APPENDIX H.13

TEDF (CP-OP-12, CENTRAL PLATEAU)
EVALUATION UNIT SUMMARY TEMPLATE

This page intentionally left blank.

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

PART I. EXECUTIVE SUMMARY

EU LOCATION

300 Area (Slightly east of the 200 East Area)

RELATED EUS

ETF&LERF (CP-OP-11), SALDS (CP-OP-13)

PRIMARY CONTAMINANTS, CONTAMINATED MEDIA AND WASTES

None/not applicable

BRIEF NARRATIVE DESCRIPTION

The Treated Effluent Disposal Facility (TEDF) is one of the four primary facilities for processing and disposing of Hanford liquid waste. The other three are the Effluent Treatment Facility (ETF), Liquid Effluent Retention Facility (LERF), and the State-Approved Land Disposal Site (SALDS). The TEDF facility provides a collection, conveyance, and disposal system for treated liquid effluents from numerous 200 Area Hanford Site facilities. After being sampled at the facility of origin, the treated waste is pumped to one of two adjacent State approved infiltration basins. TEDF handles non-contaminated waste only. [1]

Treated non-hazardous and non-radioactive liquid wastes are collected and then disposed of through the systems at the Treated Effluent Disposal Facility (TEDF) which is referred to as the 200 Area TEDF. More than twelve miles of polyvinyl chloride piping connects facilities throughout the Site to TEDF's state permitted disposal basin in the 200 East Area of Hanford. TEDF has the ability to collect and safely dispose of 5.5 million gallons/day[2] as a monthly average (which equates to nearly 2 billion gallons of liquid per year) in accordance with its state discharge permit.[3] The 200 Area TEDF is a collection and disposal system for non-RCRA waste streams. The facility began operating in April 1995 and continues to operate to this day.

From December 1994 to September 2009, the 300 area TEDF operated under the miscellaneous liquid waste discharge permit ST-4511[4,] and accepted liquid waste that met water quality standards from

---

[1] RPP-RPT-5827, Rev 0, pg. E-1 and pg. 58

[2] Pg. 6 of the State Waste Discharge Permit Number ST0004502

[3] Hanford.gov. (2015, Last Revised December 1, 2015). "Treated Effluent Disposal Facility." Accessed February 25, 2016, from http://www.hanford.gov/page.cfm/TEDF.

[4] This Categorical State Waste Discharge Permit consists of four former State Waste Discharge Permits (ST4501, ST4508, ST4509, and ST4510). Categorical permits are unique to the Hanford Site and are not used elsewhere in the state. The Categorical permits are intended to provide compliance with regulations while providing a streamlined and cost-effective permitting approach. The wastewater discharges addressed in this permit include the discharge of hydrotesting, construction, and maintenance wastewater; the discharge of cooling water and condensate; and the collection and the discharge of industrial stormwater. [Washington State Department of Ecology. (2016). "Waste Water Discharge Permits." Accessed January 25, 2016, from http://www.ecy.wa.gov/programs/nwp/permitting/WWD/.]

industrial operations within the 300 Area.[5] The 300 area TEDF has completed terminal cleanout and all process systems have been deactivated in preparation for decommissioning and destruction. Only 200 area TEDF is described below as part of the operating facilities evaluation unit CP-OP-12.

SUMMARY TABLES OF RISKS AND POTENTIAL IMPACTS TO RECEPTORS

Table H.13-1 provides a summary of nuclear and industrial safety related risks to humans and impacts to important physical Hanford site resources.

Human Health

A Facility Worker is deemed to be an individual located anywhere within the physical boundaries or immediate areas around the outside the facility; a Co-located Person is an individual located 100 meters from the facility boundary; and Public is an individual located at the closest point on the Hanford Site boundary not subject to DOE access control. The nuclear related risks to humans are based on unmitigated (unprotected or controlled conditions) dose exposures expressed in a range of from "low" to "high" according to the consequence levels. The estimated mitigated exposure that takes engineered and administrative controls and protections into consideration, when this information is available, is shown in parentheses within Table H.13-1, "IS" denotes insufficient information is available to provide a rating. The estimated impacts to the facility worker, co-located person, and member of the public are "Non-Discernible, ND" due to the nature of the facility and the material handled at TEDF. TEDF only disposes treated non-hazardous and non-radioactive liquid wastes (sanitary/municipal liquid wastes).

Groundwater and Columbia River

Direct impacts to groundwater resources and the Columbia River have been rated based on available information for the current status and estimates for future time periods. These impacts are also expressed in a range of from *Not Discernible* (*ND*) to *Very High*.

Ecological Resources[6]

The risk ratings are based on the degree of physical disruption (and potential additional exposure to contaminants) in the current status and as a potential result of remediation options.

Cultural Resources[6]

No risk ratings are provided for Cultural Resources. The Table identifies the three overlapping Cultural Resource landscapes that have been evaluated: Native American (approximately 10,000 years ago to the present); Pre-Hanford Era (1805 to 1943) and Manhattan/Cold War Era (1943 to 1990); and provides initial information on whether an impact (both direct and indirect) is KNOWN (presence of cultural resources established), UNKNOWN (uncertainty about presence of cultural resources), or NONE (no cultural resources present) based on written or oral documentation gathered on the entire EU and buffer area. Direct impacts include but are not limited to physical destruction (all or part) or alteration such as diminished integrity. Indirect impacts include but are not limited to the introduction of visual, atmospheric, or audible elements that diminish the cultural resource's significant historic features. Impacts to Cultural Resources as a result of proposed future cleanup activities will be evaluated in depth

5 PNNL-19455, pg. 6.25

6 References throughout this Evaluation Unit Summary Template supporting analyses related to Ecological Resources and/or Cultural Resources may be found in Appendices J and K, respectively. Refer to the specific EU when searching for the reference.

under Section 106 of the National Historic Preservation Act (16 USC 470, et. seq.) during the planning for remedial action.

Table H.13-1. Risk Rating Summary (for Human Health, unmitigated nuclear safety basis indicated, mitigated basis indicated in parentheses (e.g., "High" (Low)).

Population or Resource		Evaluation Time Period: Active Cleanup (to 2064)	
		Current Condition: Stabilization & Deactivation	**From Cleanup Actions:** Final D&D[C]
Human Health	Facility Worker	***S&D***: Not Discernible (ND) (ND)	***Proposed method***: IS[d]
	Co-located Person	***S&D***: ND (ND)	***Proposed method***: IS
	Public	***S&D***: ND (ND)	***Proposed method***: IS
Environmental	Groundwater[a]	*Not Discernible* (*ND*)	*ND*
	Columbia River[a]	*ND*	*ND*
	Ecological Resources[b]	Low	No cleanup decisions have been made for this EU. Estimated to be Medium.
Social	Cultural Resources[b]	**Native American** Direct: Unknown Indirect: Known **Historic Pre-Hanford** Direct: Unknown Indirect: Known **Manhattan/Cold War** Direct: None Indirect: None	No cleanup decisions have been made for this EU. Estimated to be: **Native American** Direct: Unknown Indirect: Known **Historic Pre-Hanford** Direct: Unknown Indirect: Known **Manhattan/Cold War** Direct: None Indirect: None

a. Threat to groundwater or the Columbia River from Group A and B primary contaminants (PCs) (Table 6-1, CRESP 2015) remaining in the vadose zone. There are no vadose zone inventories associated with this EU (because of the nature of the facility and the material handled), and thus no threat to the vadose zone, groundwater, or the Columbia River.

b. For both Ecological and Cultural Resources see Appendices J and K, respectively, for a complete description of Ecological Field Assessments and literature review for Cultural Resources. Ecological ratings are described in Table 4-11 of the Final Report. (IS = insufficient information).

c. Proposed method: Dependent on D&D Methods yet to be determined. (Unknown)

d. Insufficient information

SUPPORT FOR RISK AND IMPACT RATINGS FOR EACH POPULATION OR RESOURCE HUMAN HEALTH

Current

The estimated impacts to the facility worker, co-located person, and member of the public are "Non-Discernible, ND" due to the nature of the facility and the material handled at TEDF. TEDF only disposes treated non-hazardous and non-radioactive liquid wastes (sanitary/municipal liquid wastes).

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

The 300 Area TEDF has completed terminal cleanout and all process systems have been deactivated in preparation for decommissioning and destruction, but no final cleanup decisions have been made for the Liquid Waste Disposal Facilities (including 300 Area TEDF). The author has estimated the impacts to the facility worker, co-located person, member of the public, groundwater, and the Columbia River will be "Non-Discernible, ND" due to the nature of the facility and the material handled at TEDF.

Groundwater, Vadose Zone, and Columbia River

There are no reported vadose zone inventories (because of the nature of the facility and the material handled at TEDF) and thus no significant threats to the vadose zone, groundwater, or the Columbia River for the purposes of this Review.

Ecological Resources

Current

21% of EU and 100% of the buffer area are level 3 or higher resources. Higher quality resources are located along the perimeter of the EU (retention basins). Truck traffic and herbicide application are responsible for low impacts.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

No cleanup decisions have been made, and as a result, the potential effects of cleanup on ecological resources are uncertain for the active cleanup evaluation period.

Cultural Resources

Current

Much of the land within the EU is extensively disturbed. Almost the entire EU has been inventoried for cultural resources. Geomorphology indicates a moderate potential to contain intact archaeological resources on the surface and/or subsurface. Traditional cultural places are visible from EU. One archaeological isolate is located within 500 meters of the EU.

Risks and Potential Impacts from Selected or Potential Cleanup Approaches

No cleanup decisions have been made for the deep vadose zone, and archaeological investigations and monitoring may need to occur prior to remediation. The geomorphology indicates a moderate potential for intact archaeological resources. Remediation disturbance may result in impacts to archaeological resources if they are present in the subsurface. No cleanup decisions have been selected, however the potential range of impacts could include: Temporary indirect effects during remediation; Permanent indirect effects are possible if contamination remains after remediation and from capping.

Considerations for Timing of the Cleanup Actions

Treated non-hazardous and non-radioactive liquid wastes are collected and then disposed of through the systems at the TEDF so the timing of cleanup actions would not be dependent on radiological or

hazardous material. If the basis of the timing and/or order of cleanup of TEDF is made in comparison to other facilities, then TEDF would receive a lower priority. No cleanup decisions have been made for this EU.

Near-Term, Post-Cleanup Risks and Potential Impacts

No cleanup decisions have been made for this EU.

PART II. ADMINISTRATIVE INFORMATION

OU AND/OR TSDF DESIGNATION(S)

Not Applicable

COMMON NAME(S) FOR EU

TEDF, 200 Area Treated Effluent Disposal Facility, 200 Area TEDF

KEY WORDS

Waste water treatment, non-dangerous waste

REGULATORY STATUS: (RCRA, CERCLA, ROD IN DISPOSITION TABLE FOR MANY)

Regulatory basis

Clean Water Act

Applicable regulatory documentation

200 Area TEDF: A delisting petition was approved by the EPA that exempts the treated process condensate from the requirements of hazardous waste regulations under the Resource Conservation and Recovery Act and imposes certain effluent quality restrictions. High concentrations of ammonia in the process condensate from the 242-A Evaporator Facility and treated at the Effluent Treatment Facility (ETF) also make this stream a dangerous waste subject to Washington Administrative Code (WAC) 173-303, *Dangerous Waste Regulations.* After treatment in the facility, the discharged effluent is not a dangerous waste. The disposal facility was permitted in June 1995 by the Washington State Department of Ecology under the WAC 173-216, *State Waste Discharge Permit Program.* [7] The individual waste streams that are collected via piping and routed to the 200 Area TEDF for approved discharge must be treated or otherwise comply with best available technology and all known available and reasonable treatment methods in accordance with "Submission of Plans and Reports for Construction of Wastewater Facilities" (WAC 173-240), which is the responsibility of the generating facilities

The 300 Area Treated Effluent Disposal Facility was issued the NPDES permit No. WA-002591-7 and began operations on December 31, 1994.[8]

[7] PNNL-11139, pg. 46

[8] PNNL-10574, pg. viii

Applicable Consent Decree or TPA milestones

DOE-RL also incorporated this program of pollution prevention, effluent treatment prior to discharge into the 200 Area TEDF system, and facility construction and operation as a portion of Milestone 17 in the 1989 Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) between the Department of Energy, the U.S. Environmental Protection Agency, and Ecology. The Tri-Party Agreement further requires that the Best Available Technology (BAT) that is economically achievable be applied to the effluent.[9]

The 300 Area TEDF satisfied Tri-Party Agreement milestone M-17-09 for ceasing the discharge of untreated 300 Area process sewer effluents to the soil column at the 300 Area Process Trenches. [10]

RISK REVIEW EVALUATION INFORMATION

Completed

March 10, 2017

Evaluated by

Bethany Burkhardt and Steve Krahn

Ratings/Impacts Reviewed by

Henry Mayer

PART III. SUMMARY DESCRIPTION

The current land use is Industrial for the DOE Hanford Site.

DESIGNATED FUTURE LAND USE

The designated future use of the TEDF location is categorized as the Conservation (Mining) land use. [11]

PRIMARY EU SOURCE COMPONENTS

Groundwater Plumes

Not applicable

Operating Facilities

The Treated Effluent Disposal Facility (TEDF) is one of the four primary facilities for processing and disposing of Hanford liquid waste. The other three are the Effluent Treatment Facility (ETF), Liquid Effluent Retention Facility (LERF), and the State-Approved Land Disposal Site (SALDS). The TEDF facility provides a collection, conveyance, and disposal system for treated liquid effluents from numerous 200

[9] Fact Sheet for State Permit ST0004502, Report pg. 9 from Department of Ecology State of Washington. (2016). "Waste Water Discharge Permits." Accessed January 25, 2016, from http://www.ecy.wa.gov/programs/nwp/permitting/WWD/.
[10] PNNL-10574, pg. 45
[11] DOE-EIS-0222 CLUP-EIS Summary document, Figure S-10 on page 45/131

Area Hanford Site facilities. After being sampled at the facility of origin, the treated waste is pumped to one of two adjacent State approved infiltration basins. TEDF handles non-contaminated waste only. [12]

Treated non-hazardous and non-radioactive liquid wastes are collected and then disposed of through the systems at the Treated Effluent Disposal Facility (TEDF) which is referred to as the 200 Area TEDF. More than twelve miles of polyvinyl chloride piping connects facilities throughout the Site to TEDF's state permitted disposal basin in the 200 East Area of Hanford. TEDF has the ability to collect and safely dispose of 5.5 million gallons/day[13] as a monthly average (which equates to nearly 2 billion gallons of liquid per year) in accordance with its state discharge permit.[14] The 200 Area TEDF is a collection and disposal system for non-RCRA waste streams. The facility began operating in April 1995 and continues to operate to this day.

From December 1994 to September 2009, the 300 area TEDF operated under the miscellaneous liquid waste discharge permit ST-4511[15,] and accepted liquid waste that met water quality standards from industrial operations within the 300 Area.[16] The 300 area TEDF has completed terminal cleanout and all process systems have been deactivated in preparation for decommissioning and destruction. Only 200 area TEDF is described below as part of the operating facilities evaluation unit CP-OP-12.

LOCATION AND LAYOUT MAPS

The TEDF is located east of the 200 East Area, as shown in Figure H.13-1, Figure H.13-2, and Figure H.13-3. Figure H.13-3 also shows the effluent collection system (piping routes) for the TEDF.

[12] RPP-RPT-5827, Rev 0, pg. E-1 and pg. 58

[13] Pg. 6 of the State Waste Discharge Permit Number ST0004502

[14] Hanford.gov. (2015, Last Revised December 1, 2015). "Treated Effluent Disposal Facility." Accessed February 25, 2016, from http://www.hanford.gov/page.cfm/TEDF.

[15] This Categorical State Waste Discharge Permit consists of four former State Waste Discharge Permits (ST4501, ST4508, ST4509, and ST4510). Categorical permits are unique to the Hanford Site and are not used elsewhere in the state. The Categorical permits are intended to provide compliance with regulations while providing a streamlined and cost-effective permitting approach. The wastewater discharges addressed in this permit include the discharge of hydrotesting, construction, and maintenance wastewater; the discharge of cooling water and condensate; and the collection and the discharge of industrial stormwater. [Washington State Department of Ecology. (2016). "Waste Water Discharge Permits." Accessed January 25, 2016, from http://www.ecy.wa.gov/programs/nwp/permitting/WWD/.]

[16] PNNL-19455, pg. 6.25

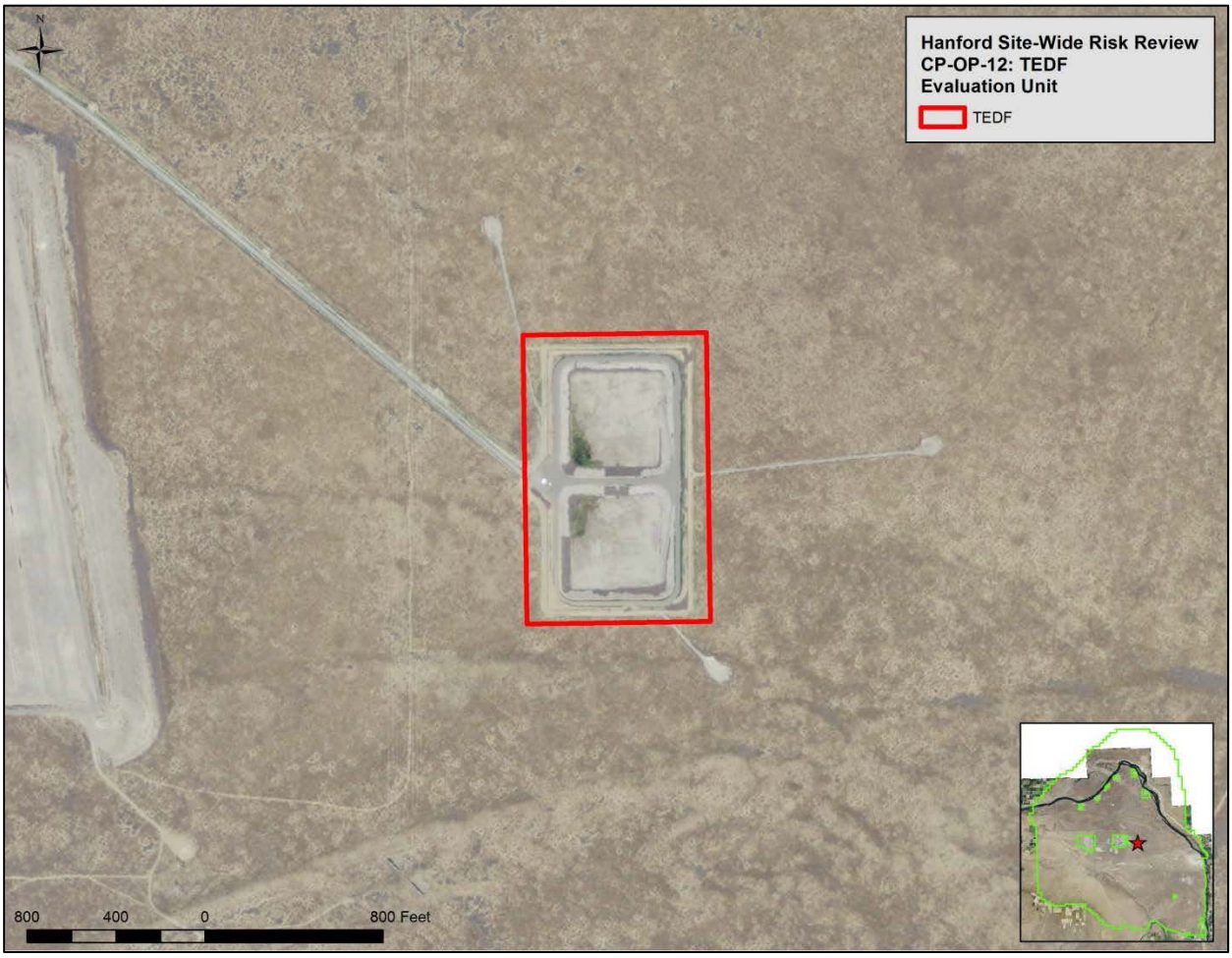

Figure H.13-1. CP-OP-12 (TEDF) Site Location Map

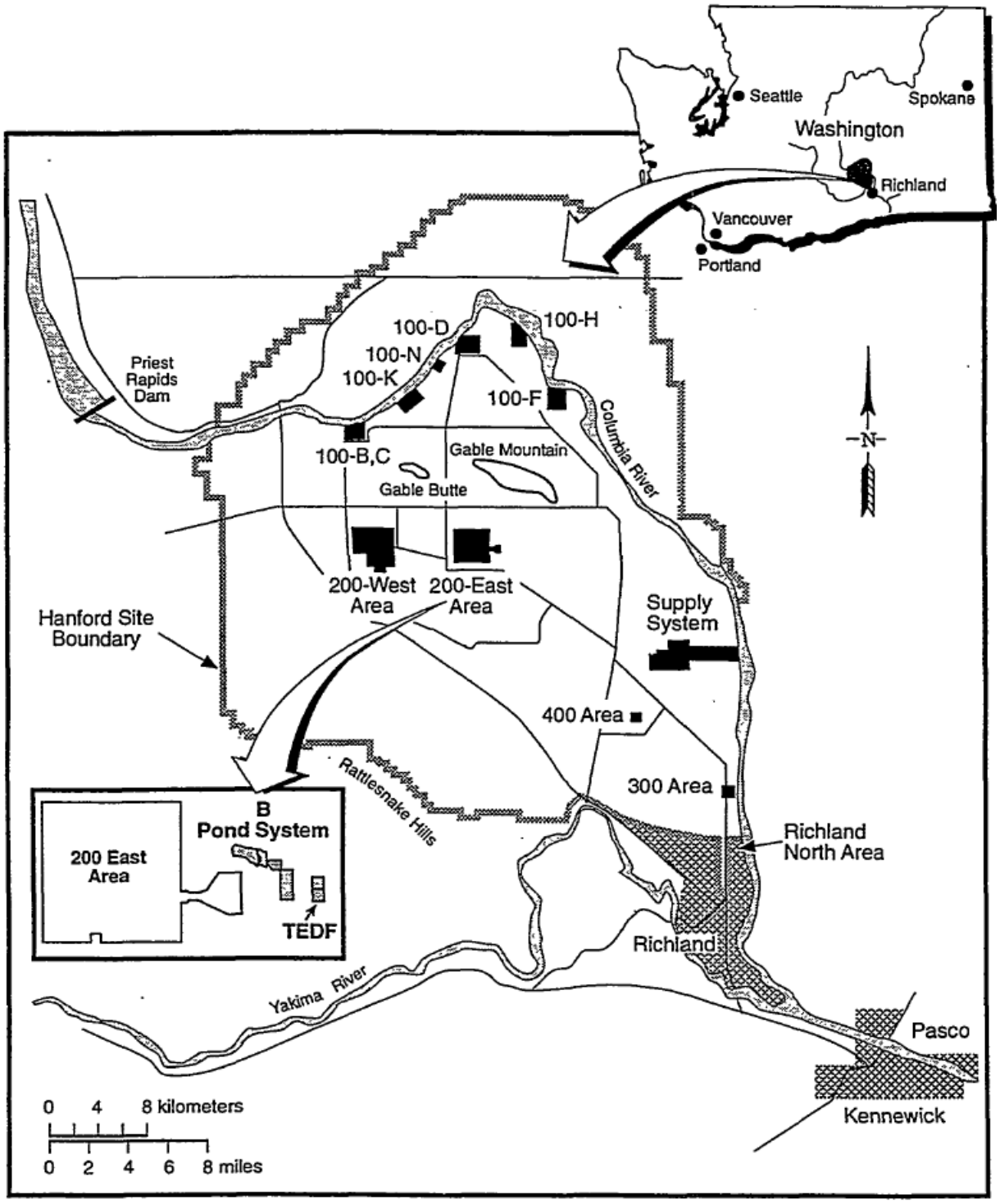

Figure H.13-2. Location of the 200 Area TEDF[17]

[17] PNNL-13032, Figure 1.1, pg. 1.2

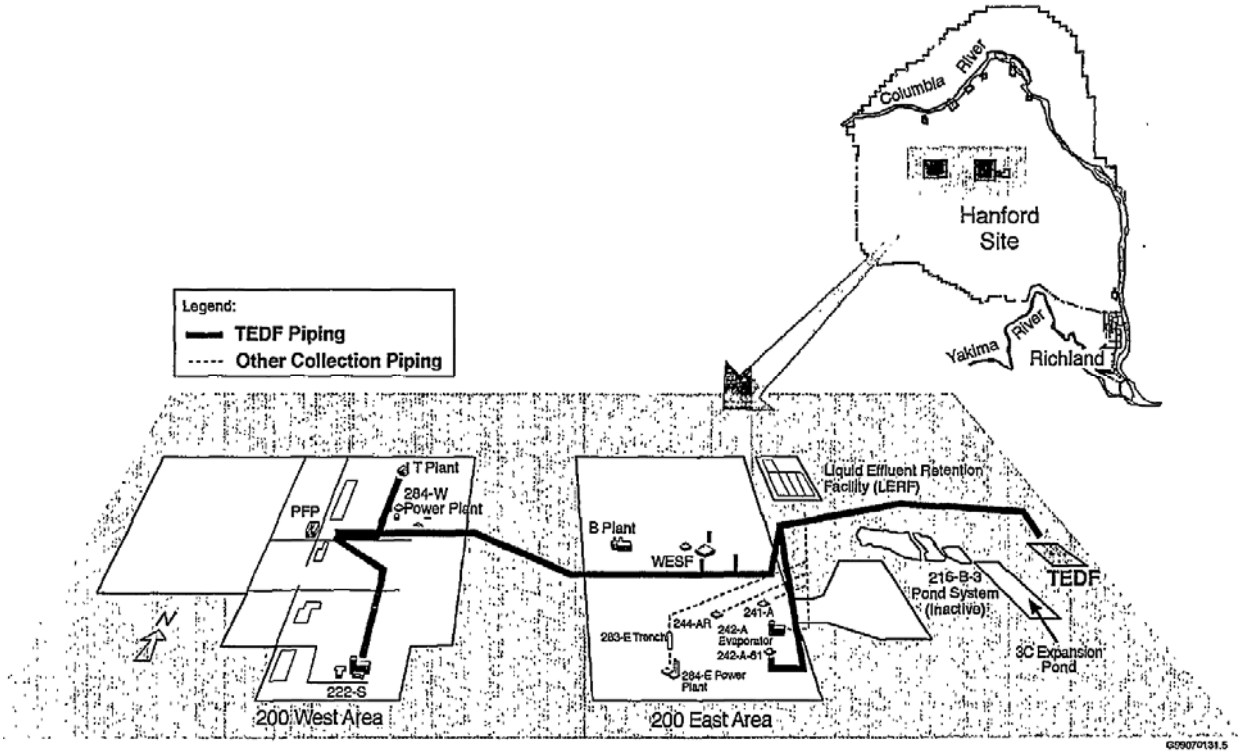

Figure H.13-3. Schematic Diagram of the Effluent Collection System for the TEDF[18]

The 200 Area TEDF consists of three (3) pump stations, a sampling building (6653), disposal ponds, and piping to connect the various major facilities in the 200E and 200W Areas to the system. Pumps are operated at the pump stations using the local control unit or from the ETF Control Room. As shown in Figure H.13-4: Pump station 1 is located in West Area; Pump station 2 is located in East Area; and Pump station 3 is located southeast of the ETF in the 600 Area east of 200E Area. The 6653 Building is used primarily for sampling the effluent flows prior to release to one of the two disposal ponds located about three (3) kilometers (about 2 miles) southeast of ETF. [19] Figure H.13-5 shows the two disposal ponds (A and B).

[18] PNNL-13032, Figure 1.2, pg. 1.4

[19] RPP-RPT-5827, Rev 0, pg. 17 and pg. 19

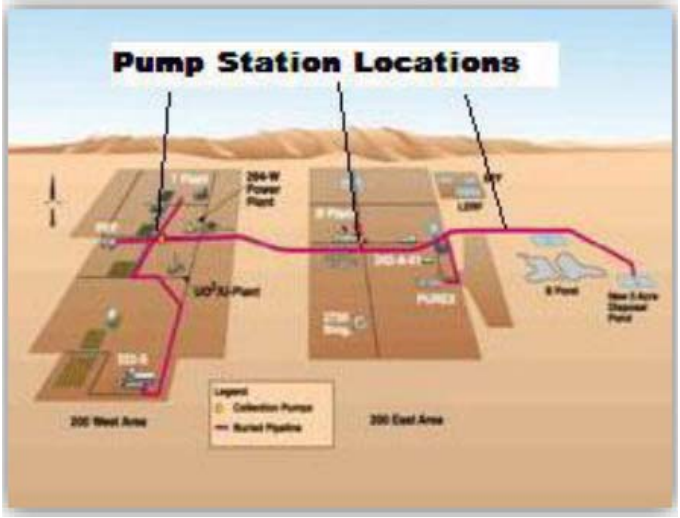

Figure H.13-4. TEDF Pump Station Locations[20]

[20] RPP-RPT-58275, Rev 0, pg. 18

Figure H.13-5. 200 Area TEDF Pond A and B[21]

PART IV. UNIT DESCRIPTION AND HISTORY

EU FORMER/CURRENT USE(S)

The 200 Area TEDF is a collection and disposal system for non-RCRA waste streams. The facility began operating in April 1995 and has a capacity of 3,400 gallons (12,900 liters) per minute. The individual waste streams must be treated or otherwise comply with best available technology and all known

[21] DOE/RL-2014-52, Figure 5.18., pg. 5.26

available and reasonable treatment methods in accordance with "Submission of Plans and Reports for Construction of Wastewater Facilities" (WAC 173-240), which is the responsibility of the generating facilities. Effluent discharges comply with the limitations established in State Waste Discharge Permit ST-4502. The 200 Area TEDF consists of approximately 11 miles (18 kilometers) of buried pipelines connecting three pumping stations, the 6653 Building (known as the disposal sample station) and two 5-acre (2-hectare) disposal ponds. [22]

All waste discharged to the TEDF system meets Washington State Department of Ecology discharge requirements. The 200 Area TEDF replaced nine individual liquid disposal sites. Facilities using this system treat their own waste first using regulator-approved best available technology. This includes source control, filtration, chemical treatment, and recycling. Wastewater generating processes include: non-contact cooling water, steam condensate, dryer condensate, air conditioning condensate, reverse osmosis unit brine, potable water, raw water, rainwater, miscellaneous effluents, water softener regenerate, filter backwash, boiler blow-down, and cooling tower blow-down(see Table H.13-2, below). [23] All of the water is generated from facility activities that do not have direct contact with industrial processes. The wastewater permit provides the terms and conditions that regulate the discharge of treated wastewater, via infiltration through soils, into groundwater of the state. The State Waste Discharge Permit ST-4502 authorizes the following discharges to the 200 Area TEDF:[24]

Table H.13-2. Authorized Discharges to the 200 Area TEDF[25]

Facility	Uses Generating Effluent
Plutonium Finishing Plan	Ventilation heating/cooling, steam condensate, cooling water, compressed air production, process water, rainwater, potable water overflow, and miscellaneous water from deactivation, dismantling, and maintenance activities.
222-S Laboratory Complex	Potable water and rainwater
T Plant	Steam condensate, cooling water, heating coil water, and floor drains
242-A Evaporator	Cooling water and steam condensate
242-A-81 Water Services Building	Untreated Columbia river water and strainer backwash
Waste Encapsulation Storage Facility (WESF)	Cooling water, rainwater, raw water, and potable water
Package boilers (242-A Annex, 283E, and 283W)	Boiler blowdown, steam condensate, cooling water, and water softener regenerate flows
241-A Tank Farm Cooling Water	Cooling water
Miscellaneous waste streams permitted by ST-4511	Miscellaneous waste streams (hydrotest, maintenance, construction, and cooling water, industrial stormwater, etc.)
Waste Treatment Plant	Cooling water, steam condensate, boiler blowdown, reverse osmosis brine, non-dangerous, and nonradioactive water.

[22] DOE/RL-2014-52, pg. 5.26
[23] RPP-RPT-58275, Rev 0, pg. 17
[24] Pg. 2 of Washington State Department of Ecology (2012). State Waste Discharge Permit Number ST0004502 (Effective until 06/30/2017). **(URL: http://www.ecy.wa.gov/programs/nwp/permitting/WWD/PDF/ST4502/st4502.pdf):** 25 pages.
[25] Pg. 2 of Washington State Department of Ecology (2012). State Waste Discharge Permit Number ST0004502 (Effective until 06/30/2017). **(URL: http://www.ecy.wa.gov/programs/nwp/permitting/WWD/PDF/ST4502/st4502.pdf):** 25 pages.

Originally, there were two functional areas of TEDF: one that disposes of treated municipal/sanitary liquid waste from the 200 Areas and one that disposes of treated industrial liquid waste from the 300 Areas (both liquid waste streams are non-hazardous/RCRA-delisted and non-radioactive). The 300 Area Treated Effluent Disposal Facility was issued the NPDES permit No. WA-002591-7 and began operations on December 31, 1994.[26] From December 1994 to September 2009, the 300 area TEDF operated under the miscellaneous liquid waste discharge permit ST-4511[27,] and accepted liquid waste that met water quality standards from industrial operations within the 300 Area.[28] The 300 area TEDF has completed terminal cleanout and all process systems have been deactivated in preparation for decommissioning and destruction. Only 200 area TEDF is described below as part of the operating facilities evaluation unit CP-OP-12.

Industrial wastewater generated throughout the Hanford Site was collected and treated in the 300 Area Treated Effluent Disposal Facility, which began operation in December 1994 and was permanently shut down on September 2, 2009. The facility has completed terminal cleanout and all process systems have been deactivated in preparation for decommissioning and destruction. [29] The 300 Area Treated Effluent Disposal Facility had a 1100 L/min (300 gal/min) treatment capacity that was operated 24 hours a day and was largely computer automated, with the capability for full manual operation when required. [30] The 300 Area TEDF also was designed with a storage capacity of up to 5 days at the design flow rate of 1,100 liters per minute (300 gallons per minute).[31] The summed annual 300 Area TEDF discharges starting at the end of 2014 to 2009 was approximately 3.0 billion liters (780 million gallons).

Industrial wastewater generated primarily from laboratories, research facilities, and office buildings in the 300 Area was collected and treated in the 300 Area Treated Effluent Disposal Facility. The wastewater consisted of cooling water, steam condensate, and other industrial wastewater.[32] The industrial wastewater that was potentially contaminated was collected in the nearby 307 Retention Basins where it was monitored and released to the 300 Area process sewer for treatment by the 300 Area TEDF. The treatment process includes iron co-precipitation to remove heavy metals, ion exchange to remove mercury, and ultra-violet light and peroxide oxidation to destroy organics and cyanide. Sludge from the iron coprecipitation process is dewatered and used for backfill in the low-level waste burial

[26] PNNL-10574, pg. viii

[27] This Categorical State Waste Discharge Permit consists of four former State Waste Discharge Permits (ST4501, ST4508, ST4509, and ST4510). Categorical permits are unique to the Hanford Site and are not used elsewhere in the state. The Categorical permits are intended to provide compliance with regulations while providing a streamlined and cost-effective permitting approach. The wastewater discharges addressed in this permit include the discharge of hydrotesting, construction, and maintenance wastewater; the discharge of cooling water and condensate; and the collection and the discharge of industrial stormwater. [Washington State Department of Ecology. (2016). "Waste Water Discharge Permits." Accessed January 25, 2016, from http://www.ecy.wa.gov/programs/nwp/permitting/WWD/.]

[28] PNNL-19455, pg. 6.25

[29] PNNL-19455, pg. 6.25

[30] PNNL-10574, pg. 45

[31] PNNL-19455, pg. 6.25

[32] PNNL-19455, pg. xiii

grounds. The treated liquid effluent is monitored and discharged through an outfall to the Columbia River under a National Pollutant Discharge Elimination System permit No. WA 002591-7. [33,34]

LEGACY SOURCE SITES

Not Applicable

GROUNDWATER PLUMES

Not Applicable

D&D OF INACTIVE FACILITIES

Not Applicable

OPERATING FACILITIES

1. Processes that produced the radioactive material and waste contained in the facility

No processes or activities conducted at TEDF produced the liquid waste being discharged at the facility. TEDF handles non-contaminated waste only [35] meaning that only treated non-hazardous and non-radioactive liquid wastes are collected and then disposed of through the systems at TEDF. [36]

2. Primary radioactive and non-radioactive constituents that are considered risk drivers

See Question 1, above. Prohibited waste discharges at TEDF include the following: [37]

- Polychlorinated biphenyl (PCB) waste regulated under the *Toxic Substances Control Act of 1976* (TSCA)
- Explosive waste
- Unstable waste
- Waste that could generate toxic gases, vapors, or fumes in concentrations that reasonably could be expected to exceed occupational exposure limits and/or air emission standards
- Biohazard waste
- Dangerous waste, as defined by Washington Administrative Code (WAC) 173-303
- Wastes with gross alpha and gross beta concentrations greater than 15 pCi/L and 50 pCi/L, respectively
- Hazardous materials and petroleum products
- Waxes, oils, greases, and solids that may interfere with monitoring instruments, clog the piping, or degrade the infiltration rate of the soils.

Because the TEDF does not provide any treatment or retention capacity, strict control is imposed on each generating facility to ensure that the TEDF discharges remain in compliance with ST 4502 and

[33] PNNL-13487, Pg. 2.38

[34] PNNL-19455, pg. 6.25

[35] RPP-RPT-5827, Rev 0, pg. E-1 and pg. 58

[36] Hanford.gov. (2015, Last Revised December 1, 2015). "Treated Effluent Disposal Facility." Accessed February 25, 2016, from http://www.hanford.gov/page.cfm/TEDF.

[37] HNF-3172, Rev. 7, pg. 5

within the TEDF system capacity. The TEDF end-of-pipe discharges must be maintained within the limits given in Table H.13-3, below.

Table H.13-3. Effluent Limits for the 200 Area TEDF[38]

Constituent	Units	Average Monthly Limitations	Maximum Daily Effluent Limitation
Arsenic (total)	µg/L	15	—
Bis (2-ethylhexyl) phthalate	µg/L	10	—
Carbon tetrachloride	µg/L	5	—
Cadmium (total)	µg/L	5	—
Chloride	µg/L	58,000	116,000
Chloroform	µg/L	7	—
Chromium (total)	µg/L	20	—
Nitrate (as N)	µg/L	620	1,240
Iron (total)	µg/L	300	—
Lead (total)	µg/L	10	—
Manganese (total)	µg/L	50	—
Mercury (total)	µg/L	2	—
Methylene chloride	µg/L	5	—
Total dissolved solids	µg/L	500,000	—
Total trihalomethanes	µg/L	20	—
Average monthly flow[2]	5,500,000 gallons per day		
Average yearly flow[3]	1,700,000 gallons per day		

µg/L = micrograms per liter

[1]Ecology, 2012, *State Waste Discharge Permit Number ST0004502,* issued June 25, 2012, State of Washington, Department of Ecology, Kennewick, Washington.

[2] Average monthly flow is calculated as the total gallons discharged during a calendar month divided by the number of days in that month.

[3] Average yearly flow is calculated as the total gallons discharged during a calendar year divided by the number of days in that year.

Under the terms of ST 4502, only wastewaters resulting from approved generating processes are authorized to discharge to the TEDF without prior Ecology approval. Most of the wastewaters accepted at the TEDF have not been in direct contact with industrial processes and are primarily associated with the following: [39]

- ventilation, heating, and cooling systems for the buildings
- steam condensate from heating potable (drinkable) water
- condensate of pressurized potable water
- storm water
- potable (treated) water
- untreated Columbia River water
- boiler blow down
- floor drains with limited and strictly controlled usage

[38] HNF-3172, Rev. 7, Table 1, pg. 6
[39] HNF-3172, Rev. 7, Table 1, pg. 7

- hydrotest, maintenance, construction, cooling water, condensate, storm water, and other
- miscellaneous wastewater discharges that are covered under the *State Waste Discharge Permit Number ST 4511* (Ecology 2005).

Such discharges are classified by the facility as either routine or non-routine. Routine discharges are pre-approved and can be made at the generators discretion, provided they are within the TEDF acceptance criteria. Non-routine discharges are single batch, with each batch requiring LWF approval prior to discharge to TEDF. The following sections summarize the acceptance process for routine and non-routine discharges to TEDF (see Question 6, below on the waste acceptance process for routine and non-routine discharges).

3. Containers or storage measures are used for radioactive materials at the facility

See Question 1, above.

4. Classification of radioactive material and waste contained or stored within the facility

Municipal liquid waste (non-dangerous/non-radioactive/non-RCRA)

5. Average and maximum occupational radiation doses incurred at the facility

Specific information on individual occupational doses was available regarding 300 Area TEDF operations for years 1996 through 2014. It was assumed that 200 Area TEDF and 300 Area TEDF would have similar annual worker doses until further information is provided.

Table H.13-4. Thermoluminescent Dosimeter Results (2009 and 2010) [40]

Table 8.11.1. Thermoluminescent Dosimeter Results (mrem/yr)[a] Near Hanford Site Operations in 2009 and 2010

Hanford Site Locations	Number of Dosimeters	2009		2010		
		Maximum[b]	Average[c,d]	Maximum[b]	Average[c,d]	% Change[e]
100-K Area	14	1,525 ± 2,814	278 ± 735	187 ± 131	109 ± 68	-60
100-N Area	5	133 ± 64	96 ± 47	152 ± 201	94 ± 65	-1
200-East Area	42	285 ± 55	102 ± 78	480 ± 187	107 ± 127	5
200-West Area	24	189 ± 21	99 ± 50	219 ± 49	98 ± 62	<1
200-North Area (212-R)	1	1,697 ± 254[f]	1,552 ± 323	1,508 ± 226	1,329 ± 397	-14
300 Area	8	101 ± 9	82 ± 17	113 ± 22	87 ± 28	6
300 Area TEDF	6	84 ± 13	80 ± 5	83 ± 3	81 ± 4	<1
400 Area	7	92 ± 8	79 ± 13	88 ± 6	79 ± 8	<1
618-10 Burial Ground	4			77 ± 20	76 ± 2	N/A
CVDF	4	243 ± 316	138 ± 149	80 ± 10	73 ± 9	-46
ERDF	3	91 ± 23	85 ± 12	80 ± 10	78 ± 2	-6
IDF	1	93 ± 14[f]	88 ± 7	88 ± 13	84 ± 8	-5

(a) To convert to international metric system units, multiply mrem/yr by 0.01 to obtain mSv/yr.
(b) Maximum values are ± analytical uncertainty.
(c) ±2 standard deviations.
(d) Each dosimeter is collected and read quarterly.
(e) Numbers indicate a decrease (-) or increase from the 2009 mean.
(f) Maximum value represents highest quarterly value ± analytical uncertainty.
CVDF = Cold Vacuum Drying Facility (100-K Area).
ERDF = Environmental Restoration Disposal Facility (200-West Area).
IDF = Integrated Disposal Facility (200-East Area).
N/A = Not applicable.
TEDF = Treated Effluent Disposal Facility.

[40] PNNL-20548, Table 8.11.1, pg. 8-122

Table H.13-5. Thermoluminescent Dosimeter Results (2010 and 2011) [41]

(mrem/year)(a)

Location	No. of Dosimeters	2010 Maximum(b)	2010 Average(c,d)	2011 Maximum(b)	2011 Average(c,d)	Percentage Change(e)
100-K	14	187 ± 131	109 ± 68	207 ± 203	102 ± 74	-6
100-N	5	152 ± 201	94 ± 65	203 ± 185	116 ± 115	23
200-East	42	480 ± 187	107 ± 127	385 ± 407	100 ± 98	-6
200-West	24	219 ± 49	98 ± 62	178 ± 63	96 ± 52	-1
200-North (212-R)(f)	1	1,508 ± 226	1,329 ± 397	570 ± 86	251 ± 456	-80
300 Area	8	113 ± 22	87 ± 28	114 ± 12	86 ± 29	-1
300 TEDF	6	83 ± 3	81 ± 4	81 ± 6	79 ± 4	-1
400 Area	7	88 ± 6	79 ± 8	89 ± 8	79 ± 9	<1
618-10	4	77 ± 20	76 ± 2	75 ± 34	74 ± 4	-2
CVDF	4	80 ± 10	73 ± 9	78 ± 13	74 ± 5	1
ERDF	3	80 ± 10	78 ± 2	89 ± 5	81 ± 13	3
IDF(f)	1	88 ± 13	84 ± 8	88 ± 13	83 ± 7	<1

(a) To convert to international metric system units, multiply mrem/year by 0.01 to obtain mSv/year
(b) Maximum values are ± analytical uncertainty
(c) ± 2 standard deviations
(d) Each dosimeter is collected and read quarterly
(e) Numbers indicate a decrease (-) or increase from the 2009 mean
(f) Maximum value represents highest quarterly value ± analytical uncertainty.

CVDF = Cold Vacuum Drying Facility (100 K Area)
ERDF = Environmental Restoration Disposal Facility (200 West Area)
IDF = Integrated Disposal Facility (200 East Area)
TEDF = 300 Area Treated Effluent Disposal Facility

Site-wide dose rate levels are provided in the Hanford Sitewide Environmental Report for Calendar Year 2014 [DOE/RL-2014-52]. The average dose rates in 2014 in the 300 and 400 Areas and at the 300 Area TEDF were generally lower by approximately 5 percent compared to 2013 levels [42] and were less than 100 mrem per individual in the year 2014 (as read from Figure H.13-6, below).

[41] DOE/RL-2011-119, Rev. 0, Table 4.1, pg. 4.3
[42] DOE/RL-2014-52, pg. 4.3

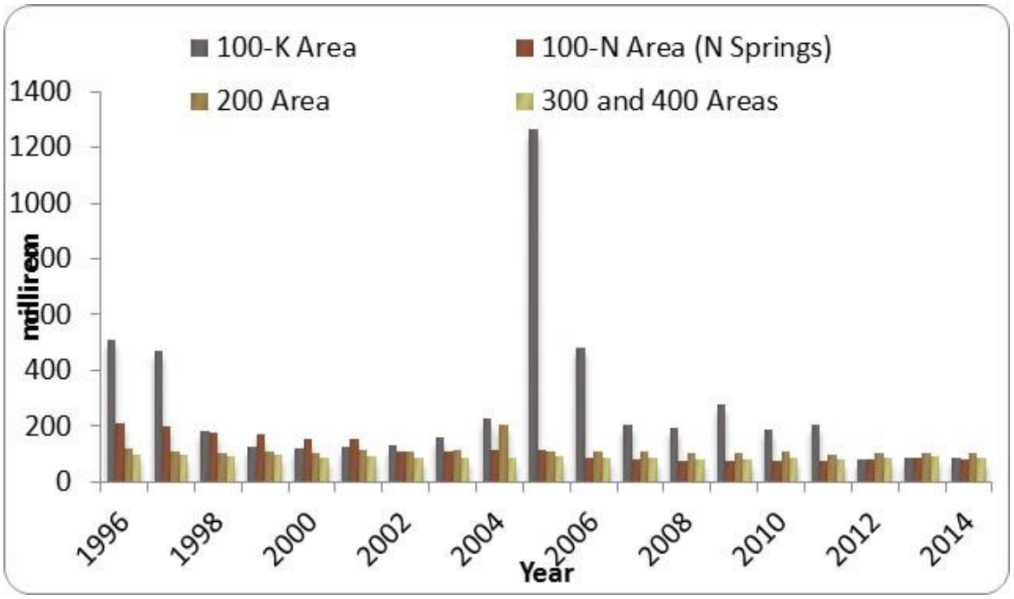

Figure H.13-6. Average Thermoluminescent Dosimeter Results from year 1996 to 2014[43]

[43] DOE/RL-2014-52, Figure 4.1., pg. 4.3

Table H.13-6. Thermoluminescent Dosimeter Results (2013 and 2014) [44]

(millirem/year) [a]

Location	No. of Dosimeters	2013		2014		Percentage Change [e]
		Maximum [b]	Average [c, d]	Maximum [b]	Average [c, d]	
100-K	14	112 ± 12	86 ± 17	177 ± 140	89 ± 52	3
100-N	1	87 ± 13	84 ± 7	91 ± 14	82 ± 14	-2
200-East	42	230 ± 131	105 ± 56	217 ± 256	104 ± 57	0
200-West	24	158 ± 9	104 ± 41	157 ± 14	102 ± 42	-1
200-North	1	91 ± 14	86 ± 14	107 ± 16	91 ± 27	5
300 Area	8	124 ± 9	95 ± 26	114 ± 14	90 ± 20	-4
300 TEDF	6	93 ± 13	91 ± 4	91 ± 14	88 ± 8	-2
400 Area	7	100 ± 58	92 ± 9	98 ± 11	88 ± 11	-3
618-10	4	84 ± 11	83 ± 3	81 ± 8	80 ± 2	-2
CVDF	4	82 ± 13	80 ± 3	78 ± 9	77 ± 2	-2
ERDF	3	91 ± 11	88 ± 6	89 ± 22	84 ± 8	-4
IDF	1	102 ± 15	92 ± 16	97 ± 14	90 ± 13	-1

[a] To convert to international metric system units, multiply millirem/year by 0.01 to obtain millisievert/year.
[b] Maximum values are ± analytical uncertainty.
[c] ± 2 standard deviations.
[d] Each dosimeter is collected and read quarterly.
[e] Numbers indicate a decrease (-) or increase from the 2013 mean.

CVDF = Cold Vacuum Drying Facility (100-K Area).
ERDF = Environmental Restoration Disposal Facility (200-West Area).
IDF = Integrated Disposal Facility (200-East Area).
TEDF = 300 Area Treated Effluent Disposal Facility.

6. Processes and operations conducted within the facility

TEDF was designed to handle the condensate streams from all the facilities located in 200 East and 200W areas. Because the majority of the facilities no longer operate (see Table H.13-2, above), TEDF has the capacity to handle current and projected flows. [45] TEDF has the ability to collect and safely dispose of nearly 2 billion gallons of liquid per year in accordance with its state discharge permit. [46] The volume of unregulated effluent disposed to this facility in 2014 was approximately 359 million gallons (1,360 million liters). [47]

At 200 Area TEDF, discharges are classified by the facility as either a routine or non-routine. Routine discharges are pre-approved and can be made at the generators discretion, provided it is within the TEDF acceptance criteria. Non-routine discharges are single batch, with each batch requiring LWF approval prior to discharge to TEDF. The following sections summarize the acceptance process for routine and non-routine discharges to TEDF. [48]

Waste Acceptance Process for Routine Discharges:

[44] DOE/RL-2014-52, Table 4.1., pg. 4.2

[45] RPP-RPT-58275, Rev 0, pg. 27

[46] Hanford.gov. (2015, Last Revised December 1, 2015). "Treated Effluent Disposal Facility." Accessed February 25, 2016, from http://www.hanford.gov/page.cfm/TEDF.

[47] DOE/RL-2014-52, pg. 5.26

[48] HNF-3172, Rev 7, pg. 7 and pg. 8

Prior to LWF accepting any new routine wastewater discharges to the TEDF, the generator must provide a description and characterization of the proposed discharge to the TEDF. If the proposed discharge is a new source not previously approved, increased volume, or change in the nature of the discharge is anticipated which is not specifically authorized by ST 4502, the generator must prepare an engineering report containing a description of proposed changes and an analysis of the best available technology/all known, available and reasonable treatment (BAT/AKART). This engineering report is provided to LWF who then submits a new permit application or a supplement to the previous permit application to Ecology. A significant new source also requires development and submittal of an Effluent Variability Study according to the requirements in the ST 4502 permit. Ecology must approve the new wastewater discharge before the discharge may commence.

Once a new routine discharge has been approved, LWF will update the *200 Area Treated Effluent Disposal Facility Interface Control Document* (TEDF ICD) (HNF-SD-W049H-ICD-001) to define requirements the new generator must meet to discharge to the TEDF. The generator will concur with updates to the TEDF ICD. The requirements established in the TEDF ICD assure that the overall TEDF operation will remain in compliance with ST 4502. The following are typical generator requirements: [49]

- Continuously monitor flow, pH, and conductivity;
- Sample and analyze for indicator parameters (anions, metals, total dissolved solids, gross alpha, and gross beta) four times each year; and
- Sample and analyze for expanded parameters (indicators parameters plus a few volatile and semi-volatile analytes) once per year.

Waste Acceptance Process for Non-Routine Discharges: [50]

Prior to accepting any new non-routine effluent discharge to TEDF, the generator must complete a TEDF Non-Routine Batch Discharge Profile Sheet (as provided within HNF-3172, Rev 7, Appendix A). The completed profile is used by LWF to assess whether LWF can approve the discharge or whether the discharge requires Ecology's approval. In general, LWF can accept into TEDF without Ecology approval effluents that are covered by *State Waste Discharge Permit ST 4511* and meet TEDF waste acceptance criteria. Generators who discharge to TEDF under ST 4511 must also perform a pollution prevention and best management practices review prior to approval to discharge. If LWF determines that the discharge requires Ecology approval, the generator must submit the following additional information.

- The nature of the activity that is generating the discharge.
- Any alternatives to the discharge, such as reuse, storage, or recycling of the water.
- Total volume of water expected to be discharged.
- The results of chemical analysis of the water (not required if discharging under ST 4511). The water shall be analyzed for all constituents given in Table 1. The analysis shall also include hardness, any metals that are limited by water quality standards, and any other parameter deemed necessary by Ecology.
- The date of proposed discharge.
- The rate at which the water will be discharged, in gallons per minute.

The discharge cannot proceed until Ecology has reviewed the information provided by the generator and has authorized the discharge. Once the non-routine discharge has been approved, the generator is required to notify the Effluent Treatment Facility (ETF) control room just prior to discharge and confirm

[49] HNF-3172, Rev 7, pg. 7 and pg. 8

[50] HNF-3172, Rev 7, pg. 8

the emergency contact information on the profile sheet is still valid. The emergency contact is someone who can stop the generator's discharge to TEDF, or assist TEDF operating personnel in stopping the discharge.

7. Process flow of material into and out of the facility

More than twelve miles of polyvinyl chloride piping connects facilities throughout the Site to TEDF's state permitted disposal basin in the 200 East Area of Hanford. [51] Once treated non-radioactive/non-RCRA liquid waste is pumped to TEDF, this liquid waste is discharged via infiltration through soils, into groundwater of the state. [52]

8. Potential effects of potential delays on the processes, operations, and radioactive materials in the facility

None.

9. Other facilities or processes that are involved in the flow of radioactive material into and out of the facility

See section above, "EU FORMER/CURRENT USE(S)".

10. Shipping of material

See Question 7, above.

11. Infrastructure considered a part of the facility

The 200 Area TEDF consists of three (3) pump stations, a sampling building (6653), disposal ponds, and piping to connect the various major facilities in the 200E and 200W Areas to the system (see Figure H.13-3 and Figure H.13-4 in Part III). Pumps are operated at the pump stations using the local control unit or from the ETF Control Room. The 6653 Building is used primarily for sampling the effluent flows prior to release to one of the two disposal ponds located about three (3) kilometers (about 2 miles) southeast of ETF.[53]

ECOLOGICAL RESOURCES SETTING

Landscape Evaluation and Resource Classification

The TEDF EU boundary encompasses the facility basins, a perimeter road outside the fence and a thin strip of vegetated habitat beyond the perimeter road (Appendix J, Figure J.121). Nearly 79% of the EU is classified as level 0 resources; the remaining 21% is classified as a level 3 resource (Appendix J, Table J.107).

The amount and proximity of biological resources surrounding the TEDF EU were examined within the adjacent landscape buffer area, which extends 1541 ft (470 m) from the geometric center of the EU. The TEDF facility, access road and nearby monitoring well pad are the only resources classified as level 0 comprising approximately 11% of the combined EU and adjacent landscape buffer area (Appendix J, Table J.107). Level 3 resources surround the EU and cover approximately 74% of the combined EU and

[51] Hanford.gov. (2015, Last Revised December 1, 2015). "Treated Effluent Disposal Facility." Accessed February 25, 2016, from http://www.hanford.gov/page.cfm/TEDF.
[52] Pg. 2 of the State Waste Discharge Permit Number ST0004502
[53] RPP-RPT-5827, Rev 0, pg. 17 and pg. 19

buffer area, while about 14% of the combined area is covered by level 4 resources; there are no resources classified as level 1, 2 or 5.

Field Survey

Within the TEDF EU an access road leads to the facility and to wells on the north, east and south sides of TEDF (Appendix J, Figure J. 121). Inside the facility fence are 2 retention basins encircled by a narrow strip of bare ground, and a dirt road surrounds the outside of the fence. The EU extends into the surrounding level 3 habitat. On the east the habitat consists of successional shrubs (green rabbitbrush [*Chrysothamnus viscidiflorus*]) with an understory dominated by introduced grass and forbs (Appendix J, Table J.106). On the west the habitat has a similar understory but the shrub layer is occupied by big sagebrush (*Artemisia tridentata*), a climax shrub, and sparse green rabbitbrush. Field data records at the end of this EU description in Appendix J provides lists of the plants and animals observed in June 2015.

CULTURAL RESOURCES SETTING

Almost the entirety of the CP-OP-12, TEDF EU has been inventoried for archaeological resources. No archaeological sites, buildings or TCPs have been recorded within the EU boundary as part of these survey efforts. Most of the EU is heavily disturbed from the installation of the TEDF disposal ponds and associated infrastructure, suggesting a low potential for the presence of intact archaeological resources within the surface and subsurface components of this EU.

There is one archeological isolate, associated with the Pre-Hanford Early Settlers/Farming Landscape, has been recorded within 500 meters of the EU. While this resource has not been formally evaluated for listing in the National Register of Historic Places, it should be noted that isolates are often considered not eligible.

Historic maps and aerial imagery indicate that the area was relatively undeveloped, suggesting a low potential for the presence of archaeological resources associated with the Pre-Hanford Early Settlers/Farming Landscape within the EU. Geomorphology indicates a moderate potential for the presence of archaeological resources associated with the Native American Precontact and Ethnographic Landscape to be present within the EU boundary. Archaeological resources, if present, would likely be limited to areas of intact, undisturbed Holocene dune sand deposits. Extensive ground disturbance across most of the EU, however, may negate this moderate potential.

Because of the potential for intact archaeological deposits within the CP-OP-12, TEDF EU, it may be appropriate to conduct surface and subsurface archaeological investigations in these areas prior to initiating any remediation activities. Indirect effects are always possible when TCPs are known to be located in the general vicinity. Consultation with Hanford Tribes (Confederated Bands of the Yakama Nation, Wanapum, Confederated Tribes of the Umatilla Indian Reservation, and the Nez Perce) and other groups who may have an interest in the areas (e.g. East Benton Historical Society, Prosser Cemetery Association, Franklin County Historical Society, the Reach, and the B-Reactor Museum Association) may need to occur. Consultation with Hanford Tribes may also be necessary to provide input on indirect effects to both recorded and potential unrecorded TCPs in the area and other cultural resource issues of concern.

PART V. WASTE AND CONTAMINATION INVENTORY

CONTAMINATION WITHIN PRIMARY EU SOURCE COMPONENTS

Vadose Zone Contamination

The reported inventories for CP-OP-12 (Table H.13-8 through Table H.13-10) are isolated from the environment because of the nature of the facility and the material handled. Thus there is no reported vadose zone inventory to be evaluated.

Groundwater Plumes and Columbia River

Not applicable

Operating Facilities

The 200 Area TEDF has the ability to collect and safely dispose of nearly 2 billion gallons of liquid per year in accordance with its state discharge permit.[54] Approved discharged liquid was disposed of in the 200 Area TEDF beginning in April 1995 and continues to operate to current day (as shown in Table H.13-7). The summed annual 200 Area TEDF discharges starting in 1995 to 2014 is 18.3 billion liters (3.4 billion gallons). Volumetric discharges for the year 2015 are unknown.

Industrial wastewater generated throughout the Hanford Site was collected and treated in the 300 Area Treated Effluent Disposal Facility, which began operation in December 1994 and was permanently shut down on September 2, 2009. The facility has completed terminal cleanout and all process systems have been deactivated in preparation for decommissioning and destruction.[55] The 300 Area Treated Effluent Disposal Facility had a 1100 L/min (300 gal/min) treatment capacity that was operated 24 hours a day and was largely computer automated, with the capability for full manual operation when required. [56] The 300 Area TEDF also was designed with a storage capacity of up to 5 days at the design flow rate of 1,100 liters per minute (300 gallons per minute). [57] The summed annual 300 Area TEDF discharges starting at the end of 2014 to 2009 was approximately 3.0 billion liters (780 million gallons).

Industrial wastewater generated primarily from laboratories, research facilities, and office buildings in the 300 Area was collected and treated in the 300 Area Treated Effluent Disposal Facility. The wastewater consisted of cooling water, steam condensate, and other industrial wastewater.[58] The industrial wastewater that was potentially contaminated was collected in the nearby 307 Retention Basins where it was monitored and released to the 300 Area process sewer for treatment by the 300 Area TEDF. The treatment process includes iron co-precipitation to remove heavy metals, ion exchange to remove mercury, and ultra-violet light and peroxide oxidation to destroy organics and cyanide. Sludge from the iron coprecipitation process is dewatered and used for backfill in the low-level waste burial

[54] Hanford.gov. (2015, Last Revised December 1, 2015). "Treated Effluent Disposal Facility." Accessed February 25, 2016, from http://www.hanford.gov/page.cfm/TEDF.

[55] PNNL-19455, pg. 6.25

[56] PNNL-10574, pg. 45

[57] PNNL-19455, pg. 6.25

[58] PNNL-19455, pg. xiii

grounds. The treated liquid effluent is monitored and discharged through an outfall to the Columbia River under a National Pollutant Discharge Elimination System permit No. WA 002591-7. [59,60]

Table H.13-7. 200 Area TEDF and 300 Area TEDF Liquid Effluent Discharges

Calendar Year	200 Area TEDF Unregulated Effluent Release	300 Area TEDF Effluent Release
1995[61]	490 million liters (130 million gallons)	310 million liters (83 million gallons)
1996[62]	37.5 million liters (9.9 million gallons)	350 million liters (92 million gallons)
1997[63]	696 million liters (184 million gallons)	331 million liters (87 million gallons)
1998[64]	742 million liters (196 million gallons)	297 million liters (78 million gallons)
1999[65,66]	534 million liters (141 million gallons)	223 million liters (59 million gallons)
2000[67,68]	502 million liters (133 million gallons)	231 million liters (61 million gallons)
2001[69,70]	484 million liters (128 million gallons)	241 million liters (64 million gallons)
2002[71]	863 million liters (227.9 million gallons)	5.5 million liters (1.5 million gallons).
2003[72]	1,269 million liters (335.4 million gallons)	145.5 million liters (38.4 million gallons)
2004[73]	540.9 million liters (142.9 million gallons)	136.8 million liters (33.13 million gallons)
2005[74]	442.8 million liters (117.0 million gallons)	135.8 million liters (35.88 million gallons)
2006[75]	765.3 million liters (202.2 million gallons)	139.5 million liters (36.87 million gallons)
2007[76]	1,310 million liters (346 million gallons)	168 million liters (44.4 million gallons).

[59] PNNL-13487, Pg. 2.38

[60] PNNL-19455, pg. 6.25

[61] PNNL-11139, pg. 46

[62] PNNL-11472, pg. 57 and 58 (Iron violation for 1996: pg. 36

[63] PNNL-11795, pg. 2.44 and

[64] PNNL-12088, pg. 2.55

[65] PNNL-13230, Pg. 2.50

[66] PNNL-13230, Pg. 2.40

[67] PNNL-13487, Pg. 2.50

[68] PNNL-13487, Pg. 2.39

[69] PNNL-13910, pg. xi

[70] PNNL-13910, pg. 3.32

[71] PNNL-14295, pg. x

[72] PNNL-14687, pg. xii

[73] PNNL-15222, pg. xii

[74] PNNL-15892, pg. xii

[75] PNNL-16623, pg. xi and pg. xiii

[76] PNNL-17603, pg. xii

Calendar Year	200 Area TEDF Unregulated Effluent Release	300 Area TEDF Effluent Release
2008[77]	276 million liters (73 million gallons)	161 million liters (42.4 million gallons).
2009[78]	1,300 million liters (340 million gallons)	98 million liters (26 million gallons). This facility was permanently shut down in September 2009.
2010[79]	1,170 million liters (310 million gallons)	--
2011[80]	53.8 million liters (14.2 million gallons)	--
2012[81]	82.4 million liters (21.8 million gallons)	--
2013[82]	105 million liters (27.8 million gallons)	--
2014[83]	1,360 million liters (359 million gallons)	--
SUM of years 1995 through 2014	**18,278 million liters (3,439 million gallons)**	**2,973 million liters (782 million gallons)**

[77] PNNL-18427, pg. xii

[78] PNNL-19455, pg. xii and pg. xiii

[79] PNNL-20548, pg. xiii

[80] DOE/RL-2011-119, Rev. 0, pg. 5.29

[81] DOE/RL-2013-18, pg. ES.9

[82] DOE/RL-2013-47, pg. ES-10

[83] DOE/RL-2014-52, pg. 5.26

Table H.13-8. Inventory of Primary Contaminants [(a)]

WIDS	Description	Decay Date	Ref	Am-241 (Ci)	C-14 (Ci)	Cl-36 (Ci)	Co-60 (Ci)	Cs-137 (Ci)	Eu-152 (Ci)	Eu-154 (Ci)	H-3 (Ci)	I-129 (Ci)
All	Sum			NR	NR	NR	NR	NR	NR	NR	NR	NR
600-291-PL	Ancillary Equipment		See note b.	NR	NR	NR	NR	NR	NR	NR	NR	NR
6653	Infrastructure Building		See note b.	NR	NR	NR	NR	NR	NR	NR	NR	NR
200-A TEDF	Pond		See note b.	NR	NR	NR	NR	NR	NR	NR	NR	NR

a. NR = Not reported

b. No known primary contaminant inventory in these sites.

Table H.13-9. Inventory of Primary Contaminants (cont)[(a)]

WIDS	Description	Decay Date	Ref	Ni-59 (Ci)	Ni-63 (Ci)	Pu (total) (Ci)	Sr-90 (Ci)	Tc-99 (Ci)	U (total) (Ci)
All	Sum			NR	NR	NR	NR	NR	NR
600-291-PL	Ancillary Equipment		See note b.	NR	NR	NR	NR	NR	NR
6653	Infrastructure Building		See note b.	NR	NR	NR	NR	NR	NR
200-A TEDF	Pond		See note b.	NR	NR	NR	NR	NR	NR

a. NR = Not reported

b. No known primary contaminant inventory in these sites.

Table H.13-10. Inventory of Primary Contaminants (cont)[(a)]

WIDS	Descrip-tion	Ref	CCl4 (kg)	CN (kg)	Cr (kg)	Cr-VI (kg)	Hg (kg)	NO3 (kg)	Pb (kg)	TBP (kg)	TCE (kg)	U (total) (kg)
All	Sum		NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
600-291-PL	Ancillary Equipment	See note b.	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
6653	Infrastructure Building	See note b.	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
200-A TEDF	Pond	See note b.	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

a. NR = Not reported

b. No known primary contaminant inventory in these sites.

Table H.13-11. Summary of the Evaluation of Threats to Groundwater as a Protected Resource from Saturated Zone (SZ) and Remaining Vadose Zone (VZ) Contamination associated with the Evaluation Unit

PC	Group	WQS	Porosity[a]	K_d (mL/g)[a]	ρ (kg/L)[a]	VZ Source M^{Source}	SZ Total M^{SZ}	Treated[c] M^{Treat}	VZ Remaining M^{Tot}	VZ GTM (Mm^3)	VZ Rating[d]
C-14	A	2000 pCi/L	0.25	0	1.82	---	---	---	---	---	*ND*
I-129	A	1 pCi/L	0.25	0.2	1.82	---	---	---	---	---	*ND*
Sr-90	B	8 pCi/L	0.25	22	1.82	---	---	---	---	---	*ND*
Tc-99	A	900 pCi/L	0.25	0	1.82	---	---	---	---	---	*ND*
CCl4	A	5 µg/L	0.25	0	1.82	---	---	---	---	---	*ND*
Cr	B	100 µg/L	0.25	0	1.82	---	---	---	---	---	*ND*
Cr-VI	A	10 µg/L[b]	0.25	0	1.82	---	---	---	---	---	*ND*
TCE	B	5 µg/L	0.25	2	1.82	---	---	---	---	---	*ND*
U(tot)	B	30 µg/L	0.25	0.8	1.82	---	---	---	---	---	*ND*

a. Parameters obtained from the analysis provided in Attachment 6-1 to Methodology Report.

b. Criteria for chronic exposure in fresh water, WAC 173-201A-240. “Water Quality Standards for Surface Waters of the State of Washington,” “Toxic Substances,” Table 240(3).

c. Treatment amounts from the 2015 Hanford Annual Groundwater Report (DOE/RL-2016-09, Rev. 0).

d. Groundwater Threat Metric rating based on Table 6-3, Methodology Report.

PART VI. POTENTIAL RISK/IMPACT PATHWAYS AND EVENTS

CURRENT CONCEPTUAL MODEL

Pathways and Barriers

Briefly describe the current institutional, engineered and natural barriers that prevent release or dispersion of contamination, risk to human health and impacts to resources:

1. What nuclear and non-nuclear safety accident scenarios dominate risk at the facility? What are the response times associated with each postulated scenario?

There are no nuclear related safety accident scenarios applicable for the 200 Area TEDF.

TEDF only poses standard industrial hazards (e.g., noise, common slips, trips, and falls) and is analyzed within the Liquid Waste and Fuel Storage (LWFS), Industrial Hygiene Baseline Hazard Assessment (IHBHA) [HNF-10555, Rev 6].

2. What are the active safety class and safety significant systems and controls?

None/not applicable

3. What are the passive safety class and safety significant systems and controls?

None/not applicable

4. What are the current barriers to release or dispersion of contamination from the primary facility? What is the integrity of each of these barriers? Are there completed pathways to receptors or are such pathways likely to be completed during the evaluation period?

None/not applicable

5. What forms of initiating events may lead to degradation or failure of each of the barriers?

None/not applicable

6. What are the primary pathways and populations or resources at risk from this source?

None/not applicable

7. What is the time frame from each of the initiating events to human exposure or impacts to resources?

None/not applicable

8. Are there current on-going releases to the environment or receptors?

There are on-going authorized discharges at the 200 Area TEDF. A state waste discharge permit governs groundwater sampling and analysis in the three monitoring wells at this facility. The groundwater monitoring network continues to show that effluent from the facility is not taking a direct route to the uppermost aquifer, which is confined.[84]

[84] PNNL-15670, pg. xxix (pg. 27 of 621 of the PDF)

POPULATIONS AND RESOURCES CURRENTLY AT RISK OR POTENTIALLY IMPACTED

Facility Worker

TEDF only poses standard industrial occupational hazards (e.g., noise, common slips, trips, and falls) and is analyzed within the Liquid Waste and Fuel Storage (LWFS), Industrial Hygiene Baseline Hazard Assessment (IHBHA) [HNF-10555, Rev 6]. The IHBHA assesses and documents the overall exposure a Similar Exposure Group (SEG) for each agent identified by assigning a numerical "Qualitative Exposure Rating" (see Table H.13-12) and a numerical "Qualitative Health Effects Rating" (see Table H.13-13). The multiplication of these two numbers results in the overall "Qualitative Exposure Assessment Rating" and can range from 0 to 16.

The highest "Qualitative Exposure Assessment Rating" assigned to a hazard at TEDF was a "3" that was associated with a confined space work environment and requires supplied air respirators be worn by authorized entering personnel only. [85] The individual components of the "Qualitative Exposure Rating" (see Table H.13-12) and the "Qualitative Health Effects Rating" (see Table H.13-13) were not provided. The estimated impact to the facility worker is "Non-Discernible, ND".

Table H.13-12. Qualitative Exposure Rating Scale used within the IHBHA[86]

Category	Description
0 (No exposure)	No contact with agent.
1 (Low Exposure)	Infrequent contact with agent at low concentrations.
2 (Moderate Exposure)	Frequent contact with agent at low concentrations or infrequent contact with agent at high concentrations.
3 (High Exposure)	Frequent contact with agent at high concentrations.
4 (Very high Exposure)	Frequent contact with agent at very high concentrations.

Exposure can be by air, dermal, or ingestion routes. Rating should not take into consideration the use of personal protective equipment. Infrequent/frequent definitions depend on the hygienist, the workplace, and the agents; consistency in application is the key, not the definitions themselves (e.g., magnitude of exposure may be thought of as multiples or fractions of the applicable occupational exposure limit).

Table H.13-13. Qualitative Health-Effect Rating Scale used within the IHBHA[87]

Category	Health Effect
0	Reversible effects of little concern or no known or suspected adverse health effects.
1	Reversible health effects of concern.
2	Severe, reversible health effects of concern.
3	Irreversible health effects of concern.
4	Life threatening or disabling injury or illness.

[85] HNF-10555, Rev 6, Pg. 30 of 43 (2nd row in the TEDF Table)

[86] HNF-10555, Rev 6, Table 1, Pg. 8 of 43

[87] HNF-10555, Rev 6, Table 2, Pg. 8 of 43

Co-Located Person (CP)

No information is provided to assess the Co-located person. Due to the nature of the facility and the material handled at TEDF, the impacts are assumed to be "Non-Discernible, ND".

Public

No information is provided to assess the maximally exposed individual (MOI)/member of the public. Due to the nature of the facility and the material handled at TEDF, the impacts are assumed to be "Non-Discernible, ND".

Groundwater and Columbia River

Not applicable because the discharge effluent does not contain elevated contaminants exceeding water quality standard discharge limits.

Ecological Resources

Summary of Ecological Review:

- Approximately 79% of the EU is classified as level 0 resources. There are no resources classified as levels 1 or 2.
- About 21% of the EU is classified as a level 3 resource that is contiguous with similar resources within the adjacent landscape buffer. Loss of this habitat is not expected to significantly impact connectivity between portions of level 3 resources occurring within the adjacent landscape buffer area or areas beyond.
- Over 88% of the combined EU and buffer area are covered by habitat classified as level 3 or above that is contiguous with similar habitat extending across much of the Hanford Site.

Cultural Resources

The CP-OP-12, TEDF (Treated Effluent Disposal Facility) EU is located in the 600 Area of the Hanford Site, just east of the 200 East Area. Most of the EU has been inventoried for cultural resources under HCRC# 90-600-006 (Gard 1990) and 98-200-022 (Hale 1998). Much of the EU is extensively disturbed from the installation of the two TEDF disposal ponds, suggesting a low potential for intact archaeological resources to be present within the surface and subsurface components of the EU.

Archaeological sites, buildings and Traditional Cultural Properties (TCPs) located within the EU[88]

- No archaeological sites, buildings, and/or TCPs are known to be located within the EU.

Archaeological sites, buildings and TCPs located within 500 meters of the EU

- One archaeological isolate dating to the Pre-Hanford Early Settlers/Farming Landscape has been recorded within 500 meters of the CP-OP-12, TEDF EU. This isolate has not been evaluated for listing in the National Register of Historic Places, however it should be noted that isolates are typically considered not eligible.

88 Traditional cultural property has been defined by the National Park Service as "a property, a place, that is eligible for inclusion on the National Register of Historic Places because of its association with cultural practices and beliefs that are (a) rooted in the history of a community, and (b) are important to maintaining the continuity of that community's traditional beliefs and practices" (Parker & King 1998).

Closest Recorded TCP

There are two recorded TCPs associated with the Native American Precontact and Ethnographic Landscape that are visible from the CP-OP-12, TEDF EU.

CLEANUP APPROACHES AND END-STATE CONCEPTUAL MODEL

Selected or Potential Cleanup Approaches

No final cleanup decisions have been made for the Liquid Waste Disposal Facilities (including 300 Area TEDF).

Contaminant Inventory Remaining at the Conclusion of Planned Active Cleanup Period

None/Not Applicable for the 300 Area TEDF

Risks and Potential Impacts Associated with Cleanup

None/Not Applicable for the 300 Area TEDF

POPULATIONS AND RESOURCES AT RISK OR POTENTIALLY IMPACTED DURING OR AS A CONSEQUENCE OF CLEANUP ACTIONS

Facility Worker

No final cleanup decisions have been made for the Liquid Waste Disposal Facilities (including 300 Area TEDF).

Co-located Person

See description above for the Facility Worker

Public

See description above for the Facility Worker

Groundwater and Columbia River

Not applicable

Ecological Resources

No cleanup decisions have been made for this EU. As a result, the potential effects of cleanup on ecological resources cannot be made for the active cleanup evaluation period.

Cultural Resources

No cleanup decision for the remaining waste treatment, storage and disposition facilities.

ADDITIONAL RISKS AND POTENTIAL IMPACTS IF CLEANUP IS DELAYED

No cleanup decisions have been made for the Liquid Waste Disposal Facilities (including 300 Area TEDF).

NEAR-TERM, POST-CLEANUP STATUS, RISKS AND POTENTIAL IMPACTS

No cleanup decisions have been made for the Liquid Waste Disposal Facilities (including 300 Area TEDF).

POPULATIONS AND RESOURCES AT RISK OR POTENTIALLY IMPACTED AFTER CLEANUP ACTIONS (FROM RESIDUAL CONTAMINANT INVENTORY OR LONG-TERM ACTIVITIES)

Table H.13-14. Summary of Populations and Resources at Risk or Potentially Impacted after Cleanup.

Population or Resource		Risk/Impact Rating	Comments
Human	Facility Worker	Insufficient information (IS)	
	Co-located Person	IS	
	Public	IS	
Environmental	Groundwater	*Not Discernible* (*ND*)	No risks because of the nature of the facility and the material handled.
	Columbia River	*ND*	
	Ecological Resources[(a)]	No cleanup decisions have been made for this EU. Estimated to be Low to Medium	Impact level depends on the remediation activities and the ability to keep activities from destroying existing quality resources.
Social	Cultural Resources[(a)]	No cleanup decisions have been made for this EU. Estimated to be: **Native American** Direct: Unknown Indirect: Known **Historic Pre-Hanford** Direct: Unknown Indirect: Known **Manhattan/Cold War** Direct: None Indirect: None	No cleanup decisions have been made for this EU. Potential direct impacts are unknown and difficult to estimate without further information on the remediation. Permanent indirect effects are possible if residual contamination remains after remediation and from capping.

a. For both Ecological and Cultural Resources see Appendices J and K, respectively, for a complete description of Ecological Field Assessments and literature review for Cultural Resources. Ecological ratings are described in Table 4-11 of the Final Report.

LONG-TERM, POST-CLEANUP STATUS – INVENTORIES AND RISKS AND POTENTIAL IMPACT PATHWAYS

No cleanup decisions have been made for this EU.

PART VII. SUPPLEMENTAL INFORMATION AND CONSIDERATIONS

None/ Not Applicable

BIBLIOGRAPHY

Barnett, D. B. (2000). Groundwater Monitoring Plan for the Hanford Site 200 Area Treated Effluent Disposal Facility Pacific Northwest National Laboratory (PNNL). **PNNL-13032 (URL: http://www.osti.gov/scitech/servlets/purl/754948-BT7SxZ/webviewable/):** 79 pages.

CRESP 2015. *Methodology for the Hanford Site-Wide Risk Review Project*, Consortium for Risk Evaluation with Stakeholder Participation (CRESP), Nashville, Tennessee. Available at: http://www.cresp.org/hanford/.

DOE/RL-2016-09, Rev. 0, *Hanford Site Groundwater Monitoring Report for 2015, Rev 0*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://higrv.hanford.gov/Hanford_Reports_2015/Hanford_GW_Report/

Gasper, J. J. (2013). Liquid Waste and Fuel Storage (LWFS), Industrial Hygiene Baseline Hazard Assessment (IHBHA), CH2M HILL Plateau Remediation Company. **HNF-10555, Revision 6:** 47 pages.

Halgren, D. L. (2015). Liquid Waste Processing Facilities Waste Acceptance Criteria CH2M HILL Plateau Remediation Company. **HNF-3172, Revision 7:** 43 pages.

Pacific Northwest National Laboratory (PNNL) (1995). Hanford Site Environmental Report for Calendar Year 1994. **PNL-10574 (URL: http://hanford-site.pnnl.gov/envreport/1994/1994PNL-10574UC-602.pdf):** 424 pages.

Pacific Northwest National Laboratory (PNNL) (1996). Hanford Site Environmental Report for Calendar Year 1995. **PNNL-11139 (URL: http://hanford-site.pnnl.gov/envreport/1995/PNNL-11139_1995.pdf):** 398 pages.

Pacific Northwest National Laboratory (PNNL) (1997). Hanford Site Environmental Report for Calendar Year 1996. **PNNL-11472 (URL: http://hanford-site.pnnl.gov/envreport/1996/PNNL-11472_1996.pdf):** 415 pages.

Pacific Northwest National Laboratory (PNNL) (1998). Hanford Site Environmental Report for Calendar Year 1997. **PNNL-11795 (URL: http://hanford-site.pnnl.gov/envreport/1997/PNNL-11795_1997.pdf):** 444 pages.

Pacific Northwest National Laboratory (PNNL) (1999). Hanford Site Environmental Report for Calendar Year 1998. **PNNL-12088 URL: http://hanford-site.pnnl.gov/envreport/1998/PNNL-12088_1998.pdf):** 509 pages.

Pacific Northwest National Laboratory (PNNL) (2000). Hanford Site Environmental Report for Calendar Year 1999. **PNNL-13230 (URL: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13230.pdf):** 502 pages.

Pacific Northwest National Laboratory (PNNL) (2001). Hanford Site Environmental Report for Calendar Year 2000. **(URL: http://hanford-site.pnnl.gov/envreport/2000/PNNL-13487_2000.pdf):** 448 pages.

Pacific Northwest National Laboratory (PNNL) (2002). Hanford Site Environmental Report for Calendar Year 2001. **PNNL-13910 (URL: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13910.pdf):** 448 pages.

Pacific Northwest National Laboratory (PNNL) (2003). Hanford Site Environmental Report for Calendar Year 2002. **PNNL-14925 (URL: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-14295.pdf):** 452 pages.

Pacific Northwest National Laboratory (PNNL) (2004). Hanford Site Environmental Report for Calendar Year 2003. **PNNL-14687 (URL: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-14687.pdf):** 381 pages.

Pacific Northwest National Laboratory (PNNL) (2005). Hanford Site Environmental Report for Calendar Year 2004. **PNNL-15222 (URL: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-15222.pdf):** 400 pages.

Pacific Northwest National Laboratory (PNNL) (2006). Hanford Site Environmental Report for Calendar Year 2005. **PNNL-15892 (URL: http://www.ntis.gov/assets/pdf/st-on-cd/DE2006893252.pdf):** 408 pages.

Pacific Northwest National Laboratory (PNNL) (2007). Hanford Site Environmental Report for Calendar Year 2006. **PNNL-16623 (URL: http://hanford-site.pnnl.gov/envreport/2006/pnnl_16623.pdf):** 361 pages.

Pacific Northwest National Laboratory (PNNL) (2008). Hanford Site Environmental Report for Calendar Year 2007. **PNNL-17603 (URL: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-17603.pdf):** 377 pages.

Pacific Northwest National Laboratory (PNNL) (2009). Hanford Site Environmental Report for Calendar Year 2008. **PNNL-18427 (URL: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-18427.pdf):** 395 pages.

Pacific Northwest National Laboratory (PNNL) (2010). Hanford Site Environmental Report for Calendar Year 2009. **PNNL-19455 (URL: http://hanford-site.pnnl.gov/envreport/2009/pnnl-19455.pdf):** 393 pages.

Pacific Northwest National Laboratory (PNNL) (2011). Hanford Site Environmental Report for Calendar Year 2010. **PNNL-20548 (URL: https://msa.hanford.gov/files.cfm/2010_PNNL-20548_Env-Report.pdf):** 400 pages.

Smith, K. E. (2014). Effluent Treatment Facility Extent of Condition Report, Washington River Protection Solutions, Indian Eyes LLC, E2 Consulting Engineers Inc., Babcock Services, Inc. RPP-RPT-58275, Rev. 0: 171 pages.

US Department of Energy (DOE) (2012). Hanford Site Environmental Report for Calendar Year 2011. **DOE/RL-2011-119 (URL: https://msa.hanford.gov/files.cfm/2011_DOE-RL_2011-119_HanfordSiteEnviroReport4CY2011.pdf):** 450 pages.

US Department of Energy (DOE) (2013). Hanford Site Environmental Report for Calendar Year 2012. **DOE/RL-2013-18 (URL: https://msa.hanford.gov/files.cfm/2012_DOE-RL-2013-18_REV_0_cleared.pdf):** 433 pages.

US Department of Energy (DOE) (2014). Hanford Site Environmental Report for Calendar Year 2013. **DOE/RL-2013-47, Revision 0 (URL: https://msa.hanford.gov/files.cfm/2013_DOE-RL-2013-47_R0.pdf):** 423 pages.

Department of Energy (DOE) (2015). Hanford Site Environmental Report for Calendar Year 2014. **DOE-RL-2014-52, Revision 0 (URL: https://msa.hanford.gov/files.cfm/DOE-RL-2014-52.pdf):** 409 pages.

Washington State Department of Ecology (2005). State Waste Discharge Permit Number ST0004511 (Effective from 2/16/2005 to 2/16/2010). **(URL: http://www.ecy.wa.gov/programs/nwp/pdf/st4511-draft%20permit-final-2-16-05.pdf):** 25 pages.

Washington State Department of Ecology (2011). Fact Sheet for State Waste Discharge Permit ST0004502 200 Area Treated Effluent Disposal Facility (TEDF) **(URL: http://pdw.hanford.gov/arpir/pdf.cfm?accession=0093586):** 50 pages.

Washington State Department of Ecology (2012). State Waste Discharge Permit Number ST0004502 (Effective from 6/25/2012 to 06/30/2017). **(URL: http://www.ecy.wa.gov/programs/nwp/permitting/WWD/PDF/ST4502/st4502.pdf):** 25 pages.

Washington State Department of Ecology (2014). State Waste Discharge Permit Number ST0004511 (Effective from 1/1/2014 to 12/31/2019). **(URL: http://www.ecy.wa.gov/programs/nwp/permitting/wwd/PDF/ST4511/st4511.pdf):** 18 pages.