing practice of processing water through the water handling system in a timely manner to keep water inventories low reduces the risk of a bypass.

Using the proposed maximum design flow rate of 60 gpm continuously taking away from the water management system, a worst-case scenario of existing EMWMF operational constraints, piping configurations, and pumping capacities (including the areal distribution referenced above of EMWMF Cells 5 and 6 and EMDF Cell 1) would require the minimum storage to be an EMWMF Cell 5 in-cell catchment reduced to 1.5 million gallons, EMWMF Cell 6 catchment of 2.0 million gallons, combined storage of Contact Water Ponds, Contact Water Tanks and Leachate Storage tanks of 3.0 million gallons, and proposed water storage feature for EMDF Cell 1 of 2.0 million gallons. As additional EMDF Cells are constructed and are opened, additional water storage must be constructed, or EMWMF water storage must be utilized.

APPENDIX I.
BASIS OF COST ESTIMATES

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Basis of Estimate
EMWMF/EMDF Leachate Management
Focused Feasibility Study: On-Site Treatment
of Leachate & Contact Water Alternative
April 8, 2015

Objective/Scope

URS | CH2M Oak Ridge LLC (UCOR) has performed a Focused Feasibility Study (FFS) to address management of contact water and leachate from the Environmental Management Waste Management Facility and the future Environmental Management Disposal Facility (EMWMF/EMDF). One FFS alternative involves construction of a water treatment facility (WTF) on the EMWMF/EMDF site.

Method of Accomplishment

A combination of U.S. Department of Energy (DOE) Prime Contractor, staff augmentation personnel, and subcontractors was estimated to perform this work; provide oversight for radiological, safety, health, and waste; and provide supervision. A breakdown of the work follows.

1. Project Management: UCOR rates were used for the DOE Prime Contractor and staff augmentation. This work involves obtaining permits/regulatory approval and managing the design, procurement, and construction of the site upgrades and the WTF.
2. Design: The design is assumed to be performed by a subcontractor. The treatability study associated with the design is assumed to be performed by both site personnel and subcontractor(s).
3. Procurement: Procurement of design, laboratory, and construction subcontractors is assumed to be performed by the DOE Prime Contractor.
4. EMWMF/EMDF Site Work: Construction subcontractors to the DOE Prime will construct EMDF and EMWMF bypass systems.
5. Construct On-Site Water Treatment Facility: Construction of an approximately 2000 square foot pre-fabricated metal building, various tanks and equipment, and installation of a pre-fabricated skid-mounted WTF.
6. Operate On-Site Water Treatment Facility: Operate the WTF for 25 years, including labor, materials (chemicals, etc.), maintenance, and waste disposal.
7. Post-Closure Leachate Management: A DOE Prime Contractor is assumed to occasionally operate and maintain the WTF for 30 years.
8. DOE Direct Costs: This is the estimate of costs for DOE personnel to provide oversight and management for this work through construction.

Estimate Type and Approach

This feasibility estimate is based upon similar work proposed in the past and work experience. The estimate was developed using a combination bottoms-up approach, parametric data from similar projects, actual costs of similar work, and estimator and team experience with similar projects. The project team had significant input.

Key Financial Data

1. The estimate was prepared in the third quarter of fiscal year (FY)2015.
2. Any actual costs of work or similar work were provided by the project team.
3. DOE Prime Contractor general and administrative costs and fee are included in this estimate at 36%.
4. All UCOR and staff augmentation rates are fully burdened, including fringes. Staff augmentation rates include overhead and profit.
5. Overhead and profit of construction subcontractors at 25% has been added on the totals page.
6. A sales tax of 9.75% has been included on all material.
7. All prices are in FY2015 dollars and no escalation has been included.
8. DOE direct costs have been added at 5% of total cost.
9. UCOR and staff augmentation rates were used for the DOE Prime Contractor.
10. The skid-mounted WTF will be purchased by the DOE Prime Contractor and furnished to the construction subcontractor for installation.

Estimate Assumptions and Exclusions

1. The Conceptual Design Report and the Critical Decision (CD-1, -2, -3, and -4) process was not included in this estimate.
2. No decontamination and demolition (D&D) costs were included, as it was assumed D&D costs would remain similar across all alternatives.
3. No overtime is included.
4. All construction will be performed under subcontract and project management of a DOE Prime Contractor.
5. The project management team is assumed to not be working on this project full-time and will be working on other projects simultaneously.

Schedule Assumptions

1. No funding limitation impacts will be experienced.
2. Design and procurement will take approximately 12 months.
3. All construction is expected to take approximately 4 months.
4. Operation is expected to last 25 years.
5. Post-closure leachate management is expected to last 30 years.

Estimate Uncertainty

Based on information found in the *Department of Energy Cost Estimating Guide* (DOE Guide 413.3-21, dated May 9, 2011, pages 13-17), this estimate is classified as a Class 4 estimate. Class 4 estimates are those with up to 15% of project definition. The expected accuracy range is -30% to +50%. The following table also includes contingency.

Point estimate	$31,309,669
Contingency @ 20%	$ 6,261,934
Subtotal	$37,571,603
Low range (-30%)	$26,300,122
High range (+50%)	$56,357,405

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Table I.1. Basis of estimates summary

EMWMF/EMDF LEACHATE FOCUSED FEASIBILITY STUDY	Alternative 2 Managed Discharge Alternative 20150324B_0	Alternative 3 On-site Treatment Alternative 20140804B_0	Alternative 4A LGWO Treatment and Pipeline Alternative 20140804C_0	Alternative 4B LGWO Treatment and Trucking Alternative 20140804D_0	Alternative 5A WETF Treatment and Pipeline Alternative	Alternative 5B WETF Treatment and Trucking Alternative	Alternative 6A OF200 Treatment and Pipeline Alternative	Alternative 6B OF200 Treatment and Trucking Alternative
Capital Costs During Design Phase (1 year):								
Perform Project Management During Design Phase	$ -	$ 324,818	$ 324,818	$ 324,818	$ 324,818	$ 324,818	$ 324,818	$ 324,818
Design Facilities	$ -	$ 162,897	$ 586,653	$ 394,649	$ 272,746	$ 322,137	$ 268,389	$ 135,259
Conduct Treatability Study	$ -	$ 47,000	$ 47,000	$ 47,000	$ 47,000	$ 47,000	$ 47,000	$ 47,000
Prepare Regulatory Documents	$ -	$ 91,705	$ 91,705	$ 91,705	$ 91,705	$ 91,705	$ 91,705	$ 91,705
Sales Tax (9.75 percent times materials)	$ -	$ 528	$ 528	$ 528	$ 528	$ 528	$ 528	$ 528
Subcontractor Overhead and Profit (25 percent times subcontracts)	$ -	$ 52,474	$ 158,413	$ 110,412	$ 79,937	$ 92,284	$ 78,847	$ 45,565
Subtotal:	$ -	$ 679,422	$ 1,209,117	$ 969,112	$ 816,734	$ 878,472	$ 811,287	$ 644,875
DOE Prime Contractor G&A and Fee (36 percent)	$ -	$ 244,592	$ 435,282	$ 348,880	$ 294,024	$ 316,250	$ 292,063	$ 232,155
Subtotal:	$ -	$ 924,014	$ 1,644,399	$ 1,317,993	$ 1,110,758	$ 1,194,721	$ 1,103,351	$ 877,030
Contingency Percentage	15%	15%	25%	15%	25%	15%	25%	15%
Contingency Amount	$ -	$ 240,515	$ 713,379	$ 343,066	$ 481,873	$ 310,979	$ 478,660	$ 228,286
Capital Cost 1:	*$ -*	*$ 1,164,530*	*$ 2,357,777*	*$ 1,661,058*	*$ 1,592,631*	*$ 1,505,700*	*$ 1,582,010*	*$ 1,105,316*
Capital Costs During Construction Phase (1 year):								
Construct EMDF Bypass	$ -	$ 77,906	$ 77,906	$ 77,906	$ 77,906	$ 77,906	$ 77,906	$ 77,906
Construct EMWMF Bypass	$ -	$ 77,906	$ 77,906	$ 77,906	$ 77,906	$ 77,906	$ 77,906	$ 77,906
Construct Treatment Plant at EMWMF to Remove Hg and C	$ -	$ 1,245,848	$ 1,245,848	$ 1,245,848	$ 1,245,848	$ 1,245,848	$ -	$ -
Construct Pipeline to LGWO or WETF or OF200 plus Lift Station	$ -	$ -	$ 2,509,357	$ -	$ 416,648	$ -	$ 1,633,449	$ -
Construct Tanker Loading Stations at EMWMF	$ -	$ -	$ -	$ 262,500	$ -	$ 262,500	$ -	$ 262,500
Construct Tanker Unloading Stations at LGWO or WETF or OF200	$ -	$ -	$ -	$ 966,834	$ -	$ 483,417	$ -	$ 483,417
Purchase Additional Tanker Trailers	$ -	$ -	$ -	$ 160,000	$ -	$ 160,000	$ -	$ 160,000
Perform Operational Readiness and Startup	$ -	$ 83,218	$ 83,218	$ 83,218	$ 83,218	$ 83,218	$ -	$ -
Sales Tax (9.75 percent times materials)	$ -	$ 22,185	$ -	$ 15,600	$ -	$ 15,600	$ -	$ 15,600
Subcontractor Overhead and Profit (25 percent times subcontracts)	$ -	$ 200,145	$ 3,852,588	$ 2,572,565	$ 1,759,878	$ 2,089,148	$ 1,730,832	$ 843,300
Subtotal:	$ -	$ 1,707,208	$ 7,846,823	$ 5,462,377	$ 3,661,404	$ 4,495,543	$ 3,520,093	$ 1,920,629
DOE Prime Contractor G&A and Fee (36 percent)	$ -	$ 614,595	$ 2,824,856	$ 1,966,456	$ 1,318,106	$ 1,618,395	$ 1,267,234	$ 691,426
Subtotal:	$ -	$ 2,321,803	$ 10,671,679	$ 7,428,832	$ 4,979,510	$ 6,113,938	$ 4,787,327	$ 2,612,055
Contingency Percentage	15%	15%	25%	15%	25%	15%	25%	15%
Contingency Amount	$ -	$ 348,270	$ 2,667,920	$ 1,114,325	$ 1,244,877	$ 917,091	$ 1,196,832	$ 391,808
Capital Cost 2:	*$ -*	*$ 2,670,073*	*$ 13,339,598*	*$ 8,543,157*	*$ 6,224,387*	*$ 7,031,028*	*$ 5,984,159*	*$ 3,003,863*

Table I.1. Basis of estimates summary (cont.)

EMWMF/EMDF LEACHATE FOCUSED FEASIBILITY STUDY	**Alternative 2 Managed Discharge Alternative 20150324B_0**	**Alternative 3 On-site Treatment Alternative 20140804B_0**	**Alternative 4A LGWO Treatment and Pipeline Alternative 20140804C_0**	**Alternative 4B LGWO Treatment and Trucking Alternative 20140804D_0**	**Alternative 5A WETF Treatment and Pipeline Alternative**	**Alternative 5B WETF Treatment and Trucking Alternative**	**Alternative 6A OF200 Treatment and Pipeline Alternative**	**Alternative 6B OF200 Treatment and Trucking Alternative**
O&M Costs During EMWMF Operations and Closure (6 years):								
Sample/Test Leachate During EMWMF Operations	$ 2,252,049	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Subtotal:	$ 2,252,049	$ -	$ -	$ -	$ -	$ -	$ -	$ -
DOE Prime Contractor G&A and Fee (36 percent)	$ 810,738	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Subtotal:	$ 3,062,787	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Contingency Percentage	20%	20%	20%	30%	20%	30%	20%	30%
Contingency Amount	$ 612,557	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total O&M Cost 1:	*$ 3,675,344*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*
Annual O&M Cost 1:	*$ 612,557*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*
O&M Costs During EMDF Operations and Closure (25 years):								
Operate On-site Treatment Plant During EMDF Operations	$ -	$ 8,947,203	$ 11,587,500	$ 11,587,500	$ 11,587,500	$ 11,587,500	$ -	$ -
Operate Pipeline During EMDF Operations	$ -	$ -	$ 1,049,285	$ -	$ 1,049,285	$ -	$ 1,049,285	$ -
Sample/Test Leachate During EMDF Operations	$ -	$ 5,312,925	$ 5,312,925	$ 5,312,925	$ 5,312,925	$ 5,312,925	$ 3,924,467	$ 3,924,467
Truck Leachate During EMDF Operations	$ -	$ -	$ -	$ 25,483,845	$ -	$ 25,483,845	$ -	$ 25,483,845
Sales Tax (9.75 percent times materials)	$ -	$ 257,338	$ 400,000	$ 400,000	$ 400,000	$ 400,000	$ -	$ -
Subtotal:	$ -	$ 14,517,466	$ 18,349,710	$ 42,784,270	$ 18,349,710	$ 42,784,270	$ 4,973,752	$ 29,408,312
DOE Prime Contractor G&A and Fee (36 percent)	$ -	$ 5,226,288	$ 6,605,896	$ 15,402,337	$ 6,605,896	$ 15,402,337	$ 1,790,551	$ 10,586,992
Subtotal:	$ -	$ 19,743,754	$ 24,955,606	$ 58,186,607	$ 24,955,606	$ 58,186,607	$ 6,764,303	$ 39,995,304
Contingency Percentage	20%	20%	20%	30%	20%	30%	20%	30%
Contingency Amount	$ -	$ 3,948,751	$ 4,991,121	$ 17,455,982	$ 4,991,121	$ 17,455,982	$ 1,352,861	$ 11,998,591
Total O&M Cost 2:	*$ -*	*$ 23,692,504*	*$ 29,946,727*	*$ 75,642,589*	*$ 29,946,727*	*$ 75,642,589*	*$ 8,117,163*	*$ 51,993,896*
Annual O&M Cost 2:	*$ -*	*$ 947,700*	*$ 1,197,869*	*$ 3,025,704*	*$ 1,197,869*	*$ 3,025,704*	*$ 324,687*	*$ 2,079,756*
O&M Costs During Post-Closure EMWMF (30 years):								
Operate On-site (or WETF) Treatment Plant During Post-Closure EMWMF	$ -	$ 1,412,820	$ 1,412,820	$ 1,412,820	$ 1,412,820	$ 1,412,820	$ -	$ -
Sample/Test Leachate During Post-Closure EMWMF	$ -	$ 1,097,880	$ 1,097,880	$ 1,097,880	$ 1,097,880	$ 1,097,880	$ 1,097,880	$ 1,097,880
Truck Leachate During Post-Closure EMWMF	$ -	$ -	$ -	$ 537,516	$ -	$ 537,516	$ -	$ 537,516
Sales Tax (9.75 percent times materials)	$ -	$ 8,775	$ 8,775	$ 8,775	$ 8,775	$ 8,775	$ 8,775	$ 8,775
Subtotal:	$ -	$ 2,519,475	$ 2,519,475	$ 3,056,991	$ 2,519,475	$ 3,056,991	$ 1,106,655	$ 1,644,171
DOE Prime Contractor G&A and Fee (36 percent)	$ -	$ 907,011	$ 907,011	$ 1,100,517	$ 907,011	$ 1,100,517	$ 398,396	$ 591,902
Subtotal:	$ -	$ 3,426,486	$ 3,426,486	$ 4,157,508	$ 3,426,486	$ 4,157,508	$ 1,505,051	$ 2,236,073
Contingency Percentage	20%	20%	20%	30%	20%	30%	20%	30%
Contingency Amount	$ -	$ 685,297	$ 685,297	$ 1,247,252	$ 685,297	$ 1,247,252	$ 301,010	$ 670,822
Total O&M Cost 3:	*$ -*	*$ 4,111,783*	*$ 4,111,783*	*$ 5,404,760*	*$ 4,111,783*	*$ 5,404,760*	*$ 1,806,061*	*$ 2,906,894*
Annual O&M Cost 3:	*$ -*	*$ 137,059*	*$ 137,059*	*$ 180,159*	*$ 137,059*	*$ 180,159*	*$ 60,202*	*$ 96,896*

Table I.1. Basis of estimates summary (cont.)

EMWMF/EMDF LEACHATE FOCUSED FEASIBILITY STUDY	**Alternative 2 Managed Discharge Alternative 20150324B_0**	**Alternative 3 On-site Treatment Alternative 20140804B_0**	**Alternative 4A LGWO Treatment and Pipeline Alternative 20140804C_0**	**Alternative 4B LGWO Treatment and Trucking Alternative 20140804D_0**	**Alternative 5A WETF Treatment and Pipeline Alternative**	**Alternative 5B WETF Treatment and Trucking Alternative**	**Alternative 6A OF200 Treatment and Pipeline Alternative**	**Alternative 6B OF200 Treatment and Trucking Alternative**
O&M Costs During Post-Closure EMDF (30 years):								
Operate On-site Treatment Plant During Post-Closure EMDF	$ -	$ 1,412,820	$ 1,412,820	$ 1,412,820	$ 1,412,820	$ 1,412,820	$ -	$ -
Sample/Test Leachate During Post-Closure EMDF	$ -	$ 1,097,880	$ 1,097,880	$ 1,097,880	$ 1,097,880	$ 1,097,880	$ 1,097,880	$ 1,097,880
Truck Leachate During Post-Closure EMDF	$ -	$ -	$ -	$ 537,516	$ -	$ 537,516	$ -	$ 537,516
Sales Tax (9.75 percent times materials)	$ -	$ 8,775	$ 8,775	$ 8,775	$ 8,775	$ 8,775	$ 8,775	$ 8,775
Subtotal:	$ -	$ 2,519,475	$ 2,519,475	$ 3,056,991	$ 2,519,475	$ 3,056,991	$ 1,106,655	$ 1,644,171
DOE Prime Contractor G&A and Fee (36 percent)	$ -	$ 907,011	$ 907,011	$ 1,100,517	$ 907,011	$ 1,100,517	$ 398,396	$ 591,902
Subtotal:	$ -	$ 3,426,486	$ 3,426,486	$ 4,157,508	$ 3,426,486	$ 4,157,508	$ 1,505,051	$ 2,236,073
Contingency Percentage	20%	20%	20%	30%	20%	30%	20%	30%
Contingency Amount	$ -	$ 685,297	$ 685,297	$ 1,247,252	$ 685,297	$ 1,247,252	$ 301,010	$ 670,822
Total O&M Cost 4:	*$ -*	*$ 4,111,783*	*$ 4,111,783*	*$ 5,404,760*	*$ 4,111,783*	*$ 5,404,760*	*$ 1,806,061*	*$ 2,906,894*
Annual O&M Cost 4:	*$ -*	*$ 137,059*	*$ 137,059*	*$ 180,159*	*$ 137,059*	*$ 180,159*	*$ 60,202*	*$ 96,896*
Un-escalated Total Cost:	***$ 3,675,344***	***$ 35,750,673***	***$ 53,867,669***	***$ 96,656,325***	***$ 45,987,311***	***$ 94,988,838***	***$ 19,295,454***	***$ 61,916,863***
Present Value:	***$ 3,558,233***	***$ 25,271,372***	***$ 41,632,262***	***$ 70,386,764***	***$ 33,751,905***	***$ 68,719,277***	***$ 15,335,395***	***$ 44,612,262***

C = carbon
G&A = General and Administrative
Hg = mercury
LGWO = Liquid and Gaseous Operations
O&M = Operation and Maintenance
OF200 = Outfall 200
WETF = West End Treatment Facility

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APPENDIX J.
SCREENING WATE SAMPLING RESULTS
FOR EVALUATING COMPLIANCE WITH ARARs

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Screening Water Sampling Results for Evaluating Compliance With ARARs

From Tennessee Department of Environment and Conservation (TDEC) regs:

The point of compliance for the discharge limits for Alternative 3 (on-site wastewater treatment) is prior to leachate and contact water combining with storm water. For determining compliance with the aquatic water quality criteria (AWQC) for treated wastewater under this alternative, the U.S. Department of Energy (DOE) is proposing that compliance with the discharge limits be based on a running annual average. Per TDEC's drinking water regulations [TDEC 0400-45-01-.04(55)], "locational running annual average (LRAA)" is defined as the "average of sample analytical results for samples taken at a particular monitoring location during the previous four calendar quarters."

From the U.S. Environmental Protection Agency's (EPA's) *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses* (PB85-227049, December 2010):

A statement of a criterion as a number that is not to be exceeded any time or place is not acceptable because few, if any, people who use criteria would take it literally and few, if any, toxicologists would defend a literal interpretation. The Criterion Continuous Concentration (CCC) is intended to be a good estimate of this threshold of unacceptable effect. If maintained continuously, any concentration above the CCC is expected to cause an unacceptable effect. On the other hand, the concentration of a pollutant in a body of water can be above the CCC without causing an unacceptable effect if (a) the magnitudes and durations of the excursions above the CCC are appropriately limited and (b) there are compensating periods of time during which the concentration is below the CCC. The higher the concentration is above the CCC, the shorter the period of time it can be tolerated. But it is unimportant whether there is any upper limit on concentrations that can be tolerated instantaneously or even for one minute because concentrations outside mixing zones rarely change substantially in such short periods of time. An elegant, general approach to the problem of defining conditions (a) and (b) would be to integrate the concentration over time, taking into account uptake and depuration rates, transport within the organism to a critical site, etc. Because such an approach is not currently feasible, an approximate approach is to require that the average concentration not exceed the CCC. The average concentration should probably be calculated as the arithmetic average rather than the geometric mean 5. If a suitable averaging period is selected, the magnitudes and durations of concentrations above the CCC will be appropriately limited, and suitable compensating periods below the CCC will be required.

From EPA's *Technical Support Document for Water Quality-based Toxics Control*:

A typical aquatic life water quality criteria statement contains a concentration, averaging period, and return frequency, stated in the following format:

The procedures described in the *Guidelines for Deriving National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses* indicate that, except possibly where a locally important species is very sensitive, (1) aquatic organisms and their uses should not be affected unacceptably if the four-day average concentration of (2) does not exceed (3) ug/L more than once every three years on the average and if the one-hour average concentration does not exceed (4) ug/L more than once every three years on the average. [In this generic example statement, the following terms are inserted at: (1) either "freshwater" or "saltwater"; (2) pollutant name; (3) the CCC number; (4) the CMC number].

From EPA's *Water Quality Guidance for the Great Lakes System: Supplementary Information Document (SID)*, EPA-820-B-95-001, March, 1995

Current National guidance [*see above guidelines document*], requires that, except possibly where a locally important species is very sensitive, aquatic organisms and their uses should not be affected unacceptably if the following conditions are met: for chronic criteria, the four-day average concentration of a chemical does not exceed the CCC or Secondary Continuous Concentration (SCC) more than once every three years on the average; for acute criteria, the one-hour average concentration of a chemical does not exceed the CMC or Secondary Maximum Concentration (SMC) more than once every three years on the average. Averaging periods are time periods over which ambient concentrations are to be averaged to determine whether criteria are exceeded. If the mean ambient concentration of a pollutant exceeds the criteria over the averaging period, adverse impacts on the resident aquatic life could occur.

Averaging periods are one means of accounting for the exposure time required to elicit toxic effects. An allowable frequency for exceeding the criteria is incorporated into the criteria because it is not necessary for concentrations to be below criteria at all times in order to adequately protect aquatic ecosystems. Also, it is not generally possible to ensure that criteria are never exceeded. Frequently, concentrations above criteria may occur without corresponding impacts on the aquatic biota if the duration is less than the averaging period. This is dependent on the magnitude and duration of the exceedance.

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