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T Plant Source Aggregate Area Management Study Report

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T PLANT SOURCE AAMS EXECUTIVE SUMMARY

This report presents the results of an aggregate area management study (AAMS) for the T Plant Aggregate Area in the 200 Areas of the U.S. Department of Energy (DOE) Hanford Site in Washington State. This scoping level study provides the basis for initiating Remedial Investigation/Feasibility Study (RI/FS) activities under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or Resource Conservation and Recovery Act (RCRA) Facility Investigations (RFI) and Corrective Measures Studies (CMS) under RCRA. This report also integrates select RCRA treatment, storage, or disposal (TSD) closure activities with CERCLA and RCRA past practice investigations.

Through the experience gained to date on developing work plans, closure plans, and permit applications at the Hanford Site, the parties to the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) have recognized that all past practice investigations must be managed and implemented under one characterization and remediation strategy, regardless of the regulatory agency lead (as defined in the Tri-Party Agreement). In particular, the parties have identified a need for greater efficiency over the existing RI/FS and RFI/CMS investigative approaches, and have determined that, to expedite the ultimate goal of cleanup, much more emphasis needs to be placed on initiating and completing waste site cleanup through interim measures.

This streamlined approach is described and justified in The *Hanford Federal Facility Agreement and Consent Order Change Package*, dated May 16, 1991 (Ecology et al. 1991). To implement this approach, the three parties have developed the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a) for streamlining the past practice remedial action process. This strategy provides new concepts for:

- Accelerating decision-making by maximizing the use of existing data consistent with data quality objectives (DQOs)

- Undertaking expedited response actions (ERAs) and/or interim remedial measures (IRMs), as appropriate, to either remove threats to human health and welfare and the environment, or to reduce risk by reducing toxicity, mobility, or volume of contaminants.

The *Hanford Site Past-Practice Strategy* (DOE/RL 1992a) describes the concepts and framework for the RI/FS (or RFI/CMS) process in a manner that has a bias-for-action through optimizing the use of interim remedial actions, culminating with decisions on final remedies on both an operable-unit and aggregate-area scale. The strategy focuses on

reaching early decisions to initiate and complete cleanup projects, maximizing the use of existing data, coupled with focused short time-frame investigations, where necessary. As more data become available on contamination problems and associated risks, the details of the longer term investigations and studies will be better defined.

The strategy includes three paths for interim decision-making and a final remedy-selection process for the operable unit that incorporates the three paths and integrates sites not addressed in those paths. The three paths for interim decision-making include the ERA, IRM, and limited field investigation (LFI) paths. The strategy requires that aggregate area management study reports (AAMSRs) be prepared to provide an evaluation of existing site data to support initial path decisions. This AAMSR is one of ten reports that will be prepared for each of the ten aggregate areas defined in the 200 Areas.

The near-term past practice strategy for the 200 Areas provides for ERAs, IRMs, and LFIs for individual waste management units, waste management unit groups, and groundwater plumes, and recommends separate source and groundwater operable units. Initial site-specific recommendations for each of the waste management units within the T Plant Aggregate Area are provided in the report. The goal of this initial focus is to establish whether IRMs are justified. Waste management units identified as candidate ERAs in Section 9.0 of the AAMS will be further evaluated following the *Site Selection Process for Expedited Response Actions at the Hanford Site* (Gustafson 1991).

While these elements may mitigate specific contamination problems through interim actions, the process of final remedy selection must be completed for the operable unit or aggregate area to reach closure. The aggregation of information obtained from the LFIs and interim actions may be sufficient to perform the cumulative risk assessment and to define the final remedy for the operable unit or aggregate area. If the data are not sufficient, additional investigations and studies will be performed to the extent necessary to support final remedy selection. These investigations would be performed within the framework and process defined for RI/FS programs.

Several integration issues exist that are generic to the overall past practice process for the 200 Areas and include the following:

Future Work Plan Scope. Although the current practice for implementing RI/FS (RFI/CMS) activities is through operable unit based work plans, individual LFI/IRMs may be more efficiently implemented using LFI/IRM-specific work plans.

Groundwater Operable Units. A general strategy recommended for the 200 Areas is to define separate operable units for groundwater affected by 200 Areas source terms. This requires that groundwater be removed from the scope of existing source operable units and new groundwater-specific operable units be established. Recommendations for groundwater operable units will be developed in the groundwater AAMSRs.

Work Plan Prioritization. Although priorities are established in the AAMSR for operable units within the aggregate area, priorities between aggregate areas have yet to be established. The integration of priorities at the 200 Areas level is considered a prerequisite for establishing a schedule for past practice activities in the 200 Areas.

It is intended that these integration issues be resolved following the completion of all ten AAMSRs (Draft A) scheduled for September 1992. Resolution of these issues will be based on a decisions/consensus process among the Washington State Department of Ecology (Ecology), U.S. Environmental Protection Agency (EPA), and DOE. Following resolution of these issues a schedule for past practice activities in the 200 Areas will be prepared.

Background, environmental setting, and known contamination data are provided in Sections 2.0, 3.0, and 4.1. This information provides the basis for development of the preliminary conceptual model in Section 4.2 and for assessing health and environmental concerns in Section 5.0. Preliminary applicable or relevant and appropriate requirements (ARARs) (Section 6.0) and preliminary remedial action technologies (Section 7.0) are also developed based on this data. Section 8.0 provides a discussion of the DQOs. Data needs identified in Section 8.0 are based on data gaps determined during the development of the conceptual model, human health and environmental concerns, ARARs, and remedial action technologies, Recommendations in Section 9.0 are developed using all the information provided in the sections that precede it.

The Hanford Site, operated by the DOE, occupies about 1,450 km^2 (560 mi^2) of the southeastern part of Washington north of the confluence of the Yakima and Columbia Rivers. The Hanford Site was established in 1943 to produce plutonium for nuclear weapons using production reactors and chemical processing plants. The T Plant Aggregate Area is located within the 200 West Area, near the middle of the Hanford Site. There are seven operable units within the T Plant Aggregate Area. Two of those operable units are associated with the Single-Shell Tank Farms.

The T Plant Aggregate Area contains 163 waste disposal and storage facilities classified as waste management units in the Tri-Party Agreement. In addition, it contains 18 unplanned releases that are associated with waste management units. High-level wastes were stored in underground single-shell tanks. Low-level wastes such as cooling and condensate water were allowed to infiltrate into the ground through cribs, ditches, and open ponds. Based on construction, purpose, or origin, the T Plant Aggregate Area waste management units fall into one of ten subgroups as follows:

- 0 (No. of waste management units) Plants, Buildings, and Storage Areas
- 50 Tanks and Vaults
- 16 Cribs and Drains

- 2 Reverse Wells
- 22 Ponds, Ditches, and Trenches
- 6 Septic Tanks and Associated Drain Fields
- 15 Transfer Facilities, Diversion Boxes, and Pipelines
- 1 Basin
- 5 Burial Sites
- 46 Unplanned Releases.

Detailed descriptions of these waste management units are provided in Section 2.3.

There are several ongoing programs that affect buildings and waste management units in the T Plant Aggregate Area (Section 2.7). These programs include RCRA, the Hanford Decommissioning and RCRA Closure Program, the Radiation Area Remedial Action (RARA) Program, the Single-Shell Tank Closure Program (SSTCP), and the Waste Management Program. Seventy-six units (primarily single-shell tanks and associated transfer facilities) fall completely within the scope of one of these programs and, therefore, recommendations on these units will be made by the respective programs rather than in this AAMSR. An additional eight waste management units will be partially addressed by an ongoing program in addition to the actions recommended in the T Plant AAMSR.

Discussions of surface hydrology and geology are provided on a regional, Hanford Site, and aggregate area basis in Section 3.0. The interpretation is based on a limited number of wells and this limitation does not support a detailed delineation of waste management unit specific features. The section also describes the flora and fauna, land use, water use, and human resources of the 200 West Area and vicinity. Groundwater of the 200 West Area is described in detail in a separate 200 West Groundwater AAMSR.

A preliminary site conceptual model is presented in Section 4.0. Section 4.1 presents the chemical and radiological data that are available for the different media types (including surface soil, vadose zone soil, air, surface water and biota) and site-specific data for each waste management unit and unplanned release.

A preliminary assessment of potential impacts to human health and the environment is presented in Section 4.2. This assessment includes a discussion of release mechanisms, potential transport pathways, and a preliminary conceptual model of human and ecological exposure based on these pathways. Physical, radiological, and toxicological characteristics of the known and suspected contaminants at the aggregate area are also discussed.

Health and environmental concerns are presented in Section 5.0. The preliminary qualitative evaluation of potential human health concerns is intended to provide input to the waste management unit recommendation process. The evaluation includes (1) an identification of contaminants of potential concern for each exposure pathway that is likely to occur within the T Plant Aggregate Area, (2) identification of exposure pathways applicable to individual waste management units and (3) estimates of relative hazard based on four available indicators of risk; the CERCLA Hazard Ranking System (HRS) and modified HRS (mHRS), surface radiation survey data, and Westinghouse Environmental Protection Group site scoring.

Potentially ARARs to be used in developing and assessing various remedial action alternatives at the T Plant Aggregate Area are discussed in Section 6.0. Specific potential requirements pertaining to hazardous and radiological waste management, remediation of contaminated soils, surface water protection, and air quality are discussed.

Preliminary remedial action technologies are presented in Section 7.0. The process includes identification of remedial action objectives (RAOs), determination of general response actions, and identification of specific process options associated with each option type. The process options are screened based on their effectiveness, implementability and cost. The screened process options are combined into alternatives and the alternatives are described.

Data quality is addressed in Section 8.0. Identification of chemical and radiological constituents associated with the units and their concentrations, with a view to determine the contaminants of concern and their action levels, is a major requirement to execute the *Hanford Site Past-Practice Strategy*. There was found to be a limited amount of data in this regard. The section provides a summary of data needs identified for each of the waste management units in the T Plant Aggregate Area. The data needs provide the basis for development of detailed DQOs in subsequent work plans.

Section 9.0 provides management recommendations for the T Plant Aggregate Area based on the *Hanford Site Past-Practice Strategy*. Criteria for selecting appropriate *Hanford Site Past-Practice Strategy* paths (ERA, IRM, and final remedy selection) for individual waste management units and unplanned releases in the T Plant Aggregate Area are developed in Section 9.1. As a result of the data evaluation process, no waste management units were recommended for an ERA, 33 units were recommended for LFIs which could lead to IRMs, and 36 units were recommended for final remedy selection. A discussion of the data evaluation process is provided in Section 9.2. Table ES-1 provides a summary of the 69 waste management units in the T Plant Aggregate Area not covered by other programs. Table ES-2 provides the decision matrix patterns each unit followed in reaching the recommendation. Recommendations for redefining operable unit boundaries and prioritizing

operable units for work plan development are provided in Section 9.3. All recommendations for future characterization needs will be more fully developed and implemented through work plans. Sections 9.4 and 9.5 provide recommendations for a focused feasibility study (FFS) and treatability study, respectively.

Table ES-1. Summary of the Results of Data Evaluation Process Assessment.

Waste Management Unit or Unplanned Release Site	Operable Unit	ERA	IRM	LFI	RA	RI	OPS	Remarks
Tanks and Vaults								
241-T-361 Settling Tank	200-TP-4	--	X	X	--	--	--	
Cribs and Drains								
216-T-6 Crib	200-TP-3	--	X	X	--	--	X	RARA - cave-in potential
216-T-7TF Crib and Tile Field	200-TP-1	--	X	X	--	--	X	RARA - cave-in potential
216-T-8 Crib	200-TP-4	--	X	X	--	--	X	RARA - cave-in potential
216-T-18 Crib	200-TP-4	--	X	X	--	--	--	
216-T-19TF Crib and Tile Field	200-TP-2	--	X	X	--	--	X	RARA - cave-in potential
216-T-26 Crib	200-TP-2	--	X	X	--	--	--	
216-T-27 Crib	200-TP-2	--	X	X	--	--	--	
216-T-28 Crib	200-TP-2	--	X	X	--	--	--	
216-T-29 Crib	200-TP-4	--	X	X	--	--	--	
216-T-31 French Drain	200-TP-2	--	--	--	X	--	--	Exhumed
216-T-32 Crib	200-TP-1	--	X	X	--	--	X	RARA - cave-in potential
216-T-33 Crib	200-TP-4	--	X	X	--	--	--	
216-T-34 Crib	200-TP-4	--	X	X	--	--	--	
216-T-35 Crib	200-TP-4	--	X	X	--	--	--	
216-T-36 Crib	200-TP-1	--	X	X	--	--	--	

Table ES-1. Summary of the Results of Data Evaluation Process Assessment.

Waste Management Unit or Unplanned Release Site	Operable Unit	ERA	IRM	LFI	RA	RI	OPS	Remarks
216-W-LWC Crib	200-SS-2	--	X	X	--	--	X	WMP Active - closed by 6/95
Reverse Wells								
216-T-2 Reverse Well	200-TP-4	--	--	--	--	X	--	
216-T-3 Reverse Well	200-TP-4	--	--	--	--	X	--	
Ponds, Ditches, and Trenches								
216-T-4A Pond	200-TP-3	--	--	--	--	X	--	
216-T-4B Pond	200-TP-3	--	--	--	--	X	--	Active - close by 6/95
216-T-1 Ditch	200-TP-4	--	X	X	--	--	--	Active - close by 6/95
216-T-4-1D Ditch	200-TP-3	--	X	X	--	--	--	
216-T-4-2 Ditch	200-TP-3	--	X	X	--	--	X	WMP Active - close by 6/95
200-W Powerhouse Pond	200-TP-2	--	--	--	--	X	--	Active - close by 6/95
216-T-5 Trench	200-TP-1	--	X	X	--	--	--	
216-T-9 Trench	200-TP-4	--	X	X	--	--	--	
216-T-10 Trench	200-TP-4	--	--	--	--	X	--	Exhumed
216-T-11 Trench	200-TP-4	--	--	--	--	X	--	Exhumed
216-T-12 Trench	200-TP-3	--	X	X	--	--	--	
216-T-13 Trench	200-TP-2	--	--		--	X	--	Exhumed
216-T-14 Trench	200-TP-3	--	X	X	--	--	--	
216-T-15 Trench	200-TP-3	--	X	X	--	--	--	

Table ES-1. Summary of the Results of Data Evaluation Process Assessment.

Waste Management Unit or Unplanned Release Site	Operable Unit	ERA	IRM	LFI	RA	RI	OPS	Remarks
216-T-16 Trench	200-TP-3	--	X	X	--	--	--	
216-T-17 Trench	200-TP-3	--	X	X	--	--	--	
216-T-20 Trench	200-TP-2	--	X	X	--	--	--	
216-T-21 Trench	200-TP-1	--	X	X	--	--	--	
216-T-22 Trench	200-TP-1	--	X	X	--	--	--	
216-T-23 Trench	200-TP-1	--	X	X	--	--	--	
216-T-24 Trench	200-TP-1	--	X	X	--	--	--	
216-T-25 Trench	200-TP-1	--	X	X	--	--	--	
Septic Tanks and Associated Drain Fields								
2607-W1 Septic Tank	200-SS-2	--	--	--	--	X	--	Active
2607-W2 Septic Tank	200-SS-2	--	--	--	--	X	--	Active
2607-W3 Septic Tank	200-TP-4	--	--	--	--	X	--	Active
2607-W4 Septic Tank	200-TP-4	--	--	--	--	X	--	Active
Basins								
207-T Retention Basin	200-TP-3	--	X	X	--	--	--	
Burial Sites								
200-W Ash Disposal Basin	200-SS-2	--	--	--	--	X	--	Active
200-W Burning Pit	200-SS-2	--	--	--	--	X	--	
200-W Powerhouse Ash Pit	200-SS-2	--	--	--	--	X	--	Active
218-W-8 Burial Ground	200-TP-4	--	--	--	--	X	X	RARA cave-in potential

Table ES-1. Summary of the Results of Data Evaluation Process Assessment.

Waste Management Unit or Unplanned Release Site	Operable Unit	ERA	IRM	LFI	RA	RI	OPS	Remarks
Unplanned Releases								
UN-200-W-2	200-TP-4	--	--	--	--	X	--	
UN-200-W-3	200-TP-4	--	--	--	--	X	--	
UN-200-W-4	200-TP-4	--	--	--	--	X	--	
UN-200-W-8	200-TP-4	--	--	--	--	X	--	
UN-200-W-14	200-TP-2	--	--	--	--	X	--	
UN-200-W-27	200-TP-4	--	--	--	--	X	--	
UN-200-W-29	200-TP-2	--	--	--	--	X	--	
UN-200-W-58	200-TP-4	--	--	--	--	X	--	
UN-200-W-63	200-TP-3	--	--	--	--	X	--	Exhumed/covered
UN-200-W-65	200-TP-4	--	--	--	--	X	--	
UN-200-W-67	200-TP-4	--	--	--	--	X	--	
UN-200-W-73	200-TP-4	--	--	--	--	X	--	
UN-200-W-77	200-TP-4	--	--	--	X	--	--	Exhumed
UN-200-W-85	200-TP-4	--	--	--	X	--	--	Exhumed
UN-200-W-88	200-SS-2	--	--	--	X	--	--	Exhumed
UN-200-W-98	200-TP-4	--	--	--	--	X	--	
UN-200-W-99	200-TP-2	--	--	--	--	X	--	
UN-200-W-102	200-TP-4	--	--	--	--	X	--	
UN-200-W-135	200-TP-2	--	--	--	--	X	--	

Table ES-1. Summary of the Results of Data Evaluation Process Assessment.

Waste Management Unit or Unplanned Release Site	Operable Unit	ERA	IRM	LFI	RA	RI	OPS	Remarks

Notes: ERA- Expediated Response Action
IRM- Interim Remedial Measure
LFI- Limited Field Investigation
OPS- Operational Programs
RA- Risk Assessment
RARA- Radiation Area Remedial Action Program
RI- Remedial Investigation/Feasibility Study
WMP- Waste Management Program

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Table ES-2. T Plant Aggregate Area Data Evaluation Decision Matrix.

Waste Management Unit	ERA EVALUATION PATH								IRM EVALUATION PATH			LFI PATH	FINAL REMEDY
	Is an ERA Justified?	Release?	Pathway?	Quantity?	Concentration?	Technology Available?	Adverse Consequences?	Operational Programs?	High Priority?	Data Adequate?	No Adverse Consequences?	Collect Data?	Data Adequate?
Tanks and Vaults													
241-T-361 Settling Tank	Y	Y	N	-	-	-	-	-	Y	N	-	Y	-
Cribs and Drains													
216-T-6 Crib	Y	Y	Y	Y	Y	Y	N	Y	N[a]	N	-	Y	-
216-T-7TF Crib and Tile Field	Y	Y	Y	Y	Y	Y	N	Y	Y	N	-	Y	-
216-T-8 Crib	Y	Y	Y	Y	Y	Y	N	Y	Y	N	-	Y	-
216-T-18 Crib	Y	Y	N	-	-	-	-	-	N[a]	N	-	Y	-
216-T-19TF Crib and Tile Field	Y	Y	Y	Y	Y	Y	N	Y	Y	N	-	Y	-
216-T-26 Crib	Y	Y	N	-	-	-	-	-	Y	N	-	Y	-
216-T-27 Crib	Y	Y	N	-	-	-	-	-	Y	N	-	Y	-
216-T-28 Crib	Y	Y	N	-	-	-	-	-	Y	N	-	Y	-
219-T-29 Crib	Y	Y	N	-	-	-	-	-	Y[a]	N	-	-	-
216-T-31 French Drain	N	-	-	-	-	-	-	-	N	-	-	-	Y
216-T-32 Crib	Y	Y	Y	Y	Y	Y	N	Y	N[a]	N	-	Y	-
216-T-33 Crib	Y	Y	N	-	-	-	-	-	Y	N	-	Y	-
216-T-34 Crib	Y	Y	N	-	-	-	-	-	Y	N	-	Y	-
216-T-35 Crib	Y	Y	N	-	-	-	-	-	Y	N	-	Y	-
216-T-36 Crib	Y	Y	N	-	-	-	-	-	Y	N	-	Y	-
216-W-LWC Crib	Y	Y	Y	Y	Y	Y	N	Y	Y	N	-	Y	-

Table ES-2. T Plant Aggregate Area Data Evaluation Decision Matrix.

Waste Management Unit	ERA EVALUATION PATH								IRM EVALUATION PATH			LFI PATH	FINAL REMEDY
	Is an ERA Justified?	Release?	Pathway?	Quantity?	Concentration?	Technology Available?	Adverse Consequences?	Operational Programs?	High Priority?	Data Adequate?	No Adverse Consequences?	Collect Data?	Data Adequate?
Reverse Wells													
216-T-2 Reverse Well	Y	Y	N	-	-	-	-	-	Y	N	-	N	N
216-T-3 Reverse Well	Y	Y	N	-	-	-	-	-	Y	N	-	N	N
Ponds, Ditches, and Trenches													
216-T-4A Pond	Y	Y	N	-	-	-	-	-	N	-	-	-	N
216-T-4B Pond	Y	Y	Y	Y	N	-	-	-	N	-	-	-	N
216-T-1 Ditch	Y	Y	Y	Y	N	-	-	-	Y	N	-	Y	-
216-T-4-1D Ditch	Y	Y	N	-	-	-	-	-	N[a]	N	-	Y	-
216-T-4-2 Ditch	Y	Y	Y	Y	Y	Y	N	Y	Y	N	-	Y	-
200-W Powerhouse Pond	N	-	-	-	-	-	-	-	N	-	-	-	N
216-T-5 Trench	Y	Y	N	-	-	-	-	-	N[a]	N	-	Y	-
216-T-9 Trench	Y	Y	N	-	-	-	-	-	N[a]	N	-	Y	-
216-T-10 Trench	N	-	-	-	-	-	-	-	N	-	-	-	N
216-T-11 Trench	N	-	-	-	-	-	-	-	N	-	-	-	N
216-T-12 Trench	Y	Y	N	-	-	-	-	-	Y	N	-	Y	-
216-T-13 Trench	N	-	-	-	-	-	-	-	N	-	-	-	N
216-T-14 Trench	Y	Y	N	-	-	-	-	-	Y	N	-	Y	-
216-T-15 Trench	Y	Y	N	-	-	-	-	-	Y	N	-	Y	-
216-T-16 Trench	Y	Y	N	-	-	-	-	-	Y	N	-	Y	-
216-T-17 Trench	Y	Y	N	-	-	-	-	-	Y	N	-	Y	-
216-T-20 Trench	Y	Y	N	-	-	-	-	-	N[a]	N	-	Y	-

Table ES-2. T Plant Aggregate Area Data Evaluation Decision Matrix.

Waste Management Unit	ERA EVALUATION PATH								IRM EVALUATION PATH			LH PATH	FINAL REMEDY
	Is an ERA Justified?	Release?	Pathway?	Quantity?	Concentration?	Technology Available?	Adverse Consequences?	Operational Programs?	High Priority?	Data Adequate?	No Adverse Consequences?	Collect Data?	Data Adequate?
216-T-21 Trench	Y	Y	N	-	-	-	-	-	N[a]	N	-	Y	-
216-T-22 Trench	Y	Y	N	-	-	-	-	-	N[a]	N	-	Y	-
216-T-23 Trench	Y	Y	N	-	-	-	-	-	N[a]	N	-	Y	-
216-T-24 Trench	Y	Y	N	-	-	-	-	-	N[a]	N	-	Y	-
216-T-25 Trench	Y	Y	N	-	-	-	-	-	N[a]	N	-	Y	-
Septic Tanks and Associated Drain Fields													
2607-W1 Septic Tank	N	-	-	-	-	-	-	-	N	-	-	-	N
2607-W2 Septic Tank	N	-	-	-	-	-	-	-	N	-	-	-	N
2607-W3 Septic Tank	N	-	-	-	-	-	-	-	N	-	-	-	N
2607-W4 Septic Tank	N	-	-	-	-	-	-	-	N	-	-	-	N
Basins													
207-T Retention Basin	Y	Y	Y	Y	N	-	-	-	Y	N	-	Y	-
Burial Sites													
200-W Ash Disposal Basin	N	-	-	-	-	-	-	-	N	-	-	-	N
200-W Burning Pit	N	-	-	-	-	-	-	-	N	-	-	-	N
200-W Powerhouse Ash Pit	N	-	-	-	-	-	-	-	N	-	-	-	N
218-W-8 Burial Ground	Y	Y	Y	Y	Y	Y	N	Y	N	-	-	-	N
Unplanned Releases													
UN-200-W-2	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UN-200-W-3	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UN-200-W-4	Y	Y	N	-	-	-	-	-	N	-	-	-	N

Table ES-2. T Plant Aggregate Area Data Evaluation Decision Matrix.

Waste Management Unit	ERA EVALUATION PATH								IRM EVALUATION PATH			LFI PATH	FINAL REMEDY
	Is an ERA Justified?	Release?	Pathway?	Quantity?	Concentration?	Technology Available?	Adverse Consequences?	Operational Programs?	High Priority?	Data Adequate?	No Adverse Consequences?	Collect Data?	Data Adequate?
UN-200-W-8	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UN-200-W-14	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UN-200-W-27	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UN-200-W-29	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UN-200-W-58	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UN-200-W-63	N	-	-	-	-	-	-	-	N	-	-	-	Y
UN-200-W-65	Y	Y	N	-	-	-	-	-	Y	N	-	N	N
UN-200-W-67	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UN-200-W-73	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UN-200-W-77	N	-	-	-	-	-	-	-	N	-	-	-	Y
UN-200-W-85	N	-	-	-	-	-	-	-	N	-	-	-	Y
UN-200-W-88	N	-	-	-	-	-	-	-	N	-	-	-	Y
UN-200-W-98	Y	Y	N	-	-	-	-	-	Y	N	-	N	N
UN-200-W-99	Y	Y	N	-	-	-	-	-	Y	N	-	N	N
UN-200-W-102	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UN-200-W-135	Y	Y	N	-	-	-	-	-	N	-	-	-	N

[a] Evaluated as high priority unit because of similarities with high priority units.

ACRONYMS AND ABBREVIATIONS

AA	aggregate area
AAMS	aggregate area management study
AAMSR	aggregate area management study report
AKART	all known, available, and reasonable treatment
ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
ARCL	allowable residual contamination level method
ASIL	acceptable source impact level
BAT	best available treatment
BDAT	best demonstrated available treatment
BWIP	Basalt Waste Isolation Project
BWID	Buried Waste Integrated Demonstration
CCWE	constituent concentrations in waste extract
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CH-TRU	contact-handled transuranic
CLP	Contract Laboratory Program
CMS	Corrective Measures Study
CSTF	Containment Systems Test Facility
CWA	Clean Water Act
DCG	Derived Concentration Guide
DOE	U. S. Department of Energy
DOE/RL	U. S. Department of Energy, Richland Field Office
DQO	data quality objective
Ecology	Washington State Department of Ecology
EDMC	Environmental Data Management Center
EF	engineered facility
EHPSS	Environmental Health and Pesticide Services Section
EII	Environmental Investigations Instructions
EIMP	Environmental Information Management Plan
ENS	insufficient data
EPA	U. S. Environmental Protection Agency
ERA	expedited response action
ERRA	Environmental Restoration Remedial Action
ES&H	Environment, Safety, and Health
FFS	focused feasibility studies
FOMP	Field Office Management Plan
FRS	final remedy selection
FS	feasibility study
FWQC	Federal Water Quality Criteria
GIS	geographic information system

ACRONYMS AND ABBREVIATIONS (cont.)

Health	Washington State Department of Health
HEAST	Health Effects Assessment Summary Tables
HEHF	Hanford Environmental Health Foundation
HEIS	Hanford Environmental Information System
HEPA	high efficiency particulate air
HISS	Hanford Inactive Site Survey
HLAN	Hanford Local Area Network
HRS	Hazard Ranking System
HSP	health and safety plan
HWOP	Hazardous Waste Operations Permit
IMO	Information Management Overview
INEL	Idaho National Engineering Laboratory
IRIS	Integrated Risk Information System
IRM	interim remedial measure
JSA	Job Safety Analysis
KEH	Kaiser Engineers Hanford
LDR	land disposal restriction
LFI	limited field investigation
LLRW	low-level radioactive waste
LSC	liquid scintillation counting
MCL	maximum contaminant level
MCS	Management Control System
mHRS	modified Hazard Ranking System
MIBK	methyl isobutyl ketone
msl	mean sea level
MTCA	Model Toxics Control Act
NAAQS	National Primary and Secondary Ambient Air Quality Standards
NAD	North American Datum
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NFA	no further action
NIOSH	National Institute for Occupational Safety and Health
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NSPS	New Source Performance Standards
OPS	existing operational programs
OSHA	Occupational Safety and Health Administration
OSM	Office of Sample Management
PA	preliminary assessment

ACRONYMS AND ABBREVIATIONS (cont.)

PARCC	precision, accuracy, representativeness, completeness, and comparability
PNL	Pacific Northwest Laboratory
PUREX	plutonium/uranium extraction
QA	quality assurance
QAPjP	Quality Assurance Project Plan
QC	quality control
RA	Risk Assessment
RAO	remedial action objective
RARA	Radiation Area Remedial Action
RAS	Routine Analytical Services
REDOX	reduction/oxidation
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
RFI	RCRA Facility Investigation
RHO	Rockwell Hanford Operations
RI	remedial investigation
RLS	Radionuclide Logging System
ROD	Record of Decision
RWP	Radiation Work Permit
SARA	Superfund Amendments and Reauthorization Act
SAS	Special Analytical Services
SCBA	self-contained breathing apparatus
SDWA	Safe Drinking Water Act
SI	site inspection
SSTCP	Single-Shell Tank Closure Program
T-BACT	best available control technology for air toxics
TBC	To-be-Considered Material
TCLP	Toxic Characteristic Leaching Procedure
TLD	thermoluminescent dosimeter
TOC	total organic carbon
TR	training records
TRAC	Tracks Radioactive Components
Tri-Party Agreement	Hanford Federal Facility Agreement and Consent Order
TRU	transuranic
TRUSAF	Transuranic Waste Storage and Assay Facility
TSD	treatment, storage, or disposal
USC	U.S. Code
USGS	United States Geological Survey
VOCs	Volatile organic compounds
WAC	Washington Administrative Code

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ACRONYMS AND ABBREVIATIONS (cont.)

WHC	Westinghouse Hanford Company
WIDS	Waste Information Data System
WIPP	Waste Isolation Pilot Plant
WISHA	Washington Industrial Safety and Health Act
WPCA	Washington State Water Pollution Control Act
WPPSS	Washington Public Power Supply System

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1.0 INTRODUCTION

The U.S. Department of Energy (DOE) Hanford Site in Washington State is organized into numerically designated operational areas including the 100, 200, 300, 400, 600, and 1100 Areas (Figure 1-1). The U.S. Environmental Protection Agency (EPA), in November 1989, included the 200 Areas of the Hanford Site on the National Priorities List (NPL) under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980. Inclusion on the NPL initiates the Remedial Investigation (RI) and Feasibility Study (FS) process for characterizing the nature and extent of contamination, assessing risks to human health and the environment, and selection of remedial actions.

This report presents the results of an aggregate area management study (AAMS) for the T Plant Aggregate Area located in the 200 Areas. The study provides the basis for initiating RI/FS under CERCLA or under the Resource Conservation and Recovery Act (RCRA) Facility Investigations (RFI) and Corrective Measures Studies (CMS). This report also integrates RCRA treatment, storage, or disposal (TSD) closure activities with CERCLA and RCRA past-practice investigations.

This chapter describes the overall AAMS approach for the 200 Areas, defines the purpose, objectives and scope of the AAMS, and summarizes the quality assurance (QA) program and contents of the report.

1.1 OVERVIEW

The 200 Areas, located near the center of the Hanford Site, encompasses the 200 West, East and North Areas which contain reactor fuel processing and waste management facilities.

Under the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement), signed by the Washington State Department of Ecology (Ecology), DOE, and EPA (Ecology et al. 1990), the 200 NPL Site encompasses the 200 Areas and selected portions of the 600 Area. The 200 NPL Site is divided into 8 waste area groups largely corresponding to the major processing plants (e.g., B Plant and T Plant), and a number of isolated operable units located in the surrounding 600 Area. Each waste area group is further subdivided into one or more operable units based on waste disposal information, location, facility type, and other site characteristics. The 200 NPL Site includes a total of 44 operable units including 20 in the 200 East Area, 17 in the 200 West Area, 1 in the 200 North Area, and 6 isolated operable units. The intent of defining operable units was to group associated waste management units together, so that they could be effectively characterized and remediated under one work plan.

The Tri-Party Agreement also defines approximately 25 RCRA TSD groups within the 200 Areas which will be closed or permitted (for operation or postclosure care) in accordance with the Washington State Dangerous Waste Regulations (Washington Administrative Code [WAC] 173-303). The TSD facilities are often associated with an operable unit and are required to be addressed concurrently with past-practice activities under the Tri-Party Agreement.

This AAMS is one of ten studies that will provide the basis for past practice activities for operable units in the 200 Areas. In addition, the AAMS will be collectively used in the initial development of an area-wide groundwater model, and conduct of an initial site-wide risk assessment. Recent changes to the Tri-Party Agreement (Ecology et al. 1991), and the *Hanford Site Past-Practice Strategy* document (DOE/RL 1992a) establish the need and provide the framework for conducting AAMS in the 200 Areas.

1.1.1 Tri-Party Agreement

The Tri-Party Agreement was developed and signed by representatives from the EPA, Ecology, and DOE in May 1989, and revised in 1990 and 1991. The scope of the agreement covers all CERCLA past-practice, RCRA past-practice, and RCRA TSD activities on the Hanford Site. The purpose of the Tri-Party Agreement is to ensure that the environmental impacts of past and present activities are investigated and appropriately remediated to protect human health and the environment. To accomplish this, the Tri-Party Agreement provides a framework and schedule for developing, prioritizing, implementing, and monitoring appropriate response actions.

The 1991 revision to the Tri-Party Agreement requires that an aggregate area approach be implemented in the 200 Areas based on the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a). This strategy requires the conduct of AAMS which are similar in nature to an RI/FS scoping study. The Tri-Party Agreement change package (Ecology et al. 1991) specifies that 10 Aggregate Area Management Study Reports (AAMSR) (major milestone M-27-00) are to be prepared for the 200 Areas. Further definition of aggregate areas and the AAMS approach is provided in Sections 1.2 and 1.3.

1.1.2 Hanford Site Past-Practice Strategy

The *Hanford Site Past-Practice Strategy* was developed between Ecology, EPA, and DOE to streamline the existing RI/FS and RFI/CMS processes. A primary objective of this strategy is to develop a process to meet the statutory requirements and integrate CERCLA RI/FS and RCRA Past Practice RFI/CMS guidance into a singular process for the Hanford Site that ensures protection of human health and welfare and the environment. The strategy refines the existing past practice decision-making process as defined in the Tri-Party

Agreement. The fundamental principle of the strategy is a bias-for-action by optimizing the use of existing data, integrating past practice with RCRA TSD closure investigations, focusing the RI/FS process, conducting interim remedial actions, and reaching early decisions to initiate and complete cleanup projects on both operable-unit and aggregate-area scale. The ultimate goal is the comprehensive cleanup or closure of all contaminated areas at the Hanford Site at the earliest possible date in the most effective manner.

The process under this strategy is a continuum of activities whereby the effort is refined based upon knowledge gained as work progresses. Whereas the strategy is intended to streamline investigations and documentation to promote the use of interim actions to accelerate cleanup, it is consistent with RI/FS and RFI/CMS processes. An important element of this strategy is the application of the observational approach, in which characterization data are collected concurrently with cleanup.

For the 200 Areas the first step in the strategy is the evaluation of existing information presented in AAMSR. Based on this information, decisions are made regarding which strategy path(s) to pursue for further actions in the aggregate area. The strategy includes three paths for interim decision making and a final remedy-selection process that incorporates the three paths and integrates sites not addressed in those paths. As shown on Figure 1-2, the three paths for decision making are the following:

- Expedited response action (ERA) path, where an existing or near-term unacceptable health or environmental risk from a site is determined or suspected, and a rapid response is necessary to mitigate the problem

- Interim remedial measure (IRM) path, where existing data are sufficient to indicate that the site poses a risk through one or more pathways and additional investigations are not needed to screen the likely range of remedial alternatives for interim actions; if a determination is made that an IRM is justified, the process proceeds to select an IRM remedy and a focused feasibility study (FFS), if needed, to select a remedy

- Limited field investigation (LFI) path, where minimum site data are needed to support IRM or other decisions, and are obtained in a less formal manner than that needed to support a final Record of Decision (ROD). Data generated from a LFI may be sufficient to directly support an interim ROD. Regardless of the scope of the LFI, it is a part of the RI process, and not a substitute for it.

The process of final remedy selection must be completed for the aggregate area to reach closure. The aggregation of information obtained from LFI and interim actions may be sufficient to perform the cumulative risk assessment and to define the final remedy for the aggregate area or associated operable units. If the data are not sufficient, additional

investigations and studies will be performed to the extent necessary to support final remedy selection. These investigations would be performed within the framework and process defined for RI/FS or RFI/CMS programs.

1.2 200 NPL SITE AGGREGATE AREA MANAGEMENT STUDY PROGRAM

The overall approach and scope of the 200 Areas AAMS program is based on the Tri-Party Agreement and the *Hanford Site Past-Practice Strategy*.

1.2.1 Overall Approach

As defined in the 1991 revision to the Tri-Party Agreement, the AAMS program for the 200 Areas consists of conducting a series of ten AAMS for eight source (Figures 1-3, 1-4, and 1-5) and two groundwater aggregate areas delineated in the 200 East, West, and North Areas. Table 1-1 lists the aggregate areas, the type of study, and associated operable units. With the exception of 200-IU-6, isolated operable units associated with the 200 NPL site (Figure 1-5) are not included in the AAMS program. Generally, the quantity of existing information associated with isolated operable units is not considered sufficient to require study on an aggregate area basis prior to work plan development. Operable unit 200-IU-6 is addressed as part of the B Plant AAMS because of similarities in waste management units (i.e., ponds).

The eight source AAMS are designed to evaluate source terms on a plant-wide scale. Source AAMS are conducted for the following aggregate areas (waste area groups) which largely correspond to the major processing plants including the following:

- U Plant
- Z Plant
- S Plant
- T Plant
- PUREX
- B Plant
- Semi-Works
- 200 North.

The groundwater beneath the 200 Areas is investigated under two groundwater AAMS on an area-wide scale (i.e., 200 West and 200 East Areas). Groundwater aggregate areas were delineated to encompass the geography necessary to define and understand the local hydrologic regime, and the distribution, migration and interaction of contaminants emanating from source terms. The groundwater aggregate areas are considered an appropriate scale for developing conceptual and numerical groundwater models.

The U.S. Department of Energy, Richland Field Office (DOE/RL) functions as the "lead agency" for the 200 AAMS program. Depending on the specific AAMS, EPA and/or Ecology function as the "Lead Regulatory Agency" (Table 1-1). Through periodic (monthly) meetings information is transferred and regulators are informed of the progress of the AAMS such that decisions established under the *Hanford Site Past-Practice Strategy* (e.g., is an ERA justified?) (Figure 1-2) can be quickly and collectively made between the three parties. These meetings will continually refine the scope of AAMS as new information is evaluated, decisions are made and actions taken. Completion milestones for AAMS are defined in Ecology et al. (1991) and duplicated in Table 1-1. All AAMSR are submitted as Secondary Documents which are defined in the Tri-Party Agreement as informational documents.

1.2.2 Process Overview

Each AAMS consists of three steps: (1) the analysis of existing data and formulation of a preliminary conceptual model, (2) identification of data needs and evaluation of remedial technologies, and (3) conduct of limited field characterization activities. Steps 1 and 2 are components of an AAMSR. Step 3 is a parallel effort for which separate reports will be produced.

The first and primary task of the AAMS investigation process involves the search, compilation and evaluation of existing data. Information collected for these purposes includes the following:

- Facility and process descriptions and operational histories for waste sources
- Waste disposal records defining dates of disposal, waste types, and waste quantities
- Sampling events of waste effluents and affected media
- Site conditions including the site physiography, geology, hydrology, meteorology, ecology, demography, and archaeology
- Environmental monitoring data for affected media including air, surface water, sediment, soil, groundwater and biota.

Collectively this information is used to identify contaminants of concern, to determine the scope of future characterization efforts, and to develop a preliminary conceptual model of the aggregate area. Although data collection objectives are similar, the types of information collected depend on whether the study is a source or groundwater AAMS. The data collection step serves to avoid duplication of previous efforts and facilitates a more focused investigation by the identification of data gaps.

Topical reports referred to as Technical Baseline Reports are initially prepared to summarize facility information. These reports describe individual waste management units and unplanned releases contained in the aggregate area as identified in the Waste Information Data System (WIDS) (WHC 1991a). The reports are based on review of current and historical Hanford Site reports, engineering drawings and photographs and are supplemented with site inspections and employee interviews. Information contained in the reports is summarized in the AAMSR. Other topical reports are used as sources of information in the AAMSR. These reports are as follows:

- U Plant Geologic and Geophysics Data Package
- Z Plant Geologic and Geophysics Data Package
- S Plant Geologic and Geophysics Data Package
- T Plant Geologic and Geophysics Data Package
- PUREX Geologic and Geophysics Data Package
- B Plant Geologic and Geophysics Data Package
- 200 N Geologic and Geophysics Data Package
- Semiworks Geologic and Geophysics Data Package
- Hydrologic Model for the 200 West Groundwater Aggregate Area
- Hydrologic Model for the 200 East Groundwater Aggregate Area
- Unconfined Aquifer Hydrologic Test Data Package for the 200 West Groundwater Aggregate Area
- Unconfined Aquifer Hydrologic Test Data Package for the 200 East Groundwater Aggregate Area

- Confined Aquifer Hydrologic Test Data Package for the 200 Groundwater Aggregate Area Management Studies
- Groundwater Field Characterization Report
- 200 West Area Borehole Geophysics Field Characterization
- 200 East Area Borehole Geophysics Field Characterization.

The general scope of the topical reports related to this AAMSR is described in Section 8.0.

Information on waste sources, pathways, and receptors is used to develop a preliminary conceptual model of the aggregate area. In the preliminary conceptual model, the release mechanisms and transport pathways are identified. If the conceptual understanding of the site is considered inadequate, limited field characterization activities can be undertaken as part of the study. Field characterization activities occurring in parallel with and as part of the AAMS process include the following:

- Expanded groundwater monitoring programs (non Contract Laboratory Program [CLP]) at approximately 80 select existing wells to identify contaminants of concern and refine groundwater plume maps
- In situ assaying of gamma-emitting radionuclides at approximately 10 selected existing boreholes per aggregate area to develop radioelement concentration profiles in the vadose zone.

Wells, boreholes, and analytes are selected based on a review of existing environmental data which is undertaken early in the AAMS process. Field characterization results will be presented later in topical reports.

After the preliminary conceptual model is developed, health and environmental concerns are identified. The purpose of this determination is to provide one basis for determining recommendations and prioritization for subsequent actions at waste management units. Potential applicable or relevant and appropriate requirements (ARARs) and potential remedial technologies are identified. In cases where the existing information is sufficient, the *Hanford Site Past-Practice Strategy* allows for a FFS or CMS to be initiated prior to the completion of the study.

Data needs are identified by evaluating the sufficiency of existing data and by determining what additional data are necessary to adequately characterize the aggregate area, refine the preliminary conceptual model and potential ARARs, and/or narrow the range of remedial alternatives. Determinations are made regarding the level of uncertainty associated

with existing data and the need to verify or supplement the data. If additional data are needed, the intended data uses are identified, data quality objectives (DQO) established and data priorities set.

Each AAMSR results in management recommendations for the aggregate area including the following:

- The need for ERA, IRM, and LFI or whether to remain in the final remedy selection path
- Definition and prioritization of operable units
- Prioritization of work plan activities
- Integration of RCRA TSD closure activities
- The conduct of field characterization activities
- The need for treatability studies
- Identification of waste management units addressed entirely under other operational programs.

The waste management units recommended for ERA, IRM, or LFI actions are considered higher priority units. Lower priority waste management units will generally follow the conventional process for RI/FS. In spite of this distinction in the priority of sites, RI/FS activities will be conducted for all the waste management units. In the case of the higher priority waste management units, response operations will be followed by conventional RI/FS activities, although these activities may be modified because of knowledge gained through the remediation activities. In the case of the lower priority waste management units, an area-wide RI/FS will be prepared which encompasses these units.

Based on the AAMSR, a decision is made on whether the study has provided sufficient information to forego further field investigations and prepare a FS. An RI/FS work plan (which may be limited to LFI activities) will be developed and executed. The background information normally required to support the preparation of a work plan (e.g., site description, conceptual model, DQO, etc.) is developed in the AAMSR. The future work plans will reference information from the AAMSR. They will also include the rationale for sampling and analysis, will present detailed, unit-specific DQO, and will further develop physical site models as the data allows. In some cases, there may be insufficient data to support any further analysis than is provided in the AAMSR, so an added level of detail in the work plan may not be feasible.

All ten AAMS are scheduled to be completed by September 1992. This will facilitate a coordinated approach to prioritizing and implementing future past-practice activities for the entire 200 Areas.

1.3 PURPOSE, SCOPE, AND OBJECTIVES

The purpose of conducting an AAMS is to compile and evaluate the existing body of knowledge and conduct limited field characterization work to support the *Hanford Site Past-Practice Strategy* decision-making process for an aggregate area. The AAMS process is similar in nature to the RI/FS scoping process prior to work plan development and is intended to maximize the use of existing data to allow a more focused RI/FS. Deliverables for an AAMS consist of the AAMSR and Health and Safety, Project Management, and Information Management Overview (IMO) Plans.

Specific objectives of the AAMS include the following:

- Assemble and interpret existing data including operational and environmental data
- Describe site conditions
- Conduct limited new site characterization work if data or interpretation uncertainty could be reduced by the work (results from this work may not be available for the AAMSR, but will be included in subsequent topical reports).
- Develop a preliminary conceptual model
- Identify contaminants of concern, and their distribution
- Identify potential ARARs
- Define preliminary remedial action objectives, screen potential remedial technologies, and if possible provide recommendations for focused FS
- Recommend treatability studies to support the evaluation of remedial action alternatives
- Define data needs, establish general DQOs and set data priorities
- Provide recommendations for ERA, IRM, LFI or other actions
- Redefine and prioritize, if necessary, operable unit boundaries

- Define and prioritize, as data allow, work plan and other past practice activities with emphasis on supporting early cleanup actions and records of decisions

- Integrate RCRA TSD closure activities with past-practice activities.

Information on single-shell and double-shell tanks is presented in Sections 2.0 and 4.0 of selected AAMSRs. The AAMSR is not intended to address remediation related to the tanks. Nonetheless, the tank information is presented because known and suspected releases from the tanks may influence the interpretation of contamination data at nearby waste management units. Information on other facilities and buildings is also presented for this same reason. However, because these structures are addressed by other programs, the AAMSR does not include recommendations for further action at these structures.

Depending on whether an aggregate area is a source or groundwater aggregate area, the scope of the AAMS varies. Source AAMS focus on source terms, and the environmental media of interest include air, biota, surface water, surface soil, and the unsaturated subsurface soil. Accordingly, detailed descriptions of facilities and operational information are provided in the source AAMSR. In contrast, groundwater AAMS focus on the saturated subsurface and on groundwater contamination data. Descriptions of facilities in the groundwater AAMSR are limited to liquid disposal facilities and reference is made to source AAMSR for detailed descriptions. The description of site conditions in source AAMSR concentrate on site physiography, meteorology, surface water hydrology, vadose zone geology, ecology, and demography. Groundwater AAMSR summarize regional geohydrologic conditions and contain detailed information regarding the local geohydrology on an area-wide scale. Correspondingly, other sections of the AAMSR vary depending on the environmental media of concern.

1.4 QUALITY ASSURANCE

A limited amount of field characterization work is performed in parallel with preparation of the AAMSR. To help ensure that data collected are of sufficient quality to support decisions, all work will be performed in compliance with *Quality Assurance*, DOE Order 5700.6C (DOE 1991), as well as Westinghouse Hanford's existing QA manual WHC-CM-4-2 (WHC 1988a), and with procedures outlined in the QA program plan WHC-EP-0383 (WHC 1990a), specific to CERCLA RI/FS activities. This QA program plan describes the various plans, procedures, and instructions that will be used by Westinghouse Hanford to implement the QA requirements. Standard EPA guidance documents such as the *USEPA Contract Laboratory Program Statement of Work for Organic Analysis* (EPA 1988a) will also be followed.

1.5 ORGANIZATION OF REPORT

In addition to this introduction, the AAMSR consists of the following nine sections and appendices:

- Section 2.0, Facility, Process, and Operational History Descriptions, describes the major facilities, waste management units, and unplanned releases within the aggregate area. A chronology of waste disposal activities is established and waste generating processes are summarized.

- Section 3.0, Site Conditions, describes the physical, environmental, and sociological setting including geology, hydrology, ecology, meteorology, and demography.

- Section 4.0, Preliminary Conceptual Model, summarizes the conceptual understanding of the aggregate area with respect to types and extent of contamination, exposure pathways, and receptors.

- Section 5.0, Health and Environmental Concerns, identifies chemicals used or disposed within the aggregate area that could be of concern regarding public health and/or the environment and describes and applies the screening process for determining the relative priority of follow-up action at each waste management unit.

- Section 6.0, Potentially Applicable or Relevant and Appropriate Requirements, identifies federal and state standards, requirements, criteria, or limitations that may be considered relevant to the aggregate area.

- Section 7.0, Preliminary Remedial Action Technologies, identifies and screens potential remedial technologies and establishes remedial action objectives for environmental media.

- Section 8.0, Data Quality Objectives, reviews QA criteria on existing data, identifies data gaps or deficiencies, and identifies broad data needs for field characterization and risk assessment. The DQO and data priorities are established.

- Section 9.0, Recommendations, provides guidance for future past practice activities based on the results of the AAMS. Recommendations are provided for ERA at problem sites, IRM, LFI, refining operable unit boundaries, prioritizing work plans, and conducting field investigations and treatability studies.

- Section 10.0, References, list reports and documents cited in the AAMSR.

- Appendix A, Supplemental Data, provides supplemental data supporting the AAMSR.

The following plans are included and will be used to support past practice activities in the aggregate area:

- Appendix B: Health and Safety Plan
- Appendix C: Project Management Plan
- Appendix D: Information Management Overview.
- Appendix E: Supporting Documentation

Community relations requirements for the T Plant Aggregate Area can be found in the *Community Relations Plan for the Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989).

9 3 1 2 9 7 0 1 7 2 4

Figure 1-1. Hanford Site Map.

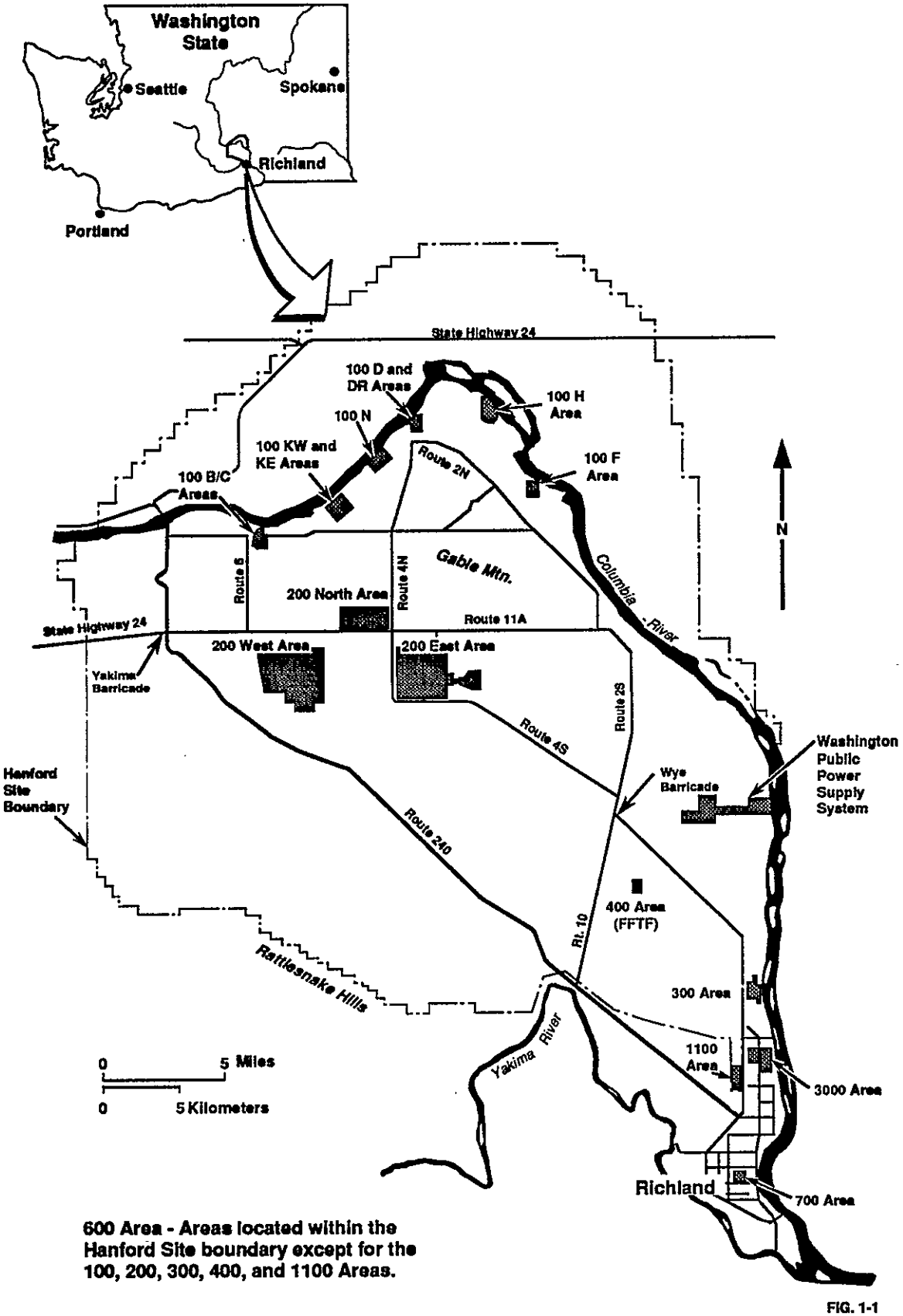
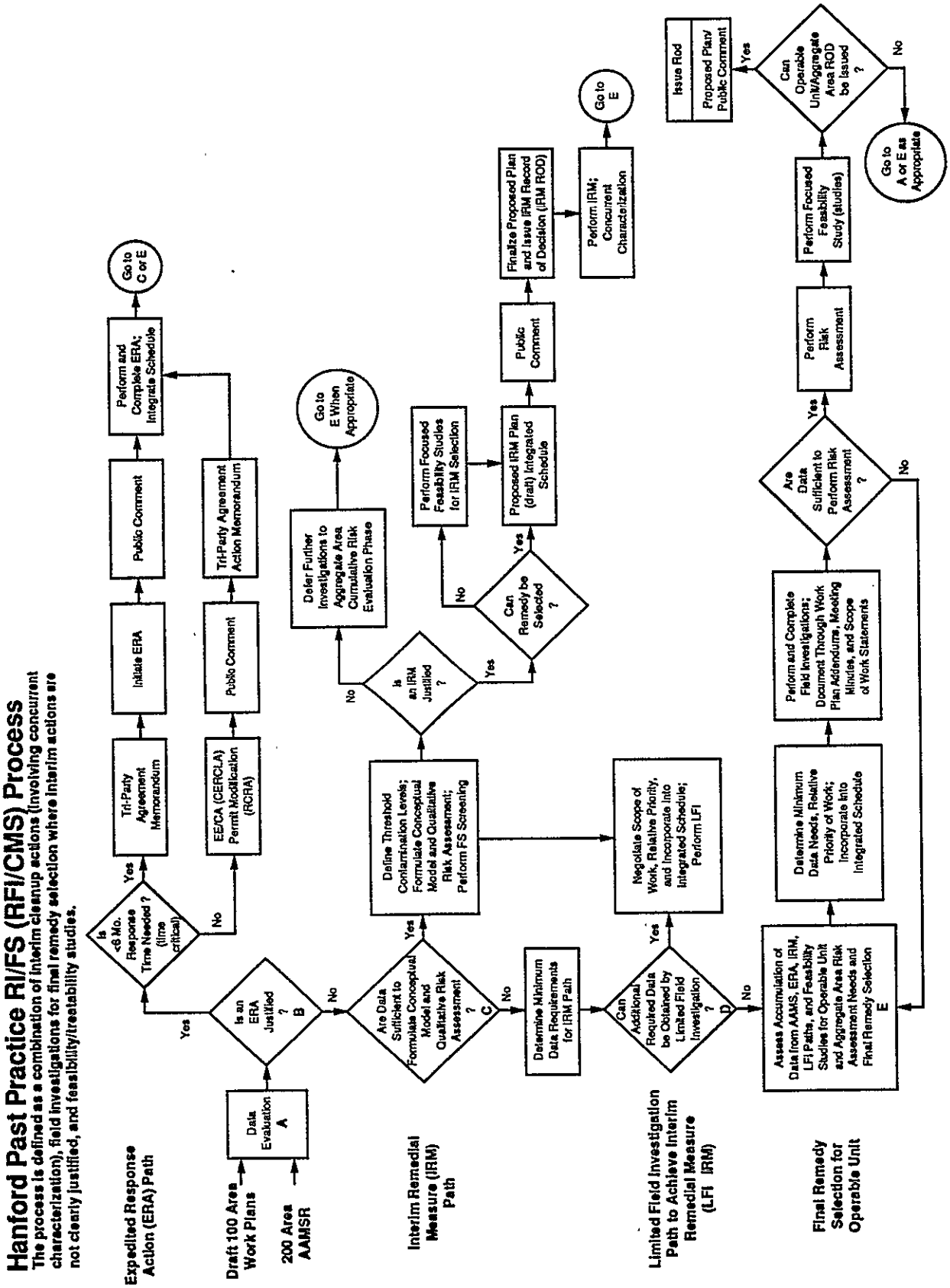


FIG. 1-1

Figure 1-2. Hanford Past-Practice Strategy Flow Chart. (DOE-RL 1992a)



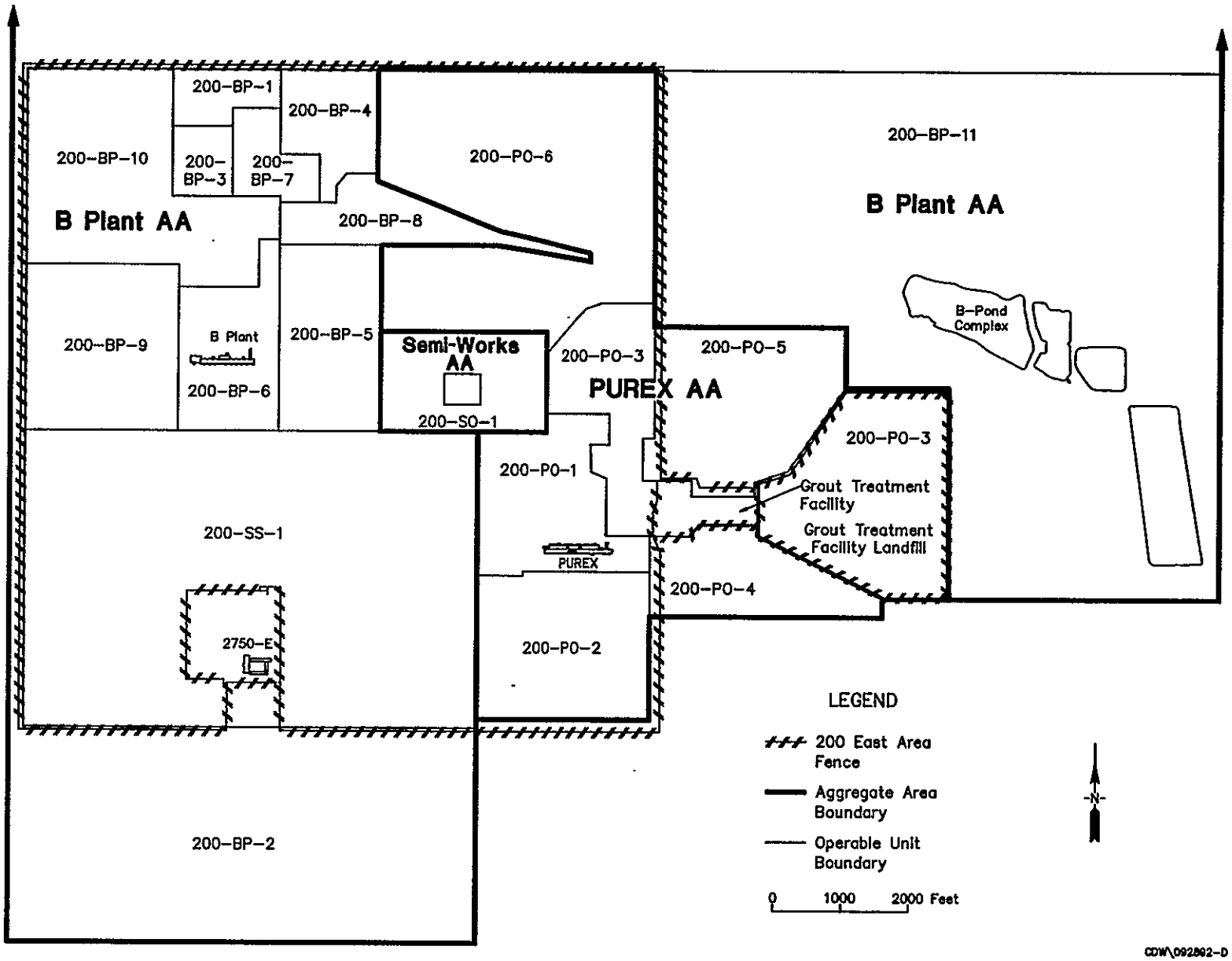


Figure 1-3. 200 East Aggregate Areas.

Figure 1-4. 200 West Aggregate Areas.

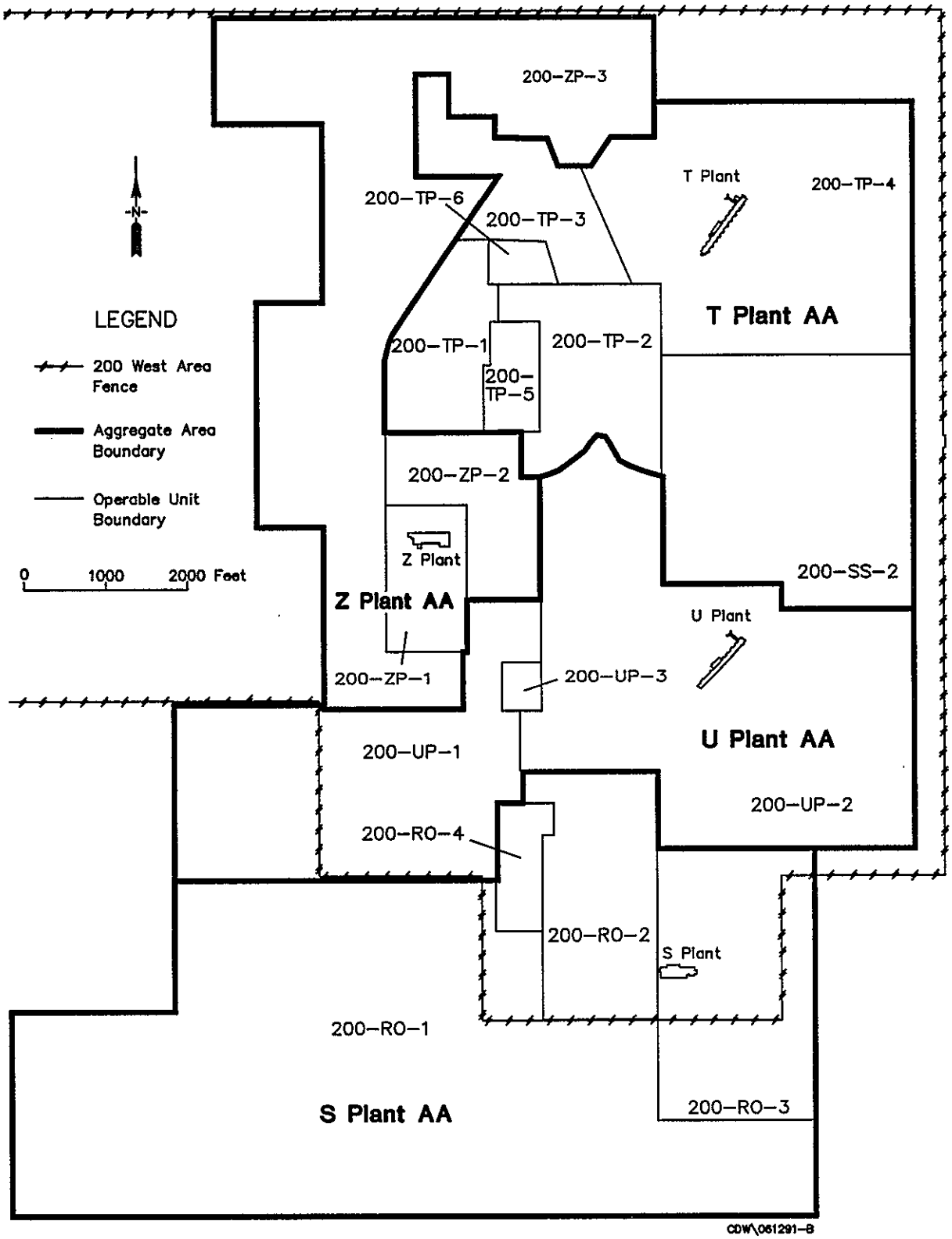


Figure 1-5. 200 NPL Site Isolated Operable Units.

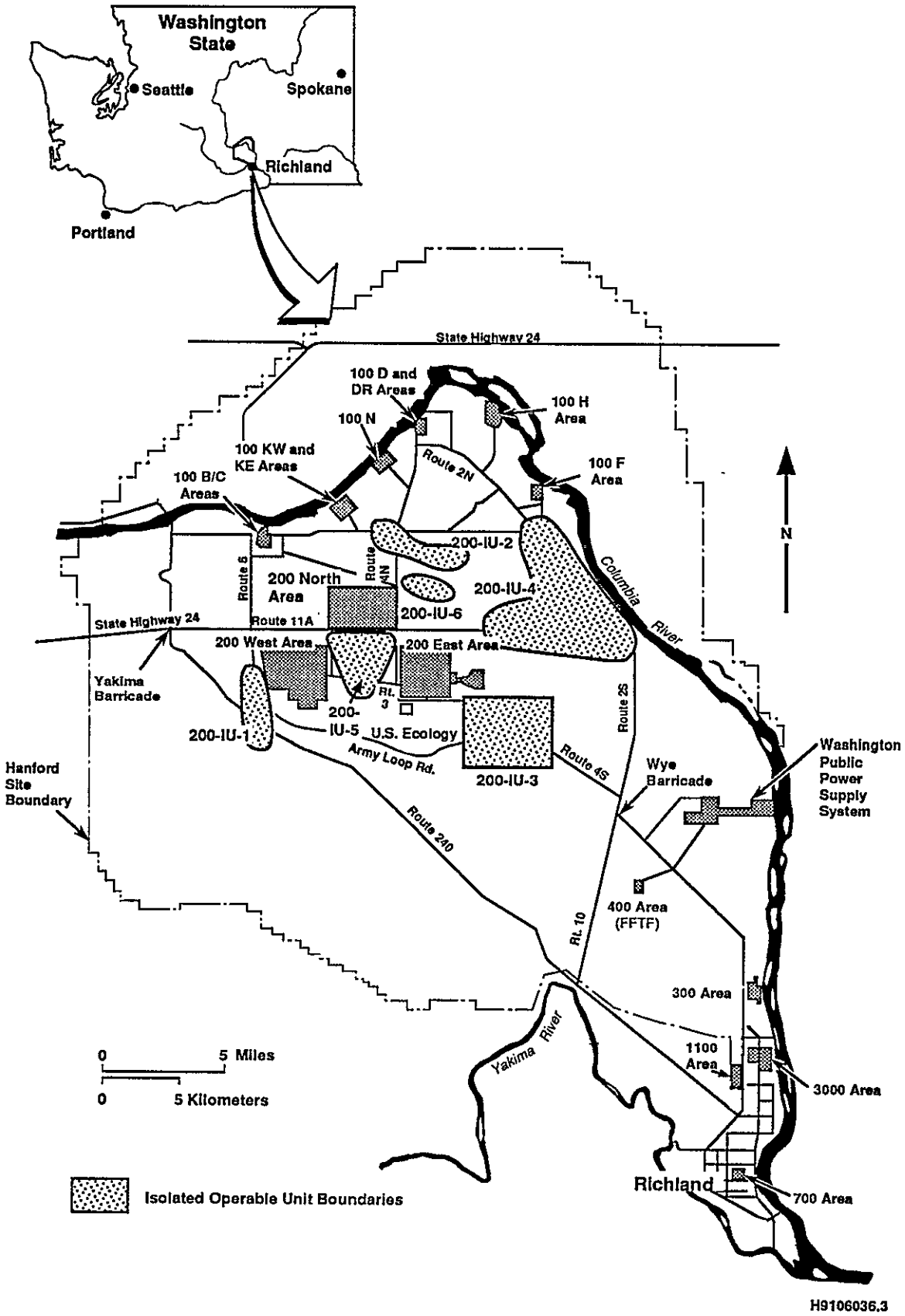


Table 1-1. Overall Aggregate Area Management Study (AAMS) Schedule for the 200 NPL Site.

AAMS Title	Operable Units	AAMS Type	Lead Regulatory Agency	M-27-00 Interim Milestones
U Plant	200-UP-1 200-UP-2 200-UP-3	Source	Ecology	M-27-02, January 1992
Z Plant	200-ZP-1 200-ZP-2 200-ZP-3	Source	EPA	M-27-03, February 1992
S Plant	200-RO-1 200-RO-2 200-RO-3 200-RO-4	Source	Ecology	M-27-04, March 1992
T Plant	200-TP-1 200-TP-2 200-TP-3 200-TP-4 200-TP-5 200-TP-6 200-SS-2	Source	EPA	M-27-05, April 1992
PUREX	200-PO-1 200-PO-2 200-PO-3 200-PO-4 200-PO-5 200-PO-6	Source	Ecology	M-27-06, May 1992
B Plant	200-BP-1 200-BP-2 200-BP-3 200-BP-4 200-BP-5 200-BP-6 200-BP-7 200-BP-8 200-BP-9 200-BP-10 200-BP-11 200-IU-6 200-SO-1	Source	EPA	M-27-07, June 1992
Semi-Works	200-SO-1	Source	Ecology	M-27-08, July 1992
200 North	200-NO-1	Source	EPA	M-27-09, August 1992
200 West	NA	Groundwater	EPA/Ecology	M-27-10, September 1992
200 East	NA	Groundwater	EPA/Ecology	M-27-11, September 1992

2.0 FACILITY, PROCESS AND OPERATIONAL HISTORY DESCRIPTIONS

Section 2.0 of the aggregate area management study (AAMS) presents historical data on the T Plant Aggregate Area and detailed physical descriptions of the individual waste management units and unplanned releases. These descriptions include historical data on waste sources and disposal practices and are based on a review of current and historical Hanford Site reports, engineering drawings, site inspections, and employee interviews. Section 3.0 describes the environmental setting of the waste management units. The waste types and volumes are qualitatively and quantitatively assessed at each waste management unit in Section 4.0. Data from these three sections are used to identify contaminants of concern (Section 5.0), potential applicable or relevant and appropriate requirements (ARARs) (Section 6.0) and current data gaps (Section 8.0).

This section describes the location of the T Plant Aggregate Area (Section 2.1), summarizes the history of operations (Section 2.2), describes the facilities, buildings, and structures of the T Plant Aggregate Area (Section 2.3), and describes T Plant Aggregate Area waste generating processes (Section 2.4). Section 2.5 discusses interactions with other aggregate areas or operable units. Sections 2.6 and 2.7 discuss interactions with the Resource Conservation and Recovery Act (RCRA) program and other Hanford programs.

2.1 LOCATION

The Hanford Site, operated by the U.S. Department of Energy (DOE), occupies about 1,450 km^2 (560 mi^2) of the southeastern part of Washington State north of the confluence of the Yakima and Columbia Rivers (Figure 1-1). The 200 West Area is a controlled area of approximately 8.3 km^2 (3.2 mi^2) near the middle of the Hanford Site. The 200 West Area is about 8 km (5 mi) from the Columbia River and 11 km (6.8 mi) from the nearest Hanford boundary. There are 17 operable units grouped into four aggregate areas in the 200 West Area (Figure 1-4). The T Plant Aggregate Area (consisting of operable units 200-TP-1, 200-TP-2, 200-TP-3, 200-TP-4, 200-TP-5, 200-TP-6 and 200-SS-2) lies in the southern portion of the 200 West Area (Figure 1-4). The location of the buildings and waste management units are shown on Plate 1. Plate 2 shows the topography of the T Plant Aggregate Area. The media sampling locations are depicted on Plate 3.

2.2 HISTORY OF OPERATIONS

The Hanford Site, established in 1943, was originally designed, built, and operated to produce plutonium for nuclear weapons using production reactors and chemical reprocessing plants. In March 1943, construction began on three reactor facilities (B,D, and F Reactors) and three chemical processing facilities (B, T, and T Plants). After World War II, six more

reactors were built (H, DR, C, KW, KE, and N Reactors). Beginning in the 1950's, energy research and development, isotope use, and other activities were added to the Hanford operation. In early 1964, a presidential decision was made to begin shut down of the reactors. Eight of the reactors were shut down by 1971. The N Reactor operated through 1987; and was placed on cold standby status in October 1989. Westinghouse Hanford was notified September 20, 1991 that they should cease preservation and proceed with activities leading to a decision on ultimate decommissioning of the reactor. These activities are scoped within a N Reactor shutdown program which is scheduled to be completed in 1999.

Operations in the 200 Areas (West and East) are mainly related to separation of special nuclear materials from spent nuclear fuel. Spent nuclear fuel is fuel that has been withdrawn from a nuclear reactor following irradiation. The 200 West Area consists of four main processing areas (Figure 1-4):

- S Plant and T Plant, where initial processing to separate uranium and plutonium from irradiated fuel rods took place
- U Plant, where uranium recovery operations took place
- Z Plant, where plutonium separation and recovery operations took place.

The 200 Areas also contain nonradioactive support facilities, including transportation maintenance buildings, service stations, and coal-fired powerhouses for process steam production, steam transmission lines, raw water treatment plants, water-storage tanks, electrical maintenance facilities, and subsurface sewage disposal systems.

Built in 1944, T Plant was the first chemical separation facility completed at the Hanford Site. The primary goal of T Plant operations was to produce purified plutonium nitrate for use in nuclear weapons. This process was initiated in one of the several Hanford production reactors, where uranium-bearing fuel rods were irradiated to create plutonium. The irradiated rods were then transferred to T Plant, where a bismuth phosphate chemical separation process was used to extract the plutonium product. The 221-T Building, also known as the T Plant or T Canyon Building, housed the first operational, full-scale, bismuth phosphate plutonium separations facility in the world. This building is one of five Hanford Site "Canyon" buildings, so called because of their large size and the canyon-like appearance of their upper galleries.

The bismuth phosphate process performed at T Plant involved dissolving the jacketed fuel rods in nitric acid and conducting multiple purification operations on the resultant aqueous nitrate solution. Chemical separation was achieved by varying the valence states of plutonium from +4 (the reduced state) to +6 (the oxidized, or hexavalent, state); no attempt to recover uranium was made in this process. Sodium nitrite solution was added to a batch of dissolver solution to ensure that the plutonium present had a valence of +4. After adding

bismuth nitrate and phosphoric acid to this solution, the resulting precipitate was separated by centrifugation, and the solution was sent to the 241-T Tank Farm for disposal. The precipitate was washed in the centrifuge and dissolved in strong nitric acid. The valence of the plutonium was then adjusted to +6 by adding a dichromate solution, and the precipitate of bismuth phosphate was again formed. At this stage of the process the precipitate held some of the fission products which were not extracted in the first liquid waste stream, but the plutonium remained in solution. These precipitation cycles were repeated twice.

The product resulting from this chemical separation process was a dilute plutonium solution. This solution was then transferred to the 224-T Bulk Reduction Building (also known as the "concentration building"), where it was purified using the lanthanum fluoride process and reduced in volume. At this final stage of the process, the original 1,250 L (330 gal) batch of plutonium solution that had entered the 224-T Building was concentrated down to 30 L (8 gal) of purified plutonium nitrate. This concentrated batch was then transferred to the 231-Z Building, located in the Z Plant Aggregate Area, for final treatment (Ballinger and Hall 1989). The plutonium product resulting from the sequential processes performed in buildings 221-T, 224-T, and 231-Z formed the material used to develop the world's first atomic weapon at the Los Alamos Laboratory located in New Mexico.

Currently, the 221-T Building serves as a decontamination facility for the Hanford Site and houses the 221-T Containment Systems Test Facility (CSTF). The CSTF is located in the north end of the 221-T Building and is used as a research laboratory to perform experiments with alkali metal compounds. The 224-T Building houses the Transuranic Waste Storage and Assay Facility (TRUSAF). The mission of the TRUSAF is to store transuranic (TRU) and/or TRU mixed waste that meets the Hanford Facility and the Waste Isolation Pilot Plant (WIPP) waste acceptance criteria for ultimate disposal at the WIPP or another approved disposal site. The TRUSAF also stores drums of retrieved TRU and/or TRU mixed waste for characterization and reprocessing in a future Hanford Facility unit (Waste Receiving and Processing Facility).

2.3 FACILITIES, BUILDINGS, AND STRUCTURES

The T Plant Aggregate Area contains a large variety of waste disposal and storage facilities that were associated with the aggregate area and, to a lesser extent, Z Plant Aggregate Area operations. Radiologically contaminated processing wastes were discharged to the soil column through cribs, trenches, and other facilities. Wastes which were not normally contaminated, but have the potential to contain radionuclides, such as cooling water

and condensate water, were allowed to infiltrate into the ground through ponds and open ditches. Radiologically contaminated waste types are defined in DOE Order 5820.2(A) (DOE 1988a):

- High-level waste is defined as: highly radioactive waste material that results from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid waste derived from the liquid, that contains a combination of transuranic (TRU) waste and fission products in concentrations as to require permanent isolation.

- TRU waste is defined as: without regard to source or form, radioactive waste that at the end of institutional control periods is contaminated with alpha-emitting transuranium radionuclides with half-lives greater than 20 years and concentrations greater than 100 nCi/g. Heads of Field Elements can determine that other alpha contaminated wastes peculiar to a specific site must be managed as a TRU waste.

- Low-level waste is defined as: radioactive waste not classified as high-level waste, TRU waste, spent nuclear fuel, or IIe(2) byproduct material as defined by this Order. Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as low-level waste, provided the concentration of TRU waste is less than 100 nCi/g.

- Byproduct Material is defined as: (a) Any radioactive material (except special nuclear material) yielded in, or made radioactive by, exposure to the radiation incident or to the process of producing or utilizing special nuclear material. For purposes of determining the applicability of RCRA to any radioactive waste, the term "any radioactive material" refers only to the actual radionuclides dispersed or suspended in the waste substance. The nonradioactive hazardous waste component of the waste substance will be subject to regulation under RCRA; (b) The tailings or waste produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content. Ore bodies depleted by uranium solution extraction operations and which remain underground do not constitute "byproduct material."

Based on construction, purpose, or origin, the T Plant Aggregate Area waste management units fall into one of ten subgroups as follows:

- Plants, Buildings, and Storage Areas (Section 2.3.1)

- Tanks and Vaults (Section 2.3.2)

- Cribs and Drains (Section 2.3.3)
- Reverse Wells (Section 2.3.4)
- Ponds, Ditches, and Trenches (Section 2.3.5)
- Septic Tanks and Associated Drain Fields (Section 2.3.6)
- Transfer Facilities, Diversion Boxes, and Pipelines (Section 2.3.7)
- Basins (Section 2.3.8)
- Burial Sites (Section 2.3.9)
- Unplanned Releases (Section 2.3.10).

Table 2-1 presents a list of the waste management units within the aggregate area. In addition, the aggregate area contains several unplanned release sites. The locations of these waste management units are shown on separate figures for each waste management group and Plate 1. Figure 2-1 summarizes the operational history of each of the waste management units (WHC 1991a; DOE/RL 1991a). Tables 2-2 and 2-3 summarize data available regarding the quantity and types of wastes disposed of to the waste management units. These data have been compiled from the Waste Information Data System (WIDS) inventory sheets (WHC 1991a) and from the Hanford Inactive Site Survey (HISS) database (DOE 1986a). These inventories include all of the contaminants reported in the databases, but do not necessarily include all of the contaminants disposed of at each waste management unit. In the following sections, each waste management unit is described within the context of one of the waste management unit types.

2.3.1 Plants, Buildings, and Storage Areas

Plants and buildings are not generally identified as past-practice waste management units according to the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) and will generally be addressed under the Decommissioning and RCRA Closure Program. The program is responsible for the surveillance, maintenance, and decommissioning of surplus facilities within the Environmental Restoration Program. Section 2.7 details the interaction of the Hanford programs. Because several of the T Plant Aggregate Area plants or buildings were the primary generators of waste disposed of within the T Plant Aggregate Area, a description of these is provided in Section 2.3.1.1 and 2.3.1.2. Some plants and buildings are or contain RCRA treatment, storage, or disposal (TSD) facilities. A description of such facilities is provided in Section 2.6. The locations of plants, buildings, and storage areas in the aggregate area are shown on Figure 2-2.

The 221-T Building (T Plant) and the 224-T Building were the primary generators of waste within the aggregate area. These plants, and the buildings associated with them, will be described in the following sections.

Other buildings and structures located within the aggregate area are not addressed in this document because they are not thought to have released contaminants and will be closed through a separate decontamination and decommissioning process. These structures include:

- 211-T Building (bulk chemical storage area)
- 221-TA Building (contains two ventilation supply fans for Building 221-T)
- 222-T Laboratory Building (originally built as a process analysis laboratory; currently houses staff from one Health Protection Technologists group and two operations groups)
- 242-T Building (houses the evaporator works for the T Plant tank farms)
- 271-T Building (adjacent to the 221-T Building, 271-T is the original office and support facility)
- 282-W Reservoir Building (powerhouse facility)
- 283-W Water Filtration Plant Building (powerhouse facility)
- 284-W Powerhouse (supplies steam to both the 200 West and East Areas)
- 291-T Building (houses the sand filters and stack for the 221-T Building)
- 2706-T Building (equipment decontamination)
- 2724-W Laundry (used for both radioactively and nonradioactively contaminated laundry; the 216-W-LWC Crib is the dedicated crib for associated wastewater; prior to 1981, wastewater was discharged to the 216-U-14 Ditch)
- 2715-T Building (paint shop).

2.3.1.1 221-T (Canyon) Building. The 221-T Building is the original bismuth phosphate process separation plant built in 1944. This facility was used to chemically extract plutonium contained in irradiated uranium fuel rods discharged from Hanford Site reactors. The first batch of irradiated fuel rods was dissolved in the 221-T Building on December 26, 1944. This building is one of five Hanford "Canyon" buildings and is the central feature and key operational facility of the T Plant Aggregate Area.

The first "hot" semi-works studies at Hanford were performed in the head-end (Cells A and B) of the 221-T Building from September to December 1944. In this semi-works plant, full scale experiments were performed with irradiated fuel to determine product yields of the bismuth phosphate process. This semi-works plant was placed on standby status in January 1945. This facility was re-activated in February 1945 for experimental work with ammonium silico-fluoride. However, because the latter process step increased product losses, the T Plant semi-works was terminated on March 15, 1945.

The 221-T Building was deactivated in 1956 concurrent with the phase-out of the bismuth phosphate process plants. The T (and B) Plant plutonium separation methodology was replaced by the reduction/oxidation (REDOX) process and, ultimately, plutonium/uranium extraction (PUREX) process methods. The 221-T Building was converted to a decontamination and equipment refurbishment facility in 1957. After removing most of the original process equipment, the 221-T head-end was partially decontaminated and stabilized. Between 1964 and 1990, the 221-T Building head-end housed a series of testing programs, discussed in the following paragraphs.

In 1964 tests using iodine and radioactive cesium were performed in a new containment vessel fabricated in the 221-T head-end dissolver cells and canyon. This modified facility was also referred to as the CSTF and the T Plant laboratory. Tests using radioactive cobalt were also conducted during this time. The CSTF testing program, managed by Pacific Northwest Laboratory (PNL), was completed in 1969.

Between 1976 and 1985, liquid-metal reactor safety tests using nonradioactive sodium, lithium, and sodium iodide were conducted by Westinghouse Hanford in the 221-T CSTF. Between 1985 and 1990, light-water reactor tests were conducted in the 221-T CSTF using nonradioactive cesium, manganese, zinc, lithium sulfate, iodine, and hydrogen iodide.

The 221-T Building is constructed entirely of reinforced concrete; dimensions are 266 x 26 x 31 m (875 x 85 x 102 ft). Process equipment is contained in small rooms, called cells, which are arranged in rows in an area spanned by a traveling crane. The cells are topped with 1.2 m (4 ft) thick concrete blocks which are removable by crane to provide access to the cell beneath. Above the blocks is a space equal in height to the cell depth, which provides headroom for manipulating the process equipment during maintenance operations. Heavy concrete shielding walls enclose this space up to the level of the crane rails giving the appearance of a canyon.

The 221-T Building currently provides services in radioactive decontamination, reclamation, and decommissioning of process equipment.

2.3.1.2 224-T Building. The 224-T Building was originally used to purify plutonium nitrate using the lanthanum fluoride process. Like the 221-T Building, this building was also deactivated in 1956 following phase-out of the bismuth-phosphate plants. The 224-T Building remained inactive until the early 1970s, when it was modified to store plutonium scrap in liquid and solid forms.

This scrap was removed in 1985, when the building was officially designated the TRUSAF. The TRUSAF operation consists of nondestructive assay and nondestructive examination of newly generated, contact-handled, transuranic (CH-TRU) solid waste. These analyses are used to overview sealed, certified CH-TRU solid waste packages, in order to verify general compliance with the WIPP waste acceptance criteria requirements.

2.3.2 Tanks and Vaults

Tanks and vaults were constructed on the Hanford Site to handle and store liquid wastes generated by uranium and plutonium processing activities. Several types of tanks are present in the T Plant Aggregate Area including seven catch tanks, one settling tank, one receiver tank, one vault, and forty single-shell tanks. Catch tanks are generally associated with diversion boxes and other transfer units and were designed to accept overflows and spills. The settling tank was used for settling suspended solids in fluid wastes prior to transfer to cribs. The receiver tank (frequently called a double-contained receiver tank, or vault) and vault received waste from single-shell tanks. Single-shell tanks were used to collect and store large quantities of mixed wastes. The catch tanks, settling tank, receiver tank, and vault will be discussed individually in this section. Septic tanks are not expected to be contaminated and are discussed in Section 2.3.6. The single-shell tanks will be addressed as a group below.

All single-shell tanks will be evaluated under the Single-Shell Tank Closure Program as discussed in Section 9.0 and, therefore, do not need to be discussed in detail in this aggregate area management study report (AAMSR). General information related to the tanks will be described in this report but investigation and remediation strategies will be deferred to the Single-Shell Tank Closure Program. Tables 2-1 and 2-4 list single-shell tank information that is of importance to this report, including source description, tank integrity, waste volume remaining, and drainable waste volume. Timeline data is presented in Figure 2-1 and a reference locator for additional single-shell tank information is provided in Table 2-5.

Sixteen of the forty single-shell tank waste management units in the T Plant Aggregate Area are contained within the 241-T Tank Farm, eighteen are contained within the 241-TX Tank Farm, and six are contained within the 241-TY Tank Farm. The 241-T Tank Farm is located northwest of the Camden Avenue and 23rd Street intersection. The 241-TY Tank Farm is located about 185 m (600 ft) south of 241-T Tank Farm and 92 m

(300 ft) west of Camden Avenue. The 241-TX Tank Farm is located about 92 m (300 ft) south of 241-TY Tank Farm. The location of the tanks is shown on Figures 2-2 and 2-3.

The 241-T Tank Farm tanks were constructed from 1943 to 1944 using two different designs. In both designs, the tanks are vertical cylinders with a domed top, and constructed of reinforced concrete with a carbon steel liner on the base and sides of the vessel. The tanks are all underground with at least 1.8 m (6 ft) of earth cover above the tank dome. Twelve tanks each with the same design, numbered 241-T-101 through 241-T-112, have a 23 m (75 ft) diameter and a capacity of 2.02×10^6 L (5.33×10^5 gal). Four smaller tanks each with the same design, numbered 241-T-201 through 241-T-204, have a 6.1 m (20 ft) diameter and a capacity of 208,000 L (55,000 gal). The current waste volumes and drainable waste volumes for each tank are listed in Table 2-4. Figure 2-4 depicts a typical 2.02×10^6 L (5.33×10^5 gal) single-shell tank.

The 241-TX and 241-TY Tank Farm tanks were constructed from 1947 to 1948 and 1951 to 1952, respectively. The tanks are all designed identically and are vertical cylinders with domed tops, and constructed of reinforced concrete with a carbon steel liner on the base and sides of the vessel. The tanks are all underground with at least 1.8 m (6 ft) of earth cover above the tank dome.

The eighteen tanks in the 241-TX Tank Farm are numbered 241-TX-101 through 241-TX-118 and the six tanks in the 241-TY Tank Farm are numbered 241-TY-101 through 241-TY-106. The tanks have a 23 m (75 ft) diameter and a capacity of 2.87×10^6 L (7.58×10^5 gal). The current waste volumes and drainable waste volumes for each tank are listed in Table 2-4.

Single-shell tank stabilization and isolation are two objectives of single-shell tank engineering. Interim stabilization criteria for single-shell tank waste storage and auxiliary tanks is set forth in *Tank Farms Facility Interim Stabilization Evaluation* (Hamrick 1988). Generally, a 100 series tank (tanks greater than 2,000,000 L) is considered interim stabilized if the tank contains less than 19,000 L (5,000 gal) of supernatant and less than 189,000 L (50,000 gal) of drainable liquid (Hanlon 1992). A 200 series tank (specifically a 208,000 L tank) is considered interim stabilized if it contains less than 1,500 L (400 gal) supernatant. Interim isolation is an administrative designation reflecting the completion of the physical effort required to minimize the unplanned addition of liquids into a tank. Partially interim isolated is an administrative designation reflecting the completion of the physical effort required for interim isolation except for isolation of risers and piping that are required for stabilization (pumping) efforts. Interim isolation and interim stabilization have been performed on the single-shell tanks to varying degrees as listed in Table 2-4.

All single-shell tanks are classified as either "sound" or as an "assumed leaker," as listed in Table 2-4. A "sound" tank is an integrity classification of a waste storage tank for which surveillance data indicate no loss of liquid attributed to a breach of integrity. An "assumed leaker" is an integrity classification of a waste storage tank for which surveillance data indicate a loss of liquid attributed to a breach of integrity (Hanlon 1992).

All single-shell tanks have been inactive (have not received waste) since at least 1980. However, several activities continue on, in, and/or around single-shell tanks on a case-by-case basis and, therefore, the status of any individual single-shell tank may change. These activities include pumping of liquid waste (stabilization), sealing tank pits, penetrations and piping (isolation), surface level monitoring, liquid level monitoring, temperature monitoring, waste sampling, core sampling, in-tank photography, filter changing, surveying, and day-to-day Operations' activities. The current status of the single-shell tanks are documented in several "living" documents with two of the most informative being, *Tank Farm Surveillance and Waste Status Summary Report* (Hanlon 1992), and *Waste Storage Tank Status and Leak Detection Criteria* (Welty 1989). The *Tank Farm Surveillance and Waste Status Summary Report* is updated monthly and the *Waste Storage Tank Status and Leak Detection Criteria* is revised as needed. General single-shell tank information found in these two documents, and others, is listed in Table 2-5.

2.3.2.1 241-T-361 Settling Tank. This inactive tank is located about 213.5 m (700 ft) southwest of the 221-T Building in the 200-TP-4 Operable Unit. The tank is a cylindrical 6.1 m (20 ft) diameter by 5.8 m (19 ft) deep and is constructed with a 15 cm (6 in.) reinforced, pre-stressed concrete shell. The top of the tank is located 2 m (6 ft) below grade. The settling tank is enclosed within a light chain boundary and is posted with surface and underground contamination warning signs, as observed during a site visit in September 1991.

The date that the 241-T-361 Settling Tank began operation could not be found. The tank stopped operating in 1976. The 241-T-361 Settling Tank received radioactive contaminated liquid from the 221-T Building processes and is connected to the 216-T-6 Crib. As of February 1992, the tank was reported to contain 105,980 L (28,000 gal) of sludge containing approximately 2 kg (4.4 lb) of plutonium (15,500 Ci beta/gamma). This unit was isolated in 1985 (Cramer 1987). No unplanned releases are reported for this unit.

2.3.2.2 244-TX Receiver Tank. This active double-contained receiver tank receives waste from the 241-T Tank Farm, 241-TX Tank Farm, 241-TY Tank Farm, and Plutonium Finishing Plant. It is located 50 m (164 ft) north of 22nd Street and 75 m (246 ft) west of Camden Avenue in the 241-TX Tank Farm. This tank is permitted as an active RCRA TSD unit. In September 1991, this tank contained 98,480 L (26,019 gal) of waste (Hanlon 1992). No information was found to indicate that this tank has released any waste to soil.

2.3.2.3 244-TXR Vault. This inactive vault is not listed in the Tri-Party Agreement or the WIDS inventory sheets (WHC 1991a). It is located approximately 50 m (150 ft) north of 20th Street and 100 m (300 ft) west of Camden Avenue.

The vault houses three steel storage tanks (TK-TXR-1, TK-TXR-2, and TK-TXR-3) used in the transfer and interim storage of wastes pumped from the 241-TX Tank Farm. The TXR-1 Tank has a 189,000 L (50,000 gal) capacity and the TXR-2 and TXR-3 each have a 57,000 L (15,000) capacity. The vault is constructed of reinforced concrete and is a 22.5 x 7.3 x 15.5 m (74 x 24 x 51 ft) deep underground concrete structure. The vault is buried to a depth that places the upper surface of its lid about 30 cm (12 in.) above grade. The vault is connected to the 241-TXR-151, 241-TR-152, and 241-TR-153 Diversion Boxes and several unspecified tank farms (Hanlon 1992).

No information concerning leaks or spills was found for the 244-TXR Vault. It is reported to contain 113,000 L (29,800 gal) of liquid (Hanlon 1992).

2.3.2.4 241-T-301 Catch Tank. This inactive tank is located east of the 241-T-252 Diversion Box, south of the 241-T-112 Single-Shell Tank. This catch tank is constructed of reinforced concrete and is 6 m (20 ft) in diameter and 4 m (13.5 ft) high. The tank has a concrete domed lid that lies approximately 3 m (10 ft) below grade. This is the only catch tank in the T Plant Aggregate Area that uses this vertical construction design. The catch tank is surrounded by a chainlink fence and is marked by a metal post with a plaque, as observed during a site visit in September 1991.

It collected overflow from the 241-T-252 and the 241-T-152 Diversion Boxes. These diversion boxes operated from 1944 to 1983.

No unplanned releases are reported for this unit.

2.3.2.5 241-T-302 Catch Tank. A review of a 200 West Area facility drawing failed to provide construction details for this catch tank. Additional research will be required to verify the existence of this catch tank. Information in WHC (1991a) indicate this catch tank is located adjacent to the 241-T-152 Diversion Box. This catch tank is posted with a plaque and is surrounded by a chain link fence as observed during a site visit in September 1991 (WHC 1991a).

It is reported to collect overflow from the 241-T-152 Diversion Box. This diversion box operated from 1944 to 1983.

No unplanned releases are reported for this tank.

2.3.2.6 241-TX-302A Catch Tank . This tank is located approximately 15.3 m (50 ft) south of the 241-TX-153 Diversion Box, inside the barricade for the 241-TX Tank Farm. The unit is currently not marked or posted, as observed during a site visit in September 1991. This catch tank is of steel construction, is 11 m (36 ft) long by 2.7 m (9 ft) in diameter, and is buried approximately 6 m (20 ft) below grade. During its period of operation (1949-1982), the tank was used to accept any overflow of solutions from processing and decontamination operations (WHC 1991a). The waste management unit is connected to the 241-TX-153 Diversion Box and 241-TX-302X Catch Tank.

No unplanned releases are reported for this tank.

2.3.2.7 241-TX-302B Catch Tank . This inactive tank is located about 200 m (600 ft) east of Camden Avenue and 200 m (600 ft) south of 22nd Street. This catch tank is of steel construction, is 11 m (36 ft) long by 2.7 m (9 ft) in diameter, and is buried approximately 6 m (20 ft) below grade. The tank is enclosed within the light chain boundary surrounding the 241-TX-155 Diversion Box and is marked by surface contamination warning signs and three yellow pipes, as observed during a site visit in September 1991. Two pipes are stubbed 0.31 m (1 ft) above the ground; one pipe is equipped with a fluid level recorder.

The tank operated from 1949 to 1982 and accepted overflow from the 241-TX-155 Diversion Box. Unplanned Release UPR-200-W-131 is associated with his waste management unit (see Table 2-6).

2.3.2.8 241-TX-302C Catch Tank. The 241-TX-302C Catch Tank is an active waste management unit located just east of the 221-T Building. This catch tank is of steel construction, is 11 m (36 ft) long by 2.7 m (9 ft) in diameter, and is approximately 6 m (20 ft) below grade. This tank has operated since 1949.

This unit used to accept overflow of radioactive waste solutions resulting from processing and decontamination operations (Cramer 1987). The overflow came from the 241-TX-154 Diversion Box. The tank currently holds 9,652 L (2,550 gal) of liquid waste and is associated with the 241-TX-154 Diversion Box and the 241-TX Tank Farm (WHC 1991a).

Three unplanned releases, UPR-200-W-21, UPR-200-W-40, and UPR-200-W-160, are associated with this unit. These releases are addressed in Table 2-6.

2.3.2.9 241-TY-302A Catch Tank. The 241-TY-302A Catch Tank is located approximately 19.2 m (63 ft) north of the 241-TY-153 Diversion Box, inside the chainlink fence barrier of the 241-TY Tank Farm. This catch tank is of steel construction, is 11 m (36 ft) long by 2.7 m (9 ft) in diameter, and is buried approximately 6 m (20 ft) below grade. The catch tank is posted with surface contamination warning signs, as observed during a site visit in September 1991.

During its period of operation (1953-1981), this unit accepted overflow of waste solutions from processing and decontamination operations. The tank is associated with the 241-TY-153 Diversion Box and the 241-TY Tank Farm, and has been isolated and stabilized with a spray covering to prevent infiltration of precipitation.

2.3.2.10 241-TY-302B Catch Tank. The 241-TY-302B Catch Tank is located approximately 51.9 m (170 ft) east of the 241-TY-101 Single-Shell Tank. This catch tank is of steel construction, is 11 m (36 ft) long by 2.7 m (9 ft) in diameter, and is buried approximately 6 m (20 ft) below grade. The tank currently has no barrier and is not marked or posted, as observed during a site visit in September 1991.

This tank operated from 1953 to 1981. This tank accepted overflow of waste solutions from processing and decontamination operations, and the 241-TY Tank Farm encasements. The unit has been isolated and stabilized with a spray covering to prevent infiltration of precipitation.

No unplanned releases are associated with this tank.

2.3.3 Cribs and Drains

The cribs and drains were all designed to inject or percolate wastewater into the ground without exposing it to the open air. The locations of cribs and drains in the aggregate area are shown in Figure 2-5. French drains are generally constructed of steel or concrete pipe and may either be open or filled with gravel. A typical french drain is illustrated in Figure 2-6. Cribs are shallow excavations that are either backfilled with permeable material or held open by wood structures. Both types of cribs are covered with an impermeable layer. Water flows directly into the backfilled material or covered open space and percolates into the vadose zone soils. A typical crib is illustrated in Figure 2-7. Occasionally, surface contamination at a crib or other waste management unit necessitates surface stabilization activities. These activities generally consist of removal of the contaminated surface soil to a burial ground followed by covering the excavated site with clean fill, gravel, or asphalt. The T Plant Aggregate Area contains 15 cribs and one french drain.

The cribs and drains typically received low-level waste for disposal. Most cribs, drains, and trenches were designed to receive liquid until the unit's specific retention or radionuclide capacity was met. The term "specific retention" is defined as that volume of waste liquid that may be disposed to the soil and be held against the force of gravity by the molecular attraction between sand grains and the surface tension of the water, when expressed as a percent of the packed soil volume (Bierschenk 1959). Experimental work performed by Bierschenk (1959) indicates that due to the time varying nature of the specific retention capacity of the soil a potential exists for long-term gravity drainage to groundwater. Radionuclide capacity refers to a specific number of curies of radioactivity the waste

management units were allowed to receive until they were shut down (Fecht et al. 1977). The following sections describe each crib and drain in the T Plant Aggregate Area.

2.3.3.1 216-T-6 Crib. This crib is actually a pair of cribs (216-T-6-1 and 216-T-6-2) located about 46 m (150 ft) north of 23rd Street and 380 m (1,250 ft) west of the 224-T Building, just west of the 216-T-3 Reverse Well. The cribs are marked by two 4.3 x 4.3 m (14 x 14 ft) light chain barricades enclosed within a 61 x 24 m (200 x 80 ft) barricade. The barricades are labelled with cave-in potential, and underground and surface radiation warning signs, as observed during a site visit in September 1991. Each wooden crib is 4.3 x 4.3 m (14 x 14 ft), and 19 m (62 ft) apart, with the liquid release point 4.9 m (16 ft) below grade. The 216-T-6-1 Crib was designed such that any overflow would discharge into the 216-T-6-2 Crib.

The two cribs were built in August 1946 and were active until June 1951 (WHC 1991a). Maxfield (1979) cites an operational period of August 1946 through October 1947. During this period, the cribs received 4.5 x 10^7 L (1.19 x 10^7 gal) of waste (WHC 1991a). This crib pair received primarily cell drainage from the 221-T Building (Tank 5-6). This unit also received waste from the 224-T Building via the overflow from the 241-T-361 Settling Tank. After the 241-T-361 Settling Tank was deactivated, the 224-T Building effluent was rerouted to the 216-T-32 Crib in October 1946. The cribs were deactivated by blanking the pipe south of the 241-T-361 Settling Tank and re-routing 221-T Cell drainage to the 216-T-7TF Crib (WHC 1991a).

No unplanned releases are associated with this crib.

2.3.3.2 216-T-7-TF Crib and Tile Field. This crib and tile field are located 15.2 m (50 ft) north of 23rd Street and 305 m (1,000 ft) west of the 207-T Retention Basin. The crib is located within the 241-T Tank Farm chain link fence barricade. The tile field is located outside the tank farm fence and is surrounded by a light chain fence extending west from the tank farm (WHC 1991a). The fence is labeled with both underground and surface contamination signs, as observed during a site visit in September 1991. The crib is a wooden structure with bottom dimensions of 3.6 x 3.6 m (12 x 12 ft). The associated tile field has bottom dimensions of 94 x 26 m (310 x 84 ft). The crib is backfilled with 3,662 m^3 (4.790 yd^3) of gravel. The side slope is 1.5:1. The liquid release point was 6 m (20 ft) below grade.

The 216-T-7TF Crib operated between April 1948 and November 1955. During this period the unit received second-cycle supernatant and cell drainage from the 221-T Building. From June 1952 to November 1955, this crib also received waste from the 224-T Building after sludge buildup in 241-T-201 through 241-T-204 Single-Shell Tanks resulted in the closing of the 216-T-32 Crib. The unit was deactivated by capping the pipeline to the crib and re-routing the effluent to the 216-T-19TF Crib (WHC 1991a). During its period of

operation, the 216-T-7TF Crib and Tile Field received 1.10 x 10^8 L (2.91 x 10^7 gal) of waste containing 5.18 x 10^6 kg (1.14 x 10^7 lb) of inorganic compounds. The unit was deactivated in 1955 when it reached its designed radionuclide capacity (Maxfield 1979).

No unplanned releases are associated with this crib.

2.3.3.3 216-T-8 Crib. The 216-T-8 Crib is an inactive waste management unit located 15 m (50 ft) south of the 222-T Building. The crib is surrounded by a light chain barricade and posted with cave-in potential and underground and surface radiation warning signs, as observed during a site visit in September 1991. The crib consists of two structures, each with a 7.5 cm (3 in.) steel pipe placed vertically into a 3.6 x 3.6 x 2.1 m (12 x 12 x 7 ft) wooden frame, 5.2 m (17 ft) below grade. The bottom dimensions are 4.3 x 4.3 m (14 x 14 ft). The excavation is 6.1 m (20 ft) deep with a 1:1 slope. The crib has been backfilled.

The 216-T-8 Crib operated between May 1950 and September 1951. During that time it received 5 x 10^5 L (1.32 x 10^5 gal) of decontamination sink and sample slurper wastes from the 222-T Building laboratory processes (Stenner et al. 1988). When laboratory operations were terminated the pipeline from the crib to the building was blanked (WHC 1991a).

No unplanned releases are associated with this crib.

2.3.3.4 216-T-18 Crib. This crib is located 152.4 m (500 ft) south of 23rd Street, 76.2 m (250 ft) east of Camden Avenue, and north of the 216-T-26, -27, and -28 Crib series (WHC 1991a). The crib is enclosed within a light chain barricade with underground contamination placards, as observed during a site visit in September 1991.

The unit consists of a 35.6 cm (14 in.) steel inlet pile reducing to a 25.4 cm (10 in.) steel pipe, 2.4 m (8 ft) below grade. This pipe branches into four 20.3 cm (8 in.) steel pipes, each one extending to a 1.2 m (4 ft) long by 1.2 m (4 ft) diameter concrete open-end sewer pipe. These structures lie in an excavation with a side slope of 1:15. A gravel fill of about 2.4 m (8 ft) in the excavation is covered by 2.1 m (7 ft) of earth backfill. The 216-T-18 Crib operated from December 8 through December 21, 1953; during that time it received 1 x 10^6 L (2.64 x 10^5 gal) of the 221-T Building first-cycle scavenged tributyl phosphate supernatant wastes. This waste stream included 194,000 kg (428,000 lb) of inorganic compounds. The above-ground piping was removed and the unit backfilled at completion of waste discharge. The crib area was stabilized in May 1990 with a layer of clean soil.

No unplanned releases are associated with this crib.

2.3.3.5 216-T-19TF Crib and Tile Field. One of the larger cribs at T Plant, this unit is located south of the 241-TX Tank Farm, 12.2 m (40 ft) west of Camden Avenue (WHC 1991a). The crib and tile field are enclosed within a light chain barricade; the crib is enclosed within a second, inner light chain barricade. The waste management unit is posted with a sign indicating underground radioactive material. The inner cave-in potential area is posted with surface contamination warning signs, as observed during a site visit in September 1991. The unit is a wooden structure, 3.7 x 3.7 m (12 x 12 ft) and a tile field 119 x 26 m (390 x 85 ft), containing 120 m (394 ft) of 20.3 cm (8 in.) trunk line with ten 15.2 cm (6 in.) pipe laterals branching at 45 degrees, perforated on the bottom and placed 7 m (23 ft) below grade.

The 216-T-19TF Crib and Tile Field was used for disposal of liquid wastes from 1951 to 1980, the longest operational period of any T Plant crib. During this period, there were brief (4 to 5 month) periods of inactivity due to temporary shutdowns of the 242-T Evaporator and/or T Plant operations. In total, this crib received 4.55 x 10^8 L (1.2 x 10^8 gal) of liquid waste. A cave-in occurred in 1956, resulting in abandonment of the crib until 1965 (WHC 1991a). After the cave-in, a bypass waste line directed to the tile field was installed. Piping to this crib was routed through the 241-TX-153 Diversion Box and the 241-TX-302A and 241-TX-302B Catch Tanks (WHC 1991a). The line to the tile field was blanked in 1980.

No unplanned releases are associated with this crib.

2.3.3.6 216-T-26 Crib. The 216-T-26 Crib is the northernmost crib of the 216-T-26, -27, and -28 Crib series. It is located 61 m (200 ft) north of 22nd Street, east of the 241-TY Tank Farm (WHC 1991a). The 216-T-26 through -28 Cribs are currently fenced within a light chain barricade with underground contamination warning placards, as observed during a site visit in September 1991. A flush tank is located in the northeast corner of the compound. Two small concrete pads, possibly truck unloading facilities, are located east of the barricaded area. The 216-T-26 Crib consists of a 36 cm (14 in.) steel inlet pipe reducing to a 25.4 cm (10 in.) steel pipe, 2.7 m (9 ft) below grade. This second pipe branches to four 20.3 cm (8 in.) steel pipes, each one extending to a vertical 1.2 m (4 ft) long, 1.2 m (4 ft) diameter, open-end concrete sewer pipe. This piping lies in a 9.1 x 9.1 m (30 x 30 ft) rectangular concrete structure. A gravel fill of approximately 2.4 m (8 ft) is covered by 2.4 m (8 ft) of earth backfill.

The 216-T-26 Crib operated between August 1955 and November 1956. During that period, it received first-cycle scavenged tributyl phosphate supernatant T Plant wastes (WHC 1992b; Stenner et al. 1988). Ferrocyanide was used to settle the ^{137}Cs before the supernatent was discharged to the crib. The waste was first routed through the 241-TY-101, -103, and -104 Single-Shell Tanks (WHC 1992a; WHC 1991a). The 216-T-26 Crib received 1.2 x 10^7 L (3.17 x 10^6 gal) of liquid mixed waste, including 2.37 x 10^6 kg (5.22 x 10^6 lb) of

ferrocyanide and other inorganic compounds. This unit was deactivated in 1956 by blanking the line leading to the 216-T-26 and 216-T-28 Cribs, between the 241-TY Tank Farm and the roadway.

2.3.3.7 216-T-27 Crib. This crib is located midway between the 216-T-26 and 216-T-28 Cribs (within the same radiation zone), 76.2 m (250 ft) north of 22nd Street and 61 m (200 ft) east of Camden Avenue (Maxfield 1979). Like the 216-T-26 Crib, the 216-T-27 Crib was constructed of steel pipes leading to vertical, open-ended sewer pipes, but the piping is 2.4 m (8 ft) below grade and has an earthen backfill of 2.1 m (7 ft) (WHC 1991a). The crib is enclosed within a light chain boundary and is posted with underground contamination warning signs, as observed during a site visit in September 1991.

The 216-T-27 Crib operated for just over one month, from September through November 1965. During this period, it received 300 Area laboratory wastes from the PNL 340 Building, via tank truck, and wastes from the 221-T Building via the 241-T-111 and -112 Single-Shell Tanks (WHC 1991a). The 216-T-27 Crib received 7.19 x 10^6 L (1.9 x 10^6 gal) of liquid containing 1,000 kg (2,203 lb) of nitrate. The unit was removed from operation when the radionuclide capacity was reached.

Diversion of wastes to this crib was initiated following breakthrough of strontium and cesium to the groundwater under the 216-T-28 Crib. The PNL wastes routed to this crib consisted of material generated during a period when a sudden increase (four orders of magnitude) in radionuclide activity in the PNL wastes occurred. Each time waste was pumped to the 216-T-27 Crib, groundwater samples taken near the 216-T-28 Crib increased in radioactivity.

Given documented surface contamination at this waste management unit (strontium and cesium), stabilization and remediation was performed in 1975 concomitant with the 216-T-26 Crib stabilization activities.

2.3.3.8 216-T-28 Crib. This crib, the southernmost of the 216-T-26, -27, and -28 Crib series, is located 91.4 m (300 ft) north of 22nd Street and 61 m (200 ft) east of Camden Avenue. The unit consists of a 36 cm (14 in.) steel inlet pipe reducing to a 25.4 cm (10 in.) steel pipe, 2.4 m (8 ft) below grade. The pipe branches to four 20.3 cm (8 in.) steel pipes, each one extending to a 1.2 m (4 ft) long by 1.2 m (4 ft) diameter, open-end concrete sewer pipe. This structure rests in an excavation that is 4.6 m (15 ft) deep by 9.2 x 9.2 m (30 x 30 ft). The excavation is filled with 2.4 m (8 ft) of gravel and 2.1 m (7 ft) of earth. The crib is enclosed within a light chain barricade and is marked with underground contamination warning signs, as observed during a site visit in September 1991.

The 216-T-28 Crib was active for six years, from February 1960 until February 1966 (WHC 1991a). Maxfield (1979) cites February 1966. During that time, it received 4.23 x 10^7 L (1.12 x 10^7 gal) of liquid mixed waste including 1,000 kg (2,203 lb) of nitrate.

Waste constituents included steam condensate decontamination waste, miscellaneous effluent from the 221-T Building, decontamination waste from the 2706-T Building, and 300 Area laboratory waste from the 340 Building. The crib was deactivated when the prescribed radionuclide capacity was reached. Deactivation consisted of blanking the pipeline to the 216-T-26 through 216-T-28 Crib series and the riser for 300 Area laboratory wastes.

Because of the radionuclide contamination of nearby surface vegetation, stabilization and surface remediation were performed in 1975 along with stabilization activities at 216-T-26 and 216-T-27 Cribs (WHC 1991a).

2.3.3.9 216-T-29 Crib. The 216-T-29 Crib is an inactive waste management unit located approximately 58 m (190 ft) east of the 221-T Building and 29 m (95 ft) west of Beloit Avenue (Maxfield 1979). This crib is constructed of 60 vitrified clay pipes, 15.2 cm (6 in.) in diameter, in a 30.5 x 14.6 m (100 x 48 ft) area. This unit operated between 1949 and 1964 and during that time received a total of 7.4 x 10^4 L (1.96 x 10^4 gal) of condensate runoff from the 291-T Sand Filter. This waste is considered potentially acidic given the presence of nitric acid (Stenner et al. 1988; Cramer 1987). The crib was deactivated when the sand filter bypass water seal was removed, allowing the 221-T Building exhaust air to flow directly to the 291-T-1 Stack (WHC 1991a).

No unplanned releases are associated with this crib.

2.3.3.10 216-T-31 French Drain. This drain is a registered underground injection well located inside the 241-TX Tank Farm fence, 24.4 m (80 ft) west of Camden Avenue and 908.3 m (2,980 ft) southwest of the 221-T Building (WHC 1991a). The french drain is surrounded by a chainlink fence and is posted with surface contamination warning signs, as observed during a site visit in September 1991.

The unit was in operation from October 1954 to February 1962. This unit was contaminated by steam condensate from a steam line blowout during efforts to unplug a waste line in October 1959. The drain was replaced in 1959; contaminated gravel and soil were removed and buried in the 200 West Area Dry Burial Ground. The waste management unit was released from radiation zone status in February 1962.

2.3.3.11 216-T-32 Crib. The 216-T-32 Crib is located 6.2 m (250 ft) north of 23rd Street and 228.6 m (750 ft) west of the 207-T Retention Basin within the confines of the 241-T Tank Farm (WHC 1991a). It consists of two wooden sumps, 3.7 x 3.7 x 1.2 m (12 x 12 x 4 ft) deep, placed 12.2 m (40 ft) apart (Maxfield 1979). The crib dimensions are 20.7 x 4.3 x 7.9 m (68 x 14 x 26 ft) deep with a side slope of 1.5:1. The cribs were fed by a single line leading from the 241-T-201 Single-Shell Tank. The crib is surrounded by a light chain barricade, as observed during a site visit in September 1991.

This crib operated between November 1946 and May 1952. During that time, it received waste from the 224-T Building via the 241-T-201 Single-Shell Tank. The 216-T-32 Crib received 2.9 x 10^7 L (7.66 x 10^6 gal) of TRU-contaminated liquid waste containing 2.62 x 10^6 kg (5.77 x 10^6 lb) of inorganic compounds (WHC 1991a). The crib was deactivated in May 1952 by blanking the line from the 241-T-201 Single-Shell Tank.

No unplanned releases are associated with this crib.

2.3.3.12 216-T-33 Crib. The 216-T-33 Crib is an inactive waste management unit located approximately 76 m (250 ft) west of the 2706-T Building and 274 m (900 ft) north of 23rd Street. The crib is surrounded by a light chain barricade and posted with underground contamination warning signs, as observed during a site visit in September 1991. This unit operated for approximately one month, between January and February 1963. During its brief period of operation, the 216-T-33 Crib apparently received 1.9 x 10^6 L (5.02 x 10^5 gal) of decontamination waste from the 2706-T Building. This waste stream consisted primarily of sodium hydroxide (Cramer 1987). However, the amount of liquid that actually reached the crib has been questioned by plant personnel who suspected that the line to the unit retained all of the waste.

The bottom of the crib is 9.1 m (30 ft) long, 1.5 m (5 ft) wide, and is 3.4 m (11 ft) deep. The slope of the excavation is 1.5:1. The bottom 1.2 m (4 ft) of the excavation is filled with washed gravel. A 20.3 cm (8 in.) perforated pipe 2.1 m (7 ft) below grade runs the length of the unit. Its use was terminated when perforations in the tile line at the discharge point to the unit became plugged. Sections of the tile line were removed and the building effluent was rerouted to the 216-T-28 Crib via the 241-T-112 Single-Shell Tank in the 241-T Tank Farm (WHC 1991a).

No surface contamination has been found at this crib (Maxfield 1979).

No unplanned releases are associated with this crib.

2.3.3.13 216-T-34 Crib. The 216-T-34 Crib is an inactive waste management unit located about 457 m (1,500 ft) north of 23rd Street and 457 m (1,500 ft) west of Beloit Avenue (Stenner et al. 1988). The crib is located in an excavation 61 m (200 ft) long, 9.1 m (30 ft) wide, and 4.9 m (16 ft) deep. The unit has a side slope of 1.5:1. The dispersal system consists of 128 m (420 ft) of perforated 20.3 cm (8 in.) line in a 4.6 x 59 m (15 x 195 ft) rectangular structure with a 15.2 cm (6 in.) perforated line extending 15.2 m (50 ft) into the unit, all 3.7 m (12.2 ft) below grade. A 1.5 m (5 ft) layer of washed gravel is in the excavation, and the site has been backfilled. The crib is surrounded by a light chain barricade and posted with underground contamination warning signs, as observed during a site visiting in September 1991.

The crib operated between May 1966 and March 1967 and during that time received 1.73×10^7 L (4.57×10^6 gal) of 300 Area laboratory waste from the 340 Building. The pipelines northwest of the unit were capped when the unit reached its prescribed radionuclide disposal capacity and the discharge lines rerouted to the 216-T-35 Crib (WHC 1991a).

No unplanned releases are associated with this crib.

2.3.3.14 216-T-35 Crib. The 216-T-35 Crib is an inactive waste management unit located 463 m (1,520 ft) northwest of the 221-T Building and 417 m (1,368 ft) north of 23rd Street. The dimensions of this unit are 137 x 3 x 4.6 m (450 x 10 x 15 ft) deep. The slope of the excavation is 2:1. A perforated 15.2 cm (6 in.) distribution line 30.4 m (100 ft) long and a parallel line 137 m (450 ft) long are placed 2.9 m (9.5 ft) below grade. These lines are covered by 1.5 m (5 ft) of gravel and 1.4 m (4.5 ft) of backfill. The crib is surrounded by a light chain barricade and posted with underground contamination warning signs, as observed during a site visit in September 1991.

This unit, which operated between March 1967 and January 1968, received 5.72×10^6 L (1.51×10^6 gal) of 300 Area laboratory waste from the 340 Building (Stenner et al. 1988). Low-level subsurface contamination of a small area near the unloading station has been reported but surface contamination has not been documented (Fecht et al. 1977). The surface of the 216-T-35 Crib was stabilized in July 1990 (Huckfeldt 1990).

No unplanned releases are associated with this crib.

2.3.3.15 216-T-36 Crib. This crib is located 12.2 m (40 ft) south of 23rd Street and northwest of the 241-TY Tank Farm. The dimensions of this crib are 48.4 m (160 ft) long, 3 m (10 ft) wide, and 4.6 m (15 ft) deep. The slope of the excavation is 1:1. The dispersal system consists of one 10.2 cm (4 in.) perforated pipe, 48.8 m (160 ft) long, lying horizontally 3.4 m (11 ft) below grade. The crib is marked by a light chain barricade with surface and underground contamination placards, as observed during a site visit in September 1991. Two vent pipes are located at the west end of the crib.

The 216-T-36 Crib operated between May 1967 and February 1968 and during that time received 5.22×10^5 L (1.38×10^5 gal) of steam condensate, decontamination, and miscellaneous waste from the 221-T and 221-U Buildings (WHC 1991a).

No unplanned releases are associated with this crib.

2.3.3.16 216-W-LWC Crib. Located about 76.2 m (250 ft) southeast of the 2724-W Building, the 216-W-LWC Crib is the only active crib within the T Plant Aggregate Area. The unit consists of two independent crib structures (drain fields) with bottom dimensions of 45.7 x 40.5 m (150 x 133 ft) for each. Each structure consists of a 20.3 cm (8 in.) central distribution pipe running east to west 4.3 m (14 ft) below grade, from which

six 10.2 cm (4 in.) perforated drain lines extend the length of the unit on both sides. The drain lines run parallel to each other, 7 m (23 ft) apart. Beneath each lies a 1.5 m (5 ft) deep rock-filled trench, giving the bottom a separated appearance. A 2.1 m (7 ft) layer of gravel fill was backfilled over to grade. The side slope is 1.5:1.

Since the unit began operating in 1981, it has received 1.2 x 10^9 L (3.17 x 10^8 gal) of process wastewater from the 2724-W and 2723-W Buildings (Brown et al. 1990). The crib contains three distribution lines marked by regularly spaced polyvinyl chloride risers. Several vertical culvert-like steel pipes with ladder extensions are located at the west end of the crib.

No unplanned releases are associated with this crib.

2.3.4 Reverse Wells

Reverse wells are buried or covered, encased drilled holes with the lower end perforated or open to allow liquid to seep to the vadose zone. These units injected wastewater into the vadose soil at depths greater than the cribs and french drains described in the previous section. Reverse wells were generally constructed of steel or concrete pipe and were either open or filled with gravel.

Reverse wells were used for the disposal of low-level liquid wastes in the early phases of Hanford Site (including T Plant) operations, but proved unsatisfactory because they plugged easily and introduced the waste into the vadose soil at or near the water table (Brown and Ruppert 1950). Therefore, by 1954, all reverse wells at the Hanford Site had been removed from service; associated wastes were re-routed to cribs and other types of ground disposal units (Fecht et al. 1977).

Two reverse wells, 216-T-2 and 216-T-3, are located in the aggregate area as shown on Figure 2-5. These units are described below.

2.3.4.1 216-T-2 Reverse Well. The 216-T-2 Reverse Well is an inactive waste management unit located within 4.6 m (15 ft) of the southwest corner of the 222-T Building (Maxfield 1979). The unit is a registered underground injection well. The well has a diameter of 15.2 m (6 in.) and extends to a depth of 22.9 m (75 ft). The pipeline is blanked at the well, which has been sprayed with concrete. The reverse well is marked with underground contamination warning signs, as observed during a site visit in September 1991.

The reverse well operated from 1945 to 1950. During that period, the reverse well received 6 x 10^6 L (1.59 x 10^6 gal) of decontamination sink waste and sample slurper waste from the 222-T Building (Stenner et al. 1988; DOE 1988b). The pipeline is blanked at the well, which has been sprayed with concrete.

No unplanned releases are associated with the well.

2.3.4.2 216-T-3 Reverse Well. The 216-T-3 Reverse Well is an inactive waste management unit located 45.7 m (150 ft) north of 23rd Street between the 241-T-361 Settling Tank and the 216-T-6 Crib (Maxfield 1979; Stenner et al. 1988). The 216-T-3 Reverse Well consists of a 0.6 m (2 ft) high, stubbed steel pipe with a gauge at the tap. The reverse well is 62.8 m (206 ft) deep with a diameter of 0.25 m (10 in.). A light chain barricade surrounds the well, which is posted with surface and underground contamination signs, as observed during a site visit in September 1991.

The well operated for only one year (1945-1946). This reverse well received 1.13 x 10^7 L (2.99 x 10^7 gal) of cell drainage from the 221-T Building (via Tank 5-6), as well as overflow from the 241-T-361 Settling Tank containing 224-T Building wastes. In August 1975, the above-ground piping was removed, all sinkholes filled, and the ground surface decontaminated and leveled (Maxfield 1979).

No unplanned releases are associated with the well.

2.3.5 Ponds, Ditches, and Trenches

The ponds, ditches, and trenches in the aggregate area were designed to percolate wastewater into the soil column. These units are shown on Figure 2-8. The 216-T-4(A/B) Pond was at the center of this disposal system and was fed by ditches that originated at the various waste generation facilities. In this report, the 216-T-4 Pond and the ditches which transferred wastewater to it are collectively called the 216-T-4 Pond. Generally, low-level liquid waste was disposed of into the pond system, and no attempt was made to isolate the wastewater from the open air. The following sections describe the 216-T-4 Pond and its associated ditches. Trenches and the 200-W Powerhouse Pond are also described.

Table 2-1 lists salient features of each disposal facility. Tables 2-2 and 2-3 summarize waste quantities received by each unit for radionuclide and chemical wastes, respectively.

2.3.5.1 Ponds. This pond system includes one pond (216-T-4A/4B) and three ditches as shown on Figure 2-8. These units were designed to percolate wastewater or effluent into the soil column.

Ponds are bodies of water enclosed in a natural or diked surface depression used for the disposal of high-volume, low-level liquid effluent and designed to promote percolation of the liquid effluent. As the liquid infiltrated into the ground, many of the radionuclides were absorbed and concentrated by the upper soil layer. Pond bottoms were covered with clean soil and stabilized after deactivation to prevent the dispersal of radionuclides by wind erosion (Stenner et al. 1988).

2.3.5.1.1 216-T-4A Pond. This L-shaped shallow pond covers 6.5 hectares (16 acres) and is located in the northwest corner of the aggregate area (WHC 1991a).

The pond received 4.25 x 10^{10} L (1.12 x 10^{10} gal) of liquid between November 1944 and May 1972, before it was backfilled. A number of leaks in the 221-T Building resulted in the historical release of radionuclide contamination to this pond. Radiation readings taken along the shoreline after the shutdown the of 221-T Building ranged from 2,000 to 15,000 ct/min (WHC 1991a). The unit was stabilized in 1972 by backfilling. In 1973, 15 to 23 cm (6 to 9 in.) of soil were removed from the entire bottom surface of the unit and placed in the 218-W-2A Burial Ground. The pond was then covered with clean soil. In 1975, the bottom of the pond was seeded with grass to stabilize the soil.

2.3.5.1.2 216-T-4B Pond. This pond was constructed in 1972, 61 m (200 ft) east of the older T-4A Pond. Though considered active, the pond has not received effluents for many years. The 216-T-4B Pond is a 0.6 hectare (1.5-acre) waste management unit (536 m [1,760 ft] long and 2.4 m [8 ft] wide) ranging from 0.9 to 1.8 m (3 to 6 ft) deep (WHC 1991a). The pond is fed by the 216-T-4-2 Ditch. It is separated from the 216-T-4A Pond by an earthen dike 396.2 m (1,300 ft) long with an average height of 0.5 m (1.5 ft).

The pond was constructed in May 1972 and was designed to receive steam condensate and condenser cooling water from the 242-T Evaporator and nonradioactive wastewater from the 221-T Building air conditioning filter units and floor drains. However, flow into the ditch is currently low, and liquid does not reach the pond. The pond has been considered dry since 1977.

The unit contains 24,000 m^3 (31,000 yd^3) of contaminated soil. The radionuclide inventories for 216-T-4A and 216-T-4B Ponds are reported together as one waste management unit under the designation of 216-T-4 (WHC 1991a).

2.3.5.1.3 200-W Powerhouse Pond. This active waste management unit is located 18.3 m (60 ft) south of the 241-TX-155 Diversion Box. Water treatment and steam production wastes are received by the pond. The powerhouse effluent consists mainly of cooling water, basin flush water, water softener backflush, and boiler blowdown (WHC 1991a). The pond is comprised of two 61 x 15.2 x 4.6 m (200 x 50 x 15 ft) rectangular basins separated by a narrow concrete channel. The slopes are stabilized with cobbles; little standing water is present in the basins. Four pipes open at the north headwall

discharge approximately 37.9 L/min (10 gal/min) into the north basin. In September, the pond was cleaned with a crane and the spoil dumped on the northwest side, near the 241-TX-152 and -155 Diversion Boxes. The unit is currently not marked or posted.

2.3.5.2 Ditches. Ditches are long, narrow, unlined excavations that percolate effluent into the soil column. Ditches were used for conveying large volumes of liquid to a pond. Both ponds are surrounded by a light chain barricade with surface and contamination warning signs, as observed during a site visit in September 1991.

2.3.5.2.1 216-T-1 Ditch. This is an active waste management unit. The headwall is located approximately 24.4 m (80 ft) north of the 221-T Building. The ditch is 556 x 0.9 m (1,825 x 3 ft), with a depth of 3.3 m (10 ft). The ditch is fed by two below-grade pipes that discharge at the headwall. From November 1944 until June 1956 (Maxfield 1979 states January 1964), the ditch received miscellaneous waste from pilot plant experimental work, intermittent decontamination waste, and waste from the head end of the 221-T Building. Production operations at the 221-T Building were shut down in 1956 and the ditch remained inactive from June 1956 through January 1964 after which it started receiving cooling water from the blowdown vessel in the 221-T Building and miscellaneous waste from PNL head end operations in the 221-T Building (WHC 1991a). Since June 1970 the unit has been receiving the condensate from steam-heated radiators at the head-end of the 221-T Building (WHC 1991a). This ditch currently receives 4 to 8 L/min (1 to 2 gal/min) from the T Plant head-end and wets probably not more than 3.1 to 4.6 m (10 to 15 ft) of the ditch (judging by the amount of vegetation growing through tumbleweeds in the ditch).

Since 1977, the waste management unit had received nonradioactive sodium hydroxide wastewater solution (less than 3,800 L/month [1,000 gal/month]) from the Hanford Environmental Development Laboratory. However, laboratory activities have been suspended and there are currently no sodium hydroxide waste solutions discharged. Thick growth of surface vegetation in the ditch is considered to prevent the contaminated soil along the bottom of the ditch from becoming airborne (Maxfield 1979).

The ditch is currently barricaded by a light chain and surface contamination markings were posted (see Appendix A). The bottom of the ditch is covered with Russian thistle and the banks are heavily vegetated. The ditch is currently enclosed within a light chain boundary and is marked with surface contamination warning signs, as observed during a site visit in September 1991.

2.3.5.2.2 216-T-4-1D Ditch. The ditch begins 231.6 m (760 ft) north of 23rd Street, 741.3 m (2,432 ft) west of the 221-T Building at a headwall and 182.9 m (600 ft) northwest of the 207-T Retention Basin. The dimensions are approximately 259 x 2.4 x 1.2 m (850 x 8 x 4 ft) deep (WHC 1991a). This ditch was active from November 1944 until May 1972 when the 216-T-4-2 Ditch replaced it. The ditch conveys wastewater from the 221-T Building and the 207-T Retention Basin to the 216-T-4 Pond (Maxfield 1979).

The waste management unit received 4.25 x 10^{10} L (1.12 x 10^{10} gal) of process cooling water and steam condensate from the 221-T Building and 242-T Evaporator (Maxfield 1979). Until September 1951, it received process cooling water from the 221-T and 224-T Buildings via the 207-T Retention Basin, and steam condensate from the 221-T Building. From September 1951 until July 1955, it also received condenser cooling water and steam condensate from the 242-T Evaporator. From July 1955 until August 1956 the unit received the same type of waste as before September 1951. From August 1956 until June 1957 the site received steam condensate from 221-T Building. The unit was on standby from June 1957 to July 1964. From July 1964 until December 1965 it carried decontamination waste from the 2706-T Building and condenser cooling water from Building 242-T. From November 1970 to its closure in May 1972, it only carried cooling water from the 242-T Building (WHC 1991a).

The bottom of the ditch was contaminated to a maximum of 20,000 ct/min, and was greatly overgrown with plants and trees. The berm from the replacement 216-T-4-2 Ditch was used to cover this ditch. The total plutonium present in the ditch is estimated to be 1.41 g (3.1 x 10^{-3} lb) (WHC 1991a). Radionuclide inventory is included in the 216-T-4A Pond inventory.

2.3.5.2.3 216-T-4-2 Ditch. This active ditch was constructed to replace the 216-T-4-1D Ditch. It begins at the outfall of the pipe from the 207-T Retention Basin, which is approximately 183 m (600 ft) northwest of the basin. The first 15.2 m (50 ft) of this ditch is common with the older 216-T-4-1D Ditch (WHC 1991a). The ditch was constructed in May 1972, and is still active. It receives both steam condensate and condenser cooling water from the 242-T Evaporator and nonradioactive wastewater from the 221-T Building air conditioning filter units, steam condensate, compressor cooling water discharge, and floor drains.

A radiation survey conducted in January 1978 showed the ditch to be free of radioactivity except for the first 15.2 m (50 ft), the portion that coincided with the old ditch. This ditch is rarely wet for more than 91.4 m (300 ft) of its length. The ditch is surrounded by a light chain barricade and is posted with surface contamination warning signs, as observed during a site visit in September 1991. Radionuclide inventory is included in the 216-T-4A Pond inventory.

2.3.5.3 Trenches. Trenches are long, narrow, unlined shallow excavations, usually about 3 m (10 ft) deep. Trenches were used for the disposal of limited quantities of liquid and/or solid (sludge) wastes and were backfilled after use (WHC 1991a). The T Plant Aggregate Area includes 16 trenches, described below.

2.3.5.3.1 216-T-5 Trench. This waste management unit is located 91.4 m (300 ft) north of 23rd Street and 305 m (1,000 ft) west of the 207-T Retention Basin. The trench is west of the 216-T-32 Crib and north of the 216-T-7TF Crib and Tile Field (WHC 1991a).

The trench is 15.2 x 3 x 3.7 m (50 x 10 x 12 ft). It is enclosed within two series of light chain barricades that also enclose the 216-T-7TF Crib and Tile Field, as observed during a site visit in September 1991.

In 1955, this trench received a total of 2.6 x 10^6 L (6.87 x 10^5 gal) of second-cycle supernatant waste from the 221-T Building via the 241-T-112 Single-Shell Tank. The waste included 3.45 x 10^5 kg (7.6 x 10^5 lb) of inorganic compounds (WHC 1991a). The trench was a specific retention trench, and was taken out of service shortly after operations began (less than one month) when the prescribed liquid waste volume was attained. When deactivated, the above-ground piping was removed and the trench was backfilled.

No unplanned releases are associated with this trench.

2.3.5.3.2 216-T-9, 216-T-10, and 216-T-11 Trenches. These trenches are inactive waste management units located about 186 m (610 ft) west of the 221-T Building (Maxfield 1979). These trenches are 15.2 x 3 x 1.8 m (50 x 10 x 6 ft).

From 1951 to 1954, these trenches received heavy equipment and vehicle decontamination waste. No reference stating the amount of waste received by these trenches was found. In 1954, the trenches were backfilled and decontamination operations were transferred to the 216-T-13 Trench. The trenches were exhumed in May 1972 and released from radiation zone status. No radionuclide or chemical contamination has been documented for these trenches. These trenches are not currently marked or posted, as observed during a site visit in September 1991.

2.3.5.3.3 Trench 216-T-12. The 216-T-12 Trench is an inactive waste management unit located about 91.4 m (300 ft) north of 23rd Street and 548.6 m (1,800 ft) west of the 224-T Building (Maxfield 1979). This trench is 4.6 x 3 x 2.4 m (15 x 10 x 8 ft).

The unit operated for less than one month in 1954. During that time, it received 5 x 10^6 L (1.32 x 10^6 gal) of contaminated slurry from the 207-T Retention Basin (Stenner et al. 1988). The unit was deactivated upon completion of the retention basin sludge removal efforts, and backfilled with clean soil (Maxfield 1979). This trench is enclosed within a light chain barricade that surrounds the 207-T Retention Basin and the 216-T-14 through -17 Trenches; its location is posted with surface contamination warning signs, as observed during a site visit in September 1991.

No unplanned releases are associated with this trench.

2.3.5.3.4 216-T-13 Trench. The trench is located 853.4 m (2,800 ft) southwest of the 221-T Building and 69.5 m (228 ft) south of 23rd Street, approximately 45.7 m (150 ft) north of the 241-T Tank Farm (WHC 1991a). The trench dimensions were 6.1 x 6.1 x 24.4 m (20 x 20 x 80 ft). This trench was excavated in April 1972 and 3 m^3 (4 yd^3) of soil

were then sent and buried in the 200 West Area Burial Grounds. This trench is not currently marked or posted, as observed during a site visit in September 1991.

The 216-T-13 Trench received an unknown volume of liquid mixed waste from vehicle decontamination between June 1954 and June 1964.

No unplanned releases are associated with this trench.

2.3.5.3.5 216-T-14, 216-T-15, 216-T-16, and 216-T-17 Trenches. These trenches are inactive waste management units located approximately 610 m (2,000 ft) west of the 224-T Building and 45.7 m (150 ft) north of the 207-T Retention Basin (Maxfield 1979). These trenches are 83.8 x 3 x 3 m (275 x 10 x 10 ft) and all received first cycle supernatant waste from the 221-T Building via 241-T Tank Farm tanks (241-T-104, -105 and -106). The 216-T-14, -15, and -16 Trenches each received 10^6 L (2.64 x 10^5 gal) of liquid wastes; the 216-T-17 Trench received 7.85 x 10^5 L (2.07 x 10^5 gal) of the first cycle supernatant waste from the 221-T Building via the 241-T-104, -105, and -106 Single-Shell Tanks in the 241-T Tank Farm.

These trenches operated for less than one year in 1954. The trenches were deactivated after they reached the prescribed liquid waste volume for their specific retention capacity. The above-ground piping was removed and the units backfilled (Maxfield 1979). The trenches are enclosed within a light chain barricade and identified by labelled concrete posts. Surface contamination warning signs and plastic radiation flags are posted in an area approximately 61 m (200 ft) east of the trenches across the railroad tracks, as observed during a site visit in September 1991.

2.3.5.3.6 216-T-20 Trench. This trench is located 228.6 m (750 ft) east of Camden Avenue and 228.6 m (750 ft) south of 22nd Street. This trench is 3 x 3 x 1.2 m (10 x 10 x 4 ft).

It was excavated in November 1952 to receive contaminated nitric acid from the 241-TX-155 Diversion Box. It was deactivated the same month by backfilling and removing the above-ground piping. While active, this trench received 1.89 x 10^4 L (4.99 x 10^3 gal) of contaminated nitric acid containing 1,500 kg (3,304 lb) of nitrate (WHC 1991a).

One additional alias not included for the 216-T-20 Trench is the contaminated acid pit (WHC 1991a). The trench is presently not marked or posted, although an undated aerial photo shows an area east of the 241-TX-155 Diversion Box that may represent the trench, as observed during a site visit in September 1991.

2.3.5.3.7 216-T-21, 216-T-22, 216-T-23, and 216-T-24 Trenches. This group of trenches is located 76.2 m (250 ft) west of the 241-TX Tank Farm. These units are specific retention trenches, and received 5.0 x 10^6 L (4.6 x 10^5 L, 1.53 x 10^6 L, 1.48 x 10^6 L, 1.53 x

10^6 L, respectively) of first-cycle supernatant waste from the 221-T Building via the 241-TX-109, -110, and -111 Single-Shell Tanks. Each trench is 73.2 x 3 x 3 m (240 x 10 x 10 ft). The trenches were in operation in 1954.

The above-ground piping to the trenches was removed and the trenches backfilled when the specific retention capacity was reached. In September 1969, thistles growing above the 216-T-21 and 216-T-24 Trenches were found to be contaminated. Herbicides were applied to trench soils in May 1970. Since the appearance of new growth, radionuclide contamination of surface vegetation has not been detected (WHC 1991a). In addition, elevated gamma scintillation readings was not detected in Well 299-W15-81, located west of the 216-T-22 Crib (Fecht et al. 1977). This trench series is marked by concrete posts and posted with underground contamination warning signs; however, individual trenches are not identified, as observed during a site visit in September 1991.

2.3.5.3.8 216-T-25 Trench. This trench, located due north of the 216-T-21 through -24 Trenches, was active during September 1954 (WHC 1991a). The trench is 54.9 x 3 x 3 m (180 x 10 x 10 ft). The trench received first-cycle evaporator bottoms consisting of sludge from 242-T Building first-cycle condensed wastes (WHC 1992a). The trench received 3 x 10^6 L (7.92 x 10^5 gal) of liquid mixed waste containing radionuclides and 2.93 x 10^6 kg (6.45 x 10^6 lb) of inorganic compounds. Radionuclides included ^{137}Cs, ^{106}Ru, ^{90}Sr, ^{60}Co, ^{238}U, and plutonium.

The above-ground piping was removed and the trench was backfilled when the waste management unit was deactivated (WHC 1991a). The trench is fenced within the same area as the 216-T-21 through -24 Trenches. This trench is marked by a concrete post, as observed during a site visit in September 1991. Portions of a concrete pad are visible northeast of the trench.

2.3.6 Septic Tanks and Associated Drain Fields

The location of the septic tanks and drain fields are shown on Figure 2-9. The T Plant Aggregate Area contains six septic tanks, described as follows.

2.3.6.1 2607-W1 Septic Tank and Drain Field. This active septic tank and associated drain field is located southeast of the 241-TX Tank Farm. This septic system has operated since 1944 and accepts sanitary wastewater and sewage at an estimated rate of 18,300 L/day (4,831 gal/day) (Cramer 1987). The septic tank structure is composed of a concrete pad with two manholes 1.5 m (5 ft) apart on the west side and one manhole on the east side, approximately 4.6 m (15 ft) from the other two. The drain field has dimensions of 30.5 x 22.9 x 1.8 m (100 x 75 x 6 ft) and is located approximately 15.3 m (50 ft) southeast of the septic tank, across Bridgeport Avenue. No information is available on known or suspected

contamination at this unit. The septic tank is surrounded by a light chain barricade with no radiation warning signs, as observed during a site visit in September 1991.

2.3.6.2 2607-W2 Septic Tank and Drain Field. This active septic tank and drain field are located southwest of the main 200 West Area guard gate. This septic system has operated since 1980 and accepts wastewater and sewage at an estimated rate of 10,200 L/day (2,693 gal/day) (Cramer 1987). The septic tank has a concrete pad with three square iron plates covering holes. The plates have rusted through and liquid is visible below. The drain field is 18.3 x 9.2 x 2.4 m (60 x 30 x 8 ft) and is located about 9.2 m (30 ft) southwest of the septic tank. The septic tank is surrounded by a light chain barricade with no radiation warning signs, as observed during a site visit in September 1991.

2.3.6.3 2607-W3 Septic Tank and Drain Field. The 2607-W3 Septic Tank is an active waste management unit that has operated since 1944. It is located southwest of the 221-T Building. This unit includes a drain field. The drain field is 3.8 m (12.5 ft) deep and constructed of reinforced concrete. The tile field is constructed of 10.2 cm (4 in.) vitrified clay pipe. The laterals are open jointed and spaced 2.4 m (8 ft) apart. The drain field has an area of 6.4 x 2.7 m (21 x 9 ft). This tank accepts sanitary wastewater and sewage and includes a drain field; the estimated rate of waste received is 14,200 L/day (3,749 gal/day) (Cramer 1987). The eastern most access port is posted with a radioactive material warning sign, as observed during a site visit in September 1991.

2.3.6.4 2607-W4 Septic Tank and Drain Field. The 2607-W4 Septic Tank is an active waste management unit operating since 1944, and is located northwest of the 221-T Building. This tank accepts wastewater and sewage and includes a drain field 3.1 x 9.2 x 0.9 m (10 x 30 x 3 ft). The estimated rate of waste received is 10,600 L/day (2,799 gal/day) (Cramer 1987). This septic tank is surrounded by a light chain barricade and is marked with surface contamination warning signs, as observed during a site visit in September 1991.

2.3.6.5 2607-WT Septic Tank and Drain Field. Located east of the evaporator between the 241-TX and 241-TY Tank Farms, this active sanitary wastewater and sewage septic tank receives approximately 20 L/day (5 gal/day) of waste. This unit began operating in 1952 and is connected to a sanitary tile field (WHC 1991a). During a previous site visit, neither the septic tank nor the drain field could be identified from outside the chain link fence barrier (see Appendix A, Table A.2.4). Based on available drawings, the septic tank is apparently located inside the 241-T-601 Building. This septic tank is surrounded by a chain link fence and is marked with surface contamination warning signs, as observed during a site visit in September 1991.

2.3.6.6 2607-WTX Septic Tank and Drain Field. This is an active septic tank (operating since 1950) located in the southwest corner of the 241-TX Tank Farm. This unit receives sanitary wastewater and sewage at a rate of 740 L/day (195 gal/day) and is connected to a

sanitary tile field (WHC 1991a). This septic tank is surrounded by a chain link fence and is marked with surface contamination warning signs, as observed during a site visit in September 1991.

2.3.7 Transfer Facilities, Diversion Boxes, and Pipelines

High-level waste transfer lines (also referred to as process lines) connect the major processing facilities with each other and with the various waste disposal and storage facilities. Most high-level waste transfer lines are 7.6 cm (3 in.) diameter stainless steel pipes with welded joints. These lines are generally enclosed in steel reinforced concrete encasements and are set below grade. The major process lines in the T Plant Aggregate Area are shown on Figure 2-10 and Plate 1. The high-level waste pipelines are not waste management units according to the Tri-Party Agreement and they will be addressed in detail under the Decommissioning and RCRA Closure Program. However, a limited study is proposed as part of T Plant past-practice investigations (see Section 8.3.3.8) to determine if the lines are leaking and if they have contaminated the surrounding soil.

Transfer lines to liquid effluent disposal facilities (e.g., cribs) were constructed of a variety of materials including vitreous clay and galvanized metal. For the purpose of the AAMS, these transfer lines are considered part of the waste management unit into which they discharged and will be investigated as part of their respective units.

Diversion boxes house the switching facilities where waste can be routed from one process line to another. They are concrete boxes that were designed to contain any waste that leaks from the high-level waste transfer line connections. The diversion boxes generally drain by gravity to nearby catch tanks where any spilled waste is stored. There are 15 diversion boxes in the T Plant Aggregate Area, one of which is not listed in the Tri-Party Agreement. These units are shown on Figure 2-11 and described below.

2.3.7.1 241-T-151 Diversion Box. This diversion box, located west of the 241-T-110 Single-Shell Tank and 241-T-153 Diversion Box and northeast of the 241-T-152 Diversion Box, was active from 1944 to 1980. This reinforced concrete structure interconnects the 241-T-153 Diversion Box, the 241-U-151 Diversion Box, 221-T Building, 241-T-301 Catch Tank, and the 241-T Tank Farm. This unit was used for the transfer of waste solutions from processing and decontamination operations. The diversion box is cordoned off by a chain link fence, as observed during a site visit in September 1991.

2.3.7.2 241-T-152 Diversion Box. This diversion box was active from 1944 to 1983 and is located southwest of the 207-T Retention Basin, just north of 23rd Street. The 241-T-152 Diversion Box is associated with the 241-T Tank Farm and the 241-T-301 Catch Tank, and

interconnects the 241-T-153, 241-TX-153, 241-TX-155 Diversion Boxes and the 221-T Building. The diversion box is cordoned off by a chain link fence, as observed during a site visit in September 1991.

2.3.7.3 241-T-153 Diversion Box. This diversion box is currently inactive; the dates of its operation are unknown. It is located within the 241-T Tank Farm, east of the 241-T-110 Single-Shell Tank. This diversion box interconnects the 241-TX-153 and 241-T-155 Diversion Boxes and the 221-T Building. This diversion box drains to the 241-T-301 Catch Tank. The diversion box is cordoned off by a chain-link fence, as observed during a site visit in September 1991.

2.3.7.4 241-T-252 Diversion Box. This inactive waste management unit operated from 1944 to September 1983. It is located within the 241-T Tank Farm, just north of 23rd Street and southwest of the 241-T-112 Single-Shell Tank. The 241-T-252 Diversion Box interconnects the 241-T-153 Diversion Box, the 221-T Building, and the 241-T Tank Farm (WHC 1991a). This diversion box drains to the 241-T-301 Catch Tank. The diversion box is cordoned off by a chain link fence, as observed during a site visit in September 1991.

2.3.7.5 241-TR-152 Diversion Box. This inactive waste management unit operated from 1944 to November 1980. It is located just east of the 241-T-104 Single-Shell Tank. The 241-TR-152 Diversion Box interconnects the 241-TR-153 Diversion Box, 241-TXR-151 Diversion Box, and the 241-T Tank Farm (WHC 1991a). This diversion box drains to the 241-T-101 Single-Shell Tank. The diversion box is cordoned off with a chain link fence and posted with surface contamination warning signs, as observed during a site visit in September 1991.

2.3.7.6 241-TR-153 Diversion Box. This inactive unit operated from 1944 until November 1983. It is located just east of the 241-T-107 Single-Shell Tank. The 241-TR-153 is associated with the 241-T Tank Farm, and interconnects the 241-TR-152 and 241-TXR-151 Diversion Boxes (WHC 1991a). This diversion box drains to the 241-T-102 Single-Shell Tank. The diversion box is cordoned off with a chain link fence and posted with surface contamination warning signs, as observed during a site visit in September 1991.

2.3.7.7 241-TX-152 Diversion Box. This active waste management unit has operated since 1949 and is located within the 241-TX Tank Farm. A review of the 200 West facility drawings failed to provide construction details for this diversion box. A structure was located at the coordinates given in WHC (1991a). Research will be required to verify this structure is the diversion box. The 241-TX-152 Diversion Box is reported to be associated with the 241-TX Tank Farm (WHC 1991a). Based on available information, this diversion box is surrounded by a light chain barricade and posted with surface contamination warning signs, as observed during a site visit in September 1991 (WHC 1991a).

2.3.7.8 241-TX-153 Diversion Box. This inactive waste management unit operated from 1949 to July 1982. It is located west of Camden Avenue within the 241-TX Tank Farm and southeast of the 241-TX-101 Single-Shell Tank. The 241-TX-153 Diversion Box interconnects the 241-TX-155 Diversion Box and the 241-TX Tank Farm, and is associated with 241-TX-302A Catch Tanks.

One known unplanned release (UPR-200-W-126) has occurred from this Diversion Box. This release occurred on May 8, 1975 when a pipefitter removed old gaskets from the diversion box for replacement and placed them in a plastic bag. The diversion box is surrounded by a chain-link fence and is posted with surface contamination warning signs, as observed during a site visit in September 1991.

2.3.7.9 241-TX-154 Diversion Box. This active unit has operated since 1949 and is located within the 241-TX Tank Farm. The 241-TX-154 Diversion Box is associated with the 241-TX-302C Catch Tank and the 241-TX Tank Farm (WHC 1991a). The diversion box is surrounded by a light chain barricade and is posted with surface and underground contamination warning signs, as observed during a site visit in September 1991.

Three unplanned releases, UPR-200-W-21, UPR-200-W-40, and UPR-200-W-160, are associated with this site. These releases are discussed in Section 2.3.2.8 and summarized in Table 2-6.

2.3.7.10 241-TX-155 Diversion Box. This inactive waste management unit operated from 1949 to December 1980. It is located east of the 241-TX Tank Farm. The 241-TX-155 Diversion Box is interconnected with the 241-TX-302B Catch Tank and the 241-T, 241-TX, and 241-TY Tank Farms.

Two unplanned releases (UPR-200-W-5 and UPR-200-W-28) are known to have occurred from this diversion box. Unplanned Release UPR-200-W-5 occurred in 1950 on the hillside west of the 216-T-20 Trench when overflow from the diversion box contaminated the soil. The area was removed from radiation zone status in December 1970. Unplanned Release UPR-200-W-28 occurred in the spring of 1954 and resulted from a leak in a jumper in the diversion box. The leak covered a 9.2 x 30.5 m (30 x 100 ft) area west of the diversion box; the area was covered with clean soil (WHC 1991a). The diversion box is surrounded by a light chain barricade and is posted with surface contamination warning signs, as observed during a site visit in September 1991.

2.3.7.11 241-TXR-151 Diversion Box. This diversion box is not listed in the Tri-Party Agreement or the WIDS inventory sheets (WHC 1991a). It is located in the 241-TX Tank Farm approximately 30 m (150 ft) north of 20th Street and 100 m (300 ft) west of Camden Avenue. This diversion box interconnects the 241-TR-152 and 241-TR-153 Diversion Boxes and drains to the 244-TXR Vault.

2.3.7.12 241-TXR-152 Diversion Box. This inactive diversion box operated from 1949 to August 1980. It is located within and associated with the 241-TX Tank Farm (WHC 1991a). This diversion box drains to the 241-TX-101 Single-Shell Tank. The diversion box is surrounded by a chain link fence and is posted with surface contamination warning signs, as observed during a site visit in September 1991.

2.3.7.13 241-TXR-153 Diversion Box. This inactive unit operated from 1949 to December 1980. It is associated with the 241-TX Tank Farm (WHC 1991a). This diversion box drains to the 241-TX-105 Single-Shell Tank. The diversion box is surrounded by a chain link fence and is posted with surface contamination warning signs, as observed during a site visit in September 1991.

2.3.7.14 241-TY-153 Diversion Box. This inactive waste management unit operated from 1953 to May 1981. It is located within the 241-TY Tank Farm, approximately 21.4 m (70 ft) north of the 242-T Evaporator Building. The 241-TY-153 Diversion Box is associated with the 241-TY Tank Farm and the 241-TY-302-A Catch Tank, and interconnects the 241-TX-153 and 241-TX-155 Diversion Boxes and the 241-TY Tank Farm (WHC 1991a). The diversion box is surrounded by a chain link fence and is posted with surface contamination warning signs, as observed during a site visit in September 1991.

2.3.7.15 242-T-151 Diversion Box. The dates of operation of this inactive waste management unit are not known. It is located southeast of the 241-TX-116 Single-Shell Tank. The 242-T-151 Diversion Box interconnects the 241-TX-113, -114, -116, and -117 Single-Shell Tanks, 241-T-153 Diversion Box, and the 242-T Evaporator (WHC 1991a). The diversion box is surrounded by a chain-link fence and is posted with surface contamination warning signs, as observed during a site visit in September 1991.

2.3.8 Basins

Basins are generally rubber-lined, open, settling ponds where wastewater was held before overflowing into a ditch. For discussion purposes, basins are considered to be waste management units that provide temporary storage for either solid or liquid wastes. One basin falls under this category for the T Plant Aggregate Area and is described below. The location of this basin is shown in Figure 2-12.

2.3.8.1 207-T Retention Basin. This basin is an active waste management unit approximately 458 m (1,500 ft) west of the 221-T Building and 61 m (200 ft) north of 23rd Street. The unit is a 75 x 37.5 x 2 m (246 x 123 x 6.5 ft) deep, concrete retention basin with inlet and outlet structures on the east and west sides (WHC 1991a). It is divided by a concrete spillway into northern and southern halves. A 1,829 m (6,000 ft) long vitrified clay pipe approximately 0.6 m (2 ft) in diameter conveys waste to the basin.

The waste management unit was constructed in 1944 to receive low-level wastes prior to discharge to the 216-T-4-2 Ditch. It receives T Plant process cooling and ventilation steam condensate. From construction completion to the 1950's, the unit received process cooling water from equipment jackets in the 221-T and 224-T Buildings. From the early 1950's to 1955, from 1965 to the late 1960's, and from 1973 to 1976, the basin received the above process cooling water and 242-T Evaporator cooling water. Since 1976, the unit has received intermittent flow from the 221-T, 221-TA, and 224-T Buildings (WHC 1991a).

The sludge and sand at the basin bottom have low-level mixed fission products; the soil surrounding the basin is generally contaminated with low-level beta-gamma activity resulting from particulate fallout associated with unloading incidents involving wastes trucked in from the 241-T Tank Farm. The basin was periodically cleaned out in the 1950's through the early 1960's by removing the sludge and blown-in sand and burying it in scooped out holes 2.4 to 3.1 m (8 to 10 ft) deep along the east side of the basins. The buried sludge was covered with 0.92 to 1.2 m (3 to 4 ft) of soil. There may be three or four such holes in addition to the listed 216-T-12 Trench.

On September 12, 1985, 1,893 L (500 gal) of solution containing 99.4 kg (219 lb) of sodium hydroxide was released to the basins. After six hours of continued condensate discharge, the pH lowered from 12.5 to 7.67, and no further action was taken (WHC 1991a). Currently, the basin is enclosed with a light chain barricade that extends east to the 216-T-14 through -17 Trenches, and north of the 241-T Tank Farm.

2.3.9 Burial Sites

The T Plant Aggregate Area contains two types of burial grounds, the 200-W Powerhouse ash-related waste management units and the 218-W-8 Burial Ground vaults. The 200-W Powerhouse has two ash-related waste management units called the 200-W Ash Disposal Basin and the 200-W Powerhouse Ash Pit. Each of these waste management units serves a separate function. In addition, the 200-W Ash Disposal Basin is associated with two other waste management units, the 200-W Ash Pit Demolition Site and the 200-W Burning Pit . The 200-W Ash Pit Demolition Site is included in the Tri-Party Agreement as an active TSD. The 218-W-8 Burial Ground was used for the disposal of radioactive laboratory process wastes. The locations of these units are shown in Figure 2-13.

2.3.9.1 200-W Ash Disposal Basin. The ash disposal basin is an active waste management unit located northeast of the 221-U Building. It is a large, irregularly-shaped excavation. The southeast corner appears to be an area where soil has been removed to be used as fill material at other units. The other slopes are low angle and are vegetated. Railroad ties and other debris are present in the central part of the excavation. At the northern end, there are large bales of dry brush.

Two fenced areas are located within the basin. One fenced area encloses a trench, approximately 18.3 x 6.1 m (60 x 20 ft). The trench is located next to the entrance ramp on the west side of the basin and is overgrown by tumbleweeds. Contaminated laundry was disposed of at this location. This clothing and soil were removed upon discovery. The second fence area corresponds to the location of the ash pit demolition site and is discussed in Section 2.3.9.2.

Adjoining the basin on the northwest is the area where ash is present at the surface. There is a cut through this zone that is about 4.6 m (15 ft) deep, 45.8 m (150 ft) long, 30.5 m (100 ft) wide at on end, and 9.2 m (30 ft) wide at the other end. The basin has no barrier but is posted with a no dumping warning sign, as observed during a site visit in September 1991.

2.3.9.2 200-W Ash Pit Demolition Site. The ash pit demolition site is located in the northeastern area of the ash disposal basin. The site is situated in a multi-use borrow pit approximately 183 x 244 m (600 x 800 ft) in size. Within this area, unstable chemicals were detonated between November 1984 and June 1986. The site has been inactive for several years. The last disposal was in 1986 and that the unit received low-level waste (WHC 1991a). The ash pit demolition site is not included in the Tri-Party Agreement.

2.3.9.3 200-W Burning Pit Based on an April 1992 site visit, the location of the burning pit could not be verified; no sign, markers, or surface disturbances were found at its suspected location, the southwest corner of the ash disposal basin, east of the 221-U Building. An aerial photograph (date unknown) shows a surface disturbance of similar size to the burning pit located 92 m (300 ft) east of its suspected location. The area is 61 x 61 m (200 x 200 ft). This unit received nonradioactive construction and office waste, chemical solvents, and paint waste to be burned. This unit has three known unplanned releases associated with it: UPR-200-W-37, UN-200-W-8, and UPR-200-W-70 (WHC 1991a).

The UPR-200-W-37 unplanned release site consisted of the disposal of three broken boxes that contained dry high-level radioactive waste with readings of 100 mR/h and that contaminated the ground in the pit. The site was cleaned by removing the cartons to the 200 West Area Burial Grounds and decontaminating the pit (Stenner et al. 1988).

The UPR-200-W-70 unplanned release consisted of the disposal of contaminated material into a non-radiation burning pit.

The UN-200-W-8 unplanned release was a release of unknown source. The release is suspected to have occurred in 1950. The coordinates in WHC (1991a) locate the release in the 200-TP-4 Operable Unit, but its text describes it as being in the old burning ground, east of the 221-U Building.

Currently there are no barricades nor any radiation warning signs in the area of the burning ground. The southwest part of the pit has been backfilled with a coarse gravel and its surface has a gentle slope.

2.3.9.4 200-W Powerhouse Ash Pit. The powerhouse ash pit is located just south of the coal storage yard and has been active since 1943. This pit is not part of the 200-W Ash Disposal Basin discussed above. This unit receives powerhouse ash, which has been analyzed using the Environmental Protection Agency Toxicity Test in accordance with WAC 173-303, and no hazardous materials were found. The ash is generated at the rate of about 6,800 m^3/yr (8,890 yd^3/yr). The pit currently contains about 43,800 m^3 (57,290 yd^3) of ash (Stenner et al. 1988). Based on observations from an April 1992 site visit, the pit is approximately 213 x 61 x 7.6 m (700 x 200 x 25 ft) with steep slopes. The eastern slope has been stabilized with cobbles. Ash and a film of water covered the bottom of the pit during a site visit. A 15 cm (6 in.) steel pipe was observed discharging about 7.6 L/min (2 gal/min) of water into the pit at the northeastern corner. Ash and sediment were heaped around the ponded water, possibly indicating higher discharges in the past. Access ramps are located in the northwest and northeast corners. The pit is surrounded by a light chain barricade and is posted with an open pit warning sign, as observed during a site visit in September 1991. Periodically (every 2 to 4 months), the ash pit is cleaned out and the material is taken to the 200-W Ash Disposal Basin for burial.

2.3.9.5 218-W-8 Burial Ground. The 218-W-8 Burial Ground is an inactive waste management unit that consists of three underground vaults. These vaults, located 274.3 m (900 ft) southeast of the 222-T Building, received 68 m^3 (89 yd^3) of 222-T Laboratory process sample waste containing ^{137}Cs, ^{106}Ru, and ^{90}Sr (Stenner et al. 1988; Anderson et al. 1991). The burial ground was in operation from 1945 to 1952. The two original vaults are 3 x 3 x 3.6 m (10 x 10 x 12 ft) deep, constructed of wooden planking, and have tops located 1.5 m (5 ft) below grade. The third vault is a concrete culvert pipe encasement 2.4 m (8 ft) in diameter and 7.6 (25 ft) long, placed approximately 0.9 m (3 ft) below grade. The top of the encasement is a 23 cm (9 in.) concrete cover and the bottom is a 30 cm (12 in.) concrete floor. The disposal chutes for the wooden vault were removed and backfilled with soil. The disposal chute and three vaults are enclosed within a surface radiation contamination barrier. An additional barrier is present within this outermost barrier which surrounds the original vault. The barrier is surrounded by a light chain barricade and labelled with cave-in potential, and underground and surface radiation warning signs, as observed during a site visit in September 1991.

2.3.10 Unplanned Releases

Forty-six unplanned releases are included in the T Plant Aggregate Area. Their locations are shown on Figure 2-14. Figure 2-15 categorizes unplanned releases by nature of origin. Twenty-eight of the unplanned releases have a UN prefix and eighteen have a UPR

prefix. Unplanned releases designated with a "UPR" are releases from or within the operations of specific waste management units and are considered part of that unit for remediation purposes. Releases designated with a "UN" are a distinct waste management unit for remediation purposes. The "UPRs" are not included as independent sites in the Tri-Party Agreement because they are closely associated with existing waste management units. These unplanned releases and their associated waste management units will be addressed together in this study. Table 2-6 summarizes the known information for each unplanned release and, where applicable, lists the waste management unit to which it is related. Most of the information available for the unplanned releases is derived from the WIDS sheets (WHC 1991a).

2.4 WASTE GENERATING PROCESSES

The primary waste generating processes in the T Plant Aggregate Area are associated with the original fuel separation operations conducted in the 221-T Building (T Plant) and its ancillary support facilities. Waste generation processes associated with these and later operations are summarized in the following sections.

Figure 2-16 presents a flow diagram of the basic process steps and waste streams generated as part of this chemical separation process. A process history of the T Plant Aggregate Area is illustrated in Figure 2-17. Table 2-7 presents a summary of waste-producing processes.

2.4.1 T Plant Fuel Separation Wastes

The first step in the bismuth phosphate process was to remove the metal cladding on the fuel. This resulted in the coating-removal waste that was subsequently combined with the first-cycle decontamination waste for storage in single-shell tanks. The coating waste contained small amounts of fission products (Waite 1991). The next step in the process was to dissolve the uranium and extract the plutonium. This step resulted in the metal waste stream, which contained the bulk of the uranium and approximately 90% of the long-lived fission products (e.g., ^{137}Cs and ^{90}Sr). This waste stream was then sent to the single-shell tanks for storage. Cooling water and steam condensate wastes from the dissolution process were discharged to the 216-T-1 Ditch.

Once the plutonium had been extracted, two decontamination cycles were performed to purify the plutonium product. The first decontamination cycle waste stream contained almost 10% of the long-lived fission products and was sent to the single-shell tanks for storage. The second decontamination cycle waste stream, which contained less than 0.1% of the fission products, was sent to single-shell tanks for storage until 1948. Because of limited tank space, the second-cycle waste supernatant was discharged to cribs and trenches from 1948 to

1956, when the 221-T and 224-T Buildings were deactivated. The second-cycle wastes discharged to cribs were combined with two other waste streams, cell drainage waste, and scavenged first-cycle wastes, described below. These combined waste streams accounted for more than 85% of the volume discharged to the ground from single-shell tanks in support of the irradiated fuel recovery operations in T Plant, but less than 20% of the radionuclides (Waite 1991).

Cell drainage waste collected from T Plant operations was sent to in-plant tanks (or cells) for interim storage and then discharged to cribs. Between 1951 and 1956, the cell drainage waste was routed along with the second-cycle wastes and 224-T Building wastes through a single-shell tank cascade before discharging to cribs. This cell drainage waste was never intended for permanent storage in the tanks. Instead, the single-shell tanks were used as settling tanks before discharging the waste to the ground (Waite 1991).

Beginning in 1955, the newly generated first-cycle waste in T Plant was scavenged before sending it to single-shell tanks for settling and subsequent discharge to the ground. This scavenging involved adding ferrocyanide to the waste to cause the normally soluble ^{137}Cs to precipitate in the settling process before discharge. The scavenging of the first-cycle waste significantly reduced the quantity of long-lived fission products discharged to the ground (Waite 1991).

While procedures were implemented to monitor and control the discharge of long-lived radionuclides to the single-shell tanks, such controls were not always applied to the discharge of chemicals (Waite 1991). Chemicals were a significant component of the waste streams generated. For example, chemicals such as sodium hydroxide were added to neutralize the waste before it was sent to the tanks for storage (Waite 1991). Ferrocyanide was added to process batches to enhance the precipitation of long-lived radionuclides before the supernatant was discharged to the ground. Such practices resulted in the discharge of substantial quantities of chemicals to the ground as part of the tank waste discharges.

Table 2-8 lists the chemicals used or produced in various T Plant processes. Table 2-9 lists the radionuclides and chemicals disposed of to T Plant Aggregate Area waste management units.

2.4.2 Equipment Decontamination and Laboratory Wastes

From 1959 to 1963, steam condensate, decontamination waste, and miscellaneous effluent were sent from the 221-T Building to the tanks for cascading and subsequent discharge to the 216-T-28 Crib. Thereafter, decontamination wastes from the 2706-T Building were combined with waste from T Plant. Also, 300 Area laboratory wastes were shipped from the 340 Building to the 200 West Area and combined with the 221-T Building and 2706-T Building waste streams (Waite 1991). The 2706-T Building

stream was rerouted directly to a separate crib in 1964. The other streams continued to be discharged to the 216-T-28 Crib via single-shell tanks until 1966. A total of 4.23 x 10^7 L (11.2 x 10^6 gal) of waste was routed through the tanks to this crib, resulting in 594 Ci of fission products. The 340 Building waste was rerouted directly to other cribs in 1966.

2.4.3 Containment Systems Test Facility Wastes

The spent fuel dissolution process equipment was removed from the 221-T Building in 1956, and the radioactivity in the facility was partially decontaminated and stabilized. A testing program was then established for testing with iodine and radioactive cesium in a new containment vessel fabricated in place of the old dissolver cells and canyon. This modified facility was referred to as the CSTF. This work was started in 1964 and completed in 1969 by PNL. A test was conducted with radioactive cobalt during this time.

In 1972, a vacuum fractionator was built, and testing began. In 1976, testing was completed and the vacuum fractionator was removed. This work was performed by Atlantic Richfield Hanford Company.

Liquid-metal reactor safety tests were conducted by Westinghouse Hanford in the CSTF with nonradioactive sodium, lithium, and sodium iodide between 1976 and 1985. These tests consisted of sodium and lithium pool reaction, spray reaction, and aerosol behavior tests. At the conclusion of the tests, the reacted sodium, lithium, and sodium iodide were dissolved in water and discharged to the 216-T-1 Ditch or, if radioactive as a result of residual contamination from previous activity, transferred to tank farm double-shell tanks for storage as waste and eventual processing through waste evaporators. Unreacted metals were transferred to the 105-DR Reactor Facility for disposal. The determining conditions for routing the solutions was the solution pH; or the 221-T Building need for caustic solution to neutralize decontamination solutions; or the presence of radioactivity. If the pH was in excess of 12.5, or the caustic solution was needed for neutralization, or radioactivity was detected, the procedure allowed for the solution to be transferred to the 221-T Building head-end; otherwise, it was discharged to the 216-T-1 Ditch. No solutions accumulated that had a pH of less than 2.

Light-water reactor tests were conducted by Westinghouse Hanford using nonradioactive cesium, manganese, zinc, lithium sulfate, iodine, and hydrogen iodide between 1985 and 1990. Several related tests were conducted using nonradioactive lithium and lithium-lead alloy in support of the fusion safety program during this same period. The process wastewater discharged to the 216-T-1 Ditch during these test programs consisted of cooling water, steam condensate, and some of the 221-T Building head-end waste solutions. The used lithium-lead alloy was packaged as solid waste after completion of the tests and shipped offsite as solid waste.

2.4.4 221-T Building Head-End Wastes

The 221-T Building Head-End operations, which consisted of two sets of light-water reactor experiments, were conducted from October 1989 through March 1990. Two sets of light-water reactor experiments were conducted during this time. Cooling water, steam condensate, process solutions, and roof and floor drains associated with these tests and the building operating functions were discharged to the 221-T Building head-end wastewater stream.

The wastewater flow to the 216-T-1 Ditch was continuous during this 6 month period. The wastewater flow consisted of two configurations: wastewater 1--plasma torch operation and wastewater 2--plasma torch standby. The wastewater 1 flow time period was defined as the time of cooling water flow to the plasma torch. This cooling water flow period was about one day (24 hours) for each of the two sets of experiments conducted. The plasma torch was operated to generate manganese aerosol in the aerosol mixing vessel for about one hour for each set of experiments conducted. Other cooling water and steam condensate flows contributed to the wastewater 1 stream.

The wastewater 2 flow consisted of process cooling water and steam condensate flows for the time period during which there was no cooling water flow to the plasma torch. Process wash solutions were also discharged on a batch basis as part of the wastewater 2 flow. The time of wastewater 2 flow consisted of the 6 month duration designation period minus the two days for plasma torch cooling water flow (wastewater 1 flow).

2.4.5 Present Decontamination and Decommissioning Wastes

The T Plant complex presently serves as a decontamination and decommissioning facility for the Hanford Site. Radioactive waste from these activities is not discharged to the chemical sewer.

The only routine "processes" that discharge to the chemical sewer are steam condensate, cooling water, and heating coil water. These process uses for each location at the T Plant complex are described below:

- 221-T Building uses steam for heating in the canyon area, decontamination activities using steam cleaning, and steam jetting to make liquid transfers within the process tanks. The steam used for decontamination and liquid transfers within the process tanks is not discharged to the chemical sewer, but is discharged to the double-shell tanks.

- 221-TA Building uses steam for the preheater and reheat coil which heat the 221-T Building.

- 224-T Building uses steam for building heating. Sanitary water is also used for the building's hot water heater and for cooling water in the fan room which supplies the evaporative cooler for building cooling.

- 271-T Building uses sanitary water to cool the two air compressors which supply all of the compressed air for T Plant. Steam is used to heat the building and can be used for a steam jet transfer from the basement sump to the chemical sewer at Section 12 if the sump pump fails.

- 291-T Building uses steam in heating coils which heat the air in the canyon area of the 221-T Building air before the air is filtered through high-efficiency particulate air (HEPA) filters in the FI-2 filter unit to help prevent HEPA filters from getting wet.

2.5 INTERACTIONS WITH OTHER AGGREGATE AREAS OR OPERABLE UNITS

The T Plant Aggregate Area is bordered by the Z Plant Aggregate Area on the west and the U Plant Aggregate Area to the southeast. Wastes from these plants, as well as the S and B Plants, did contribute a small proportion of the wastes discharged to T Plant facilities. These interactions are summarized below.

- 216-T-27 Crib received PNL 300 Area laboratory wastes from the 340 Building.

- 216-T-28 Crib received PNL 300 Area laboratory wastes from the 340 Building.

- 216-T-34 Crib received PNL 300 Area laboratory wastes from the 340 Building.

- 216-T-35 Crib received PNL 300 Area laboratory wastes from the 340 Building.

- 216-T-36 Crib received steam condensate decontamination waste and miscellaneous waste from both the 221-T Building and the 221-U Building processing facility.

- 241-T-101 Single-Shell Tank received PNL waste, 224-U Building waste, B Plant low-level waste, and coating waste, ion-exchange waste and high-level waste from the S Plant.

- 241-T-102 Single-Shell Tank received PNL waste, S Plant high-level waste, and low-level and ion-exchange waste from B Plant.

- 241-T-103 Single-Shell Tank received B Plant low-level waste, and high-level and ion-exchange waste from the S Plant. UPR-200-W-147 is an associated unplanned release involving Tank 241-T-103.

- 241-T-106 Single-Shell Tank received B Plant low-level waste and is associated with Unplanned Release UPR-200-W-148.

- 241-T-108 Single-Shell Tank received B Plant low-level waste.

- 241-T-109 and 241-T-112 Single-Shell Tanks received PNL waste and B Plant low-level waste.

- 241-T-110 and 241-T-111 Single-Shell Tanks received 224-U Building waste.

- 241-T-201, -202, -203, and -204 Single-Shell Tanks received 224-U Building waste.

- 241-TX Single-Shell Tank received waste from S Plant.

- 241-TY-104 Single-Shell Tank received ion-exchange waste from S Plant and organic wash waste from PUREX.

- Unplanned Release UN-200-W-88 received uranyl nitrate from a trailer spill.

One of the primary interactions of the T Plant Aggregate Area waste management unit with another aggregate area was the laundry (2724-W Building) discharge. Prior to the activation of the dedicated laundry waste crib, 216-W-LWC, in 1981, radioactive and nonradioactive discharges from the laundry facility were discharged to the 216-U-14 Ditch in the U Plant Aggregate Area.

2.6 INTERACTION WITH RESOURCE CONSERVATION RECOVERY ACT PROGRAM

Appendices B and C of the Tri-Party Agreement (Ecology et al. 1991) list RCRA TSD facilities on the Hanford Site which have entered interim status and, thus, will require final permitting or closure. Within the geographical extent of the T Plant Aggregate Area there are eight facilities which fall into this category:

- 241-T-101 through 241-T-112, and 241-T-201 through 241-T-204 Single Shell Tanks (16 total)

- 241-TX-101 through 241-TX-118 Single-Shell Tanks (18 total)

- 241-TY-101 through 241-TY-106 Single-Shell Tanks (6 total)
- 244-TX Receiver Tank
- 221-T CSTF
- T Plant Treatment Tank
- TRUSAF
- 200-W Ash Pit Demolition Site.

The single-shell tanks and their associated facilities will be closed under RCRA rather than seeking a RCRA operating permit. The preferred closure option will be resolved through the preparation and completion of a supplemental environmental impact statement. The forty single-shell tanks are grouped with other Hanford Site single-shell tanks into RCRA TSD facility group S-2-4. The Tri-Party Agreement milestone M-08-01 requires submission of tank farm selection criteria, closure methods, tank farm selection rational and recommended tank farm selection to Ecology for approval by January 1999. Milestone M-08-03 requires submission of tank farm closure plans to Ecology for approval by December 2003. Closure of all 149 single-shell tanks, including the tanks in the T Plant Aggregate Area is scheduled to be completed by June 2018, according to milestone M-09-00. Facilities associated with the Single-Shell Tank Closure Program are discussed in Section 9.0 and listed in Table 9-3.

The 244-TX Receiver Tank is an active facility located within the boundary of the 241-TX Tank Farm and will be addressed by the Waste Management Program.

The 221-T CSTF is a research laboratory used to perform experiments with alkali metal compounds. In the future, this facility may be used to treat hazardous alkali metal waste by heating them in a treatment tank equipped with an off-gas system. The 221-T CSTF is planned for closure under RCRA. The Part A RCRA Permit Application for the 221-T CSTF may be withdrawn because the unit never handled or never will handle hazardous waste. In addition, the 221-T CSTF is associated with T Plant Aggregate Area buildings and does not pose an environmental threat.

T Plant provides decontamination and repair services for the Hanford Site. The waste generated from the decontamination is collected by a drainage system which feeds to the 53,000 L (14,000 gal) T Plant Treatment Tank. The Part A RCRA Permit Application may be withdrawn for the T Plant Treatment Tank due to reclassification of the unit as "treatment by generator." In addition, the T Plant Treatment Tank is associated with T Plant Aggregate Area buildings and does not pose an environmental threat.

The TRUSAF operation consists of a nondestructive analysis of TRU waste. The waste is generated nationally by various DOE processing facilities, and is shipped to the Hanford Site for interim storage and handling. The waste will eventually be shipped to the WIPP in New Mexico for disposal. The TRUSAF is associated with T Plant Aggregate Area buildings and does not pose an environmental threat.

The 200-W Ash Pit Demolition Site was used to detonate explosive wastes that were generated on the Hanford Site. This site is planned for closure under RCRA. The 200-W Ash Pit Demolition Site is an active facility that is scheduled to submit a RCRA Closure Plan in November 1992. In September 1991, a Management Action Plan was submitted for the closure of the 200-W Ash Pit Demolition Site. The purpose of the Management Action Plan is to (1) provide a coordinated approach for preparing the closure plan and (2) obtain the necessary environmental permits and/or regulatory approval for final closure. Implementation of this closure plan is expected to have no impact on other T Plant Aggregate Area waste management units. No unplanned releases are associated with the 200-W Ash Pit Demolition Site.

2.7 INTERACTIONS WITH OTHER HANFORD PROGRAMS

In addition to RCRA, there are several other ongoing programs that affect buildings and waste management units in the T Plant Aggregate Area. These programs are the Environmental Restoration Program and the Waste Management Program. The Environmental Restoration Program is responsible for the Decommissioning and RCRA Closure Program, the Radiation Area Remedial Action Program, and Single-Shell Tank Closure Program.

The Decommissioning and RCRA Closure Program is responsible for the safe and cost-effective surveillance, maintenance, and decommissioning of surplus facilities at the Hanford Site. All of the major inactive buildings within the T Plant Aggregate Area are covered under this program. This program is also responsible for managing the RCRA closure activities. It establishes the cost, schedule, and technical baselines for individual projects and provides the program management for completing the work. The work activities relative to projects are completed by various functional organizations through a matrix management system. Performing organizations are assigned work by the program office using cost account authorizations and cost account plans. Project status is reported to the program office using an earned value system. The majority of decommissioning and RCRA field closure work at the Hanford Site is performed by Hanford Restoration Operations (Winship and Hughes 1991).

The Radiation Area Remedial Action (RARA) Program is responsible for the surveillance, maintenance, decontamination, and/or interim stabilization of inactive burial grounds, cribs, ponds, trenches and unplanned releases at the Hanford Site. A major

concern associated with these requirements is the management and control of surface soil contamination. All of the controlled access surface radiation zones and the cribs with collapse potential in the T Plant Aggregate Area are covered by this program.

The Single-Shell Tank Closure Program covers near-term waste management activities to ensure safe interim storage of waste in the tanks. It also addresses the environmental restoration activities to close the six single-shell tank operable units including in the 241-T, 241-TX and 241-TY Tank Farms. The primary regulatory drivers of this program are the Tri-Party Agreement and RCRA.

The Waste Management Program is responsible for all actively operating waste management units in the T Plant Aggregate Area. These facilities include the 207-T Retention Basin, the 216-T-1 and 216-T-4-1D Ditches, the 216-W-LWC Crib, the 244-TX Receiver Tank and all high-level waste process lines and their associated diversion boxes and catch tanks.

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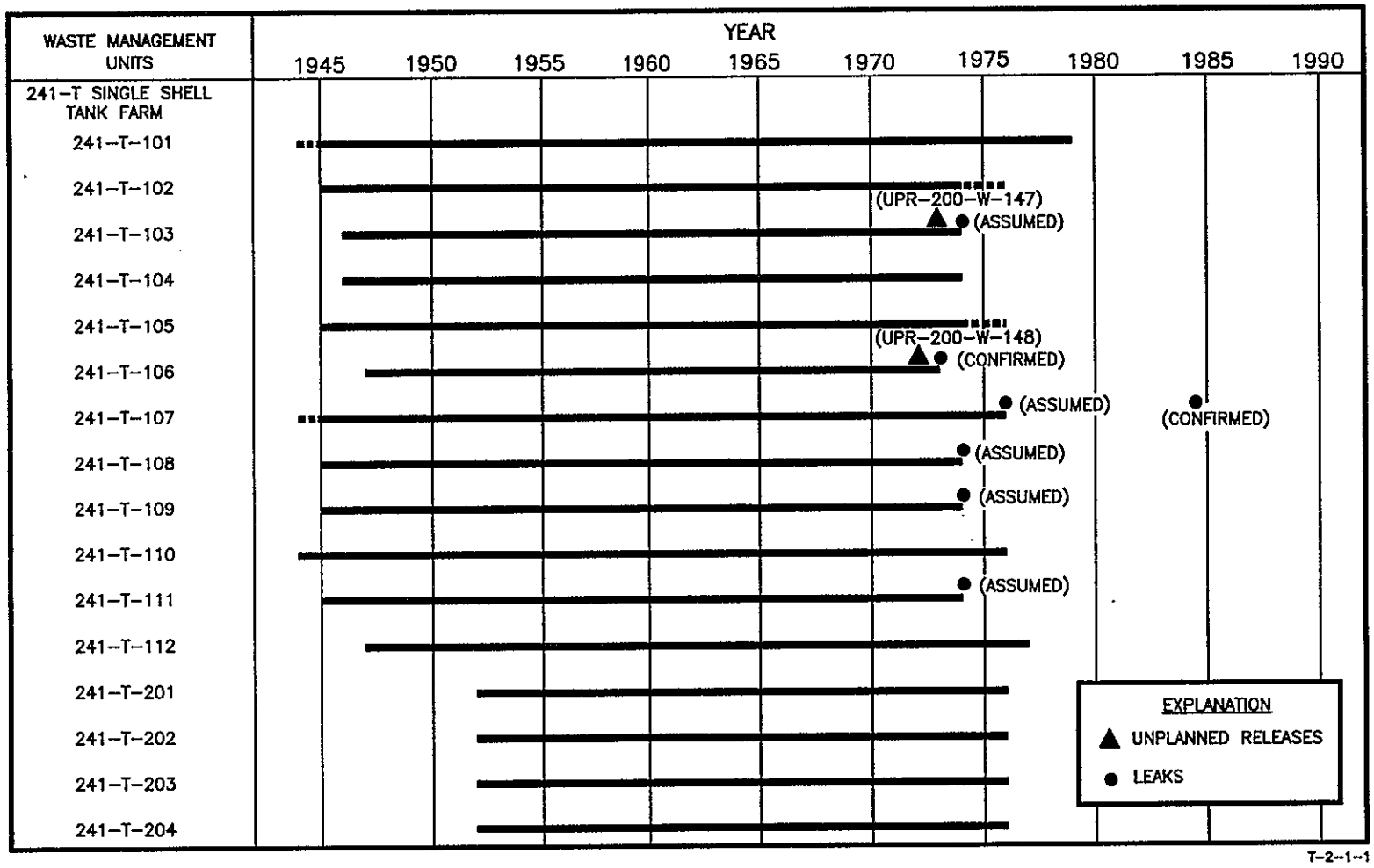
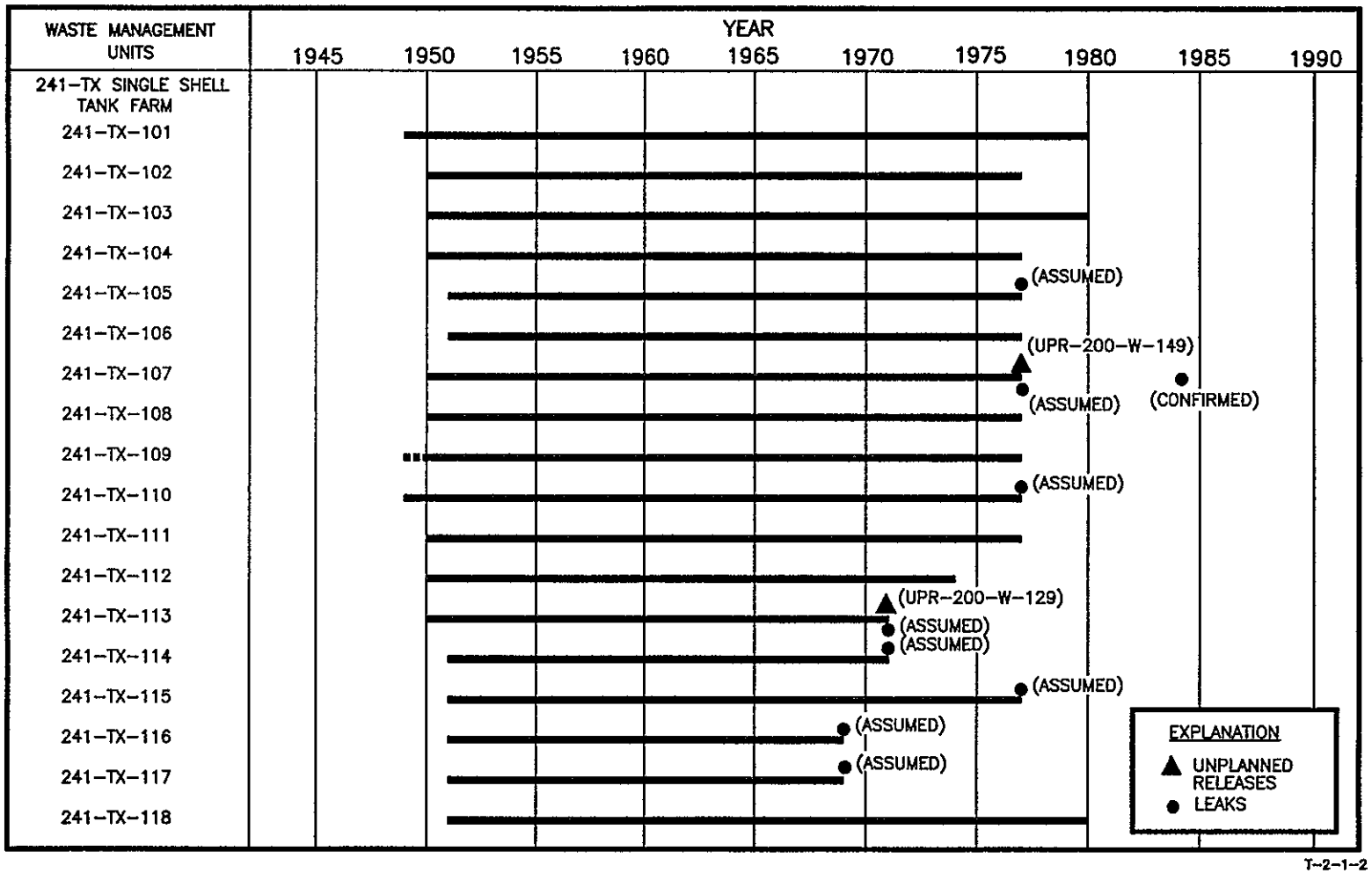


Figure 2-1. T Plant Aggregate Area Timeline. (1 of 9)

Figure 2-1. T Plant Aggregate Area Timeline. (2 of 9)



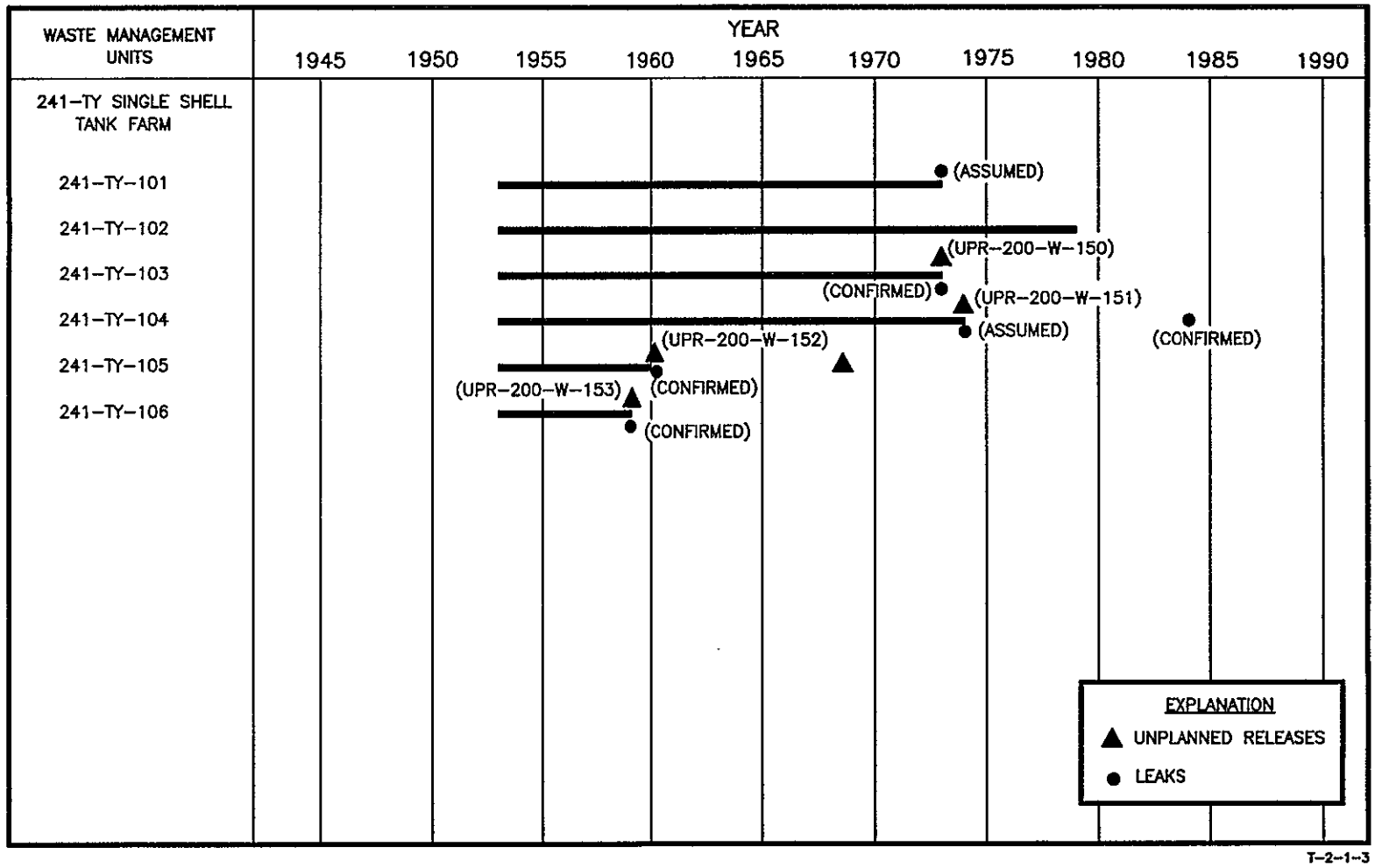


Figure 2-1. T Plant Aggregate Area Timeline. (3 of 9)

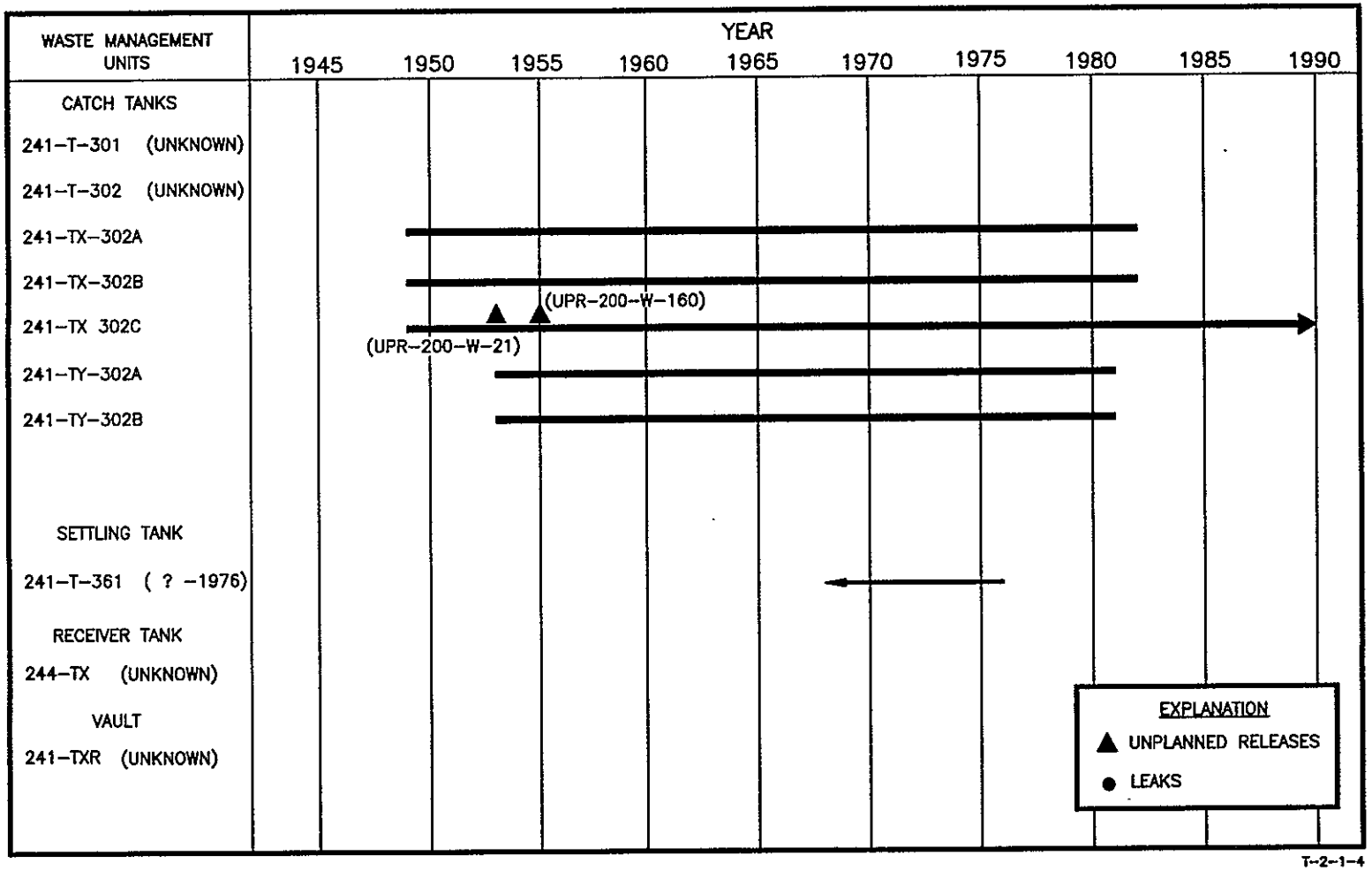


Figure 2-1. T Plant Aggregate Area Timeline. (4 of 9)

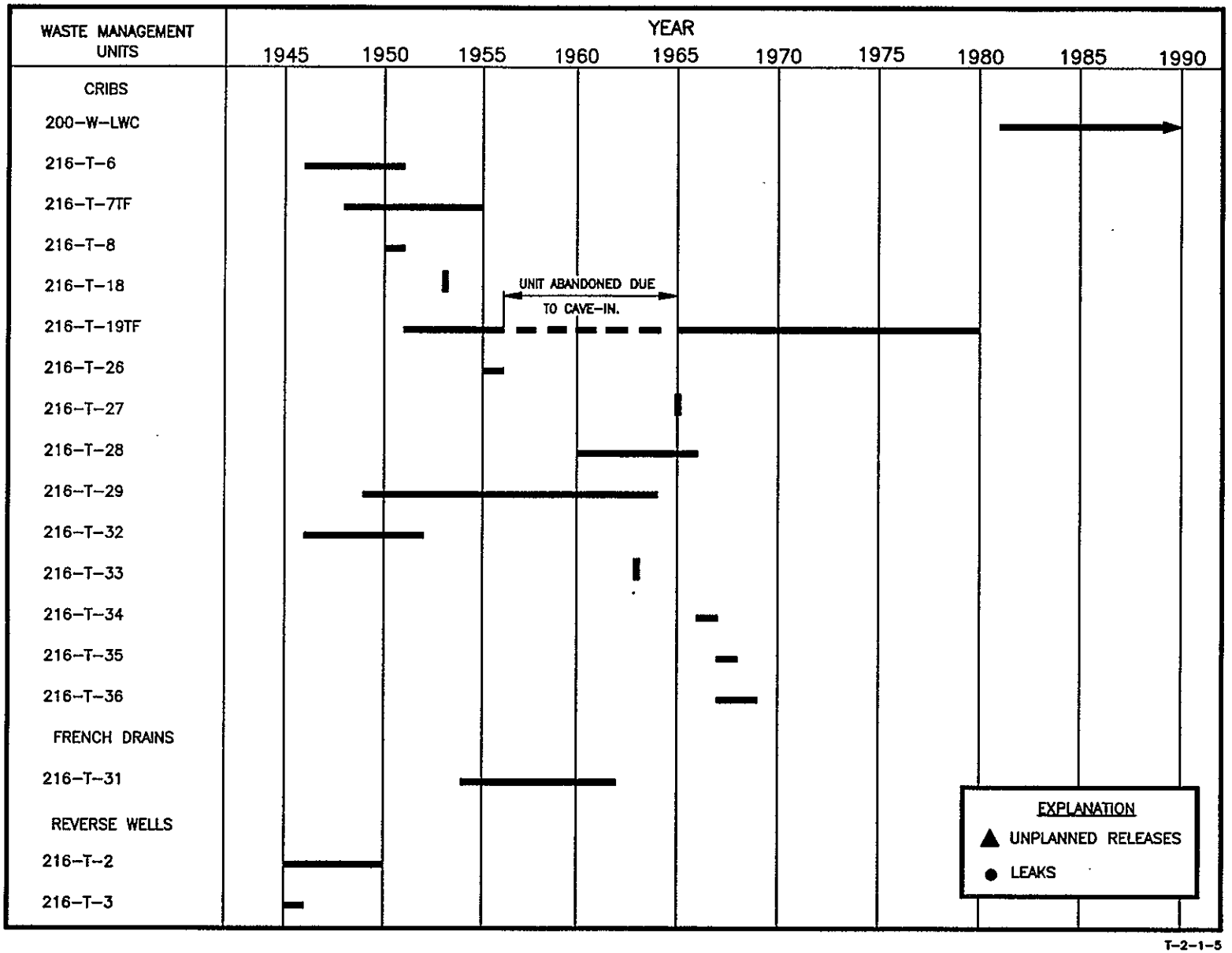


Figure 2-1. T Plant Aggregate Area Timeline. (5 of 9)

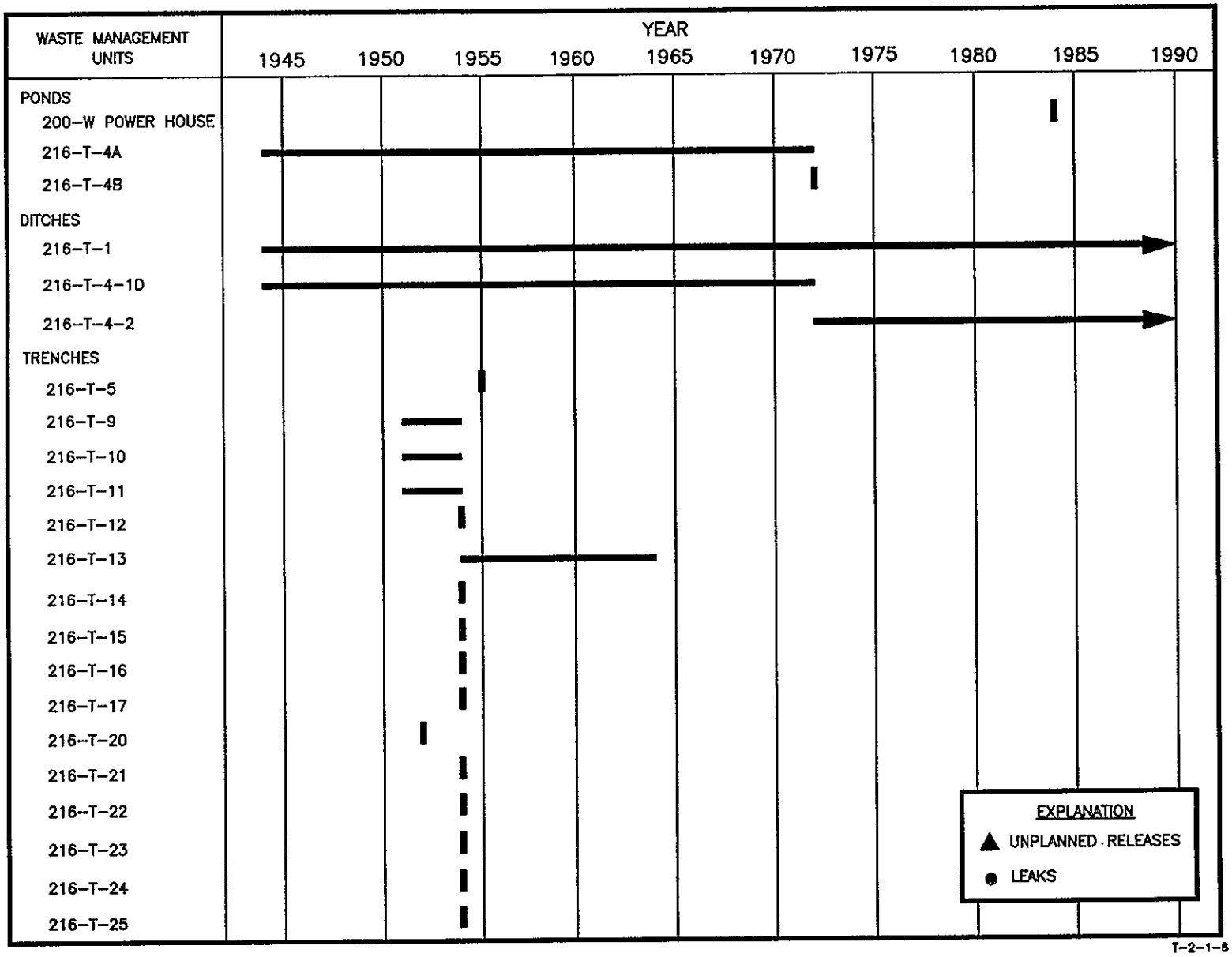


Figure 2-1. T Plant Aggregate Area Timeline. (6 of 9)

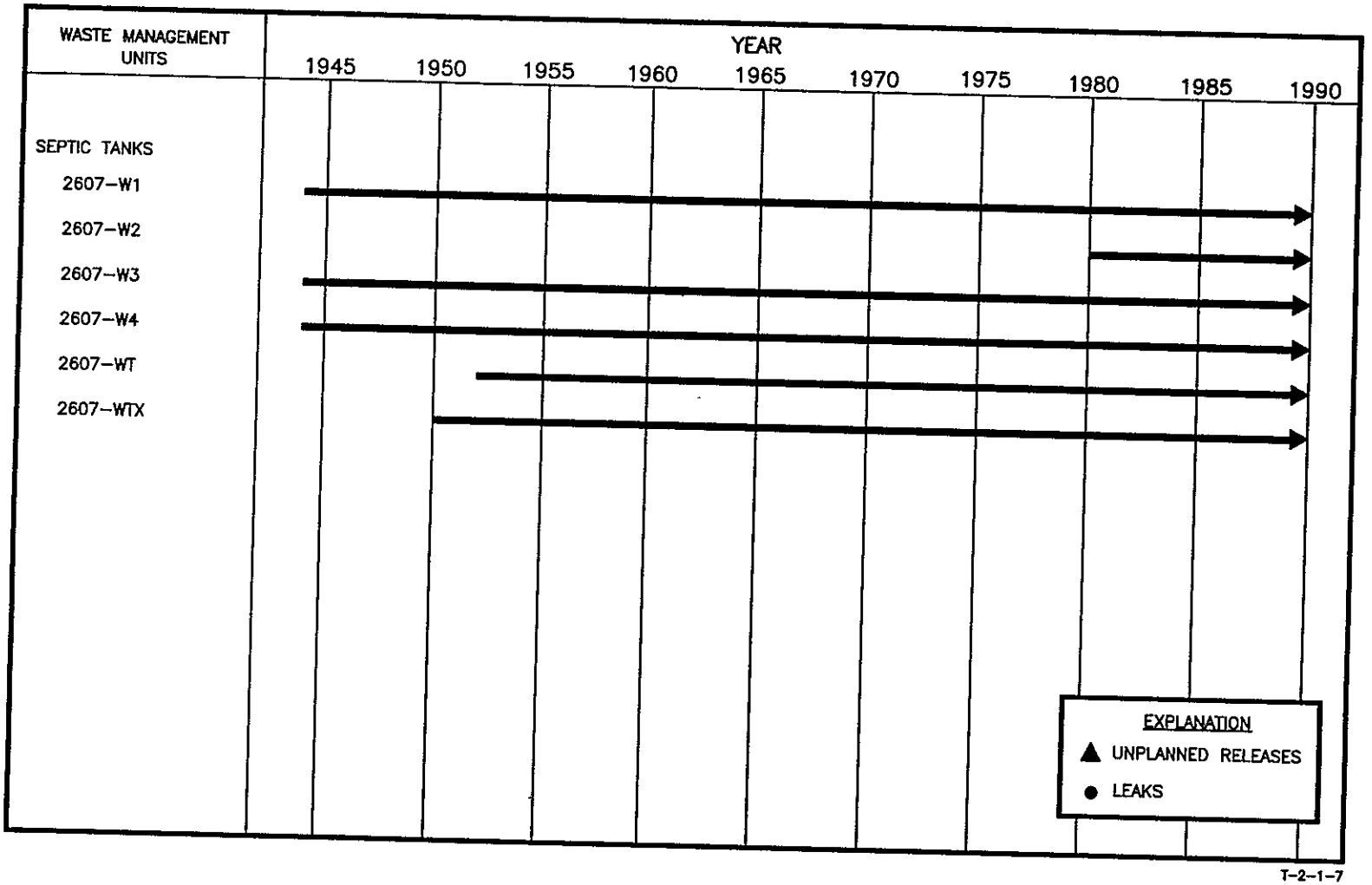


Figure 2-1. T Plant Aggregate Area Timeline. (7 of 9)

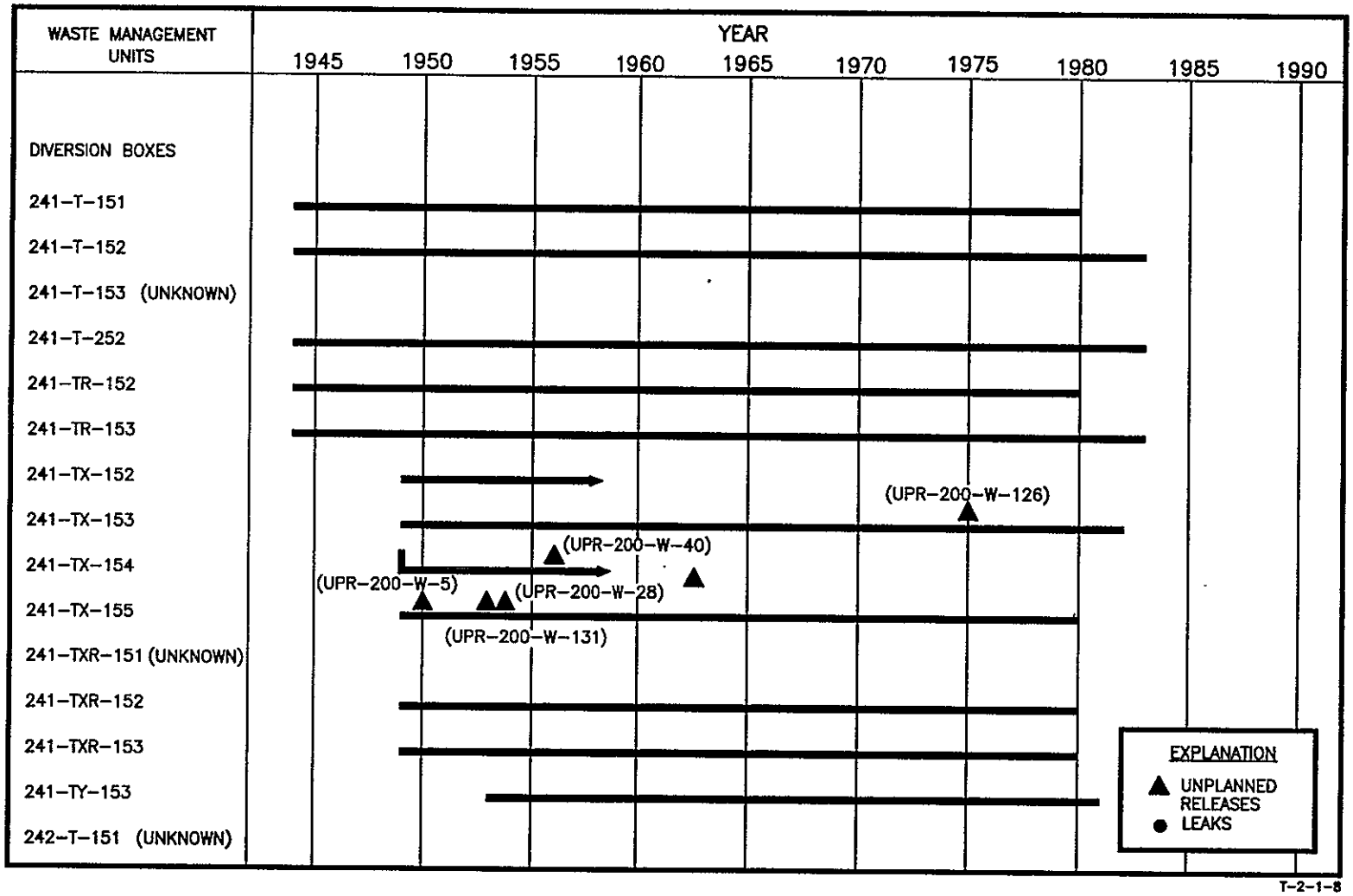


Figure 2-1. T Plant Aggregate Area Timeline. (8 of 9)

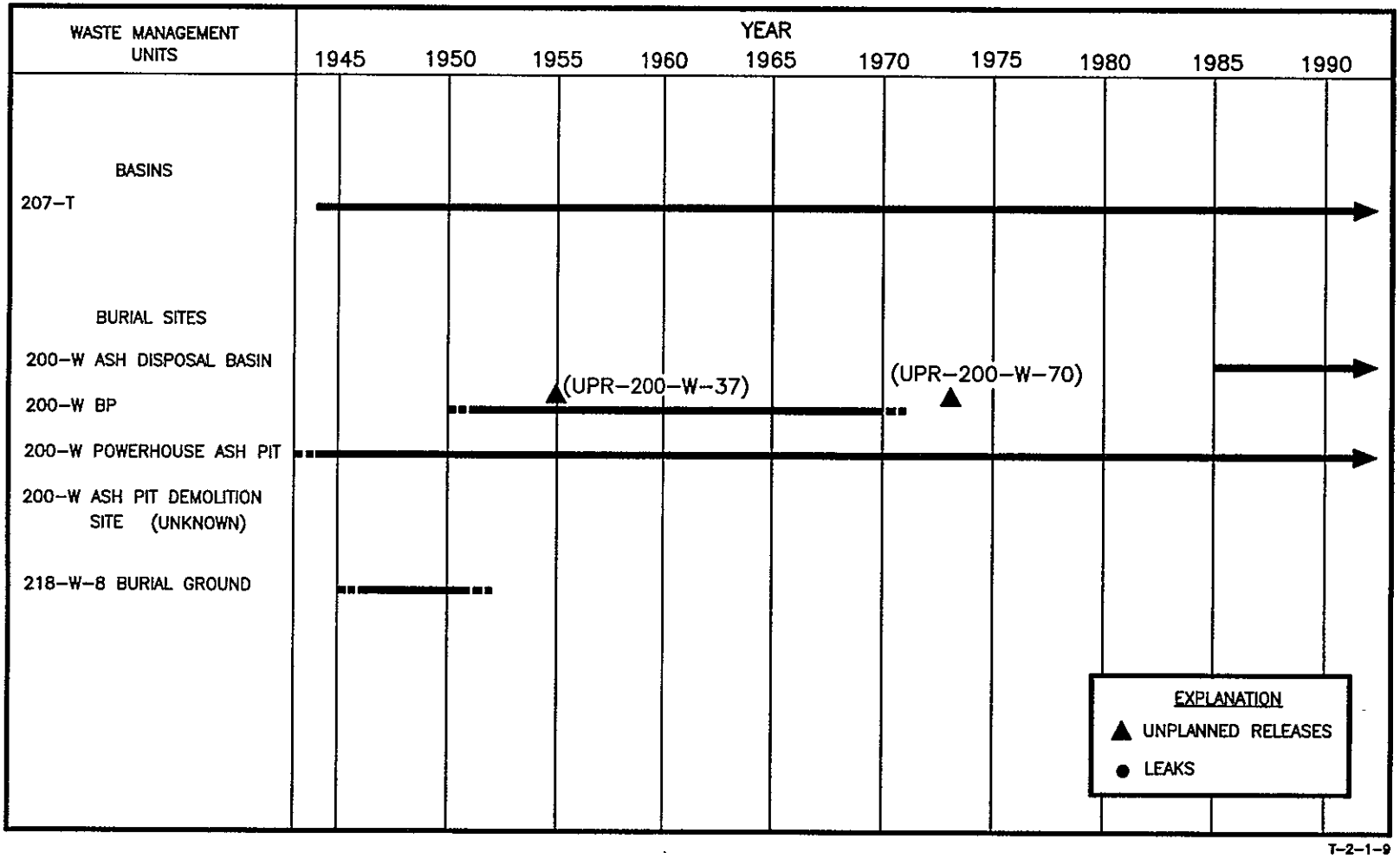


Figure 2-1. T Plant Aggregate Area Timeline. (9 of 9)

Figure 2-2. Location of Plants and Buildings.

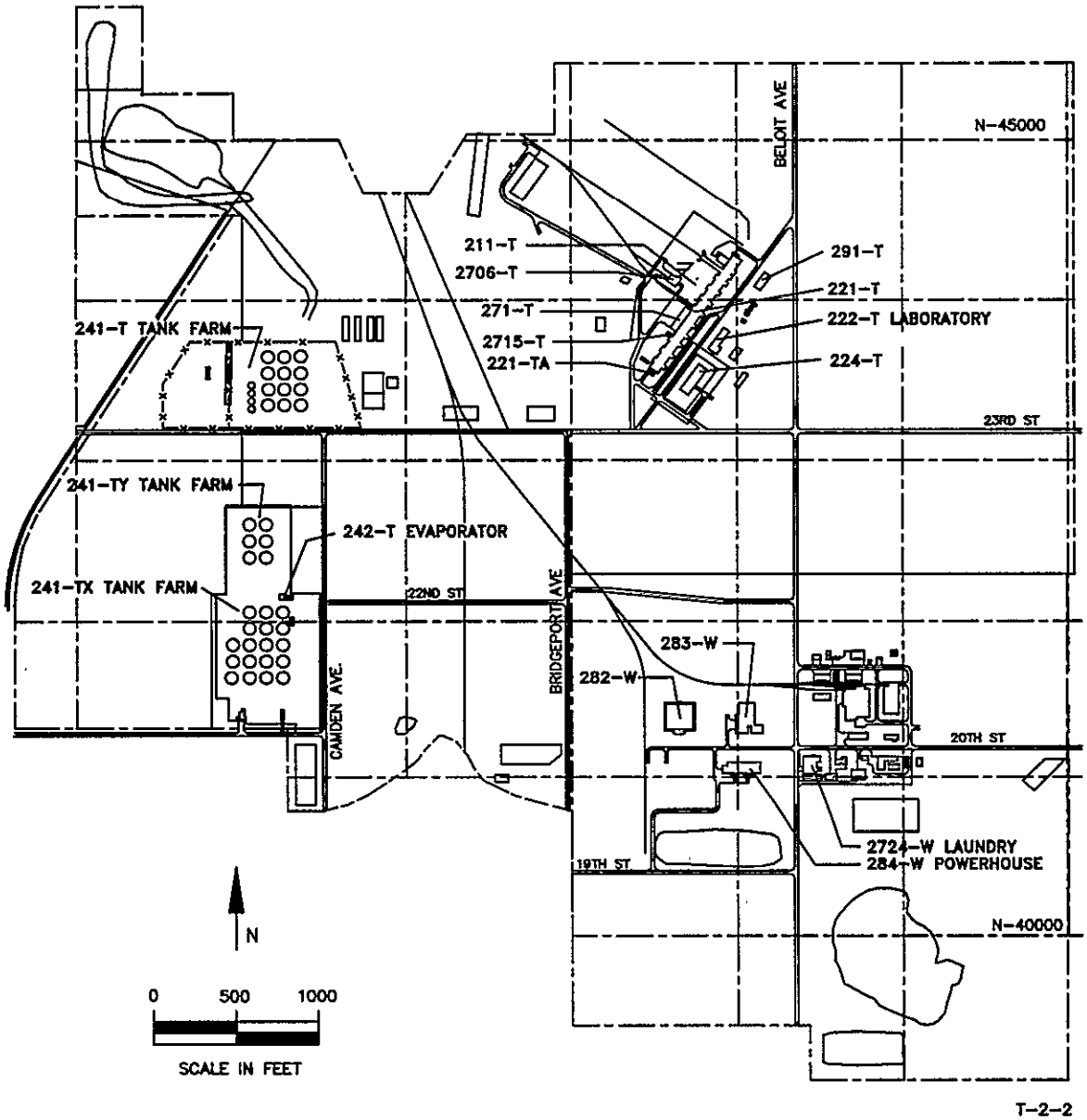


Figure 2-3. Location of Tanks and Vaults. (1 of 2)

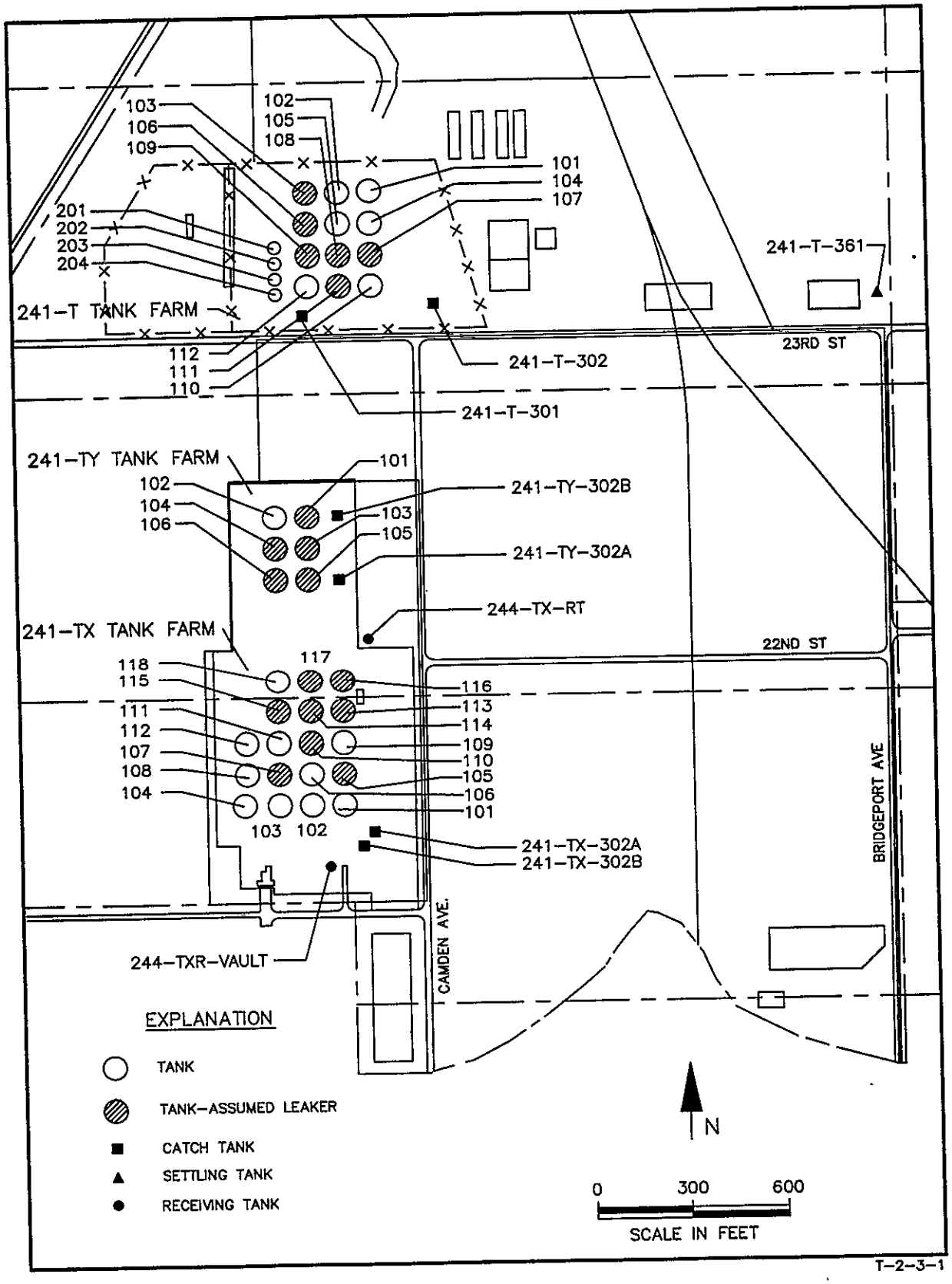


Figure 2-3. Location of Tanks and Vaults. (2 of 2)

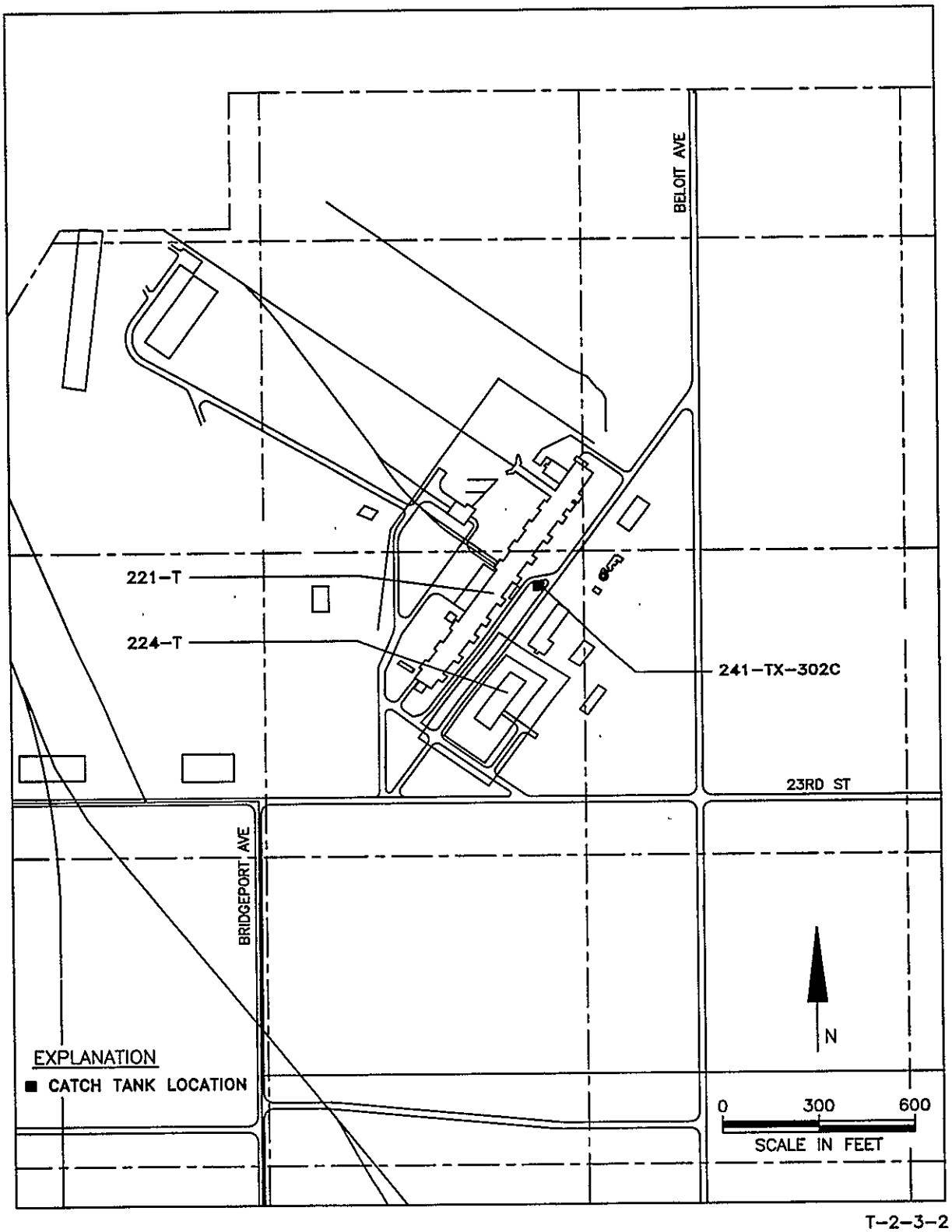


Figure 2-4. Typical Single-Shell Tank.

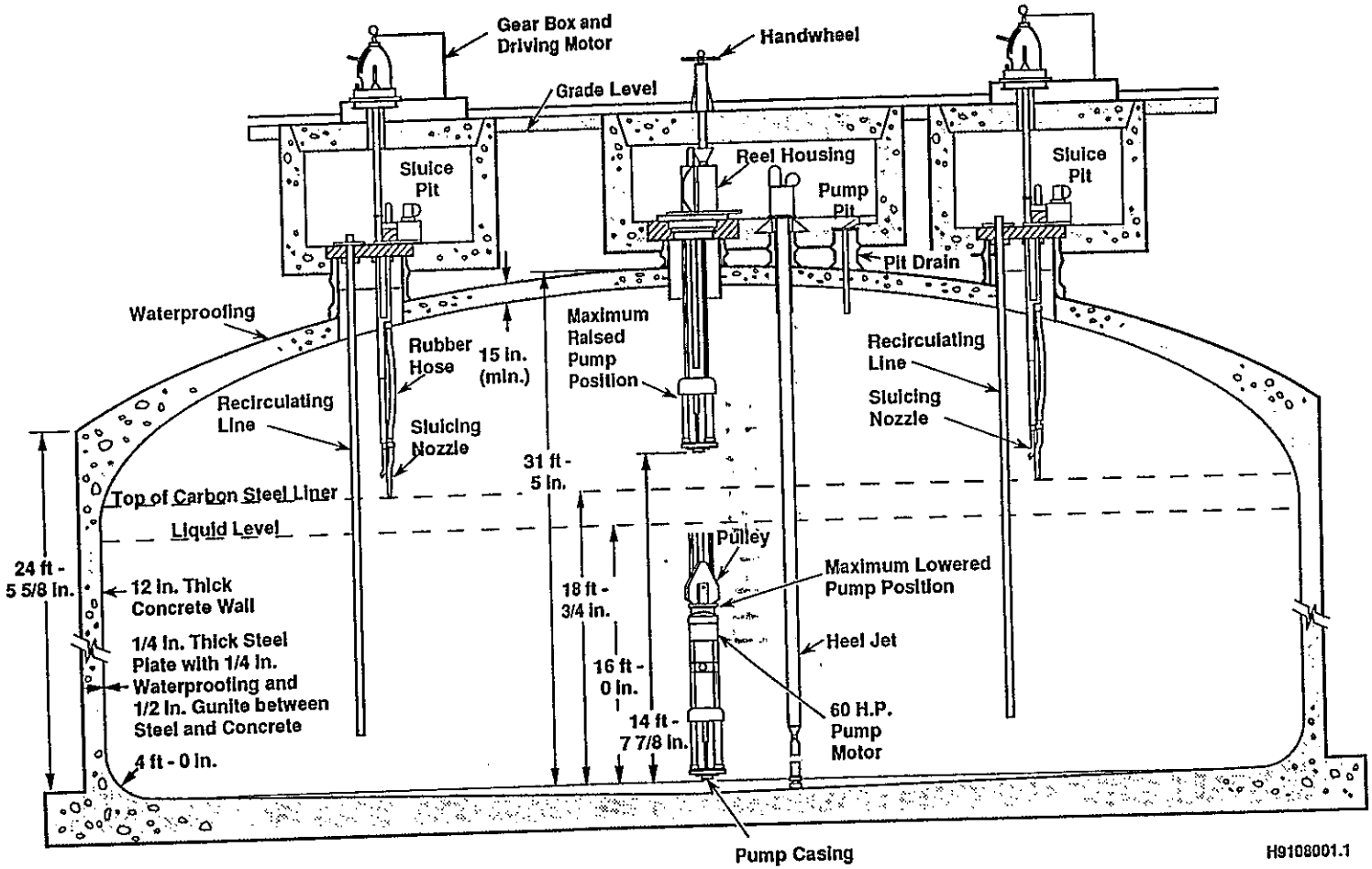


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Figure 2-5. Location of Cribs, Drains, and Reverse Wells. (1 of 2)

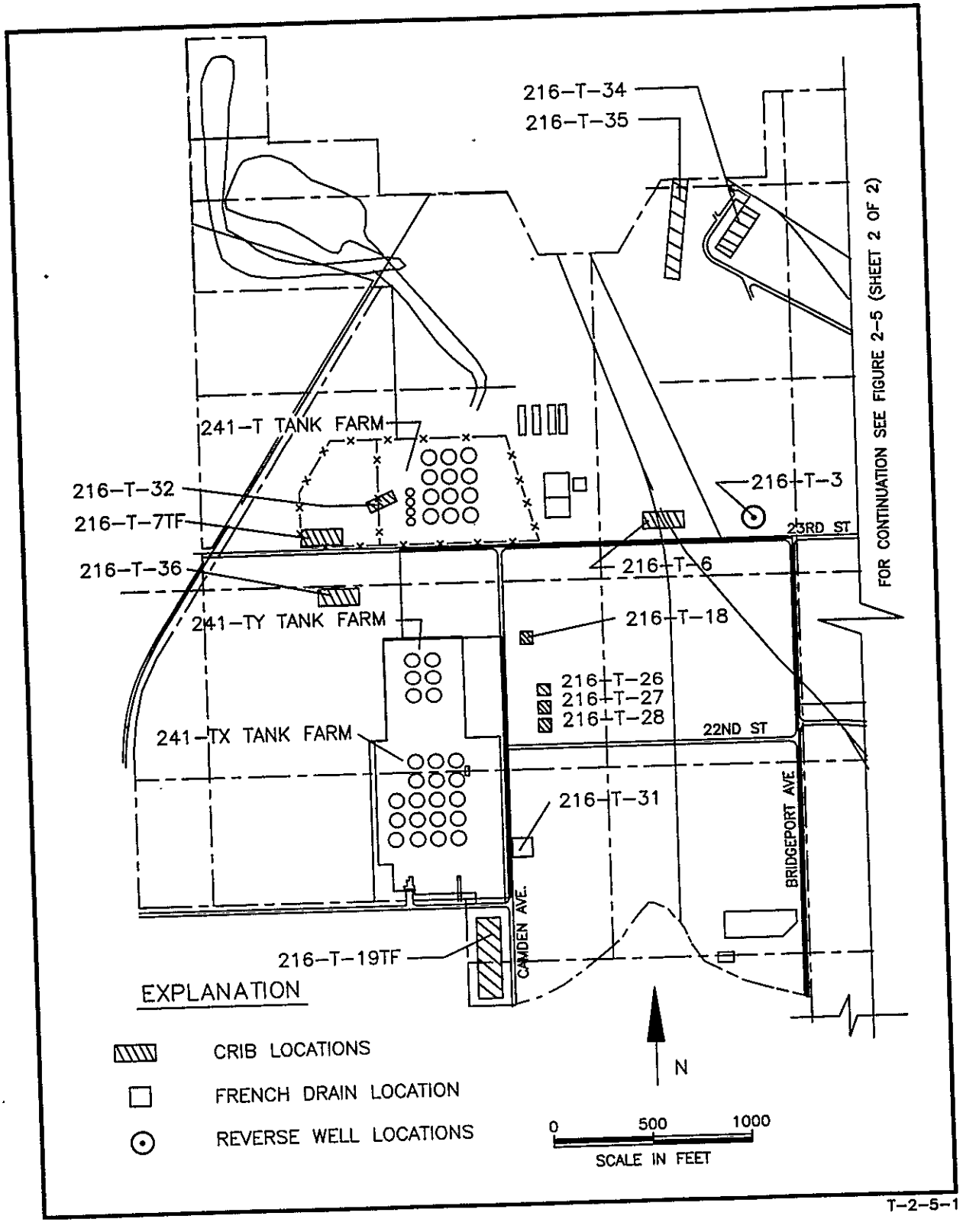

Figure 2-5. Location of Cribs, Drains, and Reverse Wells. (2 of 2)

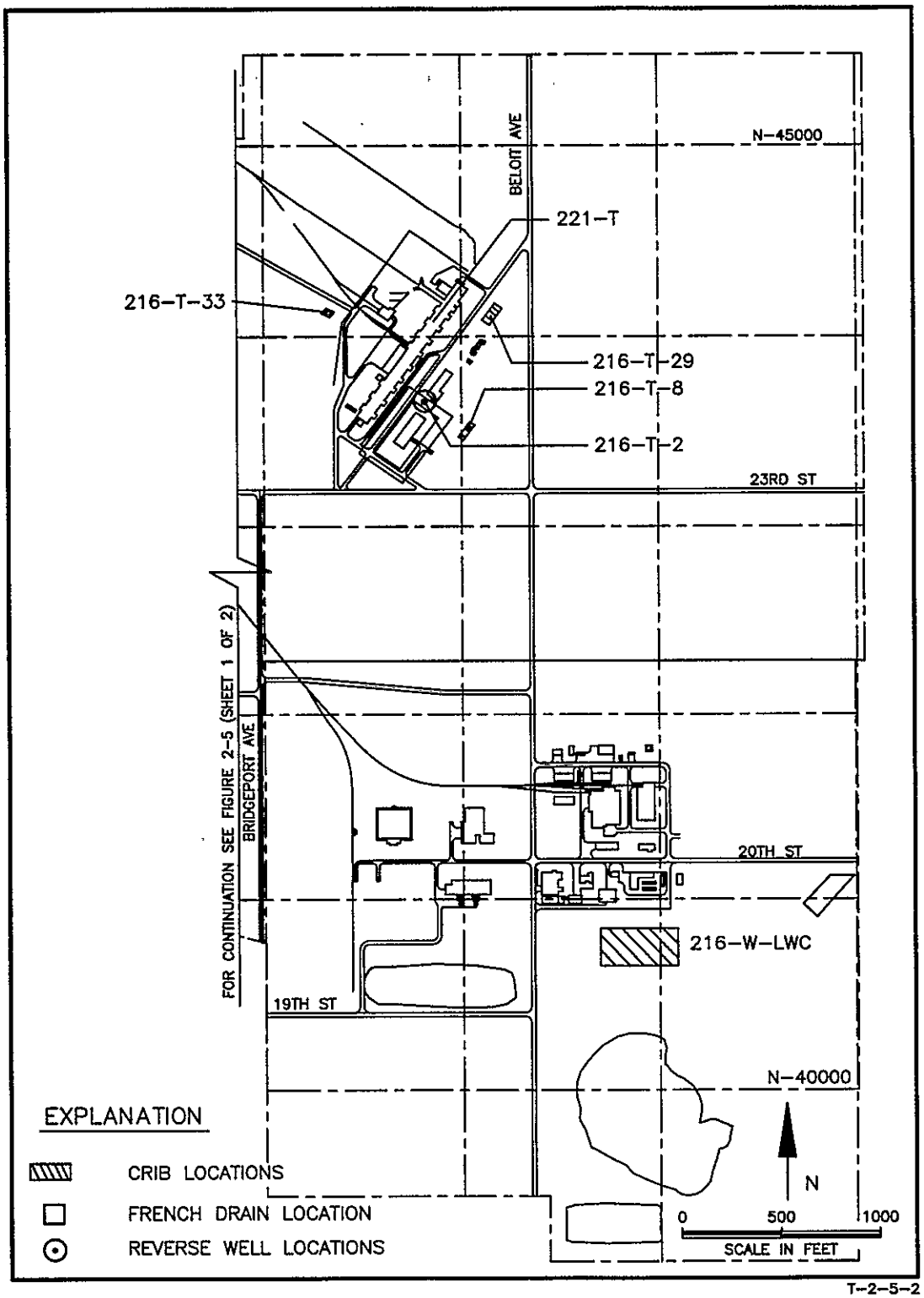

Figure 2-6. Typical French Drain.

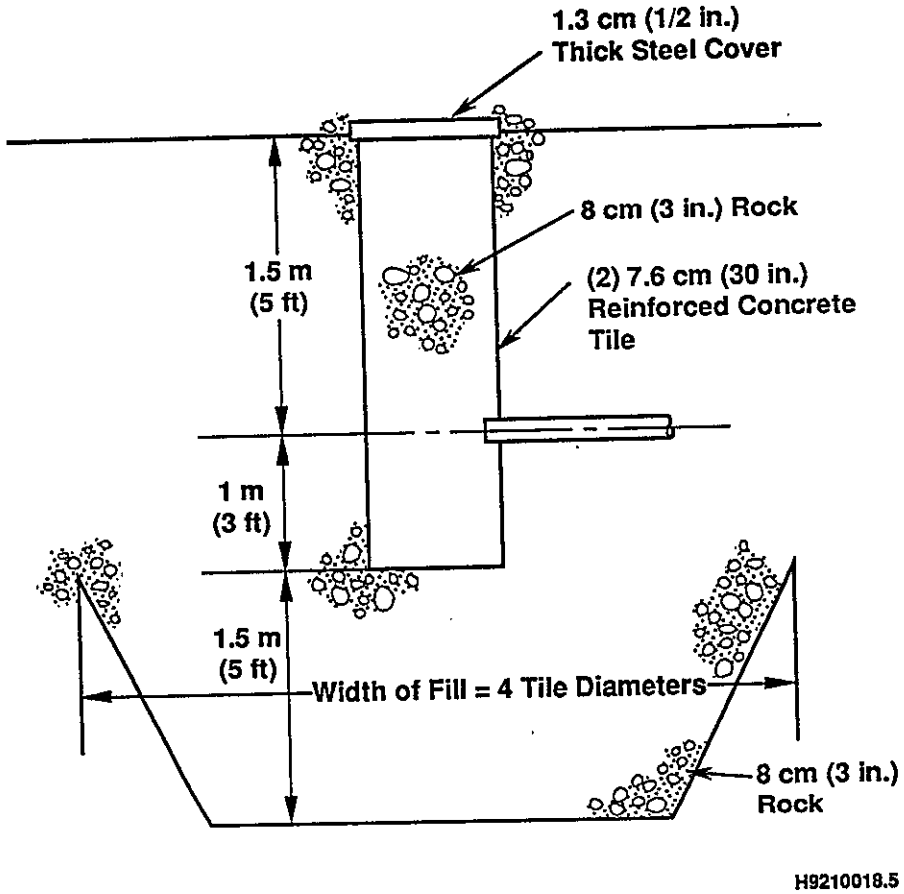

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Figure 2-7. Typical Crib. (1 of 2)

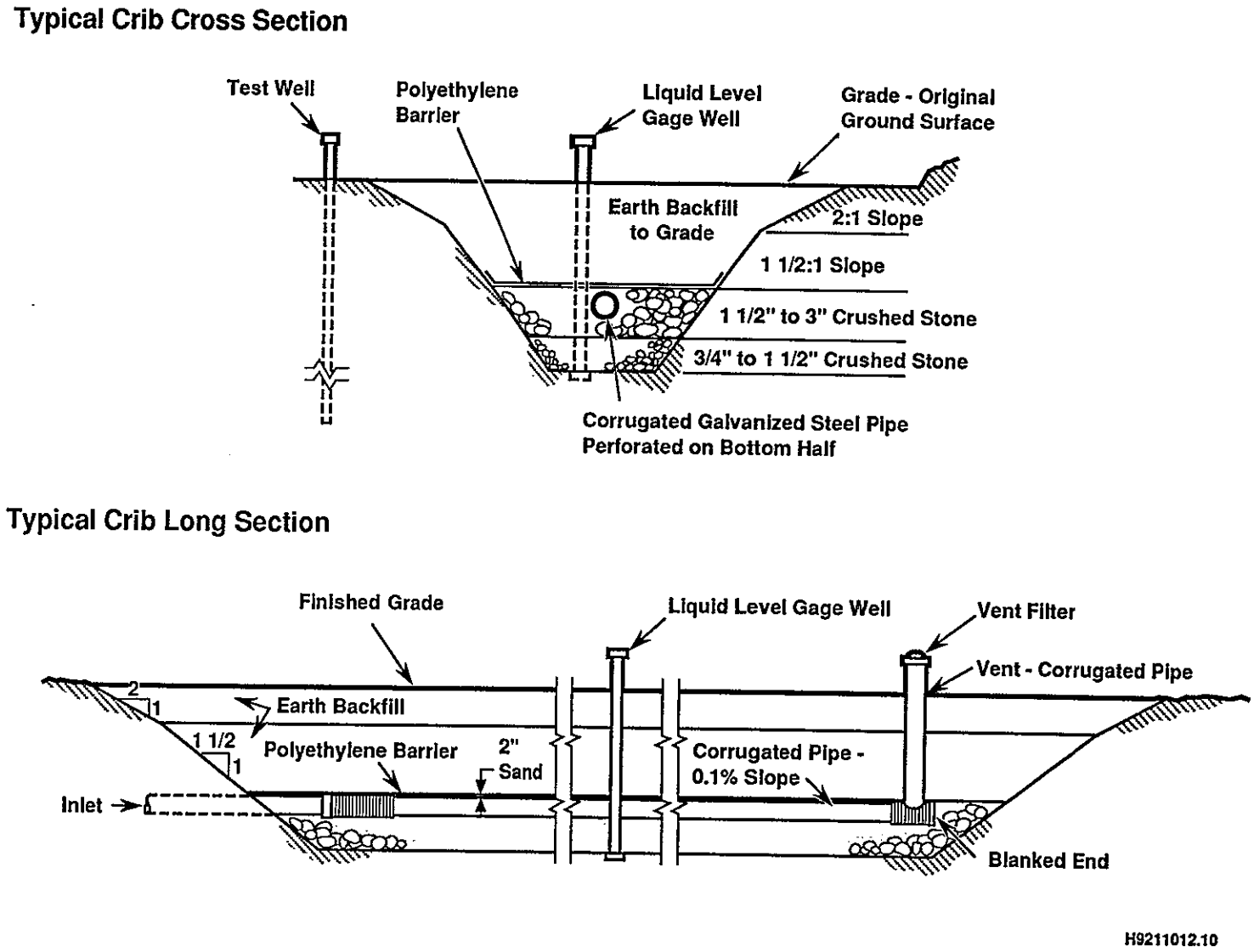


Figure 2-7. Typical Crib. (2 of 2)

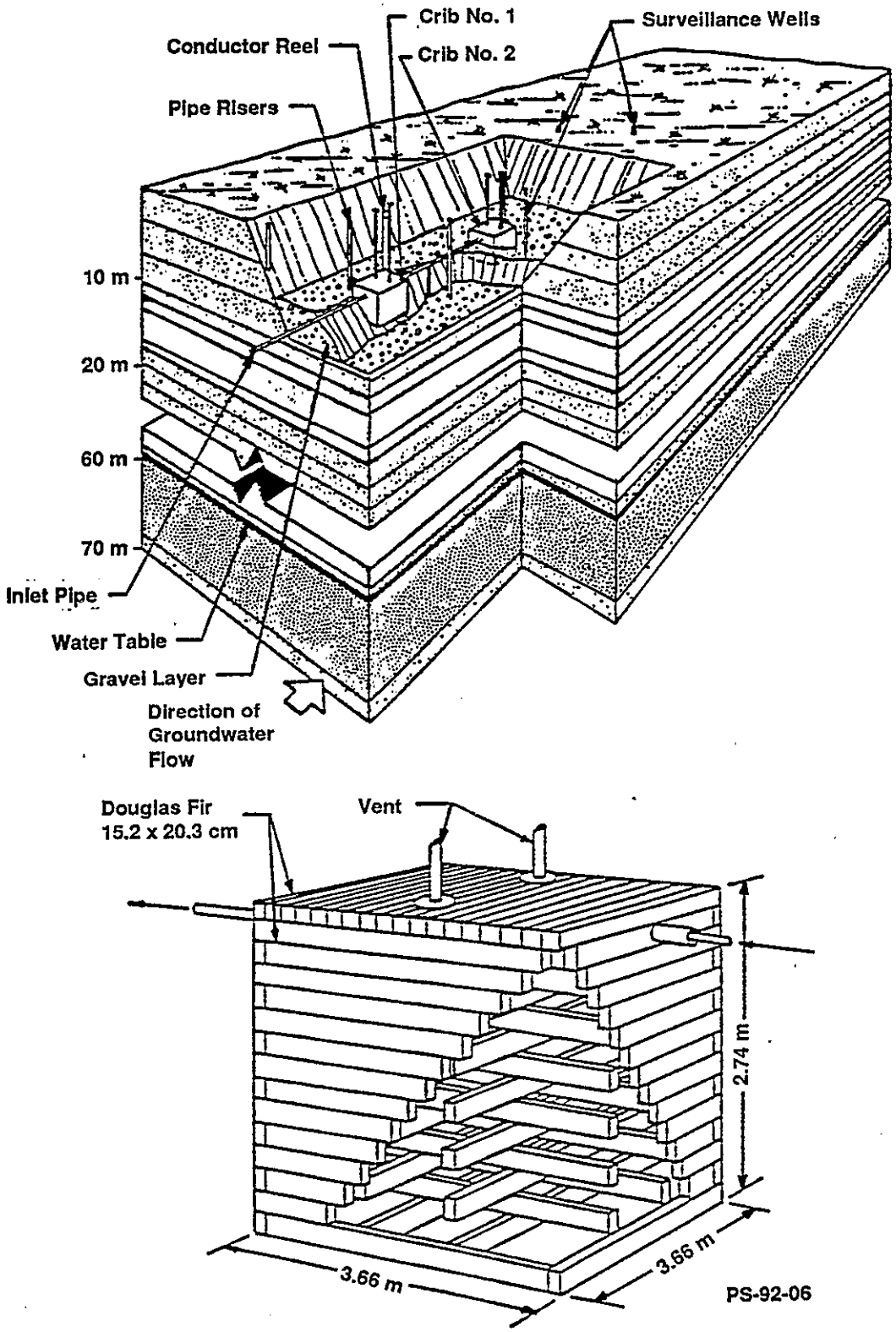
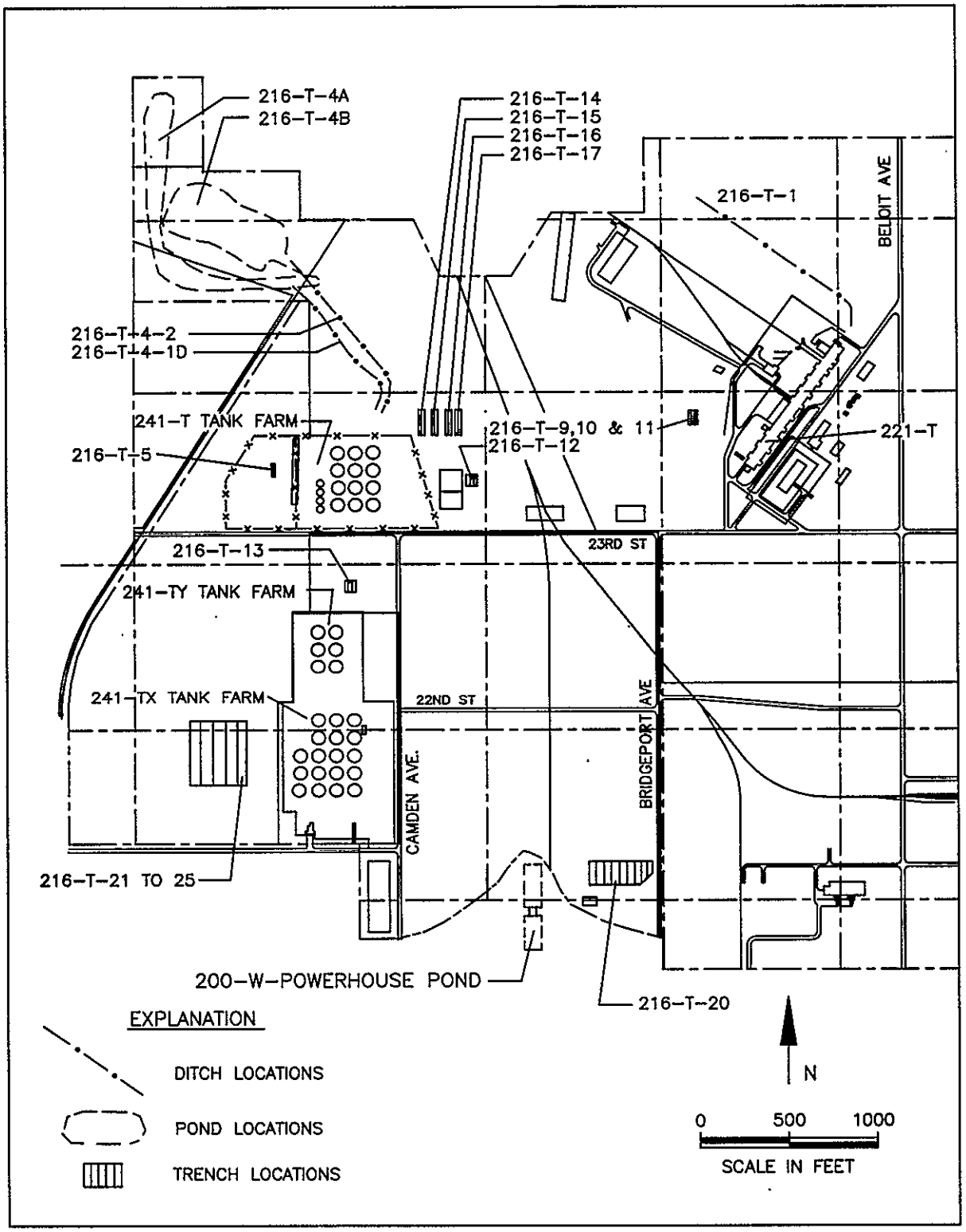
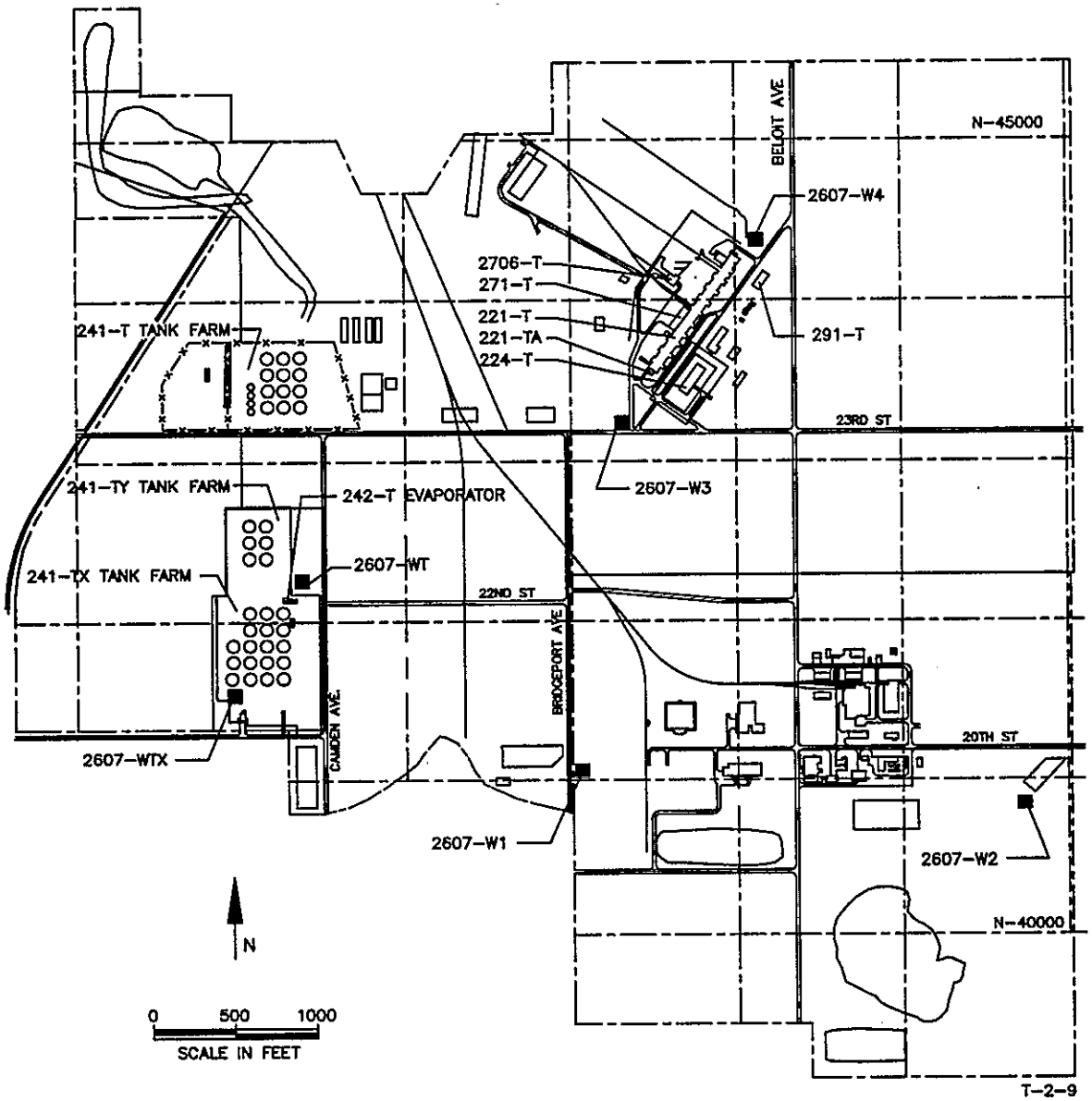


Figure 2-8. Location of Trenches, Ditches, and Ponds.



T-2-8

Figure 2-9. Location of Septic Tanks and Associated Drain Fields.



EXPLANATION

■ SEPTIC TANK LOCATIONS

Figure 2-10. Location of Process Lines. (1 of 2)

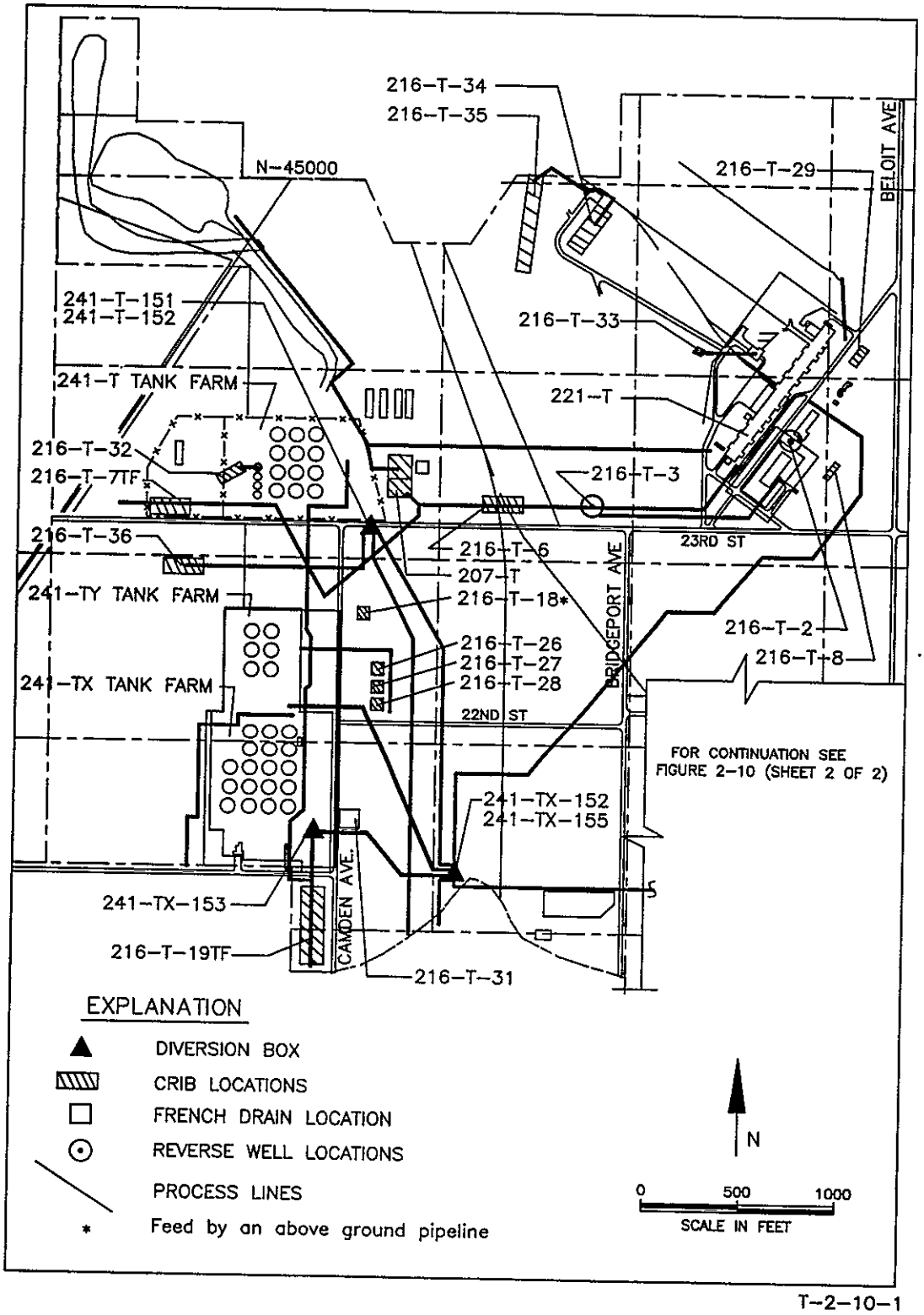


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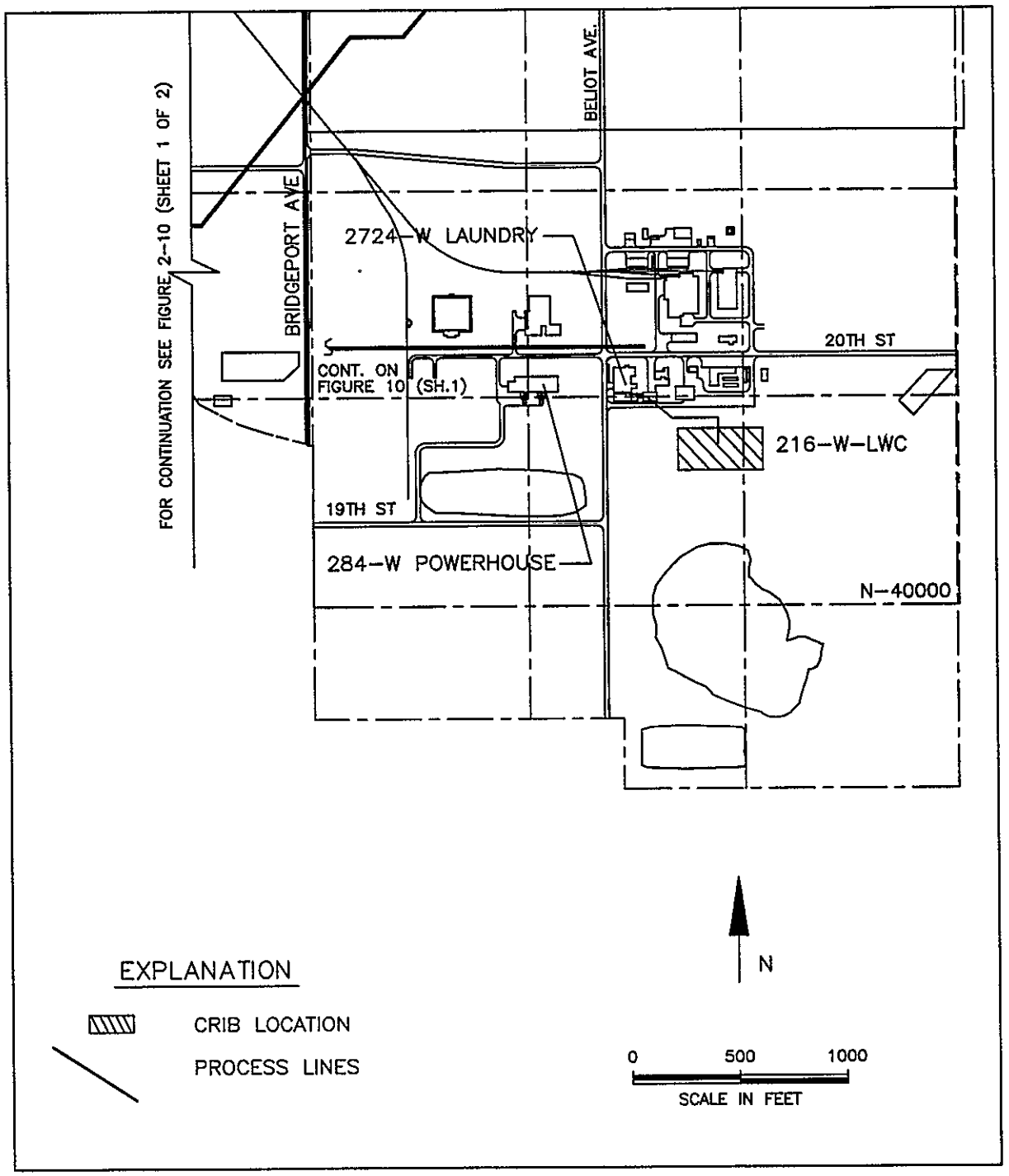
Figure 2-10. Location of Process Lines. (2 of 2)



T-2-10-2

Figure 2-11. Location of Transfer Facilities and Diversion Boxes.

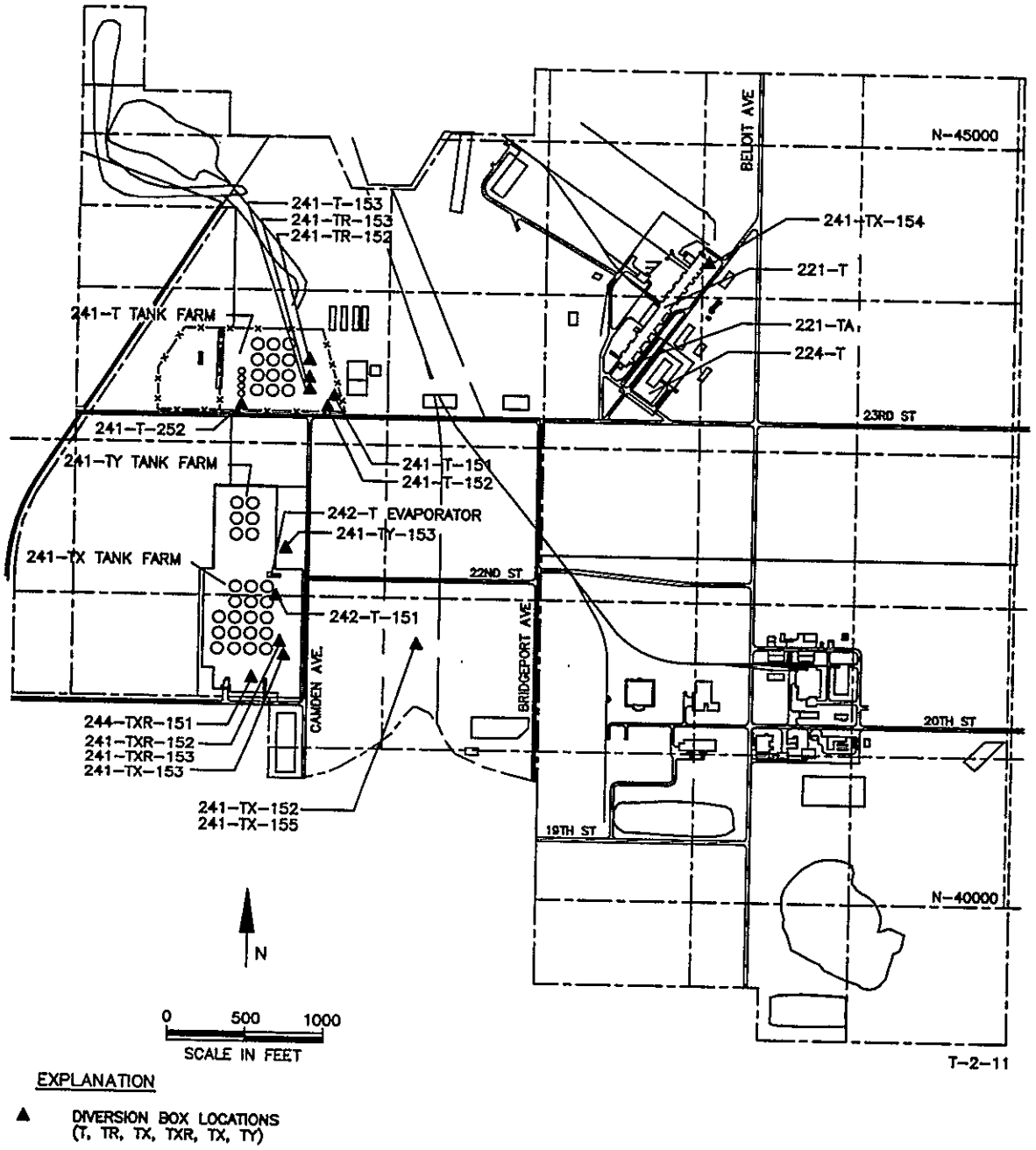


Figure 2-12. Location of Basins.

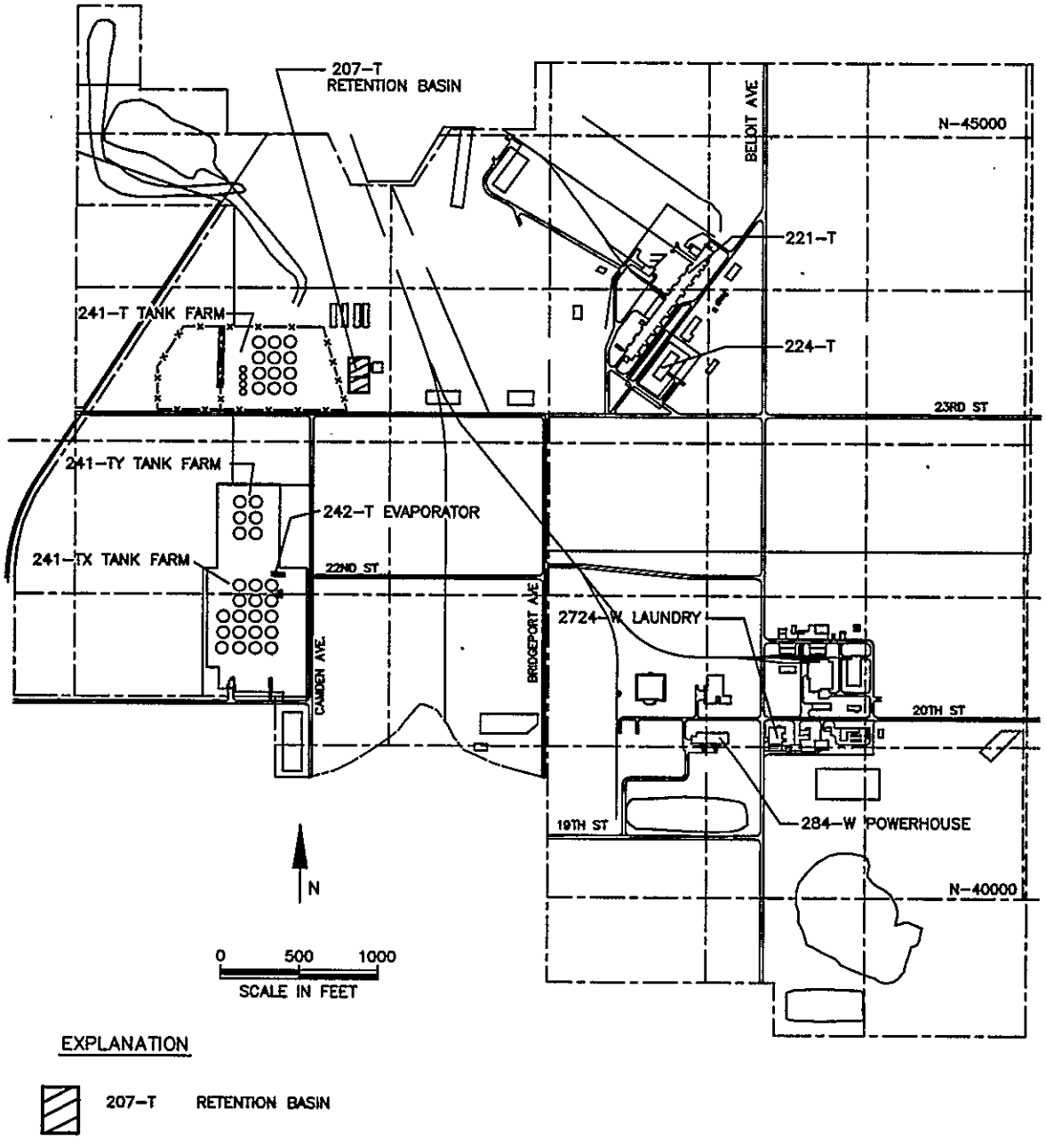


Figure 2-13. Location of Burial Sites.

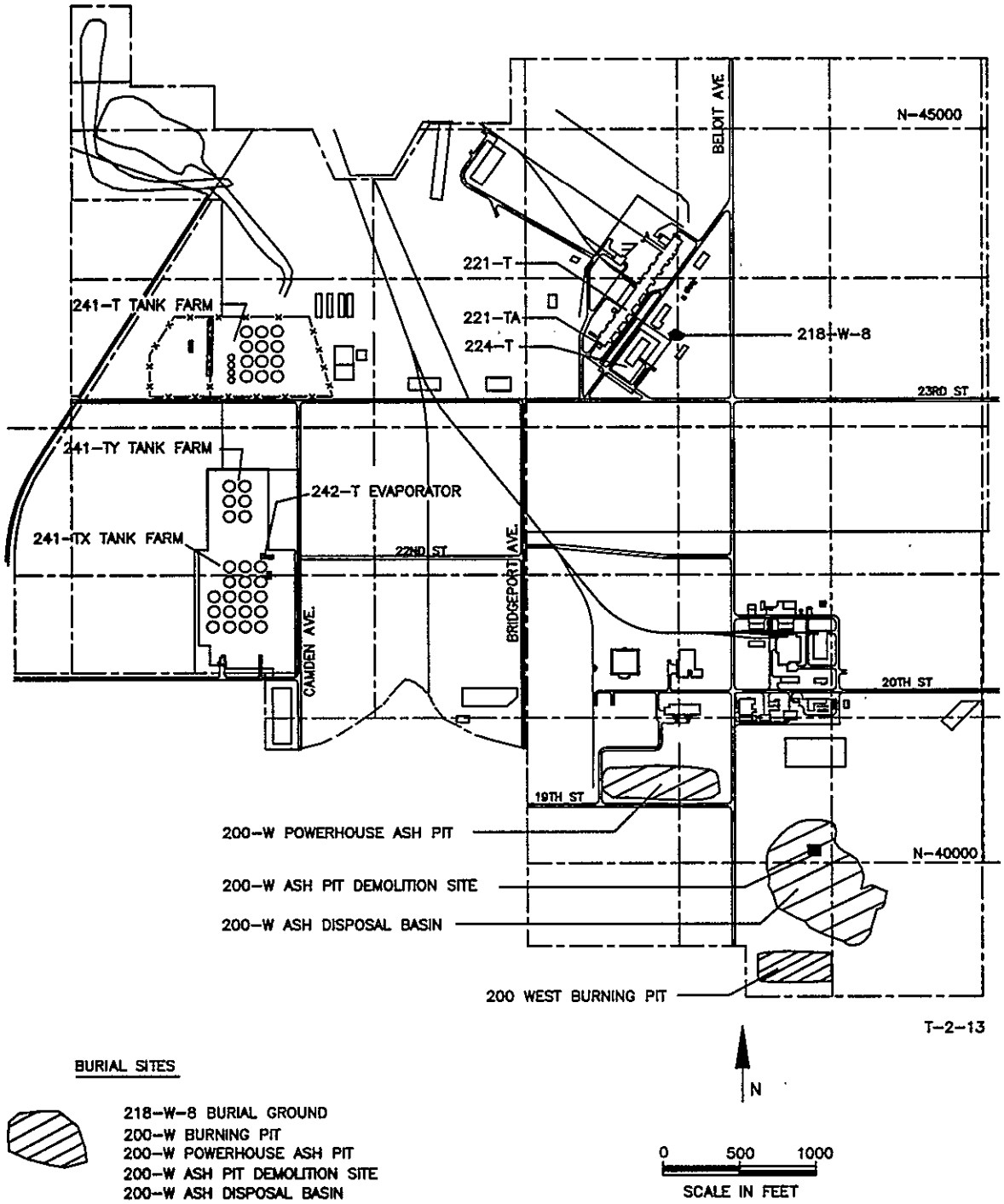


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Figure 2-14. Location of Unplanned Releases. (1 of 2)

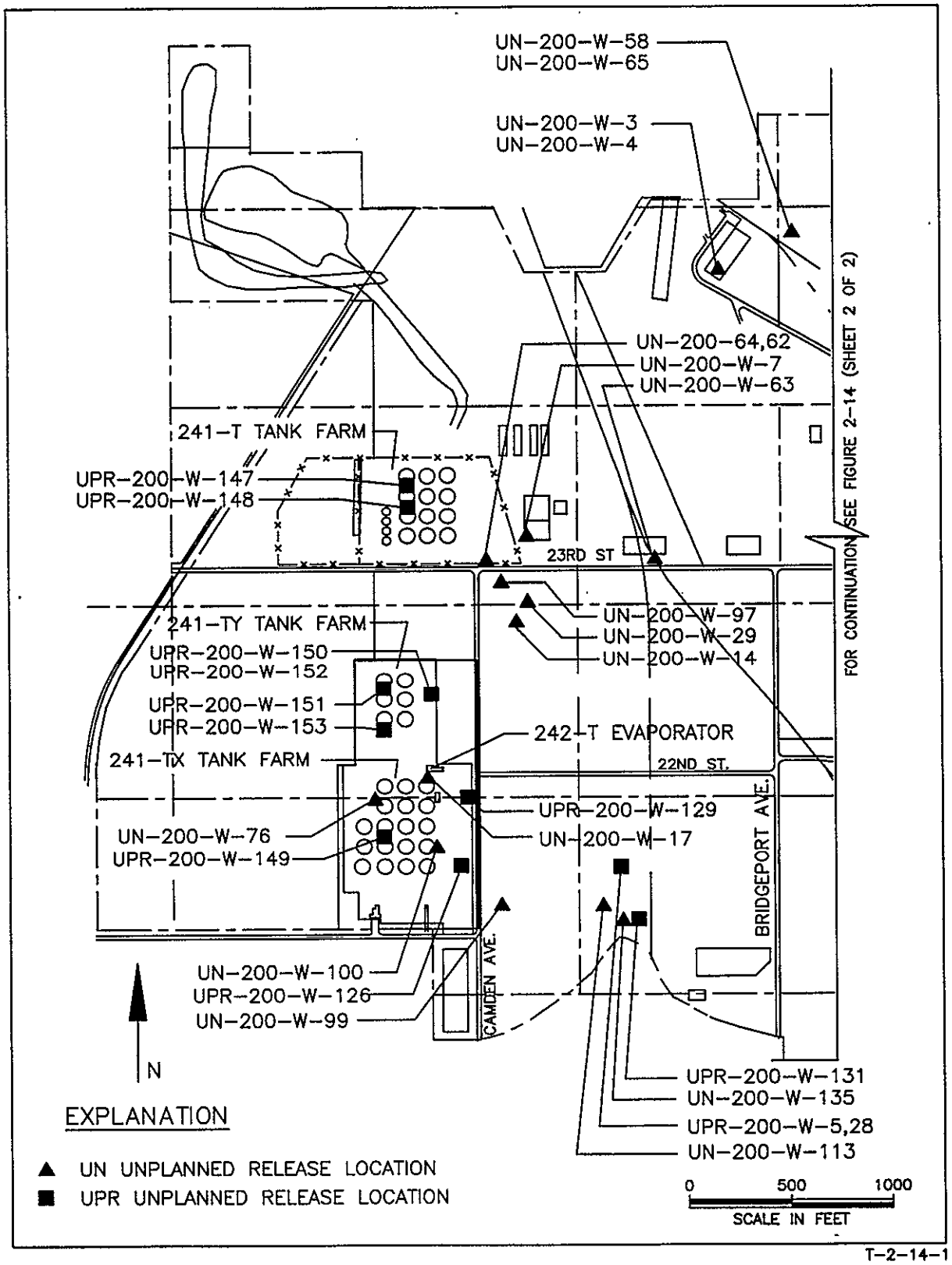
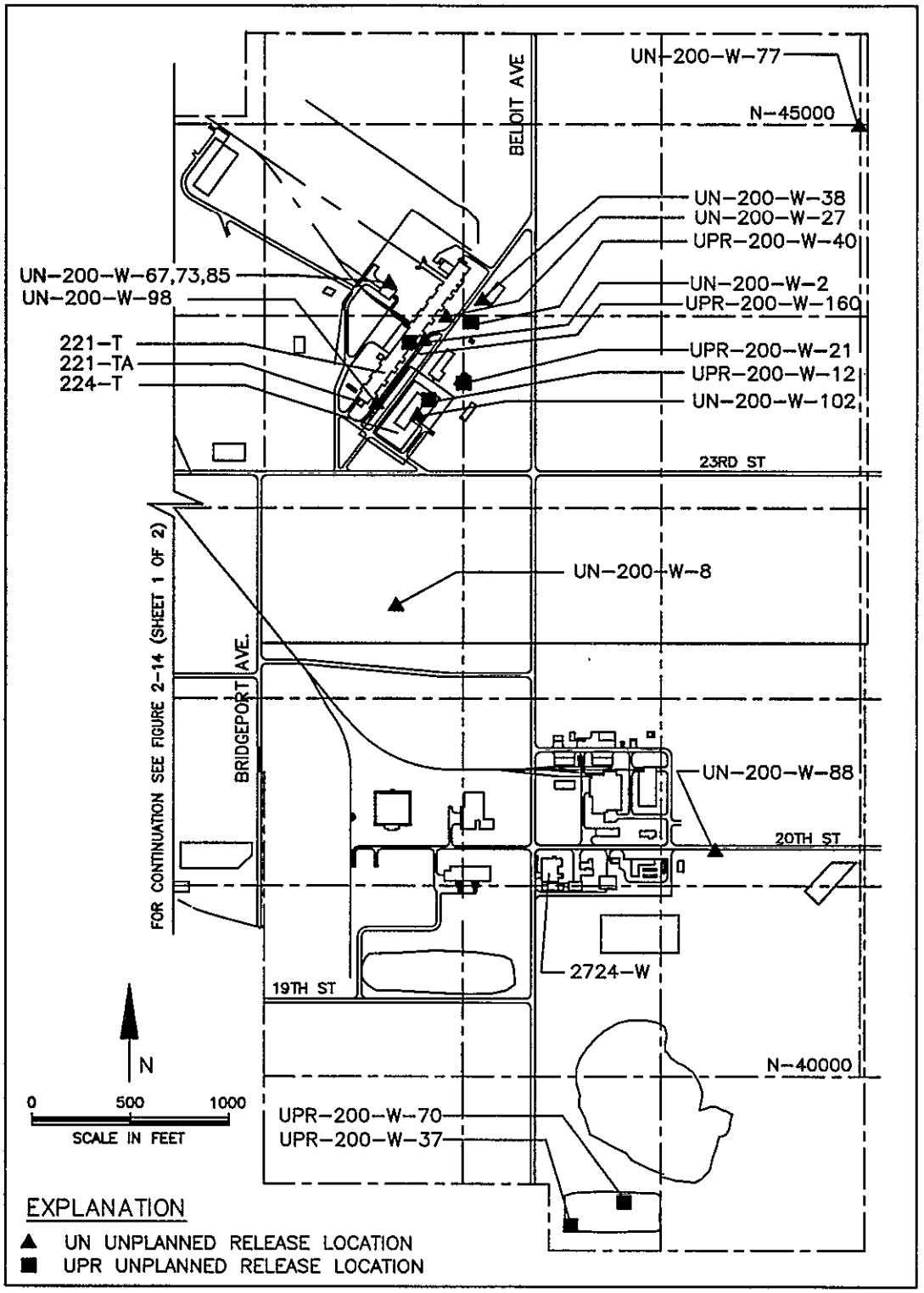
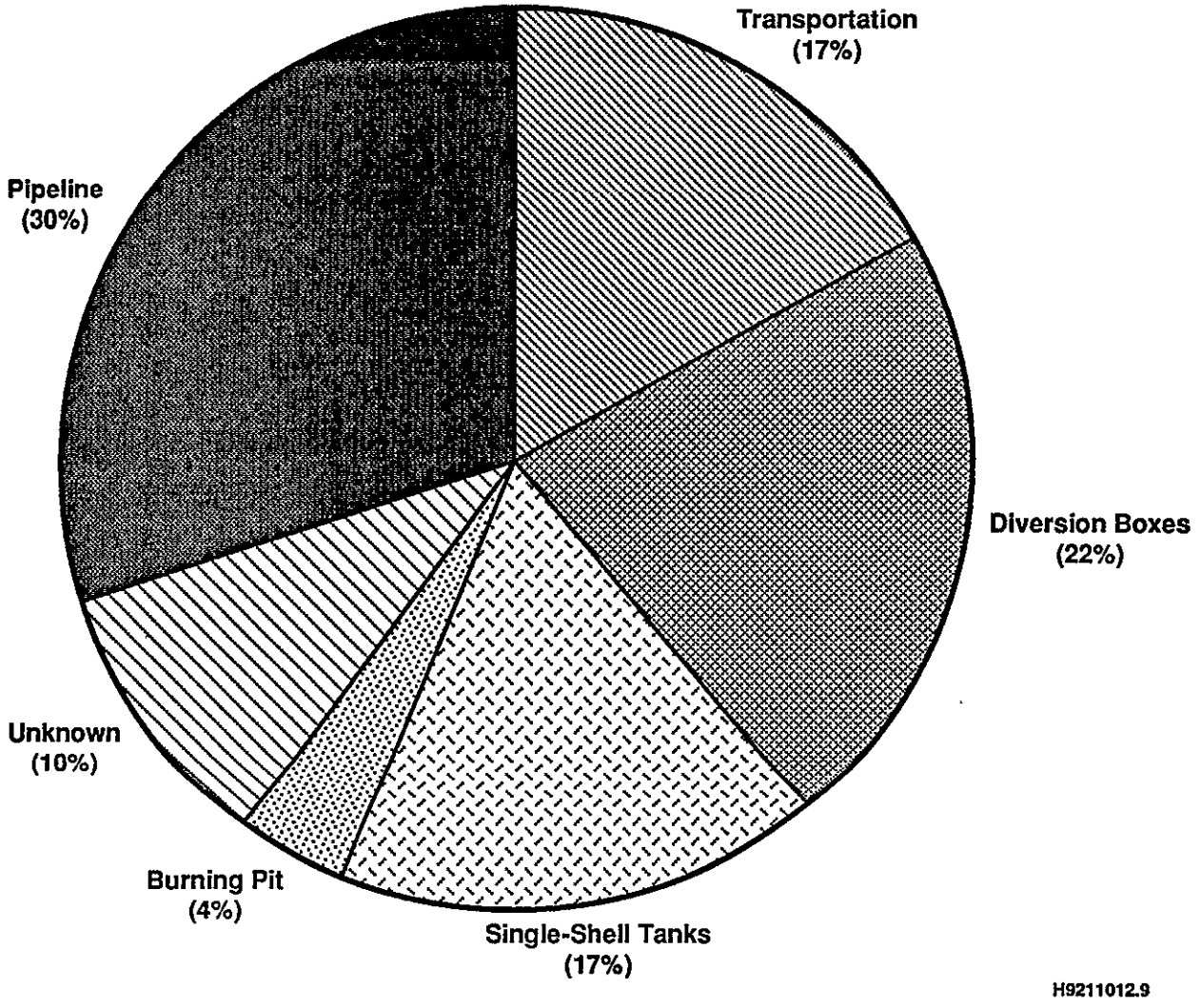


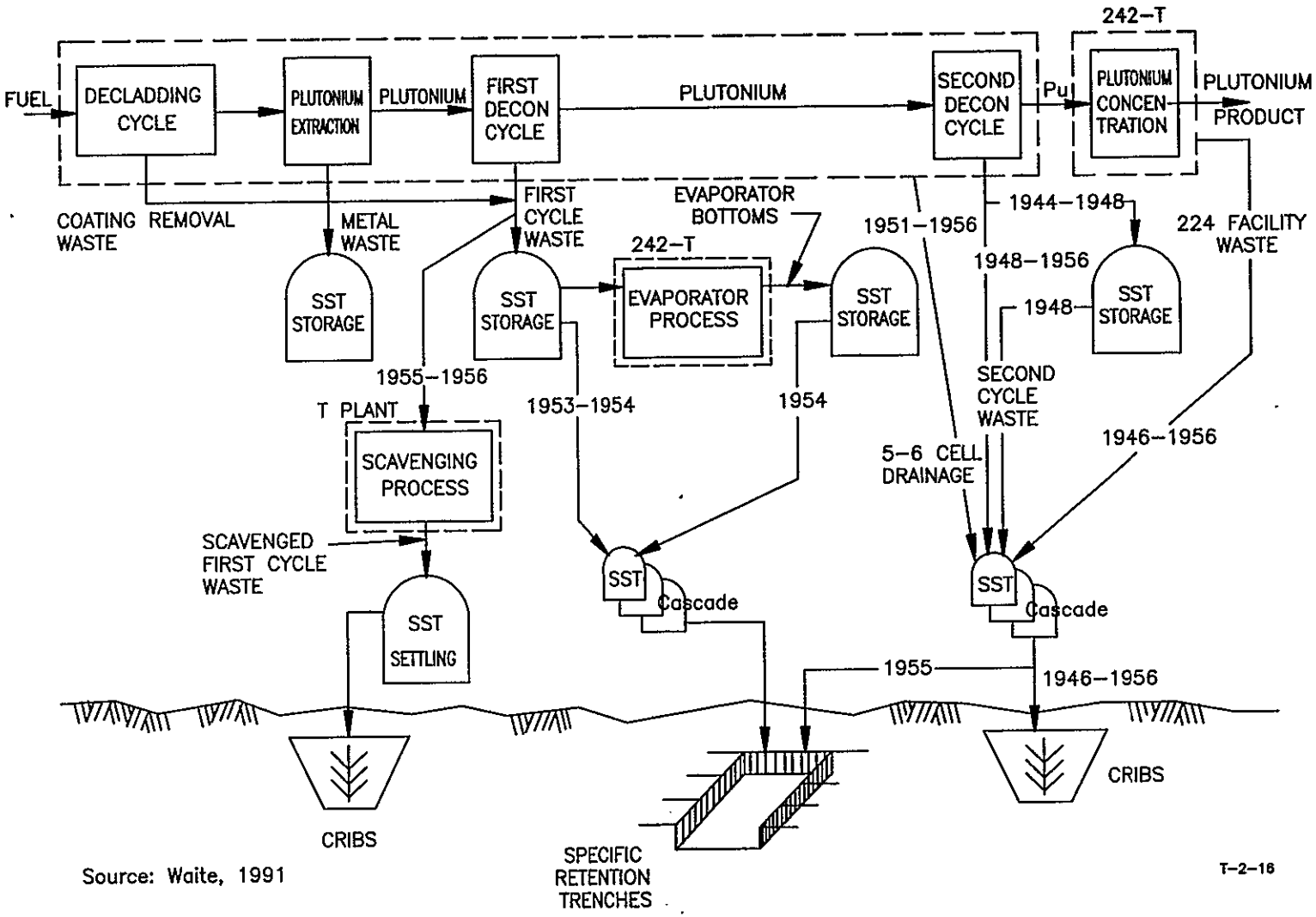
Figure 2-14. Location of Unplanned Releases. (2 of 2)



T-2-14-2

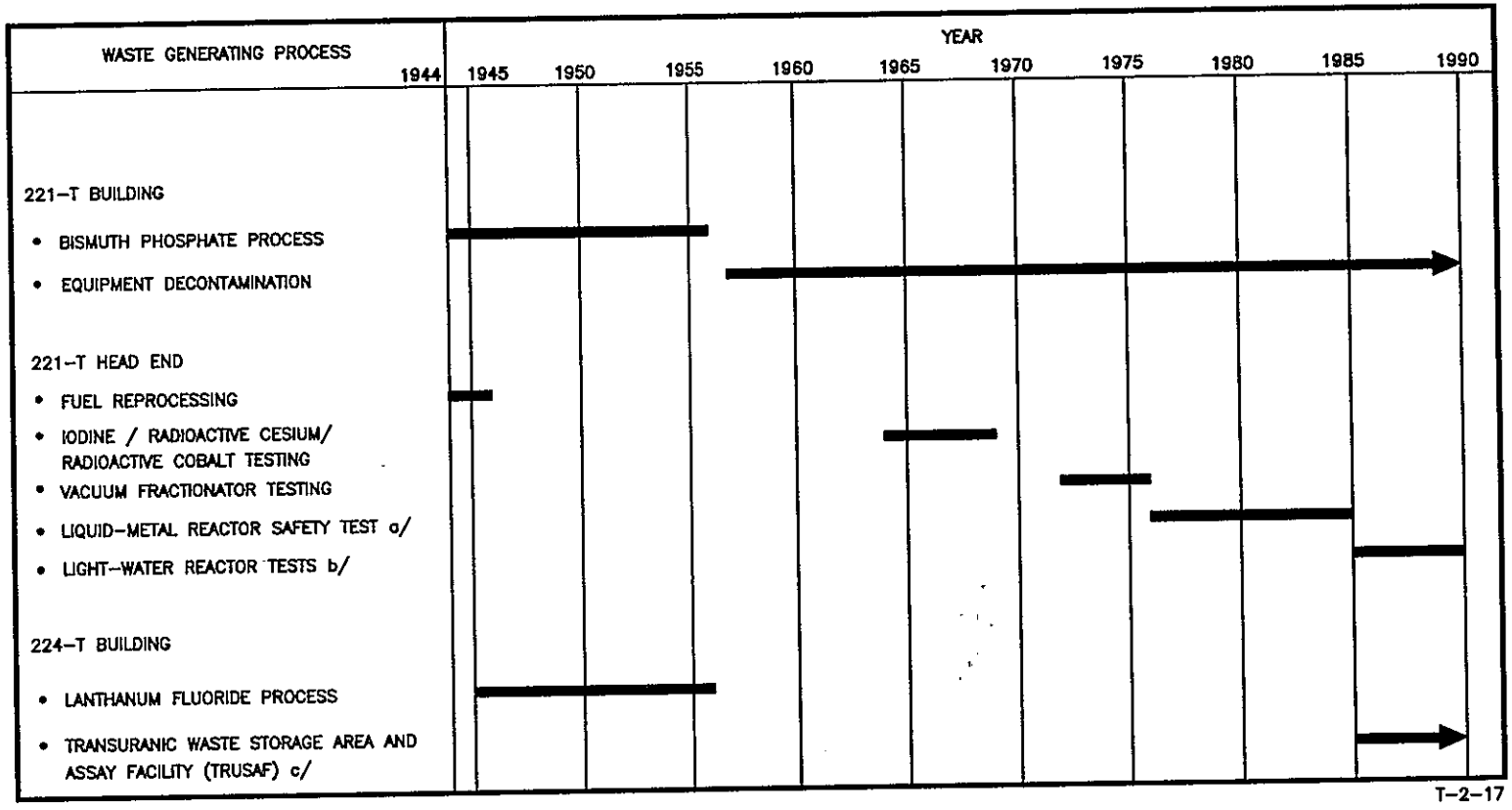
Figure 2-15. Unplanned Releases for the T Plant Aggregate Area.





Source: Waite, 1991

Figure 2-16. Waste Producing Diagram Fuel Reprocessing in T Plant.



NOTE:

a/ USED NON-RADIOACTIVE SODIUM, LITHIUM, AND SODIUM IODIDE

b/ USED NON-RADIOACTIVE CESIUM, MANGANESE, ZINC, LITHIUM SULFATE, IODINE, HYDROGEN IODIDE

c/ OPERATION CONSISTS OF NONDESTRUCTIVE ASSAY AND NONDESTRUCTIVE EXAMINATION OF NEWLY GENERATED CONTACT-HANDLED SOLID WASTE.

Source: Ayster et al, 1990

Figure 2-17. Process History of T Plant Aggregate Area.

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Table 2-1. Summary of Waste Management Units[a].

Waste Management Unit (alias)	Source Description/Type	Waste Volume Received (L)	Contaminated Soil Volume (m^3)	Operable Unit
	Tanks and Vaults			
241-T-101 Single-Shell Tank	Bismuth phosphate metal waste, tributyl phosphate, supernatant containing coating waste, REDOX ion exchange waste, REDOX HLW, PNL, decontamination waste, evaporator, bottom 224-U waste/MW	504,000[b]	NA	200-TP-6
241-T-102 Single-Shell Tank	Bismuth phosphate metal waste, REDOX coating supernatant containing REDOX HLW, evaporator bottoms, B Plant ion exchange, and B Plant LLW from tank farms/MW	122,000[b]	NA	200-TP-6
241-T-103 Single-Shell Tank	Bismuth phosphate metal waste, coating waste and supernatant containing B Plant LLW, REDOX ion exchange, REDOX HLW, and evaporator bottoms/MW	103,000[b]	NR	200-TP-6
241-T-104 Single-Shell Tank	Bismuth phosphate first-cycle waste/MW	445,000[b]	NA	200-TP-6
241-T-105 Single-Shell Tank	Bismuth phosphate first-cycle and second-cycle waste, REDOX coating, decontamination waste, Hanford Laboratory operations waste, supernatant containing LLW, and ion exchange waste from tanks/MW	371,000[b]	NA	200-TP-6
241-T-106 Single-Shell Tank	Bismuth phosphate first-cycle and supernatant containing coating waste, B Plant LLW, and ion exchange waste from tank farms/MW	80,000[b]	NR	200-TP-6
241-T-107 Single-Shell Tank	Bismuth phosphate first-cycle, tributyl phosphate, supernatant containing bismuth phosphate first-cycle, ion exchange, and coating waste from tank farms/MW	682,000[b]	NR	200-TP-6
241-T-108 Single-Shell Tank	Tributyl phosphate, bismuth phosphate first-cycle, Hanford Laboratory operations waste, supernatant tributyl phosphate, B Plant LLW, ion exchange, and evaporator bottoms from tank farms/MW	167,000[b]	NR	200-TP-6

Table 2-1. Summary of Waste Management Units[a].

Waste Management Unit (alias)	Source Description/Type	Waste Volume Received (L)	Contaminated Soil Volume (m^3)	Operable Unit
241-T-109 Single-Shell Tank	Bismuth phosphate first-cycle, tributyl phosphate, and supernatant containing tributyl phosphate, ion exchange, evaporator bottoms, and PNL waste from tank farms/MW	220,000[b]	NR	200-TP-6
241-T-110 Single-Shell Tank	Bismuth phosphate second-cycle and 224-U Building waste/MW	1,435,000[b]	NA	200-TP-6
241-T-111 Single-Shell Tank	Bismuth phosphate second-cycle and 224-U Building waste/MW	1,734,000[b]	NR	200-TP-6
241-T-112 Single-Shell Tank	Bismuth phosphate second-cycle waste, PNL waste, and supernatant containing B Plant LLW, ion exchange from 241-T tanks, and decontamination waste/MW	254,000[b]	NA	200-TP-6
241-T-201 Single-Shell Tank	224-U Building waste/MW	110,000[b]	NA	200-TP-6
241-T-202 Single-Shell Tank	224-U Building waste/MW	80,000[b]	NA	200-TP-6
241-T-203 Single-Shell Tank	224-U Building waste/MW	133,000[b]	NA	200-TP-6
241-T-204 Single-Shell Tank	224-U Building waste/MW	144,000[b]	NA	200-TP-6
241-TX-101 Single-Shell Tank	Bismuth phosphate metal waste, supernatant containing REDOX and HLW, coating waste, tributyl phosphate, bismuth phosphate first-cycle waste, REDOX and waste fractionization ion exchange, B Plant HLW and LLW, non-complexed waste, PUREX LLW, organic wash, partial neutralization feed, and evaporator bottoms and decontamination waste from tanks/MW	330,000[b]	NA	200-TP-5
241-TX-102 Single-Shell Tank	Bismuth phosphate metal waste, 242-T Evaporator waste, supernatant containing REDOX HLW, evaporator bottoms from 241-TX tanks/MW	428,000[b]	NA	200-TP-5

Table 2-1. Summary of Waste Management Units[a].

Waste Management Unit (alias)	Source Description/Type	Waste Volume Received (L)	Contaminated Soil Volume (m^3)	Operable Unit
241-TX-103 Single-Shell Tank	Bismuth phosphate metal waste, 242-T Evaporator waste, supernatant containing bismuth phosphate metal, non-complexed waste, tributyl phosphate, and partial neutralization feed from 241-TX tanks/MW	594,000[b]	NA	200-TP-5
241-TX-104 Single-Shell Tank	Bismuth phosphate metal waste, 242-T Evaporator waste, supernatant containing REDOX ion exchange, and HLW, PUREX organic wash waste, B Plant LLW and tributyl phosphate from 241-TY and -TX tanks/MW	246,000[b]	NA	200-TP-5
241-TX-105 Single-Shell Tank	Bismuth phosphate metal waste, 242-T Evaporator waste, supernatant containing REDOX ion exchange, and HLW, PUREX organic wash waste from 241-BX and -SX Tank Farms/MW	2,305,000[b]	NR	200-TP-5
241-TX-106 Single-Shell Tank	Bismuth phosphate metal waste, tributyl phosphate, 242-T Evaporator waste, supernatant containing REDOX ion HLW, PUREX organic wash waste, evaporator bottoms, and coating waste from 241-TX tanks/MW	1,715,000[b]	NA	200-TP-5
241-TX-107 Single-Shell Tank	Bismuth phosphate metal waste, 242-T Evaporator waste, supernatant containing bismuth phosphate metal, and REDOX HLW from 241-TX tanks/MW	136,000[b]	NR	200-TP-5
241-TX-108 Single-Shell Tank	Bismuth phosphate metal waste, REDOX HLW, 242-T Evaporator waste, supernatant containing decontamination waste, tributyl phosphate, and evaporator bottoms from 241-TX and -TY tanks/MW	507,000[b]	NA	200-TP-5
241-TX-109 Single-Shell Tank	Bismuth phosphate first-cycle waste, 242-T Evaporator waste, supernatant containing bismuth phosphate first-cycle waste, and evaporator bottoms from 241-T, -TX, -TY tanks/MW	1,453,000[b]	NA	200-TP-5
241-TX-110 Single-Shell Tank	Bismuth phosphate first-cycle waste, and 242-T Evaporator waste/MW	1,749,000[b]	NR	200-TP-5

Table 2-1. Summary of Waste Management Units[a].

Waste Management Unit (alias)	Source Description/Type	Waste Volume Received (L)	Contaminated Soil Volume (m^3)	Operable Unit
241-TX-111 Single-Shell Tank	Bismuth phosphate first-cycle waste, and 242-T Evaporator waste, and supernatant containing tributyl phosphate waste from 241-TX tanks/MW	1,400,000[b]	NA	200-TP-5
241-TX-112 Single-Shell Tank	242-T Evaporator waste, bismuth phosphate first-cycle waste, and supernatant containing evaporator bottoms from 241-TX tanks/MW	2,457,000[b]	NA	200-TP-5
241-TX-113 Single-Shell Tank	242-T Evaporator waste and supernatant containing evaporator bottoms from 241-TX tanks/MW	2,298,000[b]	NR	200-TP-5
241-TX-114 Single-Shell Tank	242-T Evaporator waste and supernatant containing bismuth phosphate first-cycle waste and evaporator bottoms from 241-TX tanks/MW	2,025,000[b]	NR	200-TP-5
241-TX-115 Single-Shell Tank	242-T Evaporator waste, tributyl phosphate waste, coating waste, decontamination waste, supernatant containing bismuth phosphate metal, evaporator bottoms from 241-U, -S, -T, -TX tanks/MW	2,422,000[b]	NR	200-TP-5
241-TX-116 Single-Shell Tank	Supernatant containing evaporator bottoms from 241-TX tanks/MW	2,388,000[b]	NR	200-TP-5
241-TX-117 Single-Shell Tank	Supernatant containing first-cycle waste and evaporator bottoms from 241-TX tanks/MW	2,369,000[b]	NR	200-TP-5
241-TX-118 Single-Shell Tank	242-T Evaporator feed tank waste, 234-Z and 235-Z Buildings waste, caustic solution, tributyl phosphate, decontamination waste, supernatant containing tributyl phosphate, bismuth phosphate first-cycle waste, evaporator bottoms, partial neutralization feed, and coating waste from 241-T, -TX, -TY, -U tanks/MW	1,313,400[b]	NA	200-TP-5
241-TY-101 Single-Shell Tank	Bismuth phosphate first-cycle waste and supernatant containing bismuth phosphate, first cycle waste; tributyl phosphate waste; and evaporator bottoms from 241-TY, -TX, and -SX Tank Farms/MW	447,000[b]	NR	200-TP-5
241-TY-102 Single-Shell Tank	Supernatant containing B Plant LLW, REDOX HLW, PUREX organic wash waste, REDOX ion exchange waste, and evaporator bottoms from 241-TX and -TY tanks/MW	242,000[b]	NA	200-TP-5

Table 2-1. Summary of Waste Management Units[a].

Waste Management Unit (alias)	Source Description/Type	Waste Volume Received (L)	Contaminated Soil Volume (m^3)	Operable Unit
241-TY-103 Single-Shell Tank	Bismuth phosphate first-cycle waste and supernatant containing bismuth phosphate, first cycle waste; tributyl phosphate waste; PUREX organic wash waste, REDOX ion exchange waste, coating waste, evaporator bottoms, and decontamination waste from 241-BX, -T, -TX, -TY and -AX tanks/MW	61,300[b]	NR	200-TP-5
241-TY-104 Single-Shell Tank	Tributyl phosphate waste; supernatant containing REDOX ion exchange waste; PUREX organic wash waste, bismuth phosphate first-cycle waste, tributyl phosphate waste, and decontamination waste from 241-TX and -TY Tank Farms/MW	174,000[b]	NR	200-TP-5
241-TY-105 Single-Shell Tank	Tributyl phosphate waste/MW	874,000[b]	NR	200-TP-5
241-TY-106 Single-Shell Tank	Tributyl phosphate waste/MW	64,000[b]	NR	200-TP-5
241-T-361 Settling Tank	Radioactively contaminated liquid from T-Plant/MW	105,980[a]	NA	200-TP-4
241-T-301 Catch Tank	Mixed waste liquid/MW	NR	NA	200-TP-6
241-T-302 Catch Tank	Mixed waste liquid/MW	NR	NA	200-TP-6
241-TX-302A Catch Tank	Waste solutions from processing and decontamination operations/MW	NR	NA	200-TP-5
241-TX-302B Catch Tank	Waste solutions from processing and decontamination operations/MW	NR	NA	200-TP-5
241-TX-302C Catch Tank	Waste solutions from processing and decontamination operations/MW	11,520[b]	NA	200-TP-4
241-TY-302A Catch Tank	Waste solutions from processing and decontamination operations/MW	NR	NA	200-TP-5

Table 2-1. Summary of Waste Management Units[a].

Waste Management Unit (alias)	Source Description/Type	Waste Volume Received (L)	Contaminated Soil Volume (m^3)	Operable Unit
241-TY-302B Catch Tank	Waste solutions from processing and decontamination operations/MW	NR	NA	200-TP-5
244-TXR Receiver Tank[d]	Waste from 241-T, -TX, -TY Tank Farms, and Z Plant/MW	98,480[b]	NA	200-TP-5
244-TXR Vault[d]	Waste uranium slurry generated from T Plant via the 241-T and 241-TX Tank Farms/MW	NA	NA	200-TP-5
Cribs and Drains				
216-T-6 Crib (241-T-361, 361-T-1 and -2 Cribs	Cell drainage from tanks in 221-T Building. The waste is low salt and neutral/basic/TRU, MW	45,000,000	290	200-TP-3
216-T-7TF Crib and Tile Field (241-T-3 Crib and Tile Field	Second-cycle supernatant waste from 221-T Building. Effluents plus waste via tank farm. The waste is high salt and neutral/basic/MW	110,000,000	4,500	200-TP-1
216-T-8 Crib (222-T-1 and -2 Cribs)	Decontamination sink waste and sample slurper waste. The waste is neutral/basic/MW	500,000	220	200-TP-4
216-T-18 Crib (216-T-17 Crib)	First-cycle scavenged tributyl phosphate supernatant waste/TRU, MW	1,000,000	590	200-TP-2
216-T-19TF Crib and Tile Field (241-TX-153 Crib and Tile Field)	Process condensate from waste evaporator, cell drainage, second-cycle supernatant waste, condensate and steam condensate/MW	455,000,000	4,500	200-TP-2
216-T-26 Crib (216-TY-1 Cavern)	First-cycle scavenged tributyl phosphate supernatant waste/MW	12,000,000	460	200-TP-2
216-T-27 Crib (216-TY-2 Cavern)	300 Area laboratory waste from 340 Building/MW	7,190,000	460	200-TP-2

Table 2-1. Summary of Waste Management Units[a/].

Waste Management Unit (alias)	Source Description/Type	Waste Volume Received (L)	Contaminated Soil Volume (m^3)	Operable Unit
216-T-28 Crib (216-TY-3 Cavern)	Steam condensate decontamination waste, laboratory waste, miscellaneous waste via tank farm/MW	42,300,000	460	200-TP-2
216-T-29 Crib (291-T Sand Filter and Sewer)	Condensate runoff from sand filter. The waste type is potentially acidic/MW	74,000	NR	200-TP-4
216-T-31 French Drain	Contaminated steam condensate/MW	NR	NR	200-TP-2
216-T-32 Crib (241-T-1 and -2 Cribs)	Waste from 224-T Building via tank farm/TRU, MW	29,000,000	460	200-TP-1
216-T-33 Crib	Decontamination waste from 2706-T Building/MW	1,900,000	61	200-TP-4
216-T-34 Crib	300 Area laboratory waste from the 340 Building/MW	17,300,000	1,200	200-TP-4
216-T-35 Crib	300 Area laboratory waste from the 340 Building/MW	5,720,000	1,400	200-TP-4
216-T-36 Crib	Steam condensate decontamination waste, and miscellaneous waste from 221-T and 221-U Buildings/MW	522,000	410	200-TP-1
216-W-LWC Crib[c/] (216-W-1 Laundry Waste Crib)	All process wastewater from 2724-W and 2723-W Buildings/LLW	1,200,000,000	NR	200-SS-2
Reverse Wells				
216-T-2 Reverse Well (222-T-110 Dry Well)	Decontamination sink waste and sample slurper waste from 221-T Building/MW	6,000,000	NR	200-TP-4
216-T-3 Reverse Well (241-T-361-A Dry Well	Cell drainage from Tank 5-6 in the 221-T Building and overflow waste from 241-T-361 Settling Tank/TRU, MW	11,300,000	290	200-TP-4

Table 2-1. Summary of Waste Management Units[a/].

Waste Management Unit (alias)	Source Description/Type	Waste Volume Received (L)	Contaminated Soil Volume (m^3)	Operable Unit
	Ponds, Ditches, and Trenches			
216-T-4A Pond (216-T-4 Swamp)	Process cooling water, steam condensate and condenser cooling water/MW	42,500,000,000	24,000	200-TP-3
216-T-4B Pond (216-T-4 New Pond)	Steam condensate, condenser cooling water, and nonradioactive wastewater from 221-T Building/LLW	NR	24,000	200-TP-3
216-T-1 Ditch[c/] (221-T Ditch)	Miscellaneous waste from pilot plant experimental work, intermittent decontamination waste, and waste from the head end of the 221-T Building/LLW	178,000,000[c/]	2,200	200-TP-4
216-T-4-1D Ditch (216-T-4 Swamp)	Process cooling water, steam condensate and decontamination waste from 2706-T Building/MW	NR	890	200-TP-3
216-T-4-2 Ditch[a/]	Steam condensate, condenser cooling water and nonradioactive wastewater/LLW	Volume included with 216-T-4 Pond	890	200-TP-3
200-W Powerhouse Pond	Wastes from steam production and water treatment activities/NHNR	38 L/min	NR	200-TP-2
216-T-5 Trench (216-T-12 Trench)	Second-cycle supernatant waste. The waste is high salt and neutral/basic/MW	2,600,000	44	200-TP-1
216-T-9 Trench (Decon. Trench)	Heavy equipment and vehicle decontamination waste/NHNR	NR	NR	200-TP-4
216-T-10 Trench (Decon. Trench)	Heavy equipment and vehicle decontamination waste/NHNR	NR	NR	200-TP-4
216-T-11 Trench (Decon. Trench)	Heavy equipment and vehicle decontamination waste/NHNR	NR	NR	200-TP-4
216-T-12 Trench (207-T Sludge Pit)	Contaminated sludge/MW	5,000,000	9.90	200-TP-3

Table 2-1. Summary of Waste Management Units[a/].

Waste Management Unit (alias)	Source Description/Type	Waste Volume Received (L)	Contaminated Soil Volume (m^3)	Operable Unit
216-T-13 Trench (269-W Regulated Garage)	Vehicle decontamination sludge/MW	NR	NR	200 TP-2
216-T-14 Trench (241-T-1 Trench)	First cycle supernatant waste/MW	1,000,000	110	200-TP-3
216-T-15 Trench (241-T-2 Trench)	First cycle supernatant waste/MW	1,000,000	120	200-TP-3
216-T-16 Trench (216-T-3 Trench, 216-T-15 Trench)	First cycle supernatant waste/MW	1,000,000	120	200-TP-3
216-T-17 Trench (241-T-4 Trench, 216-T-6 Trench)	First cycle supernatant waste/MW	785,000	120	200-TP-3
216-T-20 Trench (216-TX-2, 155-TX Trench)	Contaminated nitric acid/MW	18,900	2	200-TP-2
216-T-21 Trench (241-TX-1)	First cycle supernatant waste/MW	460,000	120	200-TP-1
216-T-22 Trench (241-TX-2)	First cycle supernatant waste/MW	1,530,000	120	200-TP-1
216-T-23 Trench (241-TX-3)	First cycle supernatant waste/MW	1,480,000	120	200-TP-1
216-T-24 Trench (241-TX-4)	First cycle supernatant waste/MW	1,530,000	120	200-TP-1
216-T-25 Trench (241-TX-5)	First-cycle evaporator bottoms/MW	3,000,000	89	200-TP-1

Table 2-1. Summary of Waste Management Units[a/].

Waste Management Unit (alias)	Source Description/Type	Waste Volume Received (L)	Contaminated Soil Volume (m^3)	Operable Unit
	Septic Tanks and Associated Drain Fields			
2607-W1 Septic Tank/Drain Field	Sanitary wastewater and sewage/NHNR	18,300/day	NA	200-SS-2
2607-W2 Septic Tank/Drain Field	Sanitary wastewater and sewage/NHNR	10,200/day	NA	200-SS-2
2607-W3 Septic Tank/Drain Field	Sanitary wastewater and sewage/NHNR	14,200/day	NA	200-TP-4
2607-W4 Septic Tank/Drain Field	Sanitary wastewater and sewage/NHNR	10,600/day	NA	200-TP-4
2607-WT Septic Tank/Drain Field	Sanitary wastewater and sewage/NHNR	20/day	NA	200-TP-5
2607-WTX Septic Tank/Drain Field	Sanitary wastewater and sewage/NHNR	740/day	NA	200-TP-5
	Transfer Facilities, Diversion Boxes, and Pipelines			
241-T-151 Diversion Box	Waste solutions from processing and decontamination operations/MW	NA	NA	200-TP-6
241-T-152 Diversion Box	Waste solutions from processing and decontamination operations/MW	NA	NA	200-TP-6
241-T-153 Diversion Box	Waste solutions from processing and decontamination operations/MW	NA	NA	200-TP-6
241-T-252 Diversion Box	Waste solutions from processing and decontamination operations/MW	NA	NA	200-TP-6
241-TR-152 Diversion Box	Waste solutions from processing and decontamination operations/MW	NA	NA	200-TP-6

Table 2-1. Summary of Waste Management Units[a/].

Waste Management Unit (alias)	Source Description/Type	Waste Volume Received (L)	Contaminated Soil Volume (m^3)	Operable Unit
241-TR-153 Diversion Box/Booster Pump Pit	Waste solutions from processing and decontamination operations/MW	NA	NA	200-TP-6
241-TX-152 Diversion Box	Waste solutions from processing and decontamination operations/MW	NA	NA	200-TP-5
241-TX-153 Diversion Box	Waste solutions from processing and decontamination operations/MW	NA	NA	200-TP-5
241-TX-154 Diversion Box	Waste solutions from processing and decontamination operations/MW	NA	NA	200-TP-4
241-TX-155 Diversion Box	Waste solutions from processing and decontamination operations/MW	NA	NA	200-TP-2
241-TXR-151 Diversion Box[d/]	No information available/MW	NA	NA	200-TP-5
241-TXR-152 Diversion Box	Waste solutions from processing and decontamination operations/MW	NA	NA	200-TP-5
241-TXR-153 Diversion Box	Waste solutions from processing and decontamination operations/MW	NA	NA	200-TP-5
241-TY-153 Diversion Box	Waste solution from processing and decontamination operations/MW	NA	NA	200-TP-5
242-T-151 Diversion Box	Unknown/MW	NA	NA	200-TP-5
Basins				
207-T Retention Basin[c/]	Process cooling water, steam condensate, evaporator cooling water, flow from 221-T, 221-TA, and 224-T Buildings/LLW	NA	NA	200-TP-3

Table 2-1. Summary of Waste Management Units[a/].

Waste Management Unit (alias)	Source Description/Type	Waste Volume Received (L)	Contaminated Soil Volume (m^3)	Operable Unit
	Burial Sites			
200-W Ash Disposal Basin	Various hazardous organic chemicals/LLW, HW	NA	NA	200-SS-2
200-W Ash Pit Demolition Site[d/]	Various unstable chemicals/LLW	NA	NA	200-SS-2
200-W Burning Pit	Construction and office waste, paint waste, and chemical solvents/HW	NA	NA	200-SS-2
200-W Powerhouse Ash Pit	Ash from the 200 West Area Powerhouse cooling and ventilation steam condensate/NHNR	43,827,000 m^3	NR	200-SS-2
218-W-8 Burial Ground (222-T Vault)	Laboratory process sample waste from 222-T Building/MW	68,000 m^3	NR	200-TP-4

[a/] Data taken from WHC 1991a.
[b/] Waste volume remaining (Hanlon 1992).
[c/] Waste volume received as of 1979 (Maxfield 1979). Unit still active.
[d/] Waste management units are not listed in the Tri-Party Agreement.

NA - Not applicable
NR - No value reported
Waste Type: HLW - high-level waste
LLW - low-level waste
MW - mixed waste
TRU - transuranic waste
NHNR - nonhazardous, nonradioactive waste

Table 2-2. Radionuclide Waste Inventory Summary.

Waste Management Unit	QUANTITY OF REPORTED RADIONUCLIDES (Ci)[a]										
	Total Pu (grams)	^{238}U	^{137}Cs	^{106}Ru	^{90}Sr	^{60}Co	^{3}H	^{241}Am	Other Radionuclides	^{239}Pu	^{240}Pu
Tanks and Vaults											
241-T-361 Settling Tank	15,500 Ci	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-T-301 Catch Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-T-302 Catch Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TX-302A Catch Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TX-302B Catch Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TX-302C Catch Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TY-302A Catch Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TY-302B Catch Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
244-TX Receiving Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
244-TXR Vault	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cribs and Drains											
216-T-6 Crib	390.0	0.0076	110.0	6.070E-11	124.0	0.0305	NR	NR	NR	22.30	6.01
216-T-7TF Crib and Tile Field	130.0	0.00304	21.20	2.020E-09	24.00	0.0142	NR	NR	NR	7.42	2.00
216-T-8 Crib	5.000	0.0015	0.04010	6.630E-12	0.3760	0.00099	NR	NR	NR	0.285	0.077
216-T-18 Crib	1800.0	0.00911	24.20	1.380E-09	2.800	0.137	0.800[a]	NR	NR	103.0	27.7
216-T-19TF Crib and Tile Field	14.40	NR	17.50	6.030E-06	27.80	NR	4.250	.009820	NR	NR	NR
216-T-26 Crib	59.00	0.503	75.60	8.020E-08	282.0	0.0189	NR	NR	NR	3.37	0.908
216-T-27 Crib	13.00	0.00243	55.90	4.090E-5	75.30	0.067	NR	NR	NR	0.742	0.200
216-T-28 Crib	70.00	0.131	193.0	1.960E-5	106.0	0.319	NR	NR	NR	4.00	1.08
216-T-29 Crib	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table 2-2. Radionuclide Waste Inventory Summary.

	QUANTITY OF REPORTED RADIONUCLIDES (Ci)[a]										
Waste Management Unit	Total Pu (grams)	^{238}U	^{137}Cs	^{106}Ru	^{90}Sr	^{60}Co	^{3}H	^{241}Am	Other Radionuclides	^{239}Pu	^{240}Pu
216-T-31 French Drain	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
216-T-32 Crib	3200.0	0.0076	9.710	4.440E-11	10.90	0.00827	NR	NR	NR	1.83	49.3
216-T-33 Crib	5.000	0.00152	0.2670	6.860E-08	0.2560	0.0515	NR	NR	NR	0.285	0.077
216-T-34 Crib	107.0	0.00138	157.0	5.980E-06	178.0	0.585	NR	NR	NR	6.11	1.65
216-T-35 Crib	66.20	0.01640	11.70	1.440E-05	11.4	0.298	NR	NR	NR	3.78	1.02
216-T-36 Crib	2.480	0.00039	3.790	5.24E-06	4.360	0.0487	NR	NR	NR	0.142	0.0381
216-W-LWC Crib	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Reverse Wells											
216-T-2 Reverse Well	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
216-T-3 Reverse Well	3350.0	NR	21.30	5.220E-12	18.60	NR	NR	NR	NR	191.0	51.5
Ponds, Ditches, and Trenches											
216-T-4A Pond	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
216-T-4B Pond	3.71	0.232	6.23	8.67E-07	3.37	NR	NR	NR	NR	NR	NR
200-W Powerhouse Pond	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
216-T-1 Ditch	0.1	0.0015	0.0387	4.39E-13	0.0363	NR	NR	NR	NR	NR	NR
216-T-4-1D Ditch	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
216-T-4-2 Ditch	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
216-T-5 Trench	180.0	0.00152	31.10	8.250E-10	0.4200	0.0899	NR	NR	NR	10.30	2.77
216-T-9 Trench	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
216-T-10 Trench	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
216-T-11 Trench	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table 2-2. Radionuclide Waste Inventory Summary.

Waste Management Unit	QUANTITY OF REPORTED RADIONUCLIDES (Ci)[a]										
	Total Pu (grams)	^{238}U	^{137}Cs	^{106}Ru	^{90}Sr	^{60}Co	^{3}H	^{241}Am	Other Radionuclides	^{239}Pu	^{240}Pu
216-T-12 Trench	1.000	0.0152	4.340	1.380E-10	2.050	0.0341	NR	NR	NR	0.0571	0.0154
216-T-13 Trench	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
216-T-14 Trench	0.8800	0.0102	204.0	2.070E-10	2.460	0.236	0.800[a]	NR	NR	0.0502	0.135
216-T-15 Trench	0.9400	0.00911	450.0	1.660E-10	8.620	0.188	0.800[a]	NR	NR	0.0537	0.0145
216-T-16 Trench	0.6500	0.00743	227.0	1.790E-10	3.280	0.204	0.800[a]	NR	NR	0.0372	0.1010
216-T-17 Trench	0.5300	0.0068	162.0	1.380E-10	1.230	0.0157	0.600[a]	NR	NR	0.303	0.00816
216-T-20 Trench	NR	0.0167	0.4400	7.440E-12	0.3880	NR	NR	NR	NR	NR	NR
216-T-21 Trench	1.000	0.00033	174.0	8.560E-10	3.280	0.314	0.400[a]	NR	NR	0.571	0.154
216-T-22 Trench	2.0000	0.00067	803.0	4.140E-10	20.90	0.0157	1.20[a]	NR	NR	0.114	0.308
216-T-23 Trench	1.000	0.00034	577.0	3.590E-10	16.82	0.0157	1.20[a]	NR	NR	0.0571	0.0154
216-T-24 Trench	2.000	0.00278	617.0	4.420E-10	16.40	0.0157	1.20[a]	NR	NR	0.114	0.0308
216-T-25 Trench	1.000	0.00030	3860.0	1.380E-09	1.640	0.00157	2.40[a]	NR	NR	0.571	0.154
Septic Tanks and Drain Fields											
2607-W1 Septic Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
2607-W2 Septic Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
2607-W3 Septic Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
2607-W4 Septic Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
2607-WT Septic Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
2607-WTX Septic Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Diversion Boxes											
241-T-151 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table 2-2. Radionuclide Waste Inventory Summary.

	QUANTITY OF REPORTED RADIONUCLIDES (Ci)[a]										
Waste Management Unit	Total Pu (grams)	^{238}U	^{137}Cs	^{106}Ru	^{90}Sr	^{60}Co	^{3}H	^{241}Am	Other Radionuclides	^{239}Pu	^{240}Pu
241-T-152 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-T-153 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-T-252 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TR-152 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TR-153 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TX-152 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TX-153 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TX-154 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TX-155 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TXR-151 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TXR-152 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TXR-153 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TY-153 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
242-T-151 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Basins											
207-T Retention Basin	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Burial Sites											
200-W Ash Disposal Basin	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
200-W Ash Pit Demolition Site	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
200-W Burning Pit	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
200-W Powerhouse Ash Pit	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table 2-2. Radionuclide Waste Inventory Summary.

	QUANTITY OF REPORTED RADIONUCLIDES (Ci)[a]										
Waste Management Unit	Total Pu (grams)	^{238}U	^{137}Cs	^{106}Ru	^{90}Sr	^{60}Co	^{3}H	^{241}Am	Other Radionuclides	^{239}Pu	^{240}Pu
218-W-8 Burial Ground	0.3000	0.0001	6.403	3.607E-11	5.625	NR	NR	NR	NR	0.171	0.00462
Unplanned Releases											
UPR-200-W-160 Unplanned Release	1.000	NR	17.00	3.460E-10	16.00	NR	NR	NR	NR	NR	NR

Source: WHC 1991a.

[a] Values are from HISS Database (Stenner et al. 1988) and are decayed through April 1, 1986.
NR - No value reported.

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Table 2-3. Chemical Waste Inventory Summary.

Waste Management Unit	QUANTITY OF REPORTED CHEMICALS (kg)															
	NH_4NO_3	Ferro-cyanide	Fluoride	Nitrate	Nitrite	HNO_3	Phosphate	Potassium	Sodium	Sodium Aluminate	Sodium Dichromate	NaOH	Sodium Oxalate	Sodium Silicate	Sulfate	H_2SO_4
Tanks and Vaults																
241-T-361 Settling Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-T-301 Catch Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-T-302 Catch Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TX-302A Catch Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TX-302B Catch Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TX-302C Catch Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TY-302A Catch Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TY-302B Catch Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
244-TX Receiving Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
244-TXR Vault	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cribs & Drains																
216-T-6 Crib	2,600	NR	24,000	180,000	NR	NR	13,000	NR	160,000	NR	NR	NR	6,000	NR	1,500	NR
216-T-7TF Crib and Tile Field	140,000	NR	170,000	2,300,000	NR	NR	500,000	250,000	1,700,000	NR	NR	NR	40,000	NR	70,000	NR
216-T-8 Crib	NR	NR	NR	NR	NR	1,000	NR	NR	NR	NR	10	NR	NR	NR	NR	1,000
216-T-18 Crib	NR	NR	2,500	80,000	9,000	NR	19,000	NR	60,000	8,000	NR	8,000	NR	3,200	4,000	NR
216-T-19TF Crib and Tile Field	18,000	NR	NR	150,000	NR	NR	60,000	NR	90,000	NR	NR	NR	NR	NR	9,000	NR
216-T-26 Crib	NR	6,000	30,000	1,000,000	110,000	NR	230,000	NR	700,000	100,000	NR	100,000	NR	40,000	50,000	NR

Table 2-3. Chemical Waste Inventory Summary.

Waste Management Unit	QUANTITY OF REPORTED CHEMICALS (kg)															
	NH_4NO_3	Ferro-cyanide	Fluoride	Nitrate	Nitrite	HNO_3	Phosphate	Potassium	Sodium	Sodium Aluminate	Sodium Dichromate	NaOH	Sodium Oxalate	Sodium Silicate	Sulfate	H_2SO_4
216-T-27 Crib	NR	NR	NR	1,000	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
216-T-28 Crib	NR	NR	NR	10,000	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
216-T-29 Crib	NR	NR	NR	NR	NR	8,000	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
216-T-31 French Drain	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
216-T-32 Crib	1,600	NR	160,000	1,200,000	NR	NR	90,000	NR	1,100,000	NR	NR	NR	40,000	NR	10,000	NR
216-T-33 Crib	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	10	NR	NR		NR
216-T-34 Crib	NR	NR	NR	1,000	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
216-T-35 Crib	NR	NR	NR	1,000	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
216-T-36 Crib	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	1,000	NR	NR	NR	NR
216-W-LWC Crib	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Reverse Wells																
216-T-2 Reverse Well	NR	NR	NR	NR	NR	6,000	NR	NR	NR	NR	200	NR	NR	NR	NR	10,000
216-T-3 Reverse Well	4,000	NR	40,000	290,000	NR	NR	21,000	60,000	250,000	NR	NR	NR	NR	NR	2,400	NR
Ponds, Ditches and Trenches																
216-T-4A Pond	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
216-T-4B Pond	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
200-W Powerhouse Pond	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
216-T-1 Ditch	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	10000	NR	NR	NR	NR

Table 2-3. Chemical Waste Inventory Summary.

Waste Management Unit	QUANTITY OF REPORTED CHEMICALS (kg)															
	NH_4NO_3	Ferro-cyanide	Fluoride	Nitrate	Nitrite	HNO_3	Phosphate	Potassium	Sodium	Sodium Aluminate	Sodium Dichromate	NaOH	Sodium Oxalate	Sodium Silicate	Sulfate	H_2SO_4
216-T-4-1D Ditch	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
216-T-4-2 Ditch	NR	NR	NR	1.0	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
216-T-5 Trench	20,000	NR	8,000	140,000	NR	NR	6,000	NR	100,000	NR	NR	NR	NR	8,000	9,000	NR
216-T-9 Trench	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
216-T-10 Trench	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
216-T-11 Trench	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
216-T-12 Trench	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
216-T-13 Trench	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
216-T-14 Trench	NR	NR	2,500	80,000	9,000	NR	19,000	NR	60,000	8,000	NR	8,000	NR	3,200	4,000	NR
216-T-15 Trench	NR	NR	2,500	80,000	9,000	NR	19,000	NR	60,000	8,000	NR	8,000	NR	3,200	4,000	NR
216-T-16 Trench	NR	NR	2,500	80,000	9,000	NR	19,000	NR	60,000	8,000	NR	8,000	NR	3,200	4,000	NR
216-T-17 Trench	NR	NR	2,000	60,000	7,000	NR	15,000	NR	50,000	7,000	NR	6,000	NR	2,500	3,100	NR
216-T-20 Trench	NR	NR	NR	15,000	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table 2-3. Chemical Waste Inventory Summary.

Waste Management Unit	QUANTITY OF REPORTED CHEMICALS (kg)															
	NH_4NO_3	Ferro-cyanide	Fluoride	Nitrate	Nitrite	HNO_3	Phosphate	Potassium	Sodium	Sodium Aluminate	Sodium Dichromate	NaOH	Sodium Oxalate	Sodium Silicate	Sulfate	H_2SO_4
216-T-21 Trench	NR	NR	1,200	40,000	4,000	NR	9,000	NR	28,000	4,000	NR	4,000	NR	1,500	1,800	NR
216-T-22 Trench	NR	NR	4,000	120,000	14,000	NR	29,000	NR	90,000	13,000	NR	12,000	NR	5,000	6,000	NR
216-T-23 Trench	NR	NR	4,000	120,000	14,000	NR	28,000	NR	90,000	12,000	NR	12,000	NR	5,000	6,000	NR
216-T-24 Trench	NR	NR	4,000	120,000	14,000	NR	29,000	NR	90,000	13,000	NR	12,000	NR	5,000	6,000	NR
216-T-25 Trench	NR	NR	40,000	1,200,000	140,000	NR	290,000	NR	900,000	130,000	NR	120,000	NR	50,000	60,000	NR
Septic Tanks and Drain Fields																
2607-W1 Septic Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
2607-W2 Septic Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
2607-W3 Septic Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
2607-W4 Septic Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
2607-WT Septic Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
2607-WTX Septic Tank	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Diversion Boxes																
241-T-151 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table 2-3. Chemical Waste Inventory Summary.

Waste Management Unit	QUANTITY OF REPORTED CHEMICALS (kg)															
	NH_4NO_3	Ferro-cyanide	Fluoride	Nitrate	Nitrite	HNO_3	Phosphate	Potassium	Sodium	Sodium Aluminate	Sodium Dichromate	NaOH	Sodium Oxalate	Sodium Silicate	Sulfate	H_2SO_4
241-T-152 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-T-153 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-T-252 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TR-152 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TR-153 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TX-152 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TX-153 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TX-154 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TX-155 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TXR-151 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TXR-152 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TXR-153 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
241-TY-153 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table 2-3. Chemical Waste Inventory Summary.

Waste Management Unit	QUANTITY OF REPORTED CHEMICALS (kg)															
	NH_4NO_3	Ferro-cyanide	Fluoride	Nitrate	Nitrite	HNO_3	Phosphate	Potassium	Sodium	Sodium Aluminate	Sodium Dichromate	NaOH	Sodium Oxalate	Sodium Silicate	Sulfate	H_2SO_4
242-T-151 Diversion Box	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Basins																
207-T Retention Basin	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Burial Sites																
200-W Ash Disposal Basin	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
200-W Ash Pit Demolition Site	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
200-W Burning Pit	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
200-W Powerhouse Ash Pit	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
218-W-8 Burial Ground	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Source: WHC 1991a.

[a] Inventory of 216-T-4-2 Trench and 216-T-4B Pond are included in the 216-T-4A inventory.

Table 2-4. Description of 241-T, -TX, and -TY Tank Farms.

Name	Type	Integrity	Interim Stabilized	Isolation	Total Waste Volume Remaining (L)	Drainable Waste Volume (L)
241-T Tank Farm						
241-T-101	single-shell	sound	no	PI	504,000	132,500
241-T-102	single-shell	sound	IS	II	121,200	49,200
241-T-103	single-shell	assumed leaker	IS	II	102,200	15,100
241-T-104	single-shell	sound	no	PI	1,684,400	189,300
241-T-105	single-shell	sound	IS	II	370,900	87,100
241-T-106	single-shell	assumed leaker	IS	II	79,500	7,600
241-T-107	single-shell	assumed leaker	no	PI	681,300	83,300
241-T-108	single-shell	assumed leaker	IS	II	166,500	0
241-T-109	single-shell	assumed leaker	IS	II	219,500	0
241-T-110	single-shell	sound	no	PI	1,434,500	159,000
241-T-111	single-shell	assumed leaker	no	PI	1,733,500	193,000
241-T-112	single-shell	sound	IS	II	253,600	26,500
241-T-201	single-shell	sound	IS	II	109,800	15,100
241-T-202	single-shell	sound	IS	II	79,500	7,600
241-T-203	single-shell	sound	IS	II	132,500	15,100
241-T-204	single-shell	sound	IS	II	143,800	15,100
241-TX Tank Farm						
241-TX-101	single-shell	sound	IS	II	329,300	18,900
241-TX-102	single-shell	sound	IS	II	427,700	83,300

Table 2-4. Description of 241-T, -TX, and -TY Tank Farms.

Name	Type	Integrity	Interim Stabilized	Isolation	Total Waste Volume Remaining (L)	Drainable Waste Volume (L)
241-TX-103	single-shell	sound	IS	II	594,200	56,800
241-TX-104	single-shell	sound	IS	II	246,000	56,800
241-TX-105	single-shell	assumed leaker	IS	II	2,305,100	75,700
241-TX-106	single-shell	sound	IS	II	1,714,600	37,900
241-TX-107	single-shell	assumed leaker	IS	II	136,300	7,600
241-TX-108	single-shell	sound	IS	II	507,200	0
241-TX-109	single-shell	sound	IS	II	1,453,400	37,900
241-TX-110	single-shell	assumed leaker	IS	II	1,748,700	56,800
241-TX-111	single-shell	sound	IS	II	1,400,500	34,100
241-TX-112	single-shell	sound	IS	II	2,456,500	90,800
241-TX-113	single-shell	assumed leaker	IS	II	2,297,500	60,600
241-TX-114	single-shell	assumed leaker	IS	II	2,025,000	56,800
241-TX-115	single-shell	assumed leaker	IS	II	2,422,400	71,900
241-TX-116	single-shell	assumed leaker	IS	II	2,388,300	87,100
241-TX-117	single-shell	assumed leaker	IS	II	2,369,400	30,300
241-TX-118	single-shell	sound	IS	II	1,313,400	102,200
241-TY Tank Farm						
241-TY-101	single-shell	assumed leaker	IS	II	446,600	0
241-TY-102	single-shell	sound	IS	II	242,200	53,000
241-TY-103	single-shell	assumed leaker	IS	II	613,200	18,900

Table 2-4. Description of 241-T, -TX, and -TY Tank Farms.

Name	Type	Integrity	Interim Stabilized	Isolation	Total Waste Volume Remaining (L)	Drainable Waste Volume (L)
241-TY-104	single-shell	assumed leaker	IS	II	174,100	56,800
241-TY-105	single-shell	assumed leaker	IS	II	874,300	0
241-TY-106[a/]	single-shell	assumed leaker	IS	II	64,300	0

Source: Hanlon 1992.

Notes:

IS - interim stabilized
II - interim isolated
PI - partially interim isolated
[a/] Waste volume includes diatomaceous earth

Table 2-5. General 200 West Single-Shell Tank Information Reference Locator.

Desired Single-Shell Tank Information	Reference Document
Watch List Tanks: Identification per Public Law 101-510, Section 3137, "Safety Measures for Waste Tanks at Hanford Nuclear Reservation." (Wyden Bill Amendment)	WHC-EP-0182, *Tank Farm Surveillance and Waste Status Summary Report*, Table 1
Definitions: Definitions include Interim Stabilized (IS), Partial Interim Isolated (PI), Interim Isolated (II), Tank Integrity (Sound or Assumed Leaker), Intrusion, Drywells, Laterals, Surface Levels, Automatic FIC, Liquid Observation Well (LOW), Thermocouple (TC), Sludge, and Salt Cake.	WHC-EP-0182, Appendix A
Tank Schematic: Quick reference for tank capacities and relative dimensions.	WHC-EP-0182, Figure B-1
Tank Information: Tank waste material, tank integrity ("sound" or "assumed leaker" stabilization/isolation status, total waste, supernatant waste, drainable interstitial, sludge volume, salt cake volume, last in-tank photo date.	WHC-EP-0182, Table C-5
Single-Shell Tank Leak Volume Estimates	WHC-EP-0182, Table H-1
Leak Detection Equipment: Type and description of leak detection devices for each tank, and detection criteria.	WHC-SD-WM-TI-357, *Waste Storage Tank Status and Leak Detection Criteria*
West Area Waste Storage Tank Criteria: Criteria is discussed by tank farm and includes leak detection drywells (type of probe used, radiation criteria, well location, well depths and monitoring frequency), surface level measurement (decrease/increase criteria, monitoring frequency).	WHC-SD-WM-TI-357, Section 6.0
Tank Farms Facility Interim Stabilization Evaluation: Provides the stabilization criteria for single-shell tanks and auxiliary tanks.	WHC-CM-5-7 Section 1.11
Single-Shell Tank Operating Specifications: Information includes structural limitations (tank content composition, dome loading, waste temperatures, vapor space pressures), radiological containment requirements, cross-connection requirements, and leak detection control.	OSD-T-151-00013

Table 2-6. Summary of Unplanned Releases.[a]

Unplanned Release No.	Location (Operable Unit)	Date	Associated Waste Management Unit[b]	Reported Waste-Related History
UN-200-W-2	North of 224-T Building (200-TP-4)	1947	NA	· Waste line failure resulted in discharge to ground. · Radionuclide contamination measure to a depth of 10-11 ft bgs. · Waste line replaced.
UN-200-W-3	T Plant railroad cut, northwest of 221-T Building (200-TP-4)	1949	NA	· Spillage of radioactive cask cars and equipment in transit from T Plant to the 200 West Burial Ground. · Contaminated area was covered with approximately 10 inches of clean gravel in the Spring of 1950.
UN-200-W-4	Northwest of 221-T Building (200-TP-4)	1949	NA	· Contamination spread from a burial box in transit from T Plant to the heavy equipment burial ground. · Readings averaged 7 mR/h of unknown beta/gamma.
UN-200-W-7	241-T-151 and -152 Diversion Boxes (200-TP-3)	Spring 1950	NA	· Resulted from work at the diversion boxes. · Contaminated soil partially removed; remainder covered with approximately one foot of clean soil.
UN-200-W-8	approximately 1500 feet east of 221-U Building {old burning ground} (200-TP-4)	1950	NA	· Release of unknown source. · Fission products with approximately 1 Ci and a maximum dose rate of 45 R/h were measured at the surface. · Area removed from radiation zone status in 1972.
UN-200-W-14	Along the waste line connecting the 242-T Building and the 207-T Retention Basin (200-TP-2)	10/52	NA	· Detected when contaminated water rose to the ground surface above the waste line. · Waste line leakage repaired and contaminated area covered with approximately 1 ft of soil.
UN-200-W-17	South of 241-TX Tank Farm (200-TP-5)	9/11/52	NA	· Spill during transfer of a temporary process waste pump from tank 241-TX-106 to tank 241-TX-114 resulted in surface contamination distributed over a 300 x 600 ft area. · Radionuclides released included cerium, cesium, nobelium, ruthenium, strontium and zirconium; surface readings ranged from 2,000 - 5,000 ct/min. · Some highly contaminated areas were stabilized with emulsified asphalt.

Table 2-6. Summary of Unplanned Releases.[a]

Unplanned Release No.	Location (Operable Unit)	Date	Associated Waste Management Unit[b]	Reported Waste-Related History
UN-200-W-27	Near 221-T Building; exact location unknown (200-TP-4)	12/20/54	NA	· Failure of an unencased process waste line from T Plant resulted in a cave-in and run-off of first-cycle process wastes. Readings indicated high ground-surface dose rates.
UN-200-W-29	A cave-in approximately 75 ft east of Camden and approximately 75 ft south of 23rd Street, between 241-T-152 and 241-TX-153 Diversion Boxes (200-TP-2)	11/15/54	NA	· Failure of an enencased line connecting diversion boxes. · First-cycle supernatant wastes from the 241-T-105 Single-Shell Tank release, with dose rates of 11.5 R/h at 2 in. · Area hosed down with water and backfilled shortly after the leak was discovered. · A spill occurred in May 1966 at the same location due to re-use of same unencased line. · In 1978, the entire area was excavated to a depth of 1 ft and treated with fiber-film to prevent moisture penetration; surface was stabilized to prevent wind dispersal; and area was backfilled and later filled with gravel.
UN-200-W-38	Near 241-TX-154 Diversion Box (200-TP-4)	1956	NA	· Rupture of underground process line released a 15 x 30 ft pool of metal waste on the ground surface. · Radiation field of 1.2 R/h at 80 ft. · Area around diversion box stabilized with sprayed concrete.
UN-200-W-58	Area between the 221-T railroad cut and the 200 West Burial Ground (200-TP-4)	4/26/65	NA	· Release occurred during transit of cell blocks from 221-T Canyon Building to burial ground. · Unknown beta/gamma with readings to a maximum of 5 R/h, including 100,000 ct/minin. · Contaminated soil removed from the railroad bed.
UN-200-W-62	Corner of 23rd Street and Camden Avenue (200-TP-6)	5/4/66	NA	· Second-cycle wastes released to the ground from a ruptured transfer line during transfer of bismuth phosphate waste from the 241-T-107 Tank to the 242-T Evaporator Feed. · Readings ranged from 20 to 5,000 mR/h. · Liquid dispersed over an approximate 72 x 1440 ft area which was isolated and covered with sand and gravel.

Table 2-6. Summary of Unplanned Releases.[a]

Unplanned Release No.	Location (Operable Unit)	Date	Associated Waste Management Unit[b]	Reported Waste-Related History
UN-200-W-63	Along 23rd Street and shoulder from 241-TX-153 Diversion Box (200-TP-3)	9/21/66	NA	· Released from a used diversion box jumper in transit via truck from 200 West dry waste Burial Ground to the 221-T Canyon. · Waste material contained strontium-90 with readings of approximately 1 Ci. · Contamination on road removed and area covered with 6 inches of soil. · Currently no signs of stabilization in the area.
UN-200-W-64	Along Camden Avenue and 23rd Street (200-TP-6)	2/13/69	NA	· Contamination of cesium-137 to 600 ct/min discovered in mud samples in an area cordoned off as a radiation zone. · Cause may be snow melt run-off of nearby radiation zones (possibly UN-200-W-29 and -987 releases).
UN-200-W-65	T Plant railroad cut (200-TP-4)	10/27/69	NA	· Release of contamination from a rail car. · Unknown beta/gamma readings from 5,000 ct/min to 150 mR/h. · Spur line not labelled, stabilized or barricaded.
UN-200-W-67	North side of the 2706-T Building (200-TP-4)	8/5/70	NA	· Contamination of 20,000 ct/min found following removal of a lift that was reading 500 mR/h. · Fence surrounds building on north, west and south sides, and extends 100 feet from building. · North side of building paved with gravel and used for equipment storage. · Area not marked for radiation hazard.
UN-200-W-73	Area of railway between 221-T Building to 2706-T Building (200-TP-4)	10/6/74	NA	· Released from a hole in a multi-purpose box in transit from 221-T Building tunnel to the 2706-T Building. · Unknown beta/gamma with readings up to 40 mR/h. · Area not barricaded.
UN-200-W-76	Around the 241-TX-155 Diversion Box (200-TP-5)	8/24/77	NA	· Discovery of contaminated rabbit fecal pellets containing cesium-137, cesium-134, europium-155, and strontium-90. · Pellets and soil removed to dry waste burial. · Remaining contamination covered with clean soil.

Table 2-6. Summary of Unplanned Releases.[a]

Unplanned Release No.	Location (Operable Unit)	Date	Associated Waste Management Unit[b]	Reported Waste-Related History
UN-200-W-77	Northeast corner of 200 West Area (200-TP-4)	4/4/78	NA	· Discovery of highly radioactive coyote feces. · Readings of 40,000 ct/min beta/gamma and 55,000 ct/min alpha activity of plutonium-239 and americium-241 respectively. · Feces collected and sent to laboratory for radioisotopic analysis. · Area not marked or barricaded.
UN-200-W-85	Rear of 2706-T Building (200-TP-4)	4/22/82	NA	· Leakage from multi-purpose transfer box while parked on a concrete pad. · Liquid contamination had unknown beta/gamma readings of 100,000 ct/min. · Area contaminated to background radiation levels. · Area not labelled or barricaded; no indication of a radiation hazard or stabilization.
UN-200-W-88	Inside main gate of 200-W Area (200-SS-2)	5/28/84	NA	· Spill from uranyl nitrate liquid trailer. · Readings from 300 to 650 ct/min unknown beta/gamma readings. · Detectable contamination removed by chipping asphalt and repaving it. · Some discrepancy in WIDS about location of spill. Coordinates do match the written description of location; location does correspond to location given by Health Physics personnel.
UN-200-W-97	Southeast corner of 23rd Street and Camden Avenue, south to near 22nd Street (200-TP-6)	5/66	NA	· Release of liquid waste solution from broken underground line of southeast corner of Camden Avenue, surfaced, and crossed the street, but did not run down the side of the road. · Surface contamination removed to a depth of 3 ft and buried in 200 West Burial Ground. · In 1978, contaminated soil adjacent to the zone removed on south side to a depth of 4 ft and on west side to a depth of 3 ft. Area backfilled with earth and later covered with clean soil. · Subsurface contamination of 600 ct/min detected.

Table 2-6. Summary of Unplanned Releases.[a]

Unplanned Release No.	Location (Operable Unit)	Date	Associated Waste Management Unit[b]	Reported Waste-Related History
UN-200-W-98	Southeast corner of the 221-T Building (200-TP-4)	Spring 1945	NA	· Leak in an underground metal waste transfer line surfaced, resulting in contamination of small surface area with mixed fission products. · Maximum dose of 20 R/h. · Affected area overfilled with approximately 4 ft of clean soil; a blacktop road has since been constructed over the area. · No radioactivity has been detected. · Area around site to east is barricaded and surface contamination is marked.
UN-200-W-99	250 yd north and south along Camden Avenue and extending from 75 to 100 yd east of Camden Avenue (200-TP-2)	9/68	NA	· Airborne contamination of strontium-90 resulting from 241-TY-153 Diversion Box. · Readings ranged from 20,000 to 100,000 ct/min. · Road contamination covered with new tar mat; area between Camden and 241-TX Tank Farm covered with gravel; area east of Camden is barricaded, labelled, and marked with underground contamination signs. · Test plots in 1978 showed strontium-90 particulate matter still present.
UN-200-W-100	Process line extending from 241-TX-105 to 241-TX-118 Single-Shell Tanks in the 241-TX Tank Farm (200-TP-5)	11/54	NA	· Spill of first-cycle high-salt neutral/basic waste. · Waste contained fission products with approximately 10 Ci, which generated a maximum dose rate of 4.5 R/h at 4 ft. · Contaminated area covered with 1 ft of clean soil. · Area is entirely within chain-link fence surrounding TX Tank Farm.
UN-200-W-102	Southeast side of 224-T Building (200-TP-4)	2/72	NA	· Contamination resulted from moisture seeping through pipe joints from underground process tank vent lines during years of operation. · Excavation revealed subsurface contamination 50 ft long by 12 feet wide by 12 ft deep. · Total of 139 drums of soil, containing approximately 10 g of plutonium, were removed; northwest side of building covered with asphalt; southwest side of building has extensive gravel. · No barricades or other signs of release.

Table 2-6. Summary of Unplanned Releases.[a]

Unplanned Release No.	Location (Operable Unit)	Date	Associated Waste Management Unit[b]	Reported Waste-Related History
UN-200-W-113	700 feet east of the 241-TX Tank Farm, just north of the 241-TX-155 Diversion Box (200-TP-2)	Mid 1950's	NA	· Discovered in 1977, when radioactive rabbit feces were found near diversion box. · After soil removal, radioactivity increased and source believed to be a leak in a waste transfer line. · Acid spill from diversion box catch tank is a possible influence. · Stabilized with clean gravel. · Area is stabilized with soil, sown with grass and posted with underground radiation hazard signs.
UN-200-W-135	150 feet northwest of 241-TX-155 Diversion Box (200-TP-2)	4/5/54	NA	· Failure of the jumper in the diversion box allowed liquid to flow along the encasement and exit on a hillside. · Approximately 1,000 gal of supernatant leaked. WIDS document estimates 60,000 ft^3. · Dose rate of 5 r/h including 2.5 r/h at 3 ft. · Access roads barricaded until contamination was covered; area sealed and covered with earth.
UPR-200-W-5	Hillside to the west of 216-T-20 Trench (200-TP-2)	1950	241-TX-155 Diversion Box	· Resulted from leaky jumpers or overflow and contaminated soil around the diversion box. · Area around the diversion box was covered with clean soil. · Presently, the diversion box is coated with weatherproofing foam. · Light chain barricade with surface contamination placards surrounds the diversion box.
UPR-200-W-12	Southside of 242-T Building (200-TP-5)	Spring 1951	NA	· While jetting concrete from the waste evaporator, the waste was forced up and out of an open riser. · Portion of contamination removed, remainder covered with a ft of clean soil.

Table 2-6. Summary of Unplanned Releases.[a]

Unplanned Release No.	Location (Operable Unit)	Date	Associated Waste Management Unit[b]	Reported Waste-Related History
UPR-200-W-21	241-TX-302C Catch Tank (200-TP-4)	7/53	241-TX-302C Catch Tank	· Cave-in over a process line caused contamination of an extended area between the 221-T and 222-T Buildings. · Dose rates or 25 R//h at 8 in. · Jumper leak in the 241-TX-154 Diversion Box caused the 241-TX-302C Catch Tank to overflow. · Area covered with blacktop and posted with underground contamination warning signs. · Associated with UPR-200-W-40 and UPR-200-W-160.
UPR-200-W-28	West of 241-TX-155 Diversion Box (200-TP-2)	Spring 1954	241-TX-155 Diversion Box	· Leaky jumpers or overflow contaminated soil around the diversion box. · Area around the diversion box was covered with clean soil; diversion box is coated with weatherproofing foam. · Light chain barricade with surface contamination placards surround the diversion box.
UPR-200-W-37	200-W Burning Pit (200-SS-2)	6/10/55	200-W Burning Pit	· Disposal of three broken boxes containing dry high-level radioactive waste into a non-radiation burning pit. · Reading of 100 mR/h. · No barricades or radiation signs in the area.
UPR-200-W-40	Southeast of 221-T Building between 241-TX-154 Diversion Box and 241-TX-302C Catch Tank (200-TP-4)	1/3/56	241-TX-302C Catch Tank	· Leakage of an unknown liquid from the 241-TX-154 Diversion Box and the 241-TY-302C Catch Tank. · Contamination limited to an area of ~1,500 ft^2 (139 m^2) on the southeast side of the 221-T Building. · Associated with UPR-200-W-21 and UPR-200-W-160.

Table 2-6. Summary of Unplanned Releases.[a]

Unplanned Release No.	Location (Operable Unit)	Date	Associated Waste Management Unit[b]	Reported Waste-Related History
UPR-200-W-70	200-W Burning Pit (200-SS-2)	1/22/73	200-W Burning Pit	· Disposal of contaminated material into a non-radiation burning pit. · Beta/gamma contamination of 5,000 to 50,000 ct/min along bumper rails at edge of pit. · Beta/gamma contamination of 20,000 to 30,000 ct/min pit bottom itself. · Dump area on south side of pit found to have 5,000 to 200,000 dis/m alpha contamination. · Area barricaded; radiation signs posted. · To stabilize, fiber-film was sprayed on affected areas.
UPR-200-W-126	Next to 241-TX-153 Diversion Box (200-TP-5)	5/8/75	241-TX-153 Diversion Box	· A pipe-fitter removed old gaskets from the 241-TX-153 Diversion Box (for replacement) and placed them in a plastic bag; spotty contamination became airborne. · Contamination was limited to the transfer line from the 241-TX-153 Diversion Box. · Affected employees were decontaminated.
UPR-200-W-129	Pump pit at 241-TX-113 Tank (200-TP-5)	1/7/71	241-TX-113 Single-Shell Tank	· While leak testing a new jumper assembly, an employee closed a valve in a pump pit causing a caustic radioactive solution to spray up through the pit cover. · Employee was decontaminated. · Area was surveyed and the pump pit hosed down.
UPR-200-W-131	5 ft diameter around the 241-TX-155 Diversion Box risers (200-TP-2)	3/13/53	241-TX-155 Diversion Box	· Resulted from leaky jumpers or overflow and contaminated soil around the diversion box. · Area around the diversion box was covered with clean soil; diversion box is coated with weatherproofing foam. · Light chain barricade with surface contamination placards surround the diversion box.
UPR-200-W-147	Southeast side of the 241-T-103 Single-Shell Tank (200-TP-6)	1973	241-T-103 Single-Shell Tank	· Contamination encountered while monitoring wells were being drilled to track tank leak. · Leak possibly resulted from a failed grout seal in a spare entry line. · Spill approximately 5 m^3.

Table 2-6. Summary of Unplanned Releases.[a]

Unplanned Release No.	Location (Operable Unit)	Date	Associated Waste Management Unit[b]	Reported Waste-Related History
UPR-200-W-148	23 ft from 241-T-106 Single-Shell Tank (200-TP-6)	4/20/73	241-T-106 Single-Shell Tank	· Leak suspected to have started during a routine filling operation, but not detected until June 8, 1973. · 115,000 gal of fluid released to ground. · Fluid contained approximately 40,000 ci of cesium-137, 14,000 ci of strontium-90, 4 ci of plutonium, and various fission products. · Leak contaminated over 25,000 m^3 of soil. · Leak possibly resulted from corrosion of aging (29-30 year old) carbon steel tank by the caustic waste solution.
UPR-200-W-149	Surrounding 241-TX-107 Single-Shell Tank (200-TP-5)	During 1977	241-TX-107 Single-Shell Tank	· High levels of radioactivity detected in Well 51-07-118. · Tank leak suspected source of contamination. · Tank pumped to a minimum level to remove as much of the supernatant material as possible.
UPR-200-W-150	Surrounding 241-TY-103 Single-Shell Tank (200-TP-5)	1973	241-TY-103 Single-Shell Tank	· Overflow of the 241-TX-155 Diversion Box flowed back into the tank, depositing 1.3 in. of sludge waste. · Dry wells show no significant increase attributable to this flooding event.
UPR-200-W-151	Surrounding 241-TY-104 Single-Shell Tank (200-TP-5)	1974	241-TY-104 Single-Shell Tank	· Approximately 1,400 gal of supernatant leaked from this tank. · Leak consisted of REDOX ion exchange waste, PUREX organic waste, bismuth phosphate first-cycle waste, tributyl phosphate waste, and decontamination waste from the 241-TX and -TY Tank Farms. · P-10 saltwell was pumped as a cleanup effort for this unplanned release.
UPR-200-W-152	Surrounding 241-TY-105 Single-Shell Tank (200-TP-5)	1960	241-TY-105 Single-Shell Tank	· Tank identified as a "confirmed" leaker. · Waste was listed as tributyl phosphate of unknown quantity. · A saltwell pump system was installed to remove the pumpable interstitial liquid.
UPR-200-W-153	Surrounding 241-TY-106 Single-Shell Tank (200-TP-5)	During 1959	241-TY-106 Single-Shell Tank	· Tank identified as a "confirmed" leaker. · Routine surveillance of radiation dry wells indicated a change of profile in dry well 52-06-05, which now appears stabilized. · Waste identified as tributyl phosphate; quantity unknown. · Tank stabilized with diatomaceous earth.

Table 2-6. Summary of Unplanned Releases.[a]

Unplanned Release No.	Location (Operable Unit)	Date	Associated Waste Management Unit[b]	Reported Waste-Related History
UPR-200-W-160	Around 241-TX-302C Catch Tank between 221-T and 222-T Buildings (200-TP-4)	12/30/55	241-TX-302C Catch Tank	· Failure of an underground transfer line from 241-TX-302C Catch Tank to 241-U-101 Single-Shell Tank · Spill of several thousand gallons of metal waste and rainwater. · Liquid forced through several feet of soil onto the surface surrounding the 241-TX-302C Catch Tank. · Area backfilled and sprayed with tar and posted as a radiation zone. · In 1968, a 10-ft cut placed in the eastern side of the zone was covered with cement blocks to provide an adequate shielding measure. · Tank and surrounding area sprayed with concrete. · Associated with UPR-200-W-21 and UPR-200-W-40.

[a] All unplanned releases reported are liquid mixed waste (except UN-200-W-3, UN-200-W-4, UN-200-W-8, UN-200-W-58, UN-200-W-67, UN-200-W-73, UN-200-W-76, UN-200-W-77, UN-200-W-99, UN-200-W-37, and UN-200-W-70).

[b] If a waste management unit is listed in this column, the unplanned release is not included as a separate site in the Tri-Party Agreement Action Plan.

Table 2-7. Summary of Waste-Producing Processes in the T Plant Aggregate Area.

Process	Waste Generated	Major Chemical Constituents	Ionic Strength	pH	Organic Concentration	Radioactivity
221-T Building						
Bismuth Phosphate	Process waste Aqueous process waste	nitric acid phosphoric acid nitrate solution uranium, plutonium	high	acidic	low	high
Lanthanum Fluoride	Process waste Aqueous process waste	plutonium sodium bismuthate phosphoric acid nitric acid hydrogen fluoride lanthanum salts	NA	NA	NA	high
"Hot" Semi-Works	Aqueous process waste	ammonium silico-fluoride	NA	NA	NA	high
Decontamination and Equipment Refurbishment	Wastewater	bismuth phosphate	low	neutral	low	low-high
Containment Systems Test Facility (CSTF)	NA	NA	NA	NA	NA	NA
222-T Laboratory						
Liquid Metal Reactor Safety Tests	Aqueous process waste	sodium, lithium, sodium iodine	NA	NA	NA	low
Light Water Reactor Tests	Aqueous process waste	cesium, manganese, zinc, lithium, sulfate, iodine and hydrogen iodine	NA	NA	NA	low

NA - Not Available

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Table 2-8. Radionuclides and Chemicals Used or Produced in Separation/Recovery Processes.

RADIONUCLIDES	Lanthanum-140	Selenium-79
	Lead-209	Silver-110m
Actinium-225	Lead-210	Sodium-22
Actinium-227	Lead-211	Strontium-85
Americium-241	Lead-212	Strontium-89
Americium-242	Lead-214	Strontium-90
Americium-242m	Manganese-54	Technetium-99
Americium-243	Neptunium-237	Tellurium-129
Antimony-126	Neptunium-239	Thallium-207
Antimony-126m	Nickel-59	Thorium-227
Astitine-217	Nickel-63	Thorium-229
Barium-135m	Niobium-93m	Thorium-230
Barium-137m	Niobium-95	Thorium-231
Barium-140	Palladium-107	Thorium-233
Bismuth-210	Plutonium-238	Tin-126
Bismuth-211	Plutonium-239/240	Tritium
Bismuth-213	Plutonium-241	Uranium-233
Bismuth-214	Polonium-210	Uranium-234
Carbon-14	Polonium-213	Uranium-235
Cerium-141	Polonium-214	Uranium-238
Cerium-144	Polonium-215	Yttrium-90
Cesium-134	Polonium-218	Yttrium-91
Cesium-135	Potassium-40	Zinc-65
Cesium-137	Praeseodymium-144	Zirconium-93
Cobalt-57	Promethium-147	Zirconium-95
Cobalt-58	Protactinium-231	
Cobalt-60	Protactinium-233	INORGANIC CHEMICALS
Curium-242	Protactinium-234m	
Curium-244	Radium	Aluminum
Curium-245	Radium-223	Ammonium ion
Europium-152	Radium-225	Ammonium nitrate
Europium-154	Radium-226	Ammonium sulfate
Europium-155	Rhodium-103	Antifreeze
Francium-221	Rhodium-106	Arsenic
Francium-223	Ruthenium-103	Barium
Iodine-129	Ruthenium-106	Bismuth
Iron-59	Samarium-151	Bismuth phosphate

Table 2-8. Radionuclides and Chemicals Used or Produced in Separation/Recovery Processes. Page 2 of 2

INORGANIC CHEMICALS (continued)	Phosphoric acid	ORGANIC CHEMICALS
	Potassium	
Boric acid	Potassium ferrocyanide	Bismuth phosphate
Boron	Potassium hydroxide	Butyl alcohol
Cadmium	Potassium permanganate	Chloroform
Calcium	Silica	Decane
Carbonate	Silicon	Dibutyl phosphate
Chromium	Silver	Diesel fuel
Copper	Sodium	Flammable solvents
Cyanide	Sodium bismuthate	Grease
Ferric cyanide	Sodium carbonate	Halogenated hydrocarbons
Ferrous sulfate	Sodium dichromate	Kerosene
Fluoride	Sodium hydroxide	Methyl ethyl ketone
Hydrogen fluoride	Sodium nitrate	Monobutyl phosphate
Hydrogen peroxide	Sodium nitrite	Paraffin hydrocarbons
Hydroxide	Sodium thiosulfate	Tributyl phosphate
Iron	Sulfamic acid	Trichloroethane
Lanthanum nitrate	Sulfate	
Lead	Sulfuric acid	
Lithium	Thorium	
Mangnesium	Tin	
Manganese	Titanium	
Nickel sulfate	Uranium	
Nitrate	Uranium oxide	
Nitric acid	Uranyl nitrate hexahydrate	
Nitrite	Zinc	
Oxalic acid	Zirconyl nitrate	
Phosphate		

Note: Not all analytes are reported in waste inventories. This list contains those chemicals known or based on their association with T Plant processes are suspected to have been disposed of to T Plant Aggregate Area waste management units.

Table 2-9. Radionuclides and Chemicals Disposed of to T Plant Waste Management Units. Page 1 of 2

RADIONUCLIDES		
	Iodine-129	Rhodium-106
	Iron-59	Ruthenium-103
Actinium-225	Lanthanum-140	Ruthenium-106
Actinium-227	Lead-209	Samarium-151
Americium-241	Lead-210	Selenium-79
Americium-242	Lead-211	Silver-110m
Americium-242m	Lead-212	Sodium-22
Americium-243	Lead-214	Strontium-85
Antimony-126	Manganese-54	Strontium-89
Antimony-126m	Neptunium-237	Strontium-90
Astitine-217	Neptunium-239	Technetium-99
Barium-135m	Nickel-59	Tellurium-129
Barium-137m	Nickel-63	Thallium-207
Barium-140	Niobium-93m	Thorium-227
Bismuth-210	Niobium-95	Thorium-229
Bismuth-211	Palladium-107	Thorium-230
Bismuth-213	Plutonium-238	Thorium-231
Bismuth-214	Plutonium-239/240	Thorium-233
Carbon-14	Plutonium-241	Thorium-234
Cerium-141	Polonium-210	Tin-126
Cerium-144	Polonium-213	Tritium
Cesium-134	Polonium-214	Uranium-233
Cesium-135	Polonium-215	Uranium-234
Cesium-137	Polonium-218	Uranium-235
Cobalt-57	Potassium-40	Uranium-238
Cobalt-58	Praeseodymium-144	Yttrium-90
Cobalt-60	Promethium-147	Yttrium-91
Curium-242	Protactinium-231	Zinc-65
Curium-244	Protactinium-233	Zirconium-93
Curium-245	Protactinium-234m	Zirconium-95
Europium-152	Radium	
Europium-154	Radium-223	INORGANIC
Europium-155	Radium-225	CHEMICALS
Francium-221	Radium-226	
Francium-223	Rhodium-103	Aluminum

9 3 1 2 8 7 0 1 8 4 6

Table 2-9. Radionuclides and Chemicals Disposed of to T Plant Waste Management Units. Page 2 of 2

INORGANIC CHEMICALS (Continued)	Lead	Sulfamic acid
	Lithium	Sulfate
	Mangnesium	Sulfuric acid
	Manganese	Thorium
Ammonium ion	Nickel	Tin
Ammonium nitrate	Nickel sulfate	Titanium
Ammonium sulfate	Nitrate	Uranium
Arsenic	Nitric acid	Uranium oxide
Barium	Nitrite	Uranyl nitrate hexahydrate
Bismuth	Oxalic acid	
Bismuth phosphate	Phosphate	Zinc
Boric acid	Phosphoric acid	Zirconyl nitrate
Boron	Potassium	
Cadmium	Potassium ferrocyanide	ORGANIC CHEMICALS
Calcium	Potassium hydroxide	
Carbonate	Potassium permanganate	Bismuth phosphate
Ceric nitrate	Silica	Butyl alcohol
Cerium	Silicon	Chloroform
Chloride	Silver	Decane
Chromium	Sodium	Dibutyl phosphate
Copper	Sodium bismuthate	Halogenated hydrocarbons
Cyanide	Sodium carbonate	
Ferric cyanide	Sodium dichromate	Kerosene
Ferrous sulfate	Sodium hydroxide	Methyl ethyl ketone
Fluoride	Sodium iodine	Monobutyl phosphate
Hydrogen fluoride	Sodium nitrate	Paraffin hydrocarbons
Hydrogen peroxide	Sodium nitrite	Tributyl phosphate
Hydroxide	Sodium thiosulfate	Trichloroethane
Iron		
Lanthanum nitrate		

Note: Not all analytes are reported in waste inventories. This list contains those chemicals known or based on their association with T Plant processes, are suspected to have been disposed of to T Plant Aggregate Area waste management units.

3.0 SITE CONDITIONS

The following sections describe the physical nature and setting of the Hanford Site, the 200 West Area, and the T Plant Aggregate Area. The site conditions are presented in the following sections:

- Physiography and Topography (Section 3.1)
- Meteorology (Section 3.2)
- Surface Hydrology (Section 3.3)
- Geology (Section 3.4)
- Hydrogeology (Section 3.5)
- Environmental Resources (Section 3.6)
- Human Resources (Section 3.7).

Sections describing topography, geology, and hydrogeology have been taken from standardized texts provided by Westinghouse Hanford (Delaney et al. 1991; Lindsey et al. 1991; and Lindsey et al. 1992) for that purpose.

3.1 PHYSIOGRAPHY AND TOPOGRAPHY

The Hanford Site (Figure 3-1) is situated within the Pasco Basin of southcentral Washington. The Pasco Basin is one of a number of topographic depressions located within the Columbia Basin Subprovince of the Columbia Intermontane Province (Figure 3-2), a broad basin located between the Cascade Range and the Rocky Mountains. The Columbia Intermontane Province is the product of Miocene continental flood basalt volcanism and regional deformation that occurred over the past 17 million years. The Pasco Basin is bounded on the north by the Saddle Mountains, on the west by Umtanum Ridge, Yakima Ridge, and the Rattlesnake Hills, on the south by Rattlesnake Mountain and the Rattlesnake Hills, and on the east by the Palouse Slope (Figure 3-1).

The physiography of the Hanford Site is dominated by the low-relief plains of the Central Plains physiographic region and anticlinal ridges of the Yakima Folds physiographic region (Figure 3-3). Surface topography seen at the Hanford Site is the result of (1) uplift of anticlinal ridges, (2) Pleistocene cataclysmic flooding, and (3) Holocene eolian activity (DOE 1988b). Uplift of the ridges began in the Miocene epoch and continues to the present.

Cataclysmic flooding occurred when ice dams in western Montana and northern Idaho were breached, allowing large volumes of water to spill across eastern and central Washington. The last major flood occurred about 13,000 years ago, during the late Pleistocene epoch. Anastomosing flood channels, giant current ripples, bergmounds, and giant flood bars are among the landforms created by the floods. Since the end of the Pleistocene epoch, winds have locally reworked the flood sediments, depositing dune sands in the lower elevations and loess (windblown silt) around the margins of the Pasco Basin. Generally, sand dunes have been stabilized by anchoring vegetation except where they have been reactivated where vegetation is disturbed (Figure 3-4).

A series of numbered areas have been delineated at the Hanford Site. The 100 Areas are situated in the northern part of the Hanford Site adjacent to the Columbia River in an area commonly called the "Horn." The elevation of the "Horn" is between 119 and 143 m (390 and 470 ft) above mean sea level (msl) with a slight increase in elevation away from the river. The 200 Areas are situated on a broad flat area called the 200 Areas Plateau. The 200 Areas plateau is near the center of the Hanford Site at an elevation of approximately 198 to 229 m (650 to 750 ft) above msl. The plateau decreases in elevation to the north, northwest, and east toward the Columbia River, and plateau escarpments have elevation changes of between 15 to 30 m (50 to 100 ft).

The 200 West Area is situated on the 200 Areas Plateau on a relatively flat prominent terrace (Cold Creek Bar) formed during the late Pleistocene flooding (Figure 3-5). Cold Creek Bar trends generally east to west and is bisected by a flood channel that trends north to south. This terrace drops off rather steeply to the north and northwest with elevation changes between 15 and 30 m (50 to 100 ft).

The topography of the 200 West Area is generally flat (Figure 3-1). The elevation in the vicinity of the T Plant Aggregate Area ranges from approximately 221 m (725 ft) along the eastern part of the unit to about 204 m (670 ft) above msl in the western part. A detailed topographic map of the area is provided as Plate 2. There are no natural surface drainage channels within the area.

3.2 METEOROLOGY

The following sections provide information on Hanford Site meteorology including precipitation (Section 3.2.1), wind conditions (Section 3.2.2), and temperature variability (Section 3.2.3).

The Hanford Site lies east of the Cascade Mountains and has a semiarid climate because of the rainshadow effect of the mountains. The weather is monitored at the Hanford Meteorology Station, located between the 200 East and 200 West Areas, and at other points

situated through the reservation. The following sections summarize the Hanford Site meteorology.

3.2.1 Precipitation

The Hanford Site receives an annual average of 16 cm (6.3 in.) of precipitation. Precipitation falls mainly in the winter, with about half of the annual precipitation occurring between November and February. The maximum 25 yr/24 h storm event has been calculated at 3.8 cm (1.5 in.) (Stone et al. 1983). The maximum 100 yr/24 h storm event is approximately 5 cm (2 in.). Average winter snowfall ranges from 13 cm (5.3 in.) in January to 0.8 cm (0.31 in.) in March. The record snowfall of 62 cm (24.4 in.) occurred in February 1916 (Stone et al. 1983). During December through February, snowfall accounts for about 38% of all precipitation in those months.

The average yearly relative humidity at the Hanford Site for 1946 to 1980 was 54.4%. Humidity is higher in winter than in summer. The monthly averages for the same period range from 32.2% for July to 80% in December. Atmospheric pressure averages are higher in the winter months and record absolute highs and lows also occur in the winter.

3.2.2 Winds

The Cascade Mountains have considerable effect on the wind regime at the Hanford Site by serving as a source of cold air drainage. This gravity drainage results in a northwest to west-northwest prevailing wind direction. The average mean monthly speed for 1945 to 1980 is 3.4 m/s (7.7 mph). Peak gust speeds range from 28 to 36 m/s (63 to 80 mph) and are generally southwest or west-southwest winds (Stone et al. 1983).

Figure 3-6 shows wind roses for the Hanford Telemetry Network (Stone et al. 1983). The gravity drainage from the Cascades produces a prevailing west-northwest wind in the 200 West Area. In July, hourly average wind speeds range from a low of 2.3 m/s (5.2 mph) from 9 to 10 a.m. to a high of 6 m/s (13.0 mph) from 9 to 10 p.m.

3.2.3 Temperature

Based on data from 1914 to 1980, minimum winter temperatures vary from -33 °C (-27 °F) to -6 °C (+22 °F), and maximum summer temperatures vary from 38 °C (100 °F) to 46 °C (115 °F). Between 1914 and 1980, a total of 16 days with temperatures -29 °C (-20 °F) or below are recorded. There are 10 days of record when the maximum temperature failed to go above -18 °C (0 °F). Prior to 1980, there were three summers on

record when the temperatures were 38 °C (100 °F) or above for 11 consecutive days (Stone et al. 1983).

3.3 SURFACE HYDROLOGY

3.3.1 Regional Surface Hydrology

Surface drainage enters the Pasco Basin from several other basins, which include the Yakima River Basin, Walla Walla River Basin, Palouse/Snake Basin, and Big Bend Basin (Figure 3-7). Within the Pasco Basin, the Columbia River is joined by major tributaries including the Yakima, Snake, and Walla Walla Rivers. No perennial streams originate within the Pasco Basin. Columbia River inflow to the Pasco Basin is recorded at the United States Geological Survey (USGS) gage below Priest Rapids Dam, and outflow is recorded below McNary Dam. Average annual flow at these recording stations is approximately 1.1×10^{11} m^3 (8.7×10^7 acre-ft) at the USGS gage and 1.6×10^{11} m^3 (1.3×10^8 acre-ft) at the McNary Dam gage (DOE 1988b).

Total estimated precipitation over the basin averages less than 15.8 cm/yr (6.2 in./yr). Mean annual runoff from the basin is estimated to be less than 3.1×10^7 m^3/yr (2.5×10^4 acre-ft/yr), or approximately 3% of the total precipitation. The remaining precipitation is assumed to be lost through evapotranspiration with a small component (perhaps less than 1%) recharging the groundwater system (DOE 1988b).

3.3.2 Surface Hydrology of the Hanford Site

Primary surface water features associated with the Hanford Site, located near the center of the Pasco Basin (Figure 3-7), are the Columbia and Yakima Rivers and their major tributaries, the Snake and Walla Walla Rivers. West Lake, about 4 hectares (10 acres) in size and less than 0.9 m (3 ft) deep, is the only natural lake within the Hanford Site (DOE 1988b). Wastewater ponds, cribs, and ditches associated with nuclear fuel reprocessing and waste disposal activities are also present on the Hanford Site.

The Columbia River flows through the northern part and along the eastern border of the Hanford Site. This section of the river, the Hanford Reach, extends from Priest Rapids Dam to the headwaters of Lake Wallula (the reservoir behind McNary Dam). Flow along the Hanford Reach is controlled by Priest Rapids Dam. Several drains and intakes are also present along this reach, including irrigation outfalls from the Columbia Basin Irrigation Project, the Washington Public Power Supply System (WPPSS) Nuclear Project 2, and Hanford Site intakes for onsite water use. Much of the northern and eastern parts of the Hanford Site are drained by the Columbia River.

Routine water-quality monitoring of the Columbia River is conducted by the U.S. Department of Energy (DOE) for both radiological and nonradiological parameters and has been reported by Pacific Northwest Laboratory (PNL) since 1973. Washington State Department of Ecology (Ecology) has issued a Class A (excellent) quality designation for Columbia River water along the Hanford Reach from Grand Coulee Dam, through the Pasco Basin, to McNary Dam. This designation requires that all industrial uses of this water be compatible with other uses, including drinking, wildlife habitat, and recreation. In general, the Columbia River water is characterized by a very low suspended load, a low nutrient content, and an absence of microbial contaminants (DOE 1988b).

Approximately one-third of the Hanford Site is drained by the Yakima River system. Cold Creek and its tributary, Dry Creek, are ephemeral streams on the Hanford Site that are within the Yakima River drainage system. Both streams drain areas along the western part of the Hanford Site and cross the southwestern part of the Hanford Site toward the Yakima River. Surface flow, which may occur during spring runoff or after heavier-than-normal precipitation, infiltrates and disappears into the surface sediments. Rattlesnake Springs, located on the western part of the Hanford Site, forms a small surface stream that flows for about 2.9 km (1.8 mi) before infiltrating into the ground.

3.3.3 T Plant Aggregate Area Surface Hydrology

No natural surface water bodies exist in the T Plant Aggregate Area which lies within the Yakima River system. The only existing man-made surface water bodies are the 216-T-1 Ditch, the open stretches of the 216-T-4-2 Ditch, and the 207-T Rentention Basin. The 216-T-1 Ditch is an active waste management unit north of the 221-T Building. The ditch is 556 m (1,825 ft) long and runs northwest. The 216-T-4-2 Ditch runs from northwest to southeast across about 460 m (1,500 ft) of 200 West Area. It originates about 30 m (100 ft) north of the T Tank Farm, and terminates at the old 216-T-4A Pond, which has been backfilled and stabilized. The open portions of the ditches do not present any flooding potential due to the nature of the soil which allows for rapid infiltration of surface water into the ground. The 200 West Area in not in a designated floodplain. The 207-T Retention Basin presents no threat of flooding because they discharge into the 216-T-4-2 Ditch.

The 200 West Area, and specifically the T Plant Aggregate Area, is not in a designated floodplain. Calculations of probable maximum floods for the Columbia River and the Cold Creek Watershed indicate that the 200 West Area is not expected to be inundated under maximum flood conditions (DOE/RL 1991c).

3.4 GEOLOGY

The following subsections provide information pertaining to geologic characteristics of southcentral Washington, the Hanford Site, the 200 West Area, and the T Plant Aggregate Area. Topics included are the regional tectonic framework (Section 3.4.1), regional stratigraphy (Section 3.4.2), and 200 West Area and T Plant Aggregate Area geology (Section 3.4.3).

The geologic characterization of the Hanford Site, including the 200 West Area and T Plant Aggregate Area is the result of many previous site investigation activities at Hanford. These activities include the siting of nuclear reactors, characterization activities for the Basalt Waste Isolation Project (BWIP), waste management activities, and related geologic studies supporting these efforts. Geologic investigations have included regional and Hanford Site surface mapping, borehole/well sediment logging, field and laboratory sediment classification, borehole geophysical studies (including gamma radiation logging), and in situ and laboratory hydrogeologic properties testing.

3.4.1 Regional Tectonic Framework

The following sections provide information on regional (southcentral Washington) geologic structure, structural geology of the Pasco Basin and the Hanford Site, and regional and Hanford Site seismology.

3.4.1.1 Regional Geologic Structure. The Columbia Plateau is a part of the North American continental plate and lies in a back-arc setting east of the Cascade Range. It is bounded on the north by the Okanogan Highlands, on the east by the Northern Rocky Mountains and Idaho Batholith, and on the south by the High Lava Plains and Snake River Plain (Figure 3-8).

The Columbia Plateau can be divided into three informal structural subprovinces (Figure 3-9): Blue Mountains, Palouse, and Yakima Fold Belt (Tolan and Reidel 1989). These structural subprovinces are delineated on the basis of their structural fabric, unlike the physiographic provinces that are defined on the basis of landforms. The Hanford Site is located in the Yakima Fold Belt Subprovince near its junction with the Palouse Subprovinces.

The principal characteristics of the Yakima Fold Belt (Figure 3-10) are a series of segmented, narrow, asymmetric anticlines that have wavelengths between 5 and 32 km (3 and 19 mi) and amplitudes commonly less than 1 km (0.6 mi) (Reidel 1984; Reidel et al. 1989a). The northern limbs of the anticlines generally dip steeply to the north, are vertical, or even overturned. The southern limbs generally dip at relatively shallow angles to the south. Thrust or high-angle reverse faults with fault planes that strike parallel or subparallel to the axial trends are principally found on the north sides of these anticlines. The amount of

vertical stratigraphic offset associated with these faults varies but commonly exceeds hundreds of meters. These anticlinal ridges are separated by broad synclines or basins that, in many cases, contain thick accumulations of Tertiary- to Quaternary-age sediments. The Pasco Basin is one of the larger structural basins in the Yakima Fold Belt Subprovince.

Deformation of the Yakima folds occurred under a north-south compression and was contemporaneous with the eruption of the basalt flows (Reidel 1984; Reidel et al. 1989a). Deformation occurred during the eruption of the Columbia River Basalt Group and continued through the Pliocene epoch, into the Pleistocene epoch, and perhaps to the present.

3.4.1.2 Pasco Basin and Hanford Site Structural Geology. The Pasco Basin, in which the Hanford Site is located, is a structural depression bounded on the north by the Saddle Mountains anticline, on the east by the Palouse Slope, on the west by the Umtanum Ridge, Yakima Ridge, and Rattlesnake Hills anticlines, and on the south by the Rattlesnake Mountain anticline (Figure 3-11). The Pasco Basin is divided by the Gable Mountain anticline, the easternmost extension of the Umtanum Ridge anticline, into the Wahluke syncline in the north, and the Cold Creek syncline in the south. Both the Cold Creek and Wahluke synclines are asymmetric and relatively flat-bottomed structures. The north limbs of both synclines dip gently (approximately 5°) to the south and the south limbs dip steeply to the north. The deepest parts of the Cold Creek syncline, the Wye Barricade depression, and the Cold Creek depression are approximately 12 km (7.5 mi) southeast of the Hanford Site 200 Areas, and just to the west-southwest of the 200 West Area, respectively. The deepest part of the Wahluke syncline lies just north of Gable Gap.

The 200 West Area is situated on the generally southward dipping north limb of the Cold Creek syncline 1 to 5 km (0.6 to 3 mi) north of the syncline axis. The Gable Mountain-Gable Butte segment of the Umtanum Ridge anticline lies approximately 4 km (2.5 mi) north of the 200 West Area. The axes of the anticline and syncline are separated by a distance of 9 to 10 km (5.6 to 6.2 mi) and the crest of the anticline (as now exposed) is over 200 m (656 ft) higher than the uppermost basalt layer in the syncline axis. As a result, the basalts and overlying sediments dip to the south and southwest beneath the 200 West Area.

3.4.1.3 Regional and Hanford Site Seismology. Eastern Washington, especially the Columbia Plateau region, is a seismically inactive area when compared to the rest of the western United States (DOE 1988b). The historic seismic record for eastern Washington began in approximately 1850, and no earthquakes large enough to be felt had epicenters on the Hanford Site. The closest regions of historic moderate-to-large earthquake generation are in western Washington and Oregon and western Montana and eastern Idaho. The most significant event relative to the Hanford Site is the 1936 Milton-Freewater, Oregon, earthquake that had a magnitude of 5.75 and that occurred more than 90 km (54 mi) away. The largest Modified Mercalli Intensity for this event was felt about 105 km (63 mi) from the Hanford Site at Walla Walla, Washington, and was VII.

Geologic evidence of past moderate or possibly large earthquake activity is shown by the anticlinal folds and faulting associated with Rattlesnake Mountain, Saddle Mountain, and Gable Mountain. The currently recorded seismic activity related to these structures consists of micro-size earthquakes. The suggested recurrence rates of moderate and larger-size earthquakes on and near the Hanford Site are measured in geologic time (tens of thousands of years).

3.4.2 Regional Stratigraphy

The following subsections summarize regional stratigraphic characteristics of the Columbia River Basalt and Suprabasalt sediments. Specific references to the Hanford Site and 200 West Area are made where applicable to describe the general occurrence of these units within the Pasco Basin.

The principal geologic units within the Pasco Basin include the Miocene age basalt of the Columbia River Basalt Group, and overlying late Miocene to Pleistocene suprabasalt sediments (Figure 3-12). Older Cenozoic sedimentary and volcaniclastic rocks underlying the basalts are not exposed at the surface near the Hanford Site. The basalts and sediments thicken into the Pasco Basin and generally reach maximum thicknesses in the Cold Creek syncline. The suprabasalt sedimentary sequence at the Hanford Site pinches out against the anticlinal structures of Saddle Mountains, Gable Mountain/Umtanum Ridge, Yakima Ridge, and Rattlesnake Hills.

The suprabasalt sediment sequence is up to approximately 230 m (750 ft) thick and dominated by laterally extensive deposits assigned to the late Miocene- to Pliocene-age Ringold Formation and the Pleistocene-age Hanford formation (Figure 3-13). Locally occurring strata informally referred to as the pre-Missoula gravels, the Plio-Pleistocene unit, and the early "Palouse" soil comprise the remainder of the sedimentary sequence. The pre-Missoula gravels underlie the Hanford formation in the east-central Cold Creek syncline and at the east end of Gable Mountain anticline east and south of 200 Areas. The pre-Missoula gravels have not been identified in the 200 West Area. The nature of the contact between the pre-Missoula gravels has not been identified in the 200 West Area. The nature of the contact between the pre-Missoula gravels and the overlying Hanford formation has not been completely delineated. In addition, it is unclear whether the pre-Missoula gravels overlie or interfinger with the early "Palouse" soil and Plio-Pleistocene unit. Magnetic polarity data indicate the unit is no younger than early Pleistocene in age (>1 Ma [million years before present]) as reported in Baker et al. (1991).

Relatively thin surficial deposits of eolian sand, loess, alluvium, and colluvium discontinuously overlie the Hanford formation.

3.4.2.1 Columbia River Basalt Group. The Columbia River Basalt Group (Figure 3-12) comprises an assemblage of tholeiitic, continental flood basalts of Miocene age. These flows cover an area of more 163,700 km^2 (63,000 mi^2) in Washington, Oregon, and Idaho and have an estimated volume of about 174,356 km^3 (40,800 mi^3) (Tolan et al. 1989). Isotopic age determinations indicate that basalt flows were erupted approximately 17 to 6 Ma, with more than 98% by volume being erupted in a 2.5 million year period (17 to 14.5 Ma) (Reidel et al. 1989b).

Columbia River Basalt flows were erupted from north-northwest-trending fissures of linear vent systems in north-central and northeastern Oregon, eastern Washington, and western Idaho (Swanson et al. 1979). The Columbia River Basalt Group is formally divided into five formations (from oldest to youngest): Imnaha Basalt, Picture Gorge Basalt, Grande Ronde Basalt, Wanapum Basalt, and Saddle Mountains Basalt. Of these, only the Picture Gorge Basalt is not known to be present in the Pasco Basin. The Saddle Mountains Basalt, divided into the Ice Harbor, Elephant Mountain, Pomona, Esquatzel, Asotin, Wilbur Creek and Umatilla Members (Figure 3-12), forms the uppermost basalt unit throughout most of the Pasco Basin. The Elephant Mountain Member is the uppermost unit beneath most of the Hanford Site except near the 300 Area where the Ice Harbor Member is found and north of the 200 Areas where the Saddle Mountains Basalt has been eroded down to the Umatilla Member locally. On anticlinal ridges bounding the Pasco Basin, the Saddle Mountains Basalt is locally absent, exposing the Wanapum and Grande Ronde Basalts.

3.4.2.2 Ellensburg Formation. The Ellensburg Formation consists of all sedimentary units that occur between the basalt flows of the Columbia River Basalt Group in the central Columbia Basin. The Ellensburg Formation generally displays two main lithologies: volcaniclastics (Reidel and Fecht 1981; Smith et al. 1989), and siliciclastics (DOE 1988b). The volcaniclastics consist mainly of primary pyroclastic air fall deposits and reworked epiclastics derived from volcanic terrains west of the Columbia Plateau. Siliciclastic strata in the Ellensburg Formation consists of clastic, plutonic, and metamorphic detritus derived from the Rocky Mountain terrain. These two lithologies occur as both distinct and mixed in the Pasco Basin. A detailed discussion of the Ellensburg Formation in the Hanford Site is given by Reidel and Fecht (1981). Smith et al. (1989) provides a discussion of age equivalent units adjacent to the Columbia Plateau.

The stratigraphic names for individual units of the Ellensburg Formation are given in Figure 3-12. The nomenclature for these units is based on the upper- and lower-bounding basalt flows and thus the names are valid only for those areas where the bounding basalt flows occur. Because the Pasco Basin is an area where most bounding flows occur, the names given in Figure 3-12 are applicable to the Hanford Site. At the Hanford Site the three

uppermost units of the Ellensburg Formation are the Selah interbed, the Rattlesnake Ridge interbed, and the Levey interbed.

3.4.2.2.1 Selah Interbed. The Selah interbed is bounded on the top by the Pomona Member and on the bottom by the Esquatzel Member. The interbed is a variable mixture of silty to sandy vitric tuff, arkosic sands, tuffaceous clays, and locally thin stringers of predominantly basaltic gravels. The Selah interbed is found beneath most of the Hanford Site.

3.4.2.2.2 Rattlesnake Ridge Interbed. The Rattlesnake Ridge interbed is bounded on the top of the Elephant Mountain Member and on the bottom by the Pomona Member. The interbed is up to 33 m (108 ft) thick and dominated by three facies at the Hanford Site: (1) a lower clay or tuffaceous sandstone, (2) a middle, micaceous-arkosic and/or tuffaceous sandstone, and (3) an upper, tuffaceous siltstone to sandstone. The unit is found beneath most of the Hanford Site.

3.4.2.2.3 Levey Interbed. The Levey interbed is the uppermost unit of the Ellensburg Formation and occurs between the Ice Harbor Member and the Elephant Mountain Member. It is confined to the vicinity of the 300 Area. The Levey interbed is a tuffaceous sandstone along its northern edge and a fine-grained tuffaceous siltstone to sandstone along its western and southern margins.

3.4.2.3 Ringold Formation. The Ringold Formation at the Hanford Site is up to 185 m (607 ft) thick in the deepest part of the Cold Creek syncline south of the 200 West Area and 170 m (558 ft) thick in the western Wahluke syncline near the 100-B Area. The Ringold Formation pinches out against the Gable Mountain, Yakima Ridge, Saddle Mountains, and Rattlesnake Mountain anticlines. It is largely absent in the northern and northeastern parts of the 200 East Area and adjacent areas to the north in the vicinity of West Lake. The Ringold Formation is assigned a late Miocene to Pliocene age (Fecht et al. 1987; DOE 1988b) and was deposited in alluvial and lacustrine environments (Bjornstad 1984; Fecht et al. 1987; Lindsey et al. 1991).

Recent studies of the Ringold Formation (Lindsey and Gaylord 1989; Lindsey et al. 1992) indicate that it is best described and divided on the basis of sediment facies associations and their distribution. Facies associations in the Ringold Formation (defined on the basis of lithology, petrology, stratification, and pedogenic alteration) include fluvial gravel, fluvial sand, overbank deposits, lacustrine deposits, and alluvial fan. The facies associations are summarized as follows:

- Fluvial gravel--Clast-supported granule to cobble gravel with a sandy matrix dominates the association. Intercalated sands and muds also are found. Clast composition is very variable, with common types being basalt, quartzite, porphyritic volcanics, and greenstones. Silicic plutonic rocks, gneisses, and volcanic breccias also are found.

Sands in this association are generally quartzo-feldspathic, with basalt contents generally in the range of 5 to 25%. Low angle to planar stratification, massive channels, wide, shallow channels, and large-scale cross-bedding are found in outcrops. The association was deposited in a gravelly fluvial system characterized by wide, shallow shifting channels.

- Fluvial sand--Quartzo-feldspathic sands displaying cross-bedding and cross-lamination in outcrop dominate this association. These sands usually contain less than 15% basalt lithic fragments, although basalt contents as high as 50% may be encountered. Intercalated strata consist of lenticular silty sands and clays up to 3 m (10 ft) thick and thin (<0.5 m) gravels. Fining upwards sequences less than 1 m (3.3 ft) to several meters thick are common in the association. Strata comprising the association were deposited in wide, shallow channels.

- Overbank deposits--This association dominantly consists of laminated to massive silt, silty fine-gained sand, and paleosols containing variable amounts of calcium carbonate. Overbank deposits occur as thin lenticular interbeds (<0.5 m to 2 m, <1.6 ft to 6 ft) in the fluvial gravel and fluvial sand associations and as thick (up to 10 m, 33 ft) laterally continuous sequences. These sediments record deposition in a floodplain under proximal levee to more distal floodplain conditions.

- Lacustrine deposits--Plane laminated to massive clay with thin silt and silty sand interbeds displaying some soft-sediment deformation characterize this association. Coarsening upwards packages less than 1 m (3.3 ft) to 10 m (33 ft) thick are common in the association. Strata comprising the association were deposited in a lake under standing water to deltaic conditions.

- Alluvial fan--Massive to crudely stratified, weathered to unweathered basaltic detritus dominates this association. These basaltic deposits generally are found around the periphery of the basin. This association was deposited largely by debris flows in alluvial fan settings.

The lower half of the Ringold Formation contains five separate stratigraphic intervals dominated by fluvial gravels. These gravels, designated units, A, B, C, D, and E (also called FSA, FSB, FSC, FSD, and FSE [Lindsey and Gaylord 1989; Lindsey et al. 1991]) (Figure 3-13), are separated by intervals containing deposits typical of the overbank and lacustrine facies associations. The lowermost of the fine-grained sequences, overlying unit A, is designated the lower mud sequence. The uppermost gravel unit, unit E, grades upwards into interbedded fluvial sand and overbank deposits. These sands and overbank deposits are overlain by lacustrine-dominated strata.

Fluvial gravel units A and E correspond to the lower basal and middle Ringold units respectively as defined by DOE (1988b). Gravel units B, C, and D do not correlate to any

previously defined units (Lindsey et al. 1991). The lower mud sequence corresponds to the upper basal and lower units as defined by DOE (1988b). The upper basal and lower units are not differentiated. The sequence of fluvial sands, overbank deposits, and lacustrine sediments overlying unit E corresponds to the upper unit as seen along the White Bluffs in the eastern Pasco Basin. This essentially is the same usage as originally proposed by Newcomb (1958) and Myers et al. (1979).

3.4.2.4 Plio-Pleistocene Unit. Unconformably overlying the Ringold Formation in the western Cold Creek syncline in the vicinity of 200 West Area (Figures 3-11, 3-12, and 3-13) is the laterally discontinuous Plio-Pleistocene unit (DOE 1988b). The unit is up to 25 m (82 ft) thick and divided into two facies: (1) sidestream alluvium and (2) calcic paleosol (Stage III and Stage IV) (DOE 1988b). The calcic paleosol facies consists of massive calcium carbonate-cemented silt, sand, gravel (caliche) to interbedded caliche-rich and caliche-poor silts and sands. The basaltic detritus facies consists of weathered and unweathered basaltic gravels deposited as locally derived slope wash, colluvium, and sidestream alluvium. The Plio-Pleistocene unit appears to be correlative to other sidestream alluvial and pedogenic deposits found near the base of the ridges bounding the Pasco Basin on the north, west, and south. These sidestream alluvial and pedogenic deposits are inferred to have a late Pliocene to early Pleistocene age on the basis of stratigraphic position and magnetic polarity of interfingering loess units.

3.4.2.5 Pre-Missoula Gravels. Quartzose to gneissic clast-supported pebble to cobble gravel with a quartzo-feldspathic sand matrix underlies the Hanford formation in the east-central Cold Creek syncline and at the east end of Gable Mountain anticline east and south of the 200 East Area (Figures 3-11, 3-12, and 3-13). These gravels, called the pre-Missoula gravels (PSPL 1982), are up to 25 m (82 ft) thick, contain less basalt than underlying Ringold gravels and overlying Hanford deposits, have a distinctive white or bleached color, and sharply truncate underlying strata. The nature of the contact between the pre-Missoula gravels and the overlying Hanford formation is not clear. In addition, it is unclear whether the pre-Missoula gravels overlie or interfinger with the early "Palouse" soil and Plio-Pleistocene unit. Magnetic polarity data indicates the unit is no younger than early Pleistocene in age (>1 Ma) (Baker et al. 1991).

3.4.2.6 Early "Palouse" Soil. The early "Palouse" soil consists of up to 20 m (66 ft) of massive, brown yellow, and compact, loess-like silt and minor fine-grained sand (Tallman et al. 1979, 1981; DOE 1988b). These deposits overlie the Plio-Pleistocene unit in the western Cold Creek syncline around the 200 West Area (Figures 3-11, 3-12, and 3-13). The unit is differentiated from overlying graded rhythmites (Hanford formation) by greater calcium carbonate content, massive structure in core, and high natural gamma response in geophysical logs (DOE 1988b). This natural gamma response is due to the inherent stratigraphic properties of the unit, rather than from effects of radionuclide contamination. The upper contact of the unit is poorly defined, and it may grade up-section into the lower

part of the Hanford formation. Based on a predominantly reversed polarity the unit is inferred to be early Pleistocene in age (Baker et al. 1991).

3.4.2.7 Hanford Formation. The Hanford formation consists of pebble to boulder gravel, fine- to coarse-grained sand, and silt (Baker et al. 1991). These deposits are divided into three facies: (1) gravel-dominated, (2) sand-dominated, and (3) silt-dominated facies. These facies are referred to as coarse-grained deposits, plane-laminated sand facies, and rhythmite faces, respectively, in Baker et al. (1991). The silt-dominated deposits also are referred to as the "Touchet Beds," while the gravelly facies are generally referred to as the Pasco Gravels. The Hanford formation is thickest in the Cold Creek bar in the vicinity of 200 West and 200 East Areas where it is up to 65 m (213 ft) thick (Figures 3-11, 3-12, and 3-13). The Hanford formation was deposited by cataclysmic flood waters that drained out of glacial Lake Missoula (Fecht et al. 1987; DOE 1988b; and Baker et al. 1991). Hanford deposits are absent on ridges above approximately 385 m (1,263 ft) above sea level. The following sections describe the three Hanford formation facies.

In addition to the three Hanford formation facies, clastic dikes (Black 1980) also are commonly found in the Hanford formation. These dikes, while common in the Hanford formation, also are found locally in other sedimentary units in the Pasco Basin. Clastic dikes, whether in the Hanford formation or other sedimentary units, are structures that generally cross-cut bedding, although they do locally parallel bedding. The dikes generally consist of alternating vertical to subvertical layers (millimeters to centimeters thick) of silt, sand, and granules. Where the dikes intersect the ground surface, a feature known as patterned ground can be observed (Lindsey et al. 1992).

3.4.2.7.1 Pasco Gravels. The Pasco Gravels consist of two facies, a gravel-dominated facies and a silt-dominated facies. The gravel-dominated facies is dominated by coarse-grained basaltic sand and granule to boulder gravel. These deposits display massive bedding, plane to low-angle bedding, and large-scale planar cross-bedding in outcrop, while the gravels generally are matrix-poor and display an open-framework texture. Lenticular sand and silt beds are intercalated throughout the facies. Gravel clasts in the facies generally are dominated by basalt (50 to 80%). Other clast types include Ringold and Plio-Pleistocene rip-ups, granite, quartzite, and gneiss. The relative proportion of gniessic and granitic clasts in Hanford gravels versus Ringold gravels generally is higher (up to 20% as compared to less than 5%). Sands in this facies usually are very basaltic (up to 90%), especially in the granule size range. Locally Ringold and Plio-Pleistocene rip-up clasts dominate the facies comprising up to 75% of the deposit. The gravel facies dominates the Hanford formation in the 100 Areas north of Gable Mountain, the northern part of 200 East Area, and the eastern part of the Hanford Site including the 300 Area. The gravel-dominated facies was deposited by high-energy flood waters in or immediately adjacent to the main cataclysmic flood channelways.

The sand-dominated facies consists of fine-grained to coarse-grained sand and granular sand displaying plane lamination and bedding and less commonly plane cross-bedding in outcrop. These sands may contain small pebbles and rip-up clasts in addition to pebble-gravel interbeds and silty interbeds less than 1 m (3.3 ft) thick. The silt content of these sands is variable, but where it is low an open framework texture is common. These sands are typically very basaltic, commonly being referred to as black or gray or salt and pepper sands. This facies is most common in the central Cold Creek syncline, in the central to southern parts of the 200 East and 200 West Areas, and in the vicinity of the WPPSS facilities. The sand-dominated facies was deposited in channelways as flow power waned and adjacent to main flood channelways as water in the channelways spilled out of them, losing their competence. The facies is transitional between gravel-dominated facies and silt-dominated facies.

3.4.2.7.2 Touchet Beds. The Touchet Beds consist of a silt-dominated facies. The silt-dominated facies consists of thinly bedded, plane laminated and ripple cross-laminated silt and fine- to coarse-grained sand that commonly display normally graded rhythmites similar to Bouma sequences, a few centimeters to several tens of centimeters thick in outcrop (Myers et al. 1979; DOE 1988b). This facies dominates the Hanford formation throughout the central, southern, and western Cold Creek syncline within and south of 200 East and West Areas. These sediments were deposited under slackwater conditions and in backflooded areas (DOE 1988b).

3.4.2.8 Surficial Deposits. Surficial deposits consist of silt, sand, and gravel that form a thin (< 10 m, 33 ft) veneer across much of the Hanford Site. These sediments were deposited by a mix of eolian and alluvial processes.

3.4.3 200 West Area and T Plant Aggregate Area Geology

The following subsections describe the occurrence and variation of suprabasalt sediments in the 200 West Area. The subsections discuss notable stratigraphic characteristics, sediment thickness variations, dip trends, and other features such as areas where sediments are known or suspected to be absent. Stratigraphic variations pertinent to the T Plant Aggregate Area are identified where applicable, and are presented in the overall context of stratigraphic trends throughout the 200 West Area.

Geologic cross sections depicting the distribution of basalt and sedimentary units within and near the T Plant Aggregate Area are presented on Figures 3-14 through 3-19. Figure 3-14 illustrates the cross sections locations. A legend for symbols used on the cross sections is provided on Figure 3-15. The cross sections are based on geologic information from wells shown on the figures, as interpreted in Lindsey et al. (1991) and from Chamness et al. (1991). Chamness et al. (1991) provide a compilation of geologic logs from the T Plant

Aggregate Area, and a listing of additional geological, geochemical, and geophysical data available from the boreholes. This information was compiled in support of the T Plant Aggregate Area Management Study (AAMS). The cross sections depict subsurface geology near solid waste burial ground areas in the western and northern part of the T Plant Aggregate Area and burial ground areas and liquid waste disposal sites in the southern portion of the site (Figures 3-16 through 3-19: Sections B-B′, D-D′, E-E′, and F-F′). For each cross section, locations of T Plant Aggregate Area waste sites are identified for reference. Figures 3-20 through 3-37 present structural maps of the top of the sedimentary units, and isopach maps illustrating the thickness of each unit in the 200 West Area and T Plant Aggregate Area. The structural and isopach maps are included from Lindsey et al. (1991). Plate 1 should be consulted to identify locations of T Plant Aggregate Area buildings and waste sites referenced in the text.

3.4.3.1 Elephant Mountain Basalt. The Elephant Mountain Member of the Saddle Mountains Basalt is continuous beneath the entire 200 West Area. The top of the Elephant Mountain Member dips to the southwest and south into the Cold Creek syncline, reflecting the structure of the area (Figure 3-20). There is little evidence of significant erosion into the top of the Elephant Mountain Member and no indication of erosional "windows" through the basalt into the underlying Rattlesnake Mountain interbed.

3.4.3.2 Ringold Formation. Within the 200 West Area, the Ringold formation includes the fluvial gravels of unit A, the paleosol and lacustrine muds of the lower mud sequence, the fluvial gravels of unit E, and the sands and minor muds of the upper unit. Ringold units B, C, and D are not found in the immediate vicinity of the 200 West Area.

Several observations can be made regarding the variation of sediment types within the Ringold units in the 200 West Area. In the Ringold unit A gravels, intercalated lenticular sand and silt are most common in the western portion of the 200 West Area (including a portion of the T Plant Aggregate Area), and in the southern part of the 200 West Area. In the overlying lower mud sequence, stratigraphic trends seen elsewhere in the Pasco Basin suggest that paleosols in the unit become more common progressing structurally up-dip (Lindsey et al. 1991). In the Ringold unit E gravels, intercalated lenticular beds of sand and silt occur throughout the 200 West Area, although predicting where they will occur is difficult. The upper unit of the Ringold in the 200 West Area tends to be dominated by sand, unlike the upper unit elsewhere in the Pasco Basin where paleosols tend to dominate the upper unit.

Beneath the 200 West Area, the fluvial gravels of Ringold unit A, and the Ringold lower mud sequence tend to thicken and dip to the south-southwest, toward the axis of the Cold Creek Syncline (Figures 3-16 and 3-22 through 3-24). The top of unit A is relatively flat in the 200 Areas, dipping gently to the west and southwest. Like the unit A gravels, the Ringold lower mud sequence thickens and dips to the south and southeast over the 200 West Area (Figures 3-21 and 3-22). The top of the lower mud unit is less regular, however, and

the unit pinches out in the northeastern corner of the 200 West Area. Within the T Plant Aggregate Area, unit A reaches a thickness of more than 26 m (80 ft) in the eastern part of the Aggregate Area, and apparently pinches out just north of the 200 West Area boundary. The lower mud sequence ranges in thickness from about 13 m (40 ft) at the southwest corner of the Aggregate Area to not present in the northeast corner of the T Plant Aggregate Area.

Isopach and structural contour maps of fluvial gravel unit E (Figures 3-25 and 3-26) and the upper Ringold unit (Figures 3-27 and 3-28) show trends not seen in the underlying unit A and the lower mud sequence in the 200 West Area. The top of unit E is irregular, and displays several highs near the north and northeastern parts of the 200 West Area. These highs include the northern part of the Aggregate Area. Unit E gravels generally thin from north-northeast to southwest, and generally dips to the southeast across the 200 Areas. Unit E thickness varies from about 66 m (200 ft) at the southern boundary of the T Plant Aggregate Area to over 100 m (300 ft) at the northeastern boundary of the T Plant Aggregate Area.

The upper unit of the Ringold formation is present only in the western, northern, and central portion of the 200 West Area (Figures 3-27 and 3-28). Where the upper unit is present, the top generally dips to the south-southwest. The upper unit is absent on the eastern and southern parts of the T Plant Aggregate Area (Figures 3-16, and 3-17 through 3-19). The upper unit reaches a thickness of about 6 m (25 ft) at the southwest corners of the T Plant Aggregate Area.

3.4.3.3 Plio-Pleistocene Unit. As discussed in the regional stratigraphy section (Section 3.4.2), the carbonate-rich strata of the Plio-Pleistocene unit is largely restricted to the vicinity of the 200 West Area, pinching out near the north, east, and west of the area (Figure 3-29 and 3-30). The western most extent of the unit is not clear, although it seems to extend west and northwest of the 200 West Area. Thickness variations in the unit are irregular. Relatively thick portions of the unit [approximately 12 m (40 ft)] also occur northwest of the T Plant Aggregate Area, and near the northern boundary of the aggregate area [8 m (25 ft)]. Several prominent thin areas [1.5 m (5 ft) or less] occur near the central portion of the main T Plant Aggregate Area building complex. Although no erosional windows through the units have been encountered in bore holes, there is a possibility they exist, especially in the areas where the unit thins. In addition, fracturing in the carbonate is potentially common and interbedded carbonate-poor lithologies are found at many locations. The top of the unit generally dips to the southwest, although irregularities occur, especially in the southeastern part of the T Plant Aggregate Area.

3.4.3.4 Early "Palouse" Soil. As for the Plio-Pleistocene unit, the early "Palouse" soil is largely restricted to the vicinity of the 200 West Area (Figures 3-31 and 3-32). The unit pinches out near the southern, eastern, and northern portions of the 200 West Area. Data from boreholes located west of the 200 West Area indicate that the unit extends to the west. The early "Palouse" soil is also absent at several locations within the 200 West Area,

including locations north and southwest of the T Plant Aggregate Area. Like the Plio-Pleistocene unit, the thickness of the Early Palouse Soil in the 200 Area varies considerably. The unit is thickest in the southeast and southwest parts of the 200 West Area. Within the T Plant Aggregate Area, the unit reaches a thickness of about 6.5 m (20 ft) in the southern part of the aggregate area. Across the 200 Areas, the top of the unit dips to the south.

Although carbonate is present in the unit in the 200 Area, no obvious caliches like those seen in the underlying Plio-Pleistocene unit are documented. The loess-like sediments of the early "Palouse" soil are uncemented.

3.4.3.5 Hanford Formation. As discussed in the regional geology section, the cataclysmic flood deposits of the Hanford formation are divided into three facies: (1) gravel-dominated, (2) sand-dominated, and (3) silt-dominated facies. Typical lithologic successions consist of fining upwards package, major fine-grained intervals, and laterally persistent coarse-grained sequences. Mineralogic and geochemical data were not used in differentiating units because of the lack of a comprehensive mineralogic and geochemical data set. The Hanford formation is divided into two units, upper coarse-grained and lower fine-grained, based on lithology. These are essentially the same units as defined in Last et al. (1989). Neither of these units are continuous across the entire 200 West Area, they both display marked changes in thickness and continuity, and they are very heterogeneous.

The lower fine-grained unit of the Hanford formation in the 200 West Area is thick but locally discontinuous (Figures 3-33 and 3-34). The lower unit is 0 to 33 m (0 to 100 ft) thick and consists of silt, silty sand, and sand typical of the silt-dominated facies interbedded with coarser sands like those comprising the sand-dominated facies. This lower unit is cross-cut in places by vertical clastic dikes. These dikes, believed to be the product of dynamic loading from flood waters are distributed randomly throughout this lower unit. They are commonly filled with fine sands and silts and oriented nearly vertical. Thin (<3 m [10 ft]) intervals dominated by the gravel facies are found locally. The distribution of the gravel-dominated facies within the lower unit is quite variable, although the unit generally fines to the south where deposits associated with the silt-dominated facies become more common. The lower unit is not present over much of the northern part of the 200 West Area, and an area which includes the western portion of the T Plant Aggregate Area (Figures 3-16 through 3-19, and 3-33 and 3-34). Erosional windows through the lower fine unit are present to the south of the T Plant Aggregate Area. These erosional windows are elongated in a north-south direction. The lower unit dips irregularly across the 200 West Area. The lower unit is up to about 33 m (100 ft) thick toward the southeastern edge of the T Plant Aggregate Area, and generally dips to the north, toward the area where the unit is not present.

The upper coarse-grained unit of the Hanford formation consists of interstratified gravel, sand, and lesser silt (Figures 3-35 and 3-36). Deposits typical of the gravel-dominated facies generally dominate the upper unit. However, at some localities the upper unit, sand with minor silt and gravel typical of the sand-dominated facies is prevalent.

Minor silty deposits associated with the silt-dominated facies are found locally. The distribution of each of the facies types within the upper coarse-grained unit is quite variable. Fining upward sequences from coarser to finer gravel, or to sand and silt are present at some locations. The thickness of the upper coarse-grained unit varies across the 200 West Area (Figures 3-35 and 3-36), and is thickest at the southeast corner of the area. The unit is laterally discontinuous and pinches out south and southwest of the 200 West Area. Several local areas occur where thickness of the upper coarse-grained unit exceeds 30 m (100 ft), including areas in the southern and northern parts of the T Plant Aggregate Area. The base of the upper coarse-grained unit is incised into the underlying lower fine unit, and fills erosional windows where the lower unit is absent. The contact between the upper coarse-grained unit and underlying strata is generally sharp, and consists of the gravel-dominated facies deposits overlying the fines of the lower unit, early "Palouse" soil, or the Plio-Pleistocene unit.

3.4.3.6 Surficial Deposits. Surficial deposits consist of silt, sand, and gravel that form a thin veneer of less than about 10 m (33 ft) across much of the Hanford Site (Figure 3-37). The sediments are a mix of eolian-deposited sands and alluvial materials. In the vicinity of the 200 West Area, eolian sands dominate. Holocene deposits have been removed from much of the area by construction activities. Dune structures are not generally well developed within the 200 West Area. In the T Plant Aggregate Area these surficial deposits are found only in scattered portions.

3.5 HYDROGEOLOGY

Regional hydrogeology and hydrogeology of the 200 West Area are summarized in the following sections. Where sufficient data exists, interpretations of the hydrogeology beneath the T Plant Aggregate Area are presented. The information presented in these sections is principally taken from the standardized text (Delaney et al. 1991) provided by Westinghouse Hanford for this purpose.

3.5.1 Regional Hydrogeology

The hydrogeology of the Pasco Basin is characterized by a multiaquifer system that consists of four hydrogeological units that correspond to the upper three formations of the Columbia River Basalt Group (Grande Ronde Basalt, Wanapum Basalt, and Saddle Mountains Basalt) and the suprabasalt sediments. The basalt aquifers consist of the tholeiitic flood basalts of the Columbia River Basalt Group and relatively minor amounts of intercalated fluvial and volcaniclastic sediments of the Ellensburg Formation. Confined zones in the basalt aquifers are present in the sedimentary interbeds and/or interflow zones that occur between dense basalt flows. The main water-bearing portions of the interflow zones are networks of interconnecting vesicles and fractures of the flow tops and flow

bottoms (DOE 1988b). The suprabasalt sediment or uppermost aquifer system consists of fluvial, lacustrine, and glaciofluvial sediments. This aquifer is regionally unconfined and is contained largely within the Ringold Formation and Hanford formation. The position of the water table in the southwestern Pasco Basin is generally within Ringold fluvial gravels of unit E. In the northern and eastern Pasco Basin the water table is generally within the Hanford formation. Table 3-1 presents hydraulic parameters for various water-bearing geologic units at the Hanford Site.

Local recharge to the shallow basalt aquifers results from infiltration of precipitation and runoff along the margins of the Pasco Basin, and in areas of artificial recharge where a downward gradient from the unconfined aquifer systems to the uppermost confined basalt aquifer may occur. Regional recharge of the deep basalt aquifers is inferred to result from interbasin groundwater movement originating northeast and northwest of the Pasco Basin in areas where the Wanapum and Grande Ronde Basalts crop out extensively (DOE 1988b). Groundwater discharge from shallow basalt aquifers is probably to the overlying aquifers and to the Columbia River. The discharge area(s) for the deeper groundwater system is uncertain, but flow is inferred to be generally southeastward with discharge thought to be south of the Hanford Site (DOE 1988b).

Erosional "windows" through dense basalt flow interiors allow direct interconnection between the uppermost aquifer systems and underlying confined basalt aquifers. Graham et al. (1984) reported that some contamination was present in the uppermost confined aquifer (Rattlesnake Ridge interbed) south and east of Gable Mountain Pond. Graham et al. (1984) evaluated the hydrologic relationships between the Rattlesnake Ridge interbed aquifer and the unconfined aquifer in this area and delineated a potential area of intercommunication beneath the northeast portion of the 200 East Area.

The base of the uppermost aquifer system is defined as the top of the uppermost basalt flow. However, fine-grained overbank and lacustrine deposits in the Ringold Formation locally form confining layers for Ringold fluvial gravels underlying unit E. The uppermost aquifer system is bounded laterally by anticlinal basalt ridges and is approximately 152 m (500 ft) thick near the center of the Pasco Basin.

Sources of natural recharge to the uppermost aquifer system are rainfall and runoff from the higher bordering elevations, water infiltrating from small ephemeral streams, and river water along influent reaches of the Yakima and Columbia Rivers. The movement of precipitation through the unsaturated (vadose) zone has been studied at several locations on the Hanford Site (Gee 1987; Routson and Johnson 1990; Rockhold et al. 1990). Conclusions from these studies vary. Gee (1987) and Routson and Johnson (1990) conclude that no downward percolation of precipitation occurs on the 200 Areas Plateau where the sediments are layered and vary in texture, and that all moisture penetrating the soil is removed by evapotranspiration. These two studies analyzed data collected over a period of 12 and 14 years, respectively, and do not specifically address short-term seasonal fluctuations.

Rockhold et al. (1990) suggest that downward water movement below the root zone is common in the 300 Area, where soils are coarse-textured and precipitation was above normal.

3.5.2 Hanford Site Hydrogeology

This section describes the hydrogeology of the Hanford Site with specific reference to the 200 Areas.

3.5.2.1 Hydrostratigraphy. The hydrostratigraphic units of concern in the 200 Areas are (1) the Rattlesnake Ridge interbed (confined water-bearing zone), (2) the Elephant Mountain Basalt Member (confining horizon), (3) the Ringold Formation (locally semi-confined and confined water-bearing zones in Unit A gravels, beneath the lower mud sequence, and unconfined aquifer in unit A and unit E gravels), (4) the Plio-Pleistocene unit and early "Palouse" soil (primary vadose zone perching horizons and/or perched groundwater zones) and (5) the Hanford formation (vadose zone) (Figure 3-38). The Plio-Pleistocene unit and early "Palouse" soil are only encountered in the 200 West Area. Strata below the Rattlesnake Ridge interbed are not discussed because the more significant water-bearing intervals, relating to environmental issues, are primarily closer to ground surface. The hydrogeologic designations for the 200 Areas were determined by examination of borehole logs and integration of these data with stratigraphic correlations from existing reports.

3.5.2.1.1 Vadose Zone. The vadose zone beneath the 200 Areas ranges from approximately 55 m (180 ft) beneath the former U Pond to approximately 104 m (340 ft) west of the 200 East Area (Last et al. 1989). Sediments in the vadose zone consist of the (1) fluvial gravel of Ringold unit E, (2) the upper unit of the Ringold Formation, (3) Plio-Pleistocene unit, (4) early "Palouse" soil, and (5) Hanford formation. Only the Hanford formation is continuous throughout the vadose zone in the 200 Areas. The upper unit of the Ringold Formation, the Plio-Pleistocene unit, and the early "Palouse" soil only occur in 200 West Area. The unconfined aquifer water table (discussed in Section 3.5.2.1.3) lies within the Ringold unit E.

The transport of water through the vadose zone depends in complex ways on several factors, including most significantly the moisture content of the soils and their hydraulic properties. Darcy's law, although originally conceived for saturated flow only, was extended by Richards to unsaturated flow, with the provisions that the soil hydraulic conductivity becomes a function of the water content of the soil and the driving force is predominantly

differences in moisture level. The moisture flux, q, in cm/s in one direction is then described by a modified form of Darcy's law commonly referred to as Richards' Equation (Hillel 1971) as follows:

$$q = K(\theta) \times \partial\varphi/\partial\theta \times \partial\theta/\partial x \text{ (Richards' Equation)}$$

where

- $K(\theta)$ is the water-content-dependent unsaturated hydraulic conductivity in cm/s
- $\partial\varphi/\partial\theta$ is the slope of the soil-moisture retention curve $\varphi(\theta)$ at a particular volumetric moisture content θ (a soil-moisture retention curve plots volumetric moisture content observed in the field or laboratory against suction values for a particular soil, see Figure 3-39 from Gee and Heller [1985] for an example)
- $\partial\theta/\partial x$ is the water content gradient in the x direction.

More complicated forms of this equation are also available to account for the effects of more than one dimensional flow and the effects of other driving forces such as gravity.

The usefulness of Richards' Equation is that knowing the moisture content distribution in soil, having measured or estimated values for the unsaturated hydraulic conductivity corresponding to these moisture contents, and having developed a moisture retention curve for this soil, one can calculate a steady state moisture flux. With appropriate algebraic manipulation or numerical methods, one could also calculate the moisture flux under transient conditions.

In practice, applying Richards' Equation is quite difficult because the various parameters involved are difficult to measure and because soil properties vary depending on whether the soil is wetting or drying. As a result, soil heterogeneities affect unsaturated flow even more than saturated flow. Several investigators at the Hanford Site have measured the vadose zone moisture flux directly using lysimeters (e.g., Rockhold et al. 1990; Routson and Johnson 1990). These direct measurements are discussed in Section 3.5.2.2 under the heading of natural groundwater recharge.

An alternative to direct measurement of unsaturated hydraulic conductivity is to use theoretical methods which predict the conductivity from measured soil moisture retention data (Van Genuchten et al. 1991).

Thirty-five soil samples from the 200 West Area have had moisture retention data measured. These samples were collected from Wells 299-W18-21, 299-W15-16, 299-W15-2, 299-W10-13, 299-W7-9, and 299-W7-2. Eleven of these samples were reported by Bjornstad (1990). The remaining 24 were analyzed as part of an ongoing performance

assessment of the low-level burial grounds (Connelly et al. 1992). For each of these samples saturated hydraulic conductivity was measured in the laboratory. Van Genuchten's computer program RETC was then used to develop wetting and drying curves for the Hanford, early "Palouse" soil, Plio-Pleistocene, upper Ringold, and Ringold gravel lithologic units. An example of the wetting and drying curves, and corresponding grain size distributions, is provided on Figure 3-40.

The unsaturated hydraulic conductivities may vary by orders of magnitude with varying moisture contents and among differing lithologies with significantly different soil textures and hydraulic conductivities. Therefore, choosing a moisture retention curve should be made according to the particle size analyses of the samples and the relative density of the material.

Once the relationship between unsaturated hydraulic conductivity and moisture content is known for a particular lithologic unit, travel time can also be estimated for a steady-state flux passing through each layer by assuming a unit hydraulic gradient. Under the unit gradient condition, only the force of gravity is acting on water and all other forces are considered negligible. These assumptions may be met for flows due to natural recharge since moisture differences become smoothed out after sufficient time. Travel time for each lithologic unit of a set thickness and calculated for any given recharge rate and the total travel time is equivalent to the sum of the travel times for each individual lithologic unit. To calculate the travel time for any particular site the detailed layering of the lithologic units should be considered. For sites with artificial recharge (e.g., cribs and trenches) more complicated analyses would be required to account for the effects of saturation.

Several other investigators have measured vadose zone soil hydraulic conductivities and moisture retention characteristics at the Hanford Site both in situ (i.e., in lysimeters) and in specially prepared laboratory test columns. Table 3-1 summarizes data identified for this study by stratigraphic unit. Rockhold et al. (1988) presents a number of moisture retention characteristic curves and plots of hydraulic conductivity versus moisture content for various Hanford soils. For the Hanford formation, vadose zone hydraulic conductivity values at saturation range from 10^{-4} to 10^{-2} cm/s. These saturated hydraulic conductivity values were measured at volumetric water contents of 40 to 50%. Hydraulic conductivity values corresponding to volumetric water contents ranging from 2 to 10% ranged from 2×10^{-11} to 7×10^{-7} cm/s.

An example of the potential use of this vadose zone hydraulic parameter information is presented by Smoot et al. (1989) in which precipitation infiltration and subsequent contaminant plume movement near a prototype single-shell tank was evaluated using a numerical computer code. Smoot el al. (1989) used the UNSAT-H one-dimensional finite-difference unsaturated zone water flow computer code to predict the precipitation infiltration for several different soil horizon combinations and characteristics. The researchers used statistically generated precipitation values which were based on actual daily precipitation values recorded at the Hanford Site between 1947 and 1989 to simulate precipitation

infiltration from January 1947 to December 2020. The same authors also used the PORFLO-3 computer code to simulate ^{106}Ru and ^{137}Cs movement through the unsaturated zone.

Smoot et al. (1989) concluded that 68 to 86% of the annual precipitation infiltrated into a gravel-capped soil column while less than 1% of the annual precipitation infiltrated into a silt loam-capped soil column. For the gravel-capped soil column, the simulations showed the ^{106}Ru plume approaching the water table after 10 years of simulated precipitation infiltration. The simulated ^{137}Cs plume migrated a substantially shorter distance due to greater adsorption on soil particles. In both cases, the simulated plume migration scenarios are considered to be conservative due to the relatively high soil absorption coefficients used.

Graham et al. (1981) estimated that historical artificial recharge from liquid waste disposal in the 200 (Separations) Areas exceeded all natural recharge by a factor of ten. In the absence of ongoing artificial recharge, i.e., liquid waste disposal to the soil column, natural recharge could potentially be a driving force for mobilizing contaminants in the subsurface. Natural sources of recharge to the vadose zone and the underlying water table aquifer are discussed in Section 3.5.2.2. Additional discussion of the potential for natural and artificial recharge to mobilize subsurface contaminants is presented in Section 4.2.

Another facet of moisture migration in the vadose zone is moisture retention above the water table. Largely due to capillary forces, some portion of the moisture percolating down from the ground surface to the unconfined aquifer will be held against gravity in soil pore space. Finer-grained soils retain more water (against the force of gravity) on a volumetric basis than coarse-grained soils (Hillel 1971). Because unsaturated hydraulic conductivity increases with increasing moisture content, finer-grained soils may be more permeable than coarse-grained soils at the same water content. Also, because the moisture retention curve for coarse-grained soils is generally quite steep (Smoot et al. 1989), the permeability contrast between fine-grained and coarse-grained soils at the same water content can be substantial. The occurrence of interbedded fine-grained and coarse-grained soils may result in the formation of "capillary barriers" and can in turn lead to the formation of perched water zones. General conditions leading to the formation of perched water zones at the Hanford Site are discussed in Section 3.5.2.1.2. Potential perched water zones in the T Plant Aggregate Area are discussed in Section 3.5.3.1.2.

3.5.2.1.2 Perched Water Zones. Moisture moving downward through the vadose zone may accumulate on top of highly cemented horizons and may accumulate above the contact between a fine-grained horizon and an underlying coarse-grained horizon as a result of the "capillary barrier" effect. If sufficient moisture accumulates, the soil pore space in these perching zones may become saturated. In this case, the capillary pressure within the horizon may locally exceed atmospheric pressure, i.e., saturated conditions may develop. Additional input of downward percolating moisture to this horizon may lead to a hydraulic

head buildup above the top of the horizon. Consequently, a monitoring well screened within or above this horizon would be observed to contain free water.

The lateral extent and composition of the Plio-Pleistocene and early "Palouse" soil units may provide conditions amenable to the formation of perched water zones in the vadose zone above the unconfined aquifer. The calcrete facies of the Plio-Pleistocene unit, consisting of calcium-carbonate-cemented silt, sand, and gravel, is a potential perching horizon due to its likely low hydraulic conductivity. However, the Plio-Pleistocene unit is typically fractured and may have erosional scours in some areas, potentially allowing deeper infiltration of groundwater, a factor which may limit the lateral extent of accumulated perched groundwater. The early "Palouse" soil horizon, consisting of compact, loess-like silt and minor fine-grained sand, is also a likely candidate for accumulating moisture percolating downward through the sand and gravel-dominated Hanford formation.

3.5.2.1.3 Unconfined Aquifer. The uppermost aquifer system in the 200 Areas occurs primarily within the sediments of the Ringold Formation and Hanford formation. In the 200 West Area the upper aquifer is contained within the Ringold Formation and displays unconfined to locally confined or semiconfined conditions. In the 200 East Area the upper aquifer occurs in the Ringold Formation and Hanford formation. The depth to groundwater in the upper aquifer underlying the 200 Areas ranges from approximately 60 m (197 ft) beneath the former U Pond in 200 West Area to approximately 105 m (340 ft) west of the 200 East Area. The saturated thickness of the unconfined aquifer ranges from approximately 67 to 112 m (220 to 368 ft) in the 200 West Area and approximately 61 m (200 ft) in the southern 200 East Area to nearly absent in the northeastern 200 East Area where the aquifer thins out and terminates against the basalt located above the water table in that area.

The upper part of the uppermost aquifer in the 200 West Area consists of generally unconfined water-bearing zone within the Ringold unit E. The lower part of the uppermost aquifer consists of confined to a semi-confined water-bearing zone within the gravelly sediments of Ringold unit A. The Ringold unit A is generally confined by fine-grained sediments of the lower mud sequence. The thickness of this confined zone ranges from greater than 38 m (125 ft) in the southeastern portion of the 200 West Area to nearly absent where it pinches out just north of the northern 200 West Area boundary. The lower mud sequence confining zone overlying unit A is up to 30 m (100 ft) thick below the south-central section of the 200 West Area before pinching out in the northeastern corner of the 200 West Area. Where it is absent, the Ringold units A and E combine to form a single thick unconfined aquifer.

Due to its importance with respect to contaminant transport, the unconfined aquifer is generally the most characterized hydrologic unit beneath the Hanford Site. A number of observation wells have been installed and monitored in the unconfined aquifer. Additionally,

in situ aquifer tests have been conducted in a number of the unconfined aquifer monitoring wells. Results of these in situ tests vary greatly depending on the following:

- Horizontal position/location between areas across the Hanford Site and even smaller areas (such as across portions of the 200 Areas)
- Depth, even within a single hydrostratigraphic unit
- Analytical methods for estimating hydraulic conductivity.

Details regarding this aquifer system can be found in the 200 West Groundwater Aggregate Area Management Study Report (AAMSR).

3.5.2.2 Natural Groundwater Recharge. Sources of natural recharge to groundwater at the Hanford Site include precipitation infiltration, runoff from higher bordering elevations and subsequent infiltration within the Hanford Site boundaries, water infiltrating from small ephemeral streams, and river water infiltrating along influent reaches of the Yakima and Columbia Rivers (Graham et al. 1981). The principal source of natural recharge is believed to be precipitation and runoff infiltration along the periphery of the Pasco Basin. Small streams such as Cold Creek and Dry Creek, west of the 200 West Area, also lose water to the ground as they spread out on the valley plain. Considerable debate exists as to whether any recharge to groundwater occurs from precipitation falling on broad areas of the 200 Areas Plateau.

Natural precipitation infiltration at or near waste management units or unplanned releases may provide a driving force for the mobilization of contaminants previously introduced to surface or subsurface soils. For this reason, determination of precipitation recharge rates at the Hanford Site has been the focus of many previous investigations. Previous field programs have been designed to assess precipitation, infiltration, water storage changes, and evaporation to evaluate the natural water balance during the recharge process. Precipitation recharge values ranging from 0 to 10 cm/yr (0 to 4 in./yr) have been estimated from various studies.

The primary factors affecting precipitation recharge appear to be surface soil type, vegetation type, topography, and year-to-year variations in seasonal precipitation. A modeling analysis (Smoot et al. 1989) indicated that 68 to 86% of the precipitation falling on a gravel-covered site might infiltrate to a depth greater than 2 m (6 ft). As discussed below, various field studies suggest that less than 25% of the precipitation falling on typical Hanford Site soils actually infiltrates to any depth.

Examples of precipitation recharge studies include the following:

- A study by Gee and Heller (1985) described various models used to estimate natural recharge rates. Many of the models use a water retention relationship for the soil. This relates the suction required to remove (or move) water to its dryness (saturation or volumetric moisture content). Two of these have been developed by Gee and Heller (1985) for soils in lysimeters on the Hanford Site. As an example of available data, the particle size distribution and the water retention curves of these two soils are shown in Figure 3-40. Additional data and information about possible models for unsaturated flow may be found in Brownell et al. (1975), and Rockhold et al. (1990).

- Moisture contents have been obtained from a number of core-barrel samples in the 200 Areas (East and West) and varied from 1 to 18%, with most in the range of 2 to 6% (Last et al. 1989). The data appear to indicate zones of increased moisture content that could be interpreted as signs of moisture transport. None of the boreholes that this study used (for moisture content or other parameters) were located in the vicinity of the T Plant Aggregate Area.

- A lysimeter study reported by Routson and Johnson (1990) was conducted at a location 1.6 km (1 mi) south of the 200 East Area. During much of the lysimeters' 13-year study period between 1972 and 1985, the surface of the lysimeters were maintained unvegetated with herbicides. No information regarding the soil types in the lysimeters was found. To a precision of $\pm$ 0.2 cm ($\pm$ 0.08 in.), no downward moisture movement was observed in the instruments during periodic neutron-moisture measurements or as a conclusion of a final soil sample collection and moisture content analysis episode.

- An assessment of precipitation recharge involving the redistribution of ^{137}Cs in vadose zone soil also reported by Routson and Johnson (1990). In this study, split-spoon soil samples were collected beneath a solid waste burial trench in the T Plant Aggregate Area. The trench, apparently located just south and west of the 218-W-3AE Burial Ground, received soil containing ^{137}Cs from an unspecified spill. Cesium-137 was not detected below the bottom of the burial trench. However, increased ^{137}Cs activity was observed above the top of the waste fill which Routson and Johnson concluded indicated that net negative recharge (loss of soil moisture to evapotranspiration) had occurred during the 10-year burial period.

  Sparse Russian thistle was observed at the burial trench area in 1980. Rockhold et al. (1990) noted that ^{137}Cs appears to strongly sorb to Hanford Site soils indicating that the absence of the radionuclide at depth below the burial trench may not support the conclusion that no downward moisture movement occurred.

- A weighing lysimeter study reported by Rockhold et al. (1990) which was conducted at a grassy plot approximately 5 km (3 mi) northwest of the 300 Area. The grass test site was located in a broad, shallow topographic depression approximately 900 m (2,950 ft) wide, several hundred meters long, trending southwest. The area is covered with annual grasses (cheatgrass and bluegrass). The upper 3.5 m of the soil profile consists of slightly silty to silty sand (sandy loam) with an estimated saturated hydraulic conductivity of 9×10^{-3} cm/sec. Rockhold et al. (1990) estimated that approximately 0.8 cm (0.3 in.) of downward moisture movement occurred between July 1987 and June 1988. This represents approximately 7% of the total precipitation recorded in that area during that time period.

- A gravel-covered lysimeter study discussed by Rockhold et al. (1990) which was conducted at the 622 Area Lysimeter Site, approximately 0.5 km (0.3 mi) east of the 200 West Area. Approximately 4 cm (1.6 in.) of downward moisture movement was observed in two gravel-covered lysimeters during 1988 and 1989. This represented approximately 25% of the total precipitation recorded in the area during the study period. The authors concluded that gravel placed on the soil surface reduces evaporation and facilitates precipitation infiltration.

The drainage (downward moisture movement) observed in these studies may represent potential recharge to deeper vadose zone soils and/or the underlying water table.

3.5.2.3 Groundwater Flow. Groundwater flow north of Gable Mountain currently trends in a northeasterly direction as a result of mounding near reactors and flow through Gable Gap. South of Gable Mountain, flow is interrupted locally by the groundwater mounds in the 200 Areas. There is also a component of groundwater flow to the north between Gable Mountain and Gable Butte from the 200 Areas. In the 200 East Area, groundwater elevations in June 1990 (Figure 3-41) for the unconfined aquifer showed little variation and were generally around 133 m (405 ft) (Kasza et al. 1990).

Temporary reversal of groundwater flow entering the Columbia River may occur during transient, high-river stages. This occurrence is known as bank storage. Correlations were made between groundwater level and river-stage fluctuations along a 81 km (50 mi) reach of the Columbia River adjacent to the Hanford Site by Newcomb and Brown (1961). They concluded that a 260 km^2 (100 mi^2) area within the Hanford Site was affected by bank storage. During a 45 day rise in river stage, it was estimated that water infiltrated at an average rate of 4,600,000 m^3/day (3,700 acre-ft/day) versus 1,200,000 m^3/day (1,000 acre-ft/day) during the 165 day recession period. Since this study was conducted, dam control on the Columbia River has reduced the magnitude of bank storage on the groundwater system.

Natural groundwater inflow to the unconfined aquifer primarily occurs along the western boundary of the Hanford Site. Currently, man-made recharge occurs in several active waste management units (e.g., the 216-T-1 Ditch, 216-T-4-2 Ditch, and the 216-T-4B Pond) located within the T Plant Aggregate Areas in the 200 West Area. Historically, much greater recharge occurred from a number of waste management units in the 200 Areas. Man-made recharge probably substantially exceeds natural precipitation recharge in these areas. The unconfined aquifer ultimately discharges to the Columbia River, either near the 100 Areas, north of the 200 Areas through Gable Gap, or between the 100 Areas and the 300 Area, east of the 200 Areas. The precise path is strongly dependent on the hydrologic conditions in the 200 East Area (Delaney et al. 1991). If recharge in the 200 East Area is large, more of the recharge from the 200 West Area is diverted north through Gable Gap toward the 100 Areas. Generally, however, the easterly route appears to be more likely for recharge from the 200 West Area.

3.5.2.4 Historical Effects of Operations. Historical effluent disposal at the Hanford Site altered previously prevailing groundwater hydraulic gradients and flow directions. Before operations at the Hanford Site began in 1944, groundwater flow was generally toward the east, and the groundwater hydraulic gradient in the 200 West Area was on the order of 0.001 (Delaney et al. 1991). Prior to disposing liquid waste to the soil column in the Separations Areas, groundwater elevations in the 200 West Area may have been as much as 20 m (65 ft) lower in 1944 than at present. As seen in Figure 3-40, a distinct groundwater mound is still apparent beneath the 200 West Area. The horizontal hydraulic gradient is expected to decrease and shift to the east as the mound continues to dissipate.

3.5.3 T Plant Aggregate Area Hydrogeology

This section presents additional hydrogeologic information identified with specific application to the T Plant Aggregate Area.

3.5.3.1 Hydrostratigraphy. As shown on Figure 3-42, the hydrostratigraphic units of concern beneath the T Plant Aggregate Area are (1) the Rattlesnake Ridge Interbed, (2) the Elephant Mountain Basalt Member, (3) the Ringold Formation units A and E, (4) the Plio-Pleistocene unit and early "Palouse" soil, and (5) the Hanford formation. The hydrogeologic designations for the T Plant Aggregate Area were determined by examination of borehole logs from Lindsey et al. (1991) and Chamness et al. (1991) and integration of these data with stratigraphic correlations from existing reports. For the purposes of the T Plant AAMSR, this discussion will be limited to the vadose zone and possible perching horizons within the vadose zone underlying the Aggregate Area. Additional information on the aquifer system is contained in the 200 West Groundwater AAMSR.

3.5.3.1.1 Vadose Zone. The vadose zone beneath the T Plant Aggregate Area ranges in thickness from about 90 m (272 ft) along the northern part of the aggregate area boundary to 65 m (195 ft) in the vicinity of the 216-T-19 Crib based on December 1990 groundwater elevation data (WHC 1991a). The observed variation in vadose zone thickness is the result of variable surface topography and the variable elevation of the water table in the underlying unconfined aquifer.

3.5.3.1.2 Perched Water Zones. Downward-moving moisture in the vadose zone, whether from precipitation recharge or artificial recharge, may accumulate on or within the Plio-Pleistocene and early "Palouse" soil units beneath the T Plant Aggregate Area. The top of the Plio-Pleistocene Unit occurs at elevations ranging from 180 to 206 m (540 to 620 ft). The early "Palouse" soil horizon is typically occurs at elevations between 210 m to 183 m (630 to 183 ft). Additional characteristics information on the extent and stratigraphic position of the Plio-Pleistocene and early "Palouse" soil are provided in Figures 3-16, through 3-19, and Figures 3-29 through 3-32. The high concentration, laterally continuous nature, and relatively gentle (1.5°) dip to the southwest of the Plio-Pliestocene unit indicate the possibility of perched water zones. Further examination of the existing drilling logs failed to provide additional data on the existence of perched water zones in the T Plant Aggregate Area.

3.5.3.2 Natural Groundwater Recharge. As discussed in Section 3.3.3, no natural surface water bodies were identified within the T Plant Aggregate Area. Therefore, the potential for natural groundwater recharge within the T Plant Aggregate Area is limited to precipitation infiltration. No precipitation infiltration data were identified with specific reference to the T Plant Aggregate Area. However, the amount of precipitation infiltration is likely comparable to the range of values identified for various Hanford test sites, i.e., 0 to 10 cm/yr (0 to 3.9 in./yr).

As suggested in Section 3.5.2.2, precipitation infiltration rates probably vary with respect to location within the T Plant Aggregate Area. Higher infiltration rates are expected in unvegetated areas or areas with shallow rooting plants, in areas with gravelly soils exposed at the surface, and in areas where the topography is flat.

3.5.3.3 Groundwater Flow beneath the T Plant Aggregate Area. Within the T Plant Aggregate Area, groundwater flow is generally toward the east, with some flow to the north based on December 1990 Hanford wells groundwater elevation data (WHC 1991a) (Figure 3-41). Flow is generally away from a groundwater mound located in the southern part of the 200 West Area. A review of groundwater maps of the unconfined aquifer (Kasza et al. 1990) indicates relatively steep decreases in groundwater elevations directly east of the mound and more gradual elevation decreases to the west.

3.5.3.4 Historical Effects of Operations. Data identified for this study were not sufficient to quantitatively evaluate the effect of wastewater discharges to the soil column from T Plant Aggregate Area waste management units on groundwater flow in the unconfined aquifer. Evaluations discussed in Section 4.1.8 suggest that wastewater discharged to the 216-T-6, 216-T-7, 216-T-18, 216-T-19TF, 216-T-26, 216-T-27, 216-T-28, 216-T-32, 216-T-33, 216-T-34, 216-W-LWC Cribs, 216-T-1, 216-T-4A, 216-T-4-2 Ponds and Ditches, and 216-T-2, 216-T-3 Reverse Wells may have infiltrated to the underlying unconfined aquifer. Although an estimate of the total volume of fluid discharged to each of these facilities was found (Table 2-2), discharge rates were not identified. Therefore, estimating the potential water level rise associated with individual waste management units by means of a point source algorithm (e.g., the Theis equation) could not be done.

3.6 ENVIRONMENTAL RESOURCES

The Hanford Site is characterized as a cool desert or a shrub-steppe and supports a biological community typical of this environment.

3.6.1 Flora and Fauna

The 200 Areas Plateau is represented by a number of plant, mammal, bird, reptile, amphibian, and insect species as discussed below.

3.6.1.1 Vegetation of the 200 Areas Plateau. The vegetation of the 200 Areas Plateau is characterized by native shrub steppe interspersed with large areas of disturbed ground with a dominant annual grass component. The native stands are classified as an *Artemisia tridentata/Poa sandbergii - Bromus tectorum* community (Rogers and Rickard 1977) meaning that the dominant shrub is big sagebrush (*Artemisia tridentata*) and the understory is dominated by the native Sandberg's bluegrass (*Poa sandbergii*) and the introduced annual cheatgrass (*Bromus tectorum*). Other shrubs that are typically present include gray rabbitbrush (*Chrysothamnus nauseosus*), green rabbitbrush (*C. viscidiflorus*), spiny hopsage (*Grayia spinosa*), and occasionally antelope bitterbrush (*Purshia tridentata*). Other native bunchgrasses that are typically present include bottlebrush squirreltail (*Sitanion hystrix*), Indian ricegrass (*Oryzopsis hymenoides*), needle-and-thread (*Stipa commode*), and prairie junegrass (*Koeleria cristata*). Common and important herbaceous species include turpentine cymopteris (*Cymopteris terebinthinus*), globemallow (*Sphaeraica munroana*), balsamroot (*Balsamorhiza careyana*), several milk vetch species (*Astragalus caricinus*, *A. sclerocarpus*, *A. succumbens*), long-leaf phlox (*Phlox longifolia*), the common yarrow (*Achillea millifolium*), pale evening-primrose (*Oenothera pallida*), thread-leaf phacelia (*Phacelia linearis*), and several daisy/fleabane species (*Erigeron poliospermus*, *E. Filifolius*, and *E. pumilus*). In all, well over 100 plant species have been documented to occur in native stands on the 200 Areas Plateau.

Disturbed communities on the 200 Areas Plateau are primarily the result of either mechanical disturbance or range fires. Mechanical disturbance, including construction activities, soil borrow areas, road clearings, and fire breaks, results in drastic changes to the plant community. This type of disturbance usually entails a complete loss of soil structure and total disruption of nutrient cycling. The principal colonizers of mechanically disturbed areas are the annual weeds Russian thistle (*Salsola kali*), Jim Hill mustard (*Sisymbrium altissimum*), and bur-ragweed (*Ambrosia acanthicarpa*). If no further disturbance occurs, the areas will eventually become dominated by cheatgrass. All of these annual weeds are occasionally found in native stands, but only at relatively low frequencies.

Range fires also have dramatic effects on the overall ecosystem, the most obvious being the complete removal of sagebrush from the community, and the rapid increase in cheatgrass coverage. Unlike the native grasses, the other important shrubs, and many of the perennial herbaceous species, sagebrush is unable to resprout from rootstocks after being burned. Therefore, there is no dominant shrub component in burned areas until sagebrush is able to become re-established from seed. Burning also opens the community to the invasion by cheatgrass which is capable of quickly utilizing the nutrients that are released through burning. The extensive cover of cheatgrass may then prevent the re-establishment of many of the native species, including sagebrush. The species richness in formerly burned areas is usually much lower than in native stands, often consisting of only cheatgrass, Sandberg's bluegrass, Russian thistle, and Jim Hill mustard, with very few other species.

The vegetation in and around the ponds and ditches on the 200 Areas Plateau is significantly different from that of the surrounding dryland areas. Several tree species are present, especially cottonwood (*Populus trichocarpa*) and willows (*Salix* spp.). A number of wetland species area also present including several sedges (*Carex* spp.), bulrushes (*Scirpus* spp.), cattails (*Typha latifolia* and *T. angustifolia*), and pond-weeds (*Potamogeton* spp.).

3.6.1.2 Plant Species of Concern. The Washington State Department of Natural Resources, Natural Heritage Program classifies rare plants in the state of Washington in three different categories, depending on the overall distribution of the taxon and the state of its natural habitat. These categories are: *Endangered*, which is a "vascular plant taxon in danger of becoming extinct or extirpated in Washington within the near future if factors contributing to its decline continue. Populations of these taxa are at critically low levels or their habitats have been degraded or depleted to a significant degree"; *Threatened*, which is a "vascular plant taxon likely to become endangered within the near future in Washington if factors contributing to its population decline or habitat degradation or loss continue"; and *Sensitive*, which is a taxon that is "vulnerable or declining, and could become endangered or threatened in the state without active management or removal of threats" (definitions taken from Washington Natural Heritage Program 1990). Of concern to the Hanford Site, there are two Endangered taxa, two Threatened taxa, and at least eleven Sensitive taxa; these are listed in Table 3-3. All four of the Threatened and Endangered taxa are presently candidates for the Federal Endangered Species List.

Of the two Endangered taxa, persistantsepal yellowcress is well documented along the banks of the Columbia River throughout the 100 Areas, it is unlikely to occur in the 200 Areas. The northern wormwood (*Artemisia campestris* spp. *borealis*) is known in the state of Washington by only two populations, one across from The Dalles, Oregon, and the other near Beverly, Washington, just north of the Hanford Site. This taxon has not been found on the Hanford Site, but would probably occur only on rocky areas immediately adjacent to the Columbia River if it were present. Neither of the Threatened taxa listed in Table 3-3 have been observed on the Hanford Site. The Columbia milk vetch *(Astragalus columbianus)* is known to be relatively common on the Yakima Firing Range, and has been documented to occur within 1.6 to 3.2 km (1 to 2 mi) to the west of the Hanford Site on both sides of Umptanum Ridge. This species could occur on the 200 Areas Plateau. Hoover's desert parsley *(Lomatium tuberosum)* inhabits the steep talus slopes near Priest Rapids Dam. Potentially, it could be found on similar slopes on Gable Mountain and Gable Butte, but has yet to be documented in these areas.

Of the Sensitive species, five are inhabitants of aquatic or moist habitats and the other six are inhabitants of dry upland habitats. Dense sedge (*Carex densa)*, shining flatsedge *(Cyperus rivularis)*, southern mudwort *(Limosella acoulis)* and false-pimpernel *(Lindernia anagallidea)* are all known to occur in the 100 Areas, especially near the 100 B-C Area, in or near the Columbia River. Some of these species could be present in or near ponds and ditches in the 200 Areas. The few-flowered collinsia *(Collinsia sparsiflora var. bruciae)* may also occur in these habitats. The gray cryptantha *(Cryptantha leucophaea)* occurs on open dunes throughout the Hanford Site. Piper's daisy *(Erigeron piperianus)* is fairly common on Umptanum Ridge and Rattlesnake Ridge, but has also been documented in the vicinity of the 216-B-3 Pond, the 216-A-24 Crib, and 100-H Area. Bristly cryptantha *(Cryptantha interrupta)*, dwarf evening-primrose *(Oenothera pygmaea)* have been found at the south end of the White Bluffs, approximately 3.2 km (2 mi) upstream from the 300 Area. The Palouse milk vetch *(Astragalus arrectus)* and coyote tobacco *(Nicotiana attenuata)* are not as well documented but are known to inhabit dry sandy areas such as the 200 Areas Plateau.

In addition to the three classifications for species of concern listed above, the Natural Heritage Program also maintains a "Monitor" list, which is divided into three groups. Group 1 consists of taxa in need of further field work before a formal status can be assigned. The tooth-sepal dodder (*Cuscuta denticulata*), which has been found in the state of Washington only on the Hanford Site is the only taxon in this group that is of concern to Hanford operations. This parasitic species has been found in the area west of McGee Ranch. Group 2 of the Monitor list includes species with unresolved taxonomic questions. Thompson's sandwort (*Arenaria franklinii* var. *thompsonii*) is of concern to Hanford operations. However, the representatives of this species in the state of Washington are now believed to all be variety *franklinii* which is not considered particularly rare. Group 3 of the Monitor list includes taxa that are either more abundant or less threatened than previously believed. There are approximately 15 taxa on the Hanford Site that are included on this list.

3.6.1.3 Fauna of the 200 Areas Plateau. The mammals, birds, reptiles, amphibians inhabiting the 200 Areas Plateau are discussed below.

3.6.1.3.1 Mammals. The largest mammal occurring on the 200 Areas Plateau is the mule deer (*Odocoileus hemionus*). Although mule deer are much more common to riparian sites along the Columbia River they are frequently observed foraging throughout the 200 Areas. Elk (*Cervus elaphus*) also occur at Hanford but they have only been observed at the Arid Lands Ecology Reserve. Other mammal species common to the 200 Areas include badgers (*Taxidea taxus*), coyotes (*Canis latrans*), blacktail jackrabbits (*Lepus californicus*), Townsend ground squirrels (*Spermophilus townsendii*), Great Basin pocket mice (*Perognathus parvus*), pocket gophers (*Thomomys talpoides*), and deer mice (*Peromyscus maniculatus*). Badgers are known for their digging capability and have been implicated several times for encroaching into inactive burial grounds throughout the 200 Areas. The majority of the badger excavations in the 200 Areas are a result of badgers searching for prey (mice and ground squirrels). Coyotes are the principal predators, consuming such prey as rodents, insects, rabbits, birds, snakes and lizards. The Great Basin pocket mouse is the most abundant small mammal, which thrives in sandy soils and lives entirely on seeds from native and revegetated plant species. Townsend ground squirrels are not abundant in the 200 Areas but they have been seen at several different sites.

Other small mammals that occur in low numbers include the western harvest mouse (*Reithrodontomys megalotis*) and the grasshopper mouse (*Onychomys leucogaster*). Mammals associated more closely with buildings and facilities include Nuttall's cottontails (*Sylvilagus nuttallii*), house mice (*Mus musculus*), Norway rats (*Rattus norvegicus*), and some bat species. Bats probably play a minor role in the 200 Areas' ecosystem but no documentation is available on bat populations at Hanford. Mammals such as skunks (*Mephitis mephitis*), raccoons (*Procyon lotor*), weasels (*Mustela* spp.), porcupines (*Erethizon dorsatum*), and bobcats (*Lynx rufus*) have only been observed on very few occassions.

3.6.1.3.2 Birds. Over 235 species of birds have been documented to occur at the Hanford Site (Landeen et al. 1991). At least 100 of these species have been observed in the 200 Areas. The most common passerine birds include starlings (*Sturnus vulgaris*), horned larks (*Ermophila alpestris*), meadowlarks (*Sturnella neglecta*), western kingbirds (*Tyranus verticalis*), rock doves (*Columba livia*), barn swallows (*Hirundo rustica*), cliff swallows (*Hirundo pyrrhonota*), black-billed magpies (*Pica pica*) and ravens (*Corvus corax*). Common raptors include the northern harrier (*Circus cyaneus*), American kestrel (*Falco sparvarius*), and red tailed hawk (*Buteo jamaicensis*). Swainson's hawks (*Buteo swainsoni*) sometimes nest in the trees located at some of the army bunker sites that were used in the 1940's. Golden eagles (*Aquila chrysaetos*) are observed infrequently. Burrowing owls (*Athene cunicularia*) nest at several locations throughout the 200 Areas. The most common upland game birds found in the 200 Areas are California quail (*Callipepla californica*) and Chukar partridge (*Alectoris chukar*), however, ring-necked pheasants (*Phasianus colchicus*) and gray partridge (*Perdix perdix*) may be found in limited numbers. The only native game bird

common to the 200 Areas Plateau is the mourning dove (*Zenaida macroura*) which migrates south each fall. Other species of note which nest in undisturbed sagebrush habitats in the 200 Areas include sage sparrows (*Amphispiza belli*), and loggerhead shrikes (*Lanius ludovicianus*). Long-billed curlews (*Numenius americanus*) also use the sagebrush areas and revegetated burial grounds for nesting and foraging.

Waterfowl and aquatic birds inhabit 216-B-3 Pond and other areas where there is running or standing water. However many of these areas such as 216-A-29 Ditch are becoming more scarce due to stabilization and remedial action cleanup activities. Aquatic birds and waterfowl common to 216-B-3 Pond on a seasonal basis include Canada geese (*Branta canadensis*), American coot (*Fulica americana*), mallard (*Anas platyrhynchos*), ruddy duck (*Oxyura jamaicensis*), redhead (*Aythya americana*), bufflehead (*Bucephala albeola*) and great blue heron (*Ardea herodius*).

3.6.1.3.3 Reptiles and Amphibians. Common reptiles include gopher snakes (*Pituophis melanoleucus*) and sideblotched lizards (*Uta stansburiana*). Other reptiles and amphibians which are infrequently observed include sagebrush lizards (*Sceloporus graciosus*), horned toads (*Phryosoma douglassii*), western spadefoot toads (*Scaphiopus intermontana*) , yellow-bellied racer (*Coluber constrictor*), Pacific rattlesnake (*Crotalus viridis*), and striped whipsnake (*Masticophis taeniatus*). Both lizards and snakes are prey items of mammalian and avian predators.

3.6.1.3.4 Insects. There are hundreds of insect species which inhabit the 200 Areas. Two of the most common groups of insects include several species of darkling beetles and grasshoppers. Harvester ants are also common and have been implicated in the uptake of radionuclides from some of the burial grounds in the 200 East Area. Harvester ants can excavate and bring up material from as far down as 5 to 6 m (15 to 20 ft). Other major groups of insects include bees, butterflies and scarab beetles. Insects impact the surrounding plant community as well as serving as the prey base for many species of birds, reptiles and mammals.

3.6.1.4 Wildlife Species of Concern. Some animals which inhabit the Hanford Site have been given special status designations by the state and federal government. Some of these designations include state and federal threatened and endangered species, federal candidate, state monitor, state sensitive, and state candidate species. Species listed in Table 3-3 as state and/or federal threatened and endangered such as the bald eagle (*Haliaeetus leucocephalus*), peregrine falcon (*Falco peregrinus*), American white pelican (*Pelecanus erythroryhnchos*), ferruginous hawk (*Buteo regalis*), and sandhill crane (*Grus canadensis*) do not inhabit the 200 Areas. The bald eagle and American white pelican utilize the Columbia River and associated habitats for roosting and feeding. Peregrine falcons and sandhill cranes fly over the Hanford Site during migration. Ferruginous hawks nest on the Hanford Site but nesting has not been documented for this species on the 200 Areas Plateau. Other species listed in

Table 3-4 as state and/or federal candidates and state monitor species such as burrowing owls, great blue herons, prairie falcons (*Falco mexicanus*), sage sparrows, and loggerhead shrikes are not uncommon to the 200 Areas Plateau.

3.6.2 Land Use

The T Plant Aggregate Area is the location of the T Plant and its attendant facilities. Past activities at the T Plant included plutonium separation from waste streams generated in other 200 Areas facilities and plutonium and americium recovery from in-plant waste streams. Historically, liquid waste generated in T Plant was disposed of to various land disposal units. Low-level and mixed waste from T Plant, other Hanford facilities, and offsite facilities was deposited in the 218-W Burial Grounds. Various storage facilities, offices, and laboratories are also located in T Plant. Waste management units that remain active are noted in Figure 2-1.

Access to the entire Hanford site is administratively controlled and is expected to remain this way to ensure public health and safety and for reasons of natural security.

3.6.3 Water Use

There is no consumptive use of groundwater within the 200 West Area. Water for drinking and emergency use, and facilities process water is drawn from the Columbia River, treated, and imported to the 200 West Area. The nearest wells used to supply drinking water are located at the Yakima barricade (Well 699-49-100-C), about 5 km (3.1 mi) west of the 200 West Area; at the Hanford Safety Patrol Training Academy (Well 699-528-EO) about 40 km (25 mi) to the southeast; at the PNL observatory (Well 6652-C); and near the Fast Flux Test Facility in the 400 Area (Well 699-51-8J), about 32 km (20 mi) to the southeast. The nearest water supply wells are located offsite about 15 km (9.4 mi) to the northwest. These wells obtain their water from the basalt and the basalt interbeds (the Berkshire well and Chateau Ste. Michelle No. 1 and No. 2). The latter wells are reportedly used for irrigation although they may also be used to supply drinking water. Three wells for emergency cooling water supply are located near the B Plant in the 200 East Area.

3.7 HUMAN RESOURCES

The environmental conditions at the T Plant Aggregate Area must be evaluated in relationship to the surrounding population centers and other human resources. A very brief summary of demography, archaeology,. historical resources, and community involvement is given below.

3.7.1 Demography

There are no residences on the Hanford Site. The nearest inhabited residences are farm homes on land located 21 km (13 mi) north of the T Plant Aggregate Area. There are approximately 411,000 people living within a 80 km (50 mi) radius of the 200 Areas Plateau. The primary population centers are the cities of Richland, Kennewick, and Pasco, located southeast of the Hanford Site, Prosser to the south, Sunnyside to the southwest, and Benton City to the southeast.

3.7.2 Archaeology

An archaeologic survey has been conducted of undeveloped portions of the 200 West Area by the Hanford Cultural Resources Laboratory. Isolated artifacts and sites of interest were identified in the 200 West Area but not within the T Plant Aggregate Area. The closest site of interest is the remains of the White Bluffs Road, located approximately 1.6 km (1 mi) northwest of the aggregate area, which was previously an Indian trail.

3.7.3 Historical Resources

The only historic site in 200 West Area is the old White Bluffs freight road which crosses diagonally through the 200 West Area. This site is not considered to be eligible for the National Register.

3.7.4 Community Involvement

A Community Relations Plan (Ecology et al. 1989) has been developed for the Hanford Site Environmental Restoration Program which includes any potentially affected community with respect to the T Plant AAMSR. The Community Relations Plan includes a discussion on analysis of key community concerns and perceptions regarding the project, along with a list of all interested parties.

Figure 3-1. Topography and Location Map for the Hanford Site.

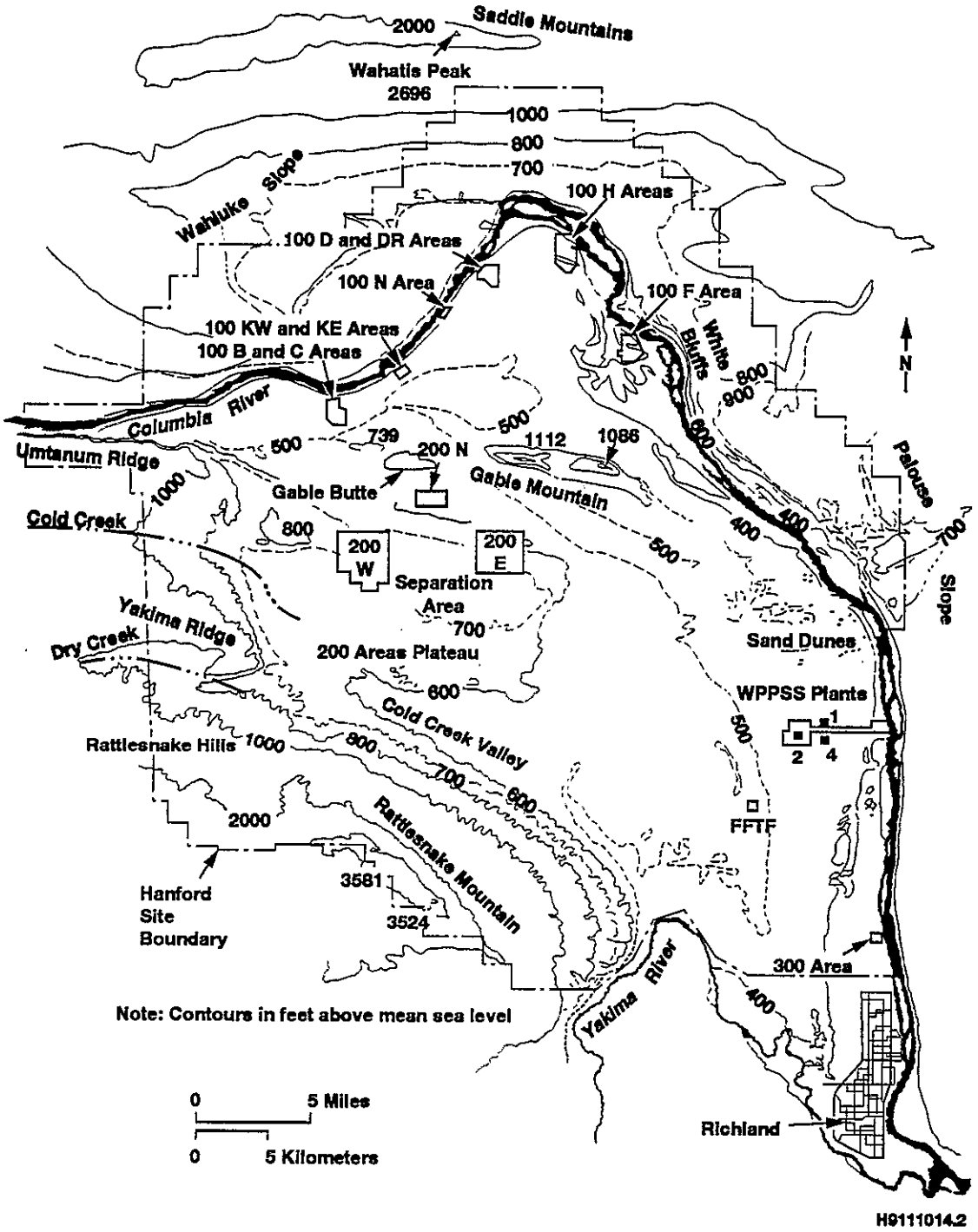


Figure 3-2. Divisions of the Columbia Intermontane Province and Adjacent Snake River Plains Province.

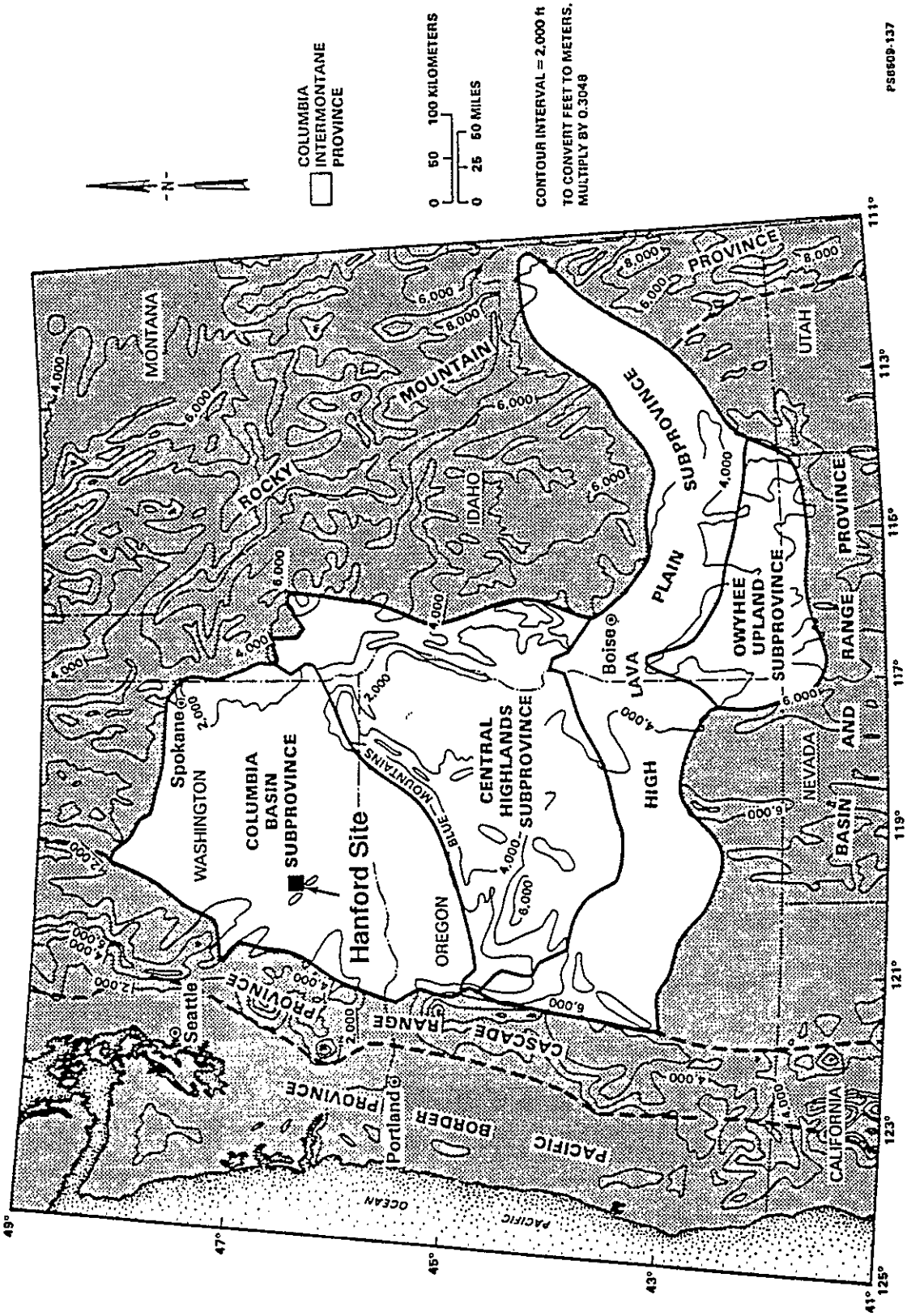


Figure 3-3. Geomorphic Units Within the Central Highlands and Columbia Basin Subprovinces that Contain the Columbia River Basalt Group (unshaded area) (after Thornbury 1965) (Last et al. 1989).

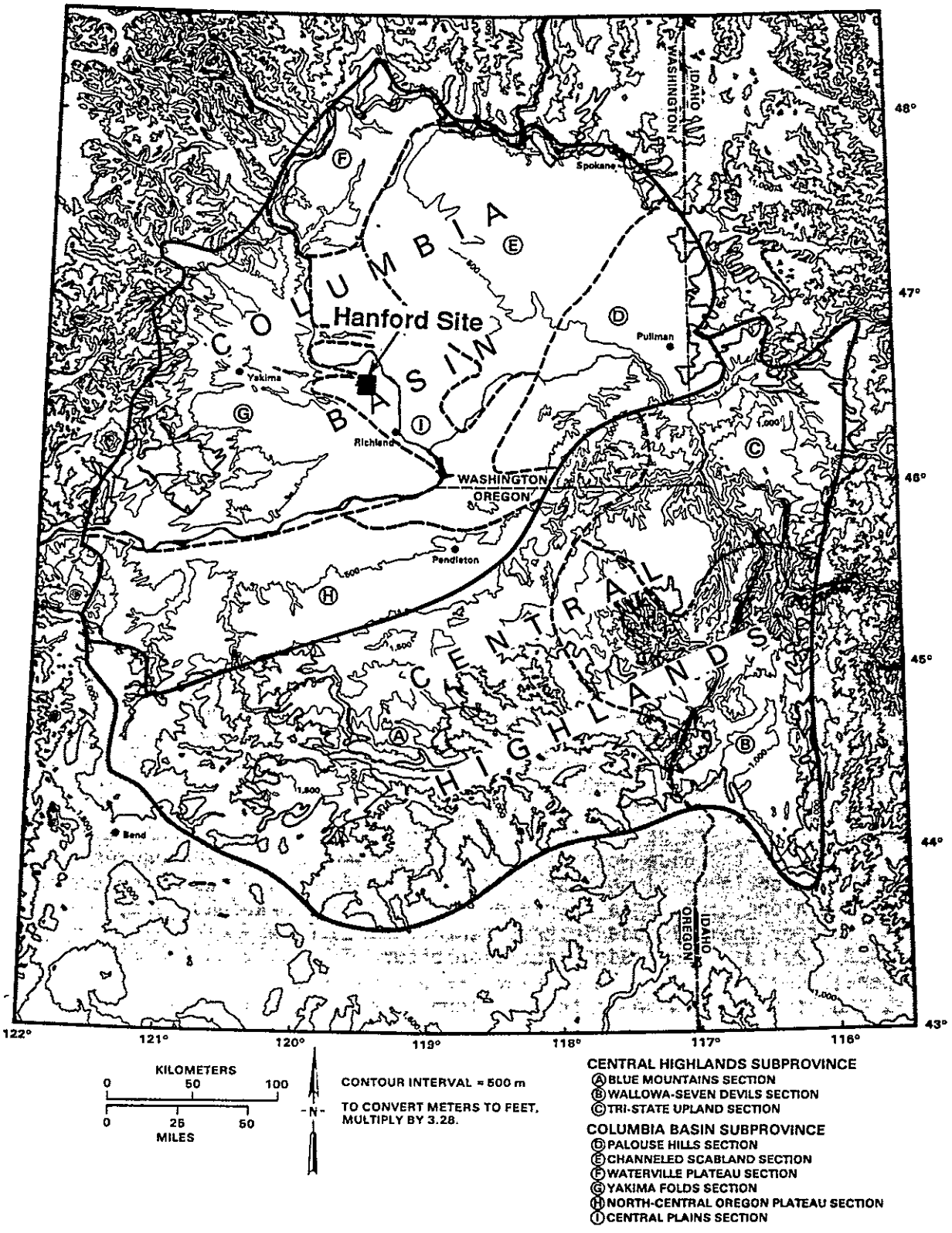
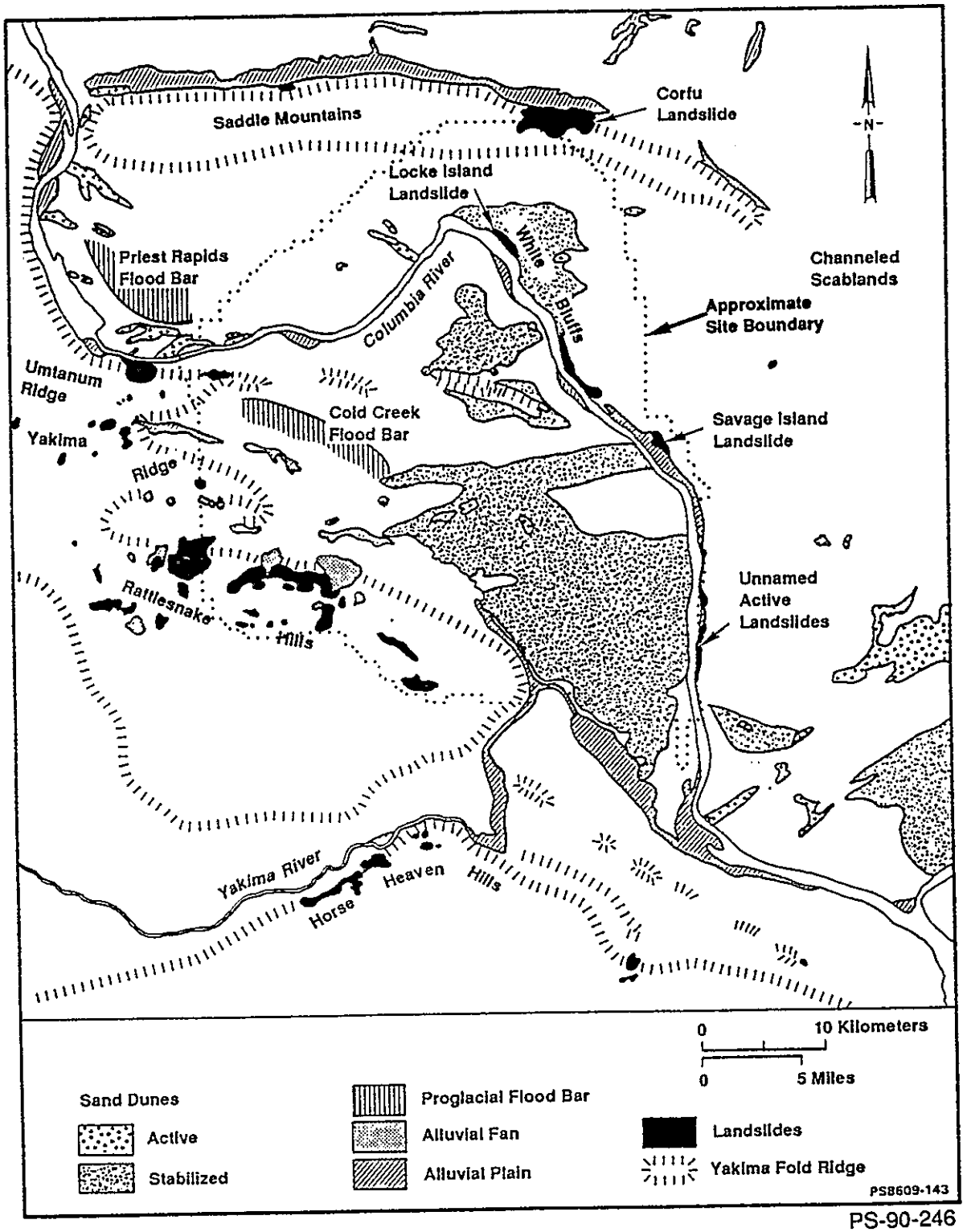
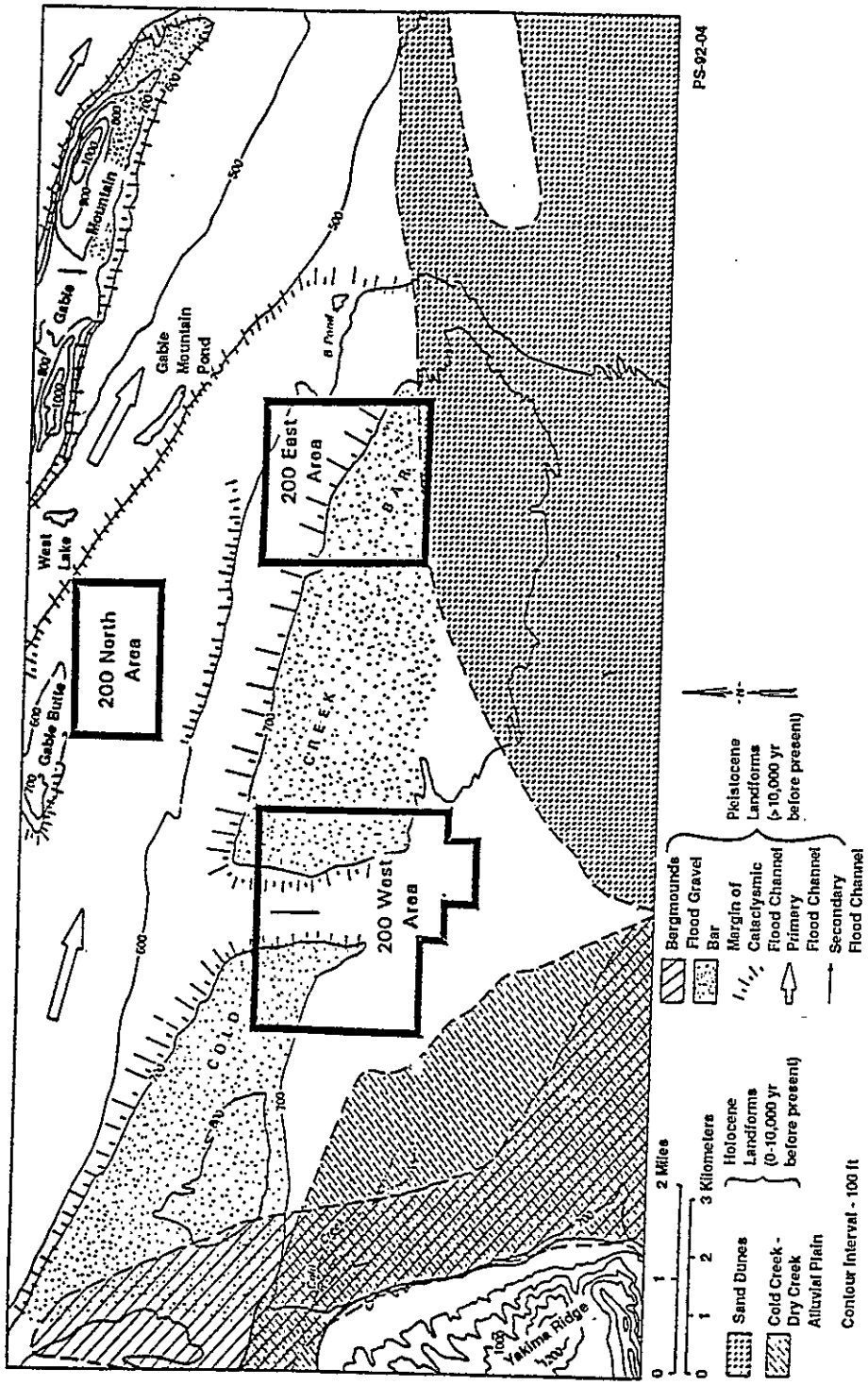


Figure 3-4. Landforms of the Pasco Basin and the Hanford Site.



PS-90-246

Figure 3-5. Geomorphic Features Surrounding the 200 Areas (Last et al. 1989).



* Keyed features are specifically selected and do not encompass all features.

Figure 3-6. Hanford Site Wind Roses, 1979 through 1982 (Stone et al. 1983).

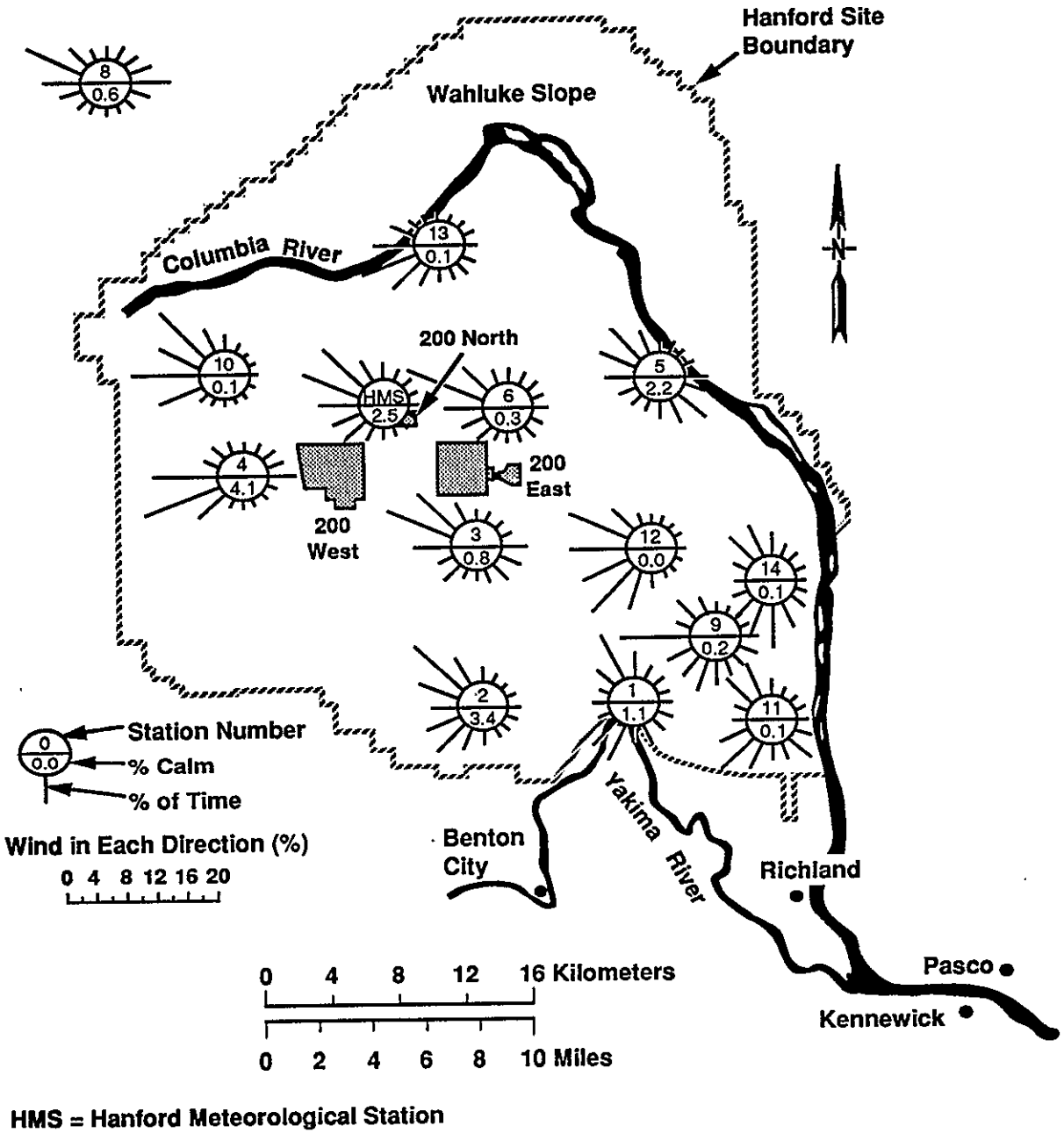


Figure 3-7. Hydrologic Basins Designated for the Washington State Portion of the Columbia Plateau (DOE 1988b).

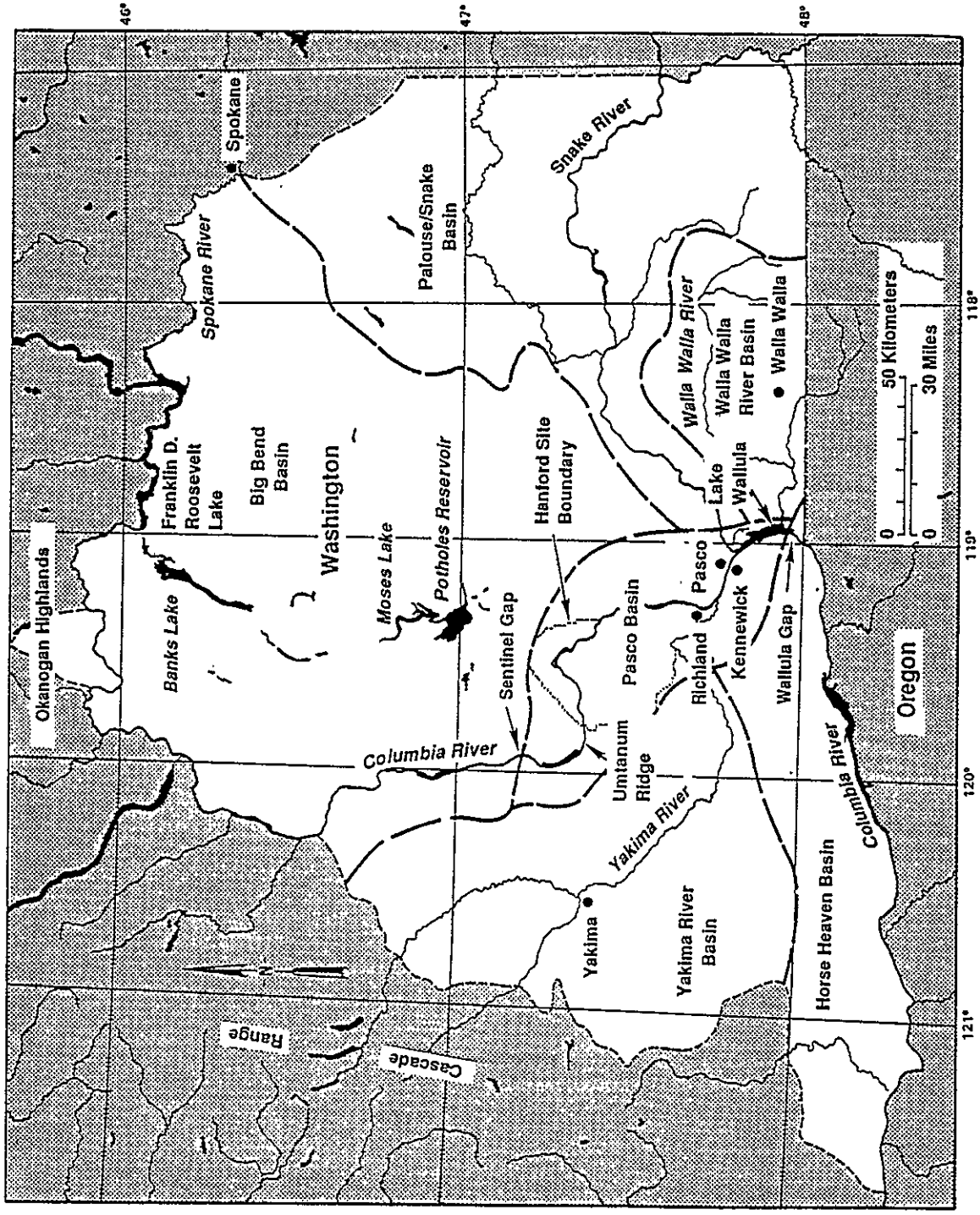


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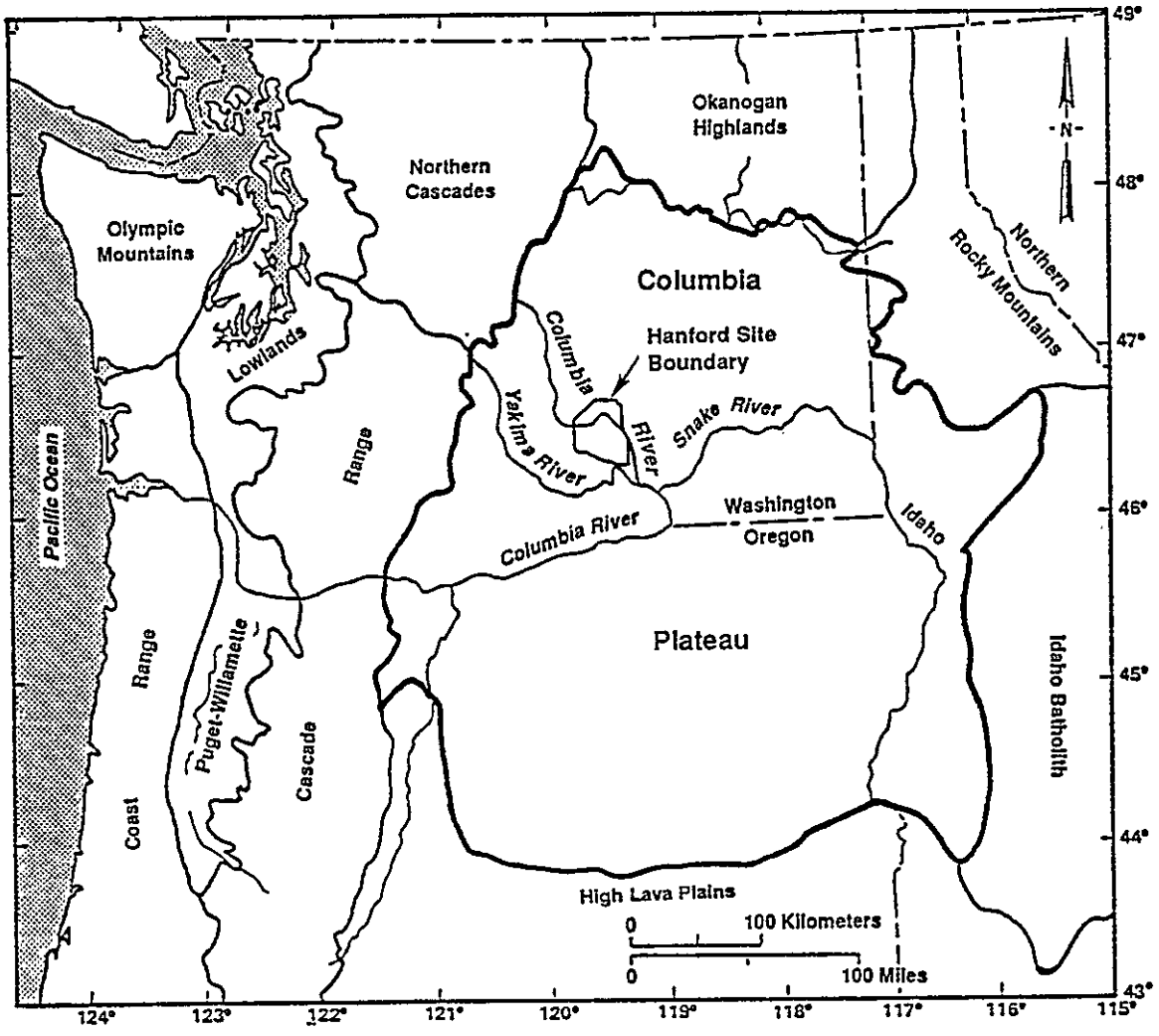
Figure 3-8. Columbia Plateau and Surrounding Structural Provinces.



PS8609-193
PS-90-248

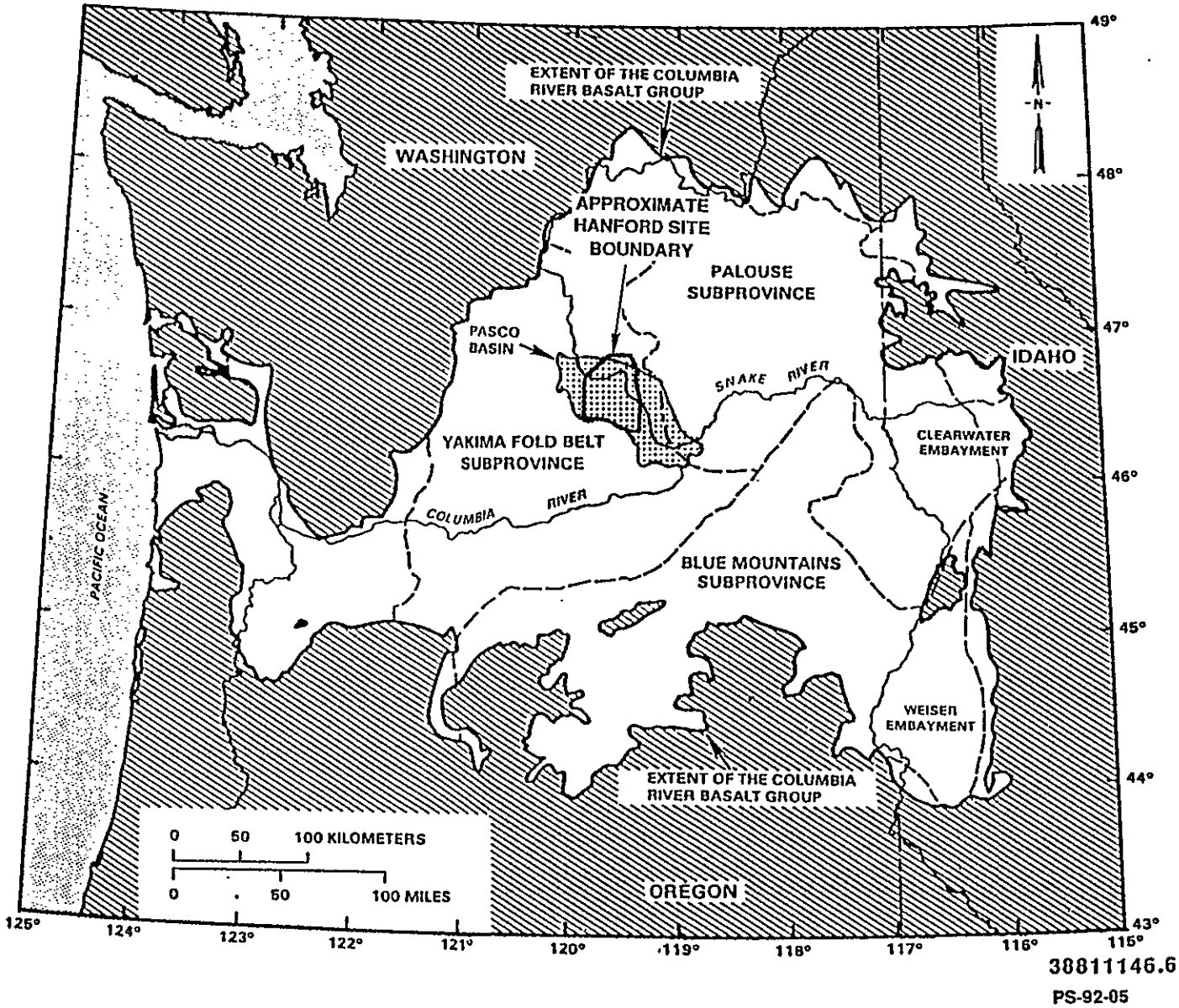


Figure 3-9. Structural Subprovinces of the Columbia Plateau (DOE 1988b).

Figure 3-10. Structured Elements of the Yakima Fold Belt Subprovince (Last et al. 1989).

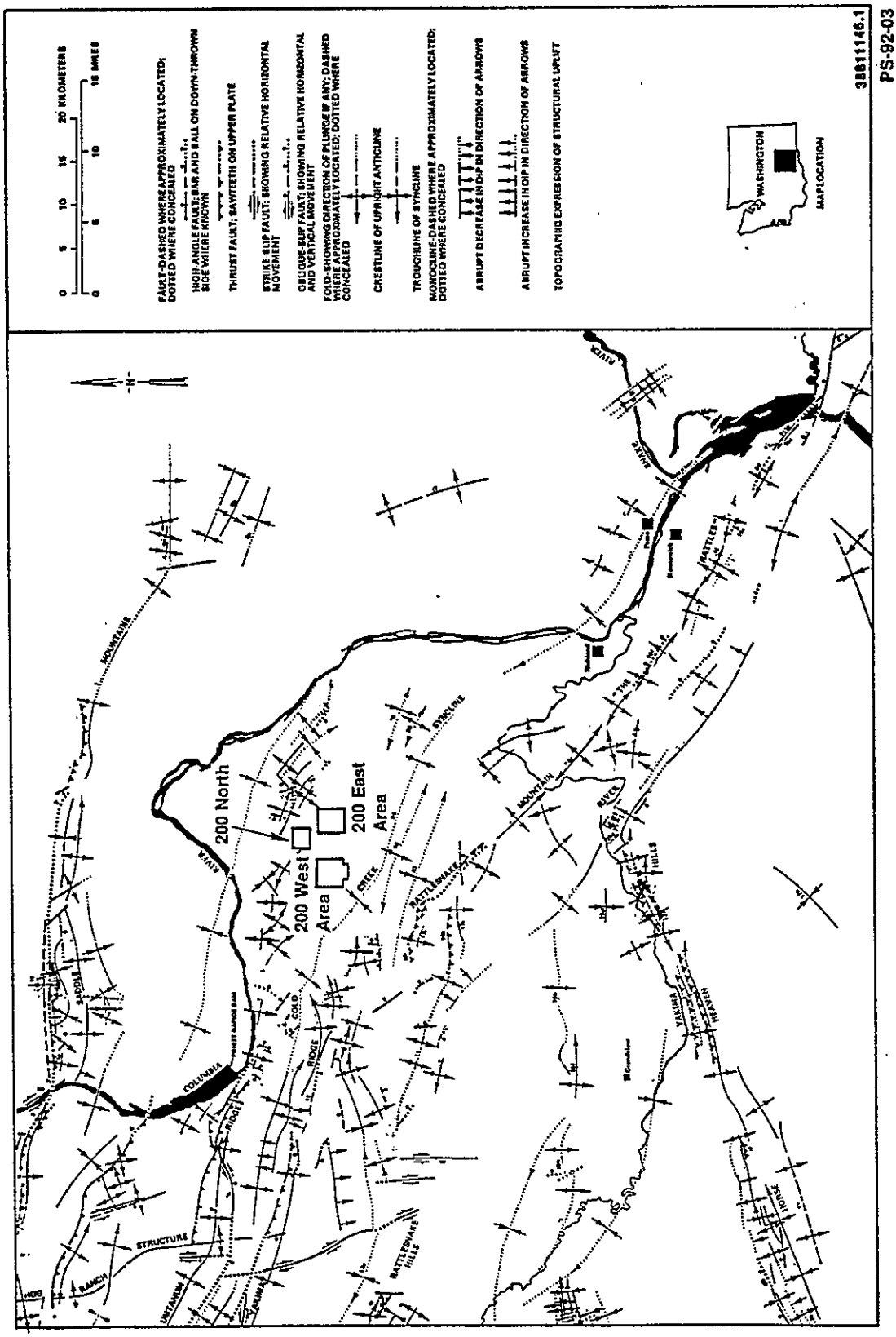


Figure 3-11. Geologic Structures of the Pasco Basin and the Hanford Site.

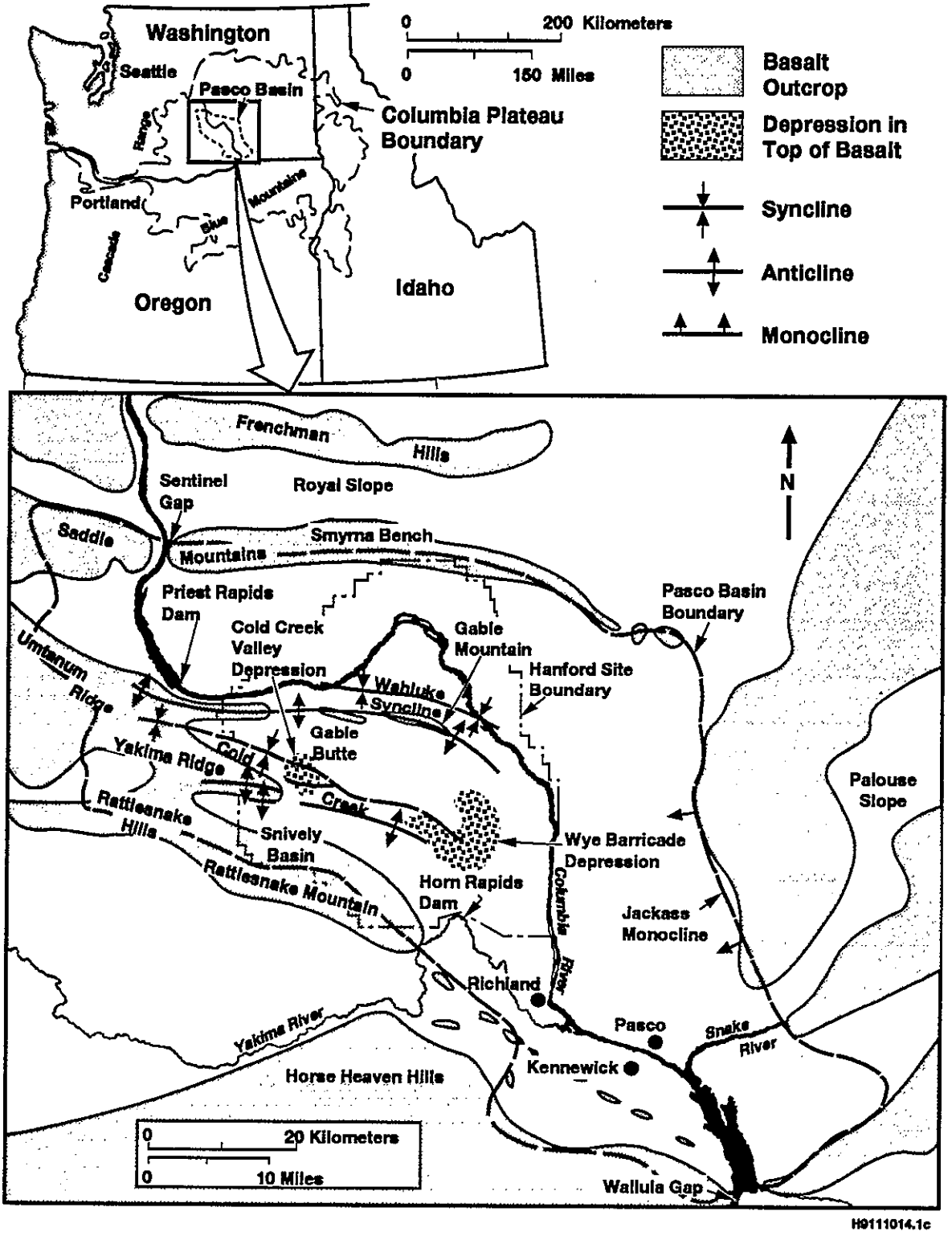
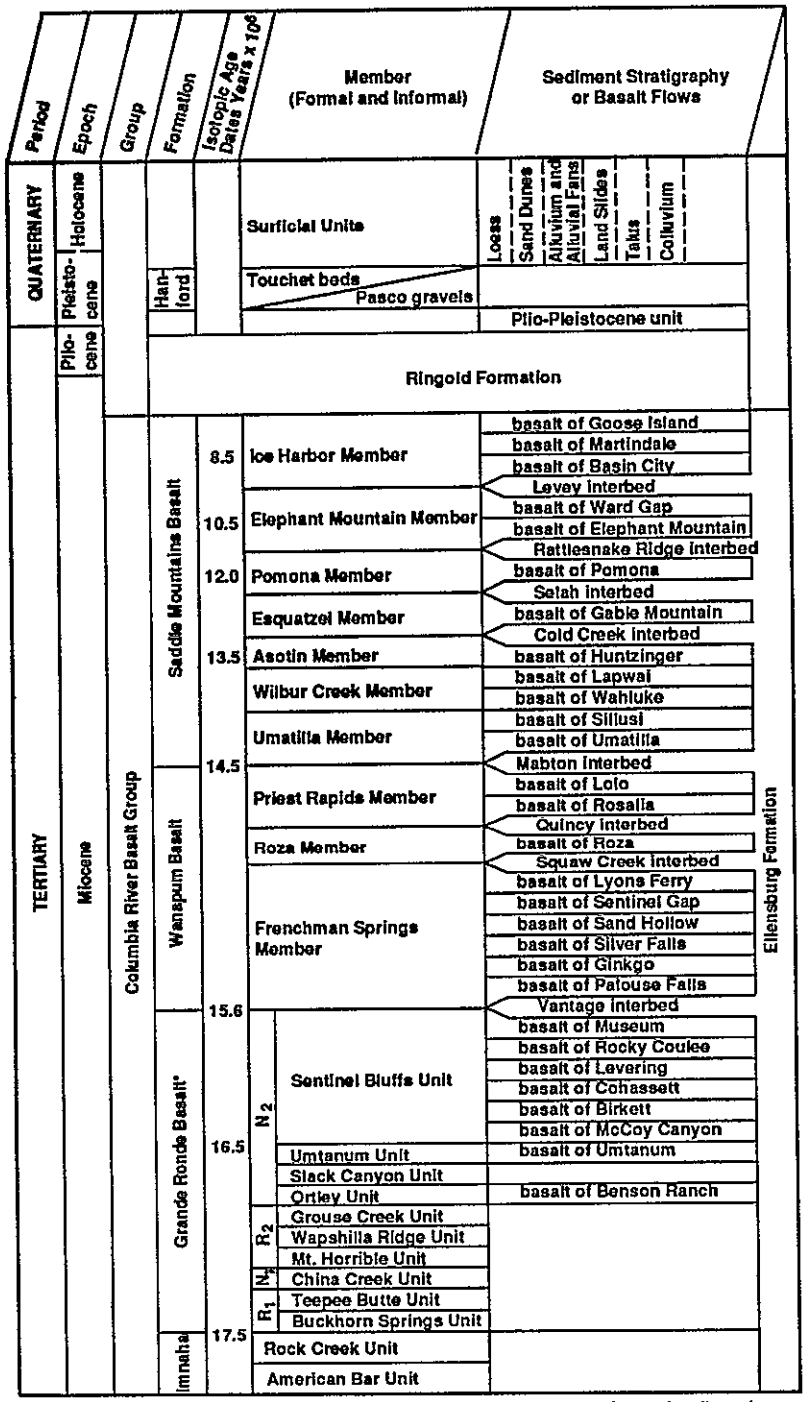


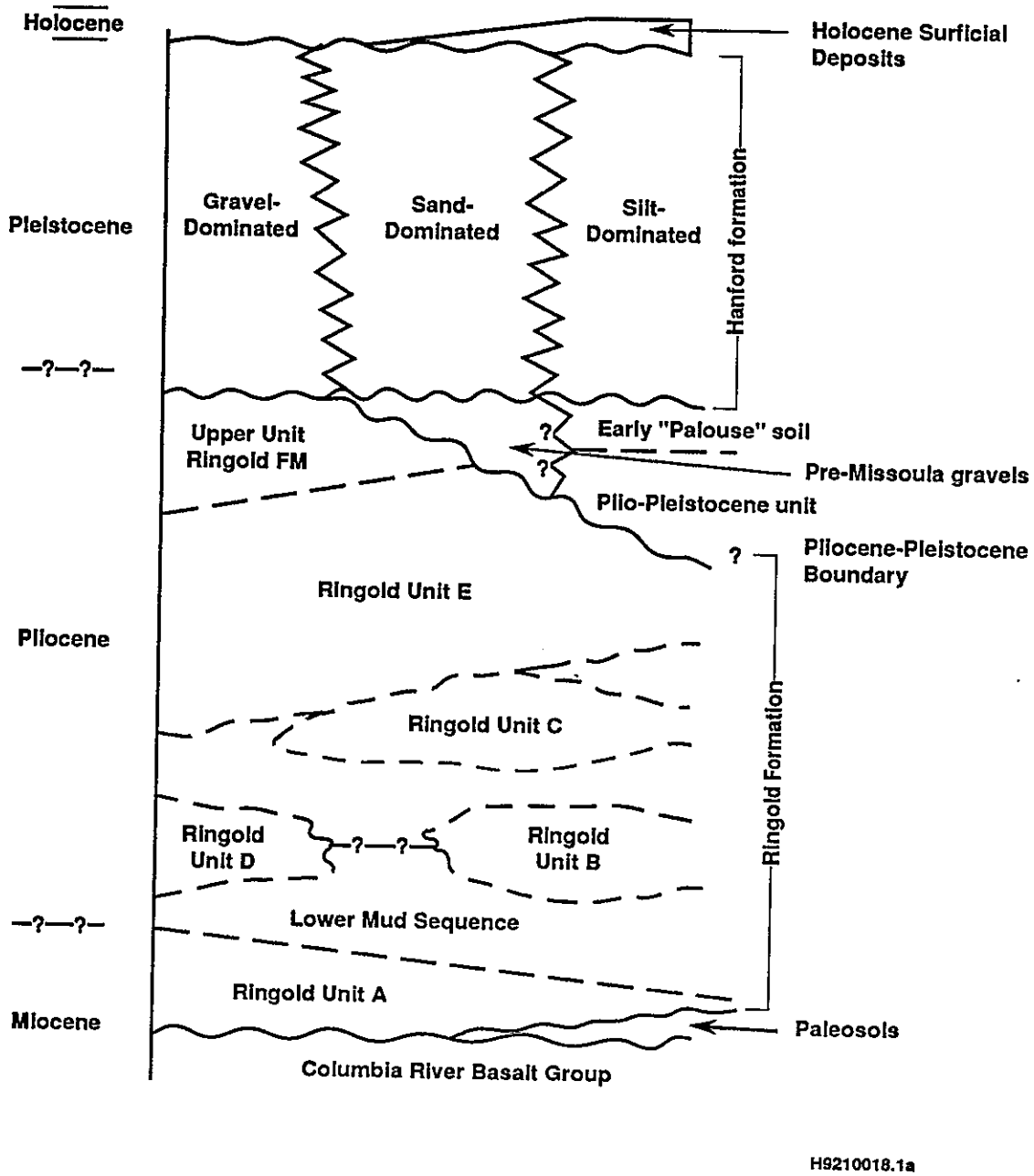
Figure 3-12. Generalized Stratigraphy of the Hanford Site.



*The Grande Ronde Basalt consists of at least 120 major basalt flows. Only a few flows have been named. N_2, R_2, N_1 and R_1 are magnetostratigraphic units.

H9102029.6a

Figure 3-13. Generalized Stratigraphy of the Suprabasalt Sediments Beneath the Hanford Site.



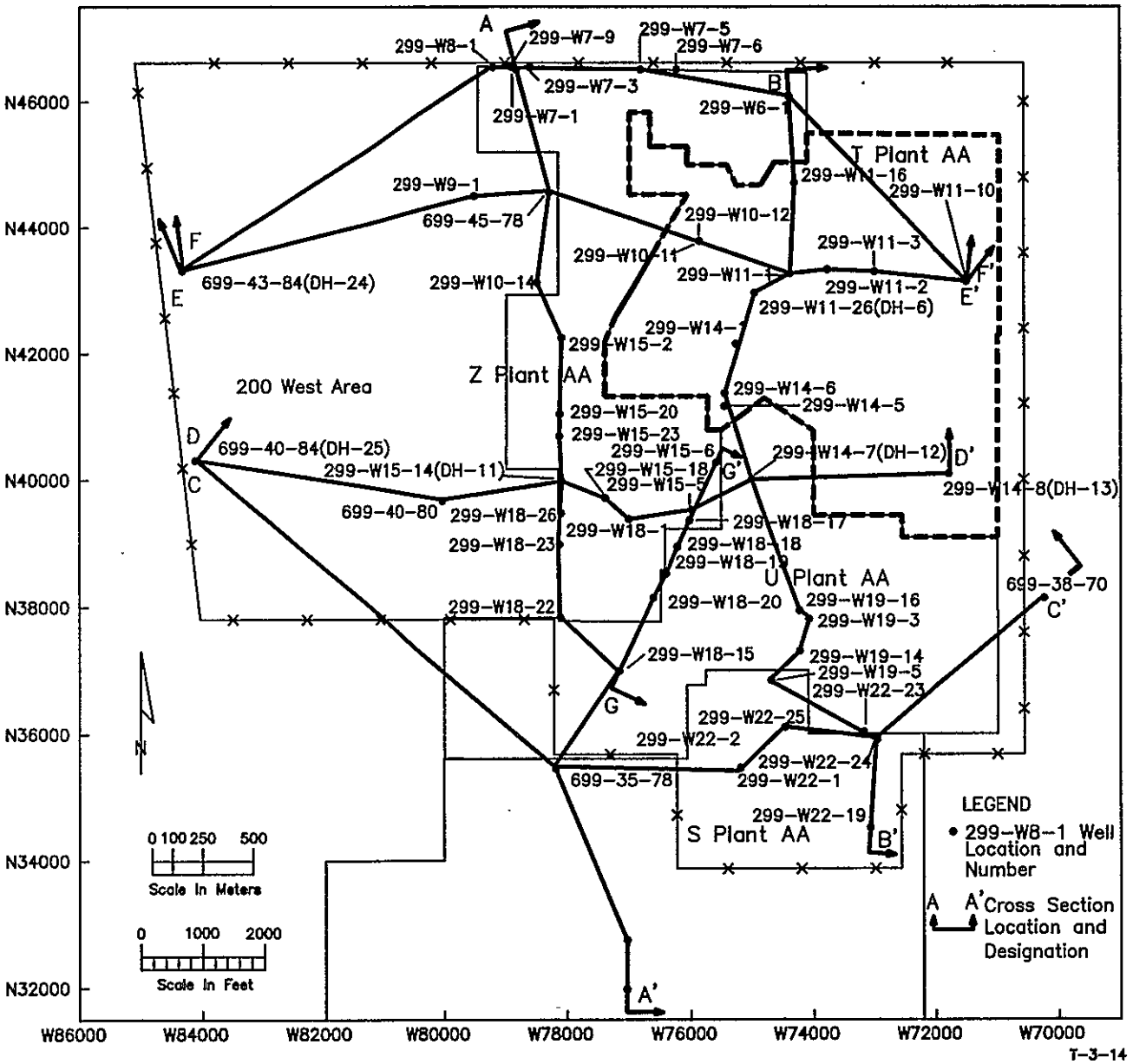


Figure 3-14. Location of Cross Sections.

Figure 3-15. Legend for Cross Sections.

UNIT ABREVIATIONS

Hc Upper Coarse Unit, Hanford formation
Hf Lower Fine Unit, Hanford formation
EP Early "Palouse" Soil
PP Plio–Pleistocene Unit
UR Upper Unit, Ringold Formation
E Gravel Unit E, Ringold Formation
LM Lower Mud Sequence, Ringold Formation
A Gravel Unit A, Ringold Formation

SYMBOLS

—?——— Formational Contact, ? Where Inferred

—·—?—·— Unit Contact, ? Where Inferred

– – – – – Major Facies Contact

Pedogenic Calcium Carbonate

Paleosols

Ringold Clast Supported Gravels

Open Framework Hanford Gravels

Laminated Muds

Basalt

Blank portions of cross section well logs represent sediments (dominantly sand) which do not fit into sediment categories depicted by symbols listed above.

NOTES

1. Refer to Figure 3–14 for cross section locations and designation. Cross sections presented on Figures 3–16 through 3–19.

2. Figures based on Lindsey et al. 1991.

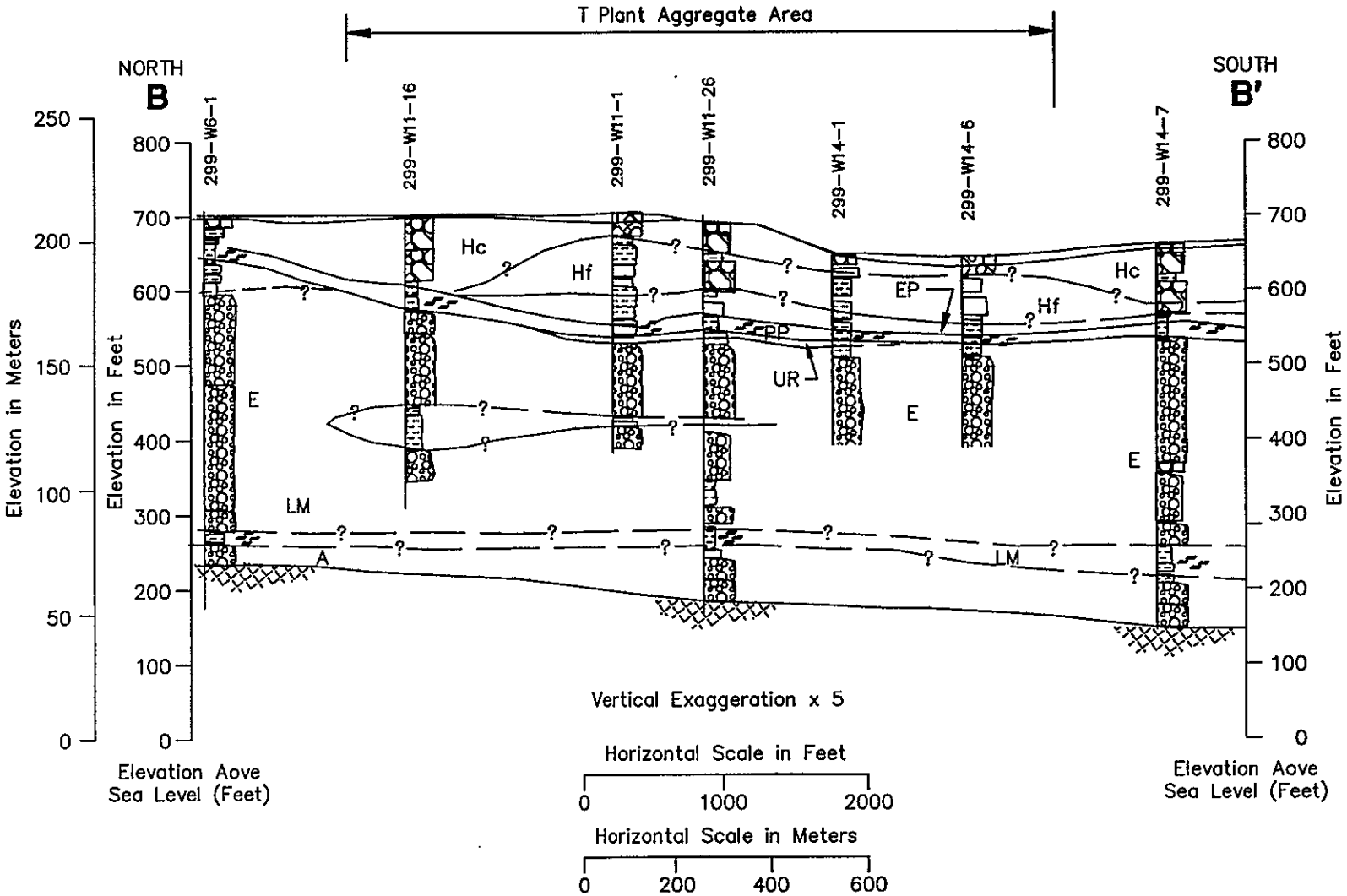


Figure 3-16. Geologic Cross Section B-B'.

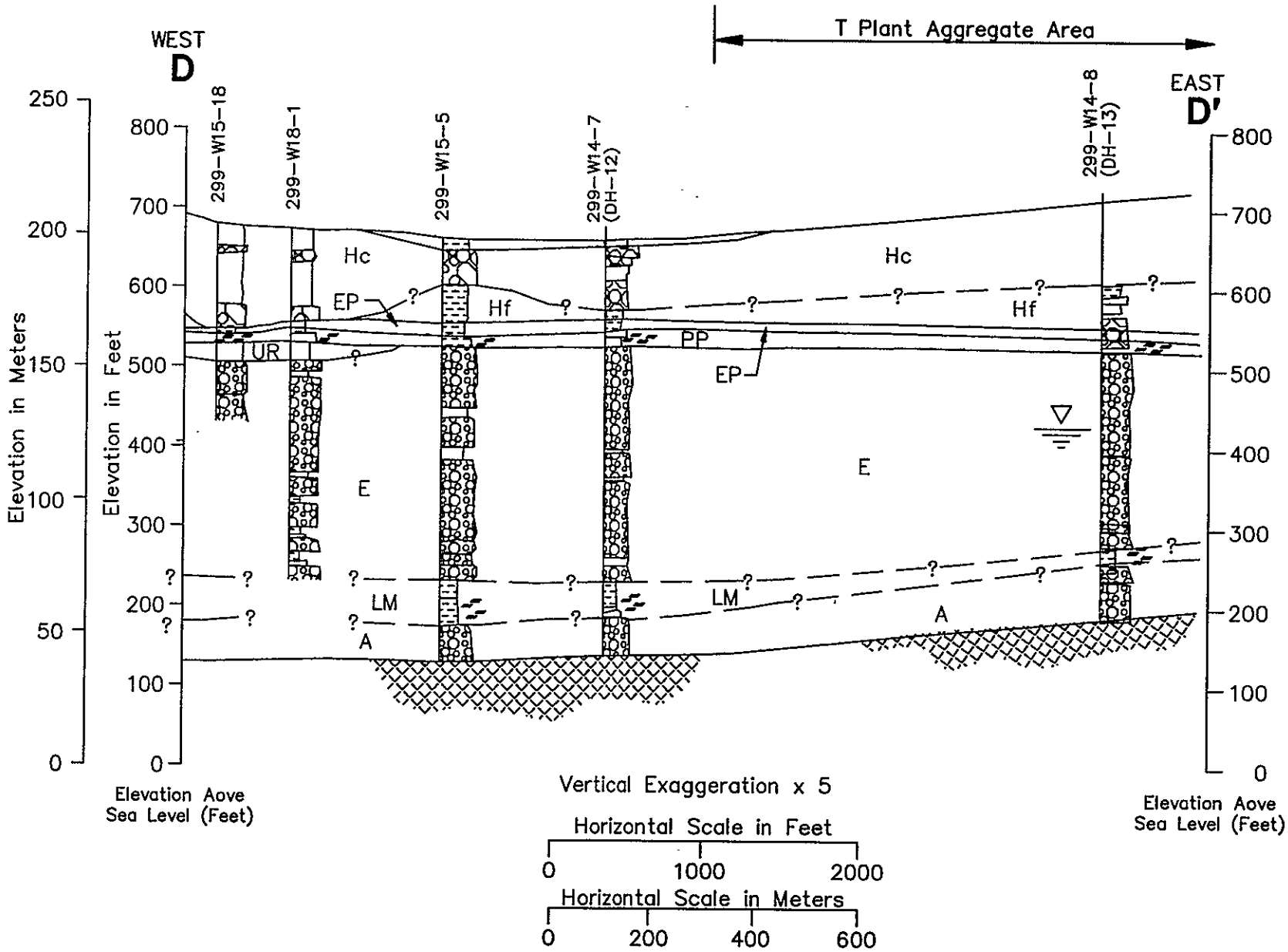


Figure 3-17. Geologic Cross Section D-D'.

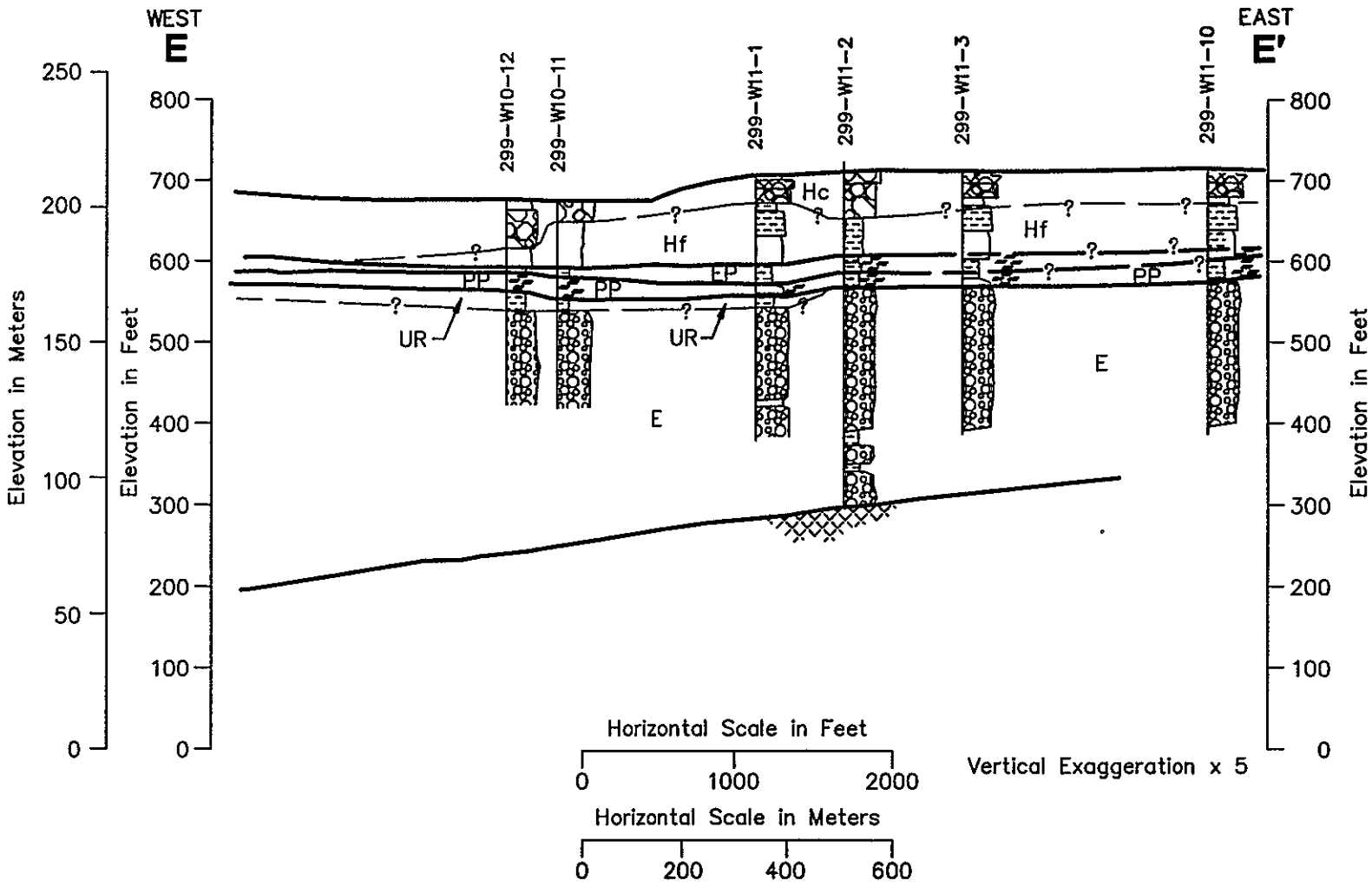


Figure 3-18. Geologic Cross Section F-F'.

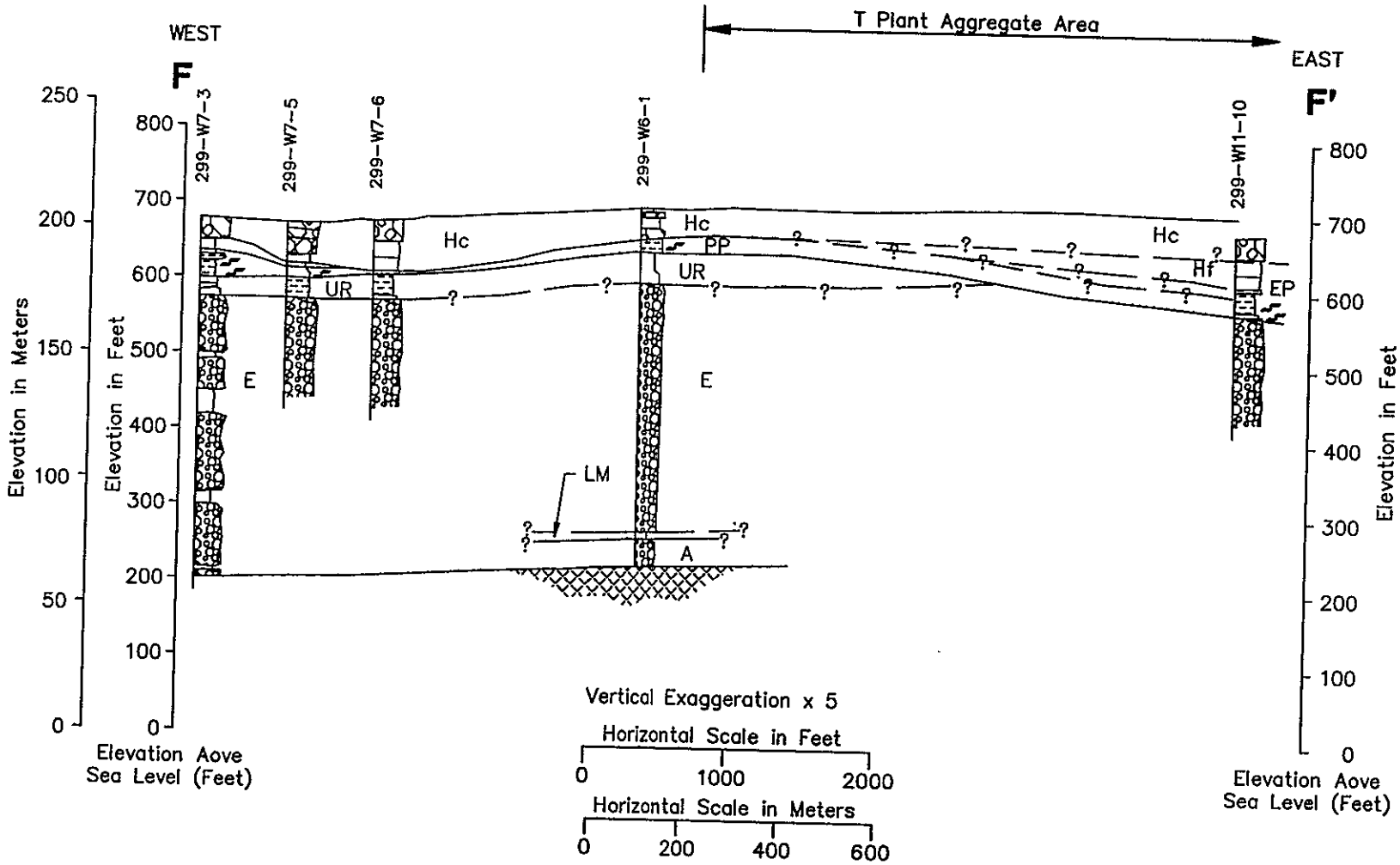


Figure 3-19. Geologic Cross Section E-E'.

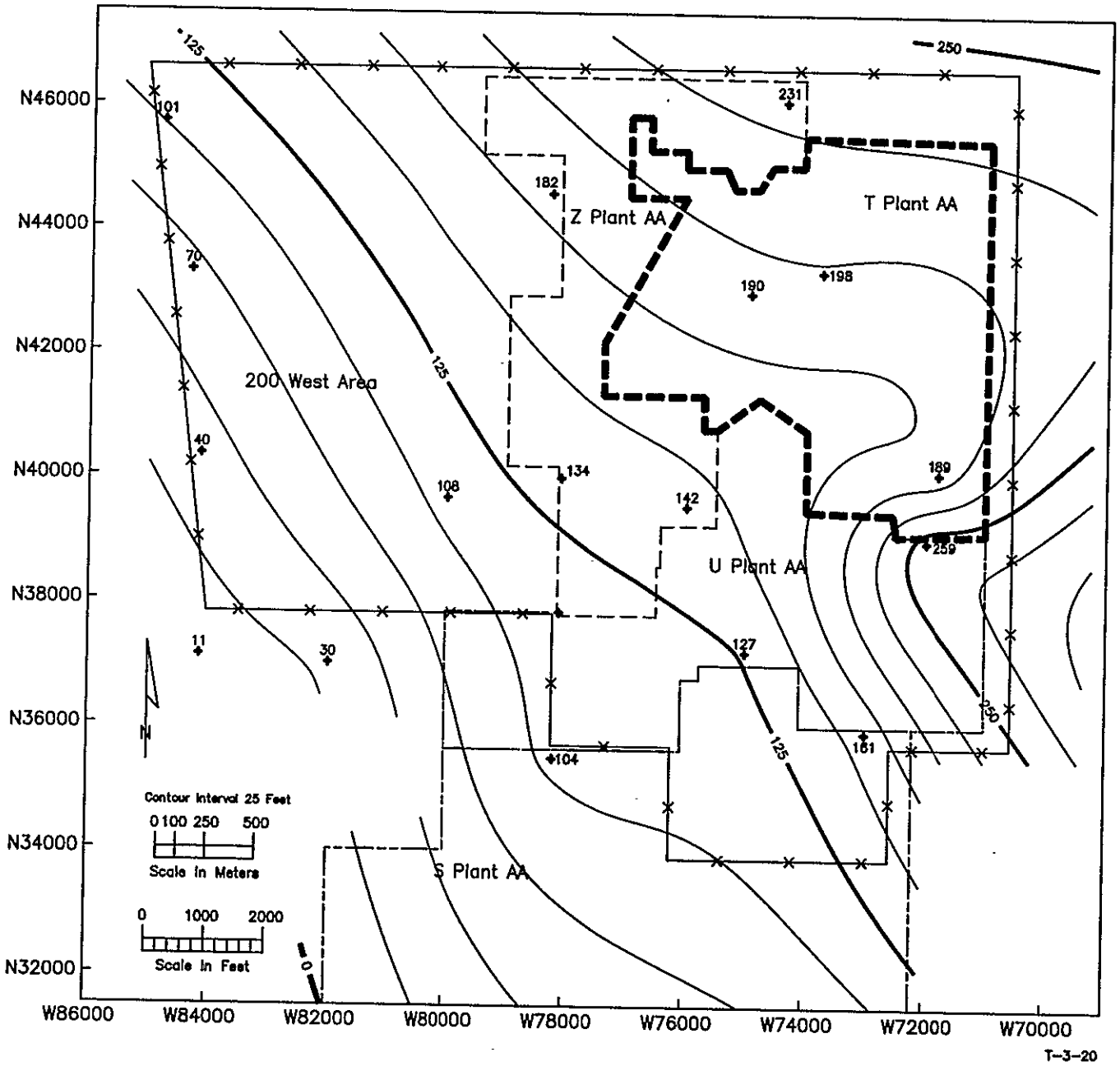


Figure 3-20. Top of the Elephant Mountain Basalts.

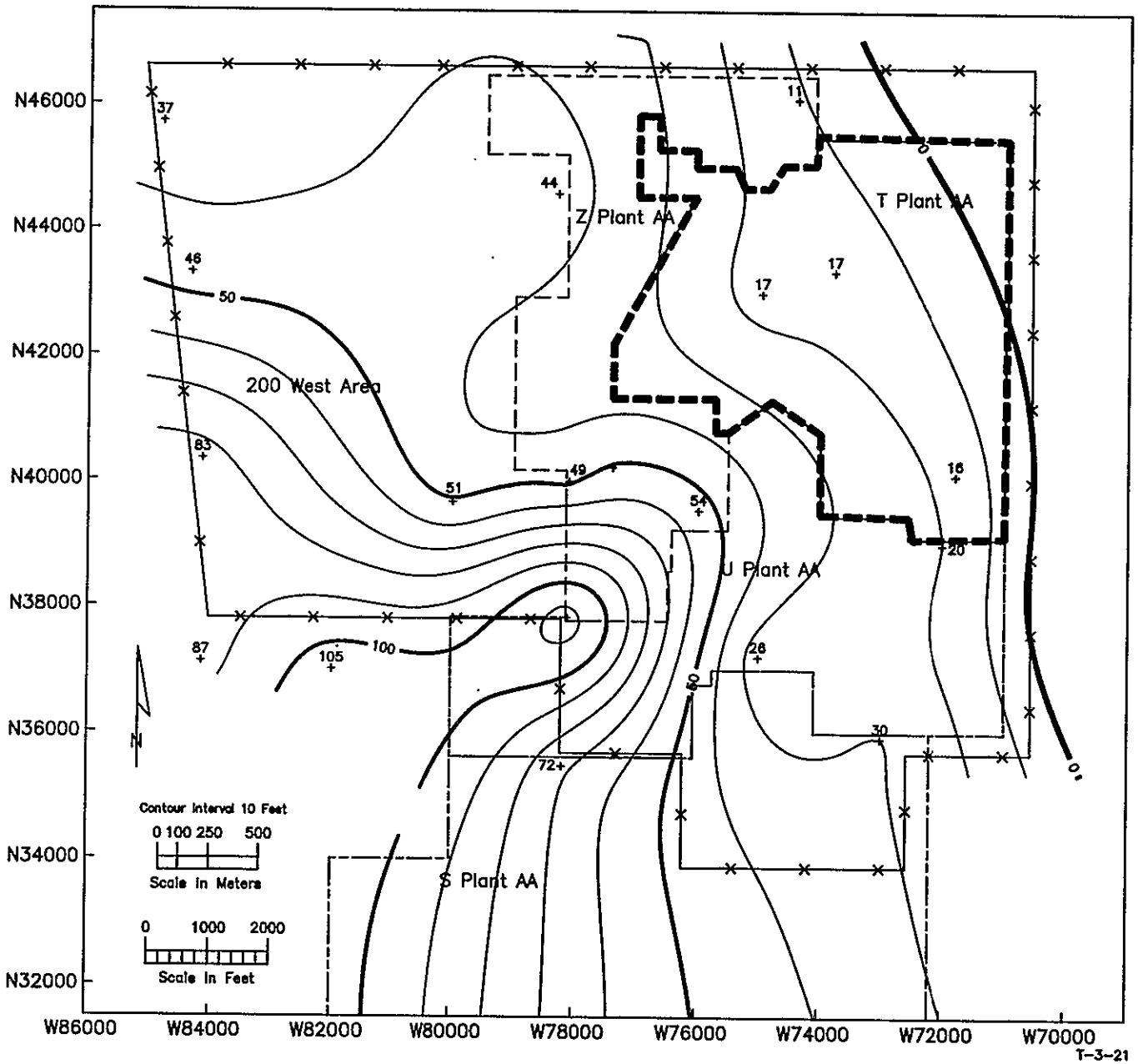


Figure 3-21. Isopach Map of the Lower Mud Sequence of the Ringold Formation.

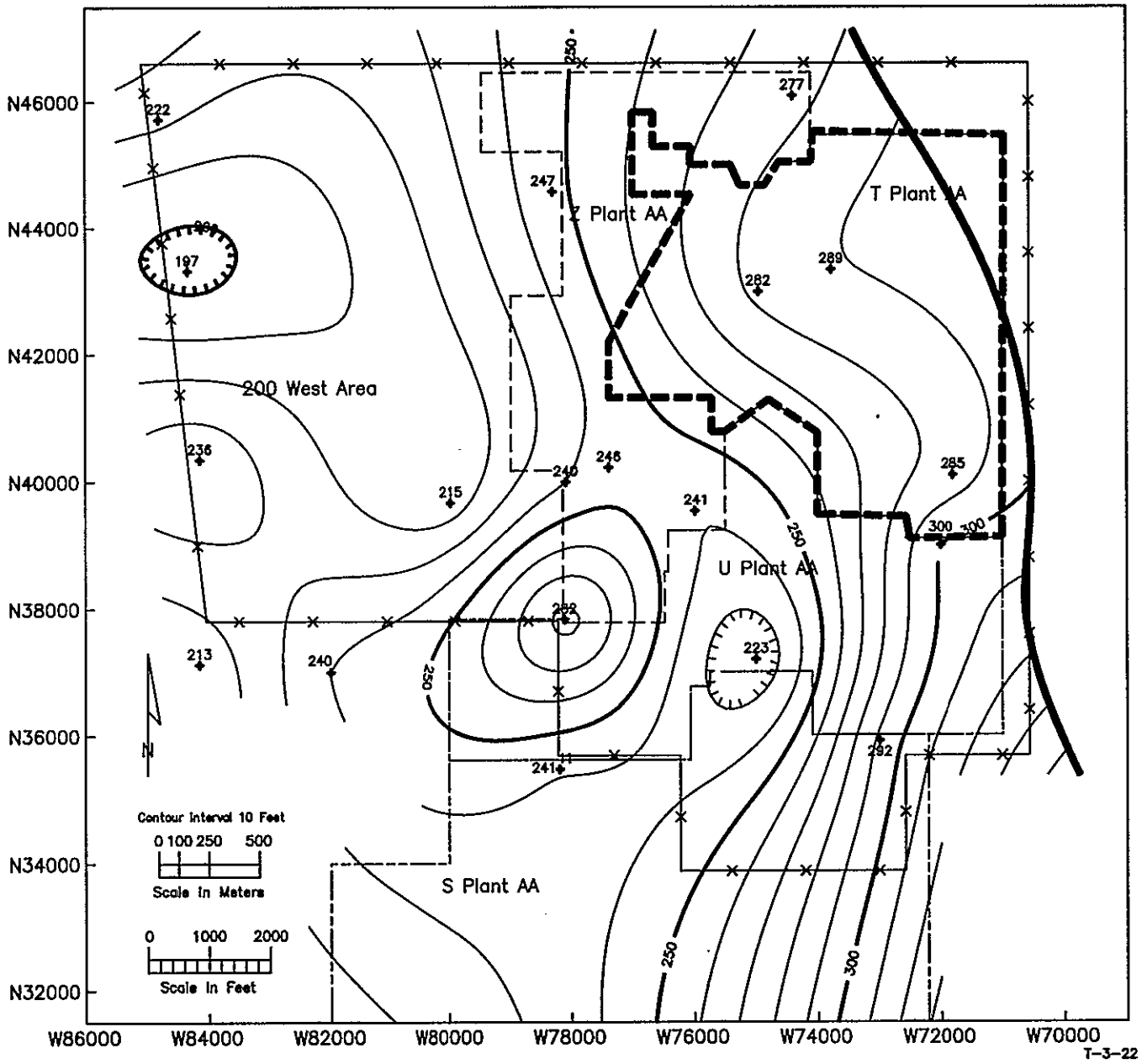


Figure 3-22. Structure Map of the Lower Mud Sequence of the Ringold Formation.

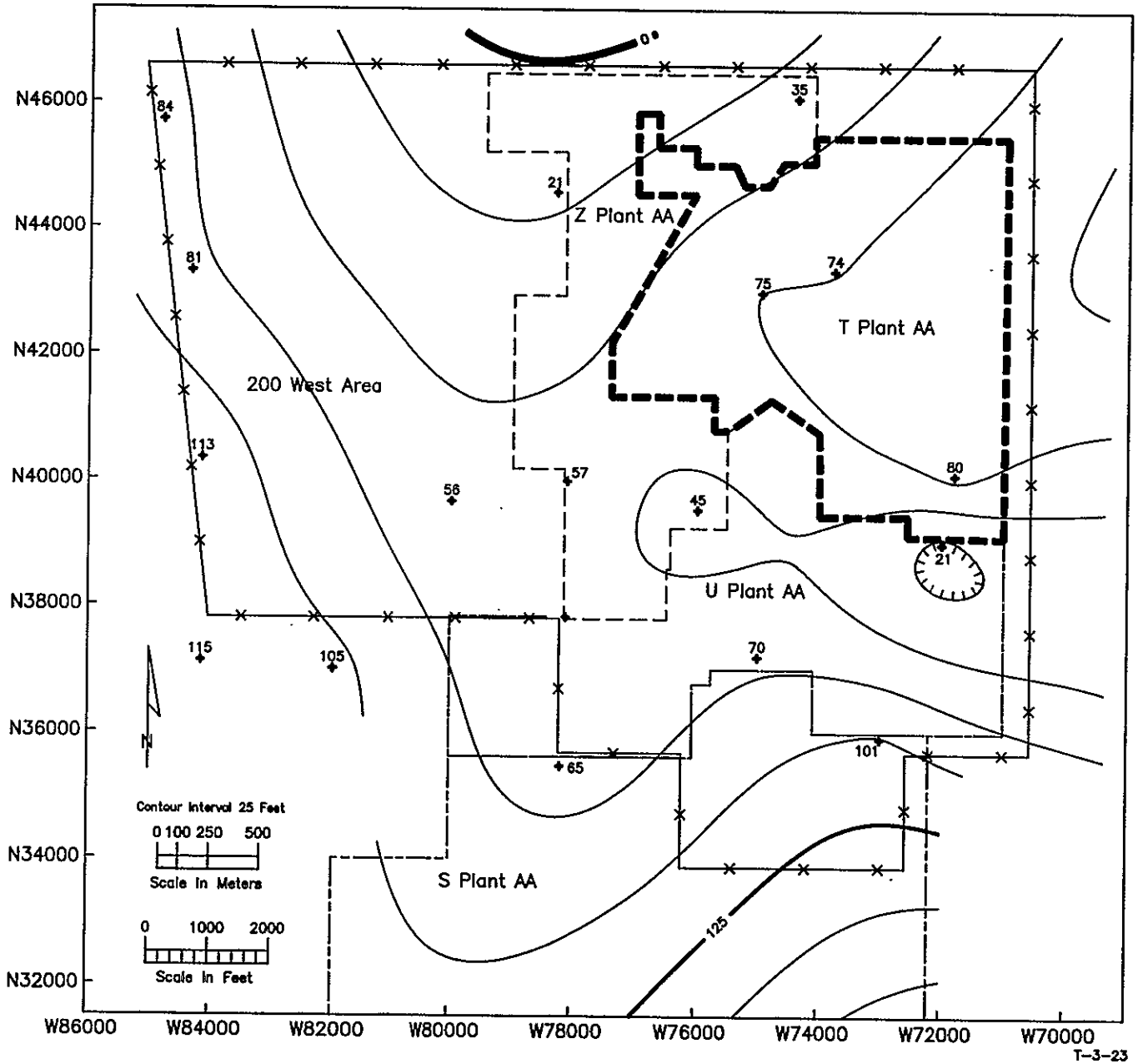


Figure 3-23. Isopach Map of the Ringold Gravel Unit A.

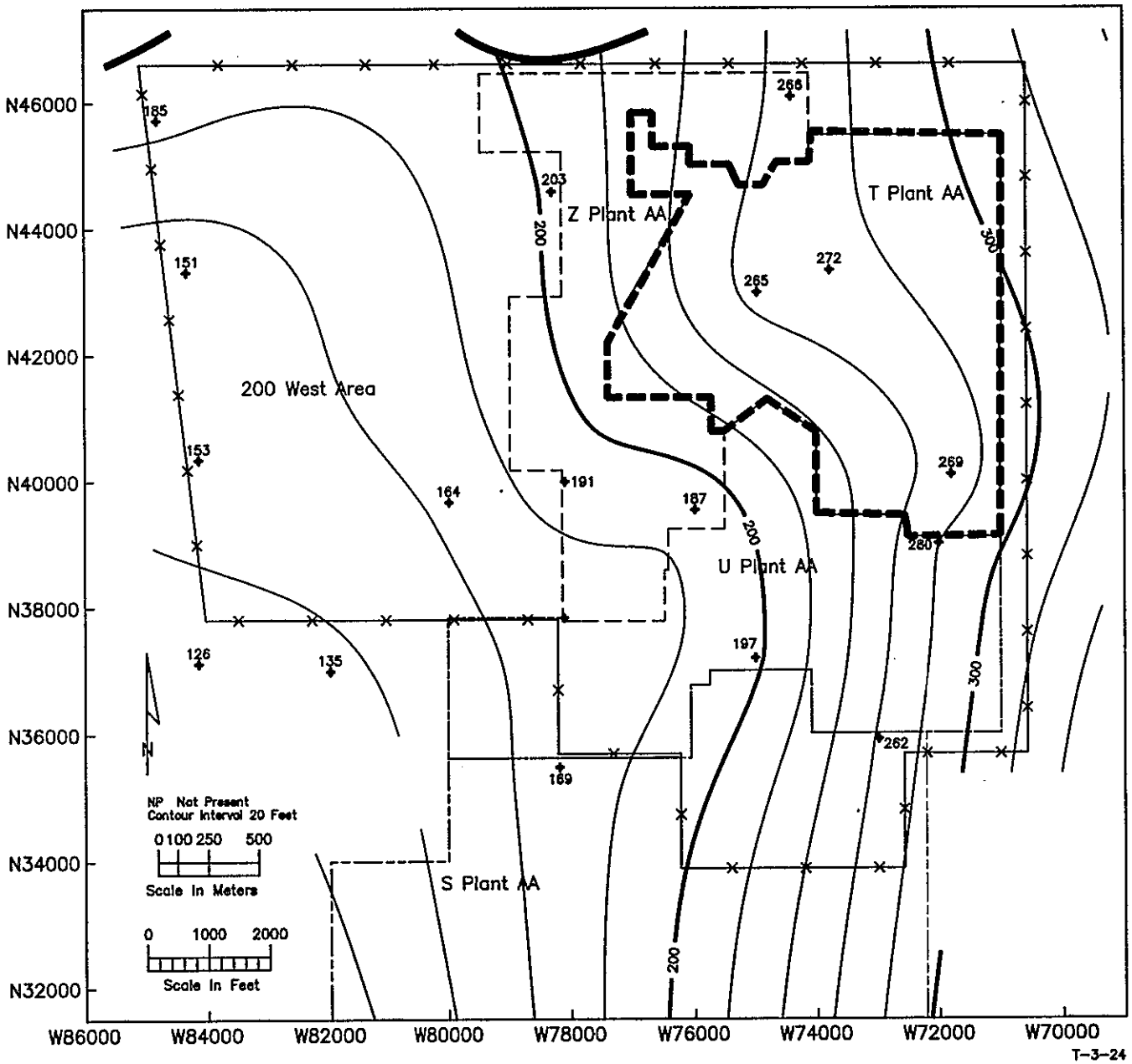


Figure 3-24. Structure Map of the Ringold Gravel Unit A.

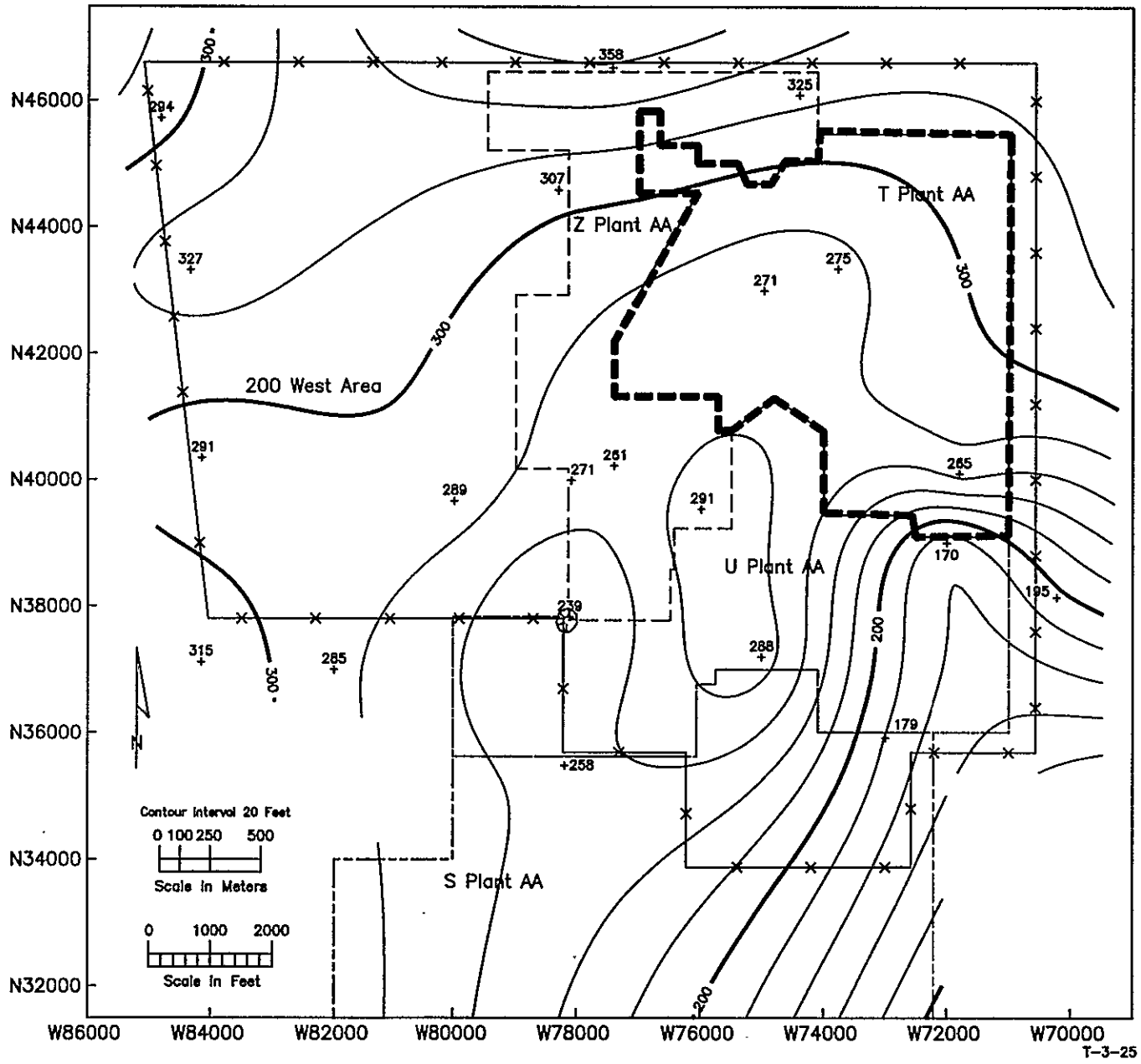


Figure 3-25. Isopach Map of the Ringold Gravel Unit E.

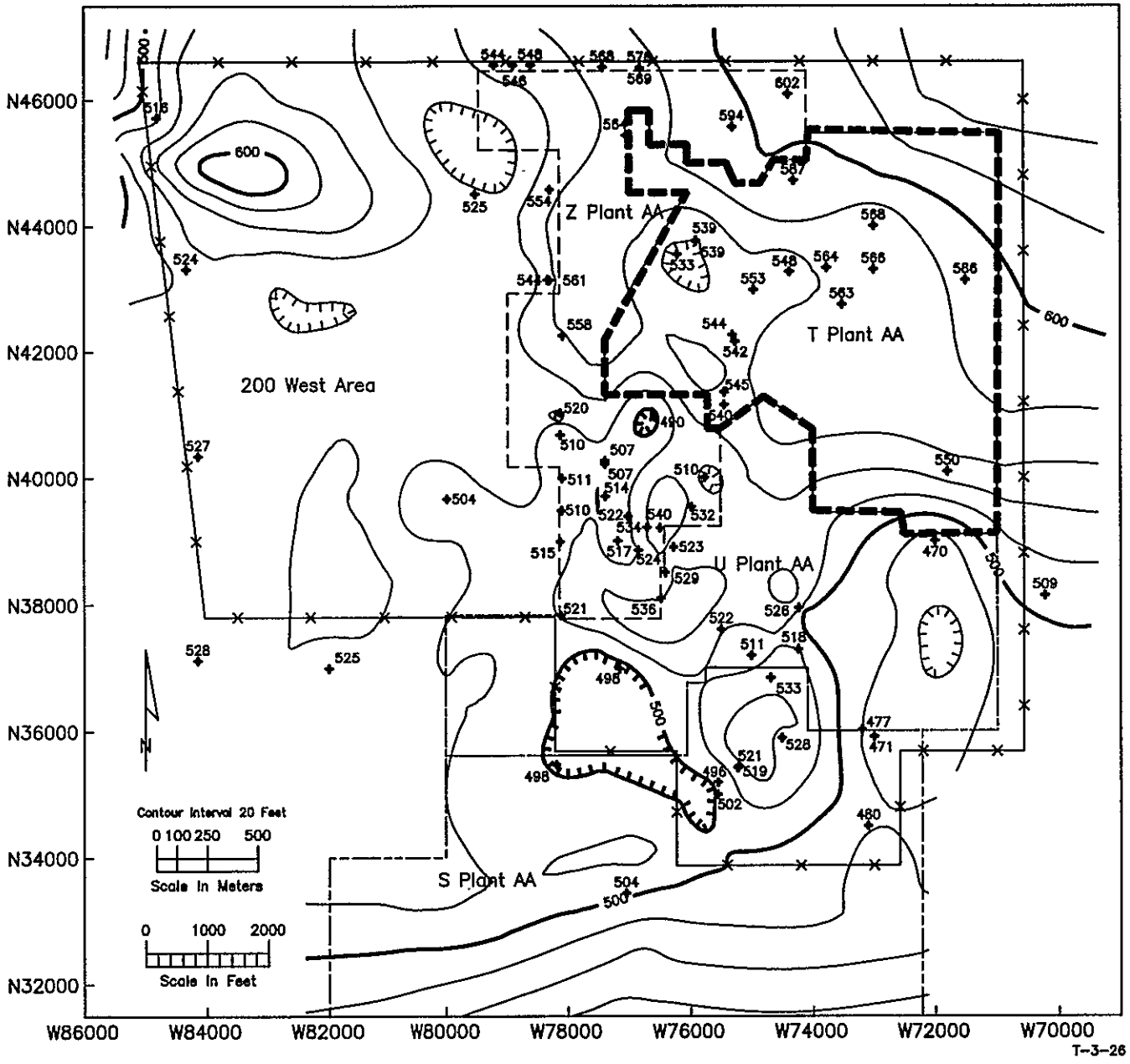


Figure 3-26. Structure Map of the Ringold Gravel Unit E.

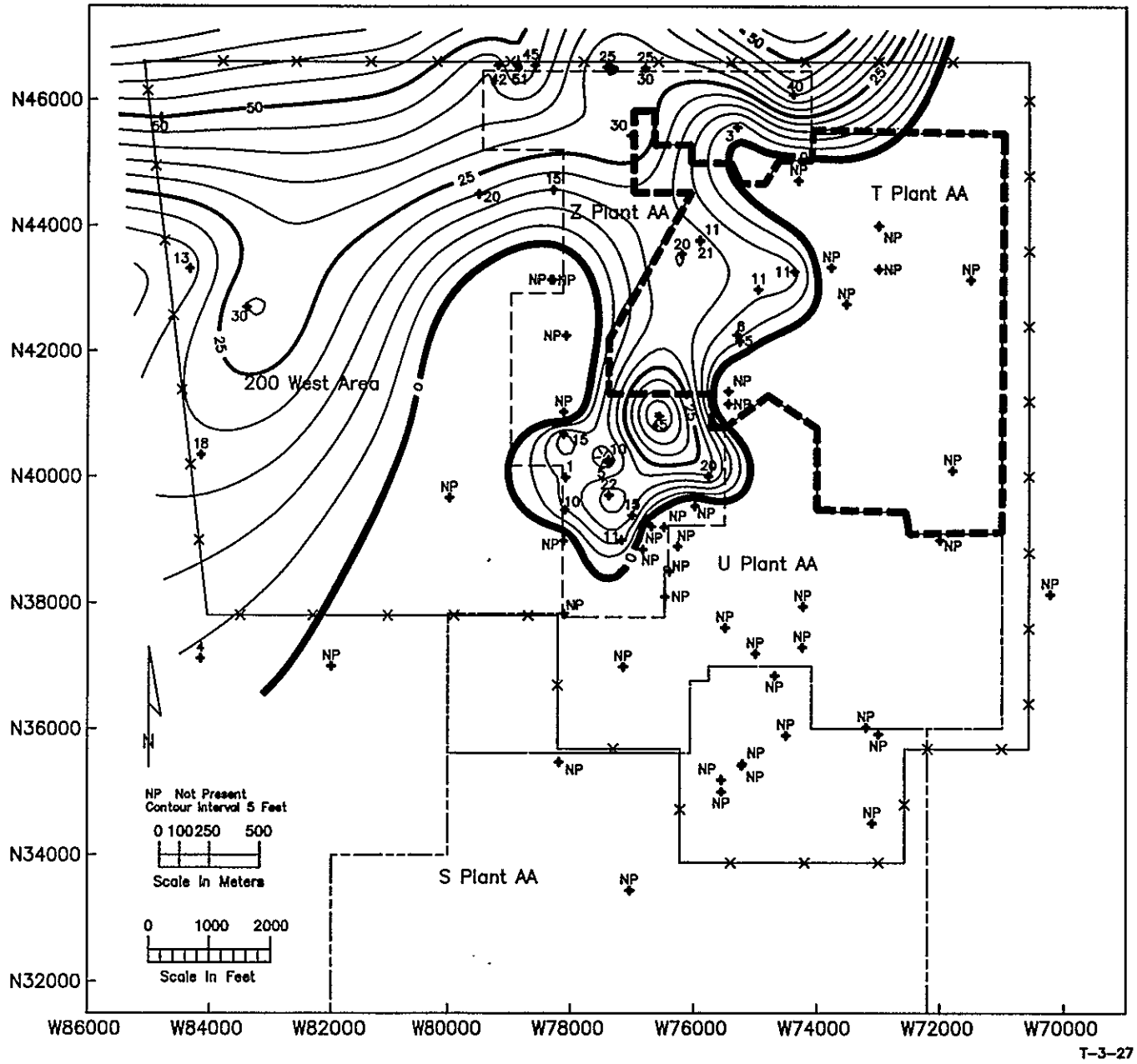


Figure 3-27. Isopach Map of the Upper Ringold Formation.

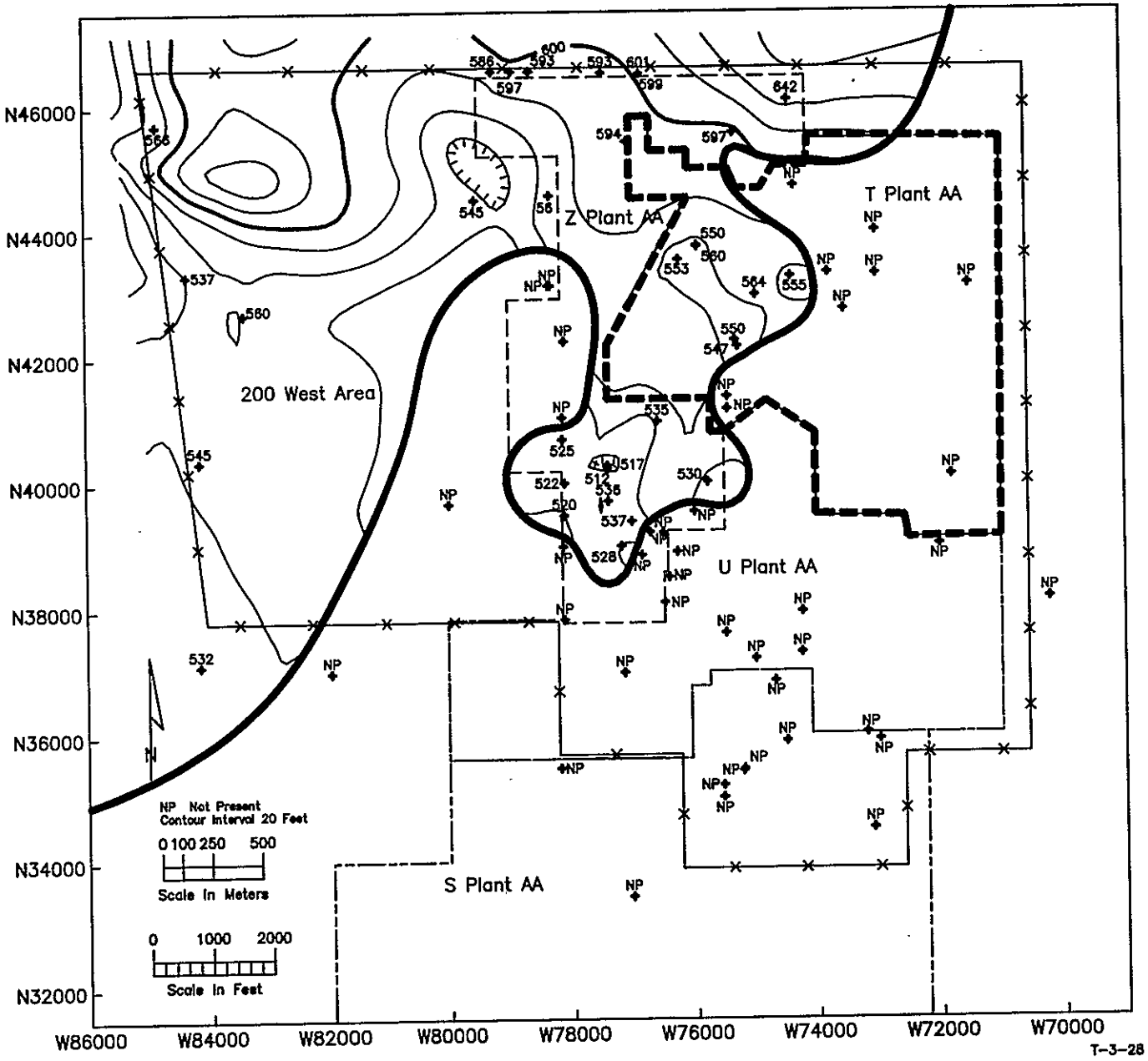


Figure 3-28. Structure Map of the Upper Ringold Formation.

9 3 1 2 8 7 0 1 9 1 2

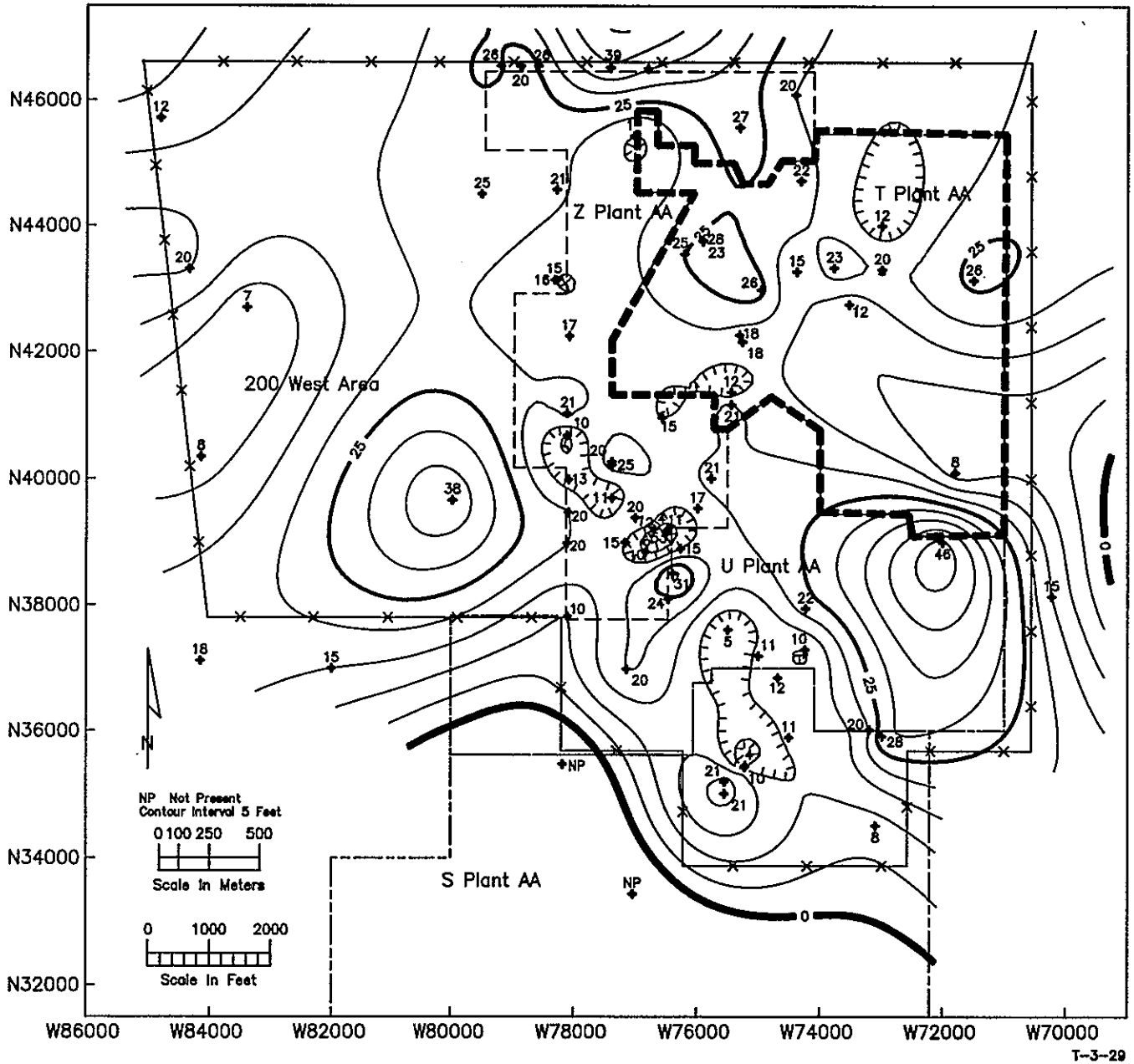


Figure 3-29. Isopach Map of the Plio-Pleistocene Unit.

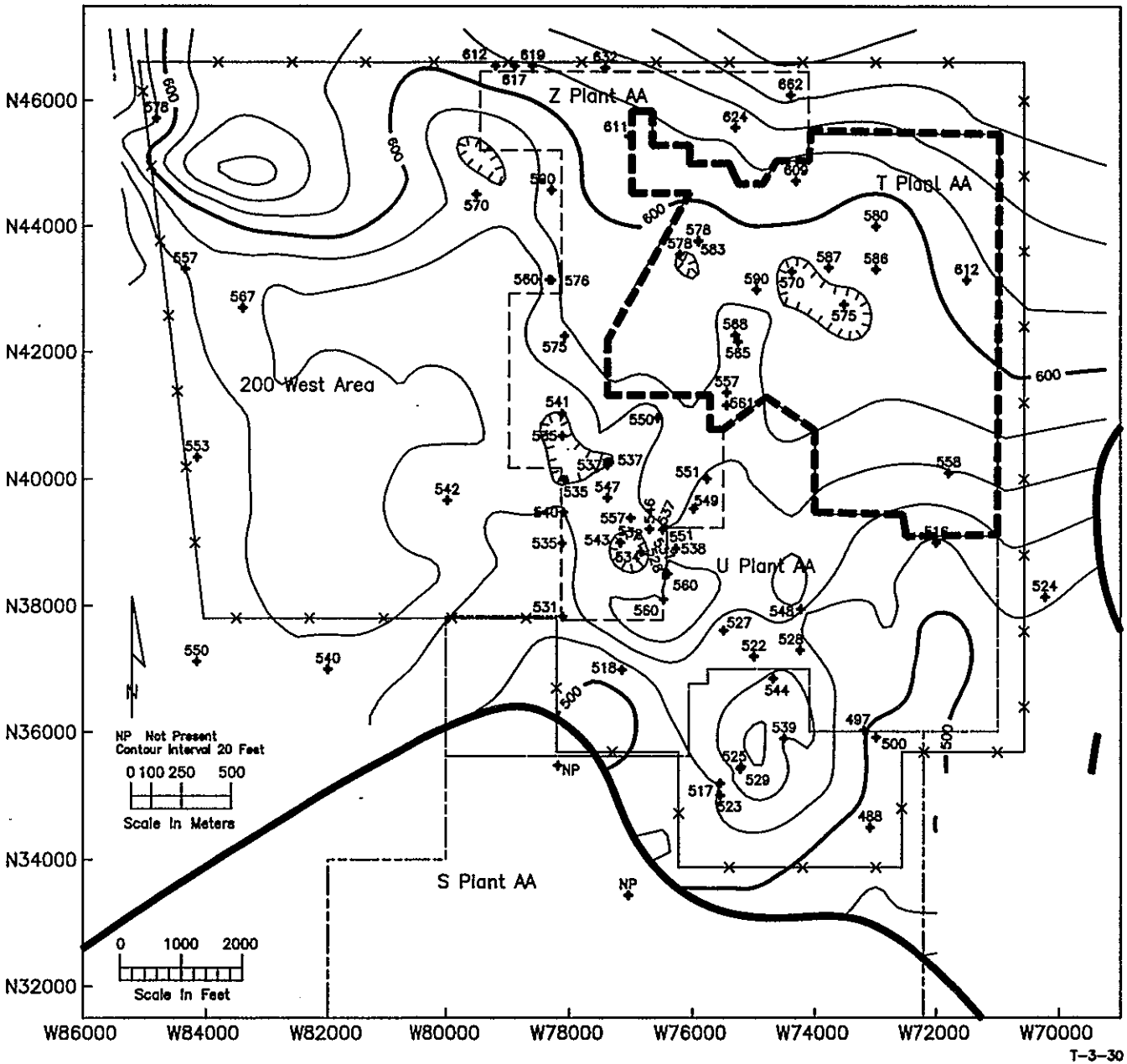


Figure 3-30. Structure Map of the Plio-Pleistocene Unit.

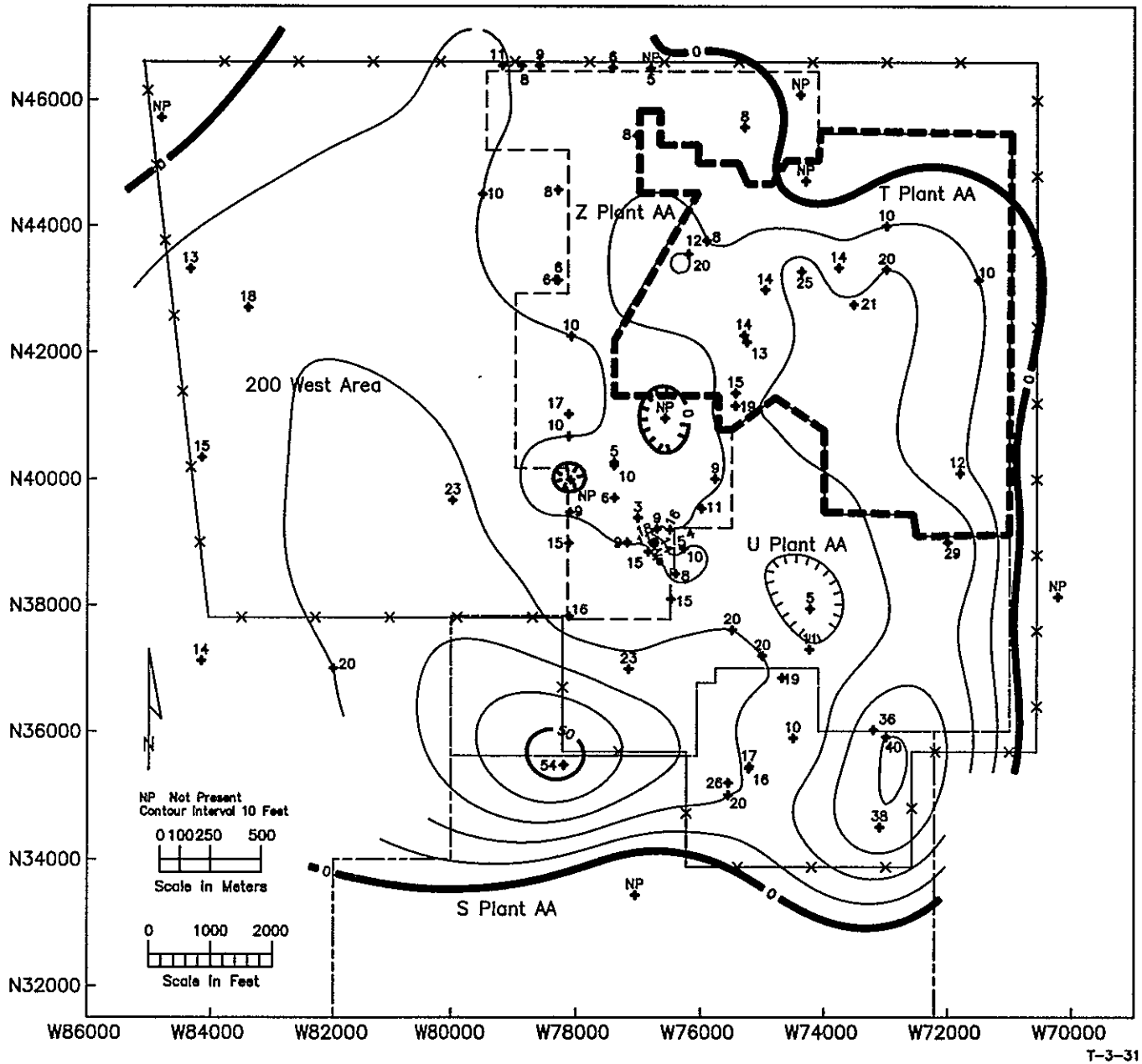


Figure 3-31. Isopach Map of the Early "Palouse" Soils.

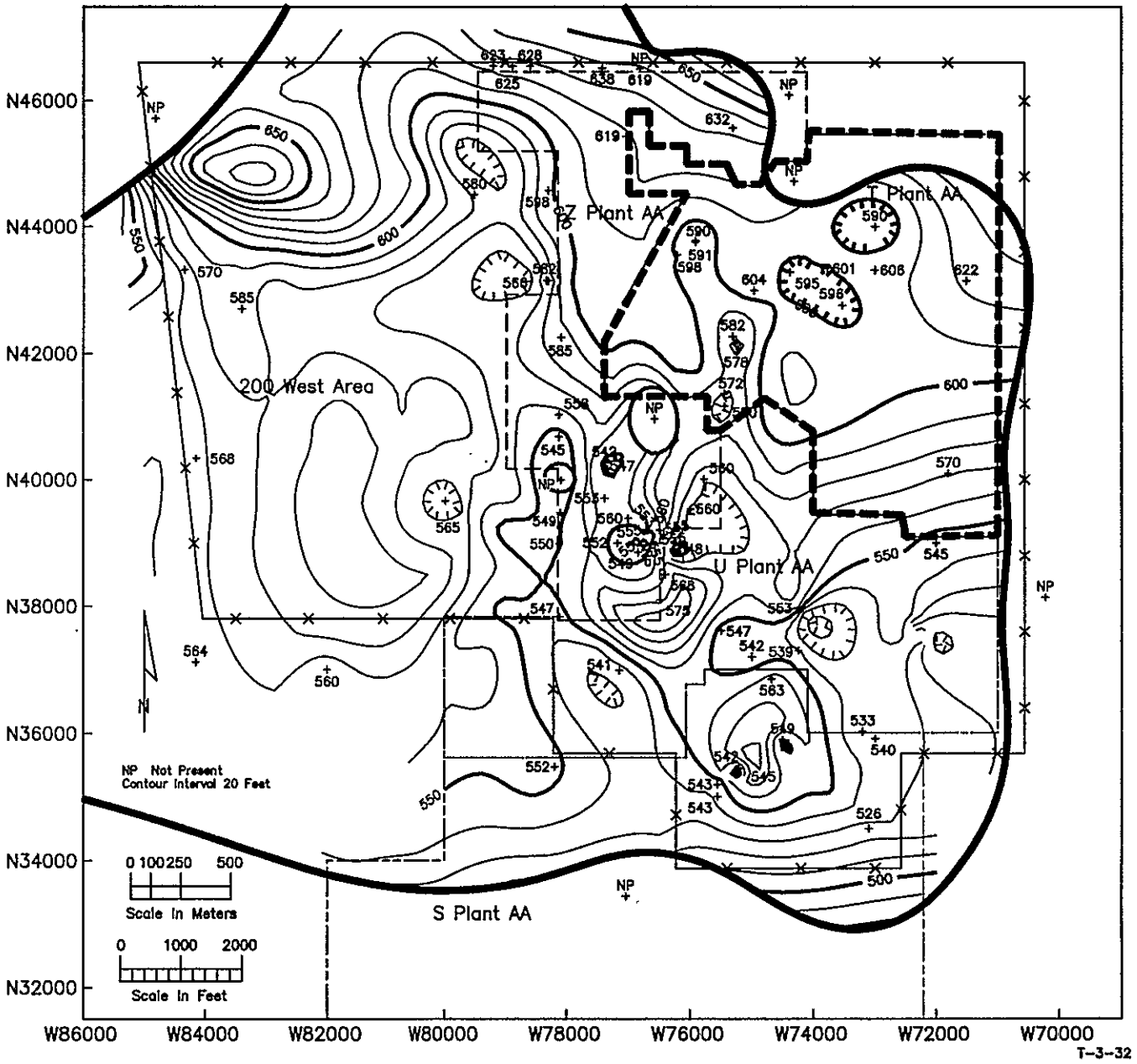


Figure 3-32. Structure Map of the Early "Palouse" Soils.

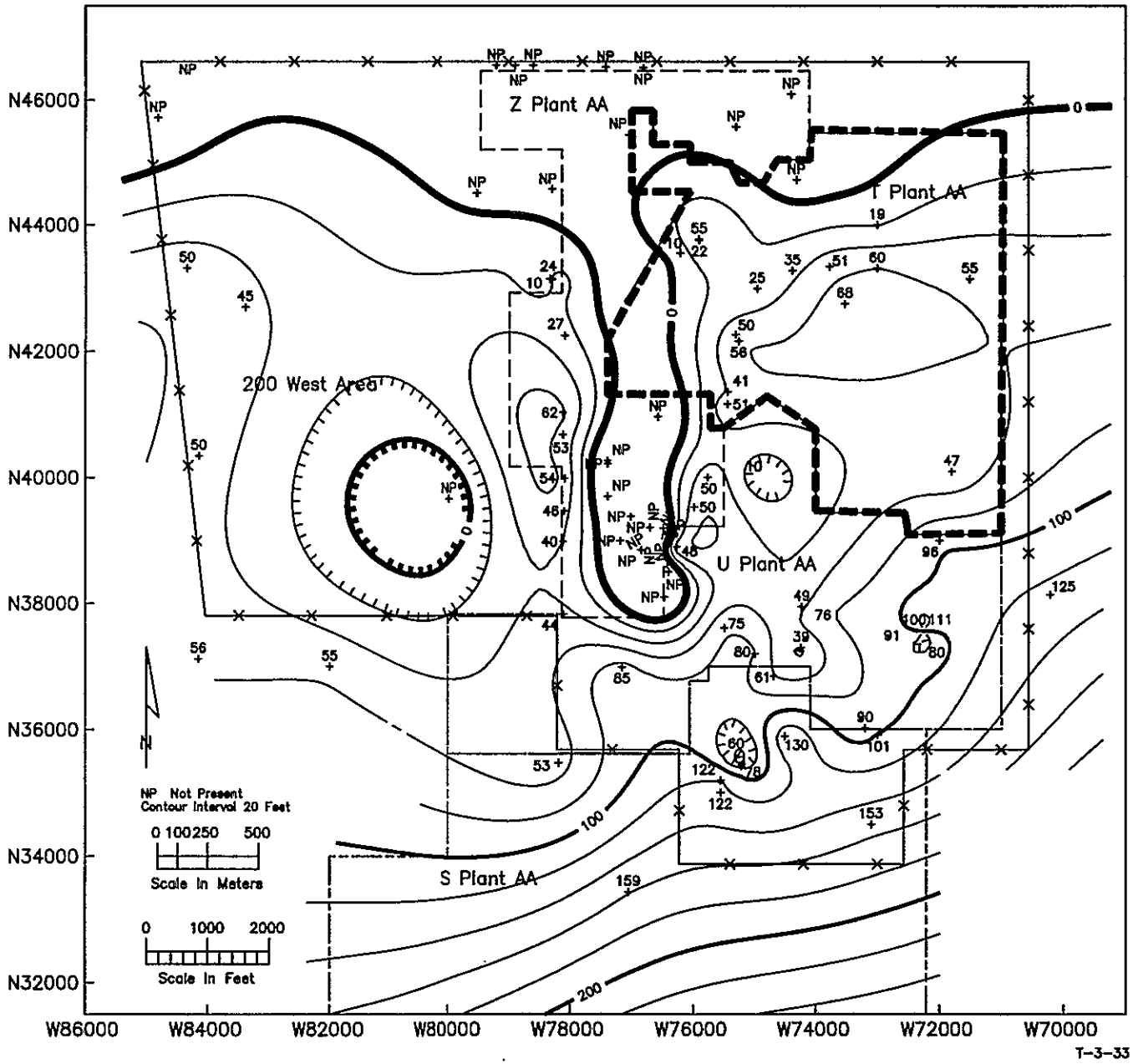


Figure 3-33. Isopach Map of the Lower Fine-Grained Unit of the Hanford Formation.

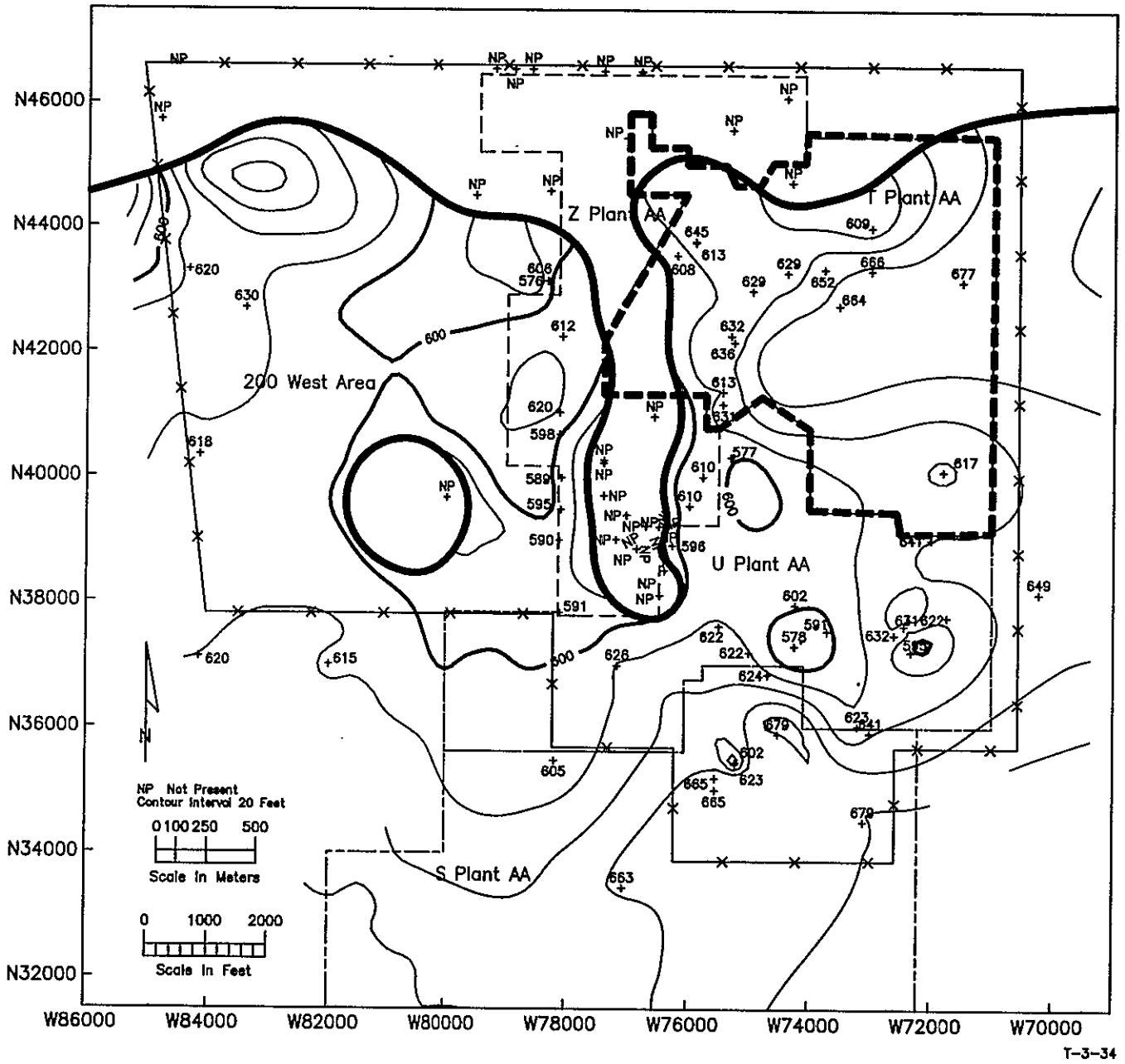


Figure 3-34. Structure Map of the Lower Fine-Grained Unit of the Hanford Formation.

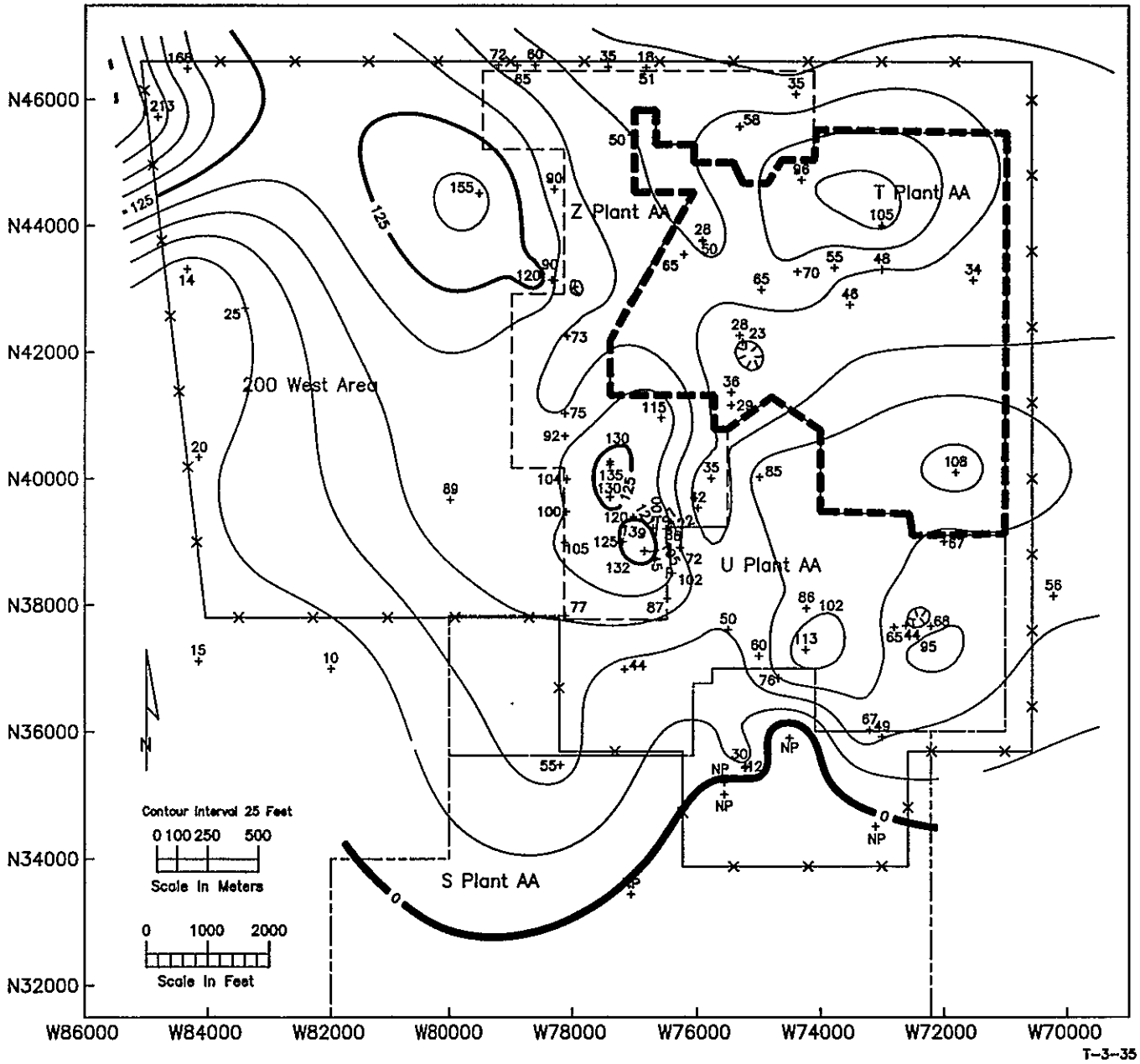


Figure 3-35. Isopach Map of the Upper Coarse-Grained Unit of the Hanford Formation.

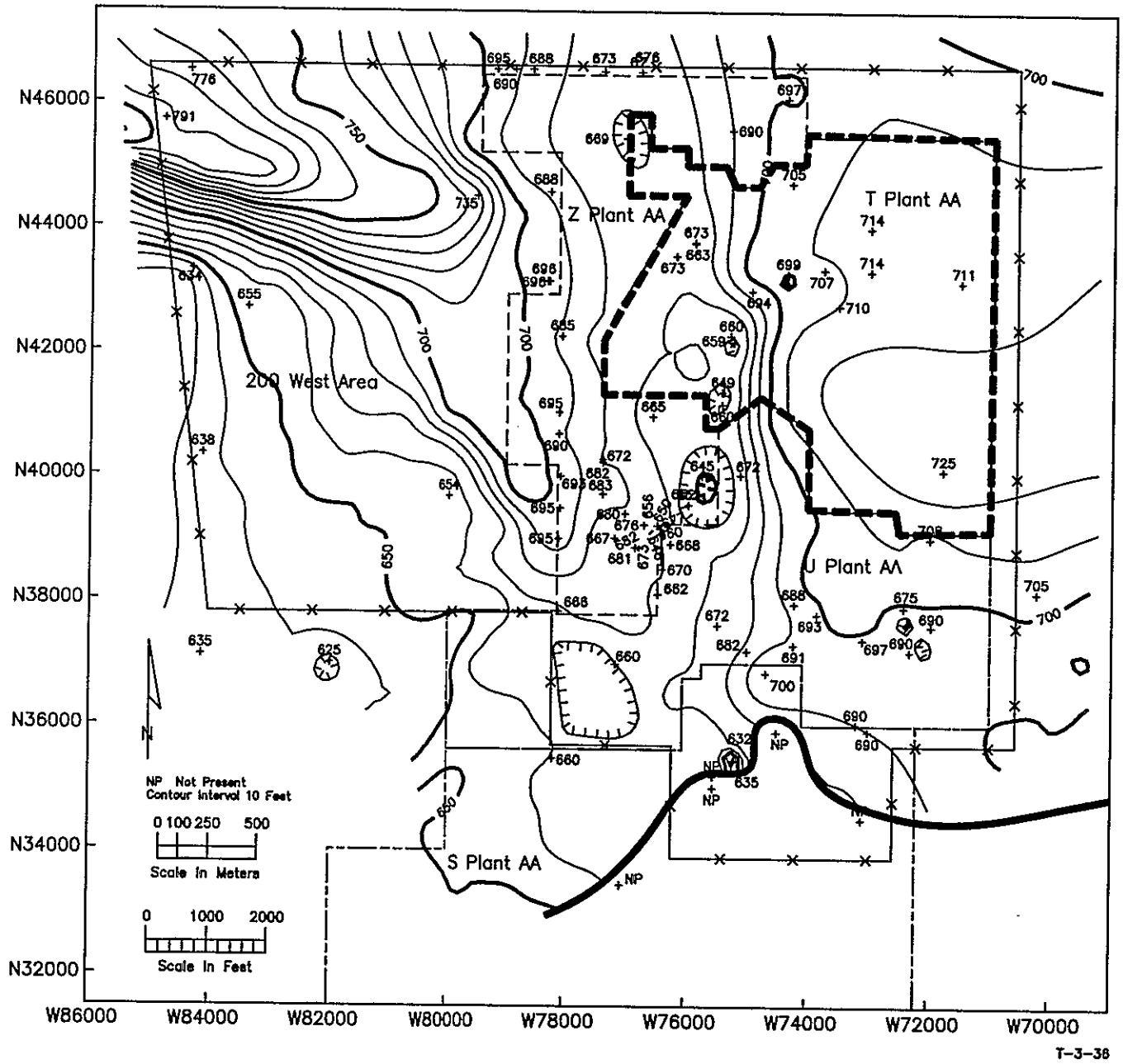


Figure 3-36. Structure Map of the Upper Coarse-Grained Unit of the Hanford Formation.

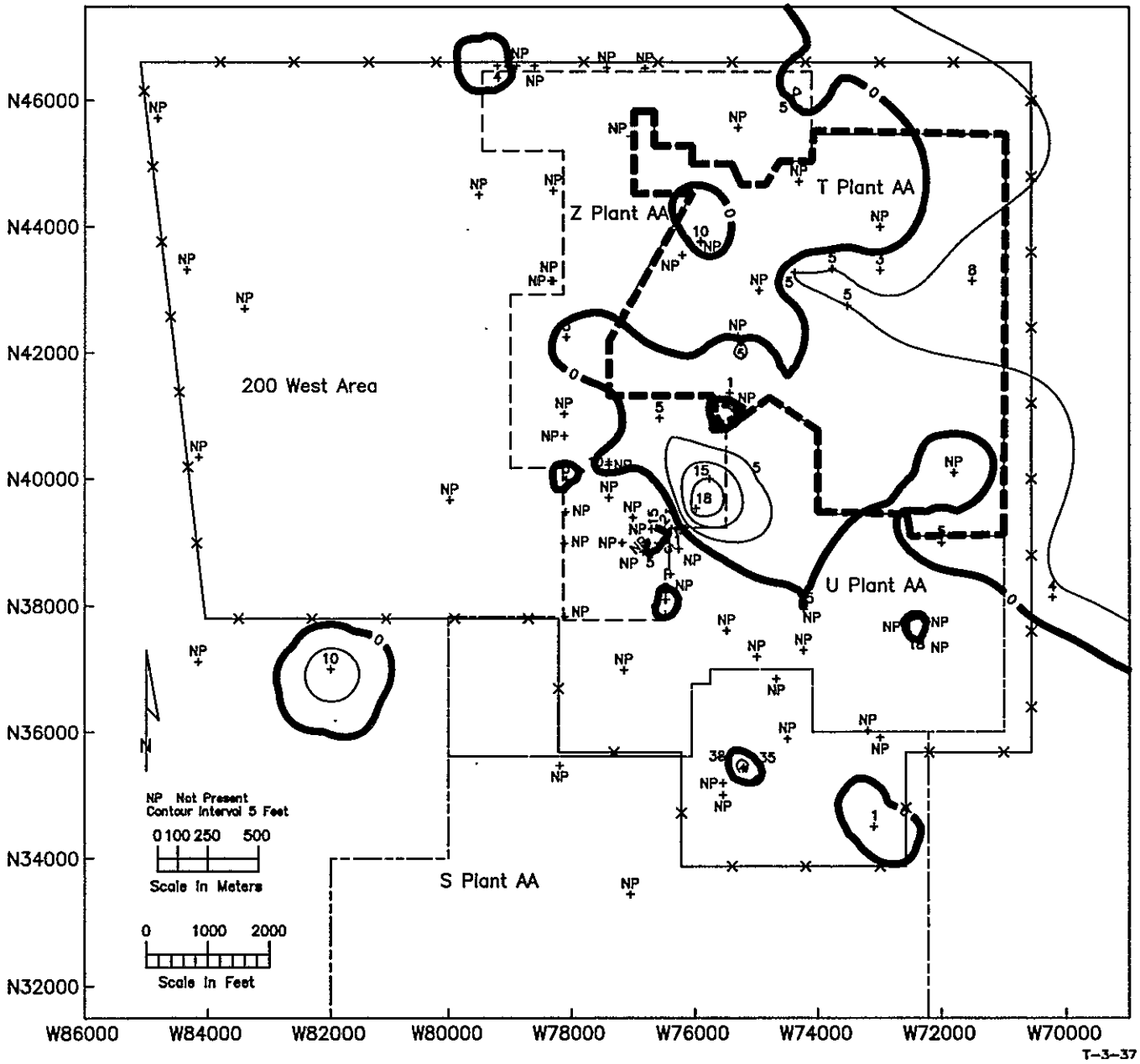


Figure 3-37. Isopach Map of the Backfilled Gravels and Eolian Sands.

Figure 3-38. Conceptual Geologic and Hydrogeological Column for the 200 West Area (Last et al. 1989).

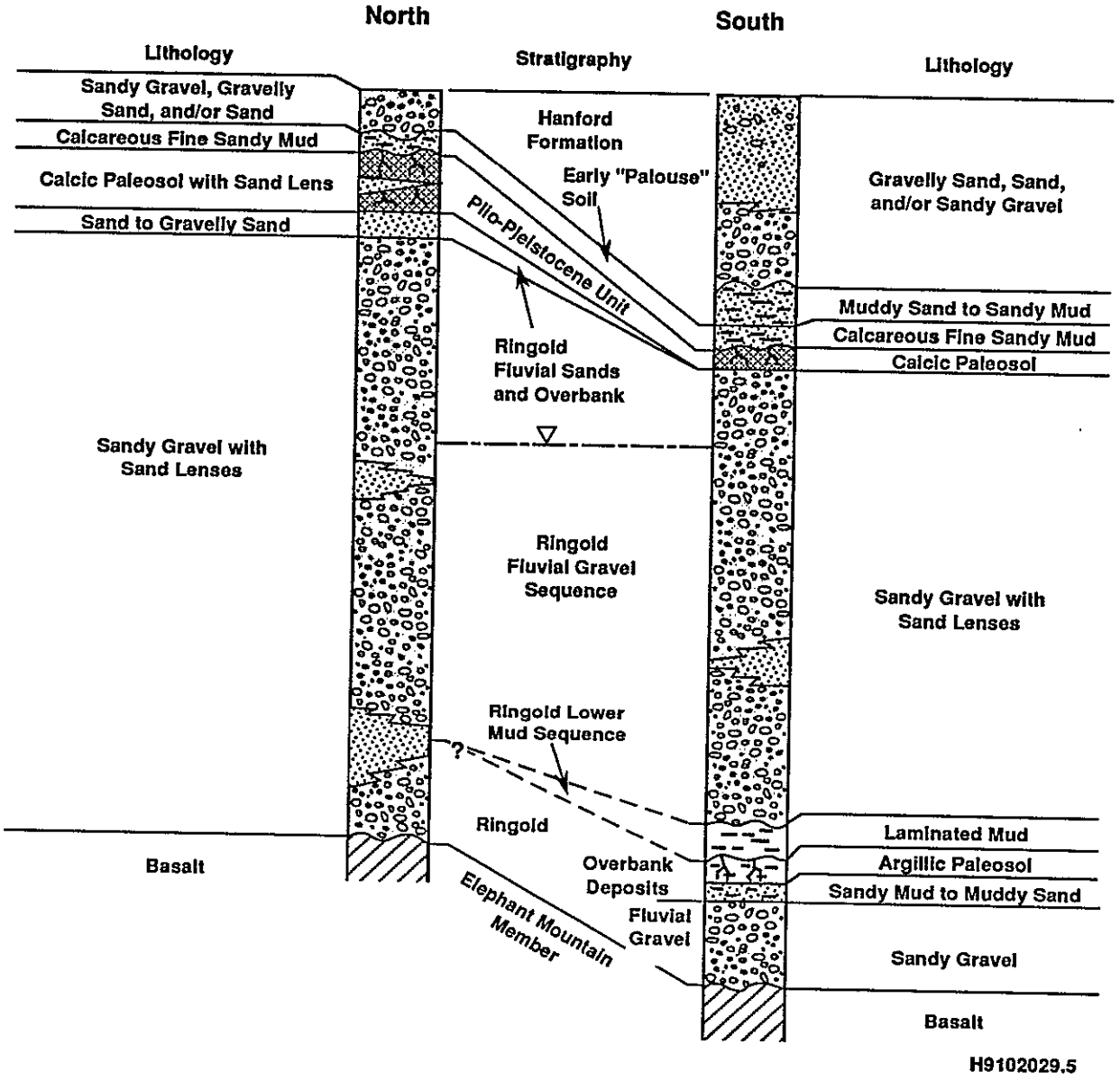
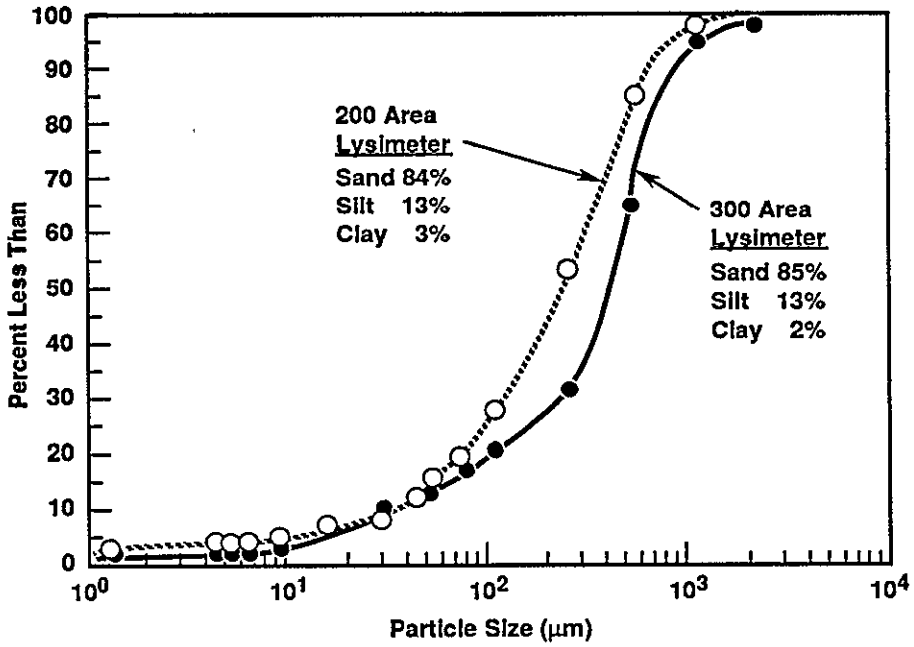
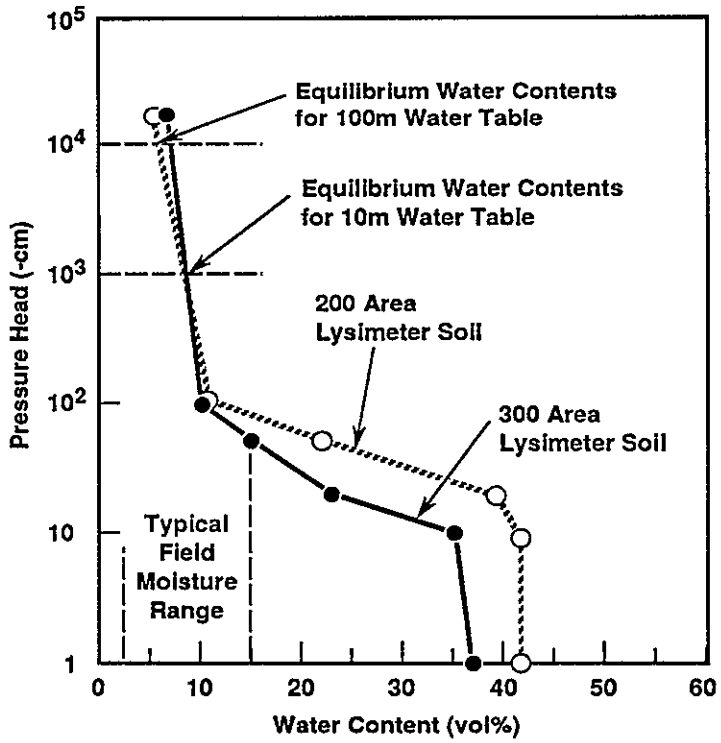


Figure 3-39. Particle Size Distribution and Water Retention Characteristics of Soils from Hanford Site Lysimeters.



a. Particle Size Distribution



b. Water Retention Characteristics

H9210018.3

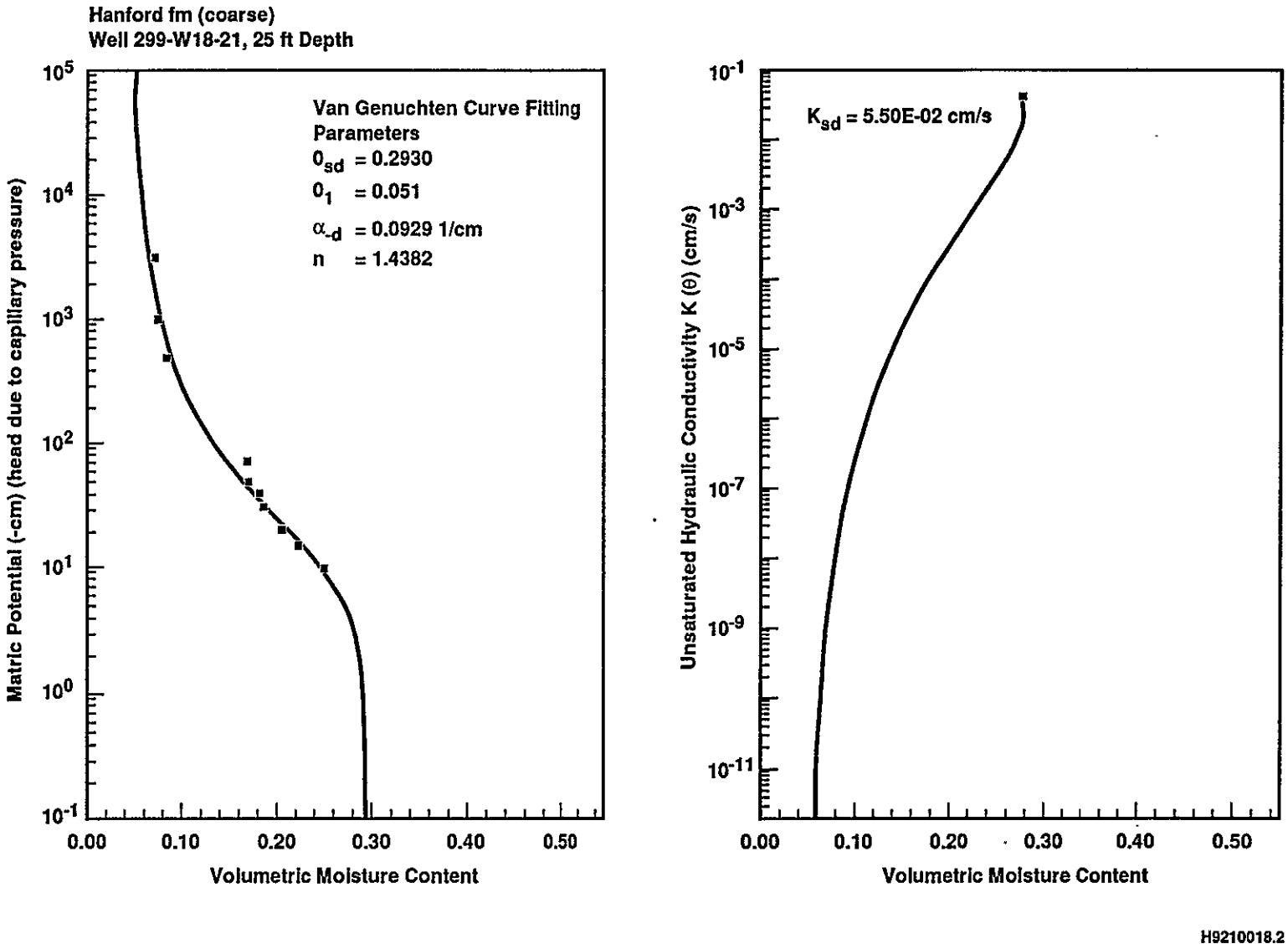


Figure 3-40. Wetting and Drying Curves for Well 299-W18-21.

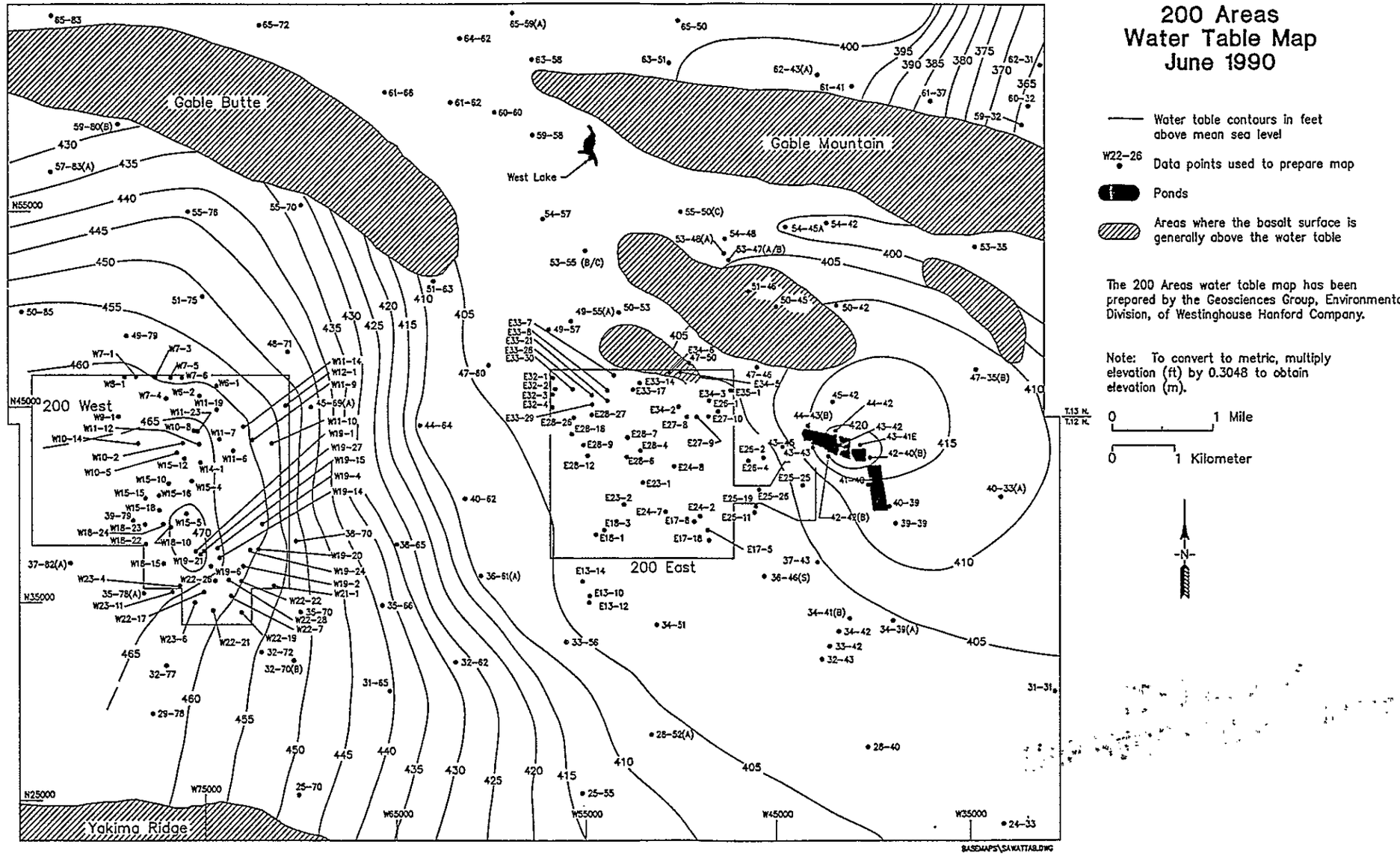


Figure 3-41. 200 Areas Water Table Map, June 1990 (Kasza et al. 1990).

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Figure 3-42. Conceptual Hydrogeologic Column for the T Plant Aggregate Area.

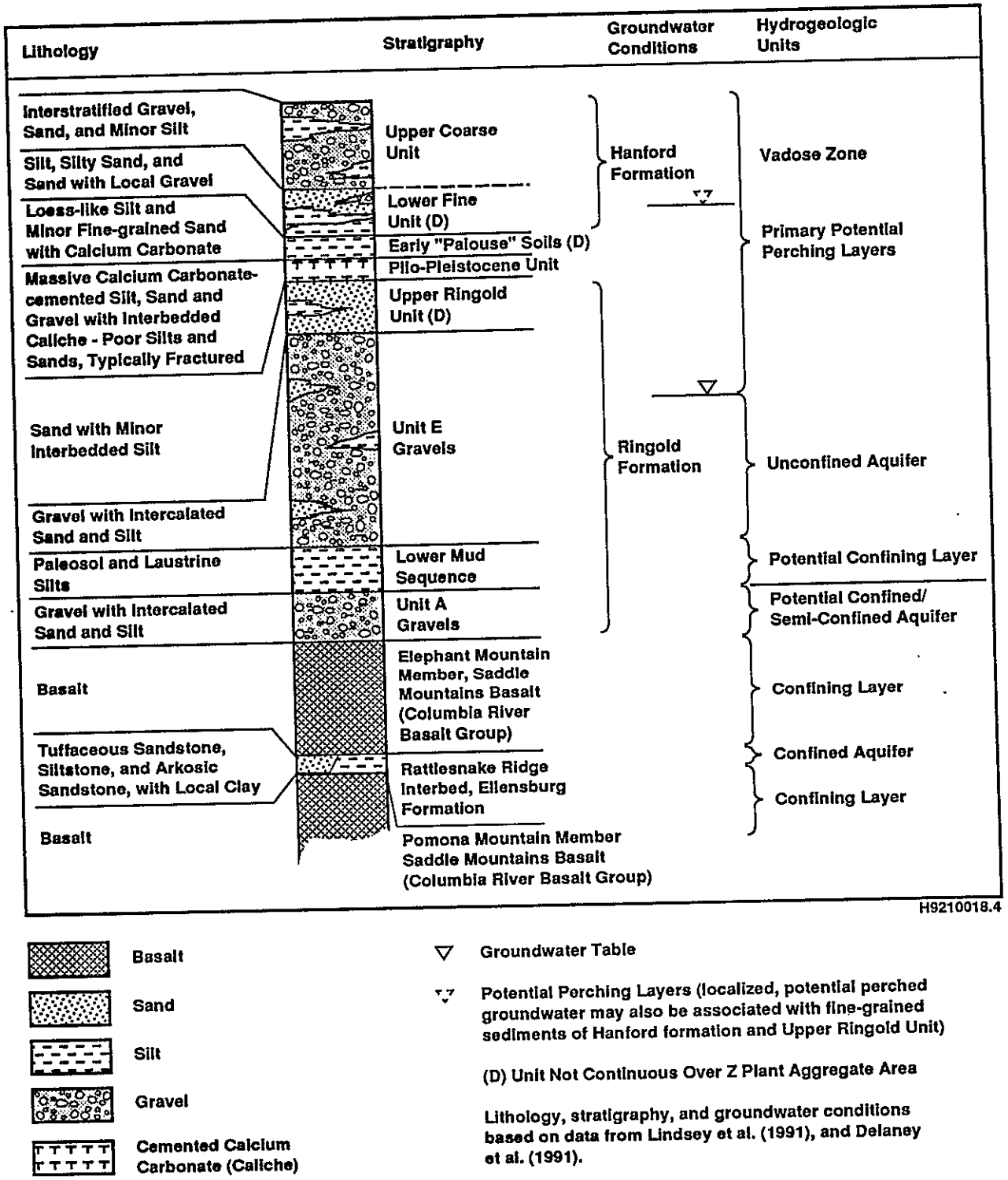

Table 3-1. Hydraulic Parameters for Various Areas and Geologic Units at the Hanford Site.

Location	Interval tested	Hydraulic conductivity (m/day)
Pasco Basin	Hanford formation	150 - 6,200
	Ringold Formation Unit E	6 - 180
	Ringold Formation Unit A	0.03 - 3
100 Area	Ringold Formation Unit E	9 - 395
200 Areas	Hanford formation	610 - 3,050
	Ringold Formation Unit E	2.7 - 70
	Ringold Formation Unit A	0.3 - 3.6
200 West Area	Ringold Formation Unit E	0.02 - 61
	Ringold Formation Unit A	0.5 - 1.2
	Lower Ringold laboratory	9×10^{-6} - 2.4×10^{-5}
Slug Tests at U-12 Crib	Upper Ringold	2.4 - 13
300 Area	Hanford Formation	3,350 - 15,250
300 Area	Ringold Formation	0.58 - 3,050
1100 Area	Ringold Formation Units C/B	0.09 -1.5
1100 Area	Ringold Formation	2.4×10^{-4}
	Overbank Deposits	0.03

Table 3-2. Summary of Reported Hydraulic Conductivity Values for Hanford Site Vadose Zone Sediments. Page 2 of 2

Reported Hydraulic Conductivity Value or Range of Values in cm/s	Water Content Volume Percent	Reported Geologic Unit or Sediment Type	Test Area or Sampling Location	Measurement Method or Basis for Reported Value
1×10^{-3} (Upper Soil, arithmetic mean of 7 measurements) 9.2×10^{-3} (Lower Soil, arithmetic mean of 4 measurements)	Field Saturation Field Saturation	Loam sand over sand na	Grass Site; 3 km of BWTF	Guelph permeameter field measurements
8×10^{-7} 9×10^{-4}	16 40	Loam to sandy loam	McGee Ranch:NW of 200 West Area on State Rt. 240	Unsteady drainage-flux field measurements.
9×10^{-4} (arithmetic mean of 9 measurements	Field Saturation	na		Guelph permeameter field measurements.
5×10^{-3} (sat) 1×10^{-3} (sat) 5×10^{-4} (sat) 1×10^{-4} (sat) 5×10^{-5} (sat)	50 50 40 40 40	Sand, Gravel Coarse Sand Fine Sand Sand, Silt Caliche	Sediment types are idealized to represent stratigraphic layers commonly encountered below 200 Areas liquid disposal sites.	K_{sat} values derived from idealized moisture content curves.
1.2×10^{-5} (sat) 6.7×10^{-6} to 2.8×10^{-1} (sat) 1.10×10^{-3} (sat) 1.80×10^{-4} to 3.00×10^{-4} (sat)	19.6 to 18.9 37.6 to 41.4 18.3 to 21 24 to 25	Hanford formation Early "Palouse" Soils Upper Ringold Middle Ringold	Well 299-W7-9, 218-W-5 Burial Ground	van Genuchten equation fitted to moisture characteristic curves for Well 299-W7-9 soil samples

Notes:

na - Not identified in source.
sat - Value for saturated soil.
field saturation - Equilibrium water content after several days of gravity drainage.

Table 3-2. Summary of Reported Hydraulic Conductivity Values for Hanford Site Vadose Zone Sediments. Page 1 of 2

Reported Hydraulic Conductivity Value or Range of Values in cm/s	Water Content Volume Percent	Reported Geologic Unit or Sediment Type	Test Area or Sampling Location	Measurement Method or Basis for Reported Value
6.7×10^{-7}	10	Sand	200 Area	Lysimeter Soil Experiments
1.7×10^{-8}	7			
1.7×10^{-9}	5.5			
1.7×10^{-10}	5			
1.3×10^{-11}	4.3			
2.6×10^{-3}	31	Sandy soil reported as "typical or many surface materials at the Hanford Site."		Unsaturated column studies.
5.7×10^{-4} (sat)	56			
6.3×10^{-11}	2.9	Near-surface soils	2-km south of 200 East Area	K estimates using water retention curve data.
2.2×10^{-11}	2.8			
5.40×10^{-8}	8.3	Sandy fill excavated from near-surface soil (Hanford formation) with 1.27-cm particle size fraction screened out.	Buried Waste Test Facility (BWTF): 300 North Area Burial Grounds	Laboratory steady-state flux measurements.
9.78×10^{-3} (sat)	42.2			
8.4×10^{-3} (sat, arithmetic mean of four measurements)	na			
8×10^{-8}	11	na	BWTF: Southeast Caisson, and North Caisson	Unsteady drainage-flux field measurements.
4×10^{-3} (Southeast Caisson	26	na		
1×10^{-8}	10	na		
1×10^{-2} (North Caisson)	29	na		
4.5×10^{-3} (arithmetic mean of 15 measurements)	Field Saturation	na	BWTF North Caisson and area north of caisson	Guelph permeameter field measurements

Table 3-3. Endangered, Threatened, and Sensitive Plant Species Reported On or Near the Hanford Site.

Scientific Name	Common Name	Family	Washington State Status
Rorippa columbiae[a/] Suksd. ex Howell	Persistantsepal Yellowcress	Brassicaceae	Endangered
Artemesia campestris L ssp. *borealis* (Pall.) Hall & Clem. var. *wormskioldii*[a/] (Bess.) Cronq.	Northern Wormwood	Asteraceae	Endangered
Astragulus columbianus[a/] Barneby	Columbia Milk Vetch	Fabaceae	Threatened
Lomatium tuberosum[a/] Hoover	Hoover's Desert-Parsley	Apiaceae	Threatened
Astragalus arrectus Gray	Palouse Milk Vetch	Fabaceae	Sensitive
Collinsia sparsiflora Fisch.&Mey. var *bruciae* (Jones) Newsom	Few-Flowered Collinsia	Scrophulariaceae	Sensitive
Cryptantha interrupta (Greene)Pays.	Bristly Cryptantha	Boraginaceae	Sensitive
Cryptantha leucophaea Dougl. Pays	Gray Cryptantha	Boraginaceae	Sensitive
Erigeron piperianus Cronq.	Piper's Daisy	Asteraceae	Sensitive
Carex densa L.H. Bailey	Dense Sedge	Cyperaceae	Sensitive
Cyperus rivularis Kunth	Shining Flatsedge	Cyperaceae	Sensitive
Limosella acaulis Ses.&Moc.	Southern Mudwort	Scrophulariaceae	Sensitive
Lindernia anagallidea (Michx.)Pennell	False-pimpernel	Scrophulariaceae	Sensitive
Nicotiana attenuata Torr.	Coyote Tobacco	Solanaceae	Sensitive
Oenothera pygmaea Dougl.	Dwarf Evening-Primrose	Onagraceae	Sensitive

a/ Indicates candidates on the 1991 Federal Register, Notice of Review.

Table 3-4. Federal and State Classifications of Animals that Could Occur on the 200 Areas Plateau.

Common Name	Status Federal	State
Peregrine Falcon *(Falco peregrinus)*	FE	SE
Sandhill Crane *(Grus canadensis)*	--	SE
Bald Eagle *(Haliaeetus leucocephalus)*	FT	ST
Ferruginous Hawk *(Buteo regalis)*	FC2	ST
Swainson's Hawk *(Buteo swainsoni)*	FC2	SC
Golden Eagle *(Aquila chrysaetos)*	--	SC
Burrowing Owl *(Athene cuniculuria)*	--	SC
Loggerhead Shrike *(Lanius lucovicianus)*	--	SC
Sage Sparrow *(Amphispiza belli)*	--	SC
Great Blue Heron *(Casmerodius albus)*	--	SM
Merlin *(Falco columbarius)*	--	SM
Prairie Falcon *(Falco mexicanus)*	--	SM
Long-billed Curlew *(Numenius americanus)*	--	SM
Striped Whipsnake *(Masticophis taeniatus*	--	SC

FE - Federal Endangered
FT - Federal Threatened
FC2 - Federal Candidate
SE - State Endangered
ST - State Threatened
SC - State Candidate
SM - State Monitor

Above information taken from Washington Department of Wildlife June 1991. Species of Concern in Washington.

4.0 PRELIMINARY CONCEPTUAL MODEL

Section 4.1 presents the chemical and radiological data available for each waste management unit. These chemical data, along with physical descriptions of the waste management units (Section 2.0) and descriptions of the surrounding environment (Section 3.0) are evaluated in Sections 4.2 and 5.0 in order to qualitatively assess the potential impacts of the contamination to human health and to the environment. The quality and sufficiency of the existing data are assessed in Section 8.0. This information is also used to identify potential applicable or relevant and appropriate requirements (ARARs) (Section 6.0). Contaminant information is assessed in Section 7.0 to provide a basis for selecting technologies which can be implemented at the sites.

Contaminants released into the environment at a waste management unit or unplanned release site may migrate from the point of release into other types of media. The potentially affected media in the T Plant Aggregate Area include surface soil, surface water, vadose zone soil and perched groundwater, air, and biota. The media affected at a specific site will depend upon the quantities, chemical and physical properties of the material released, and the subsequent site history. The potentially affected media at each waste management unit or unplanned release site are listed in Table 4-1 for radionuclide contamination and Table 4-2 for chemical contamination.

4.1 KNOWN AND SUSPECTED CONTAMINATION

There are two major categories of chemical and radiological data available for the T Plant Aggregate Area: site-specific data applicable to individual waste management units and unplanned releases; and area-wide environmental data that are useful in characterizing regional contamination trends.

Some waste management units and unplanned releases have been the subject of chemical and radiological studies in the past. However, most of these studies were limited in scope and did not provide a comprehensive analysis of the character and distribution of the contamination at each site. The types of unit-specific data that are available for some sites include inventory information, surface radiological surveys, external radiation dose rate monitoring, soil and sediment sampling, biota sampling, borehole geophysics, and groundwater sampling.

Table 4-3 summarizes the types of site-specific data available for each of the waste management units. It should be emphasized that the table only summarizes what types of data are available; it does not indicate the sufficiency of the data, either in terms of quality or quantity. These concerns are addressed in Section 8.0. The unit-specific information is presented for each waste management unit in Section 4.1.2.

Although groundwater issues are considered outside the scope of this study, some groundwater data have been included. Groundwater contaminant plumes known to have originated from specific waste management units are described because they offer insight into the distribution of contaminants within the overlying vadose zone. A limited amount of groundwater data are presented separately for some of the sites in Section 4.1.2.

In addition to these site-specific data, there are area-wide data not directly applicable to any waste management unit within the T Plant Aggregate Area. The most important sources of this general environmental data are quarterly and annual environmental surveillance reports published by Westinghouse Hanford. There are also area-wide geophysical data available that include gravity, magnetic, magnetotelluric, seismic refraction and seismic reflection surveys (DOE 1988b). However, these studies are not useful for characterizing the extent of chemical and radionuclide contamination and so are not presented in Section 4.0. These data are discussed in more detail in Section 8.1.2.

The most recent environmental monitoring of the Hanford Site was conducted by the Pacific Northwest Laboratory (PNL) (Eberhardt et al. 1989) and Westinghouse Hanford. However, most of the data applicable to the T Plant Aggregate Area have been published by Westinghouse Hanford. The latest Quarterly Environmental Radiological Survey Summary Reports (Huckfeldt 1991a, 1991b, 1991c) were reviewed during the current study, as well as the last six annually published environmental surveillance reports (Elder et al. 1986, 1987, 1988, 1989; and Schmidt et al. 1990, 1992). The quarterly reports only contain surface radiological survey results. The annual reports describe several different sampling and survey programs including surface soil sampling, external radiation measurements, biota sampling, air sampling, surface water sampling, groundwater sampling, and radiological surveys.

Air, soil, surface water, and biota samples were collected each year at the same locations within the 200 West Area. External radiation measurements were also taken annually at several locations. Until 1990, few of the sample locations were directly associated with any of the identified waste management units and so most of this information is only useful in characterizing area-wide trends. In 1990, however, new sampling locations were established near areas of known surface contamination. Currently, only external radiation data are available for these new sample locations. Both the new and old sampling locations are shown on Plate 3.

Section 4.1 describes available data regarding known and suspected contamination in the T Plant Aggregate Area on a media-specific basis (air, surface soil and biota, and vadose zone soil). The text summarizes sources of chemical and radiological sampling information. Section 4.1.1 presents data on a media-specific basis. Section 4.1.1.1 presents results of air quality sampling data. Surface soil data are described in Section 4.1.1.2. Results of surface water sampling are presented in Section 4.1.1.3. Results of vegetation and other biota sample analyses are presented in Section 4.1.1.4. Available vadose zone sampling data are

presented in Section 4.1.1.5. Section 4.1.1.5 also discusses evidence for contamination migration within the vadose zone to the unconfined aquifer underlying the site. Additional assessment of the nature and extent of groundwater contamination is presented in the 200 West Groundwater Aggregate Area Management Study Report (AAMSR).

To supplement available radiological and chemical analytical data, historical waste inventory information for the T Plant Aggregate Area waste management units were also included in the evaluation of known and suspected contaminants. Historical waste inventory data are detailed in Section 2.0 of this report (Tables 2-2 and 2-3). As discussed in Section 2.0, the compilation is based on supporting data from the Waste Inventory Data System (WIDS) (WHC 1991a) and the Hanford Inactive Site Survey (HISS) Database (DOE 1986a).

4.1.1 Affected Media

4.1.1.1 Air. This section discusses results of ambient air monitoring applicable to the T Plant Aggregate Area as reported in Rockwell Hanford and Westinghouse Hanford annual environmental surveillance monitoring reports (Elder et al. 1986, 1987, 1988, 1989; Schmidt et al. 1990, 1992). The last five years of data for the T Plant Aggregate Area are summarized in Table 4-4. The complete data set since 1985 is summarized in Appendix A.1.

Ambient air monitoring stations located within the T Plant Aggregate Area or near its boundary include sites N161, N987, N986, and N153, and N177 (Plate 3). As discussed in each of the Rockwell Hanford and Westinghouse Hanford annual environmental monitoring reports for 1985 through 1990, the sampling locations are part of a larger network within the 200 Areas to assess the effect of operations on the local environment, and to assess 200 Areas facilities performance. According to the annual reports, sample station locations throughout the 200 Areas were sited based on prevailing wind directions and potential sources of airborne contaminants. Within the T Plant Aggregate Area, Stations N986, N987, and N153 are located in and around the 241-TY-Tank Farm (Plate 3). Station N161 is east of the 221-T Building, and N177 is south of the Laundry Facility (2724-W Building).

The air samples are collected by drawing ambient air through a 47-mm, open-face, 3 μm filter at about 1 m (3 ft) above the ground with a 0.2 m^3/min (2 ft^3/min [cfm]) flow rate. Throughout the 200 Areas air samplers are operated on a continuous basis. Sample filters are exchanged weekly, held one week to allow for decay of short-lived natural radioactivity, and sent for initial laboratory analyses of gross alpha and beta activity. The initial analyses serve as an indicator of potential environmental problems. After the initial analysis, the filters are stored until the end of the calendar quarter, at which time they are composited by sample location (or as deemed appropriate according to the annual reports) and sent for laboratory analyses of specific radionuclides. Compositing of the filters by

sample location provides a larger sample size and, thus, a more accurate measurement of the concentration of airborne radionuclides resulting from operations in the 200 Areas.

The filters are analyzed quarterly for ^{137}Cs, ^{90}Sr, ^{239}Pu, and total uranium. A more detailed description of the air sampling equipment and analyses methods are provided in the annual reports. The results from this air sampling program have shown a steady decline in the concentration of these radionuclides since 1979 throughout the 200 West Area because of improvements in operational environmental controls and curtailed operations (Schmidt et al. 1990). The air monitoring results reported in Table 4-4 are averages for each year with a detection since 1985.

None of the airborne monitoring samples collected in the T Plant Aggregate Area revealed any unusual or exceptional airborne contamination for the period reviewed (Elder et al. 1986, 1987, 1988, 1989; Schmidt et al. 1990, 1992).

4.1.1.2 Surface Soil. There are several sources of data available for characterizing surface soil contamination. These include aerial and ground radiological surveys, external radiation measurements, and surface soil sampling. These data will be presented in the following sections. In addition, there is a limited amount of site-specific radiological and soil sampling data that will be presented in the appropriate subsections of Section 4.1.2.

4.1.1.2.1 Radiological Surveys. Radiological survey results may be influenced by buried or airborne radionuclide contamination but are generally indicative of surface and shallow soil contamination. Depending upon the instrumentation and survey techniques used, results may be reported in ct/min, dis/min, mr/hr, or mrem/yr. Typical natural background levels for these measurements are approximately 50 ct/min, 2,000 dis/min, (for sodium-iodide detector), 0.047 mR/h, and 84 mrem/yr (Woodruff et al. 1991). An aerial gamma-ray radiation survey was performed over the 200 West Area in July and August 1988 (Reiman and Dahlstrom 1988). The survey lines were flown with a 122 m (400 ft) spacing at an altitude of 61 m (200 ft). The data were normalized to a height of 1 m (3.3 ft) above the ground surface. Figure 4-1 presents the gross count data (counts per second) on an isoradiation contour map that covers the entire 200 West Area. In this figure background activity has been subtracted from the data. Background was determined onsite by suppressing specie-specific, naturally occurring activity and confirming with additional background measurements south and east of the Hanford Site.

The entire area has gross gamma counts that are above background. However, several high gamma count anomalies can be identified within the aggregate area. The highest gross count results in the T Plant Aggregate Area were between 220,000 and 700,000 ct/sec measured over the 241-TX and 241-TY Tank Farms. The second highest results were between 22,000 and 70,000 ct/sec measured over the 216-T-4 Pond and over the 241-T Tank Farm. The T Plant buildings, centered on the 221-T Building also exhibited significant levels in the range of 7,000 to 22,000 ct/sec.

It is impossible to accurately convert these gross gamma counts to a meaningful exposure rate because of the complex distribution of radionuclides on the site. Many of the spectra do not have readily identifiable photo peaks but rather occur on a smear or continuum. A photo peak is a specific energy or wavelength that can be associated with the emissions from a specific radionuclide. Also, aerial systems integrate radiation levels over an area whose diameter may be ten times the height of the platform above the ground (Reiman and Dahlstrom 1988). Because of the large-area integration of the airborne system, localized anomalies will appear to be spread over a larger area with lower activities than actually exist on the ground. Spectra logs were generated for each monitored area with levels greater than 7,000 ct/sec. The only radionuclide peaks identified in the T Plant Aggregate Area were ^{137}Cs and ^{60}Co. Both of these relatively high energy gamma emitting fission products were detected at the 216-T-4 Pond. The ^{137}Cs was identified aerially at the T Plant buildings, centered on the 221-T Building, the 241-T Tank Farm, and the 241-TX and 241-TY Tank Farms.

The aerial radiation survey data should only be used as a qualitative tool for identifying more highly contaminated areas within the survey boundaries. In addition, the gamma counts noted in the survey probably result from both surface and shallow buried radionuclide emissions and pipe/tank radionuclide inventories and are, thus, not entirely indicative of surface contamination.

Elevated radiation zones identified by the aerial survey generally correspond to areas where surface contamination has been noted by surface radiation surveys. Figure 4-2 shows areas of known surface contamination, underground contamination, and migration identified from surface surveys (Huckfeldt 1991a, 1991b, 1991c). The primary areas of surface contamination noted in the T Plant Aggregate Area include the following:

- The 241-T, -TX, and -TY Tank Farms
- The railroad tracks leading to 221-T Building
- The 216-T-4-2 Ditch and 216-T-4B Pond area
- An area east of 241-TX and 241-TY Tank Farms across Camden Avenue due to past unplanned releases
- The 216-T-14 to -17 Trenches
- The 216-T-21 to -25 Trenches
- Areas surrounding the 271-T Building.

Most of these areas fall within the anomalously high zones noted in the radiation survey. Areas of active surface contaminant migration include the following:

- The area north and east of the 241-T Tank Farm. The 241-T and 241-TY Tank Farms received an extensive decontamination in late 1991 to help control this spread.

Table 4-5 summarizes the radiological survey results for each waste management unit and unplanned release. The areas of surface contamination and contaminant migration are discussed in more detail in the section dealing with the individual waste management units and unplanned releases (Section 4.1.2). Surface radiological surveys are done quarterly, semiannually, or annually at the waste management units. The surface contamination posting may change often because of resurveying and because of cleanups affected under the Radiation Area Remedial Action (RARA) Program. This program is concerned with the management and control of surface contamination. These surveys yield data on gross contaminant levels (ct/min and dis/min) which are useful in identifying the presence of contamination at a waste management unit and in making available comparisons between waste management units.

4.1.1.2.2 External Radiation Dose Rate Measurements. Dose rates from penetrating radiation were measured annually at 17 locations in or adjacent to the T Plant Aggregate Area between 1985 and 1990. The sample locations are shown on Plate 3 and the survey results are listed on Table 4-6. The measurements were taken with thermoluminescent dosimeters (TLDs) and are reported in mrem/yr. The TLDs measure dose rates resulting from all types of external radiation sources including cosmic radiation, naturally occurring radioactivity, fallout from nuclear weapons testing and contributions from other Hanford Site activities. The average measured totals that exceeded 100 mrem/yr were in the areas east of 241-TX Tank Farm and north of the 216-T-4 Pond. The highest quarterly reading was located east of the 241-TX Tank Farm in 1988 and resulted in an estimated annual exposure level of 196 mrem/yr (Schmidt et al. 1992). The apparent trend from this data indicates that from 1985 to 1988 the general dose rates for the T Plant Aggregate Area increased. In 1989 there were only two measurement locations. These locations showed a reduction from previous years.

In 1990 new sampling locations were established giving the T Plant Aggregate Area four dosimeter locations. The new locations were generally located on or near areas of known contamination and the results appear similar to previous sampling rounds. Additional data will need to be collected at these new sampling locations before conclusions regarding the trends of external radiation dosages can be made. External radiation dose rate measurements for all facility and surface-water locations in the 200 West Areas showed an approximate 10 percent decrease in 1990 (Schmidt et al. 1992). This overall decrease is believed to be a result of improved operations and contaminant stabilization efforts. Measurements were generally a little above 100 mrem/yr. The highest measured total in the

T Plant Aggregate Area was again east of the 241-TX Tank Farm (147 mrem/yr). These results may be due in part to shine from waste contained within tanks.

4.1.1.2.3 Surface Soil Sampling. Between 1978 and 1989, surface soil samples were collected annually from a regular rectangular grid that covers the 200 West Area with 35 sampling points. Fourteen of these sampling sites are located within or adjacent to the T Plant Aggregate Area. The sample points have never been exactly surveyed, but are generally located close to the intersections of Hanford Site coordinate lines at 305 m (1,000 ft) spacings. In addition, between 1984 and 1989, soils have also been sampled along fences enclosing the three tank farms in the 200 West Area. There are three soil samples associated with the 241-T, -TX, and -TY Tank Farms. None of the soil sampling locations were at waste management units or unplanned release sites, so these data cannot be applied directly to any site.

The results of the two soil sampling programs since 1985 are summarized in Tables 4-7 and 4-8. Tables that present all of the data collected since 1985 are contained in Appendix A.2. The most commonly detected radionuclides were ^{90}Sr, ^{137}Cs, ^{214}Pb, ^{238}Pu, ^{239}Pu, ^{152}Eu, and total uranium. However, only ^{137}Cs, ^{90}Sr, and ^{239}Pu were found consistently at concentrations above counting errors (Schmidt et al. 1990).

The highest radionuclide concentrations were generally noted in the vicinity of the 241-T and -TX Tank Farms. Using ^{137}Cs as an indicator of radionuclide concentrations, the highest most recent levels recorded (1989) were at 2W8, adjacent to the 241-T Tank Farm, and 2W13, east of 241-TX Tank Farm. However, the trend at these locations has been generally downward since 1978 indicating that the elevated ^{137}Cs levels are not because of current operations at the tank farm (Schmidt et al. 1990). The highest most recently recorded (1989) ^{90}Sr and ^{239}Pu concentrations were found at site 2W9, east of the 221-T Building.

In 1990, new soil sampling locations were established that are located close to areas of known surface contamination. The locations of these new sites are shown on Plate 3. There are 17 new sample locations within or adjacent to the T Plant Aggregate Area. Two sample locations, one from the west of 241-TX Tank Farm, and one from the east of 241-TY Tank Farm, (sample point 13 and 14, respectively), were not sampled because work was occurring in these areas. These two areas will be sampled in 1991 (Schmidt et al. 1992).

4.1.1.2.4 Historical Waste Inventory Data. Soil contamination was caused by two primary routes, planned releases (e.g., ditches, trenches) and unplanned releases. The unplanned releases, while not as large in total activity sent to the soil, still resulted in significant quantities of contaminated soil. In the T Plant Aggregate Area, approximately 50% of the unplanned releases were caused by piping failures or diversion box leaks. Each of these releases resulted in some level of soil contamination. Some of these unplanned releases, including UN-200-W-14, -29, and -97 were initially remediated by removing the

top layer of contaminated soil and covering the remaining contamination. At other unplanned releases, including UPR-200-W-28, the area of contaminated soil was covered with clean soil and temporarily posted as a radiation zone with the signs subsequently disappearing without available explanation (WHC 1991a). Adjacent to the east side of the 221-T Building, large areas of the ground have been covered with a spray encapsulant to control soil contamination spread.

4.1.1.3 Surface Water. No natural surface water bodies exist within the T Plant Aggregate Area. However, the active man-made 216-T-1 and 216-T-4-2 Ditches are still receiving waste water from the T Plant complex. Specific information on these ditches is provided in Section 4.1.2. A summary of water quality data for the 216-T-4-2 Ditch is provided in Table 4-9. In 1990 the highest monthly result of 111 pCi/L alpha was observed at 216-T-4-2 Ditch (Schmidt et al. 1992).

The only other active surface water discharge location in the T Plant Aggregate Area, is the powerhouse pond. Field surveys of the powerhouse pond show it to be located south of the T Plant Aggregate Area in the U Plant Aggregate Area overlying the 216-U-14 Ditch.

4.1.1.4 Biota. Westinghouse Hanford and PNL have conducted various biota sampling activities beginning in 1971 through 1988 inside as well as outside the Hanford Site. No upward trends in radionuclide concentrations were detected for any of the wildlife species examined (Eberhart et al. 1989). A significant downward trend was exhibited in many analytes, particularly ^{137}Cs.

Three factors are believed to have contributed to the decline in concentration of these radionuclides: the cessation of atmospheric testing, the 1971 shutdown of the last Hanford reactor that discharged once-through cooling water to the river, and the reduction of environmental radionuclide contamination associated with some Hanford Site facilities and operations.

Biota samples have been collected since 1978 from 14 locations within or adjacent to the T Plant Aggregate Area. Vegetation samples were collected from the same locations as the grid soil samples described in Section 4.1.1.2 (Plate 3). Average analytical results from 1985 through 1990 are compiled on Table 4-10. The complete data set from this sampling is presented in Appendix A.2.

Vegetation samples have generally had radionuclide concentrations that are slightly elevated above regional background (Schmidt et al. 1990). The most commonly detected radionuclides include ^{137}Cs, ^{90}Sr, ^{60}Co, ^{238}Pu, and ^{239}Pu. Grid site 2W8, adjacent to the 241-T Tank Farm, has usually had the highest ^{137}Cs concentrations in the area. In 1989, grid site 2W9, east of the 221-T Building had the highest ^{239}Pu and ^{90}Sr concentrations recorded at any of the T Plant Aggregate Area sampling locations. These sampling results are consistent with grid sites with elevated soil contamination. During 1986 increased contamination,

primarily due to increased contaminated tumbleweed growth was found near the 216-T-3 Reverse Well and the 216-T-34 and -35 Cribs with a maximum reading of 5 mrad/h (Elder et al. 1987). In 1988, increased ^{137}Cs concentrations were noted from vegetation samples from the 216-T-4-2 Ditch (Elder et al. 1989). There have been no statistically significant trends in vegetation radionuclide concentration since 1979 (Schmidt et al. 1990).

In 1990, results from vegetation samples demonstrated that radionuclide concentrations are above regional background levels. These concentrations are attributed to root uptake from the contaminated soils and deposition from airborne contaminants. The RARA Program, initiated in 1979, has significantly reduced the amount of contaminated vegetation and spread of wind-blown contamination. However, the control of deep-rooted vegetation on waste management units is becoming more of a problem. The restructuring of the herbicide program spray schedule and use of pre-emergent herbicides will help to correct the problem.

Nearly each year special biotic samples have also been analyzed in the T Plant Aggregate Area and found to be radioactively contaminated. Known radioactive samples from the last six years are coyote feces near the 222-T Building (Elder et al. 1987), domestic pigeons from T Plant (Schmidt et al. 1990), and contaminated rabbit fecal material found near T Plant (Schmidt et al. 1990).

4.1.1.5 Vadose Zone. The extent of contamination in the vadose zone has been most extensively studied by geophysical well logging. Geophysical well logging has been conducted in the T Plant Aggregate Area since the late 1950's. Gross gamma-ray logs have been used since that time to evaluate radionuclide migration in the vadose zone beneath selected waste management units. However, very little gross gamma data have been published. Table 4-11 lists all of the logs that were reviewed as part of this study. The log interpretation generally consisted of identifying zones with anomalously high gamma-ray counts that could be indicative of radionuclide contamination. The depths, thicknesses, and intensities of these zones were then compared for logs from the same holes. Any significant changes may be indicative of contaminant migration in the vadose zone. Interpretations were complicated by the fact that logging equipment and procedures have evolved over time. Consequently, a standardized, comparative baseline for interpreting gamma log results is not available. Attempts made to normalize data collected at different times met with limited success, and quantitative interpretations were not possible. The log interpretations are discussed in detail in Appendix A.1. The results of the log interpretations are also summarized with the appropriate waste management units in Section 4.1.2.

The only known vadose zone soil samples analyzed for contaminants have been as a result of a major leak from the 241-T-106 Single-Shell Tank (Rouston et al. 1979; WHC 1991a). Vadose zone soil samples taken as a result of this leak, also identified as UPR-200-W-148, were used to determine the extent of contaminant migration. The only contaminants evaluated were ^{106}Ru, ^{144}Ce, and ^{137}Cs. These three radionuclides were chosen for evaluation because they span much of the radionuclide mobility range exhibited in the

241-T-106 Single-Shell Tank leak detection system. Cesium-137 is the least mobile and ^{106}Ru is the most mobile. It is estimated that 435,000 L (115,000 gal) leaked to the soil in an area extending 7 m (23 ft) horizontally from the tank and 33 m (108 ft) below the ground surface.

There are no known vadose zone chemical samples available from the T Plant Aggregate Area for waste management units and unplanned releases addressed in this AAMSR.

Waste management units that have received large volumes of liquid are more likely to have caused subsurface contaminant migration. The potential for liquid wastes to have migrated through the vadose zone to the groundwater was estimated by comparing the volume of waste discharged at each waste management unit to the estimated pore volume in the vadose zone soil column below the waste management unit. If the volume of liquid discharged to the ground is larger than the total soil column pore volume, then it is likely that wastewater may have reached the groundwater. These calculations are summarized on Table 4-12. They are based upon several conservative assumptions: (1) the discharged water does not spread out laterally from the point of discharge (i.e., the volume of affected vadose zone is equal to the depth to groundwater multiplied by the plan view cross-sectional area of the base of the waste management unit), (2) there is no significant change in liquid volume being introduced to the soil column due to evapotranspiration (3) the average porosity of the soil column is between 0.10 and 0.30 (the upper and lower porosity estimates shown on Table 4-12). If the amount of waste received was greater than the porosity (0.1) then the waste discharged was considered to have the potential to migrate to the groundwater. In most cases, the units are inactive and, therefore, do not presently have a driving force for contaminant migration. According to these calculations, twenty-three waste management units listed in Table 4-12 have the potential for the migration of liquid discharges to the unconfined aquifer.

4.1.2 Site-Specific Data

This section presents the site-specific data that are available for each waste management unit and unplanned release. The units are discussed in the same groups as were presented in Section 2.0. These groupings are useful because like units tend to have the similar types of available data.

4.1.2.1 Plants, Buildings, and Storage Areas. No site-specific data were compiled for any of the T Plant Aggregate Area plants, buildings, and structures.

4.1.2.2 Tanks and Vaults. Single-shell tanks will be remediated under the Single-Shell Tank Closure Program as discussed in Section 9.0. The available data for the tanks will be provided in this section since the data may be useful for characterization of other waste

management units. The data available for the single-shell waste storage tanks single-shell tank generally include: inventory information, limited waste sampling, surface radiological surveys, vadose zone well geophysics, and internal tank monitoring of chemical and physical parameters. In the past, there has been much less emphasis in characterizing the catch tanks, settling tanks and vaults, and little information is available regarding these units. The following section is subdivided between single-shell tanks and other tanks to reflect this difference. The T Plant Aggregate Area contains one vault.

4.1.2.2.1 Single-Shell Tanks. All of the single-shell tanks in the T Plant Aggregate Area are located within the boundaries of the 241-T, -TX, and -TY Tank Farms. In these areas, large quantities of liquid wastes were intentionally discharged from single-shell tanks in the T Plant Aggregate Area directly to the ground (Waite 1991). In addition to the tank wastes discharged to the ground, tank wastes have also been released to the ground as a result of leaks from single-shell tanks and transfer lines. Nineteen single-shell tanks in the T Plant Aggregate Area are assumed to have leaked (Hanlon 1992); the estimate of the volume of waste leaked is 690,000 L (180,000 gal) (WHC 1991a). Most of the long-lived radionuclides still remain in the tanks even though the total volume of liquid discharged exceeds that which is now in the tanks (Waite 1991).

Inventory Studies. Chemical inventories for the single-shell tanks have been modeled with the Tracks Radioactive Components (TRAC) computer code developed by Westinghouse Hanford. This program calculated tank inventories for 68 radioactive constituents and 30 chemical constituents. The estimates were based on the historical records of the quantities of material initially placed in the tanks from nuclear fuel production and later modified by tank transfers and radioactive decay. The TRAC inventories, though recognized as having serious limitations, represent the best current information on the contents of the tanks. The TRAC predictions for ^{14}C, ^{137}Cs, ^{137}Ba, and uranium isotopes show the least agreement with other data sources. The results of this modeling are provided in Table 4-13.

Tank Waste Sampling. Chemical sampling has been performed on some of the tanks. The usefulness of these samples is very limited because: (1) very few radionuclides or organic chemicals were analyzed, (2) much of the sampling was done in the 1970's and material has been moved into and out of the tanks since that time, and (3) no attempt was made to collect samples that were representative of the tank as a whole. Much of the sampling was done in order to characterize the chemical composition of liquid that was to be sent through an evaporator.

The results of the 241-TY Tank Farm sampling effort are documented in *TY Tank Farm Waste Characterization Data*, (Weiss 1986). The information in Table 4-4 was compiled from analytical data sheets from the MO-037 Library. The table includes any radionuclide data that are available for each sample, as well as pH and total organic carbon (TOC) data. Solutions with low pHs and high TOC (organic solvents) would tend to enhance radionuclide migration through the soil column.

Chemical Explosion Potential. There are three possible mechanisms recognized as having chemical explosion potential for Hanford single-shell tanks. The three are ferrocyanide in excess of 1,000 gram moles, hydrogen gas generation, and TOC greater than 3 wt%. Ferrocyanide was added to some tanks to act as a cesium scavenger. Hydrogen can be produced as a product of radiation bombardment of water or organic materials as well as other routes. Some tanks have high levels of organic chemicals which are potentially flammable and mixtures of organic materials mixed with nitrate and nitrate salts can deflagrate. A watch list has been generated by the Department of Energy (DOE) that ranks tanks according to their potential for explosion. The factors in this ranking include: surface level fluctuation, temperature, total curies of waste, organic content, volume of solids, waste type, pressurization, crust formation and past flammable gas detections. Six of the 241-T, 241-TX, and 241-TY Tank Farm tanks are suspected of having a ferrocyanide problem (241-T-101, 241-T-107, 241-TX-118, 241-TY-101, 241-TY-103, and 241-TY-104), one has the potential to generate significant quantities of hydrogen gas (241-T-110), and two are suspect due to high organic content (241-TX-105 and 241-TX-118) (Hanlon 1992).

Vadose Zone Well Geophysical Logging. Most of the single-shell tanks are surrounded by an array of vadose zone wells. Gamma logging is performed on these wells on a regular basis in order to identify new tank leaks and to monitor the migration of existing contaminant releases to the soil. Table 4-15 summarizes the borehole geophysical data available for each tank. All of the assumed leaking tanks in the 241-T, 241-TX, and 241-TY Tank Farms exhibit elevated gamma radiation levels in their associated monitor wells.

Single-Shell Tanks Unplanned Releases. There are eight unplanned releases associated with the single-shell tanks of the 241-T, -TX, -TY Tank Farms. Five of these unplanned releases resulted from tank leaks (UPR-200-W-148, -149, -151, -152, and -153). One unplanned release is associated with a tank pump pit (UPR-200-W-129); another is related to a possible failed grout seal (UPR-200-W-147); and the third has to do with a catch tank overflow (UPR-200-W-150). Table 2-6 summarizes the available information on the releases.

The vertical and lateral distribution of each of the tank leaks and the stability of the leak distribution can be estimated from the borehole geophysics data of Table 4-15. Tank leaks impact not only the borehole activity around a particular tank but can also affect activity in boreholes of surrounding tanks as well. All of the radiation levels measured in boreholes related to the five tank leaks have remained stable.

All eight single-shell tank unplanned releases are addressed by the Single-Shell Tank Closure Program (see Table 9-3) due to their direct association with single-shell tanks.

4.1.2.2.2 Settling Tank. The T Plant Aggregate Area contains one settling tank.

241-T-361 Settling Tank. The 241-T-361 Settling tanks received radioactively contaminated liquid from the 221-T Building and is now estimated to contain 105,840 L (28,000 gal) of sludge (2 kg [4 lb] plutonium, 15,500 Ci beta/gamma).

4.1.2.2.3 Receiver Tank. The T Plant Aggregate Area contains one receiver tank.

244-TX Receiver Tank. This active double-contained receiver tank receives waste from the 241-T Tank Farm, 241-TX Tank Farm, 241-TY Tank Farm, and the Plutonium Finishing Plant. In September 1991 this tank contained 98,480 L (26,019 gal) of waste (Hanlon 1992). No information was found to indicate that this tank has released any waste to the soil.

4.1.2.2.4 Vaults. The T Plant Aggregate Area contains one vault.

244-TXR Vault. No specific chemical or radiological sampling data were identified for the 244-TXR Vault.

4.1.2.2.5 Catch Tanks. The T Plant Aggregate Area contains seven catch tanks.

241-T-301 Catch Tank. No specific chemical or radiological sampling data were identified for the 241-T-301 Catch Tank.

241-T-302 Catch Tank. No specific chemical or radiological data were identified for the 241-T-302 Catch Tank.

241-TX-302A Catch Tank. No specific chemical or radiological data were identified for the 241-TX-302A Catch Tank.

241-TX-302B Catch Tank. No specific chemical or radiological data were identified for the 241-TX-302B Catch Tank. Unplanned Release UPR-200-W-131 occurred on March 13, 1953. Contamination was observed over an area approximately 2 m (5 ft) in diameter around the 241-TX-155 Diversion Box Catch Tank risers. Contamination spread to the ground around the 241-TX-155 Diversion Box Catch Tank risers after an attempt to neutralize acid waste in the catch tank. Ground contamination up to 25 rem/h was measured. Ground contamination was partially removed and the area was covered with paper (WHC 1991a).

241-TX-302C Catch Tank. These unplanned releases are associated with the unit and summarized on Table 2-6. Unplanned Release UPR-200-W-40 is a duplicate of UPR-200-W-160 and scheduled for deletion. Waste disposed at this unit and associated with UPR-200-W-160 are ^{137}Cs, ^{106}Ru, ^{90}Sr, plutonium, gross uranium, and alpha, and beta contamination. Inventory data are summarized in Tables 2-2 and 2-3.

241-TY-302A Catch Tank. No specific chemical or radiological data were identified for the 241-TY-302A Catch Tank.

241-TY-302B Catch Tank. No specific chemical or radiological data were identified for the 241-TY-302B Catch Tank.

4.1.2.3 Cribs and Drains. The T Plant Aggregate Area contains 15 cribs and one french drain. The types of information available for the cribs, drains, and drain fields include inventory data, radiological survey results, and borehole geophysical data. Soil, vegetation, and air monitoring data are generally unavailable for these sites. Inventory and radiological information have largely been compiled from (WHC 1991a) and the HISS database entries.

4.1.2.3.1 216-T-6 Crib Pair. The waste inventory for this unit is detailed in Tables 2-2 and 2-3. The waste disposed at the unit includes ammonium nitrate, fluoride, nitrate, phosphate, sodium, sodium oxalate, sulfate, ^{137}Cs, ^{106}Ru, ^{90}Sr, plutonium, gross uranium, and alpha and beta contamination.

Wells 229-W11-1 and 229-W11-54 through -W11-67 monitor the two cribs. Most of the radioactive contaminants are concentrated beneath the 216-T-6-1 Crib in the upper 15.5 m (50.8 ft) of the sediment column (Fecht et al. 1977). Plutonium contamination was detected as much as 6.1 m (20 ft) below the bottom of the cribs and had spread laterally about 14 m (45 ft) as of 1947. Fission products had penetrated to a depth of 32.6 m (107 ft) below the bottom of the crib and spread laterally 29 m (95 ft) (Maxfield 1979).

4.1.2.3.2 216-T-7TF Crib and Tile Field. The waste inventory for this unit is detailed in Tables 2-2 and 2-3. The waste disposed at this crib includes ammonium nitrate, fluoride, nitrate, phosphate, potassium, sodium, sodium oxalate, sulfate, ^{137}Cs, ^{106}Ru, ^{90}Sr, plutonium, gross uranium, and alpha and beta contamination.

Wells 299-W10-3, -W10-59, -W10-60, -W10-61, -W10-62, -W10-63, -W10-66, -W10-67, -W10-68, W10-74, W10-78, and W10-79 monitor this crib. Wells 299-W10-2, -W10-69, -W10-70, -W10-71, -W10-72, -W10-77, -W10-78, -W10-80, and -W10-81 monitor the tile field. Gamma scintillation profiles from Well 299-W10-3 suggest radionuclides beneath the 216-T-7TF Crib and Tile Field have moved downward in the sediment column 1.8 m (6 ft) between 1959 and 1976. The data from this well also indicate that breakthrough to groundwater could have occurred at this waste management unit (Fecht et al. 1977).

4.1.2.3.3 216-T-8 Crib. The waste inventory for this crib is summarized in Tables 2-2 and 2-3. Waste disposed at this unit includes nitric acid, sodium dichromate, sulfuric acid, ^{137}Cs, ^{106}Ru, ^{90}Sr, plutonium, gross uranium, and alpha and beta contamination.

The monitoring well nearest to the 216-T-8 Crib is the Well 299-W11-3 which is 15 m (51 ft) west and 71.6 m (235 ft) south of the crib.

4.1.2.3.4 216-T-18 Crib. The waste inventory is summarized in Tables 2-2 and 2-3. Waste disposed at this crib includes fluoride, nitrate, nitrite, phosphate, sodium silicate, sulfate, ^{137}Cs, ^{106}Ru, ^{90}Sr, plutonium, gross uranium, and alpha and beta contamination.

Well 299-W11-11 monitors this crib and indicates that breakthrough to groundwater has not occurred at this waste management unit (Fecht et al. 1977). The crib area was surface stabilized in May 1990 (Schmidt et al. 1992).

4.1.2.3.5 216-T-19TF Crib and Tile Field. The waste inventory data for this crib is summarized on Tables 2-2 and 2-3. Waste disposed at this unit includes ammonium nitrate, nitrate, phosphate, sodium, sulfate, ^{241}Am, ^{137}Cs, ^{3}H, ^{106}Ru, ^{90}Sr, plutonium, gross uranium, and alpha and beta contamination. Annual survey reports indicate surface contamination is present, generally at 3,000 dis/min.

Well 299-W15-4 monitors the 216-T-19TF Crib. Wells 299-W14-51, -W14-52, -W15-65, and -W15-66 monitor the 216-T-19TF Tile Field. In 1959, radioactive contamination was detected in Well 299-W15-4 from 3.2 m (10 ft) below the ground surface to the water table, 56.7 m (186 ft) beneath the ground surface (Fecht et al. 1977). The four tile field wells show only background levels of radioactivity.

4.1.2.3.6 216-T-26 Crib. The waste inventory data for this unit are presented in Tables 2-2 and 2-3. Waste disposed at this unit includes ferrocyanide, fluoride, nitrate, nitrite, phosphate, sodium, sodium aluminate, sodium hydroxide, sodium silicate, sulfate, ^{137}Cs, ^{106}Ru, ^{90}Sr, plutonium, gross uranium, and alpha and beta contamination.

Wells 299-W11-70 and -W11-82 monitor the 216-T-26 Crib. Radioactive contaminants were detected from near the ground surface to a depth of 28.9 m (94.8 ft). The waste inventory indicates most of the contamination detected in the soil profiles is ^{137}Cs (WHC 1991a).

For over the past ten years, Russian thistles containing strontium and cesium were often found growing on the surface of this crib waste management unit. Some thistles which were not removed have deteriorated, contaminating the ground surface. A radiation survey performed in May 1975 revealed localized surface contamination to a maximum of 30,000 ct/min (WHC 1991a). A remedial action was performed in 1975, which consisted of blading off the top 15 cm (6 in.) of soil and replacing the excavated material with clean fill to the original grade (WHC 1991a). The contaminated soil was placed in the 200 West Area dry waste burial grounds. This crib waste management unit was surface stabilized on May 21, 1990 (WHC 1991a).

4.1.2.3.7 216-T-27 Crib. The waste inventory data for this unit are summarized on Tables 2-2 and 2-3. Waste disposed at this unit includes nitrate, ^{137}Cs, ^{106}Ru, ^{90}Sr, plutonium, gross uranium, and alpha and beta contamination.

Wells 299-W14-53 and -W11-62 monitor the 216-T-27 Crib. Radioactive contaminants detected in the well prior to use of the crib are due to waste discharged to the 216-T-28 Crib immediately to the south. Discharges to the crib from 1965 to 1970 increased the size of the contaminated zone and the intensity of radiation. In 1976 the radiation intensity began to decrease due to radionuclide decay. On the basis of the scintillation probe profiles since crib operations were terminated, no measurable movement of radionuclides beneath the 216-T-27 Crib has been detected. The data indicate that breakthrough to the groundwater has not occurred at this waste management unit (Fecht et al. 1977). The evaluation of this data is provided in Appendix A.

Diversion of wastes to the 216-T-27 Crib was initiated following breakthrough of strontium and cesium to the groundwater under the 216-T-28 Crib (Section 4.1.2.3.8). A sudden increase (factor of four) in activity occurred beneath the inactive 216-T-28 Crib during the period in which the PNL waste was discharged to the 216-T-27 Crib. Subsequently, it was determined that this material does not react favorably with soil (WHC 1991a). Each time waste was pumped to the 216-T-27 Crib, groundwater samples collected near the 216-T-28 Crib increased in radioactivity.

Strontium and cesium contamination was discovered in Russian thistles growing on the waste management unit. Stabilization and surface remediation at this crib took place in 1975, along with the 216-T-26 and 216-T-28 Cribs. As of October 1989, the waste management unit had 2,000 to 50,000 dis/min general contamination, with a direct reading on a riser of 25 mR/h non-smearable (WHC 1991a).

4.1.2.3.8 216-T-28 Crib. The waste inventory data for this unit are summarized in Tables 2-2 and 2-3. Waste disposed at this unit includes nitrate, ^{137}Cs, ^{106}Ru, ^{90}Sr, plutonium, gross uranium, and alpha and beta emitters. Surface contamination was measured from 2,000 to 50,000 dis/min. Direct readings on a riser were 25 mR/h non-smearable.

Wells 299-W14-1, -W14-2, -W14-3, and -W14-4 monitor the crib. Strontium and cesium contamination was discovered in Russian thistles growing on the waste management unit. Stabilization and surface remediation took place in 1975, along with the 216-T-26 and 216-T-27 Cribs. As of October 1989, the waste management unit had 2,000 to 50,000 dis/min general contamination, with a direct reading on riser of 25 mR/hr non-smearable (WHC 1991a). The crib was stabilized in May 1990 along with the 216-T-26 and 216-T-27 Cribs.

4.1.2.3.9 216-T-29 Crib. No radiological waste inventory is available for this unit. The crib is reported to have received 8,000 kg of nitric acid (Table 2-3).

4.1.2.3.10 216-T-31 French Drain. No chemical or radiological inventory data was identified for the 216-T-31 French Drain.

4.1.2.3.11 216-T-32 Crib. The crib is monitored by Wells 299-W10-52, -56, -57, -58, -64, -65, -73, -75, and -76. Low levels of radiation have been detected between 8 and 35 m (26 and 114 ft) below ground surface (Fecht et al. 1977). The waste inventory data for this unit are summarized in Table 2-2. Waste disposed at this unit includes ^{137}Cs, ^{106}Ru, ^{90}Sr, plutonium, gross uranium, and alpha and beta contamination.

4.1.2.3.12 216-T-33 Crib. The waste inventory for this unit is summarized on Tables 2-2 and 2-3. Waste disposed at this unit includes sodium hydroxide, ^{137}Cs, ^{106}Ru, ^{90}Sr, plutonium, gross uranium, and alpha and beta contamination. The crib has surface contamination measured at 3,000 dis/min.

Well 299-W11-14 monitors this unit. Gamma scintillation data indicate that breakthrough to groundwater has not occurred at this waste management unit (Fecht et al. 1977).

4.1.2.3.13 216-T-34 Crib. The waste inventory data for this unit are summarized in Tables 2-2 and 2-3. Waste disposed at this unit includes nitrate, ^{137}Cs, ^{106}Ru, ^{90}Sr, plutonium, gross uranium, and alpha and beta contamination. During the annual surveillance of the crib, spotty contamination up to 100,000 dis/min was measured.

Activity was detected in the groundwater beneath the 216-T-34 Crib in 1966 after five months of operation (WHC 1991a). Wells 299-W11-15 and 299-W11-16 monitor the 216-T-34 Crib. Near background levels of radiation are detected in these wells. Breakthrough to the groundwater at this waste management unit is not indicated by scintillation probe data and waste volume (Fecht et al. 1977). The gamma scintillation data do not indicate that the crib was the source of the elevated activity in groundwater but the waste discharge column (Table 4-12) calculation suggests that this is possible.

The tanker unloading station and associated underground piping still remains at the northwest corner of this unit. During the construction and tie-in of the companion 216-T-35 Crib in February 1976, low-level beta/gamma soil contamination to 30,000 ct/min was found around the 216-T-34 Crib unloading station piping (Maxfield 1979). Thirty metric yards (40 yd^3) of contaminated soil were removed and buried in the 200 West Area Burial Grounds. Residue contamination still remains near the ground surface at the unloading station (Maxfield 1979). The waste management unit surface was stabilized in July 1990 (Huckfeldt 1990).

4.1.2.3.14 216-T-35 Crib. The waste inventory data for this crib are summarized on Tables 2-2 and 2-3. Waste disposed at this unit includes nitrate, ^{137}Cs, ^{106}Ru, ^{90}Sr, plutonium, gross uranium, and alpha and beta contamination. Spotty contamination up to 5,000 dis/min was noted in 1988 and 1989 during the annual survey. Low-level subsurface contamination was reported for a small area near the unloading station. (See 216-T-34 Crib.)

Wells 299-W11-17 through -21 monitor this unit. Data indicate that breakthrough to groundwater has not occurred at this waste management unit (Fecht et al. 1977). However, an elevated gamma response was noted from 5 to 30 m (16 to 98 ft) in Well W11-18 at the north end of the crib. The calculations of Table 4-12 indicated a potential for migration to groundwater. The surface of this waste management unit was stabilized in July 1990 (Huckfeldt 1990).

4.1.2.3.15 216-T-36 Crib. The waste inventory data for this crib are summarized on Tables 2-2 and 2-3. Waste disposed at this unit includes nitrate, ^{137}Cs, ^{106}Ru, ^{90}Sr, plutonium, gross uranium, and alpha and beta contamination. Spotty contamination up to 5,000 dis/min was noted in 1988 and 1989 during the annual survey. General contamination from 2,000 to 4,000 dis/min was reported in the 1989 annual survey.

Wells 299-W10-02 and 299-W10-04 monitor the 216-T-36 Crib. Gamma scintillation probe profiles indicate that breakthrough to the groundwater has not occurred at this waste management unit.

4.1.2.3.16 216-W-LWC Crib. No specific radionuclide or chemical sample data were identified for this unit.

Wells 299-W14-08, -W14-10, and -W15-08 monitor the 216-W-LWC Crib.

4.1.2.4 Reverse Wells. The T Plant Aggregate Area contains two reverse wells.

4.1.2.4.1 216-T-2 Reverse Well. The chemical waste inventory data for this reverse well is summarized in Table 2-3. Waste disposed includes nitric acid, sodium dichromate, and sulfuric acid.

4.1.2.4.2 216-T-3 Reverse Well. Waste inventory for this unit is summarized in Tables 2-2 and 2-3. Waste disposed at this unit includes ammonium nitrate, fluoride, nitrate, phosphate, potassium, sodium, sodium oxalate, sulfate ^{137}Cs, ^{106}Ru, ^{60}Si, plutonium, and alpha and beta contamination.

The reverse well is monitored by well 299-W11-7. The October 1988 and 1989 surveys identified general surface contamination at 3,000 dis/min and non-smearable contamination on the riser at 55,000 dis/min. The June 1990 survey detected no contamination around the waste management unit perimeter. Only the waste management unit perimeter was surveyed apparently due to a cave-in potential.

4.1.2.5 Ponds, Ditches, and Trenches. There are 3 ponds, 3 ditches, and 16 trenches in the T Plant Aggregate Area.

4.1.2.5.1 216-T-4A Pond. No chemical or radiological sample data were identified for this unit. The radionuclide inventory for 216-T-4A and 216-T-4B is reported together as one unit under the designation 216-T-4 (WHC 1991a). However, this information was not available. It is assumed that the 216-T-4A Pond has similar contaminants as the 216-T-4B Pond discussed in the next section.

4.1.2.5.2 216-T-4B Pond. The waste inventory for this unit is summarized in Table 2-2. The waste disposed includes ^{137}Co, ^{106}Ru, ^{90}Sr, plutonium, gross uranium, and alpha and beta contamination.

4.1.2.5.3 216-T-1 Ditch. No chemical or radiological sample data were identified for this unit. The 216-T-1 Ditch became contaminated to a maximum of 20,000 ct/min. Activity at the head of the ditch reads 1,500 ct/min (Maxfield 1979). A list of chemicals discharged to this ditch is contained in Table 4-16.

4.1.2.5.4 216-T-4-1D Ditch. No chemical or radiological sample data were identified for this unit.

4.1.2.5.5 216-T-4-2 Ditch. The waste inventory for this unit is summarized in Table 2-3. The waste disposed includes nitrate. A list of chemicals discharged to this ditch is contained in Table 4-17.

4.1.2.5.6 200-W Powerhouse Pond. No chemical or radiological sample data were identified for this unit. The powerhouse pond, based on coordinates from WHC (1991a), is located in the T Plant Aggregate Area. Field surveys of the powerhouse pond show it to be located south of the U Plant Aggregate Area in an excavated portion of the previous 216-U-14 Ditch. Water quality samples are taken weekly, composited, and analyzed monthly for total beta, total alpha, ^{137}Cs, ^{90}Sr, pH, and nitrate. The results of these samples are presented in Table 4-10 of the U Plant AAMSR (DOE/RL-91-52). This waste management unit will be recommended for inclusion in the U Plant Aggregate Area.

4.1.2.5.7 216-T-5 Trench. The waste inventory data are summarized in Tables 2-2 and 2-3. Waste disposed at the trench includes ammonium nitrate, fluoride, nitrate, phosphate, sodium, sodium silicate, sulfate, ^{137}Cs, ^{106}Ru, ^{90}Sr, plutonium, gross uranium, and alpha and beta contamination.

Well 299-W10-01 is used to monitor the trench. A scintillation probe survey performed in 1959 indicated the presence of radioactivity from the surface to a depth of 38.1 m (125 ft). Since 1959, the activity has decreased and in 1976 the radiation levels were near background (Fecht et al. 1977).

4.1.2.5.8 216-T-9, 216-T-10, and 216-T-11 Trenches. No specific chemical or radiological data were identified for this unit. All of these trenches received heavy equipment and vehicle decontamination waste. No radioactivity or evidence of chemical buildup was found in the waste management units (Stenner et al. 1988).

4.1.2.5.9 216-T-12 Trench. The waste inventory data are summarized in Table 2-2. Waste disposed at the trench includes ^{137}Cs, ^{106}Ru, ^{90}Sr, plutonium, gross uranium, and alpha and beta contamination. The unit received contaminated sludge from the 207-T Retention Basin that read a maximum of 15 mR/h at the time of burial. The majority of surface readings were in the range of 2 to 5 mR/h (WHC 1991a). During the annual surveillance conducted in June 1984, general surface reading were 500 ct/min.

4.1.2.5.10 216-T-13 Trench. No specific chemical or radiological data were identified for this unit. The trench is covered with 3 m (10 ft) of backfill. The trench was excavated in 1972 and 1,500 ct/min was found in the soil removed.

4.1.2.5.11 216-T-14, 216-T-15, 216-T-16, and 216-T-17 Trenches. The waste inventory data for the 216-T-14 Trench are summarized in Tables 2-2 and 2-3. Waste disposed at the 216-T-14 Trench includes fluoride, nitrate, nitrite, phosphate, sodium, sodium aluminate, sodium silicate, sulfate, ^{137}Cs, ^{106}Ru, ^{90}Sr, plutonium, gross uranium, and alpha and beta contamination. A large area of the 216-T-14 Trench through the 216-T-17 Trench radiation zone is contaminated up to 4,000 dis/min according to the 1990 survey. The same conditions were reported to exist in the 1988 survey (WHC 1991a).

The waste inventory data for the 216-T-15, 216-T-16 and 216-T-17 Trenches are summarized in Tables 2-2 and 2-3. Waste disposed at these trenches includes fluoride, nitrate, nitrite, phosphate, sodium, sodium aluminate, sodium hydroxide, sodium silicate, sulfate, ^{137}Cs, ^{106}Ru, ^{90}Sr, plutonium, gross uranium, and alpha and beta contamination.

In May 1970, radioactive russian thistles were found growing on the 216-T-14, 216-T-15, and 216-T-16 Trenches and had a maximum reading of 15 mR/h. To clean these waste management units, the weeds were removed and the entire surface of the radiation zone was treated with trisden-dimethylamine salts of trichlorobenzonic. The herbicide treatment was completely effective until the summer of 1976, when a few nonradioactive weeds appeared (Maxfield 1979).

Wells 299-W11-68, -W11-69, -W11-80, and -W11-81 monitor these four trenches. Scintillation profiles for Well 299-W11-68 indicate that breakthrough to the groundwater has not occurred at the 216-T-14 Trench (Fecht et al. 1977).

4.1.2.5.12 216-T-20 Trench. The waste inventory data for the 216-T-20 Trench are summarized in Tables 2-2 and 2-3. Waste disposed at the 216-T-20 Trench includes nitrate, ^{137}Cs, ^{106}Ru, ^{90}Sr, gross uranium, and beta contamination.

4.1.2.5.13 216-T-21, 216-T-22, 216-T-23, and 216-T-24 Trenches. The waste inventory data for the 216-T-21, 216-T-22, 216-T-23, and 216-T-24 Trenches are summarized in Tables 2-2 and 2-3. Waste disposed at these trenches includes fluoride, nitrate, nitrite, phosphate, sodium, sodium aluminate, sodium hydroxide, sodium silicate, sulfate, ^{137}Cs, ^{106}Ru, ^{90}Sr, plutonium, gross uranium, and alpha and beta contamination.

In September 1969, radioactive thistles were found growing above the 216-T-21 and 216-T-24 Trenches. In May 1970, all of the trenches were treated with herbicide. The area recovered the vegetative cover by 1977, but no radioactive weeds were discovered (WHC 1991a).

The 216-T-21, -22, -23, and -24 Trenches are monitored by Wells 299-W15-209, -W15-81, -W15-210, and -W15-211, respectively. The wells indicate that there is significant contamination in the vadose zone, but do not indicate that contamination has reached the groundwater.

4.1.2.5.14 216-T-25 Trench. The waste inventory data for the 216-T-25 Trench are summarized in Tables 2-2 and 2-3. This trench is monitored by Well 299-W15-212. Waste disposed at this trench includes fluoride, nitrate, nitrite, phosphate, sodium, sodium aluminate, sodium hydroxide, sodium silicate, sulfate, ^{137}Cs, ^{106}Ru, ^{90}Sr, plutonium, gross uranium, and alpha and beta contamination.

4.1.2.6 Septic Tanks and Associated Drain Fields. A total of six septic tanks, all active, are located in the T Plant Aggregate Area. No specific chemical or radiological data were identified for the septic tanks and drain fields.

4.1.2.7 Transfer Facilities, Diversion Boxes, and Pipelines. No specific chemical or radiological data were identified for any of the diversion boxes in the T Plant Aggregate Area. Since the diversion boxes in the T Plant Aggregate Area are all associated with the single-shell tanks, the diversion boxes will be handled by the Single-Shell Tank Closure Program; therefore, they will not be carried further through the AAMS process.

4.1.2.8 Basins. One basin is associated with the T Plant Aggregate Area.

4.1.2.8.1 207-T Retention Basin. No specific chemical or radiological sample data were identified for this unit.

4.1.2.9 Burial Sites. The T Plant Aggregate Area contains two types of burial grounds, the 200-W Powerhouse ash-related waste management units and the 218-W-8 Burial Ground. The 200-W Powerhouse has two ash related waste management units called the 200-W Ash Disposal Basin and the 200-W Powerhouse Ash Pit. Each of these waste management units serves a separate function. In addition, the 200-W Ash Disposal Basin is associated with two other waste management units, the 200-W Ash Pit Demolition Site and the 200-W Burning

Pit. The 200-W Ash Pit Demolition Site is included in the Tri-Party Agreement as an active TSD. The 218-W-8 Burial Ground was used for the disposal of radioactive laboratory process wastes. The locations of these sites are shown in Figure 2-13. No chemical or radiological sample data were identified for these burial sites.

4.1.2.9.1 200-W Ash Disposal Basin. The 200-W Burning Pit, and 200-W Ash Pit Demolition Site are located within the boundaries of this active basin.

4.1.2.9.2 200-W Ash Pit Demolition Site. This active treatment, storage, or disposal (TSD) waste management unit is used for treatment of shock-sensitive or potentially explosive chemical wastes. This waste management unit (not included in the Tri-Party Agreement) is located in the northern portion of the 200-W Ash Disposal Pit. Table 4-18 lists the materials burned in this pit during 1984, 1985, and 1986. In that this waste management unit is an active permitted waste management unit, the chemicals detonated in this pit are not considered contaminants of concern for the T Plant Aggregate Area.

4.1.2.9.3 200-W Burning Pit. This pit was used from 1950 to 1970 to burn construction and office waste (15,000 m^3 [19,600 yd^3]), paint waste, and chemical solvents (1,000 L [264 gal]). This pit is located on the south end of the 200-W Ash Disposal Basin. With the exception of the three unplanned releases (UPR-200-W-37, UPR-200-W-70, and UN-200-W-8) no radioactive material was discarded to this waste management unit.

4.1.2.9.4 200-W Powerhouse Ash Pit. This pit currently contains 43,800 m^3 (57,290 yd^3) of ash from the 284-W Power Plant. This pit is not physically associated with the 200-W Ash Disposal Basin. No radioactive materials have been discharged to this pit.

4.1.2.9.5 218-W-8 Burial Ground. This inactive burial waste management unit was used for disposal of process sample waste from the 222-T Laboratory. No chemical inventory data was found.

4.1.2.10 Unplanned Releases. There is very little chemical or radiological data available for any of the unplanned releases. Any information which was found is summarized in Section 2.3.10 and Table 2-6. No information regarding contaminated materials or quantities were found for the UN-200-W-3, UN-200-W-27, and UN-200-W-77 unplanned releases. It should be noted that some of the wastes contained significantly higher radionuclide levels at the time of discharge because of short lived fission products. For example, wastes discharged to the ground from the uranium recovery process contained very high levels of ^{106}Ru. Ruthenium-106 has a half-life of 373 days and has decayed to insignificant levels (Waite 1991).

4.2 POTENTIAL IMPACTS TO HUMAN HEALTH AND THE ENVIRONMENT

This preliminary assessment is intended to provide a qualitative evaluation of potential human health and environmental hazards associated with the known and suspected contaminants at the T Plant Aggregate Area. The assessment includes a discussion of release mechanisms, potential transport pathways, develops a conceptual model of human and environmental exposure based on these pathways, and presents the physical, radiological, and toxicological characteristics of the known or suspected contaminants.

In developing the conceptual model, potential exposures to groundwater have not been addressed in detail. Since migration to groundwater is the primary route for potential future exposures to many of the chemicals disposed of at the site, this pathway (i.e., travel time, receptors) will be addressed in the 200 West Groundwater AAMS.

It is important to note that these evaluations do not attempt to quantify potential human health or environmental risks associated with exposure to T Plant Aggregate Area waste management unit contaminants. Such risk assessments cannot be performed until additional waste unit characterization data are acquired. Risk assessment activities will be performed in accordance with the *Hanford Site Baseline Risk Assessment Methodology* document (DOE/RL 1992b) being prepared in response to the Tri-Party Agreement M-29 milestone. This methodology incorporates the requirements established in the *Risk Assessment Guidance for Superfund* (EPA 1989a) and the *EPA Region 10 Supplemental Risk Assessment Guidance for Superfund* (EPA 1991a).

The ability of this qualitative assessment to address potential environmental and ecological risks is severely constrained by the relative lack of data regarding potentially exposed biotic populations and exposure pathways. As discussed in Section 3.6, past studies of biota have been mostly conducted on a site-wide basis and do not provide useful data to evaluate the potential impacts of the T Plant Aggregate Area. The extent of T Plant Aggregate Area biota sampling has been limited to vegetation sampling (Section 4.1.1.4). The role of biota in transporting contaminants through the environment is discussed in the sections that follow, and biota are included as receptors in the conceptual model. However, the assessment of potential ecological risks associated with biota exposure to T Plant Aggregate Area contaminants is currently constrained by the lack of data. This data gap is addressed in Section 5.0, and is discussed further in Section 8.2.3.

4.2.1 Release Mechanisms

The T Plant Aggregate Area waste management units can be divided into two general categories based on the nature of the waste release: (1) units where waste was discharged directly to the environment; and (2) units where waste was disposed of inside a containment structure and bypassed an engineered barrier to reach the environment.

In the first group are those waste management units where release of wastes to the soil column was an integral part of the waste disposal strategy. Included in this group are tile fields, septic system drain fields, ditches, french drains, seepage basins, cribs without liners, reverse wells, and some disposal trenches. Also in this group are unplanned releases that involved waste material released to the soil. For this group of waste management units, if discharges to the unit contained contaminants of concern, it can be assumed that soils underlying the waste management unit are contaminated. The first task in developing a conceptual model for these units is to determine whether contaminants of concern are retained in soil near the waste management unit, or are likely to migrate to the underlying aquifer and then to receptor points such as drinking water wells or surface water bodies. Factors affecting migration of chemicals away from the point of release will be discussed in the following section.

In the second group are waste management units that were intended to act as a barrier to environmental releases. Included in this group are burial grounds containing drums or other containers, cribs with membrane liners, vaults, tanks, waste transfer facilities, and unplanned releases that occurred within containment structures. Waste management units that received only dry waste could also be included in this category, since the potential for wastes to migrate to soils outside of the unit is low due to the negligible natural recharge rate in the 200 Areas at the Hanford Site. For these waste management units, the first consideration to be addressed in developing a conceptual model is the integrity of the containment structure.

The ability of this report to evaluate the efficacy of engineered barriers is limited by the lack of vadose zone soil sampling data and air sampling data for many waste management units. Available sampling information for the waste management units and unplanned releases has been summarized in Section 4.1. The data indicate that membrane liner systems used in waste management units with significant liquid inputs were ineffective in preventing releases to the subsurface.

The efficacy and integrity of concrete liners (207-T Retention Basin) and concrete and steel tanks (vaults) have not been determined. For those units that received only dry wastes, such as gloves, pumps, contaminated dirt, and process equipment, the potential for release is expected to be low. However, small amounts of liquid wastes (tritium, lab wastes) are known to have been disposed of in these waste management units, and early disposal records (prior to about 1968) are incomplete. Thus, releases from these structures to the surrounding soil are possible.

In addition to evaluating releases to the subsurface, the conceptual model must address the potential for releases to air and, for radionuclides, the potential for direct irradiation. All units have some type of barrier to releases to the surface; however, barriers can fail over time or may not be designed to prevent migration by certain transport pathways (e.g., volatilization).

At least five of the cribs in the T Plant Aggregate Area, 216-T-6, -7TF, -8, -19, and -32, have been identified as having a high probability of cave-in potential (WHC 1991a) due to decomposition of the wooden framework of the cribs. A cave-in has previously occurred at Crib 216-T-19TF which resulted in its abandonment in 1956. Such collapse can lead to high levels of direct radiation at the surface and the potential for spread of contaminated materials by wind erosion. Westinghouse Hanford has an ongoing program (RARA Program) to detect and remediate cave-ins by covering the cribs with additional soil, and any exposures from these incidents are generally short-term.

4.2.2 Transport Pathways

Transport pathways expected within the T Plant Aggregate Area are summarized in this section, including:

- Drainage and leaching from soil to groundwater
- Volatilization from wastes, surface water, and shallow soils
- Wind erosion of contaminated surface soils
- Deposition of fugitive dust on soils, plants, and surface water
- Uptake from soils and surface water by vegetation
- Uptake by animals via direct contact with soils or surface water or ingestion of soils, surface water, vegetation, and other animals
- Direct radiation.

In addition, transport within the saturated zone and subsequent release to groundwater wells or to off-site surface water (i.e., the Columbia River) is of potential concern, but will not be addressed in this document, since this topic will be the focus of the 200 West Groundwater AAMS.

Following transport, exposure may occur through the following pathways:

- Inhalation of volatilized contaminants or suspended particulates
- Ingestion of contaminants in soils, vegetation, or animals

- Direct dermal contact with contaminants in soils
- Direct exposure to radiation.

4.2.2.1 Transport from Soils to Groundwater. Soil is the initial receiving medium for waste discharges in the T Plant Aggregate Area, whether the release is directly to soil or through failure of a containment system. Several factors determine whether chemicals that are introduced into the vadose zone will reach the unconfined aquifer, which lies at a depth of approximately 50 m (180 ft) below ground surface. These factors are discussed in the following sections.

4.2.2.1.1 Depth of Release. As a general rule, for a given volume, waste management units that released wastes at a greater depth below the surface have a higher potential to contaminate groundwater than waste management units where the release was shallow. Other factors, however, such as rate of discharge, underlying geology, and many others will all significantly impact contaminant movement. The 216-T-3 Reverse Well is the primary examples of a deep release at the T Plant Aggregate Area. This unit discharged wastes to the vadose zone approximately 62 m (204 ft) below the surface, or approximately 14 m (45 ft) above the water table in the unconfined aquifer.

4.2.2.1.2 Liquid Volume or Recharge Rate. For waste constituents to migrate to the underlying water table, some source of recharge must be present. In the T Plant Aggregate Area, the primary source of moisture for mobilizing contaminants are waste management units that discharge liquid waste to the soil column and precipitation recharge. As discussed in Section 3.5.2, a number of studies have estimated natural precipitation recharge in a range from 0 to 10 cm/yr (0 to 4 in./yr), primarily depending on surface soil type, vegetation, and topography. The upper value in the range was a computer model generated estimation rather than actual measurement. The actual natural precipitation recharge for T Plant is likely to fall at the lower end of this range. Gravelly surface soils with no or minor shallow rooted vegetation appear to facilitate precipitation recharge. One modelling study (Smoot et al. 1989) indicated that some radionuclide (^{137}Cs and ^{106}Ru) transport could occur with as little as 5 cm/yr (2 in./yr) of natural recharge. However, other researchers (Routson and Johnson 1990) have concluded that no net precipitation recharge occurs in the 200 Areas, particularly at waste management units that are capped with fine-grained soils or impermeable covers.

With respect to artificial recharge, some waste management units (e.g., the 216-T-12 Trench and 216-T-33 Crib) were identified in which the known volume of liquid waste discharged substantially exceeded the total estimated soil pore volume present below the footprint of the facility. In this case, the moisture content of soil below the waste management units likely approached saturation during the periods of use of these facilities. Because vadose zone hydraulic conductivities are maximized at water contents near

saturation, the volume of liquid wastewater historically discharged to the waste management units probably enhanced fluid migration in the vadose zone beneath these units.

Long term gravity drainage is also a potential mechanism of contaminant migration. It is unknown how long after shutdown the soil under such a unit will continue to drain and to transport contamination down to the groundwater.

Contaminants that are not initially transported to the water table by drainage may be mobilized at a later date if a large volume of liquid is added to the waste management unit. In addition, liquids discharged to one unit could mobilize wastes discharged to an adjacent unit if lateral migration takes place within the vadose zone. An example of this process occurred at the 216-T-27 Crib, which received trucked waste from the 300 Area. Each time this waste was pumped to the 216-T-27 Crib, groundwater samples collected near the 216-T-28 Crib increased in radioactivity.

It is also thought that the septic fields may have the potential to mobilize contaminants. In the T Plant Aggregate Area, there are no known areas of vadose zone contamination within 50 m (160 ft) of any of the septic tanks or the 241-T-4-2 Ditch.

4.2.2.1.3 Soil Moisture Transport Properties. The moisture flux in the vadose zone is dependent on hydraulic conductivity as well as gradients of moisture content or matrix suction. Higher unsaturated hydraulic conductivities are associated with higher moisture contents. However, higher unsaturated hydraulic conductivities may be associated with fine-grained soils compared to coarse-grained soils at low moisture contents. Due to the stratified nature of the Hanford Site vadose zone soils and the moisture content dependence of unsaturated hydraulic conductivity, vertical anisotropy is expected, i.e., vadose zone soils are likely to be more permeable in the horizontal direction than in the vertical. This vertical anisotropy may reduce the potential for contaminant migration to the unconfined aquifer.

4.2.2.1.4 Retardation. The rate at which contaminants will migrate out of a complex waste mixture and be transported through unsaturated soils depends on a number of characteristics of the chemical, the waste, and the soil matrix. In general, chemicals that have low solubilities in the leaching fluid or are strongly adsorbed to soils will be retarded in their migration velocity compared to the movement of soil pore water. Studies have been conducted of soil parameters affecting waste migration at the Hanford Site to attempt to identify the factors that control migration of radionuclides and other chemicals. Recent studies of soil sorption are summarized in Serne and Wood (1990). Some of the processes that have been shown to control the rate of transport are as follows:

- **Adsorption to Soils.** Most contaminants are chemically attracted to some degree to the solid components of the soil matrix. For organic compounds, the adsorption is generally to the organic fraction of the soil, although in extremely low-organic soils, adsorption to inorganic components may be of greater

importance. Soil components contributing to adsorption of inorganic compounds include clays, organic matter, and iron and aluminum oxyhydroxides. In general, Hanford surface soils are characterized as sandy or gravelly with very low organic content (<0.1%) and low clay content (<12%) (Tallman et al. 1981). Thus, site-specific adsorption factors are likely to be lower, and rate of transport higher, than the average for soils nationwide.

- **Filtration.** Filtration of suspended particulates by fine-grained sediments has been suggested as a mechanism for concentration of radionuclides in certain sedimentary layers. This finding suggests that migration of suspended particulates may be an important mechanism of transport for poorly soluble contaminants.

- **Solubility.** The rate of release of some chemicals is controlled by the rate of dissolution of the chemical from a solid form. The concentration of these chemicals in the pore water will be extremely low, even if they are poorly sorbed. An example cited by Serne and Wood (1990) is the solubility of plutonium oxide, which appears to be the limiting factor controlling the release of plutonium from waste materials at neutral and basic pH.

- **Ionic Strength of Waste.** For some inorganics, the dominant mechanism leading to desorption from the soil matrix is ion exchange. Leachate having high ionic strength (high salt content) can bias the sorption equilibrium toward desorption, leading to higher concentrations of the contaminant in the soil pore water. Wastes within the T Plant Aggregate Area that can be considered high ionic strength include the waste management units that received first-cycle supernatant waste from the 221-T Building. These waste management units include the 216-T-14, -15, -16, and -17 Trenches.

- **Waste pH.** The pH of a leachant has a strong effect on inorganic contaminant transport. Acidic leachates tend to increase migration both by increasing the solubility of precipitates and by changing the distribution of charged species in solution. The exact impact of acidic or basic wastes will depend on whether the chemical is normally in cationic, anionic, or neutral form, and the form that it takes at the new pH. Cationic species tend to be more strongly adsorbed to soils than neutral or anionic species. The extent to which addition of acidic leachate will cause a contaminant to migrate will also depend on the buffering or neutralizing capacity of the soil, which is correlated with the calcium carbonate ($CaCO_3$) content of the soil. The soils in the Hanford formation beneath the T Plant Aggregate Area generally have carbonate contents in the range of 0.1 to 5%. Higher carbonate contents (20 to 30%) are observed within the Plio-Pleistocene caliche layer.

Once the leaching solution has been neutralized, the dissolved constituents may re-precipitate or become reabsorbed to the soil. Observations of pH impacts on waste transport at the Hanford Site include:

- The remobilization of uranium beneath the U Plant Aggregate Area 216-U-1 and 216-U-2 Cribs is believed to have occurred in part because of this introduction of low pH solutions.

- Leaching of americium from the Z Plant Aggregate Area 216-Z-9 Trench sediments was found to be solubility controlled and correlated to solution pH.

4.2.2.1.5 Complexation by Organics. Certain organic materials disposed of at the T Plant Aggregate Area are known to form complexes with inorganic ions, which can enhance their solubility and mobility. Tributyl phosphate is the primary organic complexing agent disposed of at the T Plant Aggregate Area.

4.2.2.1.6 Contaminant Loss Mechanisms. Processes that can lead to loss of chemicals from soils, and thus decrease the amount of chemical available for leaching to groundwater, include:

- **Radioactive Decay.** Radioactivity decays over time, generally decreasing the quantities and concentrations of radioactive isotopes.

- **Biotransformation.** Microorganisms in the soil may degrade organic contaminants such as kerosene and inorganic chemicals such as nitrate.

- **Chemical Transformation.** Hydrolysis, oxidation, reduction, radiolytic degradation and other chemical reactions are possible degradation mechanisms for contaminants.

- **Vegetative Uptake.** Vegetation may remove chemicals from the soil, bring them to the surface, and introduce them to the food web.

- **Volatilization.** Organic chemicals and volatile radionuclides can be transported in the vapor phase through open pores in soil either to adjacent soil or to the atmosphere. These volatilized compounds could include acetone, radon (a decay product of uranium), and tritium (HTO in tritiated water). Some elements (mainly fission products such as iodine, ruthenium, cerium, and antimony) are referred to as "semivolatiles" because they have a lesser tendency to volatilize.

4.2.2.2 Transport from Soils and Surface Water to Air. Transport of contaminants from waste management units to the atmosphere can occur by means of vapor transport or by fugitive dust emissions.

Vapor transport may occur from waste management units where volatile organics (e.g., CCl_4) or volatile radionuclides (^{14}C, $^{14}CO_2$, ^{129}I, or ^{3}H) have been released. Transport mechanisms include evaporation/volatilization, diffusion down a concentration gradient, and gas-driven flow. Situations where the latter process may occur include production of methane gas from degradation of organic compounds in soil, or production of hydrogen and oxygen gases by radiolytic hydrolysis of water.

In order for fugitive dust emissions to occur, contaminants must be exposed at the surface of the waste management unit. A number of mechanisms could lead to exposure of contaminants in soil-covered waste management units. These mechanisms include uptake by vegetation, transport by animals, disruption of the waste management unit (e.g., cave-ins at cribs), and wind erosion. Wind erosion can strip off surface soil and uncover waste materials. This mechanism has been identified as an ongoing problem in some of the waste management unit areas. The processes by which biota may expose contaminated soils are discussed in Section 4.2.2.4.

The contribution of the T Plant Aggregate Area to the overall fugitive dust emissions at the Hanford Site boundary is expected to be relatively minor, based on results of air monitoring downwind of the T Plant Aggregate Area waste management units (Schmidt et al. 1992).

4.2.2.3 Transport from Soils to Surface Water. The only surface water present in the T Plant Aggregate Area is at the 216-T-1 and the 216-T-4-2 Ditches and at the powerhouse pond. Neither of these ditches flow more than 100 m (328 ft) before effluent is totally absorbed by the soil.

Transport of contaminants to surface water bodies outside of the T Plant Aggregate Area via groundwater discharge and deposition of fugitive dust on water bodies are the primary pathways of potential concern for surface water effects. Groundwater discharge will be addressed in the 200 West Groundwater AAMSR.

4.2.2.4 Transport from Soils and Surface Water to Biota. Biota, plants and animals, have the potential for taking up (bio-uptake), concentrating (bioaccumulating), transporting, and depositing contamination beyond its original extent. Transfer from one species to another in the food chain is also possible because of predation. The possibility of these processes contributing significantly to the transport of contamination from T Plant Aggregate Area waste management units, or resulting in damage to affected ecosystems, is unclear. The currently available data, as described in Sections 3.6 and 4.1, are too general and do not adequately evaluate biotic transport or ecological risk. This data gap is discussed further in

Sections 5.0 and 8.0. The future acquisition of additional data will be guided by the requirements for human health and ecological risk assessments in the *Hanford Baseline Risk Assessment Methodology* (DOE/RL 1992b) being prepared in response to the M-29 milestone.

4.2.2.4.1 Uptake by Vegetation. Release of radioactivity to the surface by growth of vegetation is an ongoing problem at T Plant Aggregate Area waste management units. Roots of sagebrush and other native species can take up radionuclides from soils below the surface and transport these chemicals to the foliage. Wind dispersal of portions of the contaminated vegetation, or entire plants (tumbleweeds) can lead to transport of contaminants outside of the unit. Westinghouse Hanford has an ongoing vegetation control (herbicide application, reseeding with shallow-rooted vegetation, and mechanical removal) and radiological survey program to prevent radioactivity from being transported by this mechanism. However, the program does not ensure complete removal of vegetation, and incidents of detection of contaminated vegetation are reported occasionally in the radiological surveys.

4.2.2.4.2 Transport by Animals. Disturbance of waste management unit barriers by animals occasionally leads to release of contaminants to the surface. Subsurface soils can be transported to the surface by burrowing animals, thus exposing contaminants for release to the air. Additionally, animals that become contaminated by direct contact with subsurface waste or through ingestion of subsurface contaminants (e.g., chemical salts) and contaminated vegetation, water, or other animals can spread contamination in their feces on the surface and outside of the waste management unit.

4.2.3 Conceptual Model

Figure 4-3 presents a graphical summary of the physical characteristics and mechanisms at the site which could potentially affect the generation, transport, and impact of contamination in the T Plant Aggregate Area on humans and biota (conceptual model).

The sources of contamination include process wastes (e.g., condensates, cooling water, and sewage) from T Plant, first-and second-cycle supernatant waste, component and vehicle decontamination waste, laundry waste, evaporator bottom waste, 222-T Laboratory waste, and waste from facilities outside the T Plant Aggregate Area. The known contamination sources originating from outside the T Plant Aggregate Area are identified in Table 4-19.

From these waste management units, various release mechanisms may have transported contamination to the potentially affected media. Volatilization could release chemicals from surface waters into the atmosphere. Materials in the 216-T-4-2 Ditch flowing toward the 216-T-4B Pond may have seeped into the vadose zone, or deposited into the sediments in the

ditch. The 207-T Retention Basins may have released contaminants in a similar fashion, with the exception of offsite flow. Biota may have taken up contaminants from the surface water and near-surface contaminated soils (via deep roots or burrowing animals).

Many waste management units discharge their waste effluents directly to the near surface (vadose zone) soils. The trenches are potential release points via leaching or drainage of the liquid portion of the disposed materials. The cribs provide seepage discharge and similarly the french drains, reverse wells, and septic system drain fields directly inject their effluents into the subsurface sediments. The unplanned releases have mainly impacted surface soils although some contamination may have also taken place on building surfaces. Fugitive dust from sediment and surface soils has also been released or resuspended due to wind effects or surface disturbances, and some surface soils have been buried or removed to offsite disposal.

The primary mechanism of vertical contaminant migration is the downward movement of water from the surface through the vadose zone to the unconfined aquifer. The contaminants generally move as a dissolved phase in the water and their rate of migration is controlled both by groundwater movement rates and by adsorption and desorption reactions involving the surrounding sediments. Some contaminants are strongly sorbed on sediments and their downward movement through the stratigraphic column is greatly retarded. Significant lateral migration of contaminants is restricted to perched water zones and to the unconfined aquifer, where water is moving laterally. Again adsorption and desorption reactions may greatly retard lateral contaminant migration. Contaminants that were introduced to the soil column outside of the aggregate area may migrate into the area along with perched or aquifer water.

Figure 4-4 is a schematic diagram illustrating these processes and describing probable contaminant distributions in the vadose zone. For liquid waste management units, the point of release shown on this figure may be in the subsurface, such as at cribs, drains, and reverse wells, or it may be exposed to the surface, such as at ponds, ditches, trenches, or at most unplanned releases. Small-scale contaminant releases are much less likely to impact the lower vadose zone or groundwater than large scale releases. Liquid disposal units in the T Plant Aggregate Area are dominated by cribs and associated ditches. Table 4-12 identifies those units that had liquid discharges large enough to reach the unconfined aquifer.

Contaminant distributions near the burial ground type units in the T Plant Aggregate Area are likely to be significantly different from those associated with the liquid waste management units. Because burial grounds received only dry waste, the burial grounds are unlikely to release contaminants to the vadose zone. As a result, only surface contaminant releases have been identified at burial grounds. In this case, wind and near surface biological activity are the dominant processes for transporting and redistributing contaminants.

Contaminant distribution at most unplanned releases is expected to be at or just below the surface. These sites generally received little, if any, liquid, therefore, migration into the lower vadose zone is not expected. The primary process for transporting and redistributing contaminants in this case is wind and near surface biological activity.

The schematic diagram is based on the stratigraphy underlying the T Plant Aggregate Area, the chemical characteristics of the primary suspected contaminants in the area, and known vadose zone contaminant distributions identified from previous studies. The subsurface geology of the aggregate area is presented in Sections 3.4 and 3.5, and the chemical characteristics of various contaminants are detailed in Section 4.2.4.

In the past, drilling and sampling programs have been conducted at the 216-Z-1A Tile Field (Price et al. 1979), the 216-Z-9 Trench (Smith 1973), the 216-Z-12 Crib (Kasper 1981), the 200-BP-1 Operable Unit cribs (the BY Cribs) (Buckmaster and Kaczor 1992, Appendix A in the U Plant AAMSR), the 216-U-10 Pond (Last and Duncan 1980), and the 216-Z-19 Ditch (Last and Duncan 1980). These studies, in conjunction with geophysical well logging data, have been used to estimate the expected contaminant distributions beneath comparable waste management units in the T Plant Aggregate Area.

Some of the general conclusions that may be drawn from these previous studies are:

(1) Maximum radionuclide contaminant concentrations should be expected directly beneath the main discharge points of the units with the exception of highly mobile contaminants such as tritium.

(2) Radionuclide contamination is not expected to spread laterally more than 15 to 30 m (50 to 100 ft) beyond the point of discharge and should be at much lower concentrations than those noted beneath the center of the discharge point; a possible exception being areas of perched water.

(3) Radionuclide contamination decreases rapidly with depth. The highest concentrations should occur within 2 or 3 m (6 to 10 ft) of the bottom of the discharge point and concentrations should be near background levels at 20 m (65 ft) depth.

(4) The maximum lateral radionuclide contaminant movement tends to occur along relatively impermeable horizons.

(5) Radionuclide contaminants should be concentrated in fine-grained horizons compared to surrounding coarse-grained horizons and when found in coarse-grained horizons they are associated with the fine-grained particles.

(6) Perched water zones are most likely to occur immediately above the caliche layer. With rapid loading, perch water may extend from the caliche layer up into the lower Hanford formation. Significant lateral water and contaminant movement may occur in such a situation.

(7) The caliche layer is an important physical and chemical barrier to vertical contaminant migration.

(8) Most chemical contaminants of concern have distributions that tend to mimic radionuclide contaminant distributions in the vadose zone.

There are four exposure routes by which humans (offsite and onsite) and other biota (plants and animals) can be exposed to these possible contaminants:

- Inhalation of airborne volatiles or fugitive dusts with adsorbed contamination
- Ingestion of surface water, fugitive dust, surface soils, biota (either directly or through the food chain), or groundwater
- Direct contact with the waste materials (such as those exhumed by burrowing animals), contaminated surface soils, buildings, or plants, and
- Direct radiation from waste materials, surface soils, building surfaces, or fugitive dusts.

4.2.4 Characteristics of Contaminants

Table 4-20 is a list of radioactive and nonradioactive chemical substances that represent candidate contaminants of potential concern for this study based on their known presence in wastes, usage, disposal in waste management units, historical association, or detection in environmental media at the T Plant Aggregate Area. Table 4-21 summarizes the types of known or suspected contamination thought to exist at the individual waste sites. Known contaminants have been proven to exist from sampling and inventory data (Tables 2-2 and 2-3). Suspected contaminants are those which could occur at a site based upon historical practices or chemical associations. Given the large number of chemicals known or suspected to be present, it is appropriate to focus this assessment on those contaminants that have been detected through sampling efforts and which pose the greatest risk to human health or the environment.

The EPA Region 10 guidance on risk-based contaminant screening (EPA 1991a), as summarized in the *Hanford Baseline Risk Assessment Methodology* (DOE/RL 1992b), was consulted to establish the T Plant Aggregate Area contaminants of potential concern. The

risk-based contaminant screening mostly involves comparing maximum contaminant concentrations to risk-based benchmark concentrations. However, contaminant concentrations in environmental media are not available for the T Plant Aggregate Area, and direct risk-based screening could not be performed. To ensure that the intent of the EPA Region 10 approach could be achieved an alternative and more conservative approach was employed. This requires T Plant Aggregate Area contaminants with potential risks to be included in the list of contaminants of potential concern. The alternative approach retains any contaminant that is known or suspected of being carcinogenic or toxic, regardless of quantity or concentration.

Table 4-22 lists the contaminants of potential concern for the T Plant Aggregate Area. This list was developed from Table 4-20 and includes only those contaminants which meet the following criteria:

- Radionuclides that have a half-life of greater than one year. Radionuclides with half-lives less than one year will not persist in the environment at concentrations sufficient to contribute to overall risks.

- Radionuclides with a half-life of less than one year and are part of long-lived decay chains that result in the buildup of the short-lived radionuclide activity to a level of 1% or greater of the parent radionuclide's activity within the time period of interest. Although daughter radionuclides are adequately identified during normal parent radionuclide investigations, they are also identified as contaminants of concern through this criterion. This provides an additional level of assurance that all primary contaminants will be addressed.

- Contaminants that are known or suspected carcinogens or have a U.S. Environmental Protection Agency (EPA) noncarcinogenic toxicity factor. In addition, chemicals with known toxic effects but no toxicity factors are included. In some instances the criteria have been withdrawn by EPA pending review of the toxicological data and will be reissued at a future date. Chemicals with known toxicity for which toxicity factors are presently not available include lead, selenium, kerosene and tributyl phosphate.

The following characteristics will be discussed for the contaminants listed in Table 4-22:

- Detection of contaminants in environmental media

- Historical association with plant activities

- Mobility

- Persistence
- Toxicity
- Bioaccumulation.

4.2.4.1 Detection of Contaminants in Environmental Media. The nature and extent of surface and subsurface soils, surface water, groundwater, air, and biota contamination have not yet been adequately characterized for the T Plant Aggregate Area. All recent environmental monitoring data were reviewed and summarized for each media in Section 4.1.

The most extensive monitoring data available has been for groundwater. Because groundwater will be evaluated in the 200 West Groundwater AAMSR, it will not be discussed further here. Surface soil and biota samples have been collected from locations on a regular rectangular grid. These sampling locations do not correspond to any of the waste management units, but are intended to characterize the T Plant Aggregate Area as a whole. Air and external radiation samples have been collected at several locations within or adjacent to the T Plant Aggregate Area. These sampling stations are also not located directly on any of the waste management units and therefore the sampling results cannot be attributed to any particular unit. The only routine sampling data that correspond directly to waste management units are the external radiation surveys, which are performed on a regular basis. There is little soil or vegetation sampling data available for any of the units.

4.2.4.2 Historical Association with T Plant Aggregate Area Activities. Radionuclides that are known components of T Plant Aggregate Area waste streams are listed in Table 2-9. This list includes chemicals in the process wastes as well as chemicals that were detected at elevated levels in wastewater. Since these waste streams are known to have been disposed of directly to the soil column in some waste management units, it is probable that the chemicals on this list have affected environmental media.

Based on the WIDS data (WHC 1991a), radionuclides that are known to have been disposed of to T Plant Aggregate Area waste management units in the greatest quantities are as follows:

- ^{239}Pu
- ^{240}Pu
- ^{137}Cs
- ^{90}Sr
- ^{238}U.

Note that a complete radionuclide analysis of the T Plant waste streams is not available. Thus, it is possible that additional radionuclides were disposed of to T Plant Aggregate Area waste management units that are not included in the waste inventories.

In addition to the releases due specifically to T Plant activities, effects from other areas, particularly U Plant and Plutonium Finishing Plant, due to cross connection of facilities, tanks, drain fields, cribs, etc., must be considered.

4.2.4.3 Mobility. Since most wastes at the T Plant Aggregate Area were released directly to subsurface soils via injection, infiltration, or burial, the mobility of the wastes in the subsurface will determine the potential for future exposures. The mobility of the contaminants listed in Table 4-22 varies widely and depends on site-specific factors as well as the intrinsic properties of the contaminant. These site-specific factors include site stratigraphy, hydraulic conductivity, porosity, and other factors. Much of the site-specific information needed to characterize mobility is not available and will need to be obtained during future field investigations. However, it is possible to make general statements about the relative mobility of the candidate contaminants of concern.

4.2.4.3.1 Transport to the Subsurface. The mobility of radionuclides and other inorganic elements in groundwater depends on the chemical form and charge of the element or molecule, which in turn depends on site-related factors such as the pH, redox state, and ionic composition of the groundwater. Cationic species (e.g., Cd^{2+}, Pu^{4+}) generally are retarded in their migration relative to groundwater to a greater extent than anionic species such as nitrate (NO_3^-). The presence in groundwater of complexing or chelating agents can increase the mobility of metals by forming neutral or negatively charged compounds.

The chemical properties of radionuclides are essentially identical to the nonradioactive form of the element; thus, discussions of the chemical properties affecting the transport of contaminants can apply to both radionuclides and nonradioactive chemicals.

A soil-water distribution coefficient (K_d) can be used to predict mobility of inorganic chemicals in the subsurface. Table 4-23 presents a summary of K_d values that have been developed for many of the inorganic chemicals of concern at the T Plant Aggregate Area. As discussed above, the pH and ionic strength of the leaching medium has an impact on the absorption of inorganics to soil; thus, the listed K_d values are valid only for a limited range of pH and waste composition. In addition, soil sorption of inorganics is highly dependent on the mineral composition of the soil, the ionic composition of the soil pore water, and other site-specific factors. Thus, a high degree of uncertainty is involved with use of K_d values that have not been verified by experimentation with site soils.

Serne and Wood (1990) recommended K_d values for use with Hanford waste assessments for a limited number of important radionuclides (americium, cesium, cobalt, copper, iodine, plutonium, ruthenium, strontium, and tritium) based on soil column or batch

desorption studies, and have proposed conservative average values for a more extensive list of elements based on a review of the literature. An assumed K_d values of <1 is recommended for americium, cesium, plutonium, and strontium under acidic conditions.

Strenge and Peterson (1989) developed default K_d values for a large number of elements for use in the Multimedia Environmental Pollution Assessment System (MEPAS), a computerized waste management unit evaluation system. The K_d values were based on findings in the scientific literature, and include non-site-specific as well as Hanford Site values. Values are provided for nine sets of environmental conditions: three ranges of waste pH and three ranges of soil adsorbent material (sum of percent clay, organic material, and metal hydrous oxides). The values presented in Table 4-23 are for conditions of neutral waste pH and less than 10% adsorbent material, which is likely to be most representative of Hanford Site soils.

The mobility of inorganic species in soil can be divided roughly into three classes using site-specific values (Serne and Wood 1990) where available and generic values otherwise: highly mobile ($K_d<5$), moderately mobile ($5<K_d<100$), and low mobility ($K_d>100$). Actual mobility of specific contaminants will be influenced by their valence state and ligands. Specific mobilities will be determined in future site investigations and will address these potential influences.

The tendency of organic compounds to adsorb to the organic fraction of soils is indicated by the soil organic matter partition coefficient, K_{oc}. Partition coefficients for the organic chemicals of concern at the T Plant Aggregate Area are listed in Table 4-24. Chemicals with low K_{oc} values are weakly absorbed by soils and will tend to migrate in the subsurface, although their rate of travel will be retarded somewhat relative to the pore water or groundwater flow. Soils at the Hanford Site have very little organic carbon content and thus sorption to the inorganic fraction of soils may dominate over sorption to soil organic matter.

4.2.4.3.2 Transport to Air. Transport of contaminants from waste management units to the atmosphere can occur by means of vapor transport or by fugitive dust emissions. Chemicals subject to transport via airborne dust dispersion are those that are non-volatile and persistent on the soil surface, including most radionuclides and inorganics, and some organics such as creosote and coal tar.

Chemicals subject to volatilization are mostly organic compounds; however, some of the radionuclides detected at the site are subject to evaporation and could be lost from shallow soils to the ambient air. The most important species in this category are ^{14}C, ^{3}H, and ^{129}I.

The tendency of an organic compound to volatilize can be predicted from its Henry's Law Constant, K_h, a measured or calculated parameter with units of atmospheres per cubic

meter per mole of chemical. Henry's Law Constants of the organic candidate contaminants of concern are presented in Table 4-24. Compounds with a K_h greater than about 10^{-3} will be lost rapidly to the atmosphere from surface water and shallow soils. Organic contaminants of concern that fall into this class include:

- Carbon tetrachloride
- Chloroform
- Methylene chloride
- Toluene
- Tributyl phosphate.

4.2.4.4 Persistence. Once released to environmental media, the concentration of a contaminant may decrease because of biological or chemical transformation, radioactive decay, or the intermediate transfer processes discussed above that remove the chemical from the medium (e.g., volatilization to air). Radiological, chemical, and biological decay processes affecting the persistence of the T Plant Aggregate Area contaminants of concern are discussed below.

The persistence of radionuclides depends primarily on their half-lives. A comparison of the half-lives and specific activities for most radionuclide contaminants of concern for T Plant is presented in Table 4-25. The specific activity is the decay rate per unit mass, and is inversely proportional to the half-life of the radionuclide. Half-lives for the radionuclides listed in Table 4-25 range from seconds to over one billion years. Also listed are the decay mechanisms of primary concern for the radionuclide. Note that radionuclides often undergo several decay steps in quick succession, (e.g., an alpha decay followed by release of one or more gamma rays). The daughter products of these decays are themselves often radioactive.

Decay will occur during transport (e.g., through the vadose zone to the aquifer, through the aquifer) and may lead to significant reductions in levels discharging to the Columbia River. For direct exposures (e.g., to surface soils or air), the half-life of the radionuclide is of less importance, unless the half-life is so short that the radionuclide undergoes substantial decay between the time of disposal and release to the environment.

Nonradioactive inorganic chemicals detected at the site are generally persistent in the environment, although they may decline in concentration due to transport processes or change their chemical form due to chemical or biological reactions. Nitrate undergoes chemical and biological transformations that may lead to its loss to the atmosphere (as N_2) or incorporation into living organisms, depending on the redox environment and microbiological communities present in the medium.

Biotransformation rates for organics vary widely and are highly dependent on site-specific factors such as soil moisture, redox conditions, and the presence of nutrients and of organisms capable of degrading the compound. Ketones, such as acetone and methyl isobutyl ketone (MIBK), are easily degraded by microorganisms in soil and thus would tend not to persist. Chlorinated solvents (e.g., carbon tetrachloride) may undergo slow biotransformation in the subsurface under anoxic conditions. Volatile aromatics such as toluene are generally intermediate in their biodegradability.

4.2.4.5 Toxicity. Contaminants may be of potential concern for impacts to human health if they are known or suspected to have carcinogenic properties, or if they have adverse noncarcinogenic human health effects. The toxicity characteristics of the chemicals detected at the aggregate area are summarized below.

4.2.4.5.1 Radionuclides. All radionuclides are classified by EPA as known human carcinogens based on their property of emitting ionizing radiation and on the evidence provided by epidemiological studies of radiation-induced cancers in humans. Non-carcinogenic health effects associated with radiation exposure include genetic and teratogenic effects; however, these effects generally occur at higher exposure levels than those required to induce cancer. Thus, the carcinogenic effect of radionuclides is the primary identified health concern for these chemicals (EPA 1989b).

Risks associated with radionuclides differ for various routes of exposure depending on the type of ionizing radiation emitted. Nuclides that emit alpha or beta particles are hazardous primarily if the materials are inhaled or ingested, since these particles expend their energy within a short distance after penetrating body tissues. Gamma-emitting radioisotopes, which deposit energy over much larger distances, are of concern as both external and internal hazards. A fourth mode of radioactive decay, neutron emission, is generally not of major health concern, since this mode of decay is much less frequent than other decay processes. In addition to the mode of radioactive decay, the degree of hazard from a particular radionuclide depends on the rate at which particles or gamma radiation are released from the material.

Excess cancer risks for exposure to the primary radionuclide contaminants of concern by inhaling air, drinking water, ingesting soil, and by external irradiation are shown in Table 4-31. These values represent the increase in probability of cancer to an individual exposed for a lifetime to a radionuclide at a level of 1 pCi/m^3 in air, 1 pCi/L in drinking water, 1 pCi/g in ingested soil, or to external radiation from soil having a radionuclide content of 1 pCi/g (EPA 1991b). These values are computed as the slope factor (risk per unit intake or exposure) multiplied by the inhalation or ingestion rate and the number of days in a 70 year lifetime (EPA 1991b).

For those radionuclides without EPA slope factors, the *Hanford Baseline Risk Assessment Methodology* (DOE/RL 1992b) will be consulted. This document proposes to

consult the EPA Office of Radiation Programs to request the development of a slope factor or to use the dose conversion factors developed by the International Commission on Radiological Protection to calculate a risk value. Any Hanford site risk assessments will be performed in accordance with the *Hanford Baseline Risk Assessment Methodology* document (DOE-RL 1992b) which includes the guidance established in the *Risk Assessment Guidance for Superfund* (EPA 1989a) and the *EPA Region 10 Supplement Risk Assessment Guidance for Superfund* (EPA 1991a).

The unit risk factors for different radionuclides are roughly proportional to their specific activities, but also incorporate factors to account for distribution of each radionuclide within various body organs, the type of radiation emitted, and the length of time that the nuclide is retained in the organ of interest.

Based on the factors listed in Table 4-26, the highest risk for exposure to 1 pCi/m^3 in air is from plutonium, americium and uranium isotopes, which are alpha emitters. Among the radionuclides contaminants of concern for the T Plant Aggregate Area, the highest risks from ingestion of soil at 1 pCi/g are for ^{227}Ac, ^{241}Am, ^{243}Am, ^{238}Pu, ^{244}Cm, ^{134}Cs, ^{129}I, ^{237}Np, ^{231}Pa, ^{226}Ra, ^{228}Ra, ^{229}Th, and the uranium isotopes. The primary gamma-emitters are ^{214}Bi, ^{60}Co, ^{134}Cs, ^{137}Cs (because of its metastable decay product, ^{137m}Ba), ^{152}Eu, ^{154}Eu, ^{239}Np, and ^{214}Pb. It is important to note that this table only presents unit risk factors for the listed radionuclides and does not include potential contributions from daughter products.

The standard EPA risk assessment methodology assumes that the probability of a carcinogenic effect increases linearly with dose at low dose levels, i.e., there is no threshold for carcinogenic response. The EPA methodology also assumes that the combined effect of exposure to multiple carcinogens is additive without regard to target organ or cancer mechanism. However, the additive risk resulting for radionuclides and carcinogenic chemicals should be computed separately (EPA 1989a).

4.2.4.5.2 Hazardous Chemicals. Carcinogenic and non-carcinogenic health effects associated with chemicals anticipated at the aggregate area are summarized in Table 4-27. The basis for these potential health effects are described in the respective reference documents and may be associated with either human or animal data. Health effects were developed according to the hierarchy established in the *Risk Assessment Guidance for Superfund* (EPA 1989a). References were consulted in the following order: IRIS (Integrated Risk Information System) (EPA 1991b), HEAST (Health Effects Assessment Summary Tables) (EPA 1991c), and other toxicity articles and documents.

Several of the chemicals have known toxic effects but no toxicity criterion is presently available. In some instances the criteria have been withdrawn by EPA pending review of the toxicological data and will be reissued at a future date. Chemicals with known toxicity for which toxicity factors are presently not available include lead, selenium, kerosene and tributyl phosphate.

4.2.4.6 Bioaccumulation potential. Contaminants may be of concern for exposure if they have a tendency to accumulate in plant or animal tissues at levels higher than those in the surrounding medium (bioaccumulation) or if their levels increase at higher trophic levels in the food chain (biomagnification). Contaminants may be bioaccumulated because of element-specific uptake mechanisms (e.g., incorporation of strontium into bone) or by passive partitioning into body tissues (e.g., concentration of organic chemicals in fatty tissues).

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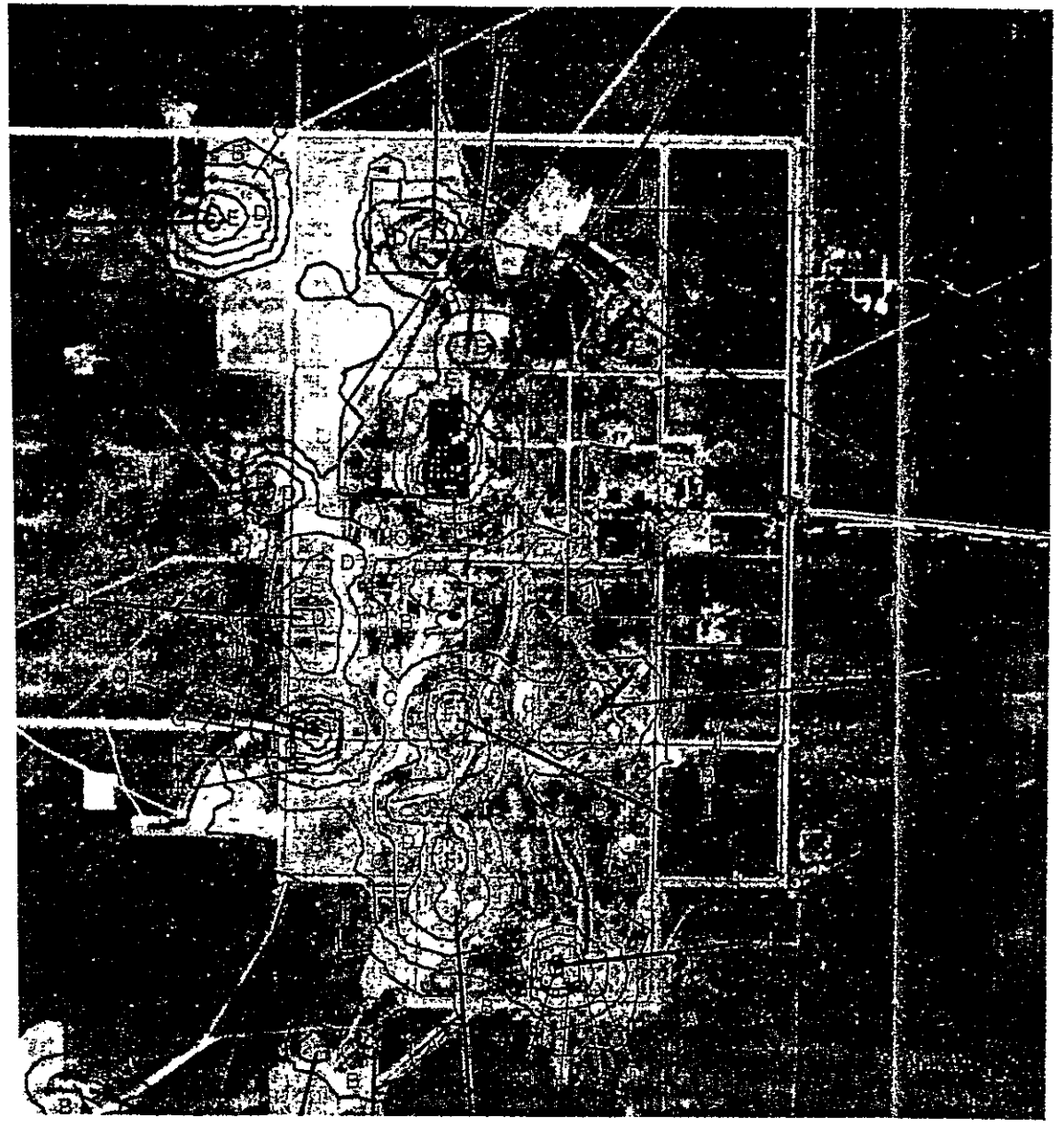

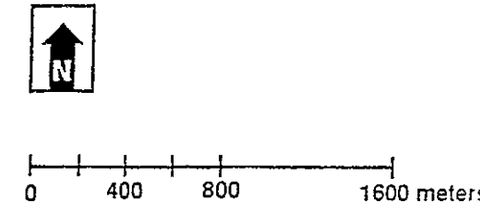

Zone A = <700 ct/s	Zone E = 22,000 to 70,000 ct/s
Zone B = 700 to 2,200 ct/s	Zone F = 70,000 to 220,000 ct/s
Zone C = 2,200 to 7,000 ct/s	Zone G = 220,000 to 700,000 ct/s
Zone D = 7,000 to 22,000 ct/s	Zone H = 700,000 to 2,200,000 ct/s
1 = 221-T Building	14 = 241-T Tank Farm
13 = 216-T-4B Pond	15 = 241-TX and 241-TY Tank Farms

Other numbers refer to sites outside the T Plant Aggregate Area.
T Plant Aggregate Area is outlined in red.
The results are displayed as relative levels of man-made radionuclide activity.

Figure 4-1. Gamma Isoradiation Contour Map of the 200 West Area. (Reiman and Dahlstrom 1988).

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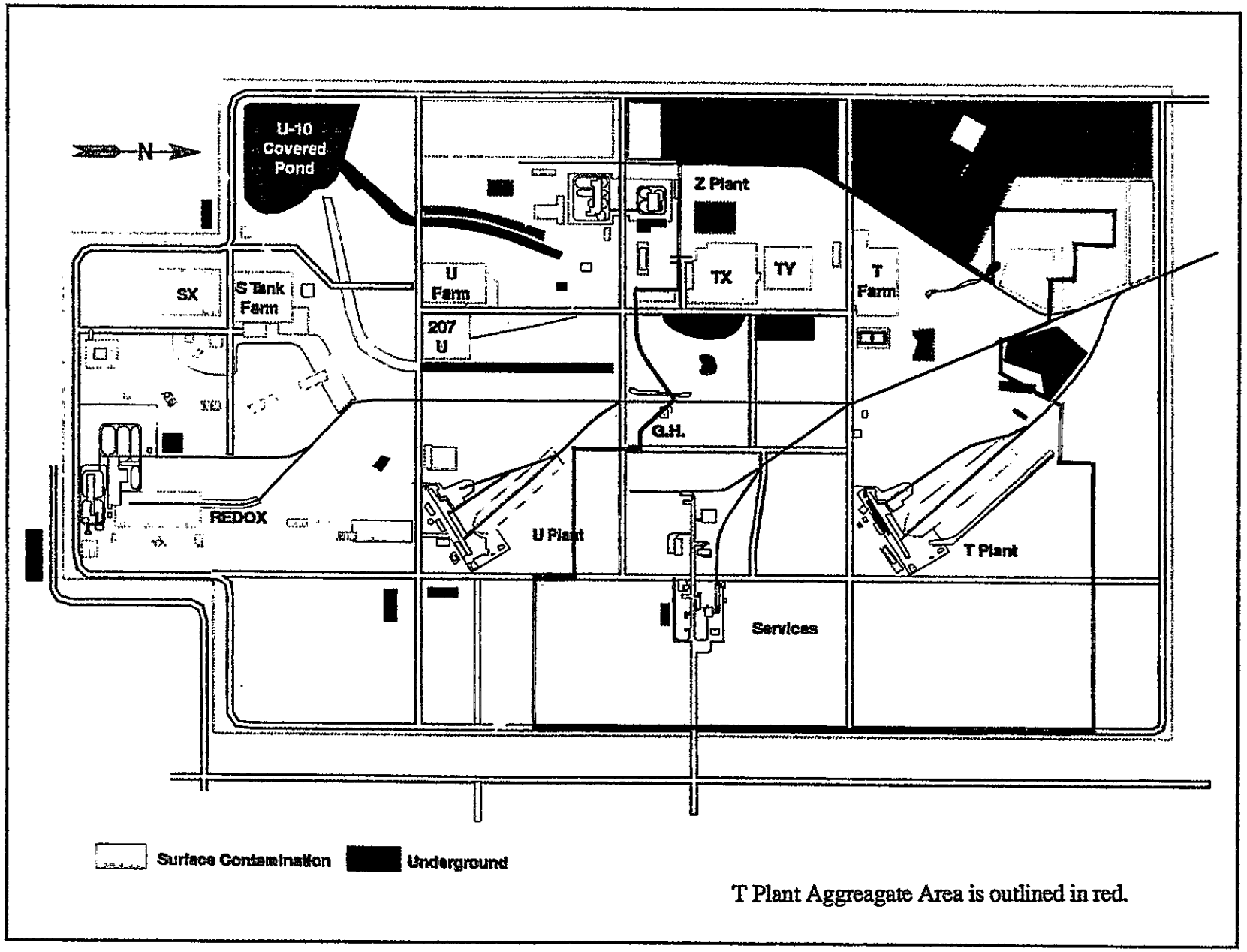


Figure 4-2. Surface, Underground, and Migrating Map of the 200 West Area. (Huckfeldt 1991b)

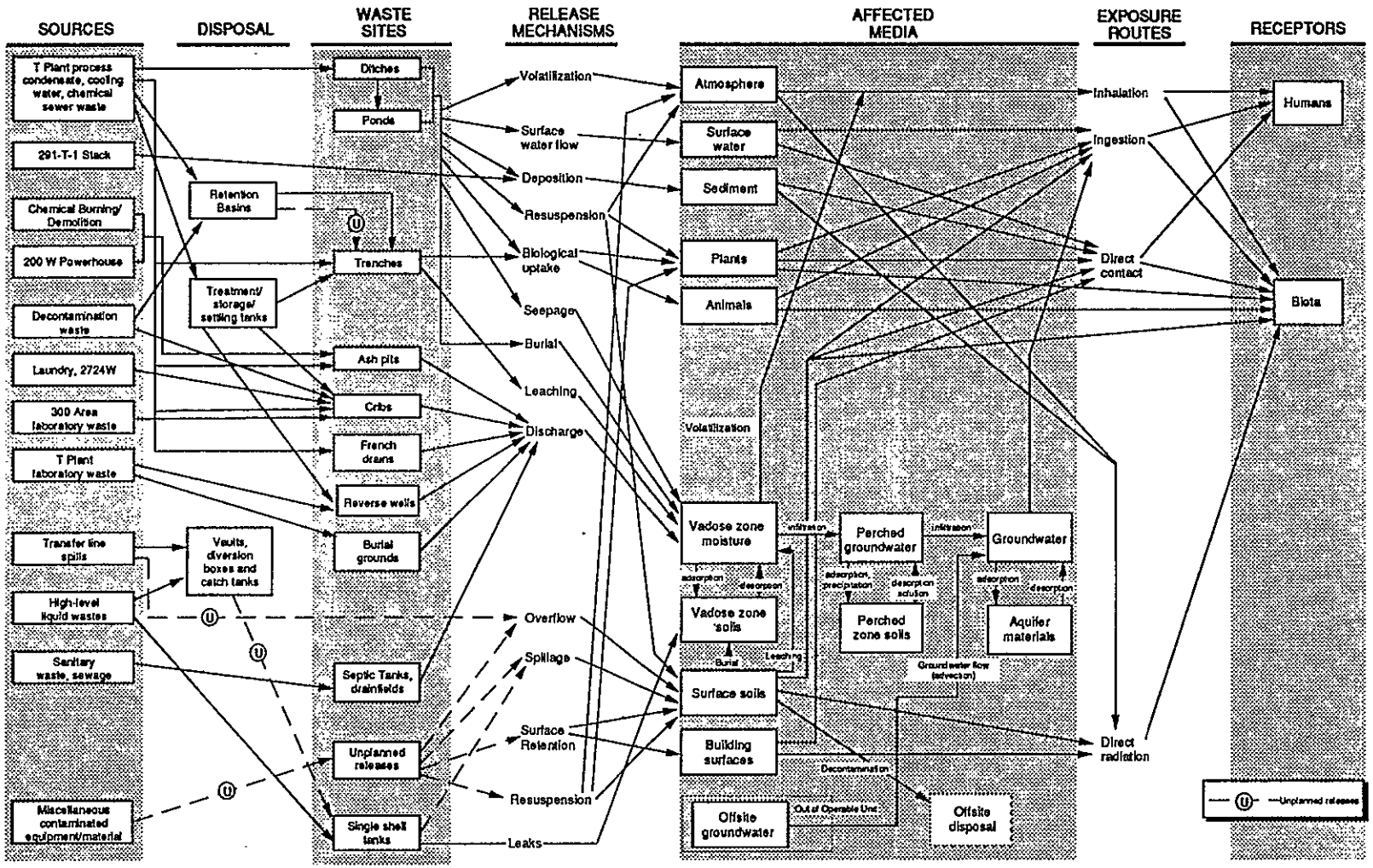
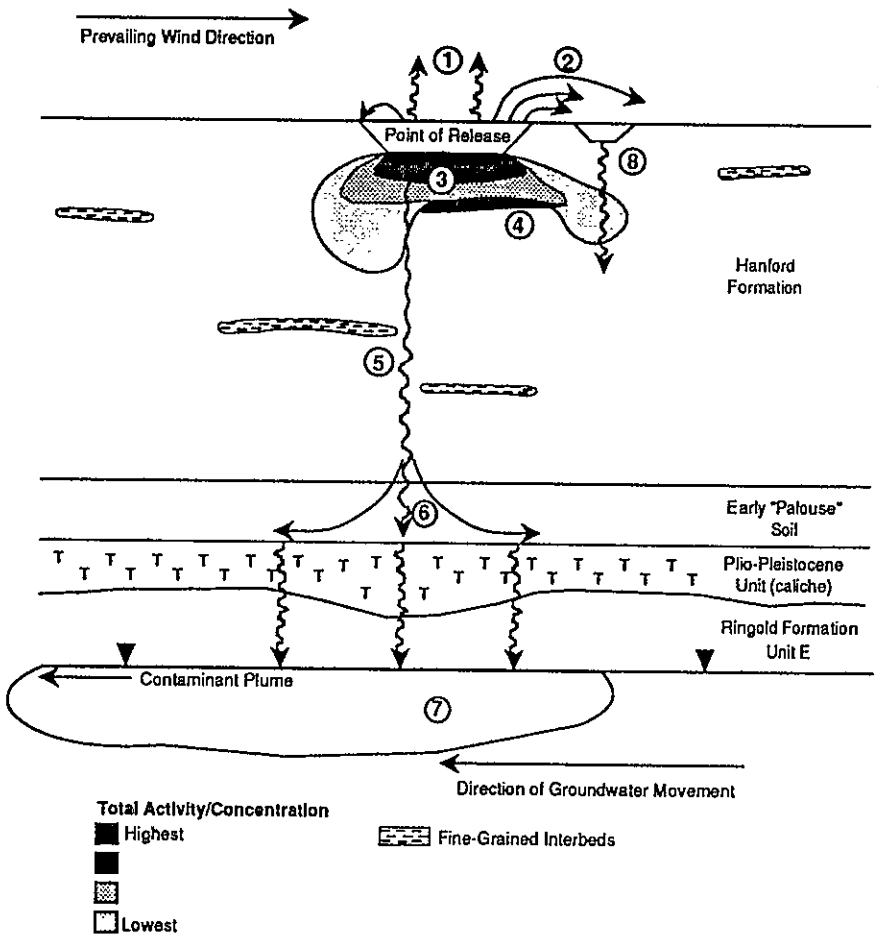


Figure 4-3. Conceptual Model of the T Plant Aggregate Area.

Figure 4-4. Physical Conceptual Model of Contaminant Distribution for Liquid Disposal Sites.



1. Some contaminants may volatilize and enter the atmosphere after release.
2. Wind may move contaminants laterally at the surface. For a surface release, this may occur immediately. For subsurface releases, contaminants must first be moved to the surface by biological activity.
3. The majority of contaminants are held in the vadose zone soils immediately beneath the point of release. The highest total activities will be immediately beneath the point of release and less mobile contaminants such as TRUs should be restricted to this area.
4. Thin discontinuous aquitards may cause small perched water zones. Some lateral migration of contaminants may occur above such a zone, particularly if it occurs close to the point of release.
5. The majority of liquid travels downward through the vadose zone carrying some more mobile contaminants such as fission products. Contaminants may be locally concentrated in fine-grained horizons, though at much lower concentrations than occur immediately beneath the point of release.
6. Some of the most mobile contaminants (tritium, cyanide, iodine, nitrates, nitrites, fluoride) reach the groundwater and may form contaminant plumes.
7. Perched water eventually percolates through the caliche layer or passes through gaps in the caliche and reaches the groundwater. Some of the most mobile contaminants (tritium, cyanide, iodine, nitrates, nitrites, fluoride) reach the groundwater and may form contaminant plumes.
8. Waste water from adjacent active waste management units may remobilize contaminants in the underlying vadose zone.

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Table 4-1. Summary of Known and Suspected Radionuclide Contamination.

Source Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone Soil Greater than 1 meter	Remarks
Tanks and Vaults						
241-T-101 Single-Shell Tank	--	K	--	--	K	FeCN tank line overflowed.
241-T-102 Single-Shell Tank	--	K	--	--	K	From 241-T-106 Single-Shell Tank leak.
241-T-103 Single-Shell Tank	--	K	--	--	K	Assumed leaker (UPR-200-W-147).
241-T-104 Single-Shell Tank	--	K	--	--	K	
241-T-105 Single-Shell Tank	--	K	--	--	K	Due to 241-T-106 Single-Shell Tank leak.
241-T-106 Single-Shell Tank	--	K	--	--	K	Confirmed leaker (UPR-200-W-148).
241-T-107 Single-Shell Tank	--	K	--	--	K	Assumed leaker.
241-T-108 Single-Shell Tank	--	K	--	--	K	Assumed leaker.
241-T-109 Single-Shell Tank	--	K	--	--	K	Assumed leaker.
241-T-110 Single-Shell Tank	--	S	--	--	S	H_2 build-up possible.
241-T-111 Single-Shell Tank	--	S	--	--	S	Assumed leaker.
241-T-112 Single-Shell Tank	--	--	--	--	--	
241-T-201 Single-Shell Tank	--	--	--	--	--	Received 224-U Building waste.
241-T-202 Single-Shell Tank	--	--	--	--	--	Received 224-U Building waste.
241-T-203 Single-Shell Tank	--	--	--	--	--	Received 224-U Building waste.

Table 4-1. Summary of Known and Suspected Radionuclide Contamination.

Source Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone Soil Greater than 1 meter	Remarks
241-T-204 Single-Shell Tank	--	--	--	--	--	Received 224-U Building waste.
241-TX-101 Single-Shell Tank	--	S	--	--	--	
241-TX-102 Single-Shell Tank	--	S	--	--	--	
241-TX-103 Single-Shell Tank	--	S	--	--	K	Due to 241-TX-107 Single-Shell Tank leak.
241-TX-104 Single-Shell Tank	--	S	--	--	--	
241-TX-105 Single-Shell Tank	--	S	--	--	--	Assumed leaker.
241-TX-106 Single-Shell Tank	--	S	--	--	--	
241-TX-107 Single-Shell Tank	--	S	--	--	K	Assumed leaker.
241-TX-108 Single-Shell Tank	--	S	--	--	--	
241-TX-109 Single-Shell Tank	--	S	--	--	--	
241-TX-110 Single-Shell Tank	--	S	--	--	S	Assumed leaker.
241-TX-111 Single-Shell Tank	--	S	--	--	--	
241-TX-112 Single-Shell Tank	--	S	--	--	--	
241-TX-113 Single-Shell Tank	--	S	--	--	S	Assumed leaker (UPR-200-W-129).
241-TX-114 Single-Shell Tank	--	S	--	--	K	Assumed leaker.

Table 4-1. Summary of Known and Suspected Radionuclide Contamination.

Source Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone Soil Greater than 1 meter	Remarks
241-TX-115 Single-Shell Tank	--	S	--	--	S	Assumed leaker.
241-TX-116 Single-Shell Tank	--	S	--	--	S	Assumed leaker.
241-TX-117 Single-Shell Tank	--	S	--	--	S	Assumed leaker.
241-TX-118 Single-Shell Tank	--	S	--	--	--	FeCN Tank
241-TY-101 Single-Shell Tank	--	S	--	--	S	Assumed leaker; FeCN tank.
241-TY-102 Single-Shell Tank	--	S	--	--	K	
241-TY-103 Single-Shell Tank	--	S	--	--	K	Confirmed leaker; FeCN tank.
241-TY-104 Single-Shell Tank	--	S	--	--	S	Assumed leaker (UPR-200-W-151).
241-TY-105 Single-Shell Tank	--	S	--	--	S	Assumed leaker (UPR-200-W-152).
241-TY-106 Single-Shell Tank	--	S	--	--	S	Assumed leaker (UPR-200-W-153).
241-T-361 Settling Tank	--	--	--	--	--	
241-T-301 Catch Tank	--	--	--	--	--	
241-T-302 Catch Tank	--	--	--	--	--	
241-TX-302A Catch Tank	--	--	--	--	--	
241-TX-302B Catch Tank	--	--	--	--	--	UPR-200-W-131 occurred here.
241-TX-302C Catch Tank	--	--	--	--	--	UPR-200-W-21 & -160 occurred here.

Table 4-1. Summary of Known and Suspected Radionuclide Contamination.

Source Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone Soil Greater than 1 meter	Remarks
241-TY-302A Catch Tank	--	K	--	--	--	
241-TY-302B Catch Tank	--	--	--	--	--	
244-TX Receiver Tank	--	--	--	--	--	
244-TXR Vault	--	--	--	--	--	
Cribs and French Drains						
216-T-6 Crib	--	K	--	--	K	
216-T-7TF Crib and Tile Field	--	K	--	--	K	
216-T-8 Crib	--	K	--	--	K	
216-T-18 Crib	--	R?	--	--	K	Stabilized in 1990.
216-T-19TF Crib and Tile Field	--	K	--	--	K	Received U Plant waste.
216-T-26 Crib	--	R?	--	R?	--	Stabilized in 1990.
216-T-27 Crib	--	R?	--	R?	--	Stabilized in 1990.
216-T-28 Crib	--	R?	--	R?	--	Stabilized in 1990.
216-T-29 Crib	--	--	--	--	--	
216-T-31 French Drain	--	R	--	--	--	Exhumed in 1959.
216-T-32 Crib	--	K	--	--	K	

Table 4-1. Summary of Known and Suspected Radionuclide Contamination.

Source Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone Soil Greater than 1 meter	Remarks
216-T-33 Crib	--	K	--	--	--	
216-T-34 Crib	--	R?	--	--	K	Stabilized 1990; received 300 Area laboratory waste.
216-T-35 Crib	--	K	--	--	K	Stabilized 1990; received 300 Area laboratory waste.
216-T-36 Crib	--	K	--	--	K	
216-W-LWC Crib	--	K	--	--	K	
Reverse Wells						
216-T-2 Reverse Well	--	K	--	--	K	
216-T-3 Reverse Well	--	R?	--	--	K	Ground surface decontaminated in 1975.
Ponds, Ditches, and Trenches						
216-T-4A Pond	--	R?	--	--	--	Radionuclides exhumed.
216-T-4B Pond	--	R?	--	--	--	Actively dredged since 1977.
216-T-1 Ditch	--	K	S	--	--	
216-T-4-1D Ditch	--	R?	K	--	S	Dredged in 1989.
216-T-4-2 Ditch	--	K	K	S	S	

Table 4-1. Summary of Known and Suspected Radionuclide Contamination.

Source Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone Soil Greater than 1 meter	Remarks
200-W Powerhouse Pond	--	--	--	--	--	
216-T-5 Trench	--	K	--	--	S	
216-T-9 Trench	--	R	--	--	--	Site exhumed in 1972.
216-T-10 Trench	--	R	--	--	--	Site exhumed in 1972.
216-T-11 Trench	--	R	--	--	--	Site exhumed in 1972.
216-T-12 Trench	--	K	--	--	S	
216-T-13 Trench	--	S	--	--	S	
216-T-14 Trench	--	K	--	R?	S	
216-T-15 Trench	--	K	--	R?	S	
216-T-16 Trench	--	K	--	R?	S	
216-T-17 Trench	--	K	--	R?	S	
216-T-20 Trench	--	R?	--	--	K	
216-T-21 Trench	--	K	--	R?	S	
216-T-22 Trench	--	K	--	R?	S	
216-T-23 Trench	--	K	--	R?	S	
216-T-24 Trench	--	K	--	R?	S	

Table 4-1. Summary of Known and Suspected Radionuclide Contamination.

Source Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone Soil Greater than 1 meter	Remarks
216-T-25 Trench	--	K	--	--	--	
Septic Tanks and Drain Fields						
2607-W1 Septic Tank	--	--	--	--	--	
2607-W2 Septic Tank	--	--	--	--	--	
2607-W3 Septic Tank	--	--	--	--	--	
2607-W4 Septic Tank	--	--	--	--	--	
2607-WT Septic Tank	--	--	--	--	--	
2607-WTX Septic Tank	--	--	--	--	--	
Transfer Facilities, Diversion Boxes, and Pipelines						
241-T-151 Diversion Box	--	--	--	--	--	No leaks reported.
241-T-152 Diversion Box	--	--	--	--	--	No leaks reported.
241-T-153 Diversion Box	--	--	--	--	--	No leaks reported.
241-T-252 Diversion Box	--	--	--	--	--	No leaks reported.
241-TR-152 Diversion Box	--	--	--	--	--	No leaks reported.
241-TR-153 Diversion Box	--	--	--	--	--	No leaks reported.
241-TX-152 Diversion Box	--	--	--	--	--	No leaks reported.

Table 4-1. Summary of Known and Suspected Radionuclide Contamination.

Source Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone Soil Greater than 1 meter	Remarks
241-TX-153 Diversion Box	--	--	--	--	--	UPR-200-W-126 occurred here.
241-TX-154 Diversion Box	--	K	--	--	--	Ground cave-in in process line.
241-TX-155 Diversion Box	--	--	--	--	--	UPR-200-W-5 & -28 occurred here.
241-TXR-151 Diversion Box	--	--	--	--	--	
241-TXR-152 Diversion Box	--	--	--	--	--	No leaks reported.
241-TXR-153 Diversion Box	--	--	--	--	--	No leaks reported.
241-TY-153 Diversion Box	--	--	--	--	--	No leaks reported.
242-T-151 Diversion Box	--	--	--	--	--	No leaks reported.
Basins						
207-T Retention Basin	--	K	--	--	--	
Burial Sites						
200-W Ash Disposal Basin	--	--	--	--	--	Chemical detonation site
200-W Ash Pit Demolition Site	--	--	--	--	--	
200-W Burning Pit	--	--	--	--	--	
200-W Powerhouse Ash Pit	--	--	--	--	--	
218-W-8 Burial Ground	--	S	--	--	S	

Table 4-1. Summary of Known and Suspected Radionuclide Contamination.

Source Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone Soil Greater than 1 meter	Remarks
Unplanned Releases						
UN-200-W-2	--	K	--	--	--	Failed waste line 10 ft. below surface.
UN-200-W-3	--	S	--	--	--	
UN-200-W-4	--	S	--	--	--	
UN-200-W-7	--	S	--	--	--	
UN-200-W-8	--	K	--	--	--	Covered with 10 ft of soil.
UN-200-W-14	--	K	--	--	--	Covered with 1 ft of soil.
UN-200-W-17	--	S	--	--	--	
UN-200-W-27	--	S	--	--	--	
UN-200-W-29	--	S	--	--	--	See UPR-200-W-93 also.
UN-200-W-38	--	S	--	--	--	
UN-200-W-58	--	S	--	--	--	
UN-200-W-62	--	S	--	--	--	Covered with sand and gravel.
UN-200-W-63	--	S	--	--	--	Covered with sand and gravel.
UN-200-W-64	--	S	--	--	--	
UN-200-W-65	--	S	--	--	--	
UN-200-W-67	--	S	--	--	--	
UN-200-W-73	--	S	--	--	--	

Table 4-1. Summary of Known and Suspected Radionuclide Contamination.

Source Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone Soil Greater than 1 meter	Remarks
UN-200-W-76	--	--	--	R?	--	Near 241-TX-155 diversion box.
UN-200-W-77	--	--	--	R?	--	
UN-200-W-85	--	R	--	R	--	Decontaminated to background levels.
UN-200-W-88	--	R	--	--	--	Contamination removed.
UN-200-W-97	--	K	--	--	--	
UN-200-W-98	--	K	--	K	--	
UN-200-W-99	--	K	--	--	--	Related to 241-TX-153 Diversion Box.
UN-200-W-100	--	S	--	--	--	Area covered with 1 ft of soil.
UN-200-W-102	--	S	--	--	--	
UN-200-W-113	--	S	--	--	--	
UN-200-W-135	--	S	--	--	--	
UPR-200-W-5	--	--	--	--	--	Removed from radiation zone status.
UPR-200-W-12	--	S	--	--	--	
UPR-200-W-21	--	S	--	--	--	
UPR-200-W-28	--	S	--	--	--	Leak from 241-TX-155 Diversion Box.
UPR-200-W-37	--	--	--	--	--	

Table 4-1. Summary of Known and Suspected Radionuclide Contamination.

Source Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone Soil Greater than 1 meter	Remarks
UPR-200-W-40	--	K	--	--	--	Leak from 241-TX 154 Diversion Box and 241-TX-302C Catch Tank.
UPR-200-W-70	--	K	--	--	--	200-W Burning Ground.
UPR-200-W-126	--	--	--	--	--	Employee contamination.
UPR-200-W-129	--	S	--	--	--	At 241-TX-113 Single-Shell Tank.
UPR-200-W-131	--	S	--	--	--	Leak from 241-TX-155 Diversion Box.
UPR-200-W-147	--	K	--	--	K	Near 241-T-103 Single-Shell Tank.
UPR-200-W-148	--	K	--	--	K	Leak from 241-T-106 Single-Shell Tank.
UPR-200-W-149	--	S	--	--	S	Possibly a leak from 241-TX-107 Single-Shell Tank.
UPR-200-W-150	--	S	--	--	S	Leak from 241-TY-103 Single-Shell Tank.
UPR-200-W-151	--	S	--	--	--	Leak from 241-TY-104 Single-Shell Tank.
UPR-200-W-152	--	S	--	--	S	Leak from 241-TY-105 Single-Shell Tank.
UPR-200-W-153	--	S	--	--	S	Leak from 241-TY-106 Single-Shell Tank.
UPR-200-W-160	--	K	--	--	S	

Notes:
S Suspected contamination, based on WIDS (WHC 1991a) and other waste inventory data.
K Known contamination based on chemical analytical data, WIDS (WHC 1991a), or other sources.
R Complete remediation reported.
R? Remediation attempted, effectiveness not documented.
-- No contamination indicated.

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Table 4-2. Summary of Chemical Contamination in Various Affected Media for T Plant Aggregate Area.

Source Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone	Remarks
Tanks and Vaults						
241-T-101 Single-Shell Tank	--	--	--	--	K	FeCN tank-line overflowed.
241-T-102 Single-Shell Tank	--	--	--	--	K	From 241-T-106 Single-Shell Tank leak.
241-T-103 Single-Shell Tank	--	--	--	--	K	Assumed leaker (UPR-200-W-147).
241-T-104 Single-Shell Tank	--	--	--	--	K	
241-T-105 Single-Shell Tank	--	--	--	--	K	Due to 241-T-106 Single-Shell Tank.
241-T-106 Single-Shell Tank	--	--	--	--	K	Confirmed leaker (UPR-200-W-148).
241-T-107 Single-Shell Tank	--	--	--	--	K	Assumed leaker.
241-T-108 Single-Shell Tank	--	--	--	--	K	Assumed leaker.
241-T-109 Singel-Shell Tank	--	--	--	--	K	Assumed leaker.
241-T-110 Single-Shell Tank	--	--	--	--	S	H_2 build-up possible.
241-T-111 Single-Shell Tank	--	--	--	--	S	Assumed leaker.
241-T-112 Single-Shell Tank	--	--	--	--	--	
241-T-201 Single-Shell Tank	--	--	--	--	--	Received 224-U Building waste.
241-T-202 Single-Shell Tank	--	--	--	--	--	Received 224-U Building waste.
241-T-203 Single-Shell Tank	--	--	--	--	--	Received 224-U Building waste.
241-T-204 Single-Shell Tank	--	--	--	--	--	Received 224-U Building waste.
241-TX-101 Single-Shell Tank	--	S	--	--	--	

Table 4-2. Summary of Chemical Contamination in Various Affected Media for T Plant Aggregate Area.

Source Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone	Remarks
241-TX-102 Single-Shell Tank	--	S	--	--	--	
241-TX-103 Single-Shell Tank	--	S	--	--	K	Due to 241-TX-107 Single-Shell Tank leak.
241-TX-104 Single-Shell Tank	--	S	--	--	--	
241-TX-105 Single-Shell Tank	--	S	--	--	S	Assumed leaker.
241-TX-106 Single-Shell Tank	--	S	--	--	--	
241-TX-107 Single-Shell Tank	--	S	--	--	K	Assumed leaker.
241-TX-108 Single-Shell Tank	--	S	--	--	--	
241-TX-109 Single-Shell Tank	--	S	--	--	--	
241-TX-110 Single-Shell Tank	--	S	--	--	S	Assumed leaker.
241-TX-111 Single-Shell Tank	--	S	--	--	--	
241-TX-112 Single-Shell Tank	--	S	--	--	--	
241-TX-113 Single-Shell Tank	--	S	--	--	S	Assumed leaker (UPR-200-W-129).
241-TX-114 Single-Shell Tank	--	S	--	--	S	Assumed leaker.
241-TX-115 Single-Shell Tank	--	S	--	--	S	Assumed leaker.
241-TX-116 Single-Shell Tank	--	S	--	--	S	Assumed leaker.
241-TX-117 Single-Shell Tank	--	S	--	--	S	Assumed leaker.
241-TX-118 Single-Shell Tank	--	S	--	--	--	Ferrocyanide Tank
241-TY-101 Single-Shell Tank	--	S	--	--	S	Assumed leaker; Ferrocyanide Tank.

Table 4-2. Summary of Chemical Contamination in Various Affected Media for T Plant Aggregate Area.

Source Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone	Remarks
241-TY-102 Single-Shell Tank	--	S	--	--	S	
241-TY-103 Single-Shell Tank	--	S	--	--	K	Confirmed leaker; ferrocyanide tank.
241-TY-104 Single-Shell Tank	--	S	--	--	S	Assumed leaker (UPR-200-W-151).
241-TY-105 Single-Shell Tank	--	S	--	--	S	Assumed leaker (UPR-200-W-152).
241-TY-106 Single-Shell Tank	--	S	--	--	S	Assumed leaker (UPR-200-W-153).
241-T-361 Settling Tank	--	--	--	--	--	
241-T-301 Catch Tank	--	--	--	--	--	
241-T-302 Catch Tank	--	--	--	--	--	
241-TX-302A Catch Tank	--	--	--	--	--	
241-TX-302B Catch Tank	--	--	--	--	--	UPR-200-W-131 occurred here.
241-TX-302C Catch Tank	--	--	--	--	--	UPR-200-W-21 & -160 occurred here.
241-TY-302A Catch Tank	--	K	--	--	--	
241-TY-302B Catch Tank	--	--	--	--	--	
244-TX Receiver Tank	--	--	--	--	--	
244-TXR Vault	--	--	--	--	--	

Table 4-2. Summary of Chemical Contamination in Various Affected Media for T Plant Aggregate Area.

Source Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone	Remarks
Cribs and French Drains						
216-T-6 Crib	--	K	--	--	K	
216-T-7TF Crib and Tile Field	--	K	--	--	K	
216-T-8 Crib	--	K	--	--	K	
216-T-18 Crib	--	R?	--	--	K	Stabilized in 1990.
216-T-19TF Crib and Tile Field	--	K	--	--	K	Received U Plant waste.
216-T-26 Crib	--	--	--	--	K	Stabilized in 1990.
216-T-27 Crib	--	--	--	--	K	Stabilized in 1990.
216-T-28 Crib	--	--	--	--	K	Stabilized in 1990.
216-T-29 Crib	--	--	--	--	--	
216-T-31 French Drain	--	--	--	--	--	Exhumed in 1959.
216-T-32 Crib	--	K	--	--	K	
216-T-33 Crib	--	K	--	--	K	
216-T-34 Crib	--	R?	--	--	K	Stabilized 1990; received 300 Area laboratory waste.
216-T-35 Crib	--	--	--	--	K	Stabilized 1990; received 300 Area laboratory waste.
216-T-36 Crib	--	--	--	--	K	
216-W-LWC Crib	--	--	--	--	S	

Table 4-2. Summary of Chemical Contamination in Various Affected Media for T Plant Aggregate Area.

Source Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone	Remarks
Reverse Wells						
216-T-2 Reverse Well	--	--	--	--	K	
216-T-3 Reverse Well	--	R?	--	--	K	
Ponds, Ditches, and Trenches						
216-T-4A Pond	--	R?	--	--	S	Radionuclides exhumed.
216-T-4B Pond	--	K	--	--	S	Actively dredged since 1977.
216-T-1 Ditch	--	K	S	--	--	
216-T-4-1D Ditch	--	R?	K	--	K	Dredged in 1989.
216-T-4-2 Ditch	--	K	K	--	K	
200-W Powerhouse Pond	--	--	--	--	--	
216-T-5 Trench	--	K	--	--	K	
216-T-9 Trench	--	R	--	--	R	Site exhumed in 1972.
216-T-10 Trench	--	R	--	--	R	Site exhumed in 1972.
216-T-11 Trench	--	R	--	--	R	Site exhumed in 1972.
216-T-12 Trench	--	K	--	--	K	
216-T-13 Trench	--	--	--	--	S	
216-T-14 Trench	--	K	--	--	K	
216-T-15 Trench	--	K	--	--	K	

Table 4-2. Summary of Chemical Contamination in Various Affected Media for T Plant Aggregate Area.

Source Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone	Remarks
216-T-16 Trench	--	K	--	--	K	
216-T-17 Trench	--	K	--	--	K	
216-T-20 Trench	--	R?	--	--	K	
216-T-21 Trench	--	--	--	--	K	
216-T-22 Trench	--	--	--	--	K	
216-T-23 Trench	--	--	--	--	K	
216-T-24 Trench	--	--	--	--	K	
216-T-25 Trench	--	--	--	--	K	
Septic Tanks and Drain Fields						
2607-W1 Septic Tank	--	--	--	--	--	
2607-W2 Septic Tank	--	--	--	--	--	
2607-W3 Septic Tank	--	--	--	--	--	
2607-W4 Septic Tank	--	--	--	--	--	
2607-WT Septic Tank	--	--	--	--	--	
2607-WTX Septic Tank	--	--	--	--	--	
Transfer Facilities, Diversion Boxes, and Pipelines						
241-T-151 Diversion Box	--	--	--	--	--	No leaks reported.
241-T-152 Diversion Box	--	--	--	--	--	No leaks reported.

Table 4-2. Summary of Chemical Contamination in Various Affected Media for T Plant Aggregate Area.

Source Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone	Remarks
241-T-153 Diversion Box	--	--	--	--	--	No leaks reported.
241-T-252 Diversion Box	--	--	--	--	--	No leaks reported.
241-TR-152 Diversion Box	--	--	--	--	--	No leaks reported.
241-TR-153 Diversion Box	--	--	--	--	--	No leaks reported.
241-TX-152 Diversion Box	--	--	--	--	--	No leaks reported.
241-TX-153 Diversion Box	--	--	--	--	--	UPR-200-W-126 occurred here.
241-TX-154 Diversion Box	--	K	--	--	--	Ground cave-in in process line.
241-TX-155 Diversion Box	--	--	--	--	--	UPR-200-W-5 & 28 occurred here.
241-TXR-151 Diversion Box	--	--	--	--	--	
241-TXR-152 Diversion Box	--	--	--	--	--	No leaks reported.
241-TXR-153 Diversion Box	--	--	--	--	--	No leaks reported.
241-TY-153 Diversion Box	--	--	--	--	--	No leaks reported.
242-T-151 Diversion Box	--	--	--	--	--	No leaks reported.
Basins						
207-T Retention Basin	--	K	--	--	S	

Table 4-2. Summary of Chemical Contamination in Various Affected Media for T Plant Aggregate Area.

Source Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone	Remarks
Burial Sites						
200-W Ash Disposal Basin	--	S	--	--	--	Chemical detonation site
200-W Ash Pit Demolition Site	--	--	--	--	--	
200-W Burning Pit	--	S	--	--	--	
200-W Powerhouse Ash Pit	--	--	--	--	--	
218-W-8 Burial Ground	--	S	--	--	S	
Unplanned Releases						
UN-200-W-2	--	K	--	--	S	Failed waste line 10 ft. below surface.
UN-200-W-3	--	S	--	--	--	
UN-200-W-4	--	S	--	--	--	
UN-200-W-7	--	S	--	--	--	
UN-200-W-8	--	K	--	--	--	Covered with 10 ft. of soil.
UN-200-W-14	--	K	--	--	S	Covered with 1 ft. of soil.
UN-200-W-17	--	S	--	--	--	
UN-200-W-27	--	S	--	--	--	
UN-200-W-29	--	S	--	--	S	See UPR-200-W-97 also.

Table 4-2. Summary of Chemical Contamination in Various Affected Media for T Plant Aggregate Area.

Source Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone	Remarks
UN-200-W-38	--	S	--	--	--	
UN-200-W-58	--	R?	--	--	--	
UN-200-W-62	--	R?	--	--	S	Covered with sand and gravel.
UN-200-W-63	--	R?	--	--	--	Covered with sand and gravel.
UN-200-W-64	--	S	--	--	--	
UN-200-W-65	--	S	--	--	--	
UN-200-W-67	--	S	--	--	--	
UN-200-W-73	--	S	--	--	--	
UN-200-W-76	--	--	--	--	--	Near 241-TX-155 diversion box.
UN-200-W-77	--	--	--	--	--	
UN-200-W-85	--	R	--	--	--	Decontaminated to background levels.
UN-200-W-88	--	R	--	--	--	Contamination removed.
UN-200-W-97	--	K	--	--	S	
UN-200-W-98	--	K	--	--	S	
UN-200-W-99	--	K	--	--	--	Related to 241-TX-153 diversion box.
UN-200-W-100	--	S	--	--	--	Area covered with 1 ft. soil.

Table 4-2. Summary of Chemical Contamination in Various Affected Media for T Plant Aggregate Area.

Source Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone	Remarks
UN-200-W-102	--	S	--	--	S	
UN-200-W-113	--	S	--	--	S	
UN-200-W-135	--	S	--	--	S	
UPR-200-W-5	--	--	--	--	--	Removed from radiation zone status.
UPR-200-W-12	--	S	--	--	--	
UPR-200-W-21	--	S	--	--	S	
UPR-200-W-28	--	S	--	--	--	Leak from 241-TX-155 diversion box.
UPR-200-W-37	--	--	--	--	--	
UPR-200-W-40	--	S	--	--	--	Leakage from 241-TX 154 diversion box and 241-TX-302C catch tank.
UPR-200-W-70	--	K	--	--	--	200-W Burning Ground.
UPR-200-W-126	--	--	--	--	--	Employee contamination.
UPR-200-W-129	--	S	--	--	--	At 241-TX-113 tank.
UPR-200-W-131	--	S	--	--	--	Leak from 241-TX-155 diversion box.
UPR-200-W-147	--	--	--	--	K	Near 241-T-103 tank.
UPR-200-W-148	--	--	--	--	K	Leak from 241-T-106 tank.
UPR-200-W-149	--	S	--	--	K	Possibly a leak from 241-TX-107 tank.
UPR-200-W-150	--	S	--	--	K	Leak from 241-TY-103 tank.
UPR-200-W-151	--	S	--	--	K	Leak from 241-TY-104 tank.

Table 4-2. Summary of Chemical Contamination in Various Affected Media for T Plant Aggregate Area.

Source Waste Management Unit	Air	Surface Soil (0-1 m)	Surface Water	Biota	Vadose Zone	Remarks
UPR-200-W-152	--	--	--	--	K	Leak from 241-TY-105 Single-Shell Tank.
UPR-200-W-153	--	S	S	--	K	Leak from 241-TY-106 Single-Shell Tank.
UPR-200-W-160	--	K	--	--	S	

Notes:

S Suspected contamination, based on WIDS (WHC 1991a) and other waste inventory data.
K Known contamination based on chemical analytical data, WIDS (WHC 1991a), or other sources.
R Complete remediation reported.
R? Remediation attempted, effectiveness not documented.
-- No contamination indicated.

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Table 4-3. Types of Data Available for each Waste Management Unit.

Waste Management Unit or Unplanned Release	Inventory	Surface Radiological Survey	Waste, Soil, Sediment Sampling	External Radiation Monitoring	Biota Sampling	Borehole Geophysics
Tanks and Vaults						
241-T-101 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-T-102 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-T-103 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-T-104 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-T-105 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-T-106 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-T-107 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-T-108 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-T-109 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-T-110 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-T-111 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-T-112 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-T-201 Single-Shell Tank	C	R	NA	NA	NA	NA
241-T-202 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-T-203 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-T-204 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-TX-101 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-TX-102 Single-Shell Tank	C,R	R	NA	NA	NA	NA

Table 4-3. Types of Data Available for each Waste Management Unit.

Waste Management Unit or Unplanned Release	Inventory	Surface Radiological Survey	Waste, Soil, Sediment Sampling	External Radiation Monitoring	Biota Sampling	Borehole Geophysics
241-TX-103 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-TX-104 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-TX-105 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-TX-106 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-TX-107 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-TX-108 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-TX-109 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-TX-110 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-TX-111 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-TX-112 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-TX-113 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-TX-114 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-TX-115 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-TX-116 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-TX-117 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-TX-118 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-TY-101 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-TY-102 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-TY-103 Single-Shell Tank	C,R	R	NA	NA	NA	NA

Table 4-3. Types of Data Available for each Waste Management Unit.

Waste Management Unit or Unplanned Release	Inventory	Surface Radiological Survey	Waste, Soil, Sediment Sampling	External Radiation Monitoring	Biota Sampling	Borehole Geophysics
241-TY-104 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-TY-105 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-TY-106 Single-Shell Tank	C,R	R	NA	NA	NA	NA
241-T-361 Settling Tank	R	NA	NA	NA	NA	NA
241-T-301 Catch Tank	NA	NA	NA	NA	NA	NA
241-T-302 Catch Tank	NA	NA	NA	NA	NA	NA
241-TX-302A Catch Tank	NA	NA	NA	NA	NA	NA
241-TX-302B Catch Tank	NA	NA	NA	NA	NA	NA
241-TX-302C Catch Tank	NA	NA	NA	NA	NA	NA
241-TY-302A Catch Tank	NA	NA	NA	NA	NA	NA
241-TY-302B Catch Tank	NA	NA	NA	NA	NA	NA
244-TX Receiver Tank	NA	NA	NA	NA	NA	NA
244-TXR Vault	NA	NA	NA	NA	NA	NA
Cribs and French Drains						
216-T-6 Crib	C,R	NA	NA	R	NA	NA
216-T-7TF Crib and Tile Field	C,R	NA	NA	R	NA	NA
216-T-8 Crib	C,R	NA	NA	R	NA	NA
216-T-18 Crib	C,R	NA	NA	NA	NA	NA
216-T-19TF Crib and Tile Field	C,R	R	NA	NA	NA	NA

Table 4-3. Types of Data Available for each Waste Management Unit.

Waste Management Unit or Unplanned Release	Inventory	Surface Radiological Survey	Waste, Soil, Sediment Sampling	External Radiation Monitoring	Biota Sampling	Borehole Geophysics
216-T-26 Crib	C,R	R	NA	NA	R	NA
216-T-27 Crib	C,R	R	NA	R	R	NA
216-T-28 Crib	C,R	R	NA	NA	R	NA
216-T-29 Crib	C	NA	NA	NA	NA	NA
216-T-31 French Drain	NA	NA	NA	NA	NA	NA
216-T-32 Crib	C,R	NA	NA	NA	NA	NA
216-T-33 Crib	C,R	R	NA	NA	NA	NA
216-T-34 Crib	C,R	R	NA	NA	NA	NA
216-T-35 Crib	C,R	R	NA	NA	NA	NA
216-T-36 Crib	C,R	R	NA	NA	NA	NA
216-W-LWC Crib	NA	NA	NA	NA	NA	NA
Reverse Wells						
216-T-2 Reverse Well	C	NA	NA	R	NA	NA
216-T-3 Reverse Well	C,R	NA	NA	NA	NA	NA
Ponds, Ditches, and Trenches						
216-T-4A Pond	NA	NA	NA	R	R	NA
216-T-4B Pond	R	NA	NA	R	R	NA
216-T-1 Ditch	C,R	NA	NA	R	NA	NA
216-T-4-1D Ditch	C,R	NA	NA	R	R	NA

Table 4-3. Types of Data Available for each Waste Management Unit.

Waste Management Unit or Unplanned Release	Inventory	Surface Radiological Survey	Waste, Soil, Sediment Sampling	External Radiation Monitoring	Biota Sampling	Borehole Geophysics
216-T-4-2 Ditch	C	NA	C,R	R	R	NA
200-W Powerhouse Pond	NA	NA	NA	NA	NA	NA
216-T-5 Trench	C,R	NA	NA	R	NA	NA
216-T-9 Trench	NA	NA	NA	NA	NA	NA
216-T-10 Trench	NA	NA	NA	NA	NA	NA
216-T-11 Trench	NA	NA	NA	NA	NA	NA
216-T-12 Trench	R	R	NA	R	NA	NA
216-T-13 Trench	NA	NA	R	NA	NA	NA
216-T-14 Trench	C,R	R	NA	R	R	NA
216-T-15 Trench	C,R	R	NA	NA	R	NA
216-T-16 Trench	C,R	R	NA	NA	R	NA
216-T-17 Trench	C,R	R	NA	NA	R	NA
216-T-20 Trench	C,R	NA	NA	NA	NA	NA
216-T-21 Trench	C,R	NA	NA	NA	R	NA
216-T-22 Trench	C,R	NA	NA	NA	R	NA
216-T-23 Trench	C,R	NA	NA	NA	R	NA
216-T-24 Trench	C,R	NA	NA	NA	R	NA
216-T-25 Trench	C,R	NA	NA	NA	NA	NA

Table 4-3. Types of Data Available for each Waste Management Unit.

Waste Management Unit or Unplanned Release	Inventory	Surface Radiological Survey	Waste, Soil, Sediment Sampling	External Radiation Monitoring	Biota Sampling	Borehole Geophysics
Septic Tanks and Drain Fields						
2607-W1 Septic Tank	NA	NA	NA	NA	NA	NA
2607-W2 Septic Tank	NA	NA	NA	NA	NA	NA
2607-W3 Septic Tank	NA	NA	NA	NA	NA	NA
2607-W4 Septic Tank	NA	NA	NA	NA	NA	NA
2607-WT Septic Tank	NA	NA	NA	NA	NA	NA
2607-WTX Septic Tank	NA	NA	NA	NA	NA	NA
Transfer Facilities, Diversion Boxes, and Pipelines						
241-T-151 Diversion Box	NA	NA	NA	NA	NA	NA
241-T-152 Diversion Box	NA	NA	NA	NA	NA	NA
241-T-153 Diversion Box	NA	NA	NA	NA	NA	NA
241-T-252 Diversion Box	NA	NA	NA	NA	NA	NA
241-TR-152 Diversion Box	NA	NA	NA	NA	NA	NA
241-TR-153 Diversion Box	NA	NA	NA	NA	NA	NA
241-TX-152 Diversion Box	NA	NA	NA	NA	NA	NA
241-TX-153 Diversion Box	NA	NA	NA	NA	NA	NA
241-TX-154 Diversion Box	NA	NA	NA	NA	NA	NA
241-TX-155 Diversion Box	NA	NA	NA	NA	NA	NA
241-TXR-151 Diversion Box	NA	NA	NA	NA	NA	NA

Table 4-3. Types of Data Available for each Waste Management Unit.

Waste Management Unit or Unplanned Release	Inventory	Surface Radiological Survey	Waste, Soil, Sediment Sampling	External Radiation Monitoring	Biota Sampling	Borehole Geophysics
241-TXR-152 Diversion Box	NA	NA	NA	NA	NA	NA
241-TXR-153 Diversion Box	NA	NA	NA	NA	NA	NA
241-TY-153 Diversion Box	NA	NA	NA	NA	NA	NA
242-T-151 Diversion Box	NA	NA	NA	NA	NA	NA
Basins						
207-T Retention Basin	C	NA	NA	NA	R	NA
Burial Sites						
200-W Ash Disposal Basin	NA	NA	NA	NA	NA	NA
200-W Ash Pit Demolition Site	NA	NA	NA	NA	NA	NA
200-W Burning Pit	C	NA	NA	NA	NA	NA
200-W Powerhouse Ash Pit	NA	NA	NA	NA	NA	NA
218-W-8 Burial Ground	C,R	NA	NA	NA	NA	NA
Unplanned Releases						
UN-200-W-2	NA	NA	NA	NA	NA	NA
UN-200-W-3	NA	NA	NA	NA	NA	NA
UN-200-W-4	NA	R	NA	NA	NA	NA
UN-200-W-7	NA	NA	NA	NA	NA	NA
UN-200-W-8	NA	R	NA	NA	NA	NA
UN-200-W-14	NA	NA	NA	NA	NA	NA

Table 4-3. Types of Data Available for each Waste Management Unit.

Waste Management Unit or Unplanned Release	Inventory	Surface Radiological Survey	Waste, Soil, Sediment Sampling	External Radiation Monitoring	Biota Sampling	Borehole Geophysics
UN-200-W-17	R	R	NA	NA	NA	NA
UN-200-W-27	NA	NA	NA	NA	NA	NA
UN-200-W-29	C, R	R	C,R	NA	NA	NA
UN-200-W-38	NA	R	NA	NA	NA	NA
UN-200-W-58	NA	R	NA	NA	NA	NA
UN-200-W-62	NA	R	NA	NA	NA	NA
UN-200-W-63	R	R	NA	R	NA	NA
UN-200-W-64	R	R	NA	NA	NA	NA
UN-200-W-65	NA	R	NA	NA	NA	NA
UN-200-W-67	NA	R	NA	NA	NA	NA
UN-200-W-73	NA	R	NA	NA	NA	NA
UN-200-W-76	R	NA	NA	NA	NA	NA
UN-200-W-77	R	R	NA	NA	R	NA
UN-200-W-85	NA	R	NA	NA	NA	NA
UN-200-W-88	C	NA	NA	NA	NA	NA
UN-200-W-97	NA	R	NA	NA	NA	NA
UN-200-W-98	C,R	R	NA	R	R	NA
UN-200-W-99	R	R	NA	NA	NA	NA
UN-200-W-100	C,R	R	NA	NA	NA	NA

Table 4-3. Types of Data Available for each Waste Management Unit.

Waste Management Unit or Unplanned Release	Inventory	Surface Radiological Survey	Waste, Soil, Sediment Sampling	External Radiation Monitoring	Biota Sampling	Borehole Geophysics
UN-200-W-102	C,R	NA	NA	NA	NA	NA
UN-200-W-113	NA	NA	NA	NA	R	NA
UN-200-W-135	R	R	NA	R	NA	NA
UN-200-W-137	NA	NA	NA	NA	NA	NA
UPR-200-W-5	NA	NA	NA	NA	NA	NA
UPR-200-W-12	NA	R	NA	R	NA	NA
UPR-200-W-21	NA	R	NA	NA	NA	NA
UPR-200-W-28	NA	NA	NA	NA	NA	NA
UPR-200-W-37	NA	R	NA	NA	NA	NA
UPR-200-W-40	NA	NA	NA	NA	NA	NA
UPR-200-W-70	NA	R	NA	NA	NA	NA
UPR-200-W-126	NA	R	NA	NA	NA	NA
UPR-200-W-129	C	R	NA	NA	NA	NA
UPR-200-W-131	C	R	NA	NA	NA	NA
UPR-200-W-147	NA	NA	NA	NA	NA	NA
UPR-200-W-148	C	NA	NA	NA	NA	NA
UPR-200-W-149	C	NA	NA	NA	NA	NA
UPR-200-W-150	C	NA	NA	NA	NA	NA
UPR-200-W-151	C	NA	NA	NA	NA	NA

Table 4-3. Types of Data Available for each Waste Management Unit. Page 10 of 10

Waste Management Unit or Unplanned Release	Inventory	Surface Radiological Survey	Waste, Soil, Sediment Sampling	External Radiation Monitoring	Biota Sampling	Borehole Geophysics
UPR-200-W-152	C	NA	NA	NA	NA	NA
UPR-200-W-153	C	NA	NA	NA	NA	NA
UPR-200-W-160	C,R	NA	NA	NA	NA	NA

Notes: C = Chemical-related data
R = Radionuclide-related data
NA = Not available

Table 4-4. Summary of Air Monitoring Results (pCi/m^3).

Radionuclide	Sampling Location				
	N153[a]	N161[a]	N177[a]	N986[a]	N987[a]
^{90}Sr	6.50×10^{-04}	6.46×10^{-04}	8.20×10^{-04}	3.74×10^{-04}	1.75×10^{-04}
^{137}Cs	3.05×10^{-03}	1.54×10^{-04}	2.58×10^{-04}	7.23×10^{-04}	5.47×10^{-04}
^{239}Pu	2.88×10^{-05}	2.27×10^{-05}	3.28×10^{-05}	2.35×10^{-05}	6.88×10^{-06}
U (total)	3.52×10^{-05}	2.36×10^{-05}	1.15×10^{-04}	3.15×10^{-05}	2.48×10^{-05}

[a] Values are averages for each year with a detection since 1985.
See Appendix A for complete data set.
See Plate 3 for sampling locations.

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Table 4-5. Radiation and Dose Rate Surveys at the T Plant Aggregate Area Waste Management Units.

Radiation Surveys					
Waste Management Unit	ct/min	dis/min	mrem/h	Survey Date	Radiation Type
Tanks and Vaults					
241-T-361 Settling Tank	NA	NA	NA	–	–
241-T-301 Catch Tank	NA	NA	NA	–	–
241-T-302 Catch Tank	NA	NA	NA	–	–
241-TX-302A Catch Tank	NA	NA	NA	–	–
241-TX-302B Catch Tank	NA	NA	NA	–	–
241-TX-302C Catch Tank	NA	NA	NA	–	–
241-TY-302A Catch Tank	NA	NA	NA	–	–
241-TY-302B Catch Tank	NA	NA	NA	–	–
244-TXR Receiver Tank	NA	NA	NA	–	–
244-TXR Vault	NA	NA	NA	–	–
Cribs and French Drains					
216-T-6 Crib	NC	NC	NC	June 1990	–
216-T-7TF Crib and Tile Field	NC	NC	NC	Oct. 1987	–
216-T-8 Crib	NC	NC	NC	June 1990	–
216-T-18 Crib	NC	NC	NC	June 1990	–
216-T-19TF Crib and Tile Field	–	3,000	–	Oct. 1989	β, γ
216-T-26 Crib	–	5,000	–	Oct. 1989	β, γ

Table 4-5. Radiation and Dose Rate Surveys at the T Plant Aggregate Area Waste Management Units.

Radiation Surveys					
Waste Management Unit	ct/min	dis/min	mrem/h	Survey Date	Radiation Type
216-T-27 Crib	–	50,000	25	Oct. 1989	Unknown
216-T-28 Crib	–	50,000	–	Oct. 1989	Unknown
216-T-29 Crib	NA	NA	NA	–	–
216-T-31 French Drain	NA	NA	NA	–	–
216-T-32 Crib	NC	NC	NC	Oct. 1987	–
216-T-33 Crib	–	3,000	–	June 1990	Unknown
216-T-34 Crib	–	100,000	–	June 1990	Unknown
216-T-35 Crib	NC	NC	NC	June 1990	–
216-T-36 Crib	NC	NC	NC	June 1990	–
216-W-LWC Crib	NC	NC	NC	Jan. 1990	–
Reverse Wells					
216-T-2 Reverse Well	NC	NC	NC	June 1990	–
216-T-3 Reverse Well	NC	NC	NC	June 1990	–
Ponds, Ditches, and Trenches					
216-T-4A Pond	NA	NA	NA	–	–
216-T-4B Pond	NA	NA	NA	–	–
216-T-1 Ditch	NC	NC	NC	Nov. 1990	–
216-T-4-1D Ditch	NC	NC	NC	Feb. 1990	–

Table 4-5. Radiation and Dose Rate Surveys at the T Plant Aggregate Area Waste Management Units.

Radiation Surveys					
Waste Management Unit	ct/min	dis/min	mrem/h	Survey Date	Radiation Type
216-T-4-2 Ditch	NC	NC	NC	Feb. 1989	–
200-W Powerhouse Pond	NA	NA	NA	–	–
216-T-5 Trench	NC	NC	NC	Oct. 1987	–
216-T-9 Trench	NA	NA	NA	–	–
216-T-10 Trench	NA	NA	NA	–	–
216-T-11 Trench	NA	NA	NA	–	–
216-T-12 Trench	500	–	–	June 1984	β, γ
216-T-13 Trench	NA	NA	NA	–	–
216-T-14 Trench	–	4,000	–	Jan. 1990	β, γ
216-T-15 Trench	–	4,000	–	Jan. 1990	β, γ
216-T-16 Trench	–	4,000	–	Jan. 1990	β, γ
216-T-17 Trench	–	4,000	–	Jan. 1990	β, γ
216-T-20 Trench	NC	NC	NC	June 1990	–
216-T-21 Trench	NC	NC	NC	Dec. 1990	–
216-T-22 Trench	NC	NC	NC	Dec. 1990	–
216-T-23 Trench	NC	NC	NC	Dec. 1990	–
216-T-24 Trench	NC	NC	NC	Dec. 1990	–
216-T-25 Trench	NC	NC	NC	Dec. 1990	–

Table 4-5. Radiation and Dose Rate Surveys at the T Plant Aggregate Area Waste Management Units.

Radiation Surveys					
Waste Management Unit	ct/min	dis/min	mrem/h	Survey Date	Radiation Type
Septic Tanks and Drain Fields					
2607-W1 Septic Tank	NA	NA	NA	–	–
2607-W2 Septic Tank	NA	NA	NA	–	–
2607-W3 Septic Tank	NA	NA	NA	–	–
2607-W4 Septic Tank	NA	NA	NA	–	–
2607-WT Septic Tank	NA	NA	NA	–	–
2607-WTX Septic Tank	NA	NA	NA	–	–
Transfer Facilities, Diversion Boxes, and Pipelines					
241-T-151 Diversion Box	NA	NA	NA	–	–
241-T-152 Diversion Box	NA	NA	NA	–	–
241-T-153 Diversion Box	NA	NA	NA	–	–
241-T-252 Diversion Box	NA	NA	NA	–	–
241-TR-152 Diversion Box	NA	NA	NA	–	–
241-TR-153 Diversion Box	NA	NA	NA	–	–
241-TX-152 Diversion Box	NA	NA	NA	–	–
241-TX-153 Diversion Box	NA	NA	NA	–	–
241-TX-154 Diversion Box	NA	NA	NA	–	–
241-TX-155 Diversion Box	NA	NA	NA	–	–

Table 4-5. Radiation and Dose Rate Surveys at the T Plant Aggregate Area Waste Management Units.

Radiation Surveys					
Waste Management Unit	ct/min	dis/min	mrem/h	Survey Date	Radiation Type
241-TXR-151 Diversion Box	NA	NA	NA	–	–
241-TXR-152 Diversion Box	NA	NA	NA	–	–
241-TXR-153 Diversion Box	NA	NA	NA	–	–
241-TY-153 Diversion Box	NA	NA	NA	–	–
242-T-151 Diversion Box	NA	NA	NA	–	–
Basins					
207-T Retention Basin	NC	NC	NC	July 1990	–
Burial Sites					
200-W Ash Disposal Basin	NA	NA	NA	–	–
200-W Ash Pit Demolition Site	NA	NA	NA	–	–
200-W Burning Pit	NA	NA	NA	–	–
200-W Powerhouse Ash Pit	NA	NA	NA	–	–
218-W-8 Burial Ground	NC	NC	NC	July 1990	–
Unplanned Releases					
UN-200-W-2	NA	NA	NA	–	–
UN-200-W-3	NA	NA	NA	–	–
UN-200-W-4	NA	NA	NA	–	–
UN-200-W-7	NA	NA	NA	–	–

Table 4-5. Radiation and Dose Rate Surveys at the T Plant Aggregate Area Waste Management Units.

Radiation Surveys					
Waste Management Unit	ct/min	dis/min	mrem/h	Survey Date	Radiation Type
UN-200-W-8	NA	NA	NA	–	–
UN-200-W-14	NA	NA	NA	–	–
UN-200-W-17	NA	NA	NA	–	–
UN-200-W-27	NA	NA	NA	–	–
UN-200-W-29	NA	NA	NA	–	–
UN-200-W-38	NA	NA	NA	–	–
UN-200-W-58	NA	NA	NA	–	–
UN-200-W-62	NA	NA	NA	–	–
UN-200-W-63	NA	NA	NA	–	–
UN-200-W-64	NA	NA	NA	–	–
UN-200-W-65	NA	NA	NA	–	–
UN-200-W-67	NA	NA	NA	–	–
UN-200-W-73	NA	NA	NA	–	–
UN-200-W-76	NA	NA	NA	–	–
UN-200-W-77	NA	NA	NA	–	–
UN-200-W-85	NA	NA	NA	–	–
UN-200-W-88	NA	NA	NA	–	–
UN-200-W-97	600	–	–	Dec. 1990	β, γ

Table 4-5. Radiation and Dose Rate Surveys at the T Plant Aggregate Area Waste Management Units.

Radiation Surveys					
Waste Management Unit	ct/min	dis/min	mrem/h	Survey Date	Radiation Type
UN-200-W-98	300	–	–	Oct. 1990	β, γ
UN-200-W-99	4,000	–	–	Sept. 1989	β, γ
UN-200-W-100	NA	NA	NA	–	–
UN-200-W-102	NC	NC	NC	Oct. 1975	–
UN-200-W-113	NC	NC	NC	Dec. 1990	–
UN-200-W-135	NA	NA	NA	–	–
UPR-200-W-5	NA	NA	NA	–	–
UPR-200-W-12	NA	NA	NA	–	–
UPR-200-W-21	NA	NA	NA	–	–
UPR-200-W-28	NA	NA	NA	–	–
UPR-200-W-37	NA	NA	NA	–	–
UPR-200-W-40	NA	NA	NA	–	–
UPR-200-W-70	NA	NA	NA	–	–
UPR-200-W-126	NA	NA	NA	–	–
UPR-200-W-129	NA	NA	NA	–	–
UPR-200-W-131	NA	NA	NA	–	–
UPR-200-W-147	NA	NA	NA	–	–
UPR-200-W-148	NA	NA	NA	–	–

Table 4-5. Radiation and Dose Rate Surveys at the T Plant Aggregate Area Waste Management Units.

Radiation Surveys					
Waste Management Unit	ct/min	dis/min	mrem/h	Survey Date	Radiation Type
UPR-200-W-149	NA	NA	NA	–	–
UPR-200-W-150	NA	NA	NA	–	–
UPR-200-W-151	NA	NA	NA	–	–
UPR-200-W-152	NA	NA	NA	–	–
UPR-200-W-153	NA	NA	NA	–	–
UPR-200-W-160	NA	NA	NA	–	–

NA No data available.
NC No contamination detected.
– Not applicable

Table 4-6. Results of External Radiation Monitoring, 1985-1990: TLDs (mrem/yr).

Location		Readings in mrem/yr						
		1985	1986	1987	1988	1989	1990	Average Total
274-W	max	--	--	--	--	--	88	
	min	--	--	--	--	--	38	
	total	--	--	--	--	--	73	73
218-W-2A	max	--	--	--	--	--	124	
	min	--	--	--	--	--	100	
	total	--	--	--	--	--	108	108
221-T East	max	--	--	--	--	--	124	
	min	--	--	--	--	--	104	
	total	--	--	--	--	--	109	109
241-TX Tank Farm East	max	--	--	--	--	--	160	
	min	--	--	--	--	--	136	
	total	--	--	--	--	--	147	147
2W2	max	160	178	131	156	--	--	156
	min	96	134	106	123	--	--	115
	total	126	152	118	133	--	--	132
2W3	max	80	93	105	118	--	--	99
	min	64	65	79	90	--	--	75
	total	74	76	89	101	--	--	85
2W4	max	82	96	100	114	--	--	98
	min	64	74	80	92	--	--	78
	total	73	81	88	99	--	--	85
2W5	max	80	97	107	105	--	--	97
	min	64	64	77	93	--	--	75
	total	73	78	90	99	--	--	85
2W7	max	98	118	115	136	120	--	117
	min	69	74	91	94	60	--	77
	total	85	93	102	110	99	--	98
2W9	max	84	106	107	123	--	--	105
	min	69	70	80	97	--	--	79
	total	76	85	92	109	--	--	91

Table 4-6. Results of External Radiation Monitoring, 1985-1990: TLDs (mrem/yr). Page 2 of 2

Location		Readings in mrem/yr						
		1985	1986	1987	1988	1989	1990	Average Total
2W10								
	max	77	101	109	115	--	--	101
	min	59	66	83	92	--	--	75
	total	71	78	91	100	--	--	85
2W12								
	max	76	89	99	125	--	--	97
	min	62	64	69	89	--	--	71
	total	68	74	82	101	--	--	81
2W13								
	max	141	169	145	196	160	--	162
	min	69	101	117	125	96	--	127
	total	105	131	135	150	133	--	131
2W14								
	max	71	90	98	101	--	--	90
	min	58	60	72	86	--	--	69
	total	64	70	83	92	--	--	77
2W15								
	max	84	107	122	111	--	--	106
	min	64	66	80	90	--	--	75
	total	76	81	96	100	--	--	88
2W19								
	max	80	94	116	109	--	--	100
	min	62	63	79	85	--	--	72
	total	72	74	96	96	--	--	85
2W20								
	max	76	104	117	124	--	--	105
	min	62	64	80	93	--	--	75
	total	71	80	93	105	--	--	87

Notes:
-- indicates results not reported.
Monthly/quarterly dose rates normalized to annual dose rate equivalent.
max - maximum quarterly value reported.
min - minimum quarterly value reported.
total - annual average value reported.
Data Sources: Elder et al. 1986 through 1989, Schmidt et al. 1990 and 1992.
See Plate 3 for sample locations.

Table 4-7. Summary of Grid Soil Sampling Results for Radionuclides (pCi/g).

Radionuclide	Sampling Locations						
	2W2[a/]	2W3[a/]	2W4[a/]	2W5[a/]	2W7[a/]	2W8[a/]	2W9[a/]
^{7}Be	--	--	--	--	--	--	--
^{141}Ce	0.00E+00	--	1.40E-02	--	-5.63E-02	2.35E-02	1.03E-02
^{144}Ce	0.00E+00	--	2.80E-02	--	-2.48E-02	-2.33E-01	2.81E-02
^{58}Co	0.00E+00	1.30E-01	4.96E-02	--	-6.28E-03	-7.41E-03	6.94E-03
^{60}Co	-4.60E-03	-1.50E-03	-1.15E-03	3.65E-02	7.59E-03	8.66E-02	7.57E-03
^{134}Cs	0.00E+00	5.00E-02	1.80E-02	7.00E-02	-2.23E-01	-1.07E-03	9.07E-03
^{137}Cs	6.40E+00	1.74E+00	1.89E+00	1.98E+00	4.51E+00	4.75E+01	4.91E+00
^{152}Eu	5.90E-02	9.80E-02	1.68E-01	1.59E-01	7.55E-02	1.35E-01	1.10E-01
^{154}Eu	-2.30E-02	1.80E-02	-4.00E-03	-3.40E-02	-2.90E-02	3.58E-02	1.23E-02
^{155}Eu	5.50E-02	2.60E-02	5.60E-02	4.40E-02	3.31E-02	-2.27E-02	7.99E-02
^{129}I	--	--	--	--	-1.58E-02	-1.74E+00	-9.97E-01
^{40}K	--	--	--	--	--	--	--
^{54}Mn	1.30E-02	1.70E-02	1.27E-02	4.10E-02	2.07E-02	2.01E-02	1.15E-02
^{95}Nb	-3.20E-02	3.90E-03	-3.40E-03	-2.90E-02	-4.88E-02	-9.56E-03	-2.32E-02
^{212}Pb	--	--	--	--	--	--	--

Table 4-7. Summary of Grid Soil Sampling Results for Radionuclides (pCi/g).

Radionuclide	Sampling Locations						
	2W2[a/]	2W3[a/]	2W4[a/]	2W5[a/]	2W7[a/]	2W8[a/]	2W9[a/]
^{214}Pb	6.00E-01	6.20E-01	6.60E-01	7.80E-01	5.36E-01	5.64E-01	5.36E-01
^{238}Pu	1.70E-03	1.07E-03	3.11E-03	2.53E-03	3.41E-03	4.93E-03	1.10E-02
^{239}Pu	7.90E-01	9.23E-02	2.50E-01	1.60E-01	5.63E-02	1.01E-01	1.26E+00
^{225}Ra	--	--	--	--	--	--	--
$^{105/106}Ru$	6.10E-02	0.00E+00	2.92E-01	2.30E-02	1.44E-01	-7.66E-02	-5.15E-02
^{125}Sb	--	--	--	--	--	--	--
^{90}Sr	9.10E-01	5.43E-01	9.03E-01	7.20E-01	4.39E-01	1.07E+00	1.96E+00
^{99}Tc	--	--	--	--	1.27E-01	3.47E-01	5.03E-02
U	3.00E-01	3.50E-01	4.13E-01	4.10E-01	3.17E-01	3.36E-01	2.59E-01
^{235}U	--	--	--	--	--	--	--
^{238}U	--	--	--	--	--	--	--
^{65}Zn	--	4.40E-01	-2.20E-02	--	-1.04E-01	-6.15E-02	-3.82E-02
^{95}Zr	3.70E-03	2.00E-02	5.00E-03	1.10E-02	-1.67E-03	1.27E-02	3.49E-02

Table 4-7. Summary of Grid Soil Sampling Results for Radionuclides (pCi/g).

Radionuclide	Sampling Locations						
	2W10[a/]	2W12[a/]	2W13[a/]	2W14[a/]	2W15[a/]	2W19[a/]	2W20[a/]
^{7}Be	--	--	--	--	--	--	--
^{141}Ce	--	--	-4.07E-02	-1.69E-02	6.50E-03	1.27E-01	--
^{144}Ce	--	--	-1.02E-01	3.06E-02	2.60E-02	8.60E-02	--
^{58}Co	3.00E-02	--	1.20E-02	3.03E-02	-4.60E-04	-7.90E-04	--
^{60}Co	1.20E-02	-1.20E-02	-5.62E-03	2.52E-02	1.01E-02	2.80E-02	-1.00E-02
^{134}Cs	6.50E-02	6.00E-02	2.41E-02	4.18E-02	6.20E-02	6.70E-02	8.00E-02
^{137}Cs	1.44E+00	1.11E+00	1.88E+01	2.93E+00	3.03E+00	7.38E+00	1.74E+00
^{152}Eu	1.35E-01	9.20E-02	6.73E-02	8.72E-02	1.18E-01	1.67E-01	1.30E-01
^{154}Eu	-2.80E-02	2.90E-03	2.36E-02	-1.17E-02	6.66E-02	6.74E-02	-2.92E-02
^{155}Eu	7.95E-02	7.30E-02	3.82E-02	2.33E-02	5.00E-02	5.75E-02	7.80E-02
^{129}I	--	--	-1.43E+00	-2.29E-01	--	--	--
^{40}K	--	--	--	--	--	--	--
^{54}Mn	1.30E-03	1.59E-01	8.11E-03	5.30E-03	-8.75E-03	1.35E-02	-5.20E-03

Table 4-7. Summary of Grid Soil Sampling Results for Radionuclides (pCi/g).

Radionuclide	Sampling Locations						
	2W10[a]	2W12[a]	2W13[a]	2W14[a]	2W15[a]	2W19[a]	2W20[a]
^{95}Nb	-2.00E-02	-1.80E-02	-1.95E-02	1.43E-02	-9.20E-03	-3.20E-02	-9.10E-03
$^{212/214}Pb$	6.60E-01	5.30E-01	6.17E-01	6.92E-01	7.60E-01	6.30E-01	6.90E-01
^{238}Pu	2.60E-03	2.17E-03	1.87E-03	3.57E-03	6.68E-03	9.18E-03	4.30E-03
^{239}Pu	2.97E-01	9.77E-02	1.06E-01	2.79E-01	6.68E-01	4.45E-01	2.33E-01
^{225}Ra	--	--	--	--	--	--	--
$^{105/106}Ru$	-3.80E-02	4.00E-02	-8.10E-02	4.27E-02	-1.20E-01	3.31E-01	1.20E-02
^{125}Sb	--	--	--	--	--	--	--
^{90}Sr	5.87E-01	3.27E-01	2.48E+00	4.14E-01	8.90E-01	7.18E-01	7.23E-01
^{99}Tc	--	--	-1.12E-01	-1.15E-01	--	--	--
U	4.43E-01	3.80E-01	3.83E-01	3.53E-01	6.03E-01	4.45E-01	4.43E-01
^{235}U	--	--	--	--	--	--	--
^{238}U	--	--	--	--	--	--	--
^{65}Zn	--	--	-1.05E-01	-6.70E-02	-1.50E-02	-5.00E-03	--
^{95}Zr	1.80E-02	3.30E-03	9.60E-03	6.18E-02	5.45E-03	1.05E-03	1.60E-02

Table 4-7. Summary of Grid Soil Sampling Results for Radionuclides (pCi/g).

Radionuclide	Sampling Locations						
	12[b/]	13[b/]	14[b/]	15[b/]	16[b/]	17[b/]	18[b/]
^{7}Be	-4.40E+01	NS	NS	-2.58E+01	-1.04E+01	-2.43E+01	1.82E+01
^{141}Ce	--	--	--	--	--	--	--
$^{144}CePr$	-2.00E-01	NS	NS	-1.70E-02	-1.39E-02	-4.18E-01	-2.42E-01
^{58}Co	--	--	--	--	--	--	--
^{60}Co	1.22E-03	NS	NS	4.50E-02	2.56E-02	5.16E-03	6.24E-03
^{134}Cs	-1.48E-01	NS	NS	-1.30E-01	-3.43E-01	-5.09E-02	-1.14E-01
^{137}Cs	3.97E+00	NS	NS	4.24E+00	6.21E+00	4.11E+00	1.31E+00
^{152}Eu	--	--	--	--	--	--	--
^{154}Eu	5.19E-03	NS	NS	5.67E-02	2.37E-02	4.39E-02	6.80E-02
^{155}Eu	7.15E-02	NS	NS	-2.78E-02	2.82E-02	3.57E-02	8.11E-03
^{129}I	--	--	--	--	--	--	--
^{40}K	1.23E+01	NS	NS	1.22E+01	1.55E+01	1.34E+01	1.39E+01
^{54}Mn	--	--	--	--	--	--	--

Table 4-7. Summary of Grid Soil Sampling Results for Radionuclides (pCi/g).

Radionuclide	Sampling Locations						
	12[b/]	13[b/]	14[b/]	15[b/]	16[b/]	17[b/]	18[b/]
^{212}Pb	6.61E-01	NS	NS	--	8.04E-01	6.46E-01	6.46E-01
^{214}Pb	5.96E-01	NS	NS	6.08E-01	7.54E-01	5.62E-01	5.63E-01
^{238}Pu	2.15E-03	NS	NS	9.67E-04	1.78E-03	1.17E-03	2.98E-03
$^{239/240}Pu$	7.46E-02	NS	NS	4.00E-02	7.00E-02	5.76E-02	2.57E-01
^{225}Ra	5.53E-01	NS	NS	--	6.03E-01	5.82E-01	5.04E-01
^{105}Ru	1.88E-01	NS	NS	4.11E-01	3.24E-02	-3.46E-01	-2.35E-01
^{125}Sb	2.53E-02	NS	NS	-1.85E-02	1.13E-01	5.38E-02	-4.04E-02
^{90}Sr	3.81E-01	NS	NS	4.47E-01	2.25E-01	3.40E-01	2.62E+00
U	2.34E-01	NS	NS	1.37E-01	1.86E-01	1.38E-01	2.60E-01
^{235}U	--	NS	NS	--	--	--	--
^{238}U	--	NS	NS	--	--	--	--
^{65}Zn	-4.08E-01	NS	NS	-4.47E-01	-3.51E-01	-4.64E-01	-4.59E-01
$^{95}ZrNb$	4.41E-01	NS	NS	-5.18E-01	-4.63E-01	-1.41E+00	1.28E+00

Table 4-7. Summary of Grid Soil Sampling Results for Radionuclides (pCi/g).

Radionuclide	Sampling Locations						
	19[b/]	20[b/]	21[b/]	22[b/]	23[b/]	24[b/]	25[b/]
^{7}Be	1.21E+01	-7.41E+00	0.00	0.00	0.00	0.00	0.00
^{141}Ce	--	--	--	--	--	--	--
$^{144}CePr$	2.01E-01	-3.52E-03	-5.38E-01	-1.10E-01	-2.12E+00	-2.96E-01	1.25E+00
^{58}Co	--	--	--	--	--	--	--
^{60}Co	6.16E-03	-2.25E-02	4.13E-02	-2.39E-02	-1.11E-02	-2.50E-03	9.89E-02
^{134}Cs	-8.62E-02	-3.39E-01	-2.35E-01	-2.44E-01	-1.45E-01	-1.23E-02	4.40E-02
^{137}Cs	3.32E+00	3.07E+00	4.20E+00	2.78E+00	9.91E+00	3.04E-01	2.56E+01
^{152}Eu	--	--	--	--	--	--	--
^{154}Eu	-3.53E-02	3.48E-02	5.33E-02	4.23E-02	9.77E-03	-4.70E-02	2.72E-02
^{155}Eu	-4.69E-02	7.79E-02	3.65E-02	1.18E-01	4.37E-02	7.69E-03	4.85E-02
^{129}I	--	--	--	--	--	--	--
^{40}K	1.29E-01	1.40E+01	1.64E+01	1.71E+01	1.73E+01	1.35E+01	1.53E+01
^{54}Mn	--	--	--	--	--	--	--
^{212}Pb	6.04E-01	6.86E-01	--	--	--	--	--
^{214}Pb	6.61E-01	6.49E-01	--	--	--	--	--
^{238}Pu	1.07E-03	8.87E-04	3.14E-02	3.78E-03	1.97E-03	6.73E-04	1.28E-02

Table 4-7. Summary of Grid Soil Sampling Results for Radionuclides (pCi/g).

Radionuclide	Sampling Locations						
	19[b/]	20[b/]	21[b/]	22[b/]	23[b/]	24[b/]	25[b/]
$^{239/240}Pu$	3.38E-02	6.62E-02	8.24E-02	1.12E-01	1.34E-02	2.55E-02	1.07E+00
^{225}Ra	5.50E-01	6.33E-01	--	--	--	--	--
^{105}Ru	-1.34E-01	-7.91E-02	2.20E-01	2.67E-02	6/30E-01	2.85E-01	3.72E-01
^{125}Sb	2.70E-02	-4.82E-03	-7.02E-02	-5.14E-02	1.12E-02	4.72E-02	-6.67E-02
^{90}Sr	3.14E-01	5.17E-01	7.88E-01	3.17E-01	9.26E-01	1.55E-01	3.11E+00
^{99}Tc	--	--	--	--	--	--	--
U	2.97E-01	1.65E-01	5.83E-01	6.00E-01	1.04E+00	6.12E-01	5.86E-01
^{235}U	--	--	3.41E-02	3.08E-02	5.92E-02	3.52E-02	1.27E-02
^{238}U	--	--	6.34E-01	6.73E-01	9.93E-01	6.14E-01	6.32E-01
^{65}Zn	-4.91E-01	-4.18E-01	-4.94E-01	-9.16E-01	-4.40E-01	1.67E-02	-3.51E-01
$^{95}ZrNb$	3.19E+00	-1.40E+00	0.00	0.00	0.00	0.00	0.00

Table 4-7. Summary of Grid Soil Sampling Results for Radionuclides (pCi/g).

Radionuclide	Sampling Locations		
	26[b/]	36[b/]	50[b/]
^{7}Be	0.00	--	1.60E+01
^{141}Ce	--	--	--
$^{144}CePr$	-4.09E-01	-1.39E+00	-1.38E-01
^{58}Co	--	--	--
^{60}Co	-1.14E-01	4.39E-02	1.67E-02
^{134}Cs	-3.49E-02	-9.89E-02	-3.33E-01
^{137}Cs	4.40E+00	1.54E+01	6.64E-01
^{152}Eu	--	--	--
^{154}Eu	2.19E-01	7.60E-02	4.51E-02
^{155}Eu	1.13E-01	-1.39E-01	6.04E-02
^{129}I	--	--	--
^{40}K	1.24E+01	1.25E+01	1.57E+01
^{54}Mn	--	--	--
^{212}Pb	--	--	8.00E-01
^{214}Pb	--	--	7.34E-01
^{238}Pu	9.20E-03	9.08E-04	9.23E-04

Table 4-7. Summary of Grid Soil Sampling Results for Radionuclides (pCi/g).

Radionuclide	Sampling Locations		
	26[b]	36[b]	50[b]
$^{239/240}Pu$	9.29E-01	4.65E-02	4.60E-02
^{225}Ra	--	--	6.24E-01
^{105}Ru	8.69E-01	8.25E-01	1.24E-02
^{125}Sb	2.77E-03	-3.01E-02	1.61E-02
^{90}Sr	2.02E+00	1.12E+00	4.41E-02
^{99}Tc	--	--	--
U	5.26E-01	7.07E-01	9.54E-01
^{235}U	3.01E-02	4.04E-02	3.80E-02
^{238}U	5.94E-01	6.96E-01	8.88E-01
^{65}Zn	-4.18E-01	-4.05E-01	-4.01E-01
$^{95}ZrNb$	0.00	--	-3.02E+00

Source: Schmidt et al. 1990, 1992; Elder et al. 1986, 1987, 1988, and 1989.
[a] Values are averages for each year with a detection since 1985.
[b] Sample locations for 1990.

Note: Negative values indicate concentrations at or near bakcground levels of radioactivity.

NS = No sample collected
-- = No data reported

Table 4-8. Summary of Fenceline Soil Sampling Results for Radionuclides (pCi/g).

Radionuclide	Site		
	TX-TF-SE[a]	TX-TF-W[a]	TX-TF-NE[a]
^{141}Ce	7.50E-03	4.60E-03	1.03E-02
^{144}Ce	6.90E-02	1.40E-01	-4.90E-02
^{58}Co	6.80E-03	-1.60E-02	-8.90E-03
^{60}Co	-2.30E-02	-5.70E-03	1.40E-02
^{134}Cs	2.60E-02	1.43E-02	3.33E-04
^{137}Cs	2.11E+01	1.11E+01	3.36E+01
^{152}Eu	1.50E-01	9.93E-02	8.63E-02
^{154}Eu	-9.20E-03	4.73E-02	2.35E-02
^{155}Eu	1.30E-01	1.03E-01	1.90E-02
^{54}Mn	1.80E-02	1.11E-02	-1.90E-03
^{238}Pu	9.30E-04	6.50E-04	5.77E-04
^{239}Pu	4.10E-02	1.95E-02	3.41E-01
^{106}Ru	-5.90E-02	7.35E-02	7.62E-02
^{90}Sr	4.08E+00	5.29E+00	3.07E+00
U	2.70E-01	3.35E-01	3.82E-01
^{65}Zn	2.60E-02	-4.70E-02	1.70E-02
^{95}Zr	4.40E-03	2.10E-02	5.15E-02

Source: Elder et al. 1986, 1987, 1988, 1989; Schmidt et al. 1990, 1992.
[a] Values are averages for each year with a detection since 1985.
Note: Negative values indicate concentrations at or near background levels of radioactivity.

Table 4-9. Results of Surface Water Sampling (pCi/L).

Radionuclide		1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	1990 Result	1990 Error
RM3: 216-T-4-2 Ditch													
beta (total)	max	9.79E+02		3.60E+02		3.36E+02		2.76E+02		<1.00E+02		2.02E+02	
	min	3.5E+01		2.90E+01		<1.00E+02		<1.00E+02		<1.00E+02		<1.00E+02	
	avg	1.59E+02	5.11E+02										
alpha (total)	max	2.3E+02		2.20E+01		7.0E+00		<4.0E+02		<4.0E+02		1.11E+02	
	min	2.0E+01		<4.0E+01		<4.0E+01		<4.0E+02		<4.0E+02		<4.0E+02	
	avg	6.0E+01	9.20E+01										
^{137}Cs	max	2.4E+02		3.38E+02		1.89E+02		<2.5E+02		<2.0E+02		<2.0E+02	
	min	4.3E+01		<2.0E+02		2.7E+01		<2.0E+02		<2.0E+02		<2.0E+02	
	avg	8.0E+01	1.04E+02										
^{90}Sr	max	3.7E+02		<9.2E+01		3.0E+01		<1.0E+02		<1.0E+02		<1.0E+02	
	min	1.4E+01		<1.0E+02		1.0E+02		<1.0E+02		<1.0E+02		<1.0E+02	
	avg	6.3E+01	1.89E+02										
pH	max			8.0		8.3		8.0		8.8		9.06	
	min			7.4		5.7		6.1		6.9		6.78	
	avg			7.6		7.1		7.5		7.8		7.76	
NO_3 (ppm)	max	<1.2		2.7		<1.2		<1.2		<1.2		<1.2	
	min	<1.2		<1.2		<1.2		<1.2		<1.2		<1.2	
	avg	<1.2		<1.2		<1.2		<1.2		<1.2		<1.2	

Source: Schmidt et al. 1990, 1992; Elder et al. 1986, 1987, 1988, 1989.

Note: 216-T-4-2 Ditch receives 221-T and 224-T Buildings wastewater.
+ Indicates Positive Detection (Result Greater Than Error)

Table 4-10. Summary of Vegetation Sampling Results (pCi/g).

Radionuclide	Sampling Locations						
	2W2[a/]	2W3[a/]	2W4[a/]	2W5[a/]	2W7[a/]	2W8[a/]	2W9[a/]
^{7}Be	--	--	--	--	1.19E+00	--	2.92E+00
$^{144}CePr$	--	--	--	--	--	--	--
^{141}Ce	--	--	--	--	-1.56E-02	--	6.82E-03
^{60}Co	-5.20E-03	5.30E-03	1.75E-02	-4.20E-03	-7.49E-03	8.57E-03	1.94E-03
^{134}Cs	--	9.60E-02	1.24E-01	1.03E-01	1.12E-01	1.08E-01	3.81E-01
^{137}Cs	1.40E-01	1.84E-01	1.65E-01	2.05E-01	3.85E-01	1.34E+00	5.40E-01
^{152}Eu	1.60E-02	2.30E-02	5.63E-02	-7.60E-02	2.72E-02	-5.10E-02	2.04E-02
^{154}Eu	3.50E-02	1.20E-02	2.57E-02	3.53E-02	2.1E-02	6.97E-02	2.62E-03
^{155}Eu	1.90E-02	4.70E-04	8.70E-03	6.80E-03	1.04E-02	8.67E-02	2.88E-02
^{129}I	--	--	--	--	-1.84E-02	-2.53E-02	2.47E-02
^{40}K	--	--	--	--	1.56E+01	1.05E+01	8.29E+00
^{95}Nb	-5.40E-02	-3.60E-02	-1.67E-02	3.50E-02	-4.90E-03	3.26E-02	-4.17E-03
^{212}Pb	--	--	--	--	4.10E-01	9.26E-02	2.30E-02
^{214}Pb	--	--	--	--	3.23E-01	1.03E-01	3.83E-02
^{238}Pu	--	--	--		1.04E-03	3.41E-04	3.06E-04
$^{239/240}Pu$	--	--	--	2.20E-03	4.68E-03	8.01E-03	4.09E-02
^{103}Ru	--	1.19E-01	1.15E-01	1.64E-01	1.70E-01	1.02E-01	3.92E-02
^{106}Ru	--	--	2.27E-01	--	2.88E-01	--	--
^{125}Sb	--	--	--	--	--	--	--
^{90}Sr	--	--	8.30E-02	2.41E-01	1.19E-01	4.63E-01	2.05E+00
^{99}Tc	--	--	--	--	1.43E+00	8.41E-01	8.07E-01
U	--	--	--	--	--	--	--
^{65}Zn	--	--	--	--	--	--	--
^{95}Zr	--	--	1.10E-02	--	2.88E-02	6.49E-02	-2.35E-02

Table 4-10. Summary of Vegetation Sampling Results (pCi/g).

Radionuclide	Sampling Locations						
	2W10[a/]	2W12[a/]	2W13[a/]	2W14[a/]	2W15[a/]	2W19[a/]	2W20[a/]
^{7}Be	--	--	1.78E+00	2.25E+00	--	--	--
$^{144}CePr$	--	--	--	--	--	--	--
^{141}Ce	--	--	-2.49E-02	-3.43E-03	--	--	--
^{60}Co	-1.20E-02	8.05E-03	3.98E-02	-2.50E-05	-5.40E-03	3.16E-02	3.93E-03
^{134}Cs	1.52E-01	1.64E-01	7.60E-02	2.21E-01	7.60E-02	9.45E-02	6.80E-02
^{137}Cs	1.77E-01	9.80E-02	1.38E+00	2.45E-01	1.80E-01	2.50E-01	1.54E-01
^{152}Eu	-1.00E-02	5.20E-02	-3.00E-03	-7.30E-03	3.37E-02	4.00E-03	9.05E-02
^{154}Eu	7.90E-02	9.40E-02	-3.56E-02	1.84E-02	-1.20E-02	1.87E-02	6.00E-03
^{155}Eu	4.41E-02	--	3.02E-02	1.09E-02	1.90E-02	-4.20E-03	
^{129}I	--	2.90E-02	-7.42E-02	-1.94E-02			
^{40}K	--	-1.70E-01	1.06E+01	1.17E+01			
^{95}Nb	-5.00E-02	--	6.59E-02	-3.18E-03	3.82E-02	-2.10E-02	3.30E-02
^{212}Pb	--	--	--	--			
^{214}Pb	--	--	--	--			
^{238}Pu	--	--	--	--			
$^{239/240}Pu$	--	--	7.90E-03	6.97E-03			
^{103}Ru	2.35E-01	1.07E-01	9.50E-02	2.03-E01	1.61E-01	9.10E-02	1.61E-01
^{106}Ru	3.31E-01	5.41E-01	--	--	2.87E-01		
^{125}Sb	--	--	--	--			
^{90}Sr	--	7.20E-02	4.20E-01	7.70E-02			9.20E-02
^{99}Tc	--	1.80E+00	7.54E-01	8.68E-01			
U	--	--	--	--			
^{65}Zn	--	--	--	--			
^{95}Zr	--	9.50E-02	-8.19E-03	-1.10E-02	3.80E-02	9.40E-03	

Table 4-10. Summary of Vegetation Sampling Results (pCi/g).

Radionuclide	Site		
	20[b]	25[b]	50[b]
^{7}Be	-4.19E-02	3.02E-02	3.36E-01
$^{144}CePr$	3.34E-03	8.89E-03	5.25E-02
^{60}Co	1.69E-02	-4.14E-03	7.96E-03
^{134}Cs	4.15E-03	8.06E-04	-1.34E
^{137}Cs	3.31E-01	1.68E-01	4.52E+0
^{154}Eu	5.22E-02	1.09E-02	1.43E-01
^{155}Eu	2.67E-03	3.90E-03	-7.29E
^{40}K	1.48E+01	1.58E+01	1.30E+0
^{212}Pb	3.50E-02	2.08E-02	8.45E-01
^{214}Pb	--	--	6.92E-01
^{238}Pu	1.85E-04	1.85E-04	5.97E-04
$^{239/240}Pu$	5.12E-03	1.01E-02	4.64E-02
^{106}Ru	-3.81E-02	2.24E-02	-4.91E
^{125}Sb	-1.20E-02	-7.65E-03	-4.25E
^{90}Sr	8.20E-02	7.62E-02	3.46E+0
U	5.04E-02	1.45E-02	1.04E-01
^{65}Zn	-1.55E-02	-1.54E-02	-2.40E
^{95}Zr	3.09E-02	8.37E-03	2.43E-02

Source: Schmidt et al. 1990 and 1992; Elder et al. 1986, 1987, 1988, 1989.

[a] Values are averages for each year with a detection since 1985.

[b] Sample locations for 1990.

Note: Negative values indicate concentrations at or near background levels of radioactivity.

-- = Not Reported

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Table 4-11. Summary of Gamma-Ray Logs Reviewed. Page 1 of 3

Waste Management Unit	Well Number	Number of Times Logged	Inclusive Dates
	Reverse Wells		
216-T-3 Reverse Well	299-W11-7	6	2/58 to 7/76
	Cribs and Drains		
216-T-6 Cribs	299-W11-1	6	2/58 to 7/87
	299-W11-54	3	2/58 to 5/76
	299-W11-55	4	9/53 to 5/76
	299-W11-56	3	2/58 to 5/76
	299-W11-57	4	2/58 to 7/87
	299-W11-58	3	2/58 to 5/76
	299-W11-59	4	2/58 to 7/87
	299-W11-60	3	2/58 to 5/76
	299-W11-61	3	2/58 to 5/76
	299-W11-62	3	2/58 to 5/76
	299-W11-63	4	2/58 to 7/87
	299-W11-64	3	2/58 to 5/76
	299-W11-65	4	2/58 to 7/87
	299-W11-66	4	2/58 to 7/87
	299-W11-67	4	2/58 to 7/87
216-T-7TF Crib and Tile Field	299-W10-59	2	5/63 to 12/76
	299-W10-03	5	6/59 to 7/89
	299-W10-59	2	5/63 to 5/76
	299-W10-60	2	5/63 to 12/76
	299-W10-61	2	5/63 to 9/76
	299-W10-62	2	5/63 to 12/76
	299-W10-63	2	4/63 to 12/76
	299-W10-66	2	4/63 to 12/76
	299-W10-67	2	5/63 to 12/76
	299-W10-68	2	5/63 to 12/76
	299-W10-69	3	5/63 to 8/87
	299-W10-70	3	5/63 to 8/87
	299-W10-71	3	5/63 to 8/87
	299-W10-72	3	5/63 to 8/87
	299-W10-74	2	4/63 to 12/76
	299-W10-77	3	5/63 to 8/87
	299-W10-78	3	5/63 to 8/87
	299-W10-79	3	5/63 to 8/87

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Table 4-11. Summary of Gamma-Ray Logs Reviewed. Page 2 of 3

Waste Management Unit	Well Number	Number of Times Logged	Inclusive Dates
	299-W10-80	2	5/63 to 9/76
	299-W10-81	2	5/63 to 9/76
216-T-26 Crib	299-W11-70	8	7/59 to 8/87
	299-W11-82	3	4/84 to 8/87
216-T-27 Crib	299-W14-53	9	7/59 to 8/87
	299-W14-62	3	4/84 to 8/87
216-T-28 Crib	299-W14-01	8	4/58 to 7/87
	299-W14-02	7	4/58 to 2/76
	299-W14-03	4	4/63 to 8/87
	299-W14-04	4	2/67 to 8/87
216-T-32 Crib	299-W10-52	1	4/63
	299-W10-56	2	5/63 to 5/76
	299-W10-57	2	5/63 to 5/76
	299-W10-58	2	5/63 to 5/76
	299-W10-64	2	5/63 to 5/76
	299-W10-65	2	5/63 to 5/76
	299-W10-73	2	5/63 to 5/76
	299-W10-75	2	5/63 to 5/76
	299-W10-76	2	5/63 to 8/87
216-T-34 Crib	299-W11-15	3	2/68 to 5/76
	299-W11-16	4	2/68 to 7/87
216-T-35 Crib	299-W11-17	5	2/67 to 7/87
	299-W11-18	4	3/67 to 2/76
	299-W11-19	3	2/70 to 7/87
	299-W11-20	3	2/70 to 7/87
	299-W11-21	3	2/70 to 7/87
216-T-36 Crib	299-W10-02	2	5/76 to 7/87
	299-W10-04	5	4/58 to 5/76
	299-W10-78	3	5/63 to 8/87
	299-W10-79	3	5/63 to 8/87
	Trenches		
216-T-5 Trench	299-W10-01	6	6/59 to 8/87
216-T-14 Trench	299-W11-68	5	5/58 to 7/87
216-T-15 Trench	299-W11-69	4	5/58 to 7/87
216-T-16 Trench	299-W11-80	2	3/84 to 6/86
216-T-17 Trench	299-W11-81	2	3/84 to 6/86
216-T-21 Trench	299-W15-209	2	3/84 to 6/86

Table 4-11. Summary of Gamma-Ray Logs Reviewed. Page 3 of 3

Waste Management Unit	Well Number	Number of Times Logged	Inclusive Dates
216-T-22 Trench	299-W15-81	2	5/63 to 12/76
216-T-23 Trench	299-W15-210	2	3/84 to 6/86
216-T-24 Trench	299-W15-211	2	3/84 to 6/86
216-T-25 Trench	299-W15-212	Unknown	Unknown

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Table 4-12. Potential for Past Migration of Liquid Discharges to the Unconfined Aquifer. Page 1 of 2

Waste Management Unit	Range of Soil Column Pore Volumes (m^3)[a]	Liquid Effluent Volume Received in (m^3)	Potential Migration to Unconfined Aquifer
Cribs			
216-T-6 Crib	435 to 1,305	45,000	Yes
216-T-7TF Crib and Tile Field	2,969 to 8,906	110,000	Yes
216-T-8 Crib	373 to 1,120	500	Yes[b]
216-T-18 Crib	233 to 699	1,000	Yes
216-T-19TF Crib and Tile Field	4,169 to 12,508	455,000	Yes
216-T-26 Crib	227 to 680	12,000	Yes
216-T-27 Crib	227 to 680	7,190	Yes
216-T-28 Crib	227 to 680	42,300	Yes
216-T-29 Crib	899 to 2,697	74	No
216-T-32 Crib	881 to 2,644	29,000	Yes
216-T-33 Crib	224 to 671	1,900	Yes
216-T-34 Crib	2,070 to 6,209	17,300	Yes
216-T-35 Crib	4,290 to 12,871	5,720	Yes[b]
216-T-36 Crib	1,270 to 3,810	522	No
216-W-LWC Crib	1,974 to 5,922	1,200,000	Yes
Ponds, Ditches and Trenches			
216-T-4A Pond	4,556 to 13,668	42,500,000	Yes
216-T-1 Ditch	12,571 to 37,712	178,000	Yes
216-T-5 Trench	318 to 953	2,600	Yes
216-T-12 Trench	71 to 214	5,000	Yes
216-T-14 Trench	1,648 to 4,943	1,000	No
216-T-15 Trench	1,648 to 4,943	1,000	No
216-T-16 Trench	1,648 to 4,943	1,000	No
216-T-17 Trench	1,648 to 4,943	1,000	No

Table 4-12. Potential for Past Migration of Liquid Discharges to the Unconfined Aquifer. Page 2 of 2

Waste Management Unit	Range of Soil Column Pore Volumes (m^3)[a/]	Liquid Effluent Volume Received in (m^3)	Potential Migration to Unconfined Aquifer
216-T-20 Trench	22 to 66	18.9	No
216-T-21 Trench	1,243 to 3,730	460	No
216-T-22 Trench	1,243 to 3,730	1,530	Yes[b/]
216-T-23 Trench	1,243 to 3,730	1,480	Yes[b/]
216-T-24 Trench	1,243 to 3,730	1,530	Yes[b/]
216-T-25 Trench	932 to 2,797	3,000	Yes
Reverse Wells			
216-T-2 Reverse Well	?	6,000	Yes
216-T-3 Reverse Well	?	11,300	Yes

Source: WHC 1991a.

a/ Pore volume calculation: (waste unit section area) x (nominal depth to groundwater) x (porosity). Lower pore volume value reflects 0.10 porosity, higher pore volume reflects 0.3 porosity. Pore volume calculation does not account for the ability of the soil to retain the liquid discharged. Groundwater depth of 50 m was used.

b/ The effluent volume received by these units exceeds the lower pore volume estimate but is below the high estimated. Given the high permeability of the soil column in general, it is likely that some of the discharged waste volume reached groundwater.

Table 4-13. TRAC Inventory of Radionuclides (curies, decayed through 1/1/90) and Chemicals (grams) in the 241-T, -TX, and -TY Tank Farms.

Radionuclide \ Tank	T-101	T-102	T-103	T-104	T-105	T-106	T-107	T-108	T-109
1. Ac-225	9E-09	1E-10	4E-09	3E-09	4E-09	2E-08	5E-09	9E-09	9E-09
2. Ac-227	3E-05	5E-07	2E-06	1E-05	3E-05	7E-06	5E-06	2E-06	9E-06
3. Am-241	9E+01	2E+00	9E+00	2E+01	2E+01	3E+00	2E+00	2E-01	2E-02
4. Am-242	2E-01	3E-03	2E-02	5E-04	8E-03	9E-04	2E-05	2E-06	3E-07
5. Am-242m	2E-01	3E-03	2E-02	5E-04	8E-03	9E-04	2E-05	2E-06	3E-07
6. Am-243	9E-02	1E-03	8E-03	2E-03	2E-03	2E-04	5E-05	5E-06	6E-07
7. At-217	8E-09	1E-10	4E-09	3E-09	4E-09	2E-08	4E-09	9E-09	9E-09
8. Ba-135m	0	0	0	0	0	0	0	0	0
9. Ba-137m	2E+04	4E+02	2E+03	1E+04	7E-13	6E+02	7E-13	1E+03	5E+03
10. Bi-210	7E-12	1E-13	2E-12	7E-11	5E-10	7E-11	4E-11	8E-12	3E-12
11. Bi-211	3E-05	5E-07	2E-06	1E-05	3E-05	7E-06	5E-06	2E-06	9E-06
12. Bi-213	9E-09	2E-10	5E-09	4E-09	4E-09	2E-08	5E-09	9E-09	9E-09
13. Bi-214	2E-11	4E-13	8E-12	3E-10	2E-09	3E-10	1E-10	3E-11	1E-11
14. C-14	7E+01	1E+00	7E+00	2E-01	2E-16	1E-01	3E-03	1E-01	1E-01
15. Cm-242	1E-01	2E-03	1E-02	4E-04	7E-03	7E-04	2E-05	2E-06	2E-07
16. Cm-244	4E-01	8E-03	4E-02	1E-03	1E-19	6E-05	6E-20	1E-04	2E-05
17. Cm-245	3E-05	5E-07	3E-06	6E-08	2E-24	2E-09	1E-24	2E-09	3E-10
18. Cs-135	1E-01	2E-03	7E-03	9E-02	7E-18	4E-03	4E-18	7E-03	1E-01
19. Cs-137	3E+04	4E+02	2E+03	1E+04	8E-13	6E+02	8E-13	1E+03	5E+03
20. Fr-221	9E-09	1E-10	4E-09	3E-09	4E-09	2E-08	5E-09	9E-09	9E-09
21. Fr-223	4E-07	7E-09	3E-08	2E-07	4E-07	1E-07	7E-08	3E-08	1E-07
22. I-129	1E-01	2E-03	1E-02	5E-03	5E-19	3E-04	3E-19	5E-04	3E-03
23. Nb-93m	1E+00	2E-02	1E-01	2E+00	1E+00	9E-02	2E+00	2E-01	3E-02
24. Ni-59	0	0	0	0	0	0	0	0	0
25. Ni-63	8E+02	2E+01	5E+02	3E+00	3E-15	2E+00	1E-15	3E+00	2E+01
26. Np-237	8E-02	1E-03	6E-03	1E-02	2E-04	6E-04	2E-05	2E-03	7E-03
27. Np-239	8E-02	1E-03	8E-03	2E-03	2E-03	2E-04	5E-05	5E-06	6E-07
28. Pa-231	5E-05	9E-07	4E-06	4E-05	8E-05	2E-05	1E-05	5E-06	1E-05
29. Pa-233	8E-02	1E-03	6E-03	1E-02	2E-04	7E-04	2E-05	2E-03	7E-03
30. Pa-234m	5E-02	5E-03	2E-02	9E-01	2E+00	1E+00	3E-01	1E-01	4E-02

Table 4-13. TRAC Inventory of Radionuclides (curies, decayed through 1/1/90) and Chemicals (grams) in the 241-T, -TX, and -TY Tank Farms.

Radionuclide \ Tank	T-101	T-102	T-103	T-104	T-105	T-106	T-107	T-108	T-109
31. Pb-209	9E-09	1E-10	4E-09	3E-09	4E-09	2E-08	5E-09	9E-09	9E-09
32. Pb-210	6E-12	1E-13	2E-12	7E-11	5E-10	6E-11	3E-11	8E-12	3E-12
33. Pb-211	3E-05	5E-07	2E-06	1E-05	3E-05	7E-06	5E-06	2E-06	9E-06
34. Pb-214	2E-11	4E-13	8E-12	3E-10	2E-09	3E-10	1E-10	3E-11	1E-11
35. Pd-107	2E-01	4E-03	2E-02	8E-03	7E-19	4E-04	3E-19	7E-04	3E-03
36. Po-210	6E-12	1E-13	2E-12	7E-11	5E-10	6E-11	3E-11	8E-12	3E-12
37. Po-213	8E-09	1E-10	4E-09	3E-09	4E-09	2E-08	4E-09	9E-09	9E-09
38. Po-214	2E-11	4E-13	1E-11	3E-10	3E-09	4E-10	1E-10	3E-11	1E-11
39. Po-215	3E-05	5E-07	2E-06	1E-05	3E-05	7E-06	5E-06	2E-06	9E-06
40. Po-218	2E-11	4E-13	8E-12	3E-10	2E-09	3E-10	1E-10	3E-11	1E-11
41. Pu-238	3E-02	5E-04	8E-02	2E+00	2E+01	3E+00	9E-02	8E-03	2E-03
42. Pu-239	7E-05	1E-06	1E-01	1E+02	2E+02	2E+01	5E+01	5E+00	5E-01
43. Pu-240	1E-03	3E-05	2E-02	2E+01	3E+01	3E+00	4E+00	4E-01	4E-02
44. Pu-241	2E-04	2E-06	8E-02	1E+02	2E+02	2E+01	5E+00	5E-01	6E-02
45. Ra-223	3E-05	5E-07	2E-06	1E-05	3E-05	7E-06	5E-06	2E-06	9E-06
46. Ra-225	9E-09	1E-10	4E-09	3E-09	4E-09	2E-08	5E-09	9E-09	9E-09
47. Ra-226	2E-11	4E-13	8E-12	3E-10	2E-09	3E-10	1E-10	3E-11	1E-11
48. Ru-106	3E-05	5E-07	3E-06	3E-06	4E-06	3E-08	1E-08	4E-07	4E-08
49. Sb-126	4E-08	3E-09	2E-03	4E-01	2E-01	2E-02	3E-01	3E-02	3E-03
50. Sb-126m	4E-08	3E-09	2E-03	4E-01	2E-01	2E-02	3E-01	3E-02	3E-03
51. Se-79	2E+00	4E-02	2E-01	9E-02	8E-18	5E-03	4E-18	9E-03	5E-02
52. Sm-151	2E-04	2E-06	4E+00	6E+02	3E+02	4E+01	9E+02	9E+01	1E+01
53. Sn-126	4E-08	3E-09	2E-03	4E-01	2E-01	2E-02	3E-01	3E-02	3E-03
54. Sr-90	2E+03	4E+01	2E+04	4E+04	5E+03	2E+02	3E+04	3E+03	7E+01
55. Tc-99	8E+01	1E+00	7E+00	3E+00	3E-16	2E-01	2E-16	3E-01	2E+00
56. Th-227	3E-05	5E-07	2E-06	1E-05	3E-05	7E-06	5E-06	2E-06	9E-06
57. Th-229	9E-09	1E-10	4E-09	3E-09	4E-09	2E-08	4E-09	9E-09	9E-09
58. Th-230	5E-10	5E-11	2E-09	6E-08	5E-07	7E-08	1E-08	4E-09	1E-09
59. Th-231	2E-03	2E-04	8E-04	4E-02	1E-01	5E-02	1E-02	5E-03	2E-03
60. Th-233	0	0	0	0	0	0	0	0	0

Table 4-13. TRAC Inventory of Radionuclides (curies, decayed through 1/1/90) and Chemicals (grams) in the 241-T, -TX, and -TY Tank Farms.

Tank / Radionuclide	T-101	T-102	T-103	T-104	T-105	T-106	T-107	T-108	T-109
61. Th-234	5E-02	5E-03	2E-02	9E-01	2E+00	1E+00	3E-01	1E-01	4E-02
62. Tl-207	3E-05	5E-07	2E-06	1E-05	3E-05	7E-06	5E-06	2E-06	9E-06
63. U-233	8E-06	2E-07	3E-06	2E-06	1E-06	6E-06	1E-06	4E-06	4E-06
64. U-234	5E-06	5E-07	1E-05	3E-04	3E-03	4E-04	5E-05	2E-05	5E-06
65. U-235	2E-03	2E-04	8E-04	4E-02	1E-01	5E-02	1E-02	5E-03	2E-03
66. U-238	5E-02	5E-03	2E-02	9E-01	2E+00	1E+00	3E-01	1E-01	4E-02
67. Y-90	3E+03	4E+01	2E+04	4E+04	5E+03	3E+02	4E+04	4E+03	7E+01
68. Zr-93	3E-07	1E-08	1E-02	2E+00	1E+00	1E-01	2E+00	2E-01	2E-02
TOTAL CURIES	6E+04	9E+02	5E+04	1E+05	1E+04	2E+03	7E+04	9E+03	1E+04

9 1 1 2 2 7 0 1 0 1 2

Table 4-13. TRAC Inventory of Radionuclides (curies, decayed through 1/1/90) and Chemicals (grams) in the 241-T, -TX, and -TY Tank Farms.

Radionuclide / Tank	T-110	T-111	T-112	T-201	T-202	T-203	T-204	Total T
1. Ac-225	2E-11	6E-11	8E-11	0	2E-14	2E-13	0	6E-08
2. Ac-227	4E-06	1E-05	3E-05	0	1E-12	1E-11	0	1E-04
3. Am-241	8E+00	2E+01	3E+01	0	5E-02	5E-01	0	2E+02
4. Am-242	8E-06	2E-03	3E-04	0	0	0	0	2E-01
5. Am-242m	8E-06	2E-03	3E-04	0	0	0	0	2E-01
6. Am-243	2E-05	1E-04	5E-04	0	0	0	0	1E-01
7. At-217	2E-11	6E-11	8E-11	0	2E-14	2E-13	0	6E-08
8. Ba-135m	0	0	0	0	0	0	0	0
9. Ba-137m	2E-07	0	0	0	0	0	0	4E+04
10. Bi-210	2E-11	4E-11	3E-10	0	6E-14	6E-13	0	1E-09
11. Bi-211	4E-06	1E-05	3E-05	0	1E-12	1E-11	0	1E-04
12. Bi-213	2E-11	6E-11	8E-11	0	2E-14	2E-13	0	7E-08
13. Bi-214	9E-11	2E-10	1E-09	0	2E-13	2E-12	0	4E-09
14. C-14	2E-12	0	4E-37	0	0	0	0	8E+01
15. Cm-242	7E-06	2E-03	3E-04	0	0	0	0	1E-01
16. Cm-244	6E-16	0	1E-33	0	0	0	0	4E-01
17. Cm-245	4E-20	0	0	0	0	0	0	3E-05
18. Cs-135	2E-12	0	1E-37	0	0	0	0	3E-01
19. Cs-137	2E-07	0	1E-31	0	0	0	0	5E+04
20. Fr-221	2E-11	6E-11	8E-11	0	2E-14	2E-13	0	6E-08
21. Fr-223	6E-08	1E-07	4E-07	0	2E-14	2E-13	0	2E-06
22. I-129	8E-14	0	9E-39	0	0	0	0	1E-01
23. Nb-93m	3E-01	2E-01	3E-01	0	0	0	0	7E+00
24. Ni-59	0	0	0	0	0	0	0	0
25. Ni-63	5E-11	7E-01	8E+00	0	0	0	0	1E+03
26. Np-237	7E-05	1E-04	3E-04	0	4E-07	4E-06	0	1E-01
27. Np-239	2E-05	1E-04	5E-04	0	0	0	0	9E-02
28. Pa-231	9E-06	2E-05	7E-05	0	4E-12	4E-11	0	3E-04
29. Pa-233	7E-05	1E-04	3E-04	0	4E-07	4E-06	0	1E-01
30. Pa-234m	2E-01	6E-01	2E+00	0	0	0	0	7E+00

Table 4-13. TRAC Inventory of Radionuclides (curies, decayed through 1/1/90) and Chemicals (grams) in the 241-T, -TX, and -TY Tank Farms.

Radionuclide / Tank	T-110	T-111	T-112	T-201	T-202	T-203	T-204	Total T
31. Pb-209	2E-11	6E-11	8E-11	0	2E-14	2E-13	0	6E-08
32. Pb-210	2E-11	4E-11	3E-10	0	5E-14	5E-13	0	1E-09
33. Pb-211	4E-06	1E-05	3E-05	0	1E-12	1E-11	0	1E-04
34. Pb-214	9E-11	2E-10	1E-09	0	2E-13	2E-12	0	4E-09
35. Pd-107	1E-13	0	1E-38	0	0	0	0	2E-01
36. Po-210	2E-11	4E-11	2E-10	0	5E-14	5E-13	0	9E-10
37. Po-213	2E-11	6E-11	8E-11	0	2E-14	2E-13	0	6E-08
38. Po-214	1E-10	2E-10	1E-09	0	3E-13	3E-12	0	5E-09
39. Po-215	4E-06	1E-05	3E-05	0	1E-12	1E-11	0	1E-04
40. Po-218	9E-11	2E-10	1E-09	0	2E-13	2E-12	0	4E-09
41. Pu-238	4E-01	7E-01	1E+01	0	2E-03	2E-02	0	4E+01
42. Pu-239	2E+02	1E+02	2E+02	0	3E-01	3E+00	0	9E+02
43. Pu-240	2E+01	2E+01	4E+01	0	6E-02	6E-01	0	1E+02
44. Pu-241	4E+01	1E+02	2E+02	0	3E-01	3E+00	0	7E+02
45. Ra-223	4E-06	1E-05	3E-05	0	1E-12	1E-11	0	1E-04
46. Ra-225	2E-11	6E-11	8E-11	0	2E-14	2E-13	0	6E-08
47. Ra-226	9E-11	2E-10	1E-09	0	2E-13	2E-12	0	4E-09
48. Ru-106	2E-08	9E-08	7E-07	0	0	0	0	4E-05
49. Sb-126	4E-02	4E-02	6E-02	0	0	0	0	1E+00
50. Sb-126m	4E-02	4E-02	6E-02	0	0	0	0	1E+00
51. Se-79	3E-12	0	3E-37	0	0	0	0	2E+00
52. Sm-151	1E+02	6E+01	7E+01	0	0	0	0	2E+03
53. Sn-126	4E-02	4E-02	6E-02	0	0	0	0	1E+00
54. Sr-90	4E+03	3E+03	4E+03	0	0	0	0	1E+05
55. Tc-99	1E-10	0	5E-36	0	0	0	0	9E+01
56. Th-227	4E-06	9E-06	3E-05	0	1E-12	1E-11	0	1E-04
57. Th-229	2E-11	6E-11	8E-11	0	2E-14	2E-13	0	6E-08
58. Th-230	2E-08	3E-08	2E-07	0	4E-11	4E-10	0	9E-07
59. Th-231	1E-02	3E-02	9E-02	0	1E-08	1E-07	0	3E-01
60. Th-233	0	0	0	0	0	0	0	0

9 3 1 2 3 7 0 1 0 1 4

Table 4-13. TRAC Inventory of Radionuclides (curies, decayed through 1/1/90) and Chemicals (grams) in the 241-T, -TX, and -TY Tank Farms.

Radionuclide / Tank	T-110	T-111	T-112	T-201	T-202	T-203	T-204	Total T
61. Th-234	2E-01	6E-01	2E+00	0	0	0	0	7E+00
62. Tl-207	4E-06	1E-05	3E-05	0	1E-12	1E-11	0	1E-04
63. U-233	1E-08	2E-08	3E-08	0	3E-11	3E-10	0	3E-05
64. U-234	8E-05	2E-04	1E-03	0	2E-07	2E-06	0	5E-03
65. U-235	1E-02	3E-02	9E-02	0	1E-08	1E-07	0	3E-01
66. U-238	2E-01	6E-01	2E+00	0	0	0	0	7E+00
67. Y-90	4E+03	3E+03	5E+03	0	0	0	0	1E+05
68. Zr-93	3E-01	3E-01	3E-01	0	0	0	0	6E+00
TOTAL CURIES	8E+03	6E+03	1E+04	0	7E-01	7E+00	0	3E+05

Table 4-13. TRAC Inventory of Radionuclides (curies, decayed through 1/1/90) and Chemicals (grams) in the 241-T, -TX, and -TY Tank Farms.

Radionuclide \ Tank	TX-101	TX-102	TX-103	TX-104	TX-105	TX-106	TX-107	TX-108	TX-109	TX-110
1. Ac-225	3E-08	5E-08	1E-08	3E-08	1E-07	4E-09	1E-15	2E-08	1E-07	5E-08
2. Ac-227	4E-13	3E-06	5E-06	9E-10	2E-05	3E-06	2E-12	3E-05	5E-04	2E-04
3. Am-241	1E-03	5E-04	1E-01	9E-06	3E-03	6E-05	7E-07	1E+00	1E+02	4E+01
4. Am-242	1E-06	1E-07	2E-04	8E-15	5E-07	2E-07	1E-11	3E-05	2E-01	8E-02
5. Am-242m	1E-06	1E-07	2E-04	8E-15	5E-07	2E-07	1E-11	3E-05	2E-01	8E-02
6. Am-243	4E-07	4E-08	1E-04	1E-15	2E-07	3E-08	3E-10	6E-04	1E-01	5E-02
7. At-217	3E-08	5E-08	1E-08	3E-08	1E-07	4E-09	1E-15	2E-08	1E-07	5E-08
8. Ba-135m	0	0	0	0	0	0	0	0	0	0
9. Ba-137m	7E-05	2E+03	3E+03	5E-04	2E+04	3E+04	9E-04	1E+05	8E+05	4E+05
10. Bi-210	2E-13	8E-14	1E-13	2E-14	7E-13	3E-14	5E-18	5E-12	1E-10	4E-11
11. Bi-211	4E-13	3E-06	6E-06	9E-10	2E-05	3E-06	2E-12	3E-05	5E-04	2E-04
12. Bi-213	3E-08	5E-08	1E-08	3E-08	1E-07	4E-09	1E-15	2E-08	1E-07	5E-08
13. Bi-214	8E-15	2E-13	2E-13	9E-14	2E-12	5E-14	2E-17	2E-11	7E-10	1E-10
14. C-14	2E+01	3E+00	8E-01	5E-07	3E+01	5E+00	1E-08	1E+01	3E+02	1E+02
15. Cm-242	9E-07	1E-07	2E-04	6E-15	4E-07	1E-07	9E-12	2E-05	2E-01	7E-02
16. Cm-244	2E-10	5E-03	1E-03	1E-09	5E-02	2E-03	2E-10	5E-02	1E+00	4E-01
17. Cm-245	2E-14	1E-07	6E-08	2E-14	1E-06	4E-08	1E-14	3E-06	6E-05	2E-05
18. Cs-135	6E-10	7E-03	4E-02	2E-09	7E-02	2E-01	1E-08	8E-01	5E+00	3E+00
19. Cs-137	7E-05	2E+03	3E+03	5E-04	2E+04	3E+04	1E-03	1E+05	9E+05	4E+05
20. Fr-221	3E-08	5E-08	1E-08	3E-08	1E-07	4E-09	1E-15	2E-08	1E-07	5E-08
21. Fr-223	5E-15	4E-08	8E-08	1E-11	3E-07	4E-08	3E-14	5E-07	7E-06	3E-06
22. I-129	9E-11	2E-02	2E-03	3E-09	1E-01	1E-02	5E-10	6E-02	1E+00	5E-01
23. Nb-93m	4E-08	1E-01	1E-02	6E-05	1E+00	6E-02	1E-07	3E-01	1E+01	3E+00
24. Ni-59	0	0	0	0	0	0	0	0	0	0
25. Ni-63	1E+02	6E-03	1E+02	4E-07	3E+00	1E+01	2E-07	3E+02	1E+03	5E+02
26. Np-237	8E-09	2E-02	4E-03	5E-09	2E-01	4E-02	2E-09	8E-02	2E+00	8E-01
27. Np-239	4E-07	4E-08	1E-04	1E-15	2E-07	3E-08	3E-10	6E-04	1E-01	5E-02
28. Pa-231	1E-12	4E-06	8E-06	3E-09	4E-05	4E-06	8E-12	5E-05	7E-04	3E-04
29. Pa-233	8E-09	2E-02	4E-03	5E-09	2E-01	4E-02	2E-09	8E-02	2E+00	8E-01
30. Pa-234m	8E-08	1E-08	2E-07	1E-04	1E-12	3E-07	2E-07	2E-01	1E+00	4E-01
31. Pb-209	3E-08	5E-08	1E-08	3E-08	1E-07	4E-09	1E-15	2E-08	1E-07	5E-08

Table 4-13. TRAC Inventory of Radionuclides (curies, decayed through 1/1/90) and Chemicals (grams) in the 241-T, -TX, and -TY Tank Farms.

Radionuclide \ Tank	TX-101	TX-102	TX-103	TX-104	TX-105	TX-106	TX-107	TX-108	TX-109	TX-110
32. Pb-210	2E-13	7E-14	1E-13	2E-14	7E-13	3E-14	5E-18	5E-12	1E-10	2E-11
33. Pb-211	4E-13	3E-06	5E-06	9E-10	2E-05	3E-06	2E-12	3E-05	5E-04	2E-04
34. Pb-214	8E-15	2E-13	2E-13	9E-14	2E-12	5E-14	2E-17	2E-11	7E-10	1E-10
35. Pd-107	2E-10	3E-02	3E-03	7E-09	3E-01	2E-02	1E-09	9E-02	2E+00	9E-01
36. Po-210	2E-13	8E-14	1E-13	1E-14	7E-13	3E-14	5E-18	5E-12	1E-10	3E-11
37. Po-213	3E-08	5E-08	1E-08	3E-08	1E-07	4E-09	1E-15	2E-08	1E-07	5E-08
38. Po-214	9E-15	2E-13	4E-13	1E-13	2E-12	6E-14	3E-17	3E-11	8E-10	1E-10
39. Po-215	4E-13	3E-06	6E-06	9E-10	2E-05	3E-06	2E-12	3E-05	5E-04	2E-04
40. Po-218	8E-15	2E-13	2E-13	9E-14	2E-12	5E-14	2E-17	2E-11	7E-10	1E-10
41. Pu-238	3E-04	1E-04	5E-04	3E-03	8E-04	1E-05	2E-07	1E-01	5E+00	2E-01
42. Pu-239	3E-05	9E-08	9E-07	3E-04	4E-04	3E-08	9E-07	6E-01	2E+02	1E+01
43. Pu-240	5E-04	1E-04	5E-06	1E-04	4E-04	7E-06	2E-07	1E-01	3E+01	2E+00
44. Pu-241	1E-04	5E-07	3E-06	1E-04	3E-03	5E-08	2E-06	1E+00	1E+02	9E+00
45. Ra-223	4E-13	3E-06	5E-06	9E-10	2E-05	3E-06	2E-12	3E-05	5E-04	2E-04
46. Ra-225	3E-08	5E-08	1E-08	3E-08	1E-07	4E-09	1E-15	2E-08	1E-07	5E-08
47. Ra-226	8E-15	2E-13	2E-13	9E-14	2E-12	5E-14	2E-17	2E-11	7E-10	1E-10
48. Ru-106	3E-06	1E-07	1E-07	4E-14	7E-05	2E-08	5E-13	3E-07	2E-04	6E-05
49. Sb-126	7E-09	8E-10	3E-09	1E-05	2E-10	9E-10	5E-08	2E-02	5E-01	4E-02
50. Sb-126m	7E-09	8E-10	3E-09	1E-05	2E-10	9E-10	5E-08	2E-02	5E-01	4E-02
51. Se-79	3E-09	3E-01	4E-02	4E-08	3E+00	3E-01	8E-09	1E+00	3E+01	9E+00
52. Sm-151	3E-04	8E-07	2E-05	2E-02	1E-04	2E-05	3E-05	3E+01	8E+02	7E+01
53. Sn-126	7E-09	8E-10	3E-09	1E-05	2E-10	8E-10	5E-08	2E-02	5E-01	4E-02
54. Sr-90	8E+03	3E+02	7E+02	6E-05	3E+03	5E-06	1E-03	5E+03	1E+05	1E+05
55. Tc-99	1E-07	1E+01	2E+00	2E-06	1E+02	9E+00	5E-07	4E+01	9E+02	3E+02
56. Th-227	4E-13	2E-06	5E-06	9E-10	2E-05	3E-06	2E-12	3E-05	4E-04	2E-04
57. Th-229	3E-08	5E-08	1E-08	3E-08	1E-07	4E-09	1E-15	2E-08	1E-07	5E-08
58. Th-230	2E-12	1E-12	9E-12	3E-11	6E-12	2E-13	6E-15	4E-09	1E-07	1E-08
59. Th-231	2E-09	5E-10	8E-09	6E-06	1E-10	2E-08	2E-08	7E-03	5E-02	2E-02
60. Th-233	0	0	0	0	0	0	0	0	0	0
61. Th-234	8E-08	1E-08	2E-07	1E-04	1E-12	3E-07	2E-07	2E-01	1E+00	4E-01
62. Tl-207	4E-13	3E-06	5E-06	9E-10	2E-05	3E-06	2E-12	3E-05	5E-04	2E-04

Table 4-13. TRAC Inventory of Radionuclides (curies, decayed through 1/1/90) and Chemicals (grams) in the 241-T, -TX, and -TY Tank Farms.

Radionuclide \ Tank	TX-101	TX-102	TX-103	TX-104	TX-105	TX-106	TX-107	TX-108	TX-109	TX-110
63. U-233	1E-05	2E-05	6E-06	2E-05	6E-05	4E-06	6E-13	1E-05	2E-04	6E-05
64. U-234	2E-08	1E-08	5E-08	2E-07	6E-08	1E-09	4E-11	3E-05	7E-04	7E-05
65. U-235	2E-09	5E-10	8E-09	6E-06	1E-10	2E-08	2E-08	7E-03	5E-02	2E-02
66. U-238	8E-08	1E-08	2E-07	1E-04	1E-12	3E-07	2E-07	2E-01	1E+00	4E-01
67. Y-90	9E+03	3E+02	7E+02	7E-05	3E+03	5E-06	1E-03	5E+03	1E+05	1E+05
68. Zr-93	6E-08	7E-09	1E-08	8E-05	8E-10	7E-09	2E-07	1E-01	3E+00	3E-01
TOTAL CURIES	2E+04	5E+03	8E+03	3E-02	5E+04	6E+04	4E-03	2E+05	2E+06	1E+06

9 3 1 2 9 7 0 1 0 1 8

Table 4-13. TRAC Inventory of Radionuclides (curies, decayed through 1/1/90) and Chemicals (grams) in the 241-T, -TX, and -TY Tank Farms.

Radionuclide \ Tank	TX-111	TX-112	TX-113	TX-114	TX-115	TX-116	TX-117	TX-118	Total TX
1. Ac-225	2E-08	2E-08	1E-08	2E-08	2E-09	1E-08	1E-08	4E-07	9E-07
2. Ac-227	7E-05	9E-05	1E-03	1E-04	3E-04	7E-05	3E-04	5E-04	3E-03
3. Am-241	5E+00	3E-01	6E+00	6E-01	7E-02	1E-02	2E-02	2E+03	2E+03
4. Am-242	8E-03	5E-04	2E-02	2E-03	2E-04	2E-06	2E-05	2E+00	2E+00
5. Am-242m	8E-03	5E-04	2E-02	2E-03	2E-04	2E-06	2E-05	2E+00	2E+00
6. Am-243	5E-03	3E-04	4E-04	3E-05	4E-06	7E-07	4E-06	7E-01	9E-01
7. At-217	2E-08	2E-08	1E-08	2E-08	2E-09	1E-08	1E-08	4E-07	9E-07
8. Ba-135m	0	0	0	0	0	0	0	0	0
9. Ba-137m	8E+04	6E+04	2E+04	6E+04	3E+04	1E+04	6E+03	1E+06	3E+06
10. Bi-210	9E-12	4E-12	2E-09	3E-10	4E-10	1E-10	5E-10	5E-10	4E-09
11. Bi-211	7E-05	9E-05	1E-03	1E-04	3E-04	7E-05	3E-04	5E-04	3E-03
12. Bi-213	2E-08	2E-08	1E-08	2E-08	2E-09	1E-08	1E-08	4E-07	9E-07
13. Bi-214	3E-11	9E-12	1E-08	1E-09	2E-09	4E-10	2E-09	2E-09	2E-08
14. C-14	1E+01	2E+00	1E+01	3E+00	7E+00	1E+00	1E+01	1E+03	2E+03
15. Cm-242	7E-03	4E-04	2E-02	2E-03	2E-04	1E-06	2E-05	2E+00	2E+00
16. Cm-244	5E-02	3E-03	4E-05	2E-04	3E-03	4E-05	2E-05	1E+00	3E+00
17. Cm-245	2E-06	1E-07	8E-10	5E-09	8E-08	8E-10	3E-10	7E-05	2E-04
18. Cs-135	1E+00	1E+00	4E-01	1E+00	4E-01	3E-01	1E-01	5E+00	2E+01
19. Cs-137	9E+04	7E+04	2E+04	7E+04	4E+04	2E+04	6E+03	1E+06	3E+06
20. Fr-221	2E-08	2E-08	1E-08	2E-08	2E-09	1E-08	1E-08	4E-07	9E-07
21. Fr-223	1E-06	1E-06	2E-05	2E-06	5E-06	1E-06	4E-06	7E-06	5E-05
22. I-129	7E-02	4E-02	1E-02	3E-02	2E-02	8E-03	3E-03	1E+00	3E+00
23. Nb-93m	4E-01	1E-01	1E+00	2E-01	5E-02	3E-02	1E-02	5E+01	7E+01
24. Ni-59	0	0	0	0	0	0	0	0	0
25. Ni-63	2E+02	2E+02	9E+01	2E+02	1E+02	4E+01	2E+01	3E+03	6E+03
26. Np-237	1E-01	8E-02	3E-02	8E-02	3E-02	2E-02	8E-03	2E+00	5E+00
27. Np-239	5E-03	3E-04	3E-04	3E-05	4E-06	6E-07	3E-06	7E-01	9E-01
28. Pa-231	1E-04	1E-04	3E-03	3E-04	7E-04	1E-04	7E-04	9E-04	7E-03
29. Pa-233	1E-01	9E-02	3E-02	8E-02	3E-02	2E-02	8E-03	2E+00	6E+00
30. Pa-234m	2E-01	4E-02	1E+02	3E+00	2E+01	3E+00	2E+01	8E+00	2E+02
31. Pb-209	2E-08	2E-08	1E-08	2E-08	2E-09	1E-08	1E-08	4E-07	9E-07

Table 4-13. TRAC Inventory of Radionuclides (curies, decayed through 1/1/90) and Chemicals (grams) in the 241-T, -TX, and -TY Tank Farms.

Radionuclide \ Tank	TX-111	TX-112	TX-113	TX-114	TX-115	TX-116	TX-117	TX-118	Total TX
32. Pb-210	8E-12	4E-12	2E-09	3E-10	4E-10	9E-11	5E-10	5E-10	4E-09
33. Pb-211	7E-05	9E-05	1E-03	1E-04	3E-04	7E-05	3E-04	5E-04	3E-03
34. Pb-214	3E-11	9E-12	1E-08	1E-09	2E-09	4E-10	2E-09	2E-09	2E-08
35. Pd-107	1E-01	4E-02	1E-02	4E-02	2E-02	9E-03	4E-03	2E+00	6E+00
36. Po-210	8E-12	4E-12	2E-09	3E-10	4E-10	9E-11	5E-10	5E-10	4E-09
37. Po-213	2E-08	2E-08	1E-08	2E-08	2E-09	1E-08	1E-08	4E-07	9E-07
38. Po-214	4E-11	1E-11	1E-08	1E-09	2E-09	5E-10	3E-09	2E-09	2E-08
39. Po-215	7E-05	9E-05	1E-03	1E-04	3E-04	7E-05	3E-04	5E-04	3E-03
40. Po-218	3E-11	9E-12	1E-08	1E-09	2E-09	4E-10	2E-09	2E-09	2E-08
41. Pu-238	2E-02	8E-04	3E-01	1E-01	6E-02	3E-03	2E-02	2E+01	3E+01
42. Pu-239	1E+00	6E-02	5E+01	5E+00	5E-01	8E-10	4E-09	9E+02	1E+03
43. Pu-240	2E-01	8E-03	8E+00	8E-01	9E-02	8E-07	1E-05	2E+02	2E+02
44. Pu-241	9E-01	2E-02	3E+01	3E+00	3E-01	1E-09	2E-08	4E+03	4E+03
45. Ra-223	7E-05	9E-05	1E-03	1E-04	3E-04	7E-05	3E-04	5E-04	3E-03
46. Ra-225	2E-08	2E-08	1E-08	2E-08	2E-09	1E-08	1E-08	4E-07	9E-07
47. Ra-226	3E-11	9E-12	1E-08	1E-09	2E-09	4E-10	2E-09	2E-09	2E-08
48. Ru-106	6E-06	4E-07	3E-07	3E-08	2E-06	6E-10	3E-09	3E-03	4E-03
49. Sb-126	5E-03	2E-04	2E-01	2E-02	2E-03	9E-13	2E-12	5E+01	5E+01
50. Sb-126m	5E-03	2E-04	2E-01	2E-02	2E-03	9E-13	2E-12	5E+01	5E+01
51. Se-79	1E+00	7E-01	2E-01	6E-01	3E-01	2E-01	6E-02	2E+01	7E+01
52. Sm-151	7E+00	4E-01	3E+02	3E+01	3E+00	2E-03	4E-03	5E+04	5E+04
53. Sn-126	5E-03	2E-04	2E-01	2E-02	2E-03	8E-13	2E-12	5E+01	5E+01
54. Sr-90	5E+04	8E+03	8E+03	8E+02	3E+04	4E+04	7E+04	7E+05	1E+06
55. Tc-99	5E+01	2E+01	8E+00	2E+01	1E+01	6E+00	2E+00	9E+02	2E+03
56. Th-227	7E-05	8E-05	1E-03	1E-04	2E-04	6E-05	3E-04	5E-04	3E-03
57. Th-229	2E-08	2E-08	1E-08	2E-08	2E-09	1E-08	1E-08	4E-07	9E-07
58. Th-230	4E-09	9E-10	2E-06	2E-07	3E-07	7E-08	4E-07	3E-07	3E-06
59. Th-231	8E-03	2E-03	4E+00	1E-01	7E-01	1E-01	9E-01	3E-01	6E+00
60. Th-233	0	0	0	0	0	0	0	0	0
61. Th-234	2E-01	4E-02	1E+02	3E+00	2E+01	3E+00	2E+01	8E+00	2E+02
62. Tl-207	7E-05	9E-05	1E-03	1E-04	3E-04	7E-05	3E-04	5E-04	3E-03

Table 4-13. TRAC Inventory of Radionuclides (curies, decayed through 1/1/90) and Chemicals (grams) in the 241-T, -TX, and -TY Tank Farms.

Radionuclide \ Tank	TX-111	TX-112	TX-113	TX-114	TX-115	TX-116	TX-117	TX-118	Total TX
63. U-233	2E-05	1E-05	5E-06	1E-05	2E-06	6E-06	5E-06	3E-04	7E-04
64. U-234	2E-05	4E-06	1E-02	7E-04	2E-03	4E-04	2E-03	2E-03	2E-02
65. U-235	8E-03	2E-03	4E+00	1E-01	7E-01	1E-01	9E-01	3E-01	6E+00
66. U-238	2E-01	4E-02	1E+02	3E+00	2E+01	3E+00	2E+01	8E+00	2E+02
67. Y-90	5E+04	8E+03	8E+03	8E+02	3E+04	4E+04	8E+04	8E+05	1E+06
68. Zr-93	3E-02	2E-03	1E+00	1E-01	1E-02	0	0	0	5E+00
TOTAL CURIES	3E+05	1E+05	6E+04	1E+05	1E+05	1E+05	2E+05	4E+06	8E+06

Table 4-13. TRAC Inventory of Radionuclides (curies, decayed through 1/1/90) and Chemicals (grams) in the 241-T, -TX, and -TY Tank Farms. Page 13 of 25

Radionuclide \ Tank	TY-101	TY-102	TY-103	TY-104	TY-105	TY-106	Total TY
1. Ac-225	8E-09	6E-08	2E-07	4E-09	1E-08	6E-09	3E-07
2. Ac-227	2E-05	1E-04	2E-04	3E-06	2E-04	7E-06	5E-04
3. Am-241	5E+01	3E-01	4E+01	2E+00	2E+01	3E+00	1E+02
4. Am-242	4E-04	5E-06	9E-04	4E-05	6E-02	6E-03	7E-02
5. Am-242m	4E-04	5E-06	9E-04	4E-05	6E-02	6E-03	7E-02
6. Am-243	6E-03	3E-05	4E-03	3E-04	2E-03	2E-04	1E-02
7. At-217	8E-09	6E-08	2E-07	4E-09	1E-08	6E-09	3E-07
8. Ba-135m	0	0	0	0	0	0	0
9. Ba-137m	6E+03	7E+04	1E+05	1E+03	3E+04	2E-04	2E+05
10. Bi-210	7E-10	1E-11	3E-09	2E-11	5E-10	6E-11	4E-09
11. Bi-211	2E-05	1E-04	2E-04	3E-06	2E-04	7E-06	5E-04
12. Bi-213	8E-09	6E-08	2E-07	4E-09	2E-08	6E-09	3E-07
13. Bi-214	3E-09	5E-11	1E-08	8E-11	2E-09	2E-10	2E-08
14. C-14	3E+00	6E+01	2E+02	3E-01	1E+01	1E-01	3E+02
15. Cm-242	3E-04	4E-06	7E-04	3E-05	5E-02	5E-03	6E-02
16. Cm-244	1E-04	1E-01	3E-01	2E-04	2E-04	1E-12	4E-01
17. Cm-245	5E-09	3E-06	9E-06	9E-09	5E-09	4E-17	1E-05
18. Cs-135	9E-02	5E-01	5E-01	1E-02	4E-01	2E-09	2E+00
19. Cs-137	6E+03	7E+04	1E+05	2E+03	3E+04	2E-04	2E+05
20. Fr-221	8E-09	6E-08	2E-07	4E-09	1E-08	6E-09	3E-07
21. Fr-223	3E-07	1E-06	2E-06	4E-08	3E-06	1E-07	7E-06
22. I-129	3E-03	4E-01	1E+00	7E-04	1E-02	9E-11	1E+00
23. Nb-93m	2E+00	3E+00	2E+01	6E-01	2E+01	2E+00	4E+01
24. Ni-59	0	0	0	0	0	0	0
25. Ni-63	6E+01	1E+02	4E-01	3E+00	3E+02	1E-06	5E+02
26. Np-237	7E-03	6E-01	2E+00	2E-03	3E-02	3E-05	3E+00
27. Np-239	6E-03	3E-05	4E-03	3E-04	2E-03	2E-04	1E-02
28. Pa-231	4E-05	2E-04	4E-04	6E-06	4E-04	2E-05	1E-03
29. Pa-233	7E-03	6E-01	2E+00	2E-03	3E-02	3E-05	3E+00
30. Pa-234m	2E-01	7E-03	2E+00	2E-01	5E+00	5E-01	8E+00

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Table 4-13. TRAC Inventory of Radionuclides (curies, decayed through 1/1/90) and Chemicals (grams) in the 241-T, -TX, and -TY Tank Farms.

Radionuclide / Tank	TY-101	TY-102	TY-103	TY-104	TY-105	TY-106	Total TY
31. Pb-209	8E-09	6E-08	2E-07	4E-09	1E-08	6E-09	3E-07
32. Pb-210	6E-10	9E-12	2E-09	2E-11	5E-10	6E-11	3E-09
33. Pb-211	2E-05	1E-04	2E-04	3E-06	2E-04	7E-06	5E-04
34. Pb-214	3E-09	5E-11	1E-08	8E-11	2E-09	2E-10	2E-08
35. Pd-107	4E-03	7E-01	2E+00	1E-03	2E-02	1E-10	3E+00
36. Po-210	6E-10	9E-12	2E-09	2E-11	5E-10	6E-11	3E-09
37. Po-213	8E-09	6E-08	2E-07	4E-09	1E-08	6E-09	3E-07
38. Po-214	4E-09	6E-11	1E-08	1E-10	2E-09	2E-10	2E-08
39. Po-215	2E-05	1E-04	2E-04	3E-06	2E-04	7E-06	5E-04
40. Po-218	3E-09	5E-11	1E-08	8E-11	2E-09	2E-10	2E-08
41. Pu-238	3E+01	5E-01	1E+02	6E-01	5E-01	6E-02	1E+02
42. Pu-239	2E+02	3E+00	3E+02	8E+00	7E+01	8E+00	6E+02
43. Pu-240	4E+01	6E-01	4E+01	2E+00	8E+00	9E-01	9E+01
44. Pu-241	3E+02	4E+00	2E+02	1E+01	2E+01	2E+00	5E+02
45. Ra-223	2E-05	1E-04	2E-04	3E-06	2E-04	7E-06	5E-04
46. Ra-225	8E-09	6E-08	2E-07	4E-09	1E-08	6E-09	3E-07
47. Ra-226	3E-09	5E-11	1E-08	8E-11	2E-09	2E-10	2E-08
48. Ru-106	9E-06	3E-06	2E-05	2E-07	2E-06	2E-07	3E-05
49. Sb-126	4E-01	5E-03	1E+00	1E-01	3E+00	3E-01	5E+00
50. Sb-126m	4E-01	5E-03	1E+00	1E-01	3E+00	3E-01	5E+00
51. Se-79	6E-02	7E+00	2E+01	1E-02	3E-01	1E-09	3E+01
52. Sm-151	5E+02	8E+00	3E+03	3E+02	6E+03	7E+02	1E+04
53. Sn-126	4E-01	5E-03	1E+00	1E-01	3E+00	3E-01	5E+00
54. Sr-90	2E+04	1E+04	1E+05	6E+03	3E+05	9E+03	5E+05
55. Tc-99	2E+00	2E+02	7E+02	4E-01	1E+01	5E-08	9E+02
56. Th-227	2E-05	1E-04	2E-04	3E-06	2E-04	7E-06	5E-04
57. Th-229	8E-09	6E-08	2E-07	4E-09	1E-08	6E-09	3E-07
58. Th-230	6E-07	9E-09	2E-06	2E-08	2E-07	2E-08	3E-06
59. Th-231	1E-02	3E-04	8E-02	1E-02	2E-01	2E-02	3E-01
60. Th-233	0	0	0	0	0	0	0

Table 4-13. TRAC Inventory of Radionuclides (curies, decayed through 1/1/90) and Chemicals (grams) in the 241-T, -TX, and -TY Tank Farms. Page 15 of 25

Radionuclide \ Tank	TY-101	TY-102	TY-103	TY-104	TY-105	TY-106	Total TY
61. Th-234	2E-01	7E-03	2E+00	2E-01	5E+00	5E-01	8E+00
62. Tl-207	2E-05	1E-04	2E-04	3E-06	2E-04	7E-06	5E-04
63. U-233	4E-06	5E-05	2E-04	2E-06	6E-06	2E-06	2E-04
64. U-234	4E-03	6E-05	1E-02	9E-05	7E-04	8E-05	1E-02
65. U-235	1E-02	3E-04	8E-02	1E-02	2E-01	2E-02	3E-01
66. U-238	2E-01	7E-03	2E+00	2E-01	5E+00	5E-01	8E+00
67. Y-90	2E+04	1E+04	1E+05	6E+03	3E+05	1E+04	5E+05
68. Zr-93	2E+00	3E-02	8E+00	7E-01	2E+01	2E+00	3E+01
TOTAL CURIES	5E+04	2E+05	4E+05	2E+04	7E+05	2E+04	1E+06

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Table 4-13. TRAC Inventory of Radionuclides (curies, decayed through 1/1/90) and Chemicals (grams) in the 241-T, -TX, and -TY Tank Farms.

Chemical \ Tank	T-101	T-102	T-103	T-104	T-105	T-106	T-107	T-108	T-109
69. Ag	0.000971	0.000022	0.000097	0.000054	3.24E-21	0.000002	2.16E-21	0.000004	0.000022
70. Al	5935939	134907.7	27790986	10819598	5396308	1349077	21585.23	26981.54	547725.3
71. Ba	480.655	3.98257	101.6242	164.796	137.33	554.8132	411.99	416.1099	288.393
72. Bi	2.93E-11	6.06E-13	1.69E-11	41796080	4.18E+08	62694120	14628628	1462863	167184.3
73. $C_2H_3O_3$	0	0	0	0	0	0	0	0	0
74. $C_6H_5O_7$	7564052	132370.9	756405.2	0	0	0	0	0	0
75. CO_3	12001840.24	240036.8	240036.8	0	3.60E-10	2.40E-10	360055.2	600092	18005160
76. C_2O_4		0	0	0	0	0	0	0	0
77. Ca	0.2004	0.000802	0.004008	0	0	0	0	2.40E-31	2.40E-32
78. Cd		0	0	0	0	0	0	0	0
79. Ce	4203.6	70.06	1.4012	56048	5.60E-14	280.24	2.80E-14	70.06	2802.4
80. Cl	0.002482	0.000035	0.000011	0	1.06E-19	0	1.06E-19	0.000142	0.003545
81. Cr	1.56E-11	4.16E-12	5.20E-13	1039920	363972	36397.2	519960	51996	5199.6
82. EDTA	0	0	0	0	0	0	0	0	0
83. F	3039744	56995.21	11399.04	7599361	1.90E-10	17117561	1.90E-10	569952.1	189984
84. Fe	335082	5584.7	33508.2	16754100	5584700	558470	11169400	1116940	111694
85. $Fe(CN)_6$	19075.83	2119.617	21.19744	0	2.12E-12	0	2.12E-12	6358.596	635.8596
86. HEDTA	1948.1	27.83	194.81	0	0	0	0	0	0
87. Hg	0	0	0	0	0	0	0	0	0
88. K	1172949	19549.15	3127.864	0	7.82E-12	0	7.82E-12	11729.49	1172.949
89. La	9.72E-11	1.39E-12	0	0	0	0	0	0	0
90. Mn	10987.6	219.752	1098.76	0	0	0	0	0	0
91. NO_2	4600550	92011	460055	13801650	1.38E-10	1840220	9.20E-12	13801.65	920110
92. NO_3	1.24E+08	2480196	12400980	2.48E+08	6.20E-10	1.36E+08	0.000012	1240098	18601470
93. Na	73567264	1149489	4597954	1.15E+08	6.896931	1.40E+08	185527.4	8966010	22990919
94. Ni	93920	2935	17610	0	1.76E-16	0	1.76E-16	0.3522	0.03522
95. OH	851215.4	102145.8	51022053	17010701	15306575	1704131	10205571	1020778	137078.8
96. PO_4	5698282	94971.36	18994.27	66479952	1.90E+08	95161303	6647995	9782050	4805551
97. Pb	1.8648	0.014504	0.08288	8.08E-08	1.45E-07	2.15E-08	2.07E-08	1.45E-08	8.91E-08
98. SeO_4	0	0	0	0	0	0	0	0	0
99. SiO_3	760837	15216.74	68475.33	4565022	3.80E-12	60866.96	2.28E-12	5325.859	304334.8
100. Sn	0	0	0	0	0	0	0	0	0
101. SO_4	6724320	96059.52	96124.84	9605856	96.0576	38807.27	288.1728	288461	7684800

Table 4-13. TRAC Inventory of Radionuclides (curies, decayed through 1/1/90) and Chemicals (grams) in the 241-T, -TX, and -TY Tank Farms.

Tank / Chemical	T-101	T-102	T-103	T-104	T-105	T-106	T-107	T-108	T-109
102. Sr	0.8762	0.026286	0.08762	0	0	0	0	0	0
103. WO_4	0	0	0	0	0	0	0	0	0
104. ZrO	58.97067	0.300214	214.9749	5360979	536097	64332.71	2144388	214438.8	32165.93
105. Volume	1E+02								
TOTAL GRAMS	2.46E+08	4624910	97519343	5.58E+08	6.35E+08	4.57E+08	45883810	25378363	74508277

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Table 4-13. TRAC Inventory of Radionuclides (curies, decayed through 1/1/90) and Chemicals (grams) in the 241-T, -TX, and -TY Tank Farms.

Tank / Chemical	T-110	T-111	T-112	T-201	T-202	T-203	T-204	Total T
69. Ag	2.16E-15	0	0	0	0	0	0	0.001171
70. Al	0	0	0	0	0	0	0	52023107
71. Ba	0.27466	0	0.82398	0	0	0	0	2560.793
72. Bi	2.09E+09	2.09E+09	2.09E+09	0	62694.12	626941.2	0	6.81E+09
73. $C_2H_3O_3$	0	0	0	0	0	0	0	0
74. $C_6H_5O_7$	0	0	0	0	0	0	0	8452828
75. CO_3	0	0	0	0	0	0	0	31447221
76. C_2O_4	0	0	0	0	0	0	0	0
77. Ca	0	0	0	0	0	0	0	0.20521
78. Cd	0	0	0	0	0	0	0	0
79. Ce	0	0	0	0	0	0	0	63475.76
80. Cl	0	0	0	0	0	0	0	0.006215
81. Cr	1039920	1559880	1559880	0	10399.2	103992	0	6291516
82. EDTA	0	0	0	0	0	0	0	0
83. F	151987.2	56995.21	56995.21	0	379968.1	949920.2	0	30180863
84. Fe	22338800	22338800	27923500	0	0	0	0	1.08E+08
85. $Fe(CN)_6$	0	0	0	0	0	0	0	28211.1
86. HEDTA	0	0	0	0	0	0	0	2170.74
87. Hg	0	0	0	0	0	0	0	0
88. K	0	0	0	0	781966	1563932	0	3554426
89. La	0	1111244	111124.4	0	13890.55	138905.5	0	1375164
90. Mn	0	1098760	109876	0	16701.15	165198.6	0	1402842
91. NO_2	0	0	0	0	0	0	0	21728398
92. NO_3	1860147	0	2.48E-26	0	6200490	12400980	0	5.64E+08
93. Na	1839182	0	0.000011	229.8977	4597954	6896931	459.7954	3.80E+08
94. Ni	0	0	0	0	0	0	0	114465.4
95. OH	17007300	34014600	34014600	170.073	714306.6	1870803	340.146	1.85E+08
96. PO_4	9.50E+08	9.50E+08	9.50E+08	0	284914.1	569828.2	0	3.23E+09
97. Pb	2.07E-08	6.22E-08	1.66E-07	0	6.22E-15	6.22E-14	0	1.962185
98. SeO_4	0	0	0	0	0	0	0	0
99. SiO_3	0.001522	0	4.57E-28	0	0	0	0	5780079
100. Sn	0	0	0	0	0	0	0	0
101. SO_4	0.194997	0	0.576346	0	28817.28	67240.32	0	24630872

Table 4-13. TRAC Inventory of Radionuclides (curies, decayed through 1/1/90) and Chemicals (grams) in the 241-T, -TX, and -TY Tank Farms.

Tank / Chemical	T-110	T-111	T-112	T-201	T-202	T-203	T-204	Total T
102. Sr	0	0	0	0	0	0	0	0.990106
103. WO_4	0	0	0	0	0	0	0	0
104. ZrO	53.6097	42.88776	53.6097	0	0	0	0	8352825
105. Volume						0	0	101
TOTAL GRAMS	3.08E+09	3.10E+09	3.10E+09	399.9707	13092101	25354672	799.9414	1.15E+10

9 3 1 2 3 7 0 1 0 5 8

Table 4-13. TRAC Inventory of Radionuclides (curies, decayed through 1/1/90) and Chemicals (grams) in the 241-T, -TX, and -TY Tank Farms.

Chemical \ Tank	TX-101	TX-102	TX-103	TX-104	TX-105	TX-106	TX-107	TX-108	TX-109	TX-110
69. Ag	7.55E-13	0.000108	0.000022	3.24E-11	0.001079	0.000108	8.63E-12	0.000539	0.010787	0.004315
70. Al	26981540	5396.362	277909.9	24283.4	43170464	5396308	0	26986936	2.70E+08	1.35E+08
71. Ba	2746.6	2756.213	557.5598	1098.64	4174.832	219.728	0.000014	1510.63	5493.2	2197.28
72. Bi	1.25E-10	2.10E-10	6.33E-11	1.46E-10	4.28E-10	1.25E-11	4.60E-18	6.48E-11	41796080	4179608
73. $C_2H_3O_3$	0.000005	0	0	0	0	0	0	0	0	0
74. $C_6H_5O_7$	0.005673	170191.2	170191.2	0.01891	1.13E+08	0	0	0	1.89E+08	75640520
75. CO_3	3.602352	360055.2	4800736	0.120018	18002760	0.012002	0.600092	12361895	3.02E+08	1.80E+08
76. C_2O_4	0	0	0	0	0	0	0	0	0	0
77. Ca	12.024	0.00016	0.000008	3.61E-11	0.16032	0	0	32064.16	0.012024	0.003607
78. Cd	0	0	0	0	0	0	0	0	0	0
79. Ce	0.000001	28.024	280.24	0.000028	280.24	0	0	126108	112096	84072
80. Cl	2.48E-13	0.000011	0.001064	1.77E-11	0.000213	0	0	0.003191	0.035453	0.028362
81. Cr	0.000016	3.69E-12	1.56E-13	2.08E-20	2.60E-11	2.08E-12	0	2.60E-11	1559880	155988
82. EDTA	0.000018	0	0	0	0	0	0	0	0	0
83. F	0.000076	3799.681	18998.4	0.009499	56995.21	0	0	2089824	9499202	7789345
84. Fe	55.84745	5584.7	11169.4	0.001675	5584700	0	0	2.23E-19	39092900	6143170
85. $Fe(CN)_6$	4239.064	19.07579	0.001272	0.000002	0.008478	0	0	0	211.9744	21.61923
86. HEDTA	0.000028	278.3	13.915	0.000056	2783	0	0	0	19481	5566
87. Hg	0	0	0	0	0	0	0	0	0	0
88. K	0.000313	1954.915	390.983	0.000313	39098.3	0	0	0	390983	234589.8
89. La	0	0	1.39E-22	0	0	0	0	0	8.33E-19	8.33E-20
90. Mn	0.000005	164.814	164.814	0.000027	109876	0	0	0	164814	54938
91. NO_2	0.004601	230027.5	322038.5	0.046006	9201100	0.000322	0	27603300	3.22E+08	1.38E+08
92. NO_3	1.24E+09	63244998	5580441	0.496039	4.34E+08	55804410	0.186015	6.20E+08	1.28E+09	6.20E+08
93. Na	4.60E+08	24139259	4597954	689.6931	1.84E+08	11494885	2298.977	2.07E+08	2.53E+08	2.30E+08
94. Ni	46960	3.52E-07	2359.74	5.28E-14	358070	0	0	0	387420	146750
95. OH	68029200	10204.38	18367.88	51532.12	68032601	6806321	1700.798	14456.21	34018001	3404861
96. PO_4	0.00038	759.7709	949713.6	0.018994	189942.7	0.004749	0.379885	19089243	1.03E+08	66479952
97. Pb	2072000	1.57E-08	0.006216	6.22E-09	4.144	2.09E-08	1.04E-14	2.15E-07	7.252	2.072
98. SeO_4	0	0	0	0	0	0	0	0	0	0
99. SiO_3	0.000304	7608.37	38041.85	0.002283	760837	0.000008	0	7608370	30433480	15216740
100. Sn	0	0	0	0	0	0	0	0	0	0
101. SO_4	960576	386151.6	1921536	768.5569	3845186	384316.9	0.576346	28818145	96059521	76846945

Table 4-13. TRAC Inventory of Radionuclides (curies, decayed through 1/1/90) and Chemicals (grams) in the 241-T, -TX, and -TY Tank Farms.

Chemical \ Tank	TX-101	TX-102	TX-103	TX-104	TX-105	TX-106	TX-107	TX-108	TX-109	TX-110
102. Sr	1.75E-07	0.000009	0.061334	2.63E-12	0.000088	0	0	0	70.096	26.286
103. WO_4	0	0	0	0	0	0	0	0	0	0
104. ZrO	85.77552	1.072194	108.2916	21.44388	16.08291	7.61E-07	0.000024	64.86774	8577874	750643
105. Volume	0	0	0	0	0	0	0	0	0	0
TOTAL GRAMS	1.80E+09	88569238	18710974	78394.57	8.81E+08	79886461	4001.517	9.52E+08	2.98E+09	1.56E+09

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Table 4-13. TRAC Inventory of Radionuclides (curies, decayed through 1/1/90) and Chemicals (grams) in the 241-T, -TX, and -TY Tank Farms.

Chemical \ Tank	TX-111	TX-112	TX-113	TX-114	TX-115	TX-116	TX-117	TX-118	Total TX
69. Ag	0.000647	0.000324	0.000097	0.000324	0.000108	0.000076	0.000032	0.01618	0.034744
70. Al	16210509	21587930	13517752	2719739	13509657	2725136	1376059	1.89E+08	7.69E+08
71. Ba	961.31	961.31	466.922	1098.64	233.461	453.189	425.723	10986.4	36341.64
72. Bi	417960.8	20898.04	20898040	2089804	208980.4	4.20E-10	0.000084	0.083592	69611371
73. $C_2H_3O_3$	0	0	0	0	0	0	0	5253073	5253073
74. $C_6H_5O_7$	7564052	378202.6	0	0	0	0	0	1.32E+08	5.19E+08
75. CO_3	1.20E+08	1.80E+08	66010120	1.26E+08	84012880	37205704	66010120	6.01E+08	1.80E+09
76. C_2O_4	0	0	0	0	0	0	0	0	0
77. Ca	0.000361	0.00002	0	0	0	0	0	1.68336	32078.04
78. Cd	0	0	0	0	0	0	0	0	0
79. Ce	28024	112096	70060	14012	28024	14012	7006	70060	666158.5
80. Cl	0.024817	0.031908	0.010636	0.028362	0.010636	0.007091	0.002836	0.035453	0.220032
81. Cr	15598.8	1039.92	519960	51996	10399.2	2.62E-10	0.000003	5199.603	2320062
82. EDTA	0	0	0	0	0	0	0	29224500	29224500
83. F	1899840	1709856	22798084	189984	7599361	38186790	57071203	41796487	1.91E+08
84. Fe	670164	39092.9	11169400	1116940	111694	1.16E-17	5.60E-17	11225247	75170118
85. $Fe(CN)_6$	4.239064	0	0	0	0	0	0	635859.6	640355.6
86. HEDTA	556.6	27.83	0	0	0	0	0	55660000	55688707
87. Hg	0	0	0	0	0	0	0	0	0
88. K	23458.98	1172.949	0	0	0	0	0	390983	1082632
89. La	1.39E-21	0	0	0	0	0	0	2.78E-23	9.18E-19
90. Mn	5493.8	384.566	0	0	0	0	0	1099859	1435695
91. NO_2	18402200	27603300	18402200	4600550	9201100	3680440	1380165	2.30E+08	8.11E+08
92. NO_3	1.86E+08	3.72E+08	3.10E+08	1.24E+08	2.48E+08	6.76E+08	4.59E+08	7.44E+09	1.41E+10
93. Na	1.84E+08	2.44E+08	3.45E+08	2.12E+08	1.36E+08	8.28E+08	7.36E+08	4.60E+09	8.66E+09
94. Ni	17023	1291.4	0	0	0	0	0	645700	1605574
95. OH	343547.5	56124.09	13609241	1363985	173474.5	86737.23	103744.5	1531507	1.98E+08
96. PO_4	47485680	47485680	3.13E+08	48340422	19070249	3.88E+08	4.79E+08	1.90E+08	1.72E+09
97. Pb	0.2072	0.016576	0.000009	8.91E-07	0.000002	3.73E-07	0.000002	6216.186	2078230
98. SeO_4	0	0	0	0	0	0	0	0	0
99. SiO_3	3043348	7608370	38041850	1521674	15216740	1.52E+08	45650220	45680653	3.63E+08
100. Sn	0	0	0	0	0	0	0	0	0
101. SO_4	57635040	86452416	38423328	67240992	19211616	19211808	7684896	3.85E+08	8.90E+08

Table 4-13. TRAC Inventory of Radionuclides (curies, decayed through 1/1/90) and Chemicals (grams) in the 241-T, -TX, and -TY Tank Farms.

Chemical \ Tank	TX-111	TX-112	TX-113	TX-114	TX-115	TX-116	TX-117	TX-118	Total TX
102. Sr	2.6286	0.17524	0	0	0	0	0	262.86	362.1073
103. WO_4	0	0	0	0	0	0	0	0	0
104. ZrO	75160.8	5382.414	3216583	321659	42888.4	536.3114	965.0389	4288.776	12996277
105. Volume	0	0	0	0	0	0	0	0	0
TOTAL GRAMS	6.44E+08	9.89E+08	1.21E+09	5.91E+08	5.52E+08	2.15E+09	1.85E+09	1.40E+10	3.03E+10

9 3 1 2 7 0 1 0 6 2

Table 4-13. TRAC Inventory of Radionuclides (curies, decayed through 1/1/90) and Chemicals (grams) in the 241-T, -TX, and -TY Tank Farms.

Chemical \ Tank	TY-101	TY-102	TY-103	TY-104	TY-105	TY-106	Total TY
69. Ag	0.000032	0.003236	0.009708	0.000006	0.000108	7.55E-13	0.013091
70. Al	558517.9	277909.9	26981542	822937	4317.046	809.4462	28646033
71. Ba	425.723	1098.64	1785.29	278.7799	1441.965	274.66	5305.058
72. Bi	16718432	417960.8	20898040	417960.8	1.13E-10	4.18E-11	38452394
73. $C_2H_3O_3$	0	0	0	0	0	0	0
74. $C_6H_5O_7$	0	3782026	11346078	0	0	0	15128104
75. CO_3	12481914	55808556	27004140	780119.6	66010120	600092.2	1.63E+08
76. C_2O_4	0	0	0	0	0	0	0
77. Ca	0	0.003206	0.036072	0.000012	0	0	0.03929
78. Cd	0	0	0	0	0	0	0
79. Ce	2802.4	2802.4	1401.2	1120.96	14.012	7.01E-08	8140.972
80. Cl	0.002127	0.010636	0.000709	0.000106	0.010636	7.09E-11	0.024214
81. Cr	519960	15598.8	519960	15598.8	1.56E-14	1.04E-22	1071118
82. EDTA	0	0	0	0	0	0	0
83. F	569952.1	197583.4	379968.1	170985.6	1709.856	0.000009	1320199
84. Fe	11169400	446776	11727870	279235	27.9235	2.79235	23623312
85. $Fe(CN)_6$	0	423.9064	1271.719	635.8596	0	0	2331.485
86. HEDTA	0	5566	19481	0	0	0	25047
87. Hg	0	0	0	0	0	0	0
88. K	0	39098.3	117294.9	1172.949	0	0	157566.1
89. La	0	0	0	0	0	0	0
90. Mn	0	3845.66	10987.6	5.4938	0	0	14838.75
91. NO_2	460055	4600550	13801650	920110	3220.385	0.000023	19785585
92. NO_3	3.41E+08	86806860	62004900	12400980	62004900	0.496535	5.64E+08
93. Na	1.33E+08	91959080	70578594	4712903	73567264	27587724	4.02E+08
94. Ni	0	0.001174	0.000023	0.03522	0	0	0.036417
95. OH	10205060	340486.1	68046207	340486.1	341846.7	68165.26	79342252
96. PO_4	13295990	19089243	9544622	474856.8	18994272	0.094971	61398984
97. Pb	2.20E-07	8.70E-07	0.000001	1.45E-08	0.000001	4.14E-08	0.000004
98. SeO_4	0	0	0	0	0	0	0
99. SiO_3	228251.1	380418.5	684753.3	76083.7	1521.674	45650220	47021248
100. Sn	0	0	0	0	0	0	0
101. SO_4	4803168	28817952	28818241	384422.5	19212481	192.3073	82036457

Table 4-13. TRAC Inventory of Radionuclides (curies, decayed through 1/1/90) and Chemicals (grams) in the 241-T, -TX, and -TY Tank Farms.

Chemical \ Tank	TY-101	TY-102	TY-103	TY-104	TY-105	TY-106	Total TY
102. Sr	0	0.000263	0.026987	0.001756	0	0	0.029006
103. WO_4	0	0	0	0	0	0	0
104. ZrO	3216582	85796.96	3216625	85775.53	4289.098	321.6582	6609390
105. Volume	0	0	0	0	0	0	0
TOTAL GRAMS	5.49E+08	2.93E+08	3.56E+08	21885668	2.40E+08	73907803	1.53E+09

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Table 4-14. Summary of Single-Shell Tank Sampling Data.

Description	Date	Pu (g/gal)	^{137}Cs (uCi/gal)	^{134}Cs (uCi/gal)	$^{89,90}Sr$ (uCi/gal)	^{60}Co (uCi/gal)	pH	Total Organic Carbon (g/gal)
241-T-104 Single-Shell Tank								
Sludge	11/13/79	--	1.30×10^{0}	--	5.0×10^{0}	--	--	--
241-T-204 Single-Shell Tank								
Liquid	12/04/78	1.23×10^{-6}	2.1×10^{-2}	--	2.23×10^{-1}	--	--	--
241-TX-118 Single-Shell Tank								
Liquid	5/12/72	--	1.40×10^{6}	1.02×10^{4}	--	--	--	--
Liquid	2/11/75	--	2.09×10^{4}	9.51×10^{-3}	--	--	--	--
Liquid	3/31/77	1.04×10^{-6}	7.30×10^{1}	--	1.60×10^{1}	--	--	0.105
Average	--	1.04×10^{-6}	4.74×10^{5}	5.1×10^{3}	1.60×10^{1}	--	--	0.105
241-TY-102 Single-Shell Tank								
Cake	02/01/80	1.195×10^{-7}	1.20×10^{1}	--	9.93×10^{0}	--	--	0.00236
241-TY-103 Single-Shell Tank								
Sludge	02/01/80	3.65×10^{-4}	2.16×10^{1}	--	1.90×10^{1}	--	--	--
241-TY-104 Single-Shell Tank								
Liquid	12/20/79	3.00×10^{-6}	--	--	3.10×10^{0}	--	--	0.004
Liquid	09/04/85	--	1.43×10^{1}	--	--	<0.002	12.5	0.000164
Average	--	3.00×10^{-6}	1.43×10^{1}	--	3.10×10^{0}	<0.002	12.5	0.0021

Table 4-14. Summary of Single-Shell Tank Sampling Data.

Description	Date	Pu (g/gal)	^{137}Cs (uCi/gal)	^{134}Cs (uCi/gal)	$^{89,90}Sr$ (uCi/gal)	^{60}Co (uCi/gal)	pH	Total Organic Carbon (g/gal)
241-TY-105 Single-Shell Tank								
Sludge	02/01/80	3.77×10^{-6}	9.16×10^{1}		1.20×10^{3}			
241-TY-106 Single-Shell Tank								
Liquid	12/20/79	1.07×10^{-7}	--	--	7.43×10^{1}	--	--	0.294
Liquid	09/04/85	--	1.50×10^{1}	--	2.35×10^{2}	<0.01	8.81	0.00025
Average	--	1.07×10^{-7}	1.50×10^{1}	--	1.55×10^{2}	<0.01	8.81	0.147

Table 4-15. Summary of Tank Farm Vadose Zone Well Geophysical Logging Results.

Tank	Number of Associated Dry Wells	Geophysical Evidence of Leaking	Comments
			241-T Tank Farm
241-T-101	5	no	Contamination in Wells 50-01-04, 50-01-06, and 50-00-03, source leakage from a spare fill line overfill. Activity in dry Well 50-01-12, at 11 m is unexplained.
241-T-102	6	no	Radiation levels in the vadose zone wells have remained stable. Slightly elevated readings in Wells 50-02-08 and 50-02-09 attributed to the 106-T tank leak.
241-T-103	6	yes	Radiation levels in the vadose zone wells have remained stable. Slightly elevated readings in Wells 50-03-04, 50-03-05, and 50-03-06 is attributed to the 106-T tank. Contamination at 6 m level of well 50-03-04 due to spare fill line overfilling.
241-T-104	5	no	Radiation levels in the vadose zone wells have remained stable. Dry Wells 50-04-08 and 50-04-10 have unexplained peaks between 20 and 21 m and the increasing activity in Well 50-05-08 (1980) has stabilized.
241-T-105	3	no	Radiation levels in the vadose zone wells have remained stable. Tank categorized as an assumed leaker.
241-T-106	9	yes	Leak plume is essentially stable, some slight migration to southeast causing activity in dry wells in proximity of tanks 108 and 105-T. Radiation levels in vadose zone have shown no significant changes.
241-T-107	3	yes	Radiation levels in vadose zone wells have remained stable. Tank categorized as an assumed leaker because of increased radiation levels in Wells 50-07-07 and 50-07-03.
241-T-108	6	yes	Radiation levels in vadose zone wells have remained stable. Dry well studies conducted in 1978 concluded that elevated dry activity associated with 106-T leak.

Table 4-15. Summary of Tank Farm Vadose Zone Well Geophysical Logging Results.

Tank	Number of Associated Dry Wells	Geophysical Evidence of Leaking	Comments
241-T-109	6	yes	Radiation levels in vadose zone wells have remained stable. Tank removed from service as a result of increasing activity in Well 50-09-10 at 12 m. Activity in wells 50-09-01, 50-09-02, 50-09-09, and 50-09-10 continue to decrease since 1976.
241-T-110	4	no	Radiation levels in vadose zone wells have remained stable.
241-T-111	5	yes	Tank categorized as an assumed leaker after unexplained liquid level decrease. Radiation levels in the vadose zone wells have remained stable.
241-T-112	3	no	Radiation levels in the vadose zone wells have remained stable.
241-T-201	none	no	
241-T-202	none	no	
241-T-203	none	no	
241-T-204	none	no	
241-TX Tank Farm			
241-TX-101	5	no	Radiation levels in the vadose zone wells have remained stable.
241-TX-102	5	no	Radiation levels in the vadose zone wells have remained stable.
241-TX-103	6	no	Radiation levels in the vadose zone wells have remained stable with the exception of well 51-03-09. Activity in this well continues to increase (approximately 140 c/sec) at a depth of approximately 18 to 21 m.
241-TX-104	6	no	Radiation levels in the vadose zone wells have remained stable with the exception of well 51-04-05. Dry Well 51-04-05 continues to show an increase in activity (approximately 100 c/sec at 22 m).

Table 4-15. Summary of Tank Farm Vadose Zone Well Geophysical Logging Results.

Tank	Number of Associated Dry Wells	Geophysical Evidence of Leaking	Comments
241-TX-105	6	yes	Tank categorized as an assumed leaker because of activity in 5 of the 6 dry wells associated with this tank. Radiation levels in vadose zone wells have remained stable.
241-TX-106	5	no	Radiation level in vadose zone wells have remained stable.
241-TX-107	7	yes	Tank categorized as an assumed leaker due to a gradual increase in activity in dry well 51-07-07. Activity in dry Well 51-07-07 appears to be increasing. The radiation levels in the remaining dry wells have remained stable.
241-TX-108	3	no	Radiation levels in vadose zone wells have remained stable.
241-TX-109	5	no	Radiation levels in vadose zone wells have remained stable.
241-TX-110	6	yes	Tanks categorized as an assumed leaker due to increased activity at 17 m (55 ft) in dry Well 51-10-01 and increased activity in dry Well 51-10-13. The radiation levels in the remaining dry wells have remained stable.
241-TX-111	5	no	Radiation levels in vadose zone wells have remained stable.
241-TX-112	6	no	Radiation levels in vadose zone wells have remained stable.
241-TX-113	3	yes	Tank categorized as an assumed leaker. Radiation levels in vadose zone wells have remained stable.
241-TX-114	3	yes	Tank categorized as an assumed leaker because all dry wells have activity at 13 m, with Well 51-14-04 having shown an extensive profile change below 15 m. Radiation levels in vadose zone wells have remained stable.
241-TX-115	4	yes	Tank categorized as an assumed leaker. Radiation levels in vadose zone wells have remained stable.

Table 4-15. Summary of Tank Farm Vadose Zone Well Geophysical Logging Results.

Tank	Number of Associated Dry Wells	Geophysical Evidence of Leaking	Comments
241-TX-116	3	yes	Tank categorized as an assumed leaker because of increased radiation levels in Well 51-16-11. Radiation levels in remaining wells have remained stable.
241-TX-117	4	yes	Tank categorized as an assumed leaker. Radiation levels in vadose zone wells have remained stable.
241-TX-118	7	no	Radiation levels in vadose zone wells have remained stable.
241-TY Tank Farm			
241-TY-101	3	yes	Tank categorized as an assumed leaker due to a liquid level decrease of greater than 0.76 m. Radiation levels in the vadose zone wells have remained stable.
241-TY-102	5	no	Radiation levels in vadose zone wells have remained stable.
241-TY-103	3	yes	Tank categorized as an assumed leaker because of increased radiation levels in Well 52-03-06 and 52-03-03. Activity levels of Cobalt-60 in Well 52-03-06 to the bottom of this well (approximately 30 m) were observed.
241-TY-104	5	yes	Tank categorized as an assumed leaker. Radiation levels in vadose zone wells have remained stable.
241-TY-105	1	yes	Tank categorized as an assumed leaker because of increased activity in Well 52-05-07. Radiation levels in the vadose well has remained stable.
241-TY-106	5	yes	Tank categorized as an assumed leaker. Radiation levels in vadose zone wells have remained stable.

Table 4-16. Deposition Rate for 221-T Building Head-End Wastewater 2 Stream--Plasma Torch Standby to 216-T-1 Ditch at the T Plant Aggregate Area. Page 1 of 2

Constituent	Concentration (kg/L)[a]	Deposition Rate (kg/mo)[b]
Aluminum	1.62e-07	1.42e-01
Barium	2.70e-08	2.36e-02
Boron	1.32e-08	1.15e-02
Calcium	1.74e-05	1.52e+01
Chloride	3.25e-06	2.84e+00
Copper	1.45e-08	1.27e-02
Fluoride	1.30e-07	1.14e-01
Iron	2.63e-07	2.30e-01
Lead	7.00e-09	6.12e-03
Magnesium	3.82e-06	3.34e+00
Manganese	1.23e-07	1.07e-01
Nitrate	5.25e-07	4.59e-01
Potassium	6.85e-07	5.98e-01
Silicon	2.00e-06	1.75e+00
Sodium	1.95e-06	1.70e+00
Strontium	8.60e-08	7.51e-02
Sulfate	1.22e-05	1.07e+01
Uranium	3.86e-10	3.37e-04
Zinc	6.02e-08	5.26e-02
Acetone	1.17e-08	1.02e-02
Ammonia	5.15e-08	4.50e-02
Trichloromethane	2.65e-08	2.32e-02
Unknown	4.50e-08	3.93e-02
Alpha activity*	7.62e-13	6.66e-07
Beta activity*	3.78e-12	3.30e-06

Table 4-16. Deposition Rate for 221-T Building Head-End Wastewater 2 Stream--Plasma Torch Standby to 216-T-1 Ditch at the T Plant Aggregate Area. Page 2 of 2

Constituent	Concentration (kg/L)[a]	Deposition Rate (kg/mo)[b]
TDS	5.71e-05	4.99e+01
Total carbon	1.29e-05	1.13e+01
TOX (as Cl)	1.99e-07	1.74e-01
60Co*	1.14e-12	9.96e-07
137Cs*	1.34e-12	1.17e-06
Radium total	1.34e-13	1.17e-07

Source: WHC 1990b.

NOTE:

The plasma torch standby flowrate is 8.74e+5 L/month.
The data was collected from October 1989 through March 1990.

[a] Constituent concentrations are average values from Table 3-2 of WHC 1990b. Concentration units flagged (*) constituents are reported as curies per liter.
[b] Deposition rate units of flagged (*) constituents are reported as curies per month.

TDS = total dissolved solids
TOX = total organic halides

Table 4-17. Deposition Rate for T Plant Wastewater to 216-T-4-2 Ditch. Flowrate: 1.60e+6 L/month. Page 1 of 2

Constituent	Concentration (kg/L)[a]	Deposition rate (kg/mo)[b]
Barium	3.00e-08	4.80e-02
Boron	2.00e-08	3.20e-02
Cadmium	2.00e-09	3.20e-03
Calcium	1.90e-05	3.04e+01
Chloride	1.17e-06	1.87e+00
Copper	1.75e-08	2.80e-02
Fluoride	1.45e-07	2.32e-01
Iron	5.40e-08	8.64e-02
Magnesium	3.97e-06	6.35e+00
Manganese	9.00e-09	1.44e-02
Nitrate	5.00e-07	8.00e-01
Potassium	7.57e-07	1.21e+00
Silicon	2.05e-06	3.28e+00
Sodium	2.03e-06	3.25e+00
Strontium	9.55e-08	1.53e-01
Sulfate	1.01e-05	1.62e+01
Uranium	4.70e-10	7.52e-04
Zinc	5.42e-08	8.67e-02
Ammonia	5.40e-08	8.64e-02
1-Butanol	1.20e-08	1.92e-02
Unknown amide	2.60e-08	4.16e-02
Beta Activity*	2.59e-12	4.14e-06
TDS	6.05e-05	9.68e+01
TOC	1.00e-06	1.60e+00
Total carbon	1.54e-05	2.46e+01
TOX (as Cl)	1.27e-08	2.03e-02

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Table 4-17. Deposition Rate for T Plant Wastewater to 216-T-4-2 Ditch. Flowrate: 1.60e+6 L/month. Page 2 of 2

Constituent	Concentration (kg/L)[a]	Deposition rate (kg/mo)[b]
137Cs*	7.67e-13	1.23e-06
Radium total*	1.08e-13	1.73e-07

Source: Ayster 1990.

NOTE:

Data was collected from October 1989 through March 1990.
Flowrate is the average of rates from Section 2.0.
Constituent concentrations are average values from the Statistics Report in Section 3.0.
Concentration units flagged (*) constituents are reported as curies per liter.
Deposition rate units of flagged (*) constituents are reported as curies per month.

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Table 4-18. Detonation of Chemicals at 200-W Ash Pit Demolition Site at the T Plant Aggregate Area. Page 1 of 2

CHEMICAL	WEIGHT
1984 Detonations	
p-dioxane	3.4 kg
tetrahydronaphthalene	3.76 kg
tetrahydrofuran	9.08 kg
benzene	9.47 kg
diisopropyl benzene	6.06 kg
bromobenzene	15.1 kg
1,4-dioxane	757 g
polyethylene glycol monoethyl ether	757 g
1,2-bis(2-chlorethoxy)ethane	3.02 kg
dioxane	567 g
2-butoxyethanol	3.02 kg
1985 Detonations	
none	
1986 Detonations	
tetrahydrofuran	6.1 kg
triethylborane	500 g
lithium hydride	230 g
acrolein	400 g
hydrazine	1 kg
aluminum chloride	450 g
unsymmetrical dimethyl hydrazine	10 g
p-nitrobenzoyl chloride	100 g
sodium peroxide	340 g
benzene/butyl lithium solution	900 g

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Table 4-18. Detonation of Chemicals at 200-W Ash Pit Demolition Site at the T Plant Aggregate Area. Page 2 of 2

CHEMICAL	WEIGHT
hexane/benzene/butyl lithium/tetrahydrofuran	1 kg
chromium metal powder	454 g
toluene/ether/benzene/ethylacetate	4 g
heptane/diethyl ether	4 kg
ethyl ether/allyl magnesium bromide	1 kg
benzene/ethyl acetate/tetrahydrofuran/ether /toluene/hydrogen sulfide/methanol	4 kg
ethyl ether	29.7 kg
picric acid	460 g
isopropyl ether	1 kg
butoxyethanol	946 g
butyl cellosolve	89 g
carbon trichloride	455 g
butyl ethanol	9.46 kg
phenylether	235 g

Source: WHC 1991a.

Table 4-19. Known Contamination Sources Originating Outside the T Plant Aggregate Area.

Waste Management Unit	Contaminant Source & Information
200-W Ash Pit Demolition Site	a) Active site for treatment of shock sensitive of potentially explosive chemical wastes
241-T Tank Farm	a) Coating waste, ion exchange waste and high-level waste from the S Plant b) PNL waste c) 224-U Building waste from the 241-B, -BX, -C, and -SX Tank Farms (Jungfleish 1983) d) B Plant low-level waste e) S Plant high-level waste f) 241-U Tank Farm
241-TX Tank Farm	a) Waste from S Plant
241-TY-104	a) S Plant ion exchange waste b) PUREX organic wash waste
216-T-27 Crib	a) 300 Area 340 Laboratory PNL wastes
216-T-28 Crib	a) 300 Area 340 Laboratory PNL wastes
216-T-34 Crib	a) 300 Area 340 Laboratory PNL wastes
216-T-35 Crib	a) 300 Area 340 Laboratory PNL wastes
216-T-36 Crib	a) 221-U Building
244-TX Receiver Tank	a) Plutonium Finishing Plant
UN-200-W-88	a) Uranyl nitrate trailer spill

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Table 4-20. Candidate Contaminants of Potential Concern for the T Plant Aggregate Area.[a/]

RADIONUCLIDES

Gross alpha
Gross beta

TRANSURANICS

Americium-241
Americium-242
Americium-242m
Americium-243
Curium-242
Curium-244
Curium-245
Einstenium-254*
Neptunium-237
Neptunium-239
Plutonium
Plutonium-238
Plutonium-239/240
Plutonium-241

URANIUM

Uranium-233
Uranium-234
Uranium-235
Uranium-238

FISSION PRODUCTS

Actinium-225
Actinium-227
Aluminium-28*
Antimony-122*
Antimony-124*
Antimony-125
Antimony-126
Antimony-126m
Astitine-217*
Barium-135m*
Barium-137m
Beryllium-7*
Beryllium-10
Bismuth-210
Bismuth-211
Bismuth-213
Bismuth-214
Cadmium-109
Carbon-14
Cerium-141*
Cerium-144*
Cesium-134
Cesium-135
Cesium-137
Chlorine-36
Chromium-51*
Cobalt-57*
Cobalt-58*
Cobalt-60
Europium-152
Europium-154
Europium-155
Francium-221
Francium-223*
Gadonlinium-153*
Germanium-68*
Gold-195*
Iodine-123*
Iodine-125*
Iodine-129
Iodine-131*
Iron-55
Iron-59*
Krypton-85
Lead-209
Lead 210
Lead 211
Lead-212*
Lead-214
Manganese-54*
Molybdenum-93
Nickel-59
Nickel 63
Niobium-91
Niobium-93m
Niobium-94
Niobium-95*
Palladium-107*
Phosphorous-32*
Polonium-210
Polonium-213*
Polonium-214
Polonium-215
Polonium-218
Potassium-40
Promethium-147
Protactinium-231
Protactinium-233*
Protactinium-234m*
Radium-223
Radium-225
Radium-226
Radium-228
Rhenium-187
Ruthenium-103*
Ruthenium-106
Samarium-151
Scandium-46*
Selenium-75*
Selenium-79
Silver-108
Silver-110m*
Sodium-22
Strontium-85*
Strontium-90
Tantalum-182*
Technetium-99
Tellurium-127*
Tellurium-129m
Thallium-204
Thallium-207
Thorium-227
Thorium-229
Thorium-230
Thorium-231
Thorium-232
Thorium-233*
Thorium-234
Thulium-170*
Tin-113*
Tin-123m*
Tin-126*
Tritium
Yttrium-90
Zinc-65*
Zirconium-93
Zirconium-95*

HEAVY METALS

Aluminum
Arsenic
Barium
Bismuth
Cadmium
Cerium
Chromium
Copper
Iron
Lanthanum
Lead
Manganese
Mercury
Nickel

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Table 4-20. Candidate Contaminants of Potential Concern for the T Plant Aggregate Area.[a/]

HEAVY METALS (cont.)	OTHER INORGANICS (cont.)	SEMIVOLATILE ORGANICS
Selenium	Magnesium	Citrate
Silver	Molybdate - Citrate reagent	Dibutyl phosphate
Strontium	Nitrate	Ethanol
Thorium	Nitric acid	Ethylene diamine tetraacetate (EDTA)
Tin	Nitrite	Gylcolate
Titanium	Oxalic acid	Kerosene
Uranium	Phosphate	Monobutyl phosphate
Vanadium	Phosphoric acid	N-(2-hydroxyethyl) ethylenediaminetriacetate (HEDTA)
Zinc	Phosphorous pentoxide	Oxalate
	Potassium	Paraffin hydrocarbons
OTHER INORGANICS	Potassium carbonate	Tributyl phosphate
	Potassium fluoride	1,1,1-Trichloroethane
Ammonium ion	Potassium hydroxide	
Ammonium fluoride	Potassium permanganate	
Ammonium nitrate	Silica	
Ammonium oxalate	Silicon	
Asbestos	Sodium	
Barium nitrate	Sodium fluoride	
Bismuth phosphate	Sodium hydroxide	
Boric acid	Sodium nitrate	
Boron	Sulfamic acid	
Calcium	Sulfate	
Carbonate	Sulfuric acid	
Ceric Iodate	Uranium oxide	
Chloride	Uranyl nitrate hexahydrate	
Chloroplatinic acid	Zirconium oxide	
Chromus sulfate		
Cyanide	VOLATILE ORGANICS	
Ferric cyanide		
Fluoride	Acetone	
Hydrobromic acid	Butyl Alcohol	
Hydrochloric acid	Carbon tetrachloride	
Hydrofluoric acid	Chloroform	
Hydroiodic acid	Decane	
Hydroxide	Ethyl ether	
Lanthanum fluoride	Methylene chloride	
Lithium	MIBK ("Hexone")	
	Toluene	

a/ Candidate chemicals of concern are those that were reported in waste management unit inventories, detected at elevated levels in environmental media within the aggregate area, or are expected to occur based on historical association with waste processes.

* The radionuclide has a half-life of < 1 year and if it is a daughter product, the parent has a half-life of < 1 year, or the buildup of the short-lived daughter would result in an activity of < 1% of the parent radionuclide's initial activity.

Table 4-21. Summary of Known and Suspected Contamination Types at Each Waste Management Unit and Unplanned Release Site.

Waste Management Unit or Unplanned Release	TRU	Fission Products	Uranium	Heavy Metals	Other Inorganics	Volatiles	Semi-volatiles
Tanks and Vaults							
241-T-101 Single-Shell Tank	K	K	K	S	K	S	K
241-T-102 Single-Shell Tank	K	K	K	S	K	S	K
241-T-103 Single-Shell Tank (UPR 200-W-147)	K	K	K	S	K	S	K
241-T-104 Single-Shell Tank	K	K	K	S	K	S	S
241-T-105 Single-Shell Tank	K	K	K	S	K	S	S
241-T-106 Single-Shell Tank (UPR-200-W-148)	K	K	K	S	K	S	K
241-T-107 Single-Shell Tank	K	K	K	S	K	S	K
241-T-108 Single-Shell Tank	K	K	K	S	K	S	K
241-T-109 Single-Shell Tank	K	K	K	S	K	S	K
241-T-110 Single-Shell Tank	K	K	K	S	K	S	S
241-T-111 Single-Shell Tank	K	K	K	S	K	S	S
241-T-112 Single-Shell Tank	K	K	K	S	K	S	S
241-T-201 Single-Shell Tank (224-U Bldg. Waste)	S	S	S	S	S	S	S
241-T-202 Single-Shell Tank (224-U Bldg. Waste)	S	S	S	S	S	S	S

Table 4-21. Summary of Known and Suspected Contamination Types at Each Waste Management Unit and Unplanned Release Site.

Waste Management Unit or Unplanned Release	TRU	Fission Products	Uranium	Heavy Metals	Other Inorganics	Volatiles	Semi-volatiles
241-T-203 Single-Shell Tank (224-U Bldg. Waste)	K	S	S	S	S	S	S
241-T-204 Single-Shell Tank (224-U Bldg. Waste)	S	S	S	S	S	S	S
241-TX-101 Single-Shell Tank	K	K	K	S	K	S	K
241-TX-102 Single-Shell Tank	K	K	K	S	K	S	S
241-TX-103 Single-Shell Tank	K	K	K	S	K	S	K
241-TX-104 Single-Shell Tank	K	K	K	S	K	S	K
241-TX-105 Single-Shell Tank	K	K	K	S	K	S	S
241-TX-106 Single-Shell Tank	K	K	K	S	K	S	K
241-TX-107 Single-Shell Tank (UPR-200-W-149)	K	K	K	S	K	S	S
241-TX-108 Single-Shell Tank	K	K	K	S	K	S	K
241-TX-109 Single-Shell Tank	K	K	K	S	K	S	S
241-TX-110 Single-Shell Tank	K	K	K	S	K	S	S
241-TX-111 Single-Shell Tank	K	K	K	S	K	S	K
241-TX-112 Single-Shell Tank	K	K	K	S	K	S	S
241-TX-113 Single-Shell Tank (UPR-200-W-129)	K	K	K	S	K	S	S
241-TX-114 Single-Shell Tank	K	K	K	S	K	S	S

Table 4-21. Summary of Known and Suspected Contamination Types at Each Waste Management Unit and Unplanned Release Site.

Waste Management Unit or Unplanned Release	TRU	Fission Products	Uranium	Heavy Metals	Other Inorganics	Volatiles	Semi-volatiles
241-TX-115 Single-Shell Tank	K	K	K	S	K	S	K
241-TX-116 Single-Shell Tank	K	K	K	S	K	S	S
241-TX-117 Single-Shell Tank	K	K	K	S	K	S	S
241-TX-118 Single-Shell Tank	K	K	K	S	K	S	K
241-TY-101 Single-Shell Tank	K	K	K	S	K	K	K
241-TY-102 Single-Shell Tank	K	K	K	S	K	S	S
241-TY-103 Single-Shell Tank (UPR-200-W-150)	K	K	K	S	K	S	K
241-TY-104 Single-Shell Tank (UPR-200-W-151)	K	K	K	S	K	K	K
241-TY-105 Single-Shell Tank (UPR-200-W-152)	K	K	K	S	K	S	K
241-TY-106 Single-Shell Tank (UPR-200-W-153)	K	K	K	S	K	S	K
241-T-361 Settling Tank (overflow to 216-T-3)	S	S	S	S	S	S	S
241-T-301 Catch Tank	--	--	--	--	--	--	--
241-T-302 Catch Tank	--	--	--	--	--	--	--
241-TX-302A Catch Tank	--	--	--	--	--	--	--
241-TX-302B Catch Tank (UPR-200-W-131)	--	--	--	--	--	--	--

Table 4-21. Summary of Known and Suspected Contamination Types at Each Waste Management Unit and Unplanned Release Site.

Waste Management Unit or Unplanned Release	TRU	Fission Products	Uranium	Heavy Metals	Other Inorganics	Volatiles	Semi-volatiles
241-TX-302C Catch Tank (UPR-200-W-21/160)	--	--	--	--	--	--	--
244-TX Receiver Tank	--	--	--	--	--	--	--
244-TXR Vault	--	--	--	--	--	--	--
241-TY-302A Catch Tank	S	S	S	--	S	--	S
241-TY-302B Catch Tank	--	--	--	--	--	--	--
Cribs and French Drains							
216-T-6 Crib	K	K	K	--	K	--	S
216-T-7TF Crib and Tile Field	K	K	K	--	K	--	S
216-T-8 Crib	K	K	K	--	K	--	--
216-T-18 Crib	K	K	K	--	K	--	K
216-T-19TF Crib and Tile Field	K	K	K	--	K	--	S
216-T-26 Crib	K	K	K	--	K	--	K
216-T-27 Crib	K	K	K	--	K	--	--
216-T-28 Crib	K	K	K	--	K	--	--
216-T-29 Crib	--	--	--	--	K	--	--
216-T-31 French Drain	--	--	--	--	--	--	--
216-T-32 Crib	K	K	K	--	K	--	S
216-T-33 Crib	K	K	K	--	K	--	--

Table 4-21. Summary of Known and Suspected Contamination Types at Each Waste Management Unit and Unplanned Release Site.

Waste Management Unit or Unplanned Release	TRU	Fission Products	Uranium	Heavy Metals	Other Inorganics	Volatiles	Semi-volatiles
216-T-34 Crib	K	K	K	--	K	--	--
216-T-35 Crib	K	K	K	--	K	--	--
216-T-36 Crib	K	K	K	--	K	--	--
216-W-LWC Crib	K	K	K	--	S	--	S
Reverse Wells							
216-T-2 Reverse Well	--	K	--	--	K	--	--
216-T-3 Reverse Well	K	K	--	--	K	--	--
Ponds Ditches and Trenches							
216-T-4A Pond	S	S	S	--	--	--	--
216-T-4B Pond	K	K	K	--	--	--	--
216-T-1 Ditch	K	K	--	S	K	S	--
216-T-4-1D Ditch	K	K	K	--	--	--	--
216-T-4-2 Ditch	K	K	K	--	--	--	--
200-W Powerhouse Pond	--	--	--	--	--	--	--
216-T-5 Trench	K	K	K	--	K	--	S
216-T-9 Trench	--	--	--	--	--	--	--
216-T-10 Trench	--	--	--	--	--	--	--
216-T-11 Trench	--	--	--	--	--	--	--

Table 4-21. Summary of Known and Suspected Contamination Types at Each Waste Management Unit and Unplanned Release Site.

Waste Management Unit or Unplanned Release	TRU	Fission Products	Uranium	Heavy Metals	Other Inorganics	Volatiles	Semi-volatiles
216-T-12 Trench	K	K	K	--	K	--	S
216-T-13 Trench	--	--	--	--	--	--	--
216-T-14 Trench	K	K	K	--	K	--	S
216-T-15 Trench	K	K	K	--	K	--	S
216-T-16 Trench	K	K	K	--	K	--	S
216-T-17 Trench	K	K	K	--	K	--	S
216-T-20 Trench	--	K	K	--	K	--	--
216-T-21 Trench	K	K	K	--	K	--	S
216-T-22 Trench	K	K	K	--	K	--	S
216-T-23 Trench	K	K	K	--	K	--	S
216-T-24 Trench	K	K	K	--	K	--	S
216-T-25 Trench	K	K	K	--	K	--	S
Septic Tanks and Drain Fields							
2607-W1 Septic Tank	--	--	--	--	--	--	--
2607-W2 Septic Tank	--	--	--	--	--	--	--
2607-W3 Septic Tank	--	S	--	--	--	--	--
2607-W4 Septic Tank	--	--	--	--	--	--	--
2607-WT Septic Tank	--	--	--	--	--	--	--

Table 4-21. Summary of Known and Suspected Contamination Types at Each Waste Management Unit and Unplanned Release Site.

Waste Management Unit or Unplanned Release	TRU	Fission Products	Uranium	Heavy Metals	Other Inorganics	Volatiles	Semi-volatiles
2607-WTX Septic Tank	--	--	--	--	--	--	--
Transfer Facilities, Diversion Boxes and Pipelines							
241-T-151 Diversion Box (UPRs)	S	S	S	--	K	--	S
241-T-152 Diversion Box (UPRs)	--	--	--	--	--	--	--
241-T-153 Diversion Box (no reported leaks)	--	--	--	--	--	--	--
241-T-252 Diversion Box (no reported leaks)	--	--	--	--	--	--	--
241-TR-152 Diversion Box	--	--	--	--	--	--	--
241-TR-153 Diversion Box	--	--	--	--	--	--	--
241-TX-152 Diversion Box (no reported leaks)	--	--	--	--	--	--	--
241-TX-153 Diversion Box (UPR-200-W-126)	K	K	K	--	K	--	K
241-TX-154 Diversion Box (UN-200-W-38,UPR-200-W21/60)	K	K	K	S	K	--	S
241-TX-155 Diversion Box (UPR-200-W-5 & UPR-200-W-28)	S	K	S	--	K	--	S
241-TXR Diversion Box (no reported leaks)	--	--	--	--	--	--	--
241-TXR-152 Diversion Box (no reported leaks)	--	--	--	--	--	--	--

Table 4-21. Summary of Known and Suspected Contamination Types at Each Waste Management Unit and Unplanned Release Site.

Waste Management Unit or Unplanned Release	TRU	Fission Products	Uranium	Heavy Metals	Other Inorganics	Volatiles	Semi-volatiles
241-TXR-153 Diversion Box (no reported leaks)	--	--	--	--	--	--	--
241-TY-153 Diversion Box (no reported leaks)	S	S	S	--	S	--	S
242-T-151 Diversion Box (no reported leaks)	--	--	--	--	--	--	--
Basins							
207-T Retention Basin	--	K	--	--	--	--	--
Burial Sites							
200-W Ash Disposal Basin	--	--	--	S	S	S	S
200-W Ash Pit Demolition Site	--	--	--	--	--	--	--
200-W Burning Pit (UPR 200-W-37/70, UN-200-W-8)	S	S	S	S	S	S	S
200-W Powerhouse Ash Pit	--	--	--	--	--	--	--
218-W-8 Burial Ground	K	K	K	--	--	--	--
Unplanned Releases							
UN-200-W-2	S	S	S	--	S	--	S
UN-200-W-3	S	S	S	S	S	S	S
UN-200-W-4	S	S	S	S	S	S	S
UN-200-W-7 (241-T-151/152)	S	S	S	--	K	--	S

Table 4-21. Summary of Known and Suspected Contamination Types at Each Waste Management Unit and Unplanned Release Site.

Waste Management Unit or Unplanned Release	TRU	Fission Products	Uranium	Heavy Metals	Other Inorganics	Volatiles	Semi-volatiles
UN-200-W-8 (200-W Burning Pit)	--	K	--	--	S	--	--
UN-200-W-14	S	S	S	--	S	--	S
UN-200-W-17	S	K	S	--	S	--	S
UN-200-W-27	S	S	S	--	S	--	S
UN-200-W-29 (241-TX-153)	K	K	K	--	S	--	S
UN-200-W-38 (241-TX-154)	S	S	S	S	S	--	S
Un-200-W-40	S	S	S	S	S	--	S
UN-200-W-58	S	S	S	--	S	--	--
UN-200-W-62 (241-TX-153)	S	K	S	--	S	--	K
UN-200-W-63 (241-TX-153)	--	K	--	--	--	--	--
UN-200-W-64 (241-TX-153)	--	K	--	--	--	--	--
UN-200-W-65	S	S	S	--	--	--	--
UN-200-W-67	S	K	S	--	S	--	--
UN-200-W-73	S	K	S	--	S	--	--
UN-200-W-76 (241-TX-155)	--	K	--	--	S	--	S
UN-200-W-77	K	--	--	--	S	--	S
UN-200-W-85	S	S	S	--	--	--	--
UN-200-W-88	S	S	S	--	K	--	--

Table 4-21. Summary of Known and Suspected Contamination Types at Each Waste Management Unit and Unplanned Release Site.

Waste Management Unit or Unplanned Release	TRU	Fission Products	Uranium	Heavy Metals	Other Inorganics	Volatiles	Semi-volatiles
UN-200-W-97 (241-TX-153)	S	K	S	--	K	--	S
UN-200-W-98	--	K	--	--	K	--	S
UN-200-W-99 (241-TX-153)	--	K	--	--	S	--	--
UN-200-W-100	S	K	S	--	K	--	S
UN-200-W-102	K	--	--	--	--	--	--
UN-200-W-113 (241-TX-155)	S	S	S	--	S	--	S
UN-200-W-135 (241-TX-155)	--	K	--	--	S	--	S
UPR-200-W-5 (241-TX-155)	S	S	S	--	S	--	S
UPR-200-W-12	S	K	S	--	K	--	S
UPR-200-W-21 (241-TX-302C Catch Tank)	S	S	S	--	S	--	S
UPR-200-W-28 (241-TX-155)	S	S	S	--	S	--	S
UPR-200-W-37 (200-W Burning Pit)	--	--	--	--	--	--	--
UPR-200-W-70	S	S	S	S	S	S	S
UPR-200-W-126 (241-TX-153)	S	S	S	--	K	--	--
UPR-200-W-129 (241-TX-113)	K	K	K	--	K	--	S
UPR-200-W-131 (241-TX-302B Catch Tank))	S	S	S	--	K	--	S
UPR-200-W-147 (241-T-103)	K	K	K	S	K	S	K

Table 4-21. Summary of Known and Suspected Contamination Types at Each Waste Management Unit and Unplanned Release Site.

Waste Management Unit or Unplanned Release	TRU	Fission Products	Uranium	Heavy Metals	Other Inorganics	Volatiles	Semi-volatiles
UPR-200-W-148 (241-T-106)	K	K	K	S	K	S	K
UPR-200-W-149 (241-TX-107)	K	K	K	--	K	--	S
UPR-200-W-150 (241-TY-103)	K	K	K	--	K	--	K
UPR-200-W-151 (241-TY-104)	K	K	K	--	K	K	K
UPR-200-W-152 (241-TY-105)	K	K	K	--	K	--	K
UPR-200-W-153 (241-TY-106)	S	S	S	--	--	--	K
UPR-200-W-160 (241-TX-302C Catch Tank)	K	K	K	--	K	--	S

K = Known contamination (contaminants identified from inventory or sampling data).
S = Suspected contamination (contaminants that could occur at a site). Evidence includes process data, historical records and chemical associations.

Table 4-22. Contaminants of Potential Concern for the T Plant Aggregate Area.

RADIONUCLIDES	FISSION PRODUCTS (cont.)	OTHER INORGANICS
Gross alpha		Ammonia
Gross beta	Lead-209	Boron
	Lead 211	Cyanide
TRANSURANICS	Lead-212	Fluoride
	Lead-214	Nitrate
Americium-241	Nickel-59	
Americium-242	Niobium-93m	VOLATILE ORGANICS
Americium-242m	Polonium-214	
Americium-243	Polonium-215	Acetone
Curium-242	Polonium-218	Carbon tetrachloride
Curium-244	Potassium-40	Chloroform
Curium-245	Protactinium-231	Methylene chloride
Neptunium-237	Protactinium-234m	MIBK
Neptunium-239	Radium-225	Toluene
Plutonium-238	Radium-226	1,1,1-Trichloroethane
Plutonium-239	Ruthenium-106	
Plutonium-240	Samarium-151	SEMIVOLATILE ORGANICS
Plutonium-241	Selenium-79	
	Sodium-22	
URANIUM	Strontium-90	Kerosene
	Technetium-99	Tributyl phosphate
Uranium-233	Thallium-207	
Uranium-234	Thorium-227	
Uranium-235	Thorium-229	
Uranium-238	Thorium-230	
	Thorium-231	
FISSION PRODUCTS	Tritium	
	Yttrium-90	
Actinium-225	Zirconium-93	
Actinium-227		
Antimony-126	HEAVY METALS	
Antimony-126m		
Bismuth-210	Arsenic	
Bismuth-211	Barium	
Bismuth-213	Cadmium	
Bismuth-214	Chromium	
Carbon-14	Copper	
Cesium-134	Iron	
Cesium-137	Lead	
Cobalt-60	Manganese	
Europium-152	Mercury	
Europium-154	Nickel	
Europium-155	Selenium	
Francium-221	Silver	
Iodine-129	Titanium	
	Vanadium	

Table 4-23. Soil-Water Distribution Coefficient K_d for Radionuclides[a] and Inorganics of Concern at T Plant Waste Management Units.

Element or Chemical	Recommended K_d for Hanford Site (Serne and Wood 1990) in mL/g	Conservative Default K_d[b] (Serne and Wood 1990) in mL/g	MEPAS Default K_d pH 6-9[c] (Strenge and Peterson 1989) in mL/g	Mobility Class
Actinium	–	–	228	low
Americium	2 100 - 1000 (<1 @ pH 1-3)	100	82	low
Antimony	–	–	2	high
Arsenic	–	0	5.86	moderate
Barium	–	50	530	moderate
Bismuth	–	20	–	moderate
Boron	–	–	0.19	high
Cadmium	–	15	14.9	moderate
Carbon (^{14}C)	–	–	0	high
Cesium	200 - 1,000 1 - 200 (acidic waste)	50	51	low
Chromium	–	0	16.8	moderate
Cobalt	500 - 2000	10	1.9	low
Copper	–	15	41.9	moderate
Curium	100 - >2,000	100	82	low
Cyanide	–	–	–	unknown
Europium	–	–	228	low
Fluoride	–	–	0	high
Francium	–	–	–	unknown
Iodine	<1	0	0	high
Iron	–	20	15	moderate
Lead	–	30	234	moderate
Manganese	–	20	16.5	moderate
Mercury	–	–	322	low
Neptunium	<1-5	3	3	high
Nickel	–	15	12.2	moderate
Niobium	–	–	50	moderate
Nitrate/nitric acid	–	–	0	high

Table 4-23. Soil-Water Distribution Coefficient K_d for Radionuclides[a] and Inorganics of Concern at T Plant Waste Management Units.

Element or Chemical	Recommended K_d for Hanford Site (Serne and Wood 1990) in mL/g	Conservative Default K_d[b] (Serne and Wood 1990) in mL/g	MEPAS Default K_d pH 6-9[c] (Strenge and Peterson 1989) in mL/g	Mobility Class
Plutonium	100 - 1,000 < 1 at pH 1 - 3	100	10	low
Polonium	–	–	5.9	high
Protactinium	–	–	0	high
Radium	–	20	24.3	moderate
Ruthenium	20 - 700 (<2 at >1 M nitrate)	–	274	moderate
Samarium	–	–	228	low
Selenium	–	0	5.91	moderate
Silver	–	20	0.4	moderate
Sodium	–	3	0	high
Strontium	5 - 100 3 - 5 (acidic conditions) 200 - 500 (w/phosphate or oxalate)	10	24.3	moderate
Technetium	0 - 1	0	3	high
Thallium	–	–	0	high
Thorium	–	50	100	moderate
Titanium	–	–	–	unknown
Tritium	0	0	0	high
Uranium	–	0	0	high
Vanadium	–	–	50	moderate
Yttrium	–	–	278	low
Zinc	–	15	12.7	moderate
Zirconium	–	30	50	moderate

a/ Radionuclides with half-lives of greater than 3 months.
b/ Average K_Ds for low salt and organic solutions with neutral pH.
c/ Default values for pH 6-9 and soil content of [clay + organic matter + metal oxyhydroxides] < 10% (Strenge and Peterson 1989).
MEPAS = Multimedia Environmental Pollution Assessment System, a computerized waste management unit evaluation system.

Table 4-24. Physical/Chemical Properties of Organic Contaminants of Concern for T Plant Aggregate Waste Management Units.

Compound	Molecular Weight (g/mole)	Water Solubility (mg/L)	Vapor Pressure (mm Hg)	Henry's Law Constant (atm-m^3/mo)	Soil/Organic Matter Partition Coef. K_{oc} (ml/g)
Acetone	58.0	miscible	270	2.1×10^{-5}	2.2
Carbon tetrachloride	154.0	758	90	2.4×10^{-2}	110
Chloroform (trichloromethane)	119	8,200	150	2.9×10^{-3}	31
Kerosene[a/]	142.2	32	0.045	2.9×10^{-4}	4,500
Methylene chloride	84.9	20,000	360	2×10^{-3}	8.8
Methyl isobutyl ketone (MIBK)	100.16	19,000	6	4.2×10^{-5}	19
Toluene	92.2	1,550[b/]	28.4	6.4×10^{-3}	300
Tributyl phosphate	266.3	280	15	1.9×10^{-2}	6,000
1,1,1-Trichloroethane	133.41	1,500	120	1.4×10^{-2}	150

Source: Strenge and Peterson 1989, except as noted in footnotes below.

a/ Kerosene properties are represented by 2-methyl napthalene.

b/ Value from Mackay and Shiu 1981.

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Table 4-25. Radiological Properties of Candidate Radionuclides of Potential Concern in T Plant Aggregate Area Waste Management Units.

Radionuclide	Half-Life	Specific Activity[a] in Ci/g	Principal Radiation of Concern[b]
^{225}Ac	10 day	5.8×10^{4}	α
^{227}Ac	21.8 yr	7.2×10^{1}	β, α
^{241}Am	432 yr	3.4×10^{0}	α
^{242}Am	16 h	8.1×10^{5}	β
^{242m}Am	152 yr	9.7×10^{0}	α
^{243}Am	7,380 yr	2.0×10^{-1}	α
^{210}Bi	5.01 day	1.2×10^{5}	β
^{211}Bi	2.13 min	4.2×10^{8}	α, β
^{213}Bi	45.6 min	1.9×10^{7}	β, α
^{214}Bi	19.9 min	4.4×10^{7}	β, γ
^{14}C	5,730 yr	4.5×10^{0}	β
^{242}Cm	163.2 day	3.3×10^{3}	α
^{244}Cm	18.1 yr	8.1×10^{1}	α
^{245}Cm	8,500 yr	1.7×10^{-1}	α, γ
^{60}Co	5.3 yr	1.1×10^{3}	γ
^{134}Cs	2.06 yr	1.3×10^{3}	γ
^{137}Cs	30 yr	8.7×10^{1}	γ [c]
^{152}Eu	13.3 yr	7.7×10^{2}	β, γ [c]
^{154}Eu	8.8 yr	2.7×10^{2}	β, γ [c]
^{155}Eu	4.96 yr	4.6×10^{2}	β
^{3}H	12.3 yr	9.7×10^{3}	β
^{129}I	1.6×10^{7} yr	1.7×10^{-4}	β
^{22}Na	2.6 yr	6.3×10^{3}	β, γ [c]
^{59}Ni	75,000 yr	7.6×10^{4}	γ [c]
^{237}Np	2.14×10^{6} yr	7.0×10^{-4}	α, γ
^{239}Np	2.35 day	2.3×10^{5}	β
^{231}Pa	32,800 yr	4.7×10^{-2}	α
^{209}Pb	3.25 h	4.5×10^{6}	β
^{211}Pb	36.1 min	2.5×10^{7}	β
^{212}Pb	10.6 h	1.4×10^{6}	β, γ [c]
^{214}Pb	26.8 min	3.3×10^{7}	β, γ [c]
^{214}Po	6×10^{-5} sec	8.8×10^{14}	α
^{215}Po	7.8×10^{-4} sec	2.9×10^{13}	α
^{218}Po	3.05 min	2.8×10^{8}	α
^{238}Pu	87.7 yr	1.7×10^{1}	α
^{239}Pu	24,400 yr	6.2×10^{-2}	α
^{240}Pu	6,560 yr	2.3×10^{-1}	α
^{241}Pu	14.4 yr	1.0×10^{2}	β

Table 4-25. Radiological Properties of Candidate Radionuclides of Potential Concern in T Plant Aggregate Area Waste Management Units.

Radionuclide	Half-Life	Specific Activity[a/] in Ci/g	Principal Radiation of Concern[b/]
^{225}Ra	14.8 day	3.9×10^{4}	β
^{226}Ra	1,600 yr	9.9×10^{-1}	α
^{106}Ru	1.0 yr	3.4×10^{3}	β, γ [c/]
^{79}Se	<65,000 yr	7.0×10^{-2}	β
^{151}Sm	90 yr	2.6×10^{1}	β
^{90}Sr	28.5 yr	1.4×10^{2}	β
^{99}Tc	213,000 yr	1.7×10^{-2}	β
^{227}Th	18.7 day	3.1×10^{4}	α
^{229}Th	7,340 yr	2.1×10^{-1}	α
^{230}Th	77,000 yr	2.1×10^{-2}	α
^{231}Th	25.5 h	5.3×10^{5}	β
^{233}U	159,000 yr	9.7×10^{-3}	α
^{234}U	244,500 yr	6.2×10^{-3}	α
^{235}U	7.0×10^{8} yr	2.2×10^{-6}	α, γ
^{238}U	4.5×10^{9} yr	3.4×10^{-7}	α
^{90}Y	6.41 h	5.4×10^{5}	β

a/ Calculated from half-life and atomic weight.
b/ α - alpha decay; β - negative beta decay; γ - release of gamma rays.
c/ Daughter radiation.

Table 4-26. Comparison of Radionuclide Relative Risks for Radionuclides of Concern at the T Plant Aggregate Area. Page 1 of 3

Radionuclide	Half-Life	Air Unit Risk[b] in $(pCi/m^3)^{-1}$	Drinking Water Unit Risk[c] in $(pCi/L)^{-1}$	Soil Ingestion Unit Risk[d] in $(pCi/g)^{-1}$	External Exposure Unit Risk[e] in $(pCi/g)^{-1}$
^{225}Ac	10 day	1.2×10^{-3}	8.7×10^{-7}	4.6×10^{-8}	9.4×10^{-6}
^{227}Ac	21.8 yr	4.2×10^{-2}	1.8×10^{-5}	9.5×10^{-7}	1.3×10^{-7}
^{241}Am	433 yr	2.1×10^{-2}	1.6×10^{-5}	8.4×10^{-7}	1.6×10^{-5}
^{242}Am	16 h	na	na	na	na
^{242m}Am	152 yr	na	na	na	na
^{243}Am	7,380 yr	2.1×10^{-2}	1.5×10^{-5}	8.1×10^{-7}	3.6×10^{-5}
^{210}Bi	5.01 day	4.1×10^{-5}	9.7×10^{-8}	5.1×10^{-9}	0
^{211}Bi	2.13 min	9.7×10^{-8}	6.1×10^{-10}	3.2×10^{-11}	2.8×10^{-5}
^{213}Bi	45.6 min	1.6×10^{-7}	1.2×10^{-8}	6.2×10^{-10}	8.1×10^{-5}
^{214}Bi	19.9 min	1.1×10^{-6}	7.2×10^{-9}	3.8×10^{-10}	8.0×10^{-4}
^{14}C	5,730 yr	3.2×10^{-9}	4.7×10^{-8}	2.5×10^{-9}	0
^{242}Cm	163.2 day	na	na	na	na
^{244}Cm	18.1 yr	1.4×10^{-2}	1.0×10^{-5}	5.4×10^{-7}	5.9×10^{-7}
^{245}Cm	8,500 yr	na	na	na	na
^{60}Co	5.3 yr	8.1×10^{-5}	7.8×10^{-7}	4.1×10^{-8}	1.3×10^{-3}
^{134}Cs	2.06 yr	1.4×10^{-5}	2.1×10^{-6}	1.1×10^{-7}	8.9×10^{-4}
^{137}Cs	30 yr	9.6×10^{-6}	1.4×10^{-6}	7.6×10^{-8}	0 (3.4×10^{-4})[f]
^{152}Eu	13.3 yr	6.1×10^{-3}	1.1×10^{-7}	5.7×10^{-9}	6.3×10^{-4}
^{154}Eu	8.8 yr	7.2×10^{-5}	1.5×10^{-7}	8.1×10^{-9}	6.8×10^{-4}
^{155}Eu	4.96 yr	na	na	na	
^{3}H	12.3 yr	4.0×10^{-8}	2.8×10^{-9}	1.5×10^{-10}	0
^{129}I	1.6×10^{7} yr	6.1×10^{-5}	9.6×10^{-6}	5.1×10^{-7}	1.5×10^{-5}
^{22}Na	2.6 yr	na	na	na	na
^{59}Ni	75,000 yr	3.5×10^{-7}	4.4×10^{-9}	2.3×10^{-10}	3.4×10^{-7}
^{237}Np	2.14×10^{6} yr	1.8×10^{-2}	1.4×10^{-5}	7.3×10^{-7}	1.8×10^{-5}
^{239}Np	2.35 day	7.7×10^{-7}	4.8×10^{-8}	2.5×10^{-9}	1.1×10^{-4}
^{231}Pa	32,800 yr	2.0×10^{-2}	9.7×10^{-6}	5.1×10^{-7}	2.0×10^{-5}

9 3 1 2 2 7 0 1 0 9 7

Table 4-26. Comparison of Radionuclide Relative Risks for Radionuclides of Concern at the T Plant Aggregate Area. Page 2 of 3

Radionuclide	Half-Life	Air Unit Risk[b] in $(pCi/m^3)^{-1}$	Drinking Water Unit Risk[c] in $(pCi/L)^{-1}$	Soil Ingestion Unit Risk[d] in $(pCi/g)^{-1}$	External Exposure Unit Risk[e] in $(pCi/g)^{-1}$
^{209}Pb	3.25 h	3.6×10^{-8}	4.3×10^{-9}	2.3×10^{-10}	0
^{210}Pb	22.3 yr	8.7×10^{-4}	3.4×10^{-5}	1.8×10^{-6}	1.8×10^{-6}
^{211}Pb	36.1 min	1.5×10^{-6}	9.2×10^{-9}	4.9×10^{-10}	2.9×10^{-5}
^{212}Pb	10. h	2.4×10^{-5}	3.7×10^{-7}	1.9×10^{-8}	9.2×10^{-5}
^{214}Pb	26.8 min	1.5×10^{-6}	9.2×10^{-9}	4.9×10^{-10}	1.5×10^{-4}
^{214}Po	6×10^{-5} sec	1.4×10^{-13}	5.1×10^{-16}	2.7×10^{-17}	4.7×10^{-8}
^{215}Po	7.8×10^{-4} sec	2.9×10^{-12}	1.4×10^{-14}	7.6×10^{-16}	8.7×10^{-8}
^{218}Po	3.05 min	3.0×10^{-7}	1.4×10^{-9}	7.6×10^{-11}	0
^{238}Pu	87.7 yr	2.1×10^{-2}	1.4×10^{-5}	7.6×10^{-7}	5.9×10^{-7}
^{239}Pu	24,400 yr	2.6×10^{-2}	1.6×10^{-5}	8.4×10^{-8}	2.6×10^{-7}
^{240}Pu	6,560 yr	2.1×10^{-2}	1.6×10^{-5}	8.4×10^{-8}	5.9×10^{-7}
^{241}Pu	14.4 yr	1.5×10^{-4}	2.5×10^{-7}	1.3×10^{-8}	0
^{225}Ra	14.8 day	8.2×10^{-4}	3.4×10^{-6}	1.8×10^{-7}	8.0×10^{-6}
^{226}Ra	1,600 yr	1.5×10^{-3}	6.1×10^{-6}	3.2×10^{-7}	4.1×10^{-6}
^{228}Ra	5.75 yr	3.4×10^{-4}	5.1×10^{-6}	2.7×10^{-7}	5.6×10^{-13}
^{106}Ru	1.0 yr	2.3×10^{-4}	4.9×10^{-7}	2.6×10^{-8}	0
^{79}Se	<65,000 yr	na	na	na	na
^{151}Sm	90 yr	na	na	na	na
^{90}Sr	28.5 yr	2.8×10^{-5}	1.7×10^{-6}	8.9×10^{-8}	0
^{99}Tc	213,000 yr	4.2×10^{-6}	6.6×10^{-8}	3.5×10^{-9}	0
^{227}Th	18.72 day	2.5×10^{-3}	2.5×10^{-7}	1.3×10^{-8}	6.6×10^{-6}
^{229}Th	7,340 yr	3.9×10^{-2}	2.0×10^{-6}	1.1×10^{-7}	5.8×10^{-5}
^{230}Th	77,000 yr	1.6×10^{-2}	1.2×10^{-6}	6.5×10^{-8}	5.9×10^{-7}
^{231}Th	25.5 h	2.5×10^{-7}	2.0×10^{-8}	1.1×10^{-9}	1.1×10^{-5}
^{233}U	159,000 yr	1.4×10^{-2}	7.2×10^{-6}	3.8×10^{-7}	3.2×10^{-7}
^{234}U	244,500 yr	1.4×10^{-2}	7.2×10^{-6}	3.8×10^{-7}	5.6×10^{-7}
^{235}U	7.0×10^{8} yr	1.3×10^{-2}	6.6×10^{-6}	3.5×10^{-7}	9.7×10^{-5}

Table 4-26. Comparison of Radionuclide Relative Risks for Radionuclides of Concern at the T Plant Aggregate Area. Page 3 of 3

Radionuclide	Half-Life	Air Unit Risk[b/] in $(pCi/m^3)^{-1}$	Drinking Water Unit Risk[c/] in $(pCi/L)^{-1}$	Soil Ingestion Unit Risk[d/] in $(pCi/g)^{-1}$	External Exposure Unit Risk[e/] in $(pCi/g)^{-1}$
^{238}U	4.5×10^9 yr	1.2×10^{-2}	6.6×10^{-6}	3.5×10^{-7}	4.5×10^{-7}
^{90}Y	64.1 h	2.8×10^{-6}	1.6×10^{-7}	8.6×10^{-9}	0

a/ Calculated from half-life and atomic weight.
b/ Excess cancer risk associated with lifetime exposure to 1 pCi/m^3 (10^{-12} curies) per day in air (EPA 1991b).
c/ Excess cancer risk associated with lifetime exposure to 1 pCi (10^{-12} curies) per day in drinking water (EPA 1991b).
d/ Excess cancer risk associated with lifetime exposure to 1 pCi/g (10^{-12} curies/g) per day in soil (EPA 1991b).
e/ Excess cancer risk associated with lifetime exposure to surface soils containing 1 pCi/g of gamma-emitting radionuclides (EPA 1991b).
f/ External radiation risk from ^{137m}Ba, a short-lived decay product of ^{137}Cs.

NA No information available.

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Table 4-27. Potential Chronic Human Health Effects of Chemicals Detected or Disposed of at T Plant Aggregate Area. Page 1 of 2

Chemical	Tumor Site Inhalation Route; Oral Route [Weight of Evidence Group[a]]	Non-carcinogenic Chronic Health Effects Inhalation Route; Oral Route	Reference
INORGANIC CHEMICALS			
Aluminum			
Ammonium ion		decreased pulmonary function; degrades odor, taste of water	EPA 1991a
Barium		fetotoxicity; increased blood pressure	EPA 1991b
Boron		NA; testicular lesions	EPA 1991a
Cadmium	respiratory tract [B1]; NA	cancer; renal damage	EPA 1991b
Calcium			
Chloride			
Chromium	lung [A] - Cr(VI) only; NA	nasal mucosa atrophy; hepatotoxicity	EPA 1991a
Copper		NA; gastrointestinal irritation	EPA 1991b
Fluoride		NA; dental flurosis at high levels	EPA 1991a
Iron			
Lead	[B2][b]; [B2]	central nervous system (CNS) effects[b]; CNS effects	EPA 1991a
Magnesium			
Nickel	respiratory tract [A]; NA	cancer; reduced weight	EPA 1991b
Nitrate/Nitrite		NA; methemoglobinemia in infants[c]	EPA 1991a
Phosphate			
Potassium			
Silica			
Silver			

Table 4-27. Potential Chronic Human Health Effects of Chemicals Detected or Disposed of at T Plant Aggregate Area. Page 2 of 2

Chemical	Tumor Site Inhalation Route; Oral Route [Weight of Evidence Group[a/]]	Non-carcinogenic Chronic Health Effects Inhalation Route; Oral Route	Reference
Sodium			
Sulfate			
Uranium (soluble salts)		NA; body weight loss, nephrotoxicity	EPA 1991a
Zinc		NA; anemia	EPA 1991b
ORGANIC CHEMICALS			
Chloroform	liver; kidney [B2]	NA; liver lesions	EPA 1991b
Methylene chloride	lung, liver [B2]; liver [B2]	NA; liver toxicity	EPA 1991a
Toluene		CNS effects, eye irritation; change in liver and kidney weights	EPA 1991a
Tributyl phosphate		respiratory irritant; kidney damage	NIOSH 1987
1,1,1-Trichloroethane		liver toxicity; liver toxicity	EPA 1991b

a/ Weight of Evidence Groups for carcinogens: A - Human carcinogen (sufficient evidence of carcinogenicity in humans); B - Probable human carcinogen (B1 - Limited evidence of carcinogenicity in humans; B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of data in humans); C - Possible human carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data); D - Not classifiable as to human carcinogenicity (inadequate or no evidence).

b/ Lead is considered by EPA to have both neurotoxic and carcinogenic effects; however, no toxicity criteria are available for lead at the present time.

c/ Toxic effect is considered to occur from exposure to nitrite; nitrate can be converted to nitrite in the body by intestinal bacteria.

NA = Information not available.

5.0 HEALTH AND ENVIRONMENTAL CONCERNS

This preliminary qualitative evaluation of potential human health and environmental concerns is intended to provide input to the T Plant Aggregate Area waste management unit recommendation process (Section 9.0). This process requires consideration of immediate and long-term impacts to human health and the environment. As discussed in Section 4.2, existing T Plant Aggregate Area and waste management unit data are not adequate to support an evaluation of potential impacts on the environment. Although ecological impacts are an integral part of the complete assessment of aggregate area and waste unit potential risks, they cannot be evaluated further at this time. Ecological risk assessment is included in the listing of data uses presented in Section 8.0 with the associated data needs identified as a data gap to be addressed in future investigations. The approach that has been taken to identify potential concerns related to individual waste management units and unplanned releases is as follows:

- Contaminants of potential concern are identified for each exposure pathway that is likely to occur within the T Plant Aggregate Area. Selection of contaminants was discussed in Section 4.2. Contaminants of potential concern were selected from the list of candidate contaminants of potential concern presented in Table 4-19. This table includes contaminants that are likely to be present in the environment based on occurrence in the liquid process wastes that were discharged to soils, and also contaminants that have been detected in environmental samples within the aggregate area but have not been identified as components of T Plant Aggregate Area waste streams.

- Exposure pathways potentially applicable to individual waste management units are identified based on the presence of the above contaminants of potential concern in wastes in the waste management units, consideration of known or suspected releases from those waste management units, and the physical and institutional controls affecting site access and use over the period of interest. The relationships between waste management units and exposure pathways are summarized in the conceptual model (Section 4.2).

- Estimates of relative hazard derived for the T Plant Aggregate Area waste management units are identified using the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Hazard Ranking System (HRS), modified Hazard Ranking System (mHRS), surface radiation survey data, and by Westinghouse Hanford Environmental Protection Group scoring. Other indicators of relative hazard, such as rate of release of contaminants and irreversible results of continuing residence of contaminants, were not used because they generally require unit-specific data that are not available for most units.

The human health concerns, and various hazard ranking scores listed above, are used to establish whether or not a site is considered a "high" priority. In the data evaluation process presented in Section 9.0, "high" priority sites are evaluated for the potential implementation of an interim remedial measure (IRM). "Low" priority sites are evaluated to determine what type of additional investigation is necessary to establish a final remedy. Further detail is presented in Section 9.0.

The data used for this evaluation are presented in the earlier sections of this report. The types of data that have been assessed include site histories and physical descriptions (Section 2.0), descriptions of the physical environment of the study area (Section 3.0) and a summary of the available chemical and radiological data for each waste management unit (Section 4.0).

The quality and sufficiency of these data are assessed in Section 8.0. This information is also used to identify potentially applicable or relevant and appropriate requirements (ARARs) (Section 6.0).

5.1 CONCEPTUAL FRAMEWORK FOR RISK-BASED SCREENING

The range of potential human health and environmental exposure pathways at the T Plant Aggregate Area was summarized in Section 4.2. In Section 4.2 the role of biota in transporting contaminants through the environment is also discussed, and biota are included as receptors in the conceptual model. However, the assessment of potential ecological risks associated with biota exposure to T Plant Aggregate Area contaminants is currently constrained by the lack of data. This gap in the T Plant Aggregate Area data is discussed in Section 8.2.3. As a result, the risk-based screening of waste management unit priorities discussed in this section is by necessity limited to potential human health risks.

The U.S. Environmental Protection Agency (EPA 1989b) considers a human exposure pathway to consist of four elements: (1) a source and mechanism for contaminant release, (2) a retention or transport medium (or media), (3) a point of potential human contact, and (4) an exposure route (e.g., ingestion) at the contact point. The probability of the existence of a particular pathway is dependent upon the physical and institutional controls affecting site access and use. In the absence of site access controls and other land use restrictions, the identified potential exposure pathways could all occur. For example, it could be hypothesized that an individual could establish a residence within the boundaries of the T Plant Aggregate Area, disrupt the soil surface and contact buried contamination, and drill a well and withdraw contaminated groundwater for drinking water and crop irrigation. However, within the five- to ten-year period of interest associated with identification and prioritization of remedial actions within the T Plant Aggregate Area, unrestricted access and uncontrolled disruption of buried contaminants have a negligible probability of occurrence.

The conceptual model presented in Section 4.2 was evaluated to identify an appropriate framework for screening waste management units and establishing their remediation priorities based on potential health hazards. Based on the five- to ten-year period of interest for waste unit prioritization, and the presence of site access controls during that period, a screening framework was developed encompassing the range of release mechanisms, affected media, and exposure routes associated with an onsite occupational receptor. The T Plant Aggregate Area is currently an industrial area. While work activities are assumed to include occasional contact with surface soils, it is assumed that no contact with buried contaminants will take place without proper protective measures.

Workers may be exposed via the following routes at the T Plant Aggregate Area:

- Ingestion of surface soils
- Inhalation of volatilized contaminants and resuspended particles
- Direct dermal contact with surface soils
- Direct exposure to radiation from surface soils and airborne resuspended particles.

Since evaluation of migration in the saturated zone is not within the scope of a source aggregate area management study (AAMS), ingestion or contact with groundwater was not evaluated as an exposure pathways. However, since migration of waste constituents within the saturated zone will be addressed in the 200 West Groundwater AAMS, contaminants likely to migrate to the water table and waste management units that have a high potential to impact groundwater will be identified.

5.2 POTENTIAL EXPOSURE SCENARIOS AND HUMAN HEALTH CONCERNS

The routes by which a Hanford Site worker could potentially be exposed to contamination at the waste management units include ingestion, inhalation, direct contact with soils, and direct exposure to radiation. To evaluate the potential for exposure at individual waste management units, it is necessary to have data available for surface soils, air, and radiation levels. Although samples have been collected from each of these media, only the surface radiation survey data (contamination levels and dose rate) are specific to individual waste management units. Therefore, only pathways associated with the surface radiological contamination and external dose rates can be evaluated with confidence at this time. Exposures by other pathways were evaluated based on available knowledge about contaminants disposed of to the waste management unit and the engineered barriers to releases.

5.2.1 External Exposure

External dose rate surveys, which are performed on a waste management unit basis, were used as the measure of a unit's potential for impacting human health through direct external radiation exposure. The contaminants of potential concern for this pathway are the radionuclides that emit moderate to high energy penetrating gamma radiation. The radiation doses from direct external exposure from the available survey data are presented in Table 5-1. Recent survey data were available for only 40 of the 69 T Plant Aggregate Area waste management units and unplanned release sites evaluated in this table.

Westinghouse Hanford manual WHC-CM-4-10, Section 7 (WHC 1988b) was used as the basis for setting one of the criteria that are used to identify waste management units that can be considered high priority sites. The manual indicates that posting ("Radiation Area") and access controls are to be implemented at a level of 2 mrem/h for the purpose of personnel protection. With the same objective in mind, the level of 2 mrem/h is recommended as one of the criteria for distinguishing high priority from lower priority waste management units. For those units that do have recent radiation survey data, none reported having a dose rate of greater than 2 mrem/h measured for surface radiation contamination areas (Huckfeldt 1991c).

High levels of radiation were reportedly associated with some of the unplanned releases that are listed in Table 5-1. However, many of these releases occurred in the early years of the Hanford Site and more recent survey data are not available. Some of the releases were reportedly remediated by removing contaminated soil for disposal in burial grounds, paving or covering the area with soil, or flushing the soil with water. The effectiveness of the various remediation measures is not known, and confirmatory survey measurements are not available. Thus, with the exception of unplanned releases located within engineered waste units, which are routinely surveyed, information on the current radiological status of remediated unplanned releases is deficient, and is identified as a data gap in Section 8.0.

Relatively few of the unplanned release sites have had recent surveys. The sites with known surveys more recent than 1988 are the following:

- UN-200-W-98
- UN-200-W-99.

5.2.2 Ingestion of Soil or Inhalation of Fugitive Dust

Radionuclides and nonradioactive chemicals of concern for the soil ingestion and fugitive dust inhalation pathways are those that are nonvolatile, persistent in surface soils, and have appreciable carcinogenic or toxic affects by ingestion or inhalation. However, little

information is available to evaluate the presence of specific radionuclides or nonradioactive chemicals in surface soils. Available gross activity survey data for the T Plant Aggregate Area waste management units are provided in Table 5-1.

The Westinghouse Hanford Environmental Protection group policies state that the presence of any smearable alpha constitutes a potential threat to human health and qualifies a waste management unit for a high remediation priority (Huckfeldt 1991b). Waste management units that exhibit elevated alpha readings in radiological surveys can be presumed to have surface contamination, since alpha radiation cannot penetrate solids.

Westinghouse Hanford manual *Radiation Protection* (WHC 1992c) was also used to set criteria for identifying waste management units that can be considered high remediation priority sites. The manual indicates that posting ("Surface Contamination Area") and access controls are to be implemented at a level of 100 ct/min above background beta/gamma, and/or 20 dis/min alpha, for the purpose of personnel protection. With the same objective in mind, the levels of 100 ct/min above background beta/gamma and 20 dis/min alpha are recommended as two of the criteria for identification of high priority waste management units. For those survey readings that are in units of dis/min, a conversion will be made to ct/min assuming a survey instrument efficiency of 10%.

It should be noted that these radiation readings may indicate transient conditions (e.g., presence of contaminated vegetation) and that routine stabilization of surface contamination is carried out under the auspices of the Westinghouse Hanford Radiation Area Remedial Action (RARA) program.

Units subject to collapse of containment structures pose a potential threat of exposure by release of contaminants to the surface. Units with high release potential based on potential occurrence of cave-ins include the following:

- 216-T-6 Crib
- 216-T-7TF Crib and Tile Field
- 216-T-8 Crib
- 216-T-19TF Crib and Tile Field
- 216-T-32 Crib
- 216-T-W8 Burial Ground.

These cribs and burial vaults, constructed with wood, are likely to suffer structural failure and should be considered to pose a risk of release to the surface.

Units subject to wind erosion because of insufficient soil cover or erodible cover materials pose a potential threat of exposure via surface soil. Wind erosion has been noted as a problem in the area east of the 241-T Tank Farm. This area of active radionuclide migration has been steadily expanding on the past several years. Recent efforts to stabilize the soil in the 241-T Tank Farm may help to reduce this expansion.

Animal burrows have been noted throughout the 200 West Area. Although contamination as a result of burrowing has not been demonstrated, surveys in the T Plant Aggregate area have found contaminated herbivore feces, bird nests, and coyote feces. These results demonstrate the real possibility for biota assisted radionuclide migration.

5.2.3 Inhalation of Volatiles

As summarized in Section 4.1, the distribution of volatile organics in soils is not well-defined in the T Plant Aggregate Area. Most of the volatile organics were used at facilities other than T Plant and would exist in the T Plant Aggregate Area due to migration. Volatile organics (e.g., methylene chloride, toluene, and isopropanol) were used for equipment decontamination at the 221-T Plant Equipment Decontamination Facility between 1964 and 1980 (Klem 1990). The quantities and potential soil locations of these volatile organics is unknown.

Waste management units that are known to have contained equipment decontamination waste are the following:

- 216-T-9 Trench
- 216-T-10 Trench — Exhumed radiologically
- 216-T-11 Trench — Exhumed radiologically
- 216-T-13 Trench — Exhumed radiologically, surface stabilized.

The primary volatile radionuclide of concern, tritium, is not known to have been disposed of directly in the T Plant Aggregate Area. Large quantities of tritium have been disposed of in areas near the T Plant Aggregate Area, including approximately 280,000 Ci (decayed through 1990) to the 218-W-3A Burial Ground (Anderson et al. 1991). Exposure to tritium (as tritiated water vapor) is of concern as is the potential for tritium release via radiolytic production of hydrogen from aqueous radioactive wastes.

5.2.4 Migration to Groundwater

Risks that could potentially occur due to migration of contaminants in groundwater to existing or potential receptors will be addressed in the 200 West Groundwater AAMS and thus, will not be discussed in the T Plant AAMS. However, the potential for individual units to impact groundwater was discussed in Section 4.1, and is summarized below.

Based on the available information on known or potential contamination of vadose zone and saturated zone soils summarized in Section 4.1 and the comparison of liquid waste volumes to effective pore space presented in Table 4-12, the following units have a high potential to have impacted area groundwater with either radionuclides or hazardous nonradioactive chemicals and could pose a risk of adverse human health effects if groundwater beneath or downgradient from the unit were to be used for a water supply in the future:

- 216-T-1 Ditch
- 216-T-2 Reverse Well
- 216-T-3 Reverse Well
- 216-T-4A Pond
- 216-T-5 Trench
- 216-T-6 Crib
- 216-T-7TF Crib and Tile Field
- 216-T-8 Crib
- 216-T-12 Trench
- 216-T-18 Crib
- 216-T-19TF Crib and Tile Field
- 216-T-22 Trench
- 216-T-23 Trench
- 216-T-24 Trench

- 216-T-25 Trench
- 216-T-26 Crib
- 216-T-27 Crib
- 216-T-28 Crib
- 216-T-32 Crib
- 216-T-33 Crib
- 216-T-34 Crib
- 216-T-35 Crib
- 216-W-LWC Laundry Crib.

Units that are estimated, based on the volume of waste and chemicals disposed of them, to have a low to moderate potential for impacts to groundwater based on the factors described above are as follows:

- 216-T-14 Trench
- 216-T-15 Trench
- 216-T-16 Trench
- 216-T-17 Trench
- 216-T-20 Trench
- 216-T-21 Trench
- 216-T-29 Crib
- 216-T-36 Crib.

In addition to the direct disposal of liquid wastes to the soil column, there is a potential that subsurface contaminant migration may be occurring as a result of liquid discharges to active waste management units affecting inactive waste management units. In the T Plant Aggregate Area, there are no known areas of vadose zone contamination within 50 m (160 ft) of any of the septic tanks or the 241-T-4-2 Ditch.

5.3 ADDITIONAL SCREENING CRITERIA

In addition to determining human health concerns for a worker at each of the waste management units, previously developed site ranking criteria were investigated for the purpose of setting priorities for waste management units and unplanned releases. These criteria are the CERCLA HRS scores assigned during preliminary assessment/site inspection (PA/SI) activities performed for the Hanford Site (DOE/RL 1988), and the rankings assigned by the Westinghouse Hanford Environmental Protection Group to prioritize sites needing remedial actions for radiological control (Huckfeldt 1991b).

Both of these ranking systems take into account some measure of hazard and environmental mobility, and are thus appropriate to consider for waste unit prioritization. The HRS ranking system evaluates sites based on their relative risk, taking into account the population at risk, the hazardous waste constituent toxicity and concentration at the facility, the potential for contamination of the environment, the potential risk of fire and explosion, and the potential for exposure associated with humans or animals that come into contact with the waste management unit inventory. The HRS is thus appropriate to consider for screening waste management units.

The PA/SI screening was performed using the EPA's HRS and the mHRS. The HRS (40 CFR 300) is a site ranking methodology which was designed to determine whether sites should be placed on the CERCLA National Priorities List (NPL) based on chemical contamination history. The EPA has established the criteria for placement on the NPL to be a score of 28.5 or greater. The HRS criteria used in the PA/SI have been revised (December 14, 1990). The HRS scores are only used as available indicators of relative risk; therefore, the revision will not impact the evaluation process. The mHRS is a ranking system developed by the Pacific Northwest Laboratory (PNL) for the U.S. Department of Energy (DOE) that uses the basic methodology of the old (pre-December 1990) HRS; however, it more accurately predicts the impacts from radionuclides. The mHRS takes into account concentration, half-life, and other chemical-specific parameters that are not considered by the old HRS. The mHRS has not been accepted by EPA as a ranking system.

Many of the T Plant Aggregate Area waste management units were ranked in the PA/SI using both the HRS and mHRS. For those waste management units that were not ranked in the PA/SI, unit type and discharge history were evaluated in comparison with ranked units for the purpose of setting priorities. If a waste management unit that has been ranked exhibits similar characteristics (e.g., construction, waste type, and volume), the value for the ranked unit was applied to the unit without an HRS or mHRS score. If no ranked waste management units exhibit similar characteristics, then the unit was not ranked; however, a high or low score was determined qualitatively through evaluation of unit configuration and contamination history.

Table 5-1 also lists the units scored by the Westinghouse Hanford Environmental Protection Group (Huckfeldt 1991b). The Environmental Protection Group's ranking system was developed to provide a remediation priority guide for managers of waste management units, based on environmental radiological concerns such as level of contamination, site accessibility, and environmental mobility. The highest ranking a site can receive is 15 (Huckfeldt 1991b, 1991c). A score of seven or greater results in the assignment of a "high" priority to the unit. A value of seven was chosen to represent the approximate midpoint of the scoring range.

The Westinghouse Hanford Environmental Protection Group has issued rankings for 12 sites within the T Plant Aggregate Area (Winship and Hughes 1991). The rankings of these sites range from 6 to 10.

Seven unplanned release sites investigated in the PA/SI did not receive a ranking, because of insufficient data. These are denoted as "ENS" by the PA/SI to indicate sites not scored because of insufficient data. Fifteen other units received a qualitative ranking based on similarities with other units which had been HRS scored. The design of the unit, volume, and type of waste received were used in evaluating similarities.

5.4 SUMMARY OF SCREENING RESULTS

The screening process was used to sort sites as either high priority or low priority. Table 5-1 lists the T Plant Aggregate Area waste units that exceeded one or more of the screening criteria identified in the preceding Section 5.2. A discussion of the site prioritization and classification process is presented in Section 9.0 of this document.

Radiation survey results (dose rate and/or contamination) were available for 40 of the 69 waste management units and unplanned releases. Twenty-three were reported as having no detectable results. The remaining 17 units had survey results that exceeded one or more of the criteria (2 mrem/hr, 100 ct/min beta/gamma, and 20 dis/min alpha).

For both the mHRS and the HRS scores, six waste management units were given scores of 28.5 or greater. Four units received a qualitative "high" score. Nine units received an Environmental Protection Group score of seven or greater. Because some sites were designated as high priority for more than one criterion, the total number of high priority sites, 26, is less than the sum of high priority ratings.

Table 5-1. Hazard Ranking Scores for T Plant Aggregate Area.

Site Name - Type	HRS Rating	mHRS Rating	Assigned Score[a]	Radiation Surveys			Environmental Protection Score[b]	High Priority
				ct/min	dis/min	mrem/h		
Tanks and Vaults								
241-T-361 Settling Tank	--	--	High	--	--	--	--	Y
Cribs and French Drains								
216-T-6 Crib	2.5	2.83	--	--	--	ND	6	N
216-T-7TF Crib and Tile Field	65.43	65.43	--	--	--	ND	--	Y
216-T-8 Crib	47.81	47.82	--	--	--	ND	--	Y
216-T-18 Crib	1.60	1.60	--	--	--	ND	--	N
216-T-19TF Crib and Tile Field	57.88	45.19	--	300[e]	--	--	9	Y
216-T-26 Crib	1.81	1.89	--	3,000[e]	--	ND	--	Y
216-T-27 Crib	1.72	2.36	--	5,000[e]	--	--	--	Y
216-T-28 Crib	47.81	42.14	--	5,000[e]	--	--	--	Y
216-T-29 Crib	1.03	0.71	--	--	--	--	--	N
216-T-31 French Drain[c]	0.00	0.00	--	--	--	--	--	N
216-T-32 Crib	1.42	1.42	--	--	--	ND	--	N
216-T-33 Crib	1.03	0.82	--	300[e]	--	--	6	Y
216-T-34 Crib	1.03	1.42	--	10,000[e]	--	--	--	Y
216-T-35 Crib	1.38	1.52	--	500[e]	--	ND	--	Y
216-T-36 Crib	1.38	1.52	--	400[e]	--	ND	6	Y
216-W-LWC Crib	--	--	High	--	--	--	--	Y
Reverse Wells								
216-T-2 Reverse Well	50.33	50.33	--	--	--	ND	--	Y
216-T-3 Reverse Well	60.40	60.40	--	ND	--	ND	8	Y

Table 5-1. Hazard Ranking Scores for T Plant Aggregate Area. Page 2 of 4

Site Name - Type	HRS Rating	mHRS Rating	Assigned Score[a]	Radiation Surveys			Environmental Protection Score[b]	High Priority
				ct/min	dis/min	mrem/h		
Ponds, Ditches, and Trenches								
216-T-4A Pond[c]	0.00	0.00	--	--	--	--	--	N
216-T-4B Pond[d]	0.00	0.00	Low	--	--	--	--	N
216-T-1 Ditch	--	--	High	--	--	ND	8	Y
216-T-4-1D Ditch[c]	0.00	0.00	--	--	--	ND	--	N
216-T-4-2 Ditch[c]	--	--	High	--	--	ND	--	Y
200-W Powerhouse Pond	--	--	Low	--	--	--	--	N
216-T-5 Trench	1.25	1.25	--	--	--	ND	--	N
216-T-9 Trench[c]	0.00	0.00	--	--	--	ND	--	N
216-T-10 Trench[c]	0.00	0.00	--	--	--	ND	--	N
216-T-11 Trench[c]	0.00	0.00	--	--	--	ND	--	N
216-T-12 Trench	0.98	1.14	--	500	--	--	--	Y
216-T-13 Trench[c]	0.00	0.00	--	--	--	--	--	N
216-T-14 Trench	1.20	1.42	--	400[e]	--	--	10	Y
216-T-15 Trench	1.20	1.42	--	400[e]	--	--	10	Y
216-T-16 Trench	1.20	1.42	--	400[e]	--	--	10	Y
216-T-17 Trench	1.20	1.42	--	400[e]	--	--	10	Y
216-T-20 Trench	1.09	0.82	--	--	--	ND	--	N
216-T-21 Trench	1.52	1.52	--	--	--	ND	--	N
216-T-22 Trench	1.67	1.89	--	--	--	ND	--	N
216-T-23 Trench	1.25	1.42	--	--	--	ND	--	N

Table 5-1. Hazard Ranking Scores for T Plant Aggregate Area.

Site Name - Type	HRS Rating	mHRS Rating	Assigned Score[a]	Radiation Surveys			Environmental Protection Score[b]	High Priority
				ct/min	dis/min	mrem/h		
216-T-24 Trench	1.67	1.89	--	--	--	ND	--	N
216-T-25 Trench	1.89	1.89	--	--	--	ND	--	N
Septic Tanks								
2607-W1 Septic Tank	--	--	Low	--	--	--	--	N
2607-W2 Septic Tank	--	--	Low	--	--	--	--	N
2607-W3 Septic Tank	--	--	Low	--	--	--	--	N
2607-W4 Septic Tank	--	--	Low	--	--	--	--	N
Basins								
207-T Retention Basin	--	--	Low	--	--	ND	9	Y
Burial Grounds								
200-W Ash Disposal Basin	--	--	Low	--	--	--	--	N
200-W Burning Pit[c]	0.00	0.00	--	--	--	--	--	N
200-W Powerhouse Ash Pit	--	--	Low	--	--	--	--	N
218-W-8 Burial Ground	0.70	0.50	--	--	--	ND	--	N
Unplanned Releases								
UN-200-W-2	ENS	--	--	--	--	--	--	N
UN-200-W-3	ENS	--	--	--	--	--	--	N
UN-200-W-4	ENS	--	--	--	--	--	--	N
UN-200-W-8	1.00	--	--	--	--	--	--	N
UN-200-W-14	ENS	--	--	--	--	--	--	N
UN-200-W-27	ENS	--	--	--	--	--	--	N
UN-200-W-29	1.00	--	--	--	--	--	--	N

Table 5-1. Hazard Ranking Scores for T Plant Aggregate Area.

Site Name - Type	HRS Rating	mHRS Rating	Assigned Score[a]	Radiation Surveys			Environmental Protection Score[b]	High Priority
				ct/min	dis/min	mrem/h		
UN-200-W-58	ENS	--	--	--	--	--	--	N
UN-200-W-63	1.00	--	--	--	--	--	--	N
UN-200-W-65	0.60	--	--	5,000	--	--	--	Y
UN-200-W-67	0.90	--	--	--	--	--	--	N
UN-200-W-73	0.70	--	--	--	--	--	--	N
UN-200-W-77	ENS	--	--	--	--	--	--	N
UN-200-W-85	--	--	Low	--	--	--	--	N
UN-200-W-88	--	--	Low	650	--	--	--	Y
UN-200-W-98	1.10	--	--	300	--	--	10	Y
UN-200-W-99	0.70	--	--	4,000	--	0.2	--	Y
UN-200-W-102	1.00	--	--	--	--	ND	--	N
UN-200-W-135	1.20	--	--	--	--	--	--	N

Sources: WHC 1991a; DOE/RL 1988; Huckfeldt 1991b.

[a] A low (high) value was given to those units for which no similarities to other ranked units exist and a qualitative investigation indicates a "low" ("high") score.
[b] Relative to a maximum environmental protection score of 15.
[c] This site was exhumed; therefore, the site did not score.
[d] Based on current operational procedures, the 216-T-4B Pond has not received inflow since 1977.
[e] Value based on high alpha contamination found in surface water samples.
[f] This unplanned release is associated with another waste management unit.
[g] Beta/gamma radiation data converted from dis/min to ct/min for the purposes of assessing criteria.
ENS= Classification given in PA/SI when sufficient information was not available for scoring.
-- = No information/data available.

6.0 POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

6.1 INTRODUCTION

The Superfund Amendments and Reauthorization Act (SARA) of 1986 amended the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to require that all applicable or relevant and appropriate requirements (ARARs) be employed during implementation of a hazardous waste site cleanup. "Applicable" requirements are defined by the U.S. Environmental Protection Agency (EPA) in "CERCLA Compliance With Other Laws Manual" (OSWER Directive 9234.1-01, August 8, 1988) as:

> cleanup standards, standards of control and other substantive environmental protection requirements, criteria or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.

A separate set of "relevant and appropriate" requirements that must be evaluated include:

> cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state 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.

"To-be-Considered Materials" (TBCs) are nonpromulgated advisories or guidance issued by federal or state governments that are not legally binding and do not have the status of potential ARARs. However, in many circumstances, TBCs will be considered along with potential ARARs and may be used in determining the necessary level of cleanup for protection of health or the environment.

The following sections identify potential ARARs to be used in developing and assessing various remedial action alternatives at the T Plant Aggregate Area. Specific requirements pertaining to hazardous and radiological waste management, remediation of contaminated soils, surface water protection, and air quality will be discussed.

The potential ARARs focus on federal or state statutes, regulations, criteria and guidelines. The specific types of potential ARARs evaluated include the following:

- Contaminant-specific

- Location-specific
- Action-specific.

Potential contaminant-specific ARARs are usually health or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of numerical contaminant values that are generally recognized by the regulatory agencies as allowable to protect human health and the environment. In the case of the T Plant Aggregate Area, potential contaminant-specific ARARs address chemical constituents and/or radionuclides. The potential contaminant-specific ARARs that were evaluated for the T Plant Aggregate Area are discussed in Section 6.2.

Potential location-specific ARARs are restrictions placed on the concentration of hazardous substances, or the conduct of activities, solely because they occur in specific locations. The potential location-specific ARARs that were evaluated for the T Plant Aggregate Area are discussed in Section 6.3.

Potential action-specific ARARs apply to particular remediation methods and technologies, and are evaluated during the detailed screening and evaluation of remediation alternatives. The potential action-specific ARARs that were evaluated for the T Plant Aggregate Area are discussed in Section 6.4.

The TBC requirements are other federal and state criteria, advisories, and regulatory guidance that are not promulgated regulations, but are to be considered in evaluating alternatives. Potential TBCs include U.S. Department of Energy (DOE) Orders that carry out authority granted under the Atomic Energy Act. All DOE Orders are potentially applicable to operations at the T Plant Aggregate Area. Specific TBC requirements are discussed in Section 6.5.

Potential contaminant- and location-specific ARARs will be refined during the aggregate area management study (AAMS) process. Potential action-specific ARARs are briefly discussed in this section, and will be further evaluated upon final selection of remedial alternatives. The points at which these ARARs must be achieved and the timing of the ARARs evaluations are discussed in Sections 6.6 and 6.7, respectively.

6.2 CONTAMINANT-SPECIFIC REQUIREMENTS

A contaminant-specific requirement sets concentration limits in various environmental media for specific hazardous substances, pollutants, or contaminants. Based on available information, some of the currently known or suspected contaminants that may be present in the T Plant Aggregate Area are outlined in Table 4-20. The currently identified potential federal and state contaminant-specific ARARs are summarized below.

6.2.1 Federal Requirements

Federal contaminant-specific requirements are specified in several statutes, codified in the U.S. Code (USC), and promulgated in the Code of Federal Regulations (CFR), as follows:

- **Clean Water Act (33 USC 1251).** Federal Water Quality Criteria (FWQC) (40 CFR 131) are developed under the authority of the Clean Water Act (CWA) (33 USC 1251) to serve as guidelines to the states for determining receiving water quality standards. Different FWQC are derived for protection of human health and protection of aquatic life. The human health FWQC are further subdivided according to how people are expected to use the water (e.g., drinking the water versus consuming fish caught from the water). The SARA 121(d)(2) states that remedial actions shall attain FWQC where they are relevant and appropriate, taking into account the designated or potential use of the water, the media affected, the purpose of the criteria, and current information. Many more substances have FWQC than maximum contaminant levels (MCLs) issued under the Safe Drinking Water Act (SDWA, see discussion below); consequently, EPA and other state agencies rely on these criteria more than MCLs, even though these criteria can only be considered relevant and appropriate and not applicable.

  The FWQC would not be considered at the T Plant Aggregate Area, as no natural surface water bodies exist. The only existing manmade surface water bodies at T Plant Aggregate Area are waste management units: the 216-T-1 Ditch, the 216-T-4-2 Ditch, the 207-T Retention Basin, and the 200 West Powerhouse Pond. The 216-T-46 Pond historically held water but is presently dry.

- **Safe Drinking Water Act (42 USC 300 (f).** Under the authority of the SDWA (42 USC 300 (f)), MCLs (40 CFR 141) apply when the water may be used for drinking. At present, EPA and the state of Washington apply MCLs as the standards for groundwater contaminants at CERCLA sites that could be used as drinking water sources. Groundwater contamination and application of MCLs as ARARs are addressed under a separate AAMS specific to groundwater.

- **Resource Conservation and Recovery Act (42 USC 6901, 40 CFR 260 to 271).** The Resource Conservation Recovery Act (RCRA) addresses the generation and transportation of hazardous waste, and waste management activities at facilities that treat, store, or dispose of hazardous wastes. Subtitle C (Hazardous Waste Management) mandates the creation of a cradle-to-grave management and permitting system for hazardous wastes. RCRA defines hazardous wastes (40 CFR 261) as "solid wastes" (even though the waste is often liquid in physical form) that may cause or significantly contribute to an increase in mortality or serious illness, or that poses a substantial hazard to human health or the

environment when improperly managed. In Washington State, RCRA is implemented by EPA and the authorized state agency, the Washington State Department of Ecology (Ecology).

The CERCLA sections 121 (d) and 121 (e) respectively require that CERCLA activities, including remedial actions, comply with substantive requirements and not administrative requirements such as permitting. Therefore, hazardous waste activities conducted on site at the T Plant Aggregate Area will comply with the substantive requirements of RCRA, and not the permitting requirements of RCRA, which are deemed to be potential ARARs.

Two key potential contaminant-specific ARARs have been adopted under the federal hazardous waste regulations: the Toxicity Characteristic Leaching Procedure (TCLP) designation limits promulgated under 40 CFR Part 261; and the hazardous waste land disposal restrictions (LDRs) for constituent concentrations promulgated under 40 CFR Part 268.

The TCLP designation limits define when a waste is hazardous, and are used to determine when more stringent management standards apply than would be applied to typical solid wastes. Thus, the TCLP potential contaminant-specific ARARs can be used to determine when RCRA waste management standards may be required. The TCLP limits are presented in Table 6-1.

The LDRs are numerical limits derived by EPA by reviewing available technologies for treating hazardous wastes. Until a prohibited waste can meet the numerical limits, it can be prohibited from land disposal. Two sets of limits have been promulgated: limits for constituent concentrations in waste extract, which uses the TCLP test to obtain a leached sample of the waste; and limits for constituent concentrations in waste, which addresses the total contaminant concentration in the waste. Applicability to CERCLA actions is based on determinations of waste "placement/disposal" during a remediation action. According to OSWER Directive 9347.3-05FS, EPA concludes that Congress did not intend in situ consolidation, remediations, or improvement of structural stability to constitute placement or disposal. The land disposal numerical limits can be used to determine if generated cleanup wastes can be redisposed of on site without further treatment, or must be subject to certain treatment practices prior to land disposal. The LDR limits are presented in Table 6-1 (see Section 6.4.1 for a further discussion on the applying LDR limits).

- **Clean Air Act (42 USC 7401).** The Clean Air Act (42 USC 7401) establishes National Primary and Secondary Ambient Air Quality Standards (NAAQS) (40 CFR Part 50), National Emission Standards for Hazardous Air Pollutants

(NESHAP)(40 CFR Part 61), and New Source Performance Standards (NSPS)(40 CFR Part 60).

In general, new and modified stationary sources of air emissions must undergo a pre-construction review to determine whether the construction or modification of any source, such as a CERCLA remedial program, will interfere with attainment or maintenance of NAAQS or fail to meet other new source review requirements including NESHAP and NSPS. However, the process applies only to "major" sources of air emissions (defined as emissions of 250 tons per year). The T Plant Aggregate Area would not constitute a major source.

Section 112 of the Clean Air Act directs EPA to establish standards at the level that provides an ample margin of safety to protect the public health from hazardous air pollutants. The NESHAP standards for radionuclides are directly applicable to DOE facilities under Subpart H of Section 112 that establishes a 10 mrem/year facility-wide standard for exposure to an offsite receptor. Further, if the maximum individual dose during remediation exceeds 1% of the NESHAP standard (0.1 mrem/yr), a report meeting the substantive requirements of an application for approval of construction must be prepared.

6.2.2 State of Washington Requirements

Potential state contaminant-specific requirements are specified in several statutes, codified in the Revised Code of Washington (RCW) and promulgated in the Washington Administrative Code (WAC).

- **Model Toxics Control Act (RCW 70.105D, Chapter 173-340 WAC).** The Model Toxics Control Act (MTCA) (RCW 70.105D) authorized Ecology to adopt cleanup standards for remedial actions at hazardous waste sites. These regulations are considered potential ARARs for soil, groundwater, and surface water cleanup actions. The processes for identifying, investigating, and cleaning up hazardous waste sites are defined and cleanup levels are set for groundwater, soil, surface water and air in Chapter 173-340 WAC.

  Under the MTCA regulations, cleanup standards may be established by one of three methods.

  - Method A may be used if a routine cleanup action, as defined in WAC 173-340-200, is being conducted at the site or relatively few hazardous substances are involved for which cleanup standards have been specified by Tables 1, 2, or 3 of WAC 173-340-720 through -745.

- Under Method B, a risk level of 10^{-6} is established and a risk calculation based on contaminants present is determined.

- Method C cleanup standards represent concentrations that are protective of human health and the environment for specified site uses. Method C cleanup standards may be established where it can be demonstrated that such standards comply with applicable state and federal laws, that all practical methods of treatment are used, that institutional controls are implemented, and that one of the following conditions exist: (1) Method A or B standards are below background concentrations; (2) Method A or Method B results in a significantly greater threat to human health or the environment; (3) Method A or B standards are below technically possible concentrations, or (4) the site is defined as an industrial site for purposes of soil remediation.

Table 1 of Method A addresses groundwater, so it is not considered to be an ARAR for the T Plant Aggregate Area (groundwater will be addressed in the 200 West Groundwater Aggregate Area Management Study Report, AAMSR). Table 2 of Method A is intended for non-industrial site soil cleanups, and Table 3 is intended for industrial site soil cleanups. Method A industrial soil cleanup standards for preliminary contaminants of concern are provided as ARARs in Table 6-1.

In addition to Method A, Method B and Method C cleanup standards may also be considered potential ARARs for T Plant Aggregate Area. Method B and Method C cleanup standards can be calculated on a case-by-case basis in concert with Ecology. Method B and Method C should be used where Method A standards do not exist or cannot be met, or where routine cleanup actions cannot be implemented at a specific waste management unit.

- **State Hazardous Waste Management Act and Dangerous Waste Regulations (Chapter 173-303 WAC).** The state of Washington is a RCRA-authorized state for hazardous waste management, and has developed state-specific hazardous waste regulations under the authority of the State Hazardous Waste Management Act. Generally, state hazardous waste regulations (WAC 173-303) parallel the federal regulations. The state definition of a hazardous waste incorporates the EPA designation of hazardous waste that is based on the compound being specifically listed as hazardous, or on the waste exhibiting the properties of reactivity, ignitability, corrosivity, or toxicity as determined by the TCLP.

  In addition, Washington State identifies other waste as hazardous. Three unique criteria are established: toxic dangerous waste; persistent dangerous waste; and carcinogenic dangerous waste. These additional designation criteria may be

imposed by Ecology as potential ARARs for purposes of determining acceptable cleanup standards and appropriate waste management standards.

- **Ambient Air Quality Standards and Emission Limits for Radionuclides (Chapter 173-480 WAC).** These Ecology ambient air quality standards specify maximum accumulated dose limits to members of the public. Other Air Quality Standards potential applicable include carbon monoxide, ozone, and nitrogen dioxide (WAC 173-475) and volatile organic compounds (WAC 173-490). Although these standards may be potential ARARs, these standards are less restrictive than DOE public dose limits per DOE Order 5400.5, Radiation Protection of the Public and the Environment.

- **Monitoring and Enforcement of Air Quality and Emission Standards for Radionuclides (WAC 246-247).** These standards by the Washington State Department of Health (Health) adopt the Ecology standards for maximum accumulated dose limits to members of the public. These standards apply to DOE facilities as provided in WAC 246-247-010(2).

- **Controls for New Sources of Toxic Air Pollutants (Chapter 173-460 WAC).** In accordance with regulations recently promulgated by Ecology in Chapter WAC 173-460, any new emission source will be subject to Toxic Air Pollutant emission standards. The regulations establish acceptable source impact levels (ASILs) for hundreds of organic and inorganic compounds. Ecology's ASILs may constitute potential ARARs for cleanup activities that have a potential to affect air. ASILs for preliminary contaminants of concern are outlined in Table 6-1.

- **Water Quality Standards.** Washington State has promulgated various numerical standards related to surface water and groundwater contaminants. They are included principally in the following regulations:

  - **Public Water Supplies (Chapter 248-54 WAC).** This regulation establishes drinking water standards for public water supplies. The standards essentially parallel the federal drinking water standards (40 CFR Parts 141 and 143).

  - **Water Quality Standards for Groundwaters of the State of Washington (RCW 90.48, Chapter 173-200 WAC).** This regulation establishes contaminant standards for protecting existing and future beneficial uses of groundwater through the reduction or elimination of the discharge of contaminants to the state's groundwater.

- **Water Quality Standards for Surface Waters of the State of Washington (Chapter 173-201 WAC and Proposed Chapters 173-203 and 173-201 WAC).** Ecology has adopted numerical ambient water quality criteria for six conventional pollutant parameters (defined at WAC 173-201-025): (1) fecal coliform bacteria; (2) dissolved oxygen; (3) total dissolved gas; (4) temperature; (5) pH; and (6) turbidity. In addition, toxic, radioactive, or deleterious material concentrations shall be below those of public health significance or which may cause acute or chronic toxic conditions to the aquatic environment or which may adversely affect any water use. Numerical criteria currently exist for a limited number of toxic substances (WAC 173-201-047). Ecology has initiated rulemaking to incorporate numerical criteria for toxic chemicals (i.e., EPA Water Quality Criteria), and reclassify certain waters of the state to Class A or better.

  Under the state Water Quality Standards, the criteria and classifications do not apply inside an authorized dilution zone surrounding a wastewater discharge. In defining dilution zones, Ecology generally follows guidelines contained in "Criteria for Sewage Works Design." Although water quality standards can be exceeded inside the dilution zone, state regulations will not permit discharges that cause mortalities of fish or shellfish within the zone or that diminish aesthetic values.

These water quality standards do not constitute ARARs for purposes of establishing cleanup standards for the T Plant Aggregate Area. Groundwater will be addressed in the 200 West Groundwater AAMSR in which pertinent groundwater-related ARARs will be covered. No natural surface water bodies exist within the T Plant Aggregate Area, so there will be no need to achieve ambient water quality standards during remediation activities.

The numerical water quality standards cited above may become potential ARARs if selected remedial actions could result in discharges to groundwater or surface water (e.g., if treated wastewaters are discharged to the soil column or the Columbia River). Determining appropriate standards on such discharges will depend on the type of remediation performed and will have to be established on a case-by-case basis as remedial actions are defined.

- **National Pollutant Discharge Elimination System and Water Quality Standards (R.C.W. 90.48, WAC 173-220 and 40 CFR 122).** National Pollutant Discharge Elimination System (NPDES) regulations govern point source discharges into navigable waters. Limits on the concentrations of contaminants and volumetric flowrates that may be discharged are determined on a case-by-case basis and permitted under this program. No point source discharges have been identified. The EPA implements this program in Washington State for federal

facilities, however, assumption of the NPDES program by the state is likely within five years.

6.3 LOCATION-SPECIFIC REQUIREMENTS

Potential location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they are in specific locations. Some examples of special locations include floodplains, wetlands, historic places, and sensitive ecosystems or habitats.

Table 6-2 lists various location-specific standards and indicates which of these may be potential ARARs. Potential ARARs have been identified as follows:

- **Floodplains.** Requirements for protecting floodplains are not ARARs for activities conducted within the T Plant Aggregate Area as the aggregate area is not located within flood plain boundaries (see Section 3.1). However, remedial actions selected for cleanup may require projects in or near floodplains (e.g., construction of a treatment facility outfall at the Columbia River). In such cases, location-specific floodplain requirements may be potential ARARs.

- **Wetlands, Shorelines, and Rivers and Streams.** Requirements related to wetlands, shorelines, and rivers and streams are not ARARs for activities conducted within the T Plant Aggregate Area. However, remedial actions selected for cleanup may require projects on a shoreline or wetland, or discharges to wetlands (e.g., construction of a treatment facility outfall at the Columbia River). In such cases, location-specific shoreline and wetlands requirements may be potential ARARs.

- **Threatened and Endangered Species Habitats.** As discussed in Section 3.6, various threatened and endangered species inhabit portions of the Hanford Site and may occur in the T Plant Aggregate Area (American peregrine falcon, bald eagle, white pelican, and sandhill crane). Therefore, critical habitat protection for these species would constitute a potential ARAR.

- **Wild and Scenic Rivers.** The Columbia River Hanford Reach is currently undergoing study pursuant to the federal Wild and Scenic Rivers Act. Pending results of this study, actions that may impact the Hanford Reach may be restricted. This requirement would not be an ARAR for remedial activities within the T Plant Aggregate Area. However, Wild and Scenic Rivers Act requirements may be potential ARARs for actions taken as a result of T Plant Aggregate Area cleanup efforts and that could affect the Hanford Reach.

6.4 ACTION-SPECIFIC REQUIREMENTS

Potential action-specific ARARs are requirements that are triggered by specific remedial actions at a unit. These remedial actions will not be fully defined until a remedial approach has been selected. However, the universe of action-specific ARARs defined by a preliminary screening of potential remedial action alternatives will help focus the selection process. Potential action-specific ARARs are outlined below. (Note that potential contaminant- and location- specific ARARs discussed above will also include provisions for potential action-specific ARARs to be applied once the remedial action is selected.)

6.4.1 Federal Requirements

- **Comprehensive Environmental Response, Compensation and Liability Act (42 USC 9601).** The CERCLA and regulations adopted pursuant to CERCLA contained in the National Contingency Plan (40 CFR 300) include selection criteria for remedial actions. Under the criteria, excavation and off-site land disposal options are least favored when on-site treatment options are available. Emphasis is placed on alternatives that permanently treat or immobilize contamination. Selected alternatives must be protective of human health and the environment, which implies that federal and state ARARs be met. However, a remedy may be selected that does not meet all ARARs if the requirement is technically impractical, if its implementation would produce a greater risk to human health or the environment, if an equivalent level of protection can otherwise be provided, if state standards are inconsistently applied, or if the remedy is only part of a complete remedial action which attains ARARs.

  CERCLA gives state cleanup standards essentially equal importance as federal standards in guiding cleanup measures in cases where state standards are more stringent. State standards pertain only if they are generally applicable, were passed through formal means, were adopted on the basis of hydrologic, geologic, or other pertinent considerations, and do not preclude the option of land disposal by a statewide ban. Most importantly, CERCLA provides that cleanup of a site must ensure that public health and the environment are protected. Selected remedies should meet all ARARs, but issues such as cost-effectiveness must be weighed in the selection process.

- **Resource Conservation and Recovery Act (42 USC 6901, 40 CFR 260 to 271).** The RCRA (42 USC 6901) and regulations adopted pursuant to RCRA describe numerous action-specific requirements that may be potential ARARs for cleanup activities. The primary regulations are promulgated under 40 CFR Parts 262 (Standards for generators), 264 and 265 (Standards for owners and operators of

hazardous waste treatment, storage and disposal facilities), and include such action-specific requirements as follows:

- Packaging, labeling, placarding, and manifesting of offsite waste shipments
- Inspecting waste management areas to ensure proper performance and safe conditions
- Preparation of plans and procedures to train personnel and respond to emergencies
- Management standards for containers, tanks, incinerators, and treatment units
- Design and performance standards for land disposal facilities
- Groundwater monitoring system design and performance.

Many of these requirements will depend on the particular remediation activity undertaken, and will have to be identified as remediation proceeds.

One key potential area of action-specific RCRA ARARs is the 40 CFR Part 268 LDRs. In addition to the contaminant-specific constituent concentration limits established in the LDRs (as previously discussed in Section 6.2.1), EPA has identified best demonstrated available treatment technologies (BDATs) for various waste streams. The EPA could require the use of BDATs prior to allowing land disposal of wastes generated during remediation. The EPA's imposition of the LDRs and BDAT requirements will depend on various factors.

Applicability to CERCLA actions is based on determinations of waste "placement/disposal" during a remediation action. According to OSWER Directive 9347.3-05FS, EPA concludes that Congress did not intend in situ consolidation, remediation, or improvement of structural stability to constitute placement or disposal. Placement or disposal would be considered to occur if the following:

- Wastes from different units are consolidated into one unit (other than a land disposal unit within an area of contamination)
- Waste is removed and treated outside a unit and redeposited into the same or another unit (other than a land disposal unit within an area of contamination)

- Waste is picked up from a unit and treated within the area of contamination in an incinerator, surface impoundment, or tank and then redeposited into the unit (except for in situ treatment).

Consequently, the requirement to use BDAT would not apply under the LDR standards unless placement or disposal had occurred. However, remediation actions involving excavation and treatment could trigger the requirements to use BDAT for wastes subject to the LDR standards. In addition, the agencies could consider BDAT technologies to be relevant and appropriate when developing and evaluating potential remediation technologies.

Two additional components of the LDR program should be considered with regard to an excavate and treat remedial action. First, a national capacity variance was issued by EPA for contaminated soil and debris for a two-year period ending May 8, 1992 (54 FR 26640). Second, a series of variances and exemptions may be applied under an excavate and treat scenario. These include the following:

- A no-migration petition
- A case-by-case extension to an effective date
- A treatability variance
- Mixed waste provisions of a Federal Facilities Compliance Act.

The applicability and relevance of each of these options will vary based on the specific details of a T Plant Aggregate Area excavate and treat option. An analysis of these variances can be developed once engineering data on the option becomes available.

The effect of the LDR program on mixed waste management is significant. Currently, limited technologies are available for effective treatment of these waste streams and no commercially available treatment facilities exist except for liquid scintillation counting fluids used for laboratory analysis and testing. The EPA recognized that inadequate capacity exists and issued a national capacity variance until May 8, 1992 to allow for the development of such treatment capacity.

Lack of treatment and disposal capacity also presents implications for storage of these materials. Under 40 CFR 268.50, mixed wastes subject to LDRs may be stored for up to one year. Beyond one year, the owner/operator has the burden of proving such storage is for accumulating sufficient quantities for treatment.

On August 29, 1991, EPA issued a mixed waste storage enforcement policy providing some relief from this provision for generators of small volumes of mixed wastes. However, the policy was limited to facilities generating less than 28 m^3 (1,000 ft^3) of land disposal-prohibited waste per year. Congress is considering amendments to RCRA postponing the storage prohibition for another five years; however, final action on these amendments has not occurred.

- **Clean Water Act (33 USC 1251).** Regulations adopted pursuant to the CWA (33 USC 1251) under NPDES mandate use of best available treatment technologies (BAT) prior to discharging contaminants to surface waters. NPDES requirements would not be ARARs for actions conducted only within the T Plant Aggregate Area. However, NPDES requirements could constitute potential ARARs for cleanup actions which would result in discharge of treated wastewaters to the Columbia River, and associated treatment systems could be required to utilize BAT.

- **Department of Transportation Standards (49 CFR 171-177).** The Department of Transportation standards contained in 49 CFR 171-177 specify the requirements for packaging, labeling, and placarding for offsite transport of hazardous materials. These standards ensure that hazardous substances and wastes are safely transported using adequate means of transport and proper documentation.

- **Ambient Air Quality Surveillance (40 CFR 58)**

6.4.2 State of Washington Requirements

- **Hazardous Waste Management (WAC 173-303).** As discussed in Section 6.4, there are various requirements addressing the management of hazardous wastes that may be potential action-specific ARARs. Pertinent Washington regulations appear in Chapter 173-303 WAC (under the authority of RCW 70.105) and generally parallel federal management standards. Determination of ARARs will be on a case-by-case basis as cleanup actions proceed.

- **Solid Waste Management (WAC 173-304).** Washington State regulations describe management standards for solid waste in Chapter 173-304 WAC (under the authority of RCW 70.95). Some of these management standards may be potential ARARs for disposal of cleanup wastes within the T Plant Aggregate Area. Solid waste standards include such requirements as the following:

  - Inspecting waste management areas to ensure proper performance and safe conditions

- Management standards for incinerators and treatment units
- Design and performance standards for landfills
- Groundwater monitoring system design and performance.

Many of these requirements will depend on the particular remediation activity undertaken, and will have to be identified as remediation proceeds.

- **Water Quality Management.** Chapter 90.48 RCW, the Washington State Water Pollution Control Act (WPCA), requires use of all known, available, and reasonable treatment (AKART) technologies for treating contaminants prior to discharge to waters of the state. Implementing regulations appear principally at Chapters 173-216, 173-220, and 173-240 WAC.

  The WPCA requirements for groundwater could be potential ARARs for actions conducted within the T Plant Aggregate Area if such actions would result in discharge of liquid contaminants to the soil column. In this event, Ecology would require use of AKART to treat the liquid discharges prior to the soil disposal.

  The WPCA requirements for surface water would not be ARARs for actions conducted only within the T Plant Aggregate Area. However, these requirements could potentially constitute ARARs for cleanup actions that would result in discharge of treated wastewaters to the Columbia River and associated treatment systems could be required to demonstrate they meet AKART.

- **Air Quality Management (RCW 70.94).** Under the authority of the Washington Clean Air Act (RCW 70.94), the Toxic Air Pollution regulations for new air emission sources, promulgated in Chapter 173-460 WAC, require use of best available control technology for air toxics (T-BACT). The Toxic Air Pollution regulations may be potential ARARs for cleanup actions at the T Plant Aggregate Area that could result in emissions of toxic contaminants to the air. Ecology may require the use of T-BACT to treat such air emissions.

- **Water Well Construction (RCW 18.104).** This regulation establishes authority for Ecology to require the licensing of water well contractors and operators and for the regulation of water well construction.

- **Nuclear Energy and Radiation (RCW 70.98).** Chapter 70.98 RCW establishes a program to establish procedures for assumption and performance of certain regulatory responsibilities with respect to byproduct, source, and special nuclear materials.

- **Pollution Disclosure Act (RCW 90.52).** Chapter 90.52 RCW describes the authority of the state to regulate reports for any commercial or industrial discharge, other than sanitary sewage, into waters of the state.

- **Water Resources Act (RCW 90.54).** Chapter 90.54 RCW gives the state authority to implement water related resources programs.

- **Minimum Standards for Construction and Maintenance of Wells (Chapter 173-160 WAC).** Well construction regulations establish minimum standards for water well construction and require the preparation of construction reports.

- **Rules and Regulations Governing the Licensing of Well Contractors and Operators (Chapter 173-162 WAC).** Chapter 173-162 WAC establishes requirements for licensing of well drillers.

- **State Waste Discharge Permit Program (Chapter 173-216 WAC).** Chapters 173-216 WAC establishes a permit system for discharges of waste water to groundwater and surface water vis municipal sewage system.

- **Underground Injection Control Program (Chapter 173-218 WAC).** Chapter 173-218 WAC pertains to the injection of wastes into aquifers that are used for drinking water.

- **Incinerators (Chapter 173-303-670 WAC).** If incinerators are used for a remedial technology this regulation would be applicable.

6.5 OTHER CRITERIA AND GUIDANCE TO BE CONSIDERED

In addition to the potential ARARs presented, other federal and state criteria, advisories, and guidance and similar materials are TBC in determining the appropriate degree of remediation for the T Plant Aggregate Area. A myriad of resources may be potentially evaluated. The following represents an initial assessment of TBC provisions.

6.5.1 Health Advisories

The EPA Office of Drinking Water publishes advisories identifying contaminants for which health advisories have been issued.

6.5.2 International Commission on Radiation Protection/National Council on Radiation Protection

The International Commission of Radiation Protection and the National Council on Radiation Protection have a guidance standard of 100 mrem/yr whole body dose of gamma radiation. These organizations also issue recommendations on other areas of interest regarding radiation protection.

6.5.3 Environmental Protection Agency Proposed Corrective Actions for Solid Waste Management Units

In the July 27, 1990, Federal Register (55 FR 20798), EPA published proposed regulations for performing corrective actions (cleanup activities) at solid waste management units associated with RCRA facilities. The proposed 40 CFR Part 264 Subpart S includes requirements that would be TBCs for determining an appropriate level of cleanup at the T Plant Aggregate Area. In particular, EPA included an appendix, "Appendix A - Examples of Concentrations Meeting Criteria for Action Levels," which presented recommended contaminant concentrations warranting corrective action. These contaminant-specific TBCs are included in Table 6-1 for the preliminary contaminants of concern.

6.5.4 Department of Energy Standards for Radiation Protection

A number of DOE Orders exist which could be TBCs. The DOE Orders that establish potential contaminant-specific or action-specific standards for the remediation of radioactive wastes and materials are discussed below.

- **DOE Order 5400.5 - DOE Standards for Radiation Protection of the Public and Environment.** The DOE Order 5400.5 establishes the requirements for DOE facilities to protect the environment and human health from radiation including soil and air contamination. The purpose of the Order is to establish standards and requirements for operations of the DOE and DOE contractors with respect to protection of members of the public and the environment against undue risk from radiation.

  The Order mandates that the exposure to members of the public from a radiation source as a consequence of routine activities shall not exceed 100 mrem/yr from all exposure sources due to routine DOE activities. In accordance with the Clean Air Act, exposures resulting from airborne emissions shall not exceed 10 mrem/yr to the maximally exposed individual at the facility boundary. The DOE Order 5400.5 provides Derived Concentration Guide (DCG) values for releases of radionuclides into the air or water. The DCG values are calculated so

that, under conditions of continuous exposure, an individual would receive an effective dose equivalent of 100 mrem/year. Because dispersion in air or water is not accounted for in the DCG, actual exposures of maximally exposed individuals in unrestricted areas are considerably below the 100 mrem/year level.

The DOE Order 5400.5 also provides for establishment of soil cleanup levels through a site-specific pathway analysis such as the allowable residual contamination level method. The calculation of allowable residual contamination level values for radionuclides is dependent on the physical characteristics of the site, the radiation dose limit determined to be acceptable, and the scenarios of human exposure judged to be possible and to result in the upper-bound exposure.

- **DOE Order 5820.2A - Radioactive Waste Management.** The DOE Order 5820.2A applies to all DOE contractors and subcontractors performing work that involves management of waste containing radioactivity. This Order requires that wastes be managed in a manner that assures protection of the health and safety of the public, operating personnel, and the environment. The DOE Order 5820.2A establishes requirements for management of high-level, transuranic, and low-level wastes as well as wastes containing naturally occurring or accelerator produced radioactive material, and for decommissioning of facilities. The requirements applicable to the T Plant Aggregate Area remediation activities include those related to transuranic waste and low-level radioactive waste. These are summarized below.

  - **Management of Transuranic Waste.** Transuranic (TRU) waste resulting from the T Plant Aggregate Area remedial action must be managed to protect the public and worker health and safety, and the environment, and performed in compliance with applicable radiation protection standards and environmental regulations. Practical and cost-effective methods must be used to reduce the volume and toxicity of TRU waste.

    Transuranic waste must be certified in compliance with the Waste Isolation Pilot Plant (WIPP) Acceptance Criteria, placed in interim storage, if required, and sent to the WIPP. Any transuranic waste that the DOE has determined, with the concurrence of the EPA Administrator, does not need the degree of isolation provided by a geologic repository or transuranic waste that cannot be certified or otherwise approved for acceptance at the WIPP must be disposed of by alternative methods. Alternative disposal methods must be approved by DOE Headquarters and comply with National Environmental Policy Act (NEPA) requirements and EPA/state regulations.

  - **Management of Low-Level Radioactive Waste.** The requirements for management of low-level radioactive waste presented in DOE

Order 5820.2A are relevant to the remedial alternative of removal and disposal of T Plant Aggregate Area wastes. Performance objectives for this option shall ensure that external exposure to the radioactive material released into surface water, groundwater, soil, plants, and animals does not result in an effective dose greater than 25 mrem/yr to the public. Releases to the environment shall be at levels as low as reasonably achievable. An inadvertent intruder after the institutional control period of 100 years is not to exceed 100 mrem/yr for continuous exposure or 500 mrem for a single acute exposure. A performance assessment is to be prepared to demonstrate compliance with the above performance objectives.

Other requirements under DOE Order 5820.2A which may affect remediation of the T Plant Aggregate Area include waste volume minimization, waste characterization, waste acceptance criteria, waste treatment, and shipment. The low-level radioactive waste may be stored by appropriate methods prior to disposal to achieve the performance objectives discussed above. Disposal site selection, closure/post-closure, and monitoring requirements are also discussed in this Order.

6.6 POINT OF APPLICABILITY

A significant factor in the evaluation of remedial alternatives for the T Plant Aggregate Area will be the determination of the point at which compliance with identified ARARs must be achieved (i.e., the point of a specific ARAR's applicability). These points of applicability are the boundaries at which the effectiveness of a particular remedial alternative will be assessed.

For most individual radioactive species transported by either water or air, Ecology and Health standards generally require compliance at the boundaries of the Hanford Site (e.g., Clean Air Act, Section 6.2.1). The assumed point of compliance for radioactive species is the point where a member of the public would have unrestricted access to live and conduct business, and, consequently, to be maximally exposed. Although Health is responsible for monitoring and enforcing the air standards promulgated by Ecology, and generally recognizes the site boundary as the point of applicability, Ecology has recently indicated that compliance may be required at the point of emission.

The point at which compliance with identified ARARs must be achieved will be a significant factor in evaluating appropriate remedial alternatives in the T Plant Aggregate Area. Applicability of ARARs at the point of discharge, at the boundary of the disposal unit, at the boundary of the AAMS, at the boundary of the Hanford Site, and/or at the point of maximum exposure will need to be determined.

6.7 POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS EVALUATION

Evaluation of ARARs is an iterative process that will be conducted at multiple points throughout the remedial process:

- When the public health evaluation is conducted to assess risks at the T Plant Aggregate Area, the contaminant-specific ARARs and advisories and location-specific ARARs will be identified more comprehensively and used to help determine the cleanup goals; and

- During detailed analyses of alternatives, all the ARARs and advisories for each alternative will be examined to determine what is needed to comply with other laws and to be protective of public health and the environment.

Following completion of the investigation, the remedial alternative selected must be able to attain all ARARs unless one of the six statutory waivers provided in Section 121 (d)(4)(A) through (f) of CERCLA is invoked. Finally, during remedial design, the technical specifications of construction must ensure attainment of ARARs. The six reasons ARARs can be waived are as follows:

- The remedial action is an interim measure, where the final remedy will attain ARARs upon completion.

- Compliance will result in greater risk to human health and the environment than will other options.

- Compliance is technically impracticable.

- An alternative remedial action will attain the equivalent performance of the ARAR.

- For state ARARs, the state has not consistently applied (or demonstrated the intention to consistently apply) the requirements in similar circumstances.

- For CERCLA-financed actions under Section 104, compliance with the ARAR will not provide a balance between the need for protecting public health, welfare, and the environment at the facility, and the need for fund money to respond to other sites (this waiver is not applicable at the Hanford Site).

Once investigations have been completed and final remedies have been selected, the ARARs that must be met will be formally identified in the Record of Decision (ROD). Compliance with those ARARs specified in the ROD will be achieved through the remedial

action. ARARs may need to be reevaluated if unanticipated circumstances are encountered during remediation which prevent the ability to satisfy the identified ARARs.

9 3 1 2 5 7 0 1 1 3 5

Table 6-1. Potential Contaminant-Specific ARARs and TBCs for Preliminary Inorganic and Organic Contaminants of Concern.

	RCRA TCLP Designation Limits	RCRA Land Ban Limits Nonwastewater		MTCA Method A Cleanup Levels Industrial Soil	WCAA Toxic Air Pollutants ASIL	RCRA Corrective Action Levels (Proposed) (1)	
	in mg/L	CCWE in mg/L	CCW in mg/kg	in mg/kg	in $\mu g/m^3$	Air in $\mu g/m^3$	Soil in mg/kg
INORGANIC CHEMICALS							
Arsenic	5.0	5.0	—	200	.00023[b/]	0.00007	80
Barium	100	100	—	—	1.7*	0.4	4,000
Beryllium	-	-	-	-	.00042**	.0004	.02
Boron	—	—	—	—	***	—	—
Cadmium	1.0	1.0	—	10	.00056[a/b/]	0.0006	40
Chromium	5.0	5.0	—	500	.000083[b/]	0.00009	40
Copper	—	—	—	—	3.3[a/]	—	—
Cyanide (total)	—	—	590	—	16.7	—	2,000
Fluoride	—	—	—	—	8.3[a/]	—	—
Iron	-	-	-	-	2.7	-	-
Lead	5.0	5.0	—	1,000	0.2	—	—
Manganese	—	—	—	—	16.7	—	—
Mercury	0.2	0.20 (low-level)	—	1.0	0.3[a/]	—	20
Nickel	—	-	—	—	3.3[a/]	—	2,000
Nitrite	—	—	—	—	—	—	—
Silver	5.0	5.0	-	-	0.03	-	200
Vanadium	—	—	—	—	0.2[b/]	—	—
Zinc	—	—	—	—	0.03	—	—
ORGANIC CHEMICALS							
Acetone	—	0.5g	160	—	5,927.4[a/]	—	8,000
Chloroform	6.0	-	5.6	—	0.043[b/]	0.04	100
Hydrazine	-	-	-	-	-	0.0002	0.2
Methylene chloride	—	0.96	0.33	0.5	2.0	0.3	90
Toluene	—	0.33	28	40.6	1,248.8	7,000	20,000

ASIL = Acceptable Source Impact Level
CCWE = Constituent Concentration in Waste Extract
CCW = Constituent Concentration in Waste
MTCA = Washington State Model Toxics Control Act
RCRA = Federal Resource Conservation and Recovery Act
TCLP = Toxic Characteristic Leaching Procedure
WCAA = Washington State Clean Air Act

a/ Cadmium and compounds
b/ as V205

mg/L = milligrams per liter
mg/kg = milligrams per kilogram
$\mu g/m^3$ = micrograms per cubic meter

(1) RCRA Corrective Action Levels are only proposed at this time (40 CFR Part 264 Subpart S), so are not ARARs yet; they are "To Be Considered."

* Soluble compounds Ba
** Beryllium and compounds
*** Borontrifluoride - 10.0

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Table 6-2. Potential Location-Specific ARARs.

Location	Requirement	Prerequisite	Citation
GEOLOGICAL:			
Within 154 m (500 ft) of a fault displaced in Holocene time.	New treatment, storage or disposal of hazardous waste prohibited.	Hazardous waste management near Holocene fault.	40 CFR 264.18; WAC 173-303-282
Holocene faults and subsidence areas.	New solid waste disposal facilities prohibited over faults with displacement in Holocene time, and in subsidence areas.	New solid waste management activities near Holocene fault.	WAC 173-304-130
Unstable slopes.	New solid waste disposal areas prohibited from hills with unstable slopes.	New solid waste disposal on an unstable slope.	WAC 173-304-130
100-year floodplains.	Solid and hazardous waste disposal facilities must be designed, built, operated, and maintained to prevent washout.	Solid or hazardous waste disposal in a 100-year floodplain.	40 CFR 264.18; WAC 173-303-282; WAC 173-304-460
	Avoid adverse effects, minimize potential harm, restore/preserve natural and beneficial values in floodplains.	Actions occurring in a floodplain.	40 CFR Part 6 Subpart A; 16 USC 661 et seq; 40 CFR 6.302
Salt dome and salt bed formations, underground mines, and caves.	Placement of non-containerized or bulk liquid hazardous wastes is prohibited.	Hazardous waste placement in salt dome, salt bed, mine, or cave.	40 CFR 264.18
SURFACE WATER:			
Wetlands.	New hazardous waste disposal facilities prohibited in wetlands.	Hazardous waste management within 154 m (500 ft) of wetland (one-quarter mile for land-based facilities).	WAC 173-303-282
	New solid waste disposal facilities prohibited within 61 m (200 ft) of surface water (stream, lake, pond, river, salt water body).	Solid waste disposal with 61 m (200 ft) of surface water.	WAC 173-304-130
	New solid waste disposal facilities prohibited in wetlands (swamps, marshes, bogs, estuaries, and similar areas).	Solid waste disposal in a wetland (swamp, marsh, bog, estuary, etc.).	WAC 173-304-130

Table 6-2. Potential Location-Specific ARARs.

Location	Requirement	Prerequisite	Citation
	Discharge of dredged or fill materials into wetlands prohibited without a permit.	Discharges to wetlands and navigable waters.	40 CFR Part 230; 33 CFR Parts 303, and 320 to 330
	Minimize potential harm, avoid adverse effects, preserve and enhance wetlands.	Construction or management of property in wetlands.	40 CFR Part 6 Appendix A
Shorelines.	Actions prohibited within 61 m (200 ft) of shorelines of statewide significance unless permitted.	Actions near shorelines.	Chapter 90.58 RCW; Chapter 173-14 WAC
Rivers and streams.	Avoid diversion, channeling or other actions that modify streams or rivers, or adversely affect fish or wildlife habitats and water resources.	Actions modifying a stream or river and affecting fish or wildlife.	40 CFR 6.302
Water code and water rights.	Specifies conditions for extracting surface water for non-domestic uses. In essence, the laws provide that water extraction must be consistent with beneficial uses of the resource and must not be wasteful.	Extracting surface water.	Chapter 90.03 RCW
GROUNDWATER:			
Water code and water rights.	Specifies conditions for extracting groundwater for non-domestic uses. In essence, the laws provide that water extraction must be consistent with beneficial uses of the resource and must not be wasteful.	Extracting groundwater.	Chapter 90.14 RCW
Sole source aquifer.	New solid and hazardous waste land disposal facilities prohibited over a sole source aquifer.	Disposal over a sole source aquifer.	WAC 173-303-282; WAC 173-304-130

Table 6-2. Potential Location-Specific ARARs.

Location	Requirement	Prerequisite	Citation
Uppermost aquifer.	Bottom of lowest liner of new solid waste disposal facility must be at least 3 m (10 ft) above seasonal high water in uppermost aquifer (1.5 m [5 ft] if hydraulic gradient controls installed).	New solid waste disposal.	WAS 173-304-130
	Protects the upper aquifers and upper aquifer zones to avoid depletions, excessive water level declines, or reductions in water quality. State regulations for upper aquifer zones are applicable to remedial alternatives that involve treating groundwater or presenting risks of groundwater contamination.	Activities within an aquifer.	Chapter 173-154 WAC
	Requires that Ecology review and approve plans for waste water treatment facilities that discharge to groundwater.	New treatment facilities discharging to the groundwater.	Chapter 173-240 WAC
Aquifer Protection Areas.	Activities restricted within designated Aquifer Protection Areas.	Activities within an Aquifer Protection Area.	Chapter 36.36 RCW
Groundwater Management Areas.	Activities restricted within Groundwater Management Areas.	Activities within a Groundwater Management Area.	Chapter 90.44 RCW; Chapter 173-100 WAC
DRINKING WATER SUPPLY:			
Drinking water supply well.	New solid waste disposal areas prohibited within 305 m (1,000 ft) upgradient, or 90 days travel time of drinking water supply well.	New solid waste disposal within 305 m (1,000 ft) of drinking water supply well.	WAC 173-304-130
Watershed.	New solid waste disposal areas prohibited within a watershed used by a public water supply system for municipal drinking water.	New solid waste disposal in a public watershed.	WAC 173-304-130

Table 6-2. Potential Location-Specific ARARs.

Location	Requirement	Prerequisite	Citation
AIR:			
Attainment areas.	Defines emissions standards and design and operation of solid waste incinerator facilities.	Activities in an attainment area.	Chapter 173-434 WAC
	Defines when certification of operators is necessary at incinerators and landfills.	Activities in an attainment area.	Chapter 173-300 WAC
Non-attainment areas.	Restrictions on air emissions in areas designated as non-attainment areas under state and federal air quality programs.	Activities in a designated non-attainment area.	Chapter 70.94 RCW; Chapters 173-400 and 173-403 WAC
SENSITIVE ENVIRONMENTS:			
Endangered/threatened species habitats.	New solid waste disposal prohibited from areas designated by US Fish and Wildlife Service as critical habitats for endangered/ threatened species.	New solid waste disposal in critical habitats.	WAC 173-304-130 16 USC 742 16 USC 2901 50 CFR 17
	Actions within critical habitats must conserve endangered/threatened species.	Activities where endangered or threatened species exist.	50 CFR Parts 200 and 402
Parks.	No new solid waste disposal areas within 305 m (1,000 ft) of state or national park.	New solid waste disposal near state/national park.	WAC 173-304-130
	Restrictions on activities in areas that are designated state parks, or recreation/ conservation areas.	Activities in state parks or recreation/conservation areas.	Chapter 43.51 RCW; Chapter 352.32 WAC
Wilderness areas.	Actions within designated wilderness areas must ensure area is preserved and not impaired.	Activities within designated wilderness areas.	16 USC 1131 et seq; 50 CFR 35.1 et seq
Wildlife refuge.	Restrictions on actions in areas that are part of the National Wildlife Refuge System.	Activities within designated wildlife refuges.	16 USC 668dd et seq; 50 CFR Part 27
Natural areas preserves.	Activities restricted in areas designated as having special habitat value (Natural Heritage Resources).	Activities within identified Natural Area Preserves.	Chapter 79.70 RCW; Chapter 332-650 WAC

Table 6-2. Potential Location-Specific ARARs.

Location	Requirement	Prerequisite	Citation
Wild, scenic, or recreational rivers.	Avoid actions that would have adverse effects on designated wild, scenic, or recreational rivers.	Activities near wild, scenic, and recreational rivers.	16 USC 1271 et seq; 40 CFR 6.302; Chapter 79.72 RCW
Columbia River Gorge.	Restrictions on activities that could affect resources in the Columbia River Gorge.	Activities within the Columbia River Gorge.	Chapter 43.97 RCW
UNIQUE LANDS AND PROPERTIES:			
Natural resource conservation areas.	Restrictions on activities within designated Conservation Areas.	Activities within designated Conservation Areas.	Chapter 79.71 RCW
Forest lands.	Activities restricted within state forest lands to minimize fire hazards and other adverse impacts.	Activities within state forest lands.	Chapter 76.04 RCW; Chapter 332-24 WAC
	Restrictions on activities in state and federal forest lands.	Activities within state and federal forest lands.	16 USC 1601; Chapter 76.09 RCW
Public lands.	Activities on public lands are restricted, regulated, or proscribed.	Activities on state-owned lands.	Chapter 79.01 RCW
Scenic vistas.	Restrictions on activities that can occur in designated scenic areas.	Activities in designated scenic vista areas.	Chapter 47.42 RCW 16 USC 461
Historic areas.	Actions must be taken to preserve and recover significant artifacts, preserve historic and archaeologic properties and resources, and minimize harm to national landmarks.	Activities that could affect historic or archaeologic sites or artifacts.	16 UST 469, 470 et seq; 36 CFR Parts 65 and 800; Chapters 27.34, 27.53, and 27.58 RCW

Table 6-2. Potential Location-Specific ARARs.

Location	Requirement	Prerequisite	Citation
LAND USE:			
Neighboring properties.	No new solid waste disposal areas within 30.5 m (100 ft) of the facility's property line.	New solid waste disposal within 30.5 m (100 ft) of facility property line.	WAC 173-304-130
	No new solid waste disposal areas within 76 m (250 ft) of property line of residential zone properties.	New solid waste disposal within 76 m (250 ft) of property line of residential property.	WAC 173-304-130
Proximity to airports.	Disposal of garbage that could attract birds prohibited within 3,050 m (10,000 ft) (turbojet aircraft)/(1,524 m) (5,000 ft) (piston-type aircraft) of airport runways.	Garbage disposal near airports.	WAC 173-304-130

7.0 PRELIMINARY REMEDIAL ACTION TECHNOLOGIES

Previous sections identified contaminants of concern at the T Plant Aggregate Area, potential routes of exposure, and potentially applicable or relevant and appropriate requirements (ARARs). Section 7.0 identifies preliminary remedial action objectives (RAOs) and develops preliminary remedial action alternatives consistent with reducing the potential hazards of this contamination and satisfying potential ARARs. The overall objective of this section is to identify viable and innovative remedial action alternatives for media of concern at the T Plant Aggregate Area.

The process of identifying viable remedial action alternatives consists of several steps. In Section 7.1, RAOs are first identified. Next, in Section 7.2, general response actions are determined along with specific treatment, resource recovery, and containment technologies within the general response categories. Specific process options belonging to each technology type are identified, and these process options are subsequently screened based on their effectiveness, implementability, and cost (Section 7.3). The combining of process options into alternatives occurs in Section 7.4. Here the alternatives are described and diagrammed. Criteria are then identified in Section 7.5 for preliminary screening of alternatives that may be applicable to the waste management units and unplanned release sites identified in the T Plant Aggregate Area. Figure 7-1 is a matrix summarizing the development of the remedial action alternatives starting with media-specific RAOs.

Because of uncertainty regarding the nature and extent of contamination at the T Plant Aggregate Area waste sites, recommendations for remedial alternatives are general and cover a broad range of actions. Remedial action alternatives will be considered and more fully developed in future focused feasibility studies. The *Hanford Site Past-Practice Strategy* (DOE/RL 1992a) is used to focus the range of remedial action alternatives that will be evaluated in focused studies. In general, the *Hanford Site Past-Practice Strategy* remedial investigation (RI)/feasibility study (FS) and the Resource Conservation and Recovery Act (RCRA)/Corrective Measures Studies (CMS) are defined as the combination of interim remedial measures (IRMs), limited field investigations (LFIs) for final remedy selection where interim actions are not clearly justified, and focused or aggregate area feasibility/treatability studies for further evaluation of treatment alternatives. After completion of an IRM, data will be evaluated including concurrent characterization and monitoring data to determine if a final remedy can be selected.

A secondary purpose of the evaluation of preliminary remedial action alternatives is the identification of additional information needed to complete the evaluation. This information may include field data needs and treatability tests of selected technologies. Additional data will be developed for most sites or waste groups during future data gathering activities (e.g., LFIs, characterization supporting IRMs, or treatability studies). These data may be used to refine and supplement the RAOs and proposed alternatives identified in this initial study.

Data needs are defined in Section 8.0. Alternatives involving technologies that are not well-demonstrated under the conditions of interest are identified in Sections 7.3 and 7.5. These technologies may require bench-scale and pilot-scale treatability studies. The intent is to conduct treatability studies for promising technologies early in the RI/FS process. Conclusions regarding the feasibility of some individual technologies may change after new data become available.

The bias-for-action philosophy of addressing contamination at the Hanford Site requires an expedited process for implementing remedial actions. Implementation of general response actions may be accomplished using an observational approach in which the implementation is redirected as information is obtained. This observational approach is an iterative process of data acquisition and refinement of the conceptual model. Data needs are determined by the model, and data collected to fulfill these needs are used as additional input to the model. Use of the observational approach while conducting response actions in the 200 Areas will allow integrating these actions with longer range objectives of final remediation of similar areas and the entire 200 Areas. Site characterization and remediation data will be collected concurrently with the use of LFIs, IRMs, and treatability testing. The knowledge gained through these different activities will be applied to similar areas. The overall goal of this approach is convergence on an appropriate response action as early as possible while continuing to obtain valuable characterization information during remediation phases.

7.1 PRELIMINARY REMEDIAL ACTION OBJECTIVES

The RAOs are remediation goals for protection of human health and the environment that specify the contaminants and media of concern, exposure pathways, and allowable contaminant levels. The RAOs discussed in this section are considered to be preliminary and may change or be refined as new data are acquired and evaluated.

The fundamental objective of the corrective action process at the T Plant Aggregate Area is to protect environmental resources and/or human receptors from the potential threats that may exist because of known or suspected contamination. Specific interim and final RAOs will depend in part on current and reasonable potential future land use in the T Plant Aggregate Area and the 200 Areas. The RAOs also take into account the preference under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) for isolation and permanent or significant reduction of volume, toxicity or mobility of hazardous substances.

To focus remedial actions with a bias for action through implementing IRMs, preliminary RAOs are identified for the 200 Areas and T Plant Aggregate Area. The overall objective for the 200 Areas is as follows:

> Reduce the risk of harmful effects to the environment and human users of the area by isolating or permanently reducing the toxicity, mobility, or volume of contaminants from the source areas to meet ARARs or risk-based levels that will allow industrial use of the area (this is a potential final RAO, and an interim action objective based on current use of the 200 Area).

The RAOs are further developed in Table 7-1 for media of concern and applicable exposure pathways (see Sections 4.1 and 4.2) for the T Plant Aggregate Area. The media of concern for the T Plant Aggregate Area include the following:

- Radionuclide-contaminated and chemically-contaminated soils that could result in direct exposure or inhalation of vapors or particles
- Contaminated soils that are or could contribute to groundwater contamination
- Vadose zone vapors that could cause ambient air impacts or contribute to the lateral and vertical migration of contaminants in the soil and to the groundwater
- Biota that could mobilize radionuclides or chemical contaminants and could thereby degrade the integrity of other controls, such as caps.

Waste materials currently stored in single-shell tanks that contribute or may contribute contaminants to environmental media will not be addressed by this aggregate area management study (AAMS) program but rather by the Single-Shell Tank Program. In addition, groundwater as an exposure medium is not addressed in this source AAMS report (AAMSR) but will be addressed in the 200 West Groundwater AAMSR.

7.2 PRELIMINARY GENERAL RESPONSE ACTIONS

General response actions represent broad classes of remedial measures that may be appropriate to achieve both interim and final RAOs at the T Plant Aggregate Area, and are presented in Table 7-2. The following are the general response actions followed by a brief description for the T Plant Aggregate Area:

- No action (applicable to specific facilities)
- Institutional controls
- Waste removal and treatment or disposal
- Waste containment
- In situ waste treatment
- Combinations of the above actions.

These general response actions are intended to cover the range of options from no action to complete remediation. Included are options that satisfy the CERCLA preference for isolation and permanent or significant reduction in volume, mobility, and toxicity of hazardous substances. No action is included for evaluations as required by the National Environmental Policy Act (NEPA) and National Contingency Plan [40 CFR 300.68 (f)(l)(v)] to provide a baseline for comparison with other response actions. The no action alternative may be appropriate for some facilities and sources of contamination if risk assessments determine acceptable natural resource or human health risks posed by those sources or facilities and no exceedances of contaminant-specific ARARs occur.

Institutional controls involve the use of physical barriers or access restrictions to reduce or eliminate public exposure to contamination. Many access and land use restrictions are currently in place at the Hanford Site and will remain in place during implementation of remedial actions. Because the 200 Areas are already committed to waste management for the long term, institutional controls will also be important for final remedial measure alternatives.

Waste removal and treatment or disposal involves excavation of contamination sources for eventual treatment and/or disposal either on a small- or large-scale basis. One approach being considered for large-scale waste removal is macro-engineering, which is based on high volume excavation using conventional surface mining technologies. Waste removal on a macro-engineering scale would be used over large areas such as groups of waste management units, operable units, or operational areas as a final remedial action. Waste removal on a

small scale would be conducted for individual waste management units on a selective basis. Small-scale waste removal could be conducted as either an interim or final remedial action.

The alternatives for disposal of the excavated waste would depend on the volume of soil and the nature of the contaminants:

- Soil that contained low levels of radionuclides but no hazardous chemical waste could be disposed of into existing disposal sites at Hanford, or it could be shipped to licensed offsite disposal sites.

- Soil that contained chemical contaminants but no radionuclides could be disposed of at existing offsite RCRA-approved landfills, or disposed of onsite in a Hanford RCRA-approved landfill.

- Soil that was designated as "mixed waste" with both low-level radionuclides and hazardous chemical contaminants would have to be disposed of at Hanford.

- There are currently no facilities at Hanford or offsite for permanent geologic disposal of transuranic (TRU) waste. If such soil was excavated, it would have to be temporarily stored at Hanford until a geologic repository disposal site was licensed and constructed or another disposal option is identified.

One potential problem with offsite disposal of radioactive waste is the lack of an alternate disposal location that will decrease the potential human exposure over the long time required for many of the contaminants. Waste removal actions may not be needed, or only be required on a small scale, to protect human health or the environment for industrial uses of the 200 Areas.

Waste treatment involves the use of biological, thermal, physical, or chemical technologies. Typical treatment options include biological land farming, thermal processing, soil washing, and fixation/solidification/stabilization. As described in Section 7.3, some of the technologies that have been used at industrial sites may not be feasible at Hanford. Some treatment technologies must may be pilot tested before they could be implemented. Waste treatment could be conducted either as an interim or final action and may be appropriate in meeting RAOs for all potential future land uses.

Waste containment includes the use of capping technologies (i.e., capping and grouting) to minimize the driving force for downward or lateral migration of contaminants. Vertical barriers can also be used to minimize lateral migration and to prevent biota from penetrating into contaminated areas. Containment also provides a radiation exposure barrier and barrier to direct exposure. In addition, these barriers provide long-term stability with relatively low maintenance requirements. Containment actions may be appropriate for either interim or final remedial actions.

In situ waste treatment includes thermal, chemical, physical, and biological technology types, of which there are several specific process options including in situ vitrification, in situ grouting or stabilization, soil flushing, and in situ biotreatment. The distinguishing feature of in situ treatment technologies is the ability to attain RAOs without removing the wastes. The final waste form generally remains in place. This feature is advantageous when exposure during excavation would be significant or when excavation is technically impractical. In situ treatment can be difficult because the process conditions may not be easily controlled.

In the next section, specific process options within these technology groups are evaluated.

7.3 TECHNOLOGY SCREENING

In this section, potentially applicable technology types and process options are identified. These process options are then screened using effectiveness, implementability, and relative cost as criteria to eliminate those process options that would not be feasible at the site. The remaining applicable processes are then grouped into remedial alternatives in Sections 7.4.

The effectiveness criteria focuses on: (1) the potential effectiveness of process options in handling the areas or volumes of media and meeting the RAOs; (2) the potential impacts to human health and the environment during the construction and implementation phase; and (3) how proven and reliable the process is with respect to the contaminants and conditions at the site. This criteria also concentrates on the ability of a process option to treat a contaminant type (organics, inorganics, metals, radionuclides, etc.) rather than a specific contaminant (nitrate, cyanide, chromium, plutonium, etc.).

The implementability criteria places greater emphasis on the institutional aspects of implementability, such as the ability to obtain necessary permits for offsite actions, the availability of treatment, storage, and disposal services, and the availability of necessary equipment and skilled workers to implement the technology. It also focuses on the process option's developmental status, whether it is an experimental or established technology.

The relative cost criteron is an estimate of the overall cost of a process, including capital and operating costs. At this stage in the process, the cost analysis is made on the basis of engineering judgement, and each process is evaluated as to whether costs are high, medium, or low relative to other process options.

A process option is rated effective if it can handle the amount of area or media required, if it does not impact human health or the environment during the construction and implementation phases, and if it is a proven or reliable process with respect to the

contaminants and conditions at the site. Also a process option is considered more effective if it treats a wide range of contaminants rather than a specific contaminant. An example of a very effective process option would be vitrification because it treats inorganics, metals, and radionuclides. On the other hand, chemical reduction may only treat chromium (VI), making it a less useful option.

An easily implemented process option is one that is an established technology, uses readily available equipment and skilled workers, uses treatment, storage, and disposal services that are readily available, and has few regulatory constraints. Preference is given to technologies that are easily implemented.

Preference is given to lower cost options, but cost is not an exclusionary criteria. A process option is not eliminated based on cost alone.

Results of the screening process are shown in Table 7-3. Brief descriptions are given of the process options, followed by comments regarding the evaluation criteria. The last column of the table indicates whether the process option is rejected or carried forward for possible alternative formation. The table first lists technologies that address soil RAOs. Next, technologies pertaining to biota RAOs are presented. All the biota-specific technologies happen to be technologies that were listed for soil RAOs. Air RAOs are dealt with as soil remediation issues because the air contamination is a result of the contaminants in the soil: addressing and remediating the air pathways would be unnecessary and ineffective as long as there is soil contamination. If the soil is remediated, the source of the air contamination would be removed.

The conclusions column of Table 7-3 indicates that no action, monitoring, 3 institutional process options, and 16 other process options are retained for further development of alternatives. These options are carried forward into the development of preliminary alternatives.

7.4 PRELIMINARY REMEDIAL ACTION ALTERNATIVES

This section develops and describes several remedial alternatives considered applicable to disposal sites that contain hazardous chemicals, radionuclides, and volatile and semi-volatile organic compounds (VOCs). These alternatives are not intended as recommended actions for any individual site, but are intended only to provide potential options applicable to most sites where multiple contaminants are present. Selection of actual remedial alternatives that should be applied to the individual sites would be partly based on future expedited or interim actions and LFIs, as recommended in Section 9.0 of this report. Selection of proper alternatives would be conducted within the framework of the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a) and the strategy outlined in Section 9.4. The selection process would also be based on a preference for isolation and permanent treatment.

The remedial alternatives are developed in Section 7.4.1. Then, in Section 7.4.2 through Section 7.4.7, the remedial action alternatives are described. Detailed evaluations and costs are not provided because site-specific conditions must be further investigated before meaningful evaluations could be conducted.

7.4.1 Development of Remedial Alternatives

Potentially feasible remedial technologies were described and evaluated in Section 7.3. Some of those technologies have been proven to be effective and constructible at industrial waste sites, while other technologies are in the developmental stages. The EPA guidance (EPA 1989c) on FSs for uncontrolled waste management units recommends that a limited number of candidate technologies be grouped into "Remedial Alternatives." For this study, technologies were combined to develop remedial alternatives and provide at least one alternative for each of the following general strategies:

- No action
- Institutional controls
- Removal, above-ground treatment, and disposal
- Containment
- In situ treatment.

The alternatives are intended to treat all or a major component of the T Plant Aggregate Area contaminated waste management units or unplanned releases. Consistent with the development of RAOs and technologies, alternatives were developed based on treating classes of compounds (radionuclides, heavy metals, inorganics, and organics) rather than specific contaminants. At a minimum, the alternative must be a complete package. For example, disposal of radionuclide-contaminated soil must be combined with excavation and backfilling of the excavated site.

One important factor in the development of the preliminary remedial action alternatives is the fact that radionuclides, heavy metals, and some inorganic compounds cannot be destroyed. Rather, these compounds must be physically immobilized, contained, isolated, or chemically converted to less mobile forms to satisfy RAOs. Organic compounds can be destroyed, but may represent a smaller portion of the overall contamination at the T Plant Aggregate Area. Both no action and institutional control options are required to be considered as part of the CERCLA RI/FS guidance. The purpose of including both of these alternatives is to provide decision makers with information on the entire range of available remedial actions.

For the containment alternative, an engineered multimedia cover, with or without vertical barriers (depending on the specifics of the remediation) was selected. Two alternatives were selected to represent the excavation and treatment strategy. One of these deals with disposal of TRU contaminated soils. Finally, three in situ alternatives were identified. One deals with vapor extraction for VOCs, one with stabilization of soils and the other with vitrification of soils.

It is recognized that this does not represent an exhaustive list of all applicable alternatives. However, these do provide a reasonable range of remedial actions that are likely to be evaluated in future feasibility studies. The remedial action alternatives are summarized as follows:

- No action
- Institutional controls
- Engineered multimedia cover with or without vertical barriers (containment) Feasible vertical barriers include slurry walls and grout curtains
- In situ grouting or stabilization of soil (in situ treatment)
- Excavation, above-ground treatment, and disposal of soil (removal, treatment and disposal). Feasible technologies for organic compounds include thermal processing and stabilization. Feasible technologies for radionuclides include soil washing, vitrification, and stabilization.
- In situ vitrification of soil (in situ treatment)
- Excavation, treatment, and geologic disposal of soil with TRU radionuclides (removal, treatment and disposal)
- In situ soil vapor extraction of VOCs (in situ treatment).

These alternatives, with the exception of no action and institutional controls, were developed because they satisfy a number of RAOs simultaneously and use technologies that are appropriate for a wide range of contaminant types. For example, constructing an engineered multimedia cover may effectively contain radionuclides, heavy metals, inorganic compounds, and organic compounds simultaneously. It satisfies the RAO of protecting human health and the environment from direct exposures from contaminated soil, bio-mobilization, and airborne contaminants. In situ soil vapor extraction is more contaminant-specific than the other alternatives, but it addresses a contaminant class (VOCs) that is not readily treated using the other options, such as in situ stabilization. It is possible

that some waste management units may require a combination of the identified alternatives to completely address all contaminants.

The use of contaminant-specific remedial technologies was avoided because there appear to be few, if any, waste management units where a single contaminant has been identified. It is possible to construct alternatives that include several contaminant-specific technologies, but the number of combinations of technologies would result in an unmanageable number of alternatives. Moreover, the possible presence of unidentified contaminants may render specific alternatives unusable. Alternatives may be refined as more contamination data are acquired. For now, the alternatives will be directed at remediating the major classes of compounds (radionuclides, heavy metals, inorganics, and organics).

In all alternatives except the no-action alternative, it is assumed that monitoring and institutional controls are required, although they may be temporary. These features are not explicitly mentioned, and details are purposely omitted until a more detailed evaluation may be performed in subsequent studies. Also, treatability studies may accompany many of the alternatives during implementation.

In the next sections, the preliminary remedial action alternatives are described in more detail, with the exception of the no-action and institutional control options.

7.4.2 Alternative 1--Engineered Multimedia Cover With or Without Vertical Barriers

Alternative 1 consists of an engineered multimedia cover. Vertical barriers such as grout curtains or slurry walls may be used in conjunction with the cover. Figure 7-2 shows a schematic diagram of an engineered multimedia cover without the vertical barriers. If the affected area includes either a naturally occurring or engineered depression, then imported backfill would be placed to control runoff and run-on water. The engineered cover itself may consist of fine-grained soil, gravel, sand, asphalt, top-soil, and/or geo-synthetics. A liquid collection layer could also be included. The specific design of the cover and vertical barriers would be the subject of a focused feasibility study which may be supported by treatability studies and performance testing. The barrier would be designed to minimize infiltration of surface water by enhancing the evapotranspiration mechanism. The covered area may be fenced, and warning signs may be posted.

Alternative 1 would provide a permanent cover over the affected area. The cover would accomplish the following: minimize the migration of precipitation into the affected soil; reduce the migration of windblown dust that originated from contaminated surface soils; reduce the potential for direct exposure to contamination; and reduce the volatilization of VOCs and tritium to the atmosphere. If vertical barriers are included, they would limit the amount of lateral migration of contaminants.

This alternative would not reduce the volume or toxicity of the contaminants, and periodic inspections, maintenance, and monitoring would be required for an indefinite period.

7.4.3 Alternative 2--In Situ Grouting or Stabilization of Soil

Radioactive and hazardous soil would be grouted in this alternative using in situ injection methods to significantly reduce the leachability of hazardous contaminants, radionuclides and/or VOCs from the affected soil. Grouting may also be used to fill voids, such as in cribs, thereby reducing subsidence. Another variation of this alternative would be to stabilize the soil using in situ mixing of soil with stabilizing compounds such as pozzolanics or fly ash.

There are two common methods of in situ grout injection that have been used at industrial sites. In the first method (Figure 7-3), grout injection wells are installed at prescribed lateral spacing (based on pilot tests) and screened through the affected vertical zones. Specially formulated grout is then injected at high pressure to provide overlapping zones of influence and allowed to cure. This first method can theoretically be used to stabilize soil deep below the ground surface. In the second method, a patented large diameter auger/mixer is used to mechanically agitate and blend grout mixtures that are injected into the soil through ports in the auger. This method has commonly been used to grout large areas of soil down to a depth of about 4.6 m (15 ft).

Alternative 2 would provide a combination of immobilization and containment of heavy metal, radionuclide, inorganic, and semi-volatile organic contamination. Thus, this alternative would reduce migration of precipitation into the affected soil; reduce the migration of windblown dust that originated from contaminated surface soils; reduce the potential for direct exposure to contaminated soils; and reduce the volatilization of VOCs.

In situ grouting has been demonstrated to be effective for stabilization of metals and semi-volatile organic compounds at several CERCLA sites. However, this is considered to be a developing technology and has not yet been fully proven. Therefore, it is expected that treatability tests would be required. Because this alternative would not remove the contaminants from the soil, it is likely that institutional controls would be required.

7.4.4 Alternative 3--Excavation, Soil Treatment, and Disposal

Under Alternative 3, radioactive and hazardous soil would be excavated using conventional techniques, with special precautions to minimize fugitive dust generation. Depending on the configuration of the area to be excavated, shoring might be required to comply with safety requirements and to reduce the quantity of excavated soil. The soil excavated would be treated above ground. Several treatment options could be selected from

the physical, chemical, and thermal treatment process options screened in Section 7.3. For example, thermal desorption with off gas treatment could be used if organic compounds are present; soil washing could be used to remove contaminated silts and sands or specific compounds; and stabilization could be used to immobilize radionuclides and heavy metals. The specific treatment method would depend on site-specific conditions. Treatability tests would be performed to determine the specific soil treatment protocols methodology. The treated soil would be backfilled into the original excavation or landfilled. Soil treatment by-products may require additional processing or treatment. Figure 7-4 shows a schematic diagram of this alternative.

Alternative 3 would be effective in treating a full range of contamination, depending on the type of treatment processes selected. Attainment of soil RAOs would depend on the depth to which the soil was excavated. If near surface soil was treated, airborne contamination, direct exposure to contaminated soil, and bio-mobilization of contamination would be minimized. Because of practical limits on deep excavation, deep contamination may not be removed and would be subject to migration into groundwater. Alternative 3 could be used in conjunction with Alternative 1 (multimedia cap) to reduce this possibility.

A combination of laboratory treatability tests and pilot scale field tests might be required to develop the optimum methods for above-ground treatment of the excavated soil. The specification of the required treatability tests would depend on the nature of the contaminants at each of the remediation sites.

7.4.5 Alternative 4--In Situ Vitrification of Soil

In this alternative, the contaminated soil in a subject site would be immobilized by in situ vitrification. Treatability tests would be performed initially to determine site-specific operating conditions. Figure 7-5 shows a schematic diagram of the alternative. Import fill would initially be placed over the affected area to reduce exposures to the remediation workers from surface contamination. High power electrodes would be used to vitrify the contaminated soil under the site to a depth below where contamination is present. A large fume hood would be constructed over the site before the start of the vitrification process to collect and treat emissions. After completion of the vitrification, the site would be built back to original grade with imported backfill. Fences and warning signs may be placed around the vitrified monolith to minimize disturbance and potential exposure.

In situ vitrification would be effective in treating radionuclides, heavy metals, and inorganic contamination and may also destroy organic contaminants. This would reduce the potential for exposures by leaching to groundwater, windblown dust and direct dermal contact. However, this alternative would not reduce the mass or toxicity of the radionuclides present onsite. Also, in situ vitrification may be limited to depths of less than about 30.5 m (100 ft), which may not be adequate to immobilize deep contamination.

If organic compounds are present in the affected area, they could migrate laterally and vertically during the vitrification process, as a result of the soil heating process. Therefore, this technology must include provisions for collection and treating organic vapors. This could be done using a combination of soil venting wells and an above-ground capture hood.

It should be noted that in situ vitrification is a relatively new technology which is experiencing some "growing pains" and has not been used for a large-scale cleanup at an industrial site. Therefore, using this technology at the Hanford Site will likely require extensive pilot testing.

7.4.6 Alternative 5--Excavation, Above-Ground Treatment, and Geologic Disposal of Soil with Transuranic Radionuclides

Some of the waste management units in the T Plant Aggregate Area may contain isolated zones where the concentrations of TRU radionuclides exceeds 100 nCi/g. For Alternative 5, the soil from those isolated zones would be excavated, stabilized or treated, and shipped to an offsite geologic disposal site. Such a disposal facility has not yet been licensed, so interim storage of the stabilized soil may be required until a final geologic repository is constructed.

Figure 7-6 shows a schematic diagram of Alternative 5. Depending on the configuration of the affected area, shoring may be required during excavation to comply with worker safety regulations and to minimize the amount of excavated soil. Special excavation procedures would have to be used to minimize fugitive dust. The excavated soil would be sorted according to TRU concentration. Soil with TRU radionuclides exceeding 100 nCi/g would be either vitrified or stabilized using an above ground treatment plant, then stored until a geologic disposal facility was available.

Some of the excavated soil could contain TRU radionuclides at concentrations less than 100 nCi/g, and could be treated using a combination of the technologies described in Section 7.3. After the non-TRU soil was treated to achieve appropriate cleanup standards, it could be backfilled into the original excavation. Alternatively, the non-TRU soil could be disposed of at an appropriate landfill. Imported fill material would be used to restore the site to its original grade. If the residual unexcavated soil or the treated soil used for backfill contained contaminants at concentrations exceeding the RAOs, then a combination of an engineered cover and vertical barriers (Alternative 1) might have to be installed at the site to prevent direct exposure or groundwater impacts.

This alternative would utilize many excavation and treatment technologies that have been only partly demonstrated at industrial sites. Extensive treatability testing would be required for the TRU-containing soil to develop optimum methods for treating or stabilizing

the TRU radionuclides. Additional treatability studies might be required to support the above-ground treatment of the non-TRU soil.

For Alternative 5, soil containing TRU radionuclides at concentrations exceeding 100 nCi/g would be excavated, treated, and disposed. Thus, potential exposure to and migration of TRU-wastes would be minimized. Potential exposure to other contaminants would be determined by other remedial alternatives implemented. At sites containing TRU and non-TRU wastes, the use of Alternative 5 alone may not satisfy all RAOs.

7.4.7 Alternative 6--In Situ Soil Vapor Extraction for Volatile Organic Compounds

Figure 7-7 shows a schematic diagram of a representative soil vapor extraction system. Soil vapor is vented from wells that are screened in permeable soil zones that contain high organic vapor concentrations. The vented air would be treated to remove water vapor, the organic vapor of concern, particulate radionuclides that might be entrained in the air stream, and volatile radionuclides. Figure 7-7 shows one common combination of offgas treatment technologies; other technologies can also be used depending on the nature of the vapors that are extracted. Water vapor must be removed (usually by condensation) to protect the vacuum pumps. If the condensed water contains organic contamination or radionuclides, then it would have to be treated and/or disposal of in an appropriate manner. Particulate radionuclides that were entrained in the air stream can be effectively removed using banks of conventional High Efficiency Particulate Air (HEPA) filters. The organic vapors would have to be treated to satisfy Best Available Control Technology in accordance with air toxics regulations. If the disposal site is considered a RCRA facility, then the offgas treatment system must also satisfy RCRA emission control standards. Destruction efficiencies exceeding 98% have often been achieved for soil vapor extraction systems at industrial sites. The required destruction efficiency will be determined based on applicable ARARs.

A pilot-scale test would probably have to be performed to determine the required venting well spacing and the required vacuum pump design. Analysis of the vented gas during the pilot test would be done to assess what types of offgas emission controls would be required.

Some of the waste management units at the T Plant Aggregate Area contain volatile organic compounds along with other non-volatile contaminants. Alternative 6 utilizes proven technologies to remove the volatilized vapors from the vadose zone soil. In situ soil vapor extraction is a proven technology for removal of VOC from the vadose zone soils although some pilot-scale testing may be needed at specific sites. Soil vapor extraction would reduce downward migration of the VOC vapors through the vadose zone, and thereby minimize potential cross-media migration into the groundwater. Soil vapor extraction would reduce upward migration of VOC through the soil column into the atmosphere, and thereby minimize inhalation exposures to the contaminants. In some cases the radionuclides were

discharged to the disposal sites with VOCs (e.g., hexone). Removal of the VOC by implementing soil vapor extraction could reduce the mobility of the radionuclides, and thereby reduce the potential for downward migration of the radionuclides. Finally, soil vapor extraction would enhance partitioning of the VOC off of the soil and into the vented air stream, resulting in the permanent removal and destruction of the VOC. Alternative 6 may be used in conjunction with other alternatives if contaminants other than VOCs are present. However, because of the limited number of T Plant Aggregate Area waste management units that contain VOCs, the use of soil vapor extraction will not be extensive.

7.5 PRELIMINARY REMEDIAL ACTION ALTERNATIVES APPLICABLE TO WASTE MANAGEMENT UNITS AND UNPLANNED RELEASE SITES

The purpose of this section is to discuss which preliminary remedial action alternatives could be used to remediate each T Plant Aggregate Area waste management unit or unplanned release site. The criteria used for deciding this are as follows:

- Installing an engineered multimedia cover with or without vertical barriers (Alternative 1) could be used on any site where contaminants may be leached or mobilized by surface water infiltration or if surface/near-surface contamination exists.

- In situ grouting or stabilization (Alternative 2) could be used on any waste management unit or unplanned release site that contain heavy metals, radionuclides, and/or other inorganic compounds. In situ grouting could also be effective in filling voids for subsidence control.

- Excavation and soil treatment (Alternative 3) could be used at most waste management units or unplanned release sites that contain radionuclides, heavy metals, other inorganics compounds, semi-volatile organic compounds, and VOCs.

- In situ vitrification (Alternative 4) could be used at most waste management unit or unplanned release sites, although vapor extraction may be needed when VOCs are present. Waste management units or unplanned release sites where in situ vitrification may not be effective include reverse wells and other sites where the contamination is present in a very narrow geometry. In situ vitrification is also not considered for surface spills.

- Excavation, treatment, and geologic disposal of TRU-containing soils (Alternative 5) could be used only on those sites that contain TRU radionuclides. Since a geologic repository is likely to accept only TRU radioactive soils, the non-TRU radioactive soils will not be remediated using this alternative.

- In situ soil vapor extraction (Alternative 6) could be used on any waste management unit or unplanned release sites that contains VOCs. Such sites are not common in the T Plant Aggregate Area. Nonetheless the 5,300 L (1,400 gal) leak from the 241-TY-104 Single-Shell Tank (UPR-200-W-151) in the T Plant Aggregate Area is an example of a site where soil vapor extraction may be an effective remedy. The waste types at this site include supernatant containing REDOX ion-exchange waste, PUREX organics wash waste, bismuth phosphate first cycle waste, tributylphosphate waste, and decontamination waste from 241-TX and 241-TY Tank Farms (WHC 1991a).

Using these criteria, Table 7-4 was prepared to show possible preliminary remedial action alternatives that could be used to remediate each of the waste management units and unplanned release sites. Table 7-4 excludes sites that will be addressed by other programs. For example, single-shell tanks are excluded because they will be addressed by the Single-Shell Tank Closure Program. Note that a single alternative may not be sufficient to remediate all contamination at a single site. For example, soil vapor extraction to remove organic contaminants could precede in situ vitrification. Also, different combinations of technologies are possible besides those presented in these preliminary alternatives.

Each waste management unit or unplanned release site may require just one alternative or a combination of many alternatives. Furthermore, similar sites may be remediated simultaneously. Also, more specific waste treatment alternatives could be identified and evaluated as more information is obtained.

Technology development studies will be needed for the in situ vitrification process, and treatability studies will be needed for the in situ grouting or stabilization process, and for soil treatment processes to make sure that they will effectively remediate the contaminants. Specifically, organic waste mobility may be a problem for in situ vitrification; grouting agents and the resulting reduction of contaminant leachability will need to be determined before in situ grouting can be performed; and appropriate treatment protocols and systems will need to be identified before soil washing can be used. Capping, soil vapor extraction, and disposal options are all proven processes but may require site-specific performance assessment (treatability) studies.

Focused feasibility studies (FFSs) will be required to evaluate alternative designs for all of the alternatives evaluated, as they relate to the specific waste management unit being remediated. A site-by-site economic evaluation is also required before making a decision. This evaluation will require site-specific information obtained in LFIs and FFSs.

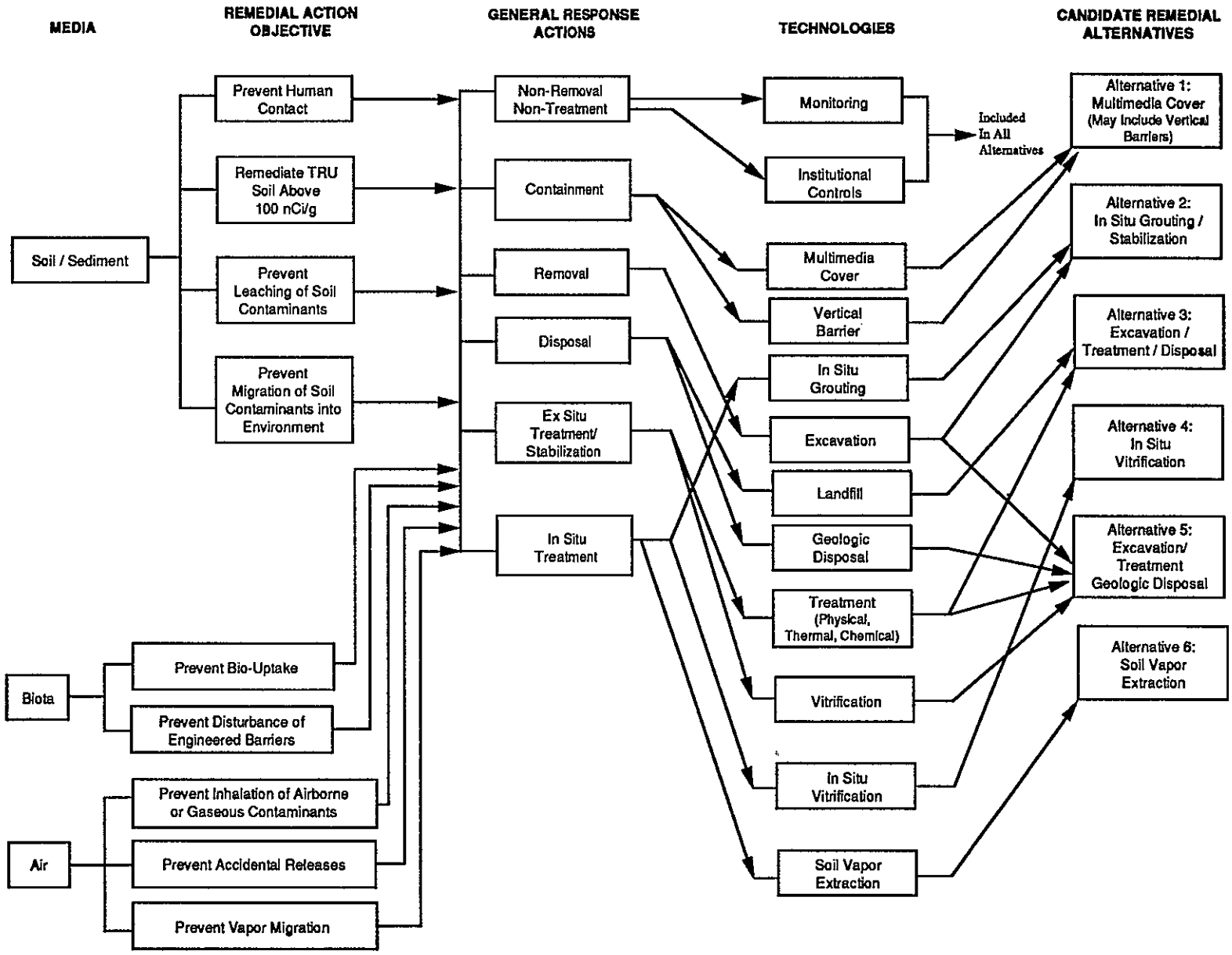
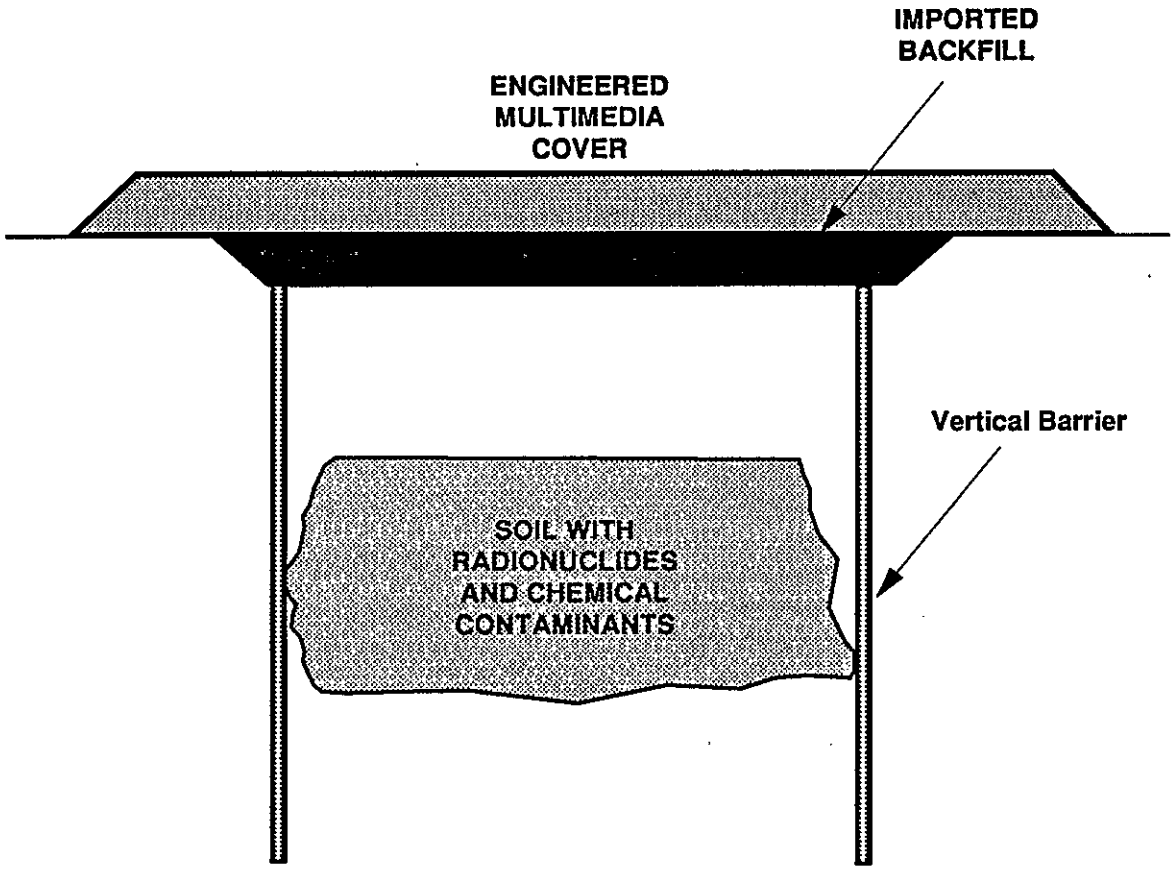


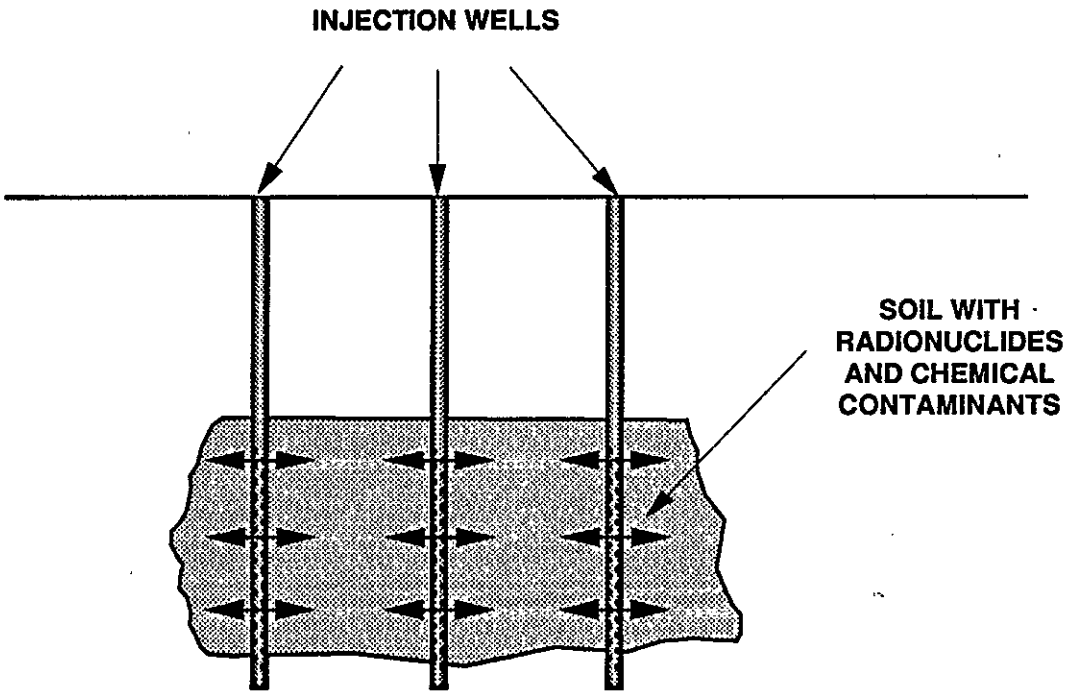
Figure 7-1. Development of Candidate Remedial Alternatives for T Plant Aggregate Area.

Figure 7-2. Alternative 1: Multimedia Cover with Vertical Barriers.



9 3 1 2 2 7 0 1 1 6 0

Figure 7-3. Alternative 2: In Situ Grouting of Soil.



9 3 1 2 9 7 0 1 1 6 1

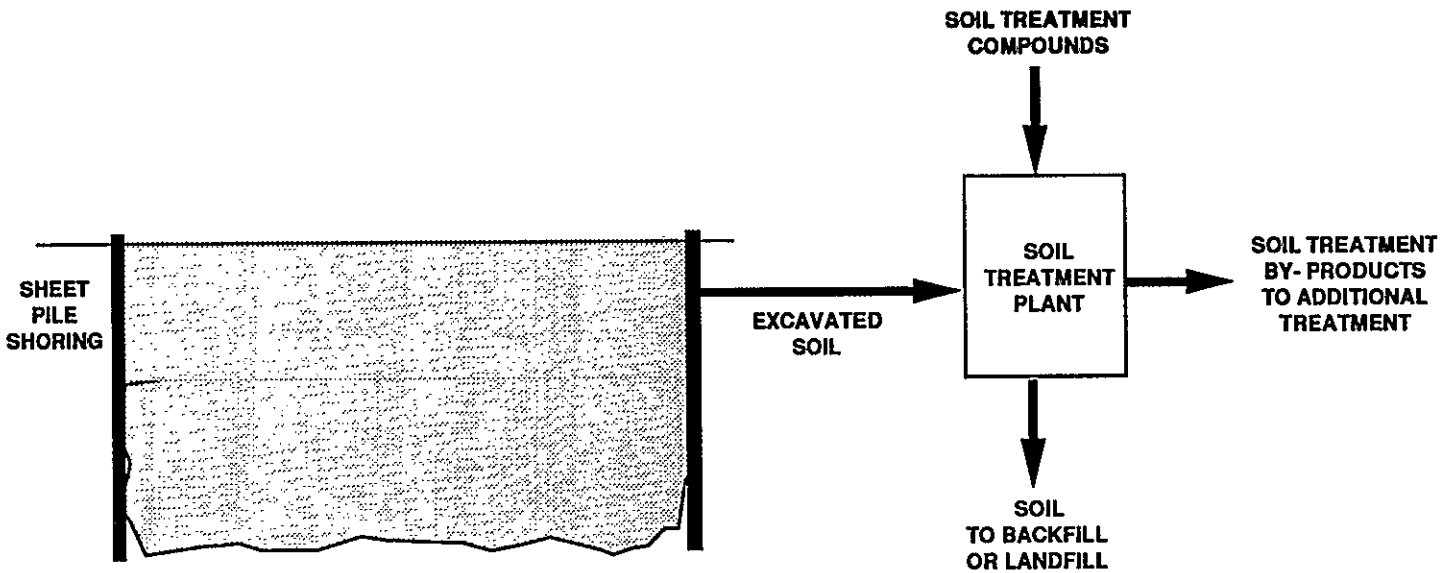


Figure 7-4. Alternative 3: Excavation, Treatment, and Disposal.

Figure 7-5. Alternative 4: In Situ Vitrification of Soil.

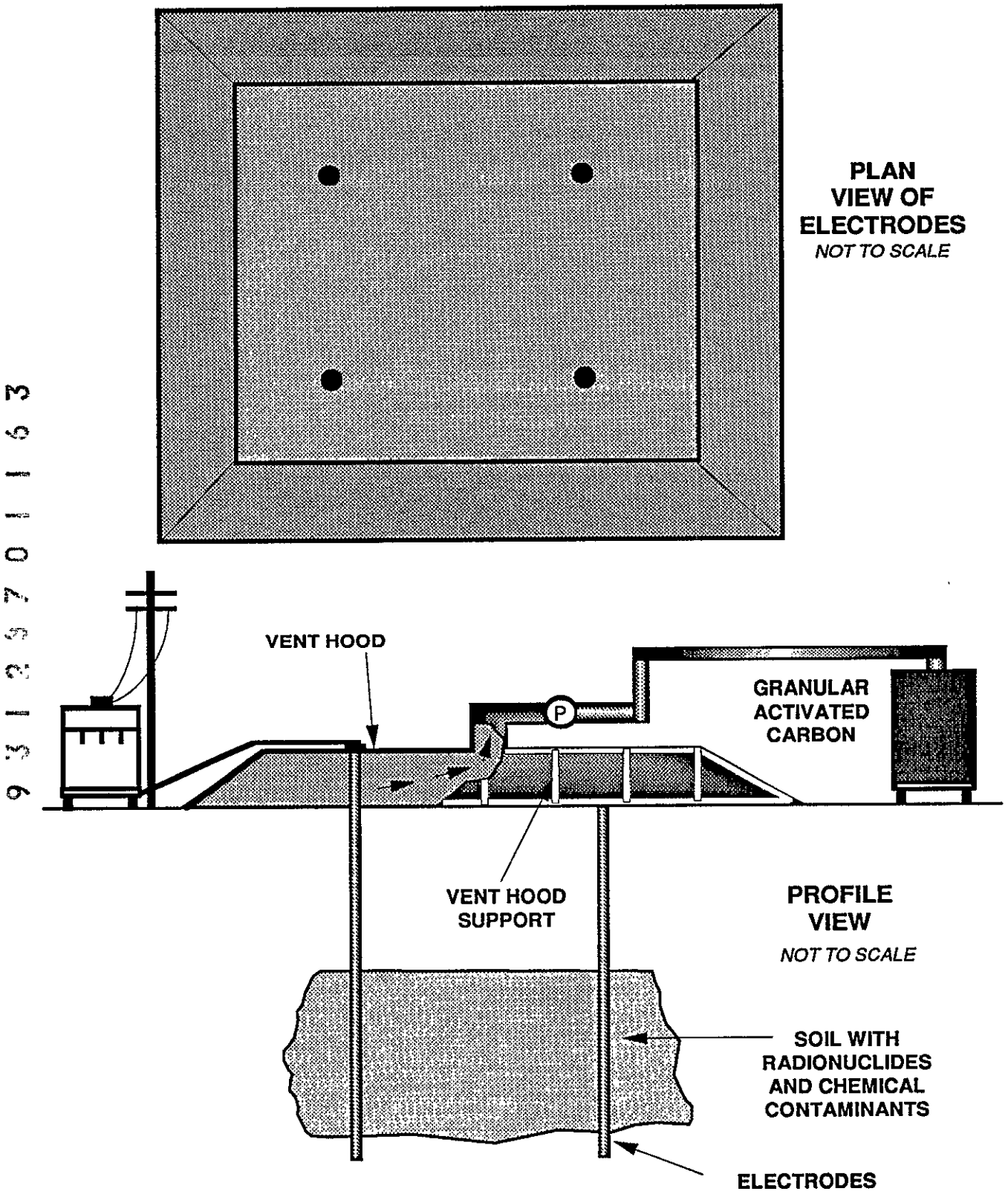
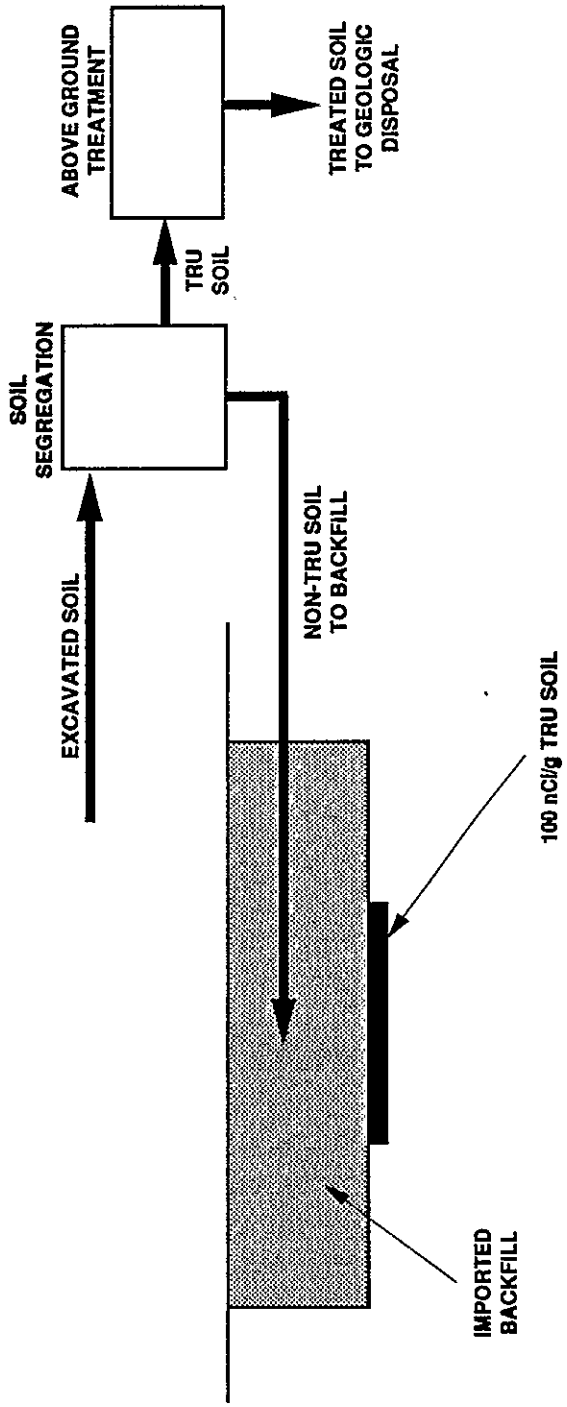


Figure 7-6. Alternative 5: Excavation, Vitrification, and Geologic Disposal of Soil with TRU Radionuclides.



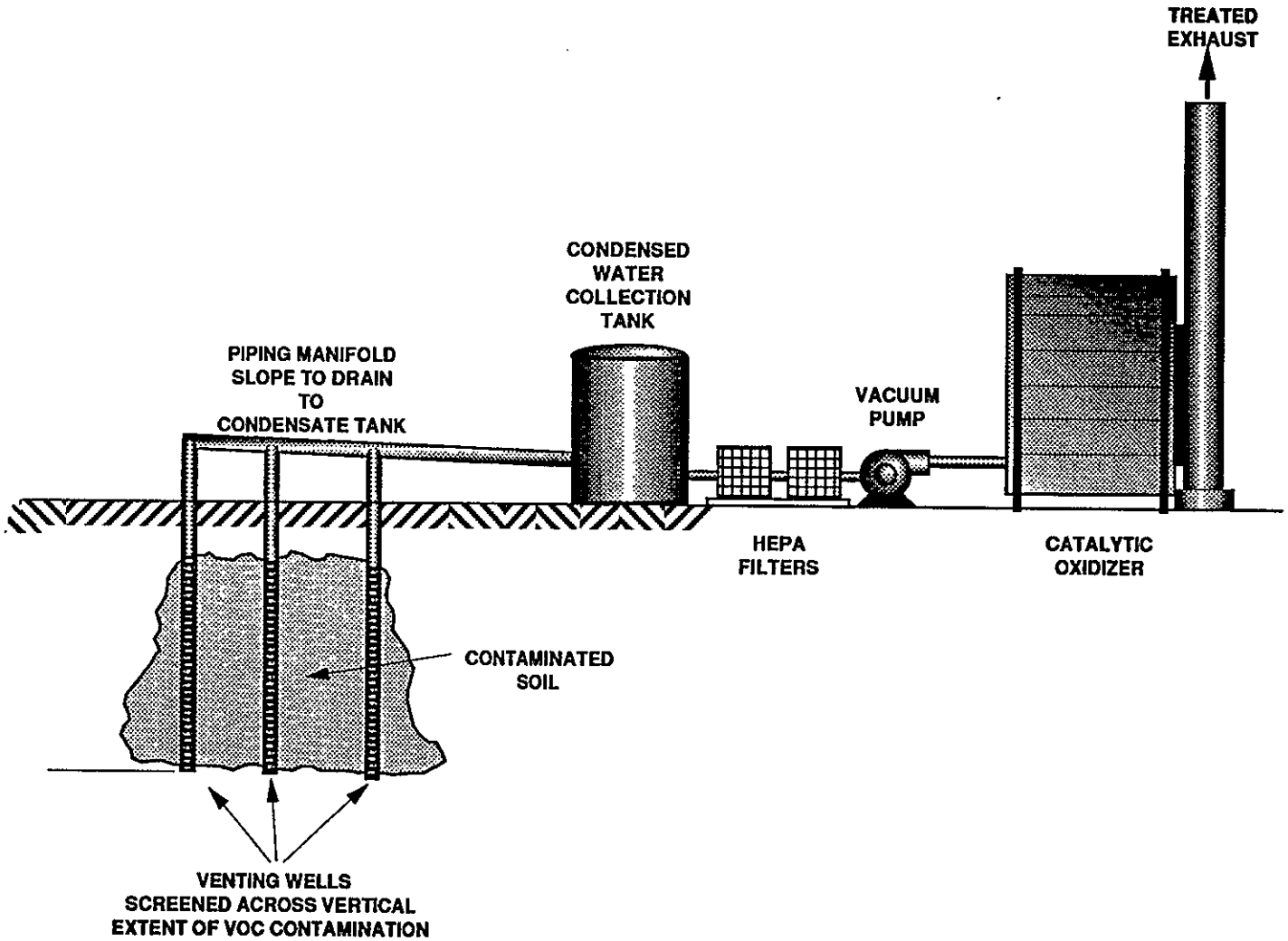


Figure 7-7. Alternative 6: Soil Vapor Extraction for VOC.

Table 7-1. Preliminary Remedial Action Objectives and General Response Actions.

Environmental Media	Remedial Action Objectives: Human Health	Remedial Action Objectives: Environmental Protection	General Response Actions
Soils/ Sediments	• Prevent ingestion, inhalation, or direct contact with solids containing radioactive and/or hazardous constituents present at concentrations above MTCA and DOE standards for industrial sites (or subsequent risk-based standards).	• Prevent migration of radionuclides and hazardous constituents that would result in groundwater, surface water, air, or biota contamination with constituents at concentrations exceeding ARARs. • Remediate soils containing TRU contamination above 100 nCi/g in accordance with 40 CFR 191 requirements. • Prevent leaching of contaminants from the soil into the groundwater that would cause groundwater concentrations to exceed MTCA and DOE standards at the compliance point location.	• No Action • Institutional Controls/Monitoring • Containment • Excavation • Treatment • Disposal • In Situ Treatment
Biota	• Prevent bio uptake by plants. • Prevent disturbance of engineered barriers by biota.	• Prevent bio-uptake of radioactive contaminants.	• No Action • Institutional Controls/Monitoring • Excavation • Treatment • Disposal • Containment • In Situ Treatment
Air[a]	• Prevent inhalation of contaminated airborne particulates and/or volatile emissions exceeding MTCA and DOE limits from soils/sediments.	• Prevent adverse environmental impacts on local biota. • Prevent accidental release from collapse of containment structures.	

[a] No General Response Actions are required for the air because soil remediation will eliminate the air contamination source.

Table 7-2. Preliminary Remedial Action Technologies.

Media	General Response Action	Technology Type	Process Option	Contaminants Treated
Soil	No Action	No Action	No Action	NA
	Institutional Controls	Land Use Restrictions	Deed Restrictions	NA
		Access Controls	Signs/Fences	NA
			Entry Control	NA
		Monitoring	Monitoring	NA
	Containment	Capping	Multimedia	I,M,R,O
		Vertical Barriers	Slurry Walls	I,M,R,O
			Grout Curtains	I,M,R,O
			Cryogenic Walls	I,M,R,O
		Dust & Vapor Suppression	Membranes/Sealants/ Wind Breaks/Wetting Agents	I,M,R,O
	Excavation	Excavation	Standard Construction Equipment	I,M,R,O
	Treatment	Thermal Treatment	Vitrification	I,M,R,O
			Incineration	O
			Thermal Desorption	O
			Calcination	I,M,R,O
		Chemical Treatment	Chemical Reduction	M

Table 7-2. Preliminary Remedial Action Technologies.

Media	General Response Action	Technology Type	Process Option	Contaminants Treated
			Hydrolysis	I,O
			Chemical Dechlorination	O
		Physical Treatment	Soil Washing	I,M,R,O
			Solvent Extraction	O
			Physical Separation	I,M,R,O
			Fixation/Solidification/ Stabilization	I,M,R,O
			Containerization	I,M,R,O
		Biological Treatment	Aerobic	O
			Anaerobic	O
	Disposal	Landfill Disposal	Onsite Landfill	I,M,R,O
			Offsite RCRA Landfill	I,M,O
		Geologic Repository	Geologic Repository	T (I,M,O, non-TRU radio-nuclides if mixed with T)
	In Situ Treatment	Thermal Treatment	Vitrification	I,M,R,O
			Thermal Desorption	O
		Chemical Treatment	Reduction	M,O
		Physical Treatment	Soil Flushing	I,M,R,O
			Vapor Extraction	O

Table 7-2. Preliminary Remedial Action Technologies.

Media	General Response Action	Technology Type	Process Option	Contaminants Treated
			Grouting	I,M,R
			Fixation/Solidification/ Stabilization	I,M,R,O
		Biological Treatment	Aerobic	O
			Anaerobic	O
Biota	No Action	No Action	No Action	NA
	Institutional Controls	Land Use Restrictions	Deed Restrictions	NA
		Access Controls	Signs/Fences	NA
			Entry Control	NA
		Monitoring	Monitoring	NA
	Excavation	Excavation	Standard Construction Equipment	I,M,R,O
	Disposal	Landfill Disposal	Landfill Disposal	I,M,R,O
	Containment	Capping	Multimedia	I,M,R,O

I = Other Inorganics contaminants applicability
M = Heavy Metals contaminants applicability
R = Radionuclide contaminants applicability
O = Organic contaminants applicability
NA = Not Applicable
T = TRU Radionuclides Applicability

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Table 7-3. Screening of Process Options.

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
SOIL TECHNOLOGIES:						
No Action	No Action	Do nothing to cleanup the contamination or reduce the exposure pathways.	Not effective in reducing the contamination or exposure pathways.	Easily implemented, but might not be acceptable to regulatory agencies, local governments, and the public.	Low	Retained as a "baseline" case.
Land Use Restrictions	Deed Restrictions	Identify contaminated areas and prohibit certain land uses such as farming.	Depends on continued implementation. Does not reduce contamination.	Administrative decision is easily implemented.	Low	Retained to be used in conjunction with other process options.
Access Controls	Signs/Fences	Install a fence and signs around areas of soil contamination.	Effective if the fence and signs are maintained.	Easily implemented. Restrictions on future land use.	Low	Retained to be used in conjunction with other process options.
	Entry Control	Install a guard/monitoring system to prevent people from becoming exposed.	Very effective in keeping people out of the contaminated areas.	Equipment and personnel easily implemented and readily available.	Low	Retained to be used in conjunction with other process options.
Monitoring	Monitoring	Analyze soil and soil gas samples for contaminants and scan with radiation detectors.	Does not reduce the contamination, but is very effective in tracking the contaminant levels.	Easily implemented. Standard technology.	Low	Retained to be used in conjunction with other process options.
Capping	Multimedia	Fine soils over synthetic membrane or other layers and covered with soil; applied over contaminated areas.	Effective on all types of contaminants, not likely to crack. Likely to hold up over time.	Easily implemented. Restrictions on future land use will be necessary.	Medium	Retained because of potential effectiveness and implementability.

Table 7-3. Screening of Process Options.

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
Vertical Barriers	Slurry Walls	Trench around areas of contamination is filled with a soil (or cement) bentonite slurry.	Effective in blocking lateral movement of all types of soil contamination. May not be effective for deep contamination.	Commonly used practice and easily implemented with standard earth moving equipment. May not be possible for deep contamination.	Medium	Retained for shallow contamination.
	Grout Curtains	Pressure injection of grout in a regular pattern of drilled holes.	Effective in blocking lateral movement of all types of soil contamination.	Commonly used practice and easily implementable, but depends on soil type. May be difficult to ensure continuous wall.	Medium	Retained because of potential effectiveness and implementability.
	Cryogenic Walls	Circulate refrigerant in pipes surrounding the contaminated site to create a frozen curtain with the pore water.	Effective in blocking lateral movement of all types of soil contamination.	Specialized engineering design required. Requires ongoing freezing.	Medium	Rejected because it is difficult to implement.
Dust and Vapor Suppression	Membranes/ Sealants/Wind Breaks/Wetting Agents	Using membranes, sealants, wind breaks, or wetting agents on top of the contaminated soil to keep the contaminants from becoming airborne.	Effective in blocking the airborne pathways of all the soil contaminants, but may require regular upkeep.	Commonly used practice and very easy to implement, but land restrictions will be necessary.	Low	Retained because of potential effectiveness and implementability.
Excavation	Standard Excavating Equipment	Moving soil around the site and loading soil onto process system equipment.	Effective in moving and transporting soil to vehicles for transportation, and for grading the surface.	Equipment and workers are readily available.	Low	Retained because of potential effectiveness and implementability.

Table 7-3. Screening of Process Options.

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
Thermal Treatment	Above-ground Vitrification	Convert soil to glassy materials by application of electric current.	Effective in destroying organics and immobilizing the inorganics and radionuclides. Off-gas treatment for volatiles and gaseous radionuclides may be required.	Commercial units are available. Laboratory testing required to determine additives, operating conditions, and off gas treatment. Must pre-treat soil to reduce size of large materials.	High	Retained because of potential ability to immobilize radionuclides and destroy organics.
	Incineration	Destroy organics by combustion in a fluidized bed, kiln, etc.	Effectively destroys the organic soil contaminants. Some heavy metals will volatilize. Radionuclides will not be treated.	Technology is well developed. Mobile units are currently available for relatively small soil quantities. Off-site treatment is available. Air emissions and wastewater generation should be addressed.	High	Rejected because of potential air emissions, wastewater generation, and low concentration of organic compounds in soil.
	Thermal Desorption	Organic volatilization at 150 to 400°C (300 to 800°F) by heating contaminated soil followed by off gas treatment.	Effectively destroys the organic soil contaminants. Heavy metals less likely to volatilize than in high temperature treatments. Radionuclides will not be treated.	Successfully demonstrated on a pilot-scale level. Full-scale remediation yet to be demonstrated. Pilot testing essential.	Medium	Retained because of potential effectiveness and implementability.

Table 7-3. Screening of Process Options.

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
	Calcination	High temperature decomposition of solids into separate solid and gaseous components without air contact.	Effective in the decomposition of inorganics such as hydroxides, carbonates, nitrates, sulfates, and sulfites. Removes organic components but does not combust them because of the absence of air. Radionuclides will not be treated.	Commercially available. Most often used for concentration and volume reduction of liquid or aqueous waste. Off-gas treatment is required.	High	Rejected because of limited effectiveness on non-liquid or aqueous wastes.
Chemical Treatment	Chemical Reduction	Treat soils with a reducing agent to convert contaminants to a more stable or less toxic form.	May be effective in treating heavy metal soil contaminants. Radioactivity will not be reduced.	Virtually untested on treating soils. Competing reactions may reduce efficiency.	Medium	Rejected because of limited applicability and implementation problems.
	Hydrolysis	Acid- or base-catalyst reaction in water to break down contaminants to less toxic components.	Very effective on compounds generally classified as reactive. Limited effectiveness on stable compounds. Radioactivity will not be reduced.	Common industrial process. Use for treatment of soils not well demonstrated.	Medium	Rejected because of limited effectiveness and unproven on soils.
	Chemical Dechlorination	Detoxify chlorinated organic chemicals by reaction with organic reagents.	Not commonly used on the chlorinated compounds that have been identified at Z Plant.	Difficult to implement. Requires soil washing or solvent extraction before use.	High	Rejected because of limited effectiveness and difficult implementation.

Table 7-3. Screening of Process Options.

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
Physical Treatment	Soil Washing	Leaching of waste constituents from contaminated soil using a washing solution.	Effectiveness is contaminant specific. Effective with sandy soil may work with only low-level radiation contaminated soil. May not work with humus soil. Generally more effective on contaminants that partition to the fine soil fraction. Radioactivity will not be reduced.	Treatability tests are necessary. Well developed technology and commercially available. Requires treatment of recycled water.	Medium	Retained because of potential effectiveness and implementability.
	Solvent Extraction	Contacting a solvent with contaminated soils to preferentially dissolve the contaminants into the solvent.	The selected solvent is often just as hazardous as the contaminants presented in the waste. May lead to further contamination. Radioactivity will not be reduced.	Laboratory testing necessary to determine appropriate solvent and operating conditions. Not fully demonstrated for hazardous waste applications.	Medium	Rejected because the solvent may lead to further contamination.
	Physical Separation	Separating soil into size fractions.	Effective as a concentration process for all contaminants that partition to a specific soil size fraction.	Most often used as a pretreatment to be combined with another technology. Equipment is readily available.	Low	Retained because of potential effectiveness and implementability.

Table 7-3. Screening of Process Options.

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
	Fixation/ Solidification/ Stabilization	Form low permeability solid matrix by mixing soil with cement, asphalt, or polymeric materials.	Effective in reducing inorganic and radionuclide soil contaminant mobility. Effectiveness for organic stabilization is highly dependent on the binding agent.	Stabilization has been implemented for site remediations. Treatability studies are needed. Volume of waste is increased.	Medium	Retained because of potential effectiveness and implementability.
	Containerization	Enclosing a volume of waste within an inert jacket or container.	Effective for difficult to stabilize, extremely hazardous, or reactive waste. Reduces the mobility of radionuclides.	May be implemented for low concentration waste. Disposal or safe storage of containers required. Regulatory constraints may prevent disposal of containers of certain waste types.	Low	Retained because of potential effectiveness and implementability.
Biological Treatment	Aerobic	Microbial degradation in an oxygen-rich environment.	Effectiveness is very contaminant- and concentration-specific. Treatment has been demonstrated on a variety of organic compounds. Not effective on inorganics or radionuclides.	Various options are commercially available to produce contaminant degradation. Treatability tests are required to determine site-specific conditions.	Medium	Rejected because of limited applicability and difficult implementation.

Table 7-3. Screening of Process Options.

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
	Anaerobic	Microbial degradation in an oxygen deficient environment.	Effectiveness is very contaminant and concentration specific. Treatment has been demonstrated on a variety of organic compounds. Not effective on inorganics or radionuclides.	Various options are commercially available to produce contaminant degradation. Treatability tests are required to determine site-specific conditions.	Medium	Rejected because of limited applicability and difficult implementation.
Disposal	Landfill Disposal	Place contaminated soil in an existing onsite landfill.	Does not reduce the soil contamination but moves all of the contamination to a more secure place.	Easily implemented if sufficient storage is available in an on-site landfill area.	Medium	Retained because of potential effectiveness and implementability.
	Geologic Repository	Put the contaminated or pretreated soil in a safe geologic repository.	Does not reduce the soil contamination, but is a very effective and long-term way of storing radionuclides. Probably unnecessary for nonradioactive waste.	Not easy to implement because of limited site availability, and permits for transporting radioactive wastes are hard to get. Requires pretreatment of contaminated soils.	High	Retained because of effectiveness on TRU wastes.
In Situ Thermal Treatment	Vitrification	Electrodes are inserted into the soil and a carbon/glass frit is placed between the electrodes to act as a starter path for initial melt to take place.	Effective in immobilizing radionuclides and most inorganics. Effectively destroys some organics through pyrolysis. Some volatilization of organics and inorganics may occur.	Potentially implementable. Implementability depends on site configuration, e.g., lateral and vertical extent of contamination. Treatability studies required.	High	Retained because of potential ability to immobilize radionuclides and destroy organics.

Table 7-3. Screening of Process Options.

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
	Thermal Desorption	Soil is heated in situ by radio-frequency electrodes or other means of heating to temperatures in the 80 to 400°C (200 to 750°F) range thereby causing desorption of volatile and semi-volatile organics from the soil.	Effective for removal of volatile and semi-volatile organics from soil. Ineffective for most inorganics and radionuclides. Contaminants are transferred from soil to air.	Implementable for shallow organics contamination. Not implementable for radionuclides and inorganics. Emission treatment and treatability studies required.	Medium	Rejected because of limited applicability.
In Situ Chemical Treatment	Chemical Reduction	Reducing agent is added to the soil to change oxidation state of target contaminant.	Effective for certain inorganics, e.g., chromium. Ineffective for organics. Limited applicability.	Difficult to implement in situ because of distribution requirements for reducing agent.	Low	Rejected because of limited applicability and implementation problems.
In Situ Physical Treatment	Soil Flushing	Solutions are injected through injection system to flush and extract contaminants.	Potentially effective for all contaminants. Effectiveness depends on chemical additives and hydrology. Flushing solutions posing environmental threat likely to be needed. Difficult recovery of flushing solution.	Difficult to implement. Not implementable for complex solvents of contaminants. Flushing solution difficult to recover. Chemical additives likely to pose environmental threat.	Medium	Rejected because of implementation problem.
	Vapor Extraction	Vacuum is applied by use of wells inducing a pressure gradient that causes volatiles to flow through air spaces between soil particles to the extraction wells.	Effective for volatile organics. Ineffective for inorganics semi-volatile organics, and radionuclides. Emission treatment required.	Easily implementable for proper site conditions. Requires emission treatment for organics and capture system for radionuclides and volatilized metals.	Medium	Retained for potential application to volatile organics.

Table 7-3. Screening of Process Options.

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
	Grouting	Involves drilling and injection of grout to form barrier or injection to fill voids.	Effective in limiting migration of leachate, but difficult to maintain barrier integrity. Potentially effective in filling voids.	Implementable as barrier and for filling voids. Implementability depends on site conditions.	Medium	Retained because of ability to limit contaminant migration and potential use for filling void spaces.
	Fixation/ Solidification/ Stabilization	Solidification agent is applied to soil by mixing in place.	Effective for inorganics and radionuclides. Potentially effective for organics. Effectiveness depends on site conditions and additives used.	Implementable. Treatability studies required to select proper additives. Thorough characterization of subsurface conditions and continuous monitoring required.	Medium	Retained because of potential effectiveness and implementability.
In Situ Biological Treatment	Aerobic	Microbial growth utilizing organic contaminants as substrate is enhanced by injection of or spraying with oxygen source and nutrients.	Effective for most organics at proper conditions. Ineffective for inorganics and radionuclides.	Difficult to implement. Treatability studies and thorough subsurface characterization required.	Low	Rejected because of limited applicability and difficult implementation.
	Anaerobic	Microbial growth utilizing organic contaminants as substrate is enhanced by addition of nutrients.	Effective for volatile and complex organics. Not effective for inorganics and radionuclides.	Difficult to implement. Anoxic ground conditions required. Treatability studies and thorough subsurface characterization necessary.	Low	Rejected because of limited applicability and difficult implementation.

Table 7-3. Screening of Process Options.

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
BIOTA TECHNOLOGIES:						
No Action	No Action	Do nothing to clean-up the contamination or reduce the exposure pathways.	Not effective in reducing the contamination or exposure pathways.	Easily implemented, but might not be acceptable to regulatory agencies, local governments, and the public.	Low	Retained as a "baseline"case.
Land Use Restrictions	Deed Restrictions	Identify contaminated areas and prohibit certain land uses such as agriculture.	Effective if implementation is continued. Does not reduce contamination.	Administrative decision is easily implemented.	Low	Retained to be used in conjunction with other process options.
Access Controls	Signs/Fences	Install a fence and signs around areas of contamination to keep people out and the biota in.	Effective if fencing is maintained.	Easily implemented. Restrictions on future land use.	Low	Retained to be used in conjunction with other process options.
	Entry Control	Install a guard/monitoring system to eliminate people from coming in contact with the contamination.	Very effective in keeping people out of the contaminated areas.	Equipment and personnel are easily implemented and readily available.	Low	Retained to be used in conjunction with other process options.
Monitoring	Monitoring	Take biota samples and test them for contaminants.	Does not reduce the contamination, but is very effective tracking the contaminant levels.	Easily implemented. Standard Technology.	Low	Retained to be used in conjunction with other process options.
Capping	Multimedia	Fine soils over synthetic membrane or other layers and covered with soil; applied over contaminated areas.	Effective in reducing the uptake of contaminants, not likely to crack. Likely to hold up over time.	Easily implemented. Restrictions on future land use will also be necessary.	Medium	Retained because of potential effectiveness and implementability.

Table 7-3. Screening of Process Options.

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
Excavation	Standard Excavating Equipment	Remove affected biota and load it onto process system equipment.	Effective in moving and transporting biota to vehicles for transportation.	Equipment and workers are readily available.	Low	Retained because of potential effectiveness and implementability.
Disposal	Landfill Disposal	Place contaminated biota in an existing landfill.	Does not reduce the biota contamination but moves all of the contamination to a more secure place.	Easily implemented if sufficient storage is available in an offsite landfill area.	Medium	Retained because of potential effectiveness and implementability.

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Table 7-4. Preliminary Remedial Action Alternatives Applicable to Waste Management Units and Unplanned Release Sites.

Waste Management Unit or Unplanned Release	Alt 1. Multimedia Cover With or Without Vertical Barriers	Alt 2. In Situ Grouting	Alt 3. Excavation and Treatment	Alt 4. In Situ Vitrification	Alt 5. Excavation, Treatment, and Geologic Disp. of TRU Soil	Alt 6. In Situ Soil Vapor Extraction for VOCs
Tanks and Vaults						
241-T-361 Settling Tank[b]						
Cribs and Drains						
216-T-6 Crib	●	●	●	●	●	
216-T-7TF Crib	●	●	●	●	●	
216-T-8 Crib	●	●	●	●	●	
216-T-18 Crib	●	●	●	●	●	
216-T-19TF Crib	●	●	●	●	●	
216-T-26 Crib	●	●	●	●	●	
216-T-27 Crib	●	●	●	●	●	
216-T-28 Crib	●	●	●	●		
216-T-29 Crib	●	●	●	●		
216-T-31 French Drain	●	●	●	●		
216-T-32 Crib	●	●	●	●	●	
216-T-33 Crib	●	●	●	●	●	
216-T-34 Crib	●	●	●	●	●	
216-T-35 Crib	●	●	●	●	●	
216-T-36 Crib	●	●	●	●	●	
216-W-LWC Crib[b]	●	●	●	●		
Reverse Wells						
216-T-2 Reverse Well	●	●				
216-T-3 Reverse Well	●	●			●	
Ponds, Ditches, and Trenches						
216-T-4A Pond	●	●	●	●	●	
216-T-4B Pond[b]	●	●	●	●	●	

Table 7-4. Preliminary Remedial Action Alternatives Applicable to Waste Management Units and Unplanned Release Sites.

Waste Management Unit or Unplanned Release	Alt 1. Multimedia Cover With or Without Vertical Barriers	Alt 2. In Situ Grouting	Alt 3. Excavation and Treatment	Alt 4. In Situ Vitrification	Alt 5. Excavation, Treatment, and Geologic Disp. of TRU Soil	Alt 6. In Situ Soil Vapor Extraction for VOCs
216-T-1 Ditch[b]	•	•	•	•	•	
216-T-4-1D Ditch	•	•	•	•	•	
216-T-4-2 Ditch[b]	•	•	•	•	•	
200-W Powerhouse Pond[b]	•	•	•	•		
216-T-5 Trench	•	•	•	•	•	
216-T-9 Trench	•	•	•	•		
216-T-10 Trench	•	•	•	•		
216-T-11 Trench	•	•	•	•		
216-T-12 Trench	•	•	•	•	•	
216-T-13 Trench	•	•	•	•		
216-T-14 Trench	•	•	•	•	•	
216-T-15 Trench	•	•	•	•	•	
216-T-16 Trench	•	•	•	•	•	
216-T-17 Trench	•	•	•	•	•	
216-T-20 Trench	•	•	•	•	•	
216-T-21 Trench	•	•	•	•	•	
216-T-22 Trench	•	•	•	•	•	
216-T-23 Trench	•	•	•	•	•	
216-T-24 Trench	•	•	•	•	•	
216-T-25 Trench	•	•	•	•	•	
Septic Tanks and Associated Drain Fields						
2607-W1 Septic Tank[b]	•	•	•	•		
2607-W2 Septic Tank[b]	•	•	•	•		
2607-W3 Septic Tank[b]	•	•	•	•		
2607-W4 Septic Tank[b]	•	•	•	•		

Table 7-4. Preliminary Remedial Action Alternatives Applicable to Waste Management Units and Unplanned Release Sites.

Waste Management Unit or Unplanned Release	Alt 1. Multimedia Cover With or Without Vertical Barriers	Alt 2. In Situ Grouting	Alt 3. Excavation and Treatment	Alt 4. In Situ Vitrification	Alt 5. Excavation, Treatment, and Geologic Disp. of TRU Soil	Alt 6. In Situ Soil Vapor Extraction for VOCs
Basins						
207-T Retention Basin[b]	•		•			
Burial Sites						
200-W Ash Disposal Basin[b]	•	•	•	•		
200-W Burning Pit	•	•	•	•		•
200-W Powerhouse Ash Pit[b]	•	•	•	•		
218-W-8 Burial Ground	•	•	•	•	•	•
Unplanned Releases						
UN-200-W-2	•	•	•	•		
UN-200-W-3	•	•	•	•		
UN-200-W-4	•	•	•	•		
UN-200-W-8	•	•	•	•		
UN-200-W-14	•	•	•	•		
UN-200-W-27	•	•	•	•		
UN-200-W-29	•	•	•	•		
UN-200-W-58	•	•	•	•		
UN-200-W-63	•	•	•	•		
UN-200-W-65	•	•	•	•		
UN-200-W-67	•	•	•	•		
UN-200-W-73[d]	•	•	•	•		
UN-200-W-77[d]						
UN-200-W-85[d]						
UN-200-W-88[d]						
UN-200-W-98	•	•	•	•		
UN-200-W-99	•	•	•	•		

Table 7-4. Preliminary Remedial Action Alternatives Applicable to Waste Management Units and Unplanned Release Sites.

Waste Management Unit or Unplanned Release	Alt 1. Multimedia Cover With or Without Vertical Barriers	Alt 2. In Situ Grouting	Alt 3. Excavation and Treatment	Alt 4. In Situ Vitrification	Alt 5. Excavation, Treatment, and Geologic Disp. of TRU Soil	Alt 6. In Situ Soil Vapor Extraction for VOCs
UN-200-W-102	•	•	•	•		
UN-200-W-135	•	•	•	•		

Notes: [a] No record was found to indicate that any environmental contamination is associated with this structure. Therefore no applicable alternative(s) was identified.

[b] This is an active unit.

[c] Records indicate that all environmental contamination resulting from this unplanned release was removed and disposed. Therefore no applicable alternative(s) was identified.

8.0 DATA QUALITY OBJECTIVES

As described in Section 1.2.2, this aggregate area management study (AAMS) process, as part of the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a), is designed to focus the remedial investigation (RI)/feasibility study (FS) process toward comprehensive cleanup or closure of all contaminated areas at the earliest possible date and in the most effective manner. The fundamental principle of the *Hanford Site Past-Practice Strategy* is a "bias for action" which emphasizes the maximum use of existing data to expedite the RI/FS process as well as allow decisions about work that can be done at the site early in the process, such as expedited response actions (ERAs), interim remedial measures (IRMs), limited field investigations (LFIs), and focused feasibility studies (FFS). The data have already been described in previous sections (2.0, 3.0, and 4.0). Remediation alternatives are described in Section 7.0. However, data, whether existing or newly acquired, can only be used for these purposes if it meets the requirements of data quality as defined by the data quality objective (DQO) process developed by the U.S. Environmental Protection Agency (EPA) for use at Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites (EPA 1987a). This section implements the DQO process for this, the scoping phase in the T Plant Aggregate Area.

In the guidance document for DQO development (EPA 1987a), the process is described as involving three stages which have been used in the organization of the following sections:

- Stage 1--Identify decision types (Section 8.1)
- Stage 2--Identify data uses and needs (Section 8.2)
- Stage 3--Design a data collection program (Section 8.3).

8.1 DECISION TYPES (STAGE 1 OF THE DQO PROCESS)

Stage 1 of the DQO process is undertaken to identify:

- The decision makers (thus data users) relying on the data to be developed (Section 8.1.1)
- The data available to make these decisions (Section 8.1.2)
- The quality of these available data (Section 8.1.3)

- The conceptual model into which these data must be incorporated (Section 8.1.4)
- The objectives and decisions that must evolve from the data (Section 8.1.5).

These issues serve to define, from various sides, the types of decisions that will be made on the basis of the T Plant AAMS.

8.1.1 Data Users

The data users for the T Plant AAMS and subsequent investigations such as LFIs, RI/FSs, and Resource Conservation and Recovery Act (RCRA) Facility Investigations (RFIs)/Corrective Measures Studies (CMSs) are the following:

- The decision makers for policies and strategies on remedial action at the Hanford Site. These are the signatories of the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1990) including the Washington State Department of Ecology (Ecology), the EPA, and the U.S. Department of Energy (DOE).

  Nominally these responsibilities are assigned to the heads of these agencies (the Secretary of Energy for DOE, the Administrator of EPA, and the Director of Ecology), although the political process requires that more local policy-makers (such as the Regional Administrator of EPA and the head of the U.S. Department of Energy, Richland Field Office (DOE/RL) and, to a great extent, technical and policy-assessment staff of these agencies will have a major say in the decisions to be evolved through this process.

- Unit managers of Westinghouse Hanford and potentially other Hanford Site contractors who will be tasked with implementing remedial activities at the T Plant Aggregate Area. Staff of these contractors will have to make the lower level (tactical) decisions about appropriate scheduling of activities and allocation of resources (funding, personnel, and equipment) to accomplish the recommendations of the AAMS.

- Concerned members of the wide community involved with the Hanford Site. These may include:

  - Other state (Washington, Oregon, and other states) and federal agencies
  - Affected Indian tribes

- Special interest groups

- The general public.

These groups will be involved in the decision process through the implementation of the Community Relations Plan (Ecology et al. 1989), and will apply their concerns through the "primary" data users, the signatories of the Tri-Party Agreement.

The needs of these users will have a pivotal role in issues of data quality. Some of this influence is already imposed by the guidance of the Tri-Party Agreement.

8.1.2 Available Information

The *Hanford Site Past-Practice Strategy* specifies a "bias for action" which intends to make the maximal use of existing data on an initial basis for decisions about remediation. This emphasis can only be implemented if the existing data are adequate for the purpose.

Available data for the T Plant Aggregate Area are presented in Sections 2.0, 3.0, and 4.0 and in topical reports prepared for this study. As described in Section 1.2.2, these data should address several issues:

- Issue 1: Facility and process descriptions and operational histories for waste sources (Sections 2.2, 2.3, and 2.4)

- Issue 2: Waste disposal records defining dates of disposal, waste types and waste quantities (Section 2.4)

- Issue 3: Sampling events of waste effluents and affected media (Section 4.1)

- Issue 4: Site conditions including the site physiography, topography, geology, hydrology, meteorology, ecology, demography, and archaeology (Section 3.0)

- Issue 5: Environmental monitoring data for affected media including air, surface water, sediment, soil, groundwater and biota (Section 4.1, except that groundwater data is presented in the separate 200 West Groundwater Aggregate Area Management Study Report, AAMSR).

A major requirement for adequate characterization of many of these issues is identification of chemical and radiological constituents associated with the sites, with a view to determine the contaminants of concern there and the extent of their distribution in the soils beneath each of the waste management units in the T Plant Aggregate Area. There was

found to be a limited amount of data in this regard. The data reported for the various waste management units in the T Plant Aggregate Area (see Section 4.1 and Tables 4-1, 4-2, and 4-3) have been found to describe:

- Inventory--generally estimated from chemical process data and emphasizing radionuclides (Issues 1 and 2). These data are especially limited regarding reconstruction of early operations activities, and even the most recent data are based on very few sampling events, possibly non-representative of the long-term activity of the waste management units. In some cases (e.g., for 216-T-4-2 and 216-T-4-1D Ditches) portions of the sites overlap and therefore should be considered jointly.

- Surface radiological surveys--undifferentiated radiation levels, without identification of radionuclides present, presented in terms of extent of radiation and maximal levels (Issue 5). These historical data are extremely difficult to relate to the present-day distribution and nature of the radioactive contamination they purport to measure because of the lack of radionuclide identification and the likelihood that changes have occurred (at least to surface soils) since the time of these surveys.

- External radiation monitoring--similar to the surface radiological surveys but provide even less information because with a fixed-point thermoluminescent dosimeter (TLD) no spatial distribution is provided. In addition, data are also available for some TLDs placed at points not associated with specific waste management units. The TLD data also do not differentiate radionuclide species.

- Waste, soil, or sediment sampling--these include waste sampling in single-shell tanks (in the 241-T, -TX, and -TY Tank Farms) and soil sampling in the vadose zone around the 241-TY-104 Single-Shell Tank as a result of a 5,300 L (1,400 gal) leak (UPR-200-W-153).

  There is also a set of data of soil sampling and analysis that was conducted for several years on a grid pattern, so cannot be assigned to a particular waste management unit. These data would indicate impacts of historical operations at the Hanford Site and in the vicinity of the grid points, but the impacts cannot be ascribed to a particular unit and so do not assist in decision making on a unit-by-unit basis but may be used to estimate background contamination levels.

- Biota sampling--there are analytical data for grid-point samples of vegetation which again cannot be assigned to a specific waste management unit but may be useful to indicate background contamination levels in vegetation. These data could assist assessment of bio-uptake and bio-transfer pathways (Issue 5).

- Borehole geophysics--these data, for a number of units which discharged to the soil column (cribs, french drains, and ditches) and the single-shell tanks, were designed to detect the presence of radionuclides (by their gamma-ray radiation) in the subsurface and to indicate whether these materials are migrating vertically (Issue 5). A list of these surveys that have been conducted in the T Plant Aggregate Area is included in the Data Package Topical Report prepared for this study (Chamness et al. 1991). Most of the earlier data are limited by the method's inability to identify specific radionuclides and thus to differentiate naturally-occurring radioactive materials from possible releases. Variations in quality control further limit their comparability and possible use for estimation of concentrations.

  Besides these historic data, additional borehole geophysical data will be available through the Radionuclide Logging System (RLS), being carried out at the time of this report and in support of the AAMS process. Like the previous (gross gamma) logging conducted at waste management units in the T Plant Aggregate Area, the RLS responds only to gamma rays and so cannot detect some species of radionuclides. However, unlike the gross gamma surveys, the RLS is designed to identify individual radionuclide species through their characteristic gamma ray photon energy levels. It should thus be able to differentiate naturally-occurring radionuclides from those resulting from releases. It will also (like gross gamma logging) determine the vertical extent of the presence of the radionuclides. It will be conducted in about ten wells located in the T Plant Aggregate Area and will be available with completion of the AAMS process.

Based on the above summary, the data are considered to be of varying quality. These data have not been validated, a process generally required for risk assessment or final Record of Decision (ROD) purposes. Most of the data are based on field methods, which are generally applicable only for screening purposes and can be used to focus future activities (e.g., sampling and analysis plans).

They are considered to be deficient in one or more of the following ways:

- Methods which have been used in the past are unable to differentiate the various radionuclides which may have been present at the time of the survey.

- The release locations have been changed (especially by remediation activities) since the time of the survey or sampling, and it is likely that contaminant distributions have changed.

- The survey or sampling has been done at a location different from the waste management unit or release, and so would not be representative of the concentrations in the zone of release. This deficiency applies to horizontal and vertical differences in location: the borehole geophysical data may be at the correct depths, but the distance of the borehole from the waste management unit can severely attenuate the gamma-radiation which is used to indicate contamination; surface sampling and surveys similarly cannot establish subsurface contaminant concentrations or even disprove the possible presence of some radioactive constituents (particularly alpha-emitting transuranic elements, TRUs).

- There has been virtually no measurement of non-radioactive hazardous constituents in the sampling and analysis of media in the T Plant Aggregate Area.

As a result of these deficiencies, the data are not considered to be usable for input to a quantitative risk assessment or for comparison to ARARs. Further discussion of the data qualities is provided in Section 8.1.3.

In addition to these data, there are also data regarding site conditions (Issue 4) which do not directly relate to the presence of environmental releases but which will assist in the assessment of their potential migration if present. These data are generally summarized in the Topical Reports prepared for this AAMS. Those include the following:

- *T Plant Geologic and Geophysics Data Package for the 200 AAMS* (Chamness et al. 1991), contains tables of wells in which borehole geophysics have been conducted, the types and dates of the tests, and a reference to indicate the physical location of the logs. The package also includes a list of the data available from the drilling of each well located in the T Plant Aggregate Area, such as the logs available (driller's or geologist's; indication of their physical location; grain size, carbonate, moisture, and chemical/radiological analyses; lists of depths, dates, elevation, and coordinates for all wells); and copies of the boring logs and well completion (as-built) summaries for a selection of wells in the T Plant Aggregate Area.

- *Geologic Setting of the 200 West Area: An Update* (Lindsey et al. 1991) includes descriptions of regional stratigraphy, structural geology, and local (200 West Area) stratigraphy,with revised structure and isopach maps of the various unconsolidated strata found beneath the 200 West Area.

The data in these topical reports was obtained for the aggregate area study based on a review of driller's and geologist's logs for wells drilled in the T Plant Aggregate Area. A selection of 15 of those logs was made which best represented the geologic structures below the aggregate area and are presented in Chamness et al. (1991). Lindsey et al. (1991) then used these wells (and others from other aggregate areas in the 200 West Area) to develop

cross-sections, structure maps, and isopach maps, which were in turn adapted to the specific needs of this report and presented in Section 3.0. Only existing logs were used; no new wells were drilled as part of this study. The quality of the data varies among the logs according to the time they were drilled and the scope of the study they were supporting, but generally these data are sufficient for the general geological characterization of the site. Issues involving the potential of contaminant migration at specific sites, based on stratigraphic concerns, may not be fully addressed through any existing borings or wells because appropriate borings may not be located in close proximity; these issues should be addressed during subsequent field investigations at locations where contaminant migration is considered likely.

Another class of data which was gathered in the general area of the 200 West Area, and thus potentially appropriate to the T Plant Aggregate Area, is the result of a set of studies which were performed for the Basalt Waste Isolation Project (BWIP) (DOE 1988b), in the attempt to site a high-level radioactive waste geologic repository in the basalt beneath and in the vicinity of the Hanford Site. The proposed Reference Repository Site included the 200 West Area and some distance beyond it, mainly to the west. For this siting project, a number of geologic techniques were used, and some of the data generated by the drilling program has been used for the stratigraphic interpretation presented in Section 3.4 (all the wells denoted with an alias "BH-.." were drilled for the BWIP project) and a number of the figures used in this and other sections of Section 3.0. The program also included a number of geophysical studies, using the following techniques:

- Gravity
- Magnetics
- Seismic reflection
- Seismic refraction
- Magnetotellurics.

These data, as presented in Section 1.3.2.2.3 of DOE (1988b), were reviewed for their relevance to the present T Plant (source area) Aggregate Area Management Study. The limitations of these studies include the following aspects:

- Most of the studies covered a regional scale with lines or coverages that may have crossed the T Plant Aggregate Area (or even the 200 West Area) only in passing. Some of the surveys (e.g., the grid of gravity stations) specifically avoided the 200 West Area ("due to restricted access").

- Many of the techniques are more sensitive to the basalt than to the suprabasalt sediments of specific interest in the AAMS program, and even less sensitive to the features which are closer to the surface, as is applicable to the source area AAMS. Basalt is by nature much denser than the unconsolidated sediments (and thus also has a characteristic seismic signature) and has more consistent magnetic properties. In addition, the analysis of the data emphasized the basalt features which were apparent in the data. All this is appropriate to a study of the basalt, but does not make the studies applicable to the present study.

- Even when features potentially due to shallow sediments are identified, they are interpreted either very generally (e.g., "erosional features in the Hanford and (or) Ringold Formations") or as complications (e.g., "shallow sediment velocity variations causing stacking velocity correction errors"). There are only a very few features (and none in the T Plant Aggregate Area) which are interpreted as descriptive of the structure of the suprabasalt sediments.

- Lastly, some of the anomalies which are interpreted in terms of a sedimentary stratigraphic cause (e.g., "erosion of Middle Ringold") do not bear up under the more detailed stratigraphic interpretation carried out under the Topical Reports for the AAMS (Lindsey et al. 1991, Chamness et al. 1991).

However, these data will be reviewed in more detail for the purposes of the 200 West Groundwater AAMSR, since deeper features (including in the basalt) are of more concern for that study.

Other data, presented in Sections 2.0, 3.0, and 4.0, are broader-scale rather than site-specific like the contaminant concentrations are. These include: topography, meteorology, surface hydrology, environmental resources, and human resources, and contaminant characteristics. These data are generally of acceptable quality for the purposes of planning remedial actions in the T Plant Aggregate Area.

8.1.3 Evaluation of Available Data

The EPA (1987a) has specified indicators of data quality, the five "PARCC" parameters (precision, accuracy, representativeness, completeness, and comparability), which can be used to evaluate the existing data and to specify requirements for future data collection.

- Precision--the reproducibility of the data

- Accuracy--the lack of a bias in the data.

Much of the existing data are of limited precision and accuracy due to the analytical methods which have been used historically. The gross gamma borehole geophysical logging in particular is limited by methodological problems although reproducibility has been generally observed in the data. Conditions that have contributed to lack of precision and/or accuracy include: improvements in analytical instrumentation and methodology making older data incompatible; effects of background levels (particularly regarding radioactivity and inorganics); and lack of quality control on data acquisition.

The limitations in precision and accuracy in existing data are mainly due to the progress of analytical methodologies and quality assurance (QA) procedures since the time they were collected. The *Hanford Site Past-Practice Strategy* (DOE/RL 1992a) recommends that existing data be used to the maximum extent possible, at two levels: first to formulate the conceptual model, conduct a qualitative risk assessment, and prepare work plans, but also as an initial data set which can be the basis for a fully-qualified data set through a process of review, evaluation, and confirmation.

- Representativeness--the degree to which the appropriate environmental parameters or media have been sampled.

This parameter highlights a shortcoming of most of the historical data. Some discussion of representativeness limitations is presented in Section 8.1.2. Limitations include the observation only of gross gamma radiation rather than differentiating it by radionuclide (e.g., through spectral surveying methods as are being used by the RLS program), the analysis of samples only for radionuclides rather than for chemicals and radionuclides, and the failure to sample (especially in the subsurface) for the full potential extent of contaminant migration.

The data are incomplete primarily because of the lack of subsurface sampling for extent of contamination. This is because no subsurface investigation has been initiated on the waste management units in the T Plant Aggregate Area yet. The lack of these data is also caused by concerns to limit the potential exposure to radioactivity of workers who would have to drill in contaminated areas and the possible release or spread of contamination through these intrusive procedures. The result of this data gap is that none of the sites can be demonstrated to have contamination either above or below levels of regulatory concern, and a full quantitative risk assessment cannot be conducted.

In addition, in many cases it has been necessary to use general data (i.e., from elsewhere in the 200 West Area or even from the vicinity of the 200 Areas) rather than data specific to a particular waste management unit. For most purposes of characterization for transport mechanisms, this procedure is

acceptable given the screening level of the present study. For example, while it is appropriate to use a limited number of boring logs to characterize the stratigraphy in the aggregate area (Chamness et al. 1991, Lindsey et al. 1991), the later, waste management unit specific, field sampling plans will require detailed consideration of more of the logs of wells drilled in the immediate vicinity, whatever their quality, as a starting point to conceptually model the geology specifically beneath that unit.

- Completeness--the fraction of samples which are considered "valid."

  None of the data that have been previously gathered in the T Plant Aggregate Area has been "validated" in the EPA Contract Laboratory Program (CLP) sense, although varying levels of quality control have been applied to the sampling and analysis procedures. The data are generally adequate for characterization purposes, but may not be suitable for use in a formal risk assessment. The best indication of the validity of the data is the reproducibility of the results, and this indicates that validity (completeness) is one of the less significant problems with the data.

- Comparability -- the confidence that can be placed in the comparison to two data sets (e.g., separate samplings).

  With varying levels of quality control and varying procedures for sample acquisition and analysis, this parameter is also generally poorly met. Much of this is due to the more recent development of QA procedures.

While these limitations cannot in most cases be quantified (and some such as representativeness are specifically only qualitative), most of the data gathered in the T Plant Aggregate Area can be cited as failing one or more of the PARCC parameters. As discussed in Section 8.1.2, the data are considered to be mainly deficient in completeness (the appropriate media, constituents, or locations were never sampled or analyzed). These data should, however, be used to the maximum extent in the development of work plans for site field investigations, prioritization of the various units, and to determine, to the extent possible, where contamination is or is not present.

In addition to these site-specific data, there are also a limited number of non site-specific sampling events that are being developed to determine background levels of naturally occurring constituents (Hoover and LeGore 1991). These data can be used to differentiate the effect of the environmental releases from naturally occurring background levels.

8.1.4 Conceptual Models

The initial conceptual model of the sites in the T Plant Aggregate Area is presented and described in Section 4.2 (Figure 4-3). The model is based on best estimates of where contaminants were discharged and their potential for migration from release points. The conceptual model is designed to be conservatively inclusive in the face of a lack of data. This means that a migration pathway was included if there is any possibility of contamination travelling on it, historically or at present. In most cases there may not be a significant flux of such contamination migration for many of the pathways shown on the figure.

All pathways are possible; only a few are likely because of the conservatism inherent in including all conceivable pathways. More importantly, even if a pathway carries significant levels of a contaminant, it still may not have carried contamination to the ultimate receptors, human or ecological. This can only be assessed by sampling at the exposure point on this pathway, or sampling at some other point and extrapolation to the exposure point, to indicate the dosage to the receptors.

There are thus significant uncertainties in the contaminant levels in the contaminant migration pathways shown on the conceptual model, yet almost none of these pathways has been sampled to determine whether any contamination still exists in any of the locations implicated from the conceptual model, and if so which constituents, how much, and to what extent.

8.1.5 Aggregate Area Management Study Objectives and Decisions

The specific objectives of the T Plant AAMS are listed in Section 1.3. They include the following:

- Assemble site data (as described in Section 8.1.2)
- Describe site conditions (see Section 3.0)
- Conduct limited new site characterization work (see separate topical reports)
- Develop a preliminary site conceptual model (see Section 8.1.4)
- Identify contaminants of concern and their distribution (Section 4.0)
- Identify potential applicable, or relevant and appropriate, regulations (ARARs, Section 6.0)

- Define preliminary remedial action objectives and screen potential remedial technologies to prepare preliminary remedial action alternatives (Section 7.0), and provide recommendations for FFS (Section 9.4.1) and treatability studies (Section 9.5)

- Define data needs, establish general DQOs, and set priorities

- Recommend ERA, IRM, LFI, or other actions (Section 9.0), and

- Redefine and prioritize, as data allow, operable units, their boundaries, and work plan activities with emphasis on supporting early cleanup actions and records of decision (Sections 8.3 and 9.0)

- Integrate RCRA TSD closure activities with past practice activities (Section 9.3.4).

The decisions that will have to be made on the basis of this AAMS can best be described according to the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a) flow chart (Figure 1-2 in Section 1.0) that must be conducted on a site-by-site basis. Decisions are shown on the flow chart as diamond-shaped boxes, and include the following:

- Is an ERA justified?

- Is less than six months' response needed (is the ERA time critical)?

- Are data sufficient to formulate the conceptual model and perform a qualitative risk assessment?

- Is an IRM justified?

- Can the remedy be selected?

- Can additional required data be obtained by LFI?

- Are data (from field investigations) sufficient to perform risk assessment?

- Can an Operable Unit/Aggregate Area ROD be issued?

(The last two questions will only be asked after additional data are obtained through field investigations, and so are DQO issues only in assessing scoping for those investigations.)

Most of these decisions are actually a complicated mixture of many smaller questions, and will be addressed in Section 9.0 in a more detailed flowchart for assessing the need for remediation or investigation.

Similarly, the tasks that will need to be performed after the AAMS that drive the data needs for the study are found in the rectangular boxes on the flow chart. These include the following:

- ERA (if justified)
- Definition of threshold contamination levels, and formulation of conceptual model, performance of qualitative risk assessment and FS screening (IRM preliminaries)
- FFS for IRM selection
- Determination of minimum data requirements for IRM path
- Negotiation of Scope of Work, relative priority, and incorporation into integrated schedule, performance of LFI
- Determination of minimum data needs for risk assessment and final Remedy Selection (preparation of RI/FS pathway).

These stages of the investigation must be considered in assessing data needs (Section 8.2.1).

8.2 DATA USES AND NEEDS (STAGE 2 OF THE DQO PROCESS)

Stage 2 of the DQO development process (EPA 1987a) defines data uses and specifies the types of data needed to meet the project objectives. These data uses and needs are based on the Stage 1 results, but must be more specific. The elements of this stage of the DQO process include:

- Identifying data uses (Section 8.2.1)
- Identifying data types (Section 8.2.2.1)
- Identifying data quality needs (Section 8.2.2.2)
- Identifying data quantity needs (Section 8.2.2.3)

- Evaluating sampling/analysis options (Section 8.2.2.4)
- Reviewing data quality parameters (Section 8.2.2.5)
- Summarizing data gaps (Section 8.2.3).

Stage 2 is developed on the basis of the conceptual model and the project objectives. These following sections discuss these issues in greater detail.

8.2.1 Data Uses

For the purposes of the remediation in the T Plant Aggregate Area, most data uses fall into one or more of four general categories:

- Site characterization
- Public health evaluation and human health and ecological risk assessments
- Evaluation of remedial action alternatives
- Worker health and safety.

Site characterization refers to a process that includes determination and evaluation of the physical and chemical properties of any wastes and contaminated media present at a site, and an evaluation of the nature and extent of contamination. This process normally involves the collection of basic geologic, hydrologic, and meteorologic data but more importantly for the T Plant Aggregate Area waste management units, data on specific contaminants and sources that can be incorporated into the conceptual model to indicate the relative significance of the various pathways. Site characterization is not an end in itself, as stressed in the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a), but rather the data must work toward the ultimate objectives of assessing the need for remediation (according to risk assessment methods, either qualitative or quantitative, or compliance with ARARs) and providing appropriate means of remediation (through an FFS, FS, or CMS. The understanding of the site characterization, based on existing data, is presented in Sections 2.0, 3.0, and 4.0, and summarized in the conceptual model (Section 4.2).

Data required to conduct a public health evaluation, and human health and ecological risk assessments at the sites in the T Plant Aggregate Area include the following: input parameters for various performance assessment models (e.g., the Multimedia Environmental Pollutant Assessment System); site characteristics; and contaminant data required to evaluate the threat to public and environmental health and welfare through exposure to the various media. These needs usually overlap with site characterization needs. An extensive

discussion of risk assessment data uses and needs, for both human health and ecological evaluations, is presented in the *Risk Assessment Guidance for Superfund Volumes 1 and 2* (EPA 1989a,c). The EPA Region 10 has also developed its preferred methodology for these risk assessment activities (EPA 1989a, 1991a). The ecological and human health risk assessments will follow the guidance outlined in the approved M-29-03 milestone document, *Hanford Site Baseline Risk Assessment Methodology*. The data requirements for an ecological risk assessment include (1) identification of critical species, (2) identification of habitat within and surrounding the Hanford Site, (3) feeding relationships among species of concern, and (4) contaminant concentrations in environmental media and species of interest. The main deficiency in the data available for waste management units in the T Plant Aggregate Area is that a quantitative assessment of contaminant concentrations for the purposes of Risk Assessment can not be performed. The present understanding of site risks is presented in the selection of constituents of concern (Section 4.0). The data needs for quantitative risk assessments will be considered in developing site specific sampling and analysis plans according to the *Hanford Site Past-Practice Strategy*.

Data collected to support evaluation of remedial action alternatives for ERAs, IRMs, FFSs, or the full RI/FS, include site screening of alternatives, feasibility-level design, and preliminary cost estimates. Once an alternative is selected for implementation, much of the data collected during site investigations (LFI or RI) can also be used for the final engineering design. Generally, collection of information during the investigations specifically for use in the final design is not cost effective because many issues must be decided about appropriate technologies before effective data gathering can be undertaken. It is preferable to gather such specific information during a separate predesign investigation or at the time of remediation (i.e., the "observational approach" of the *Hanford Site Past-Practice Strategy* [DOE/RL 1992a]). Based on the existing data, broad remedial action technologies and objectives have been identified in Section 7.0.

The worker health and safety category includes data collected to establish the required level of protection for workers during various investigation activities. These data are used to determine if there is concern for the personnel working in the vicinity of the aggregate area. The results of these assessments are also used in the development of the various safety documents required for field work (see Health and Safety Plan, Appendix B).

It should be noted that each of these data use categories (site characterization, risk assessment needs, remedial actions, and health and safety) will be required at each decision point on the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a) flow chart, as discussed at the end of Section 8.1.5. To the extent possible, however, not all sites will be investigated to the same degree but only those with the highest priority. These results will then be extended to the other, analogous sites which have similar geology and disposal histories (see Section 9.2.3).

The existing data can presently be used for two main purposes:

- Development of site-specific sampling plans (site characterization use)
- Screening for health and safety (worker health and safety use).

Table 8-1 presents a summary of the availability of existing data for these two uses.

For the purposes of developing sampling plans, existing information is available for:

- The location of sites--many of the sites have surface expressions, markers, or have been surveyed in the past. The unplanned releases in particular are lacking in this information, as well as for the 216-T-20 Trench.
- Possible contamination found at the sites--these data are derivable from the inventories for the sites (mainly for the cribs and other disposal facilities).
- The depth of contaminants--this information is obtained from the gross gamma borehole logging for many of the sites.

Two types of information are available for the purposes of worker health and safety, and will be used for the development of health and safety documents:

- Levels of surface radiation--derived from the ongoing periodic radiological surveys done under the Environmental Surveillance program (Schmidt et al. 1992). Table 8-1 shows where surveys have indicated detectible levels of surface radiation and so no additional survey is required before surface activities can be conducted.
- Expected maximum contaminant levels--these data are based simply on the results of subsurface soil sampling.

Table 8-1 also presents a first expression of the data needs for the individual waste management units in the T Plant Aggregate Area, which must be addressed for remediation approaches to be developed.

8.2.2 Data Needs

The data needs for the T Plant Aggregate Area are discussed in the following sections according to the categories of types of data (Section 8.2.2.1), quality (8.2.2.2), quantity (8.2.2.3), options for acquiring the data (8.2.2.4), and appropriate DQO (PARCC) parameters (8.2.2.5). These considerations are summarized for each category of waste management unit site in the T Plant Aggregate Area (Section 8.2.3).

8.2.2.1 Data Types. Data use categories described in Section 8.2.1 define the general purpose of collecting additional data. Based on the intended uses, a concise statement regarding the data types needed can be developed. Data types specified at this stage should not be limited to chemical parameters, but should also include necessary physical parameters such as bulk density, moisture, and hydraulic conductivity. Precipitation recharge, chemical distribution coefficients and organic complexation data appear adequate, but may require additional study based on the results of future evaluations. Since environmental media and source materials are interrelated, data types used to evaluate one media may also be useful to characterize another media.

Identifying data types by media indicates that there are overlapping data needs. Data objectives proposed for collection in the site investigations at sites in the T Plant Aggregate Area are discussed in Section 8.3 to provide focus to investigatory methods that may be employed. The data type requirements for the preliminary remedial action alternatives developed in Section 7.4 are summarized in Table 8-2.

8.2.2.2 Data Quality Needs. The various tasks and phases of a CERCLA investigation may require different levels of data quality. Important factors in defining data quality include selecting appropriate analytical levels and validation and identifying contaminant levels of concern as described below. The Westinghouse Hanford document, *A Proposed Data Quality Strategy for Hanford Site Characterization,* will be used to help define these levels (McCain and Johnson 1990). The DQOs will also be developed and defined on an operable unit basis in the work plans and, specifically, in the Quality Assurance Project Plans (QAPjPs) which will guide investigation activities.

Chemical and radionuclide laboratory analysis will be one of the most important data types, and is required at virtually all the sites in the T Plant Aggregate Area. In general, increasing accuracy, precision, and lower detection limits are obtained with increasing cost and time. Therefore, the analytical level used to obtain data should be commensurate with the intended use. Table 8-3 defines five analytical levels associated with different types of characterization efforts. While the bulk of the analysis during LFIs/RIs will be screening level (DQO Level I or II), these data will require confirmation sampling and analysis to allow final remedial decisions through quantitative risk assessment methods. Individual DQO analytical PARCC parameters for Level III or IV analytical data associated with each contaminant anticipated in the T Plant Aggregate Area (as developed in Section 5) are given

in Table 8-4. These parameters will be used for the development of site-specific sampling and analysis plans and quality assurance plans for investigations and remediations in the aggregate area.

Before laboratory or even field data can be used in the selection of the final remedial action, they must first be validated. Exceptions are made for initial evaluations of the sites using existing data, which may not be appropriate for validation but will be used on a screening basis based on the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a). Other screening data (e.g., estimates of contaminant concentration inferred from field analyses) may also be excepted. Validation involves determining the usability and quality of the data. Once data are validated, they can be used to successfully complete the remedial action selection process. Activities involved in the data validation process include the following:

- Verification of chain-of-custody and sample holding times
- Confirmation that laboratory data meet Quality Assurance/Quality Control (QA/QC) criteria
- Confirmation of the usability and quality of field data, which includes geological logs, hydrologic data, and geophysical surveys
- Proper documentation and management of data so that they are usable.

Validation may be performed by qualified Westinghouse Hanford personnel from the Office of Sample Management (OSM), other Westinghouse Hanford organizations, or a qualified independent participant subcontractor. Data validation of laboratory analyses will be performed in accordance with *A Proposed Data Quality Strategy for Hanford Site Characterization* (McCain and Johnson 1990) and standards set forth by Westinghouse Hanford.

To accomplish the second point, all laboratory data must meet the requirements of the specific QA/QC parameters as set up in the QAPjP for the project before it can be considered usable. The QA/QC parameters address laboratory precision and accuracy, method blanks, instrument calibration, and holding times.

The usability of field data must be assessed by a trained and qualified person. The project geohydrologist/geophysicists will review the geologic logs, hydrologic data, geophysical surveys, and results of physical testing, on a daily basis, and senior technical reviews will be conducted periodically throughout the project.

Data management procedures are also necessary for the validation. Data management includes proper documentation of field activities, sample management and tracking, and document and inventory control. Specific consistent procedures are discussed in the Information Management Overview (Appendix D).

8.2.2.3 Data Quantity Needs. The number of samples that need to be collected during an investigation can be determined by using several approaches. In instances where data are lacking or are limited (such as for contamination in the vadose zone soils), a phased sampling approach will be appropriate. In the absence of any available data, an approach or rationale will need to be developed to justify the sampling locations and the numbers of samples selected. This will be accomplished and documented in the production of work plans and field sampling plans for each aggregate area, under the guidance and review of the Tri-Party Agreement participants. Specific locations and numbers of samples will be determined based on data collected during screening activities. For example, the number and location of beta/gamma spectrometer probe locations can be based on results of surface geophysical and radiation surveys. These may help locate some subsurface features (such as the 216-T-20 Trench), which may not be adequately documented. Details of any higher DQO level subsurface soil sampling scheme will depend on results of screening investigations such as geophysics surveys, surface radiation surveys, field chemical screening, and beta/gamma spectrometer probe surveys. In situations where and when available data are more complete, statistical techniques may be useful in determining the additional data required.

8.2.2.4 Sampling and Analysis Options. Data collection activities are structured to obtain the needed data in a cost-effective manner. Developing a sampling and analysis approach that ensures that appropriate data quality and quantity are obtained with the resources available may be accomplished by using field screening techniques and focusing the higher DQO level analyses on a limited set of samples at each site. The investigations on sites in the T Plant Aggregate Area should take advantage of this approach for a comprehensive characterization of the site in a cost-effective manner.

A combination of lower level (Levels I and II), higher level analytical data (Levels III and IV) and special analytical data (Level V) should be collected. This approach would provide the certainty necessary to determine contaminants present near the sources. Samples collected from the other media (i.e., subsurface soils, sediments) will be analyzed by *Test Methods for Evaluating Solid Wastes* (EPA 1986), CLP (EPA 1988a, EPA 1989b), *Methods for Chemical Analysis of Water and Wastes* (EPA 1983), or *Prescribed Procedures for Measurement of Radioactivity in Drinking Water* (EPA 1980a).

8.2.2.5 Data Quality Parameters. The PARCC parameters are indicators of data quality. Ideally, the end use of the data collected should define the necessary PARCC parameters. Once the PARCC requirements have been identified, then appropriate analytical methods can be chosen to meet established goals and requirements. Definitions of the PARCC parameters are presented in Section 8.1.3.

In general the precision and accuracy objectives are governed by the capabilities of the available methodologies and in most cases these are more than adequate for the needs of the investigations. Chemical analyses can usually attain parts per billion detection range in soils and water, and this level is adequate to the needs of the risk assessment for most analytes. Radiological analyses reach similar levels. Table 8-4 shows detection levels, generally obtained from the method description such as the document *Test Methods for Evaluating Solid Wastes* (EPA 1986) or from experience with laboratory analysis. Some constituents (e.g., arsenic) would require analysis to much lower levels, but this is impossible because of the limitations of analytical methods and the effects of natural background levels. For example, EPA Method 200.62-C-CLP can analyze to detection levels of 500 μg/kg in soils, while the Model Toxics Control Act (MTCA) Method C Industrial soils cleanup level is 50 μg/kg. In some cases, special analytical methods can be developed to obtain lower detection levels. In addition, risk assessment is conventionally computed only to a single digit of precision and uses conservative assumptions, which reduce the impact of measurements with lower accuracy.

For other measurements, such as physical parameters, the precision and accuracy capabilities of existing measurement technologies are sufficient for the evaluation methods used to produce characterization data, so the objectives are based on the limitations of the analysis methodologies.

Representativeness is maintained by fitting the sampling program to the governing aspects of the sources and transport processes of the site, as demonstrated in the site conceptual model (Section 4.2). Initial sampling should concentrate on sources, which are fairly well-understood, and on representative locations of anticipated transport mechanisms. If necessary, following activities can focus on aspects or locations that were not anticipated but were demonstrated by the more general results.

Completeness is generally attained by specifying redundancy on critical samples and maintaining quality control on their acquisition and analysis. As with representativeness, the initial sampling program may lead to modifications of which samples should be considered critical during subsequent sampling activities.

Comparability will be met through the use of Westinghouse Hanford standard procedures generally incorporated into the *Environmental Investigation and Site Characterization Manual* (WHC 1988c).

8.2.3 Data Gaps

Considering the data needs developed in the subsections of Section 8.2.2, and the data available to meet these needs as presented in Section 8.1.2, it is apparent that a number of data gaps can be identified. These are summarized, on a waste management unit category

basis, in Table 8-5, and should be the focus of LFIs on a waste management unit category basis, using the analogue sites approach. The contaminant concentration data are the highest priority because of the need to assess the need for remediation (through quantitative risk assessment and evaluation of compliance with ARARs) and appropriate remedial actions for each site.

In addition to these data needs specifically addressing contamination problems at sites included for consideration in this aggregate area, there are general data needs which will be required for characterization of the possible transport pathways, as presented in the conceptual model, at locations away from the individual units. These general, non-site specific needs include characterization of the following:

- Geologic stratigraphy, particularly for possible perched water zones
- Transport through the vadose zone (mobilization through natural or artificial recharge or drainage)
- Air transport of contamination
- Ecological impacts and transport mechanisms (bio-uptake, bio-concentration, secondary receptors through predation)
- Potential releases from process effluent lines between facilities and to waste disposal sites.

All of these needs will have to be addressed in the data collection program (Section 8.3). In addition, data gaps that impact groundwater are also addressed in the 200 West Groundwater AAMSR.

8.3 DATA COLLECTION PROGRAM (STAGE 3 OF THE DQO PROCESS)

The data collection program is Stage 3 of the process to develop DQOs. Conducting an investigation with a mixture of screening and higher-level data is a common method for optimizing the quantity and quality of the data collected. It would be very inefficient and overly expensive to specify beforehand all the types of samples and analyses that will yield the most complete and accurate understanding of the contamination and physical behavior of the site. Data adequate to achieve the goals and objectives for remedial action decisions are obtained at a lower cost by using the information obtained in the field to focus the ongoing investigation and remediation process.

Initial sampling should collect new data believed most necessary to confirm and refine the conceptual model particularly at priority sites. Sampling may then be extended to further

reduce uncertainty, to fill in remaining data gaps, to collect more detailed information for certain points where such information is required, or to conduct any needed treatability studies or otherwise support the data needs of the remedial action selection process. An alternative of extrapolating the data from a limited number of sites to other analogous ones will also be used. The need for subsequent investigation phases will be assessed throughout the investigation and remediation activities as data become available. Assessing completeness of the investigation data through a formal statistical procedure is not possible, given the complexity and uncertainty of the parameters required to describe the site and the time to make decisions. Rather, the use of engineering judgement is considered sufficient to the decision process.

8.3.1 General Rationale

The general rationale for the investigation of sites in the T Plant Aggregate Area is to collect needed data that are not available. Because of the size of the aggregate area, the complexity of past operations, and the number of unplanned releases and waste management units, a large amount of new information will be required such as the specific radionuclides and chemicals present, their spatial distribution and form, and the presence of special migration pathways (such as perched groundwater systems).

The following work plan approach will be used for LFIs and RI/FS in the T Plant Aggregate Area. The results are described in Sections 8.3.2 and 8.3.3 in a general form.

- Existing data as described in Sections 2.0, 3.0, and 4.0 should be used to the maximum extent possible. Although existing data are not validated fully, the data are still useful in developing a preliminary conceptual model (Section 4.2) and in helping to focus and guide the planning of investigations, expedited actions, and interim measures.

- Additional data at validated and screening levels should be collected to obtain the maximum amount of useful information for the amount of time and resources invested in the investigation.

- Data should be collected to support the intended data uses identified in Section 8.2.1.

- Nonintrusive sampling (e.g., geophysical surveys, surface radiation surveys, soil gas, and spectral gamma probe surveys), and surficial and source sampling should be conducted early in any investigation effort to identify necessary interim response actions (i.e., additional ERAs or IRMs).

- Data collected from initial investigation activities should be used to confirm and refine the conceptual model (Section 4.2), refine the analyte constituents of concern, and provide information to conduct interim response actions or risk assessment activities.

- Additional investigation activities are proposed to support (if needed) quantitative baseline risk assessments for final cleanup actions and further refine the conceptual model.

- Field investigation techniques should be used to minimize the amount of hazardous or mixed waste generated. Any waste generated will be in accordance with EII 4.3, "Control of CERCLA and other Past-Practice Investigation Derived Waste" (WHC 1988c).

8.3.2 General Strategy

The overall objective of any field investigation (LFI, IRM, or RI) of the sites in the T Plant Aggregate Area will be to gather additional information to support risk assessment and remedial action selection according to the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a) flow chart discussed in Section 8.1.5. The general approach or strategy for obtaining this additional information is presented below.

- Analytical parameter selection should be based on verifying overall conditions and then narrowed to specific constituents of concern, in consideration with regulatory requirements and site conditions. Periodic analyses of the long list of parameters should be conducted to verify that the list of constituents of concern has not changed, either because new constituents are identified or some of those considered as a potential concern do not appear to be significant.

- Similarly, investigations should work from a screening level (DQO Levels I or II, e.g., surface radiation surveys) to successively more specific sampling and analysis methodologies (e.g., beta/gamma spectral probes, then DQO Level III or IV soil sampling and analysis), without time consuming remobilizations.

- Dangerous and radioactive wastes may be generated during the field investigation. While efforts should be made to minimize these wastes, any waste generated will be handled in accordance with EII 4.3, "Control of CERCLA and Other Past-Practice Investigation Derived Waste" (WHC 1988c). The analyses of samples for constituents of concern analytes will allow wastes generated to be adequately designated.

8.3.3 Investigation Methodology

Initial field investigations (mainly LFIs, but also associated with IRMs at appropriate sites and possibly some RIs) may include some or all of the following integrated methodologies:

- Source Investigation (Section 8.3.3.1)
- Geological Investigation (Section 8.3.3.2)
- Surface Water Sediment Investigation (Section 8.3.3.3)
- Soil Investigation (Section 8.3.3.4)
- Air Investigation (Section 8.3.3.5)
- Ecological Investigation (Section 8.3.3.6)
- Geophysical Stratigraphic Survey (Section 8.3.3.7)
- Process Effluent Pipeline Integrity Assessment (Section 8.3.3.8)
- Geodetic Survey (Section 8.3.3.9)
- Cultural Resource Investigation (8.3.3.10).

Each investigation methodology is briefly outlined in the following sections. Specific survey methods (such as electromagnetics or ground-penetrating radar) have not been recommended to allow flexibility in the development of field sampling plans which can be sensitive to very local conditions. A summary of the applicable methods for each waste management unit is presented in Table 8-6. In addition, some of the data needs must be addressed on an area-wide basis (e.g., stratigraphy interpretation). More detailed descriptions and specific methods and instrumentation will be included in site-specific work plans, sampling and analysis plans, and field sampling plans for LFIs/IRMs at waste management units that require these investigations.

These investigations are presented in the approximate priority of their need, with the source investigation first because of its importance to the decisions about remedial action on a site-by-site basis. The other investigations are of lower priority, and will be conducted according to the need to determine whether contamination has been transported beyond the immediate vicinity of the waste management units. To some extent, this need will depend on the results of the source investigation.

8.3.3.1 Source Investigation. The purpose of source investigation activities in the T Plant Aggregate Area is to characterize the known waste management units and unplanned releases that exist in the area and that may contribute to contamination of surface soil, vadose zone, surface water, sediment, air, and biota. The completeness of the characterization effort will be assessed according to the needs of risk assessment, ARARs compliance, and remedial action selection, which will also determine what levels of the various constituents of concern comprise "contamination."

Source sampling should be conducted at waste management units or unplanned release locations where the available data indicate that dangerous, mixed, or radioactive wastes may be present. Activities which are proposed to be performed during the source investigations include the following:

- Compile and evaluate additional existing data for the purpose of: verifying locations, specifications of engineered facilities, and pipelines, and waste stream characteristics; assessment of the construction and condition of boreholes/wells that exist in the operable unit and their suitability for use for investigation activities, QA/QC information, and raw data regarding radiological and hazardous substances monitoring; and integrating any additional environmental modeling data into the conceptual model. This has been done (on an aggregate area basis) in this report; the process will be extended to site-specific planning and on-going assessments of the investigation/remediation as it is carried out.

- Conduct surface radiological survey of suspected or known source areas to verify locations and nature of surface and subsurface radiological contamination. Conditions at specific sources within a waste management unit should also be noted in order to plan sampling/remediation activities and worker health and safety.

- Conduct nonintrusive geophysical surveys at waste management unit and unplanned release locations to verify locations and physical characteristics of source locations. Data generated from these activities can be used in planning intrusive source sampling activities. It is recommended that sites with structures which could not be field located, as identified in Table 8-1, and all unplanned releases associated with pipelines be investigated with surface geophysics.

- Conduct beta/gamma spectrometer probe survey to screen for near-surface contamination and to confirm the absence or presence of some specific radionuclides, which may be of particular concern. Existing boreholes will be used to the maximum extent, but new boreholes may be needed at many locations (to be decided based on screening results). Logging will be done both by NaI detectors or μR meters for rapid screening as well as the RLS high purity germanium logging system. Westinghouse Hanford will develop an EII

Procedure for the beta/gamma spectrometer probe survey. The beta/gamma spectrometer probe survey serves two purposes depending on the source conditions: to confirm absence of contamination in the near-surface soils, and to serve as a screening tool to choose locations and quantities of vadose zone soil borings. The RLS procedure could demonstrate "assay quality" data for radionuclide concentrations, but will probably continue to require supporting Level III or IV soil analysis data to allow a risk assessment before final remedial decisions. The need to conduct this survey will be based (at least in part) on the screening results of the surface survey and on information about site burial.

- Soil gas surveys should be conducted at waste management units (such as burial sites) where volatile organic chemicals are suspected, as a screening method to identify compounds such as solvents and degreasers that may have been used in processes or during construction activities. The soil gas survey should not be considered conclusive that volatile organic compounds at lower concentrations may not be present. Data from the soil gas survey can be used to help locate surface and near-surface samples and vadose zone borings.

- Collect surface and near-surface samples of contaminated soils and/or waste materials at selected locations. Specific sampling sites will be chosen to assess particular facilities or releases. Additional sampling sites may be specified based on results from nonintrusive investigations.

8.3.3.2 Geologic Investigation. A geologic investigation should be performed to better characterize the vadose zone and the nature of unsaturated soils that make up this system. The geologic investigation will include the following tasks:

- Borings may be advanced into zones where an accurate interpolation of the subsurface stratigraphy is important to understanding migration pathways in the vadose zone. An investigation of the Plio-Pleistocene unit, which may be causing perched water zones, may be especially valuable. Waste management units in areas where this unit may have an important influence are indicated in Table 8-6 according to whether perched zone monitoring wells are recommended. These recommendations were based on quantities of liquid waste received by the unit (Table 4-12) and the likelihood of the Plio-Pleistocene Unit being present at the location (Section 3.4.3.3).

- Geologic data collected during the ongoing vadose zone soil (Section 8.3.3.4) and other (deeper) investigations (e.g., geologic and geophysical logs from groundwater well installations for groundwater AAMSs) will be compared, compiled, and evaluated.

8.3.3.3 Surface Water Sediment Investigation. A surface water sediment investigation should be conducted. The investigation will include:

- Radiation survey along ditches, trenches, and ponds for health and safety purposes and to locate areas of elevated radiation for selection of specific sediment sampling locations.

- Sampling of sediment in any ditches, ponds, and trenches that still contain water. This will probably be limited to the 207-T Retention Basin and the 216-T-1 and 216-T-4-2 Ditches.

Milestone M-17-17 of the Tri-Party Agreement (Ecology et al. 1991) requires limitation of discharges to these facilities, and sampling and metering during a "stabilization run" of the UO_3 Plant. Sampling for this investigation will be coordinated with the activities for the stabilization run to avoid interference and to obtain optimal data.

8.3.3.4 Soil Investigation. The purpose of soil investigations is to determine physical and chemical properties of the soil and to determine the nature, type, and extent of soil contamination associated with waste management units and unplanned releases to allow initiation of interim remedial actions and to assess the quantitative risk at other sites. Sampling will include:

- Samples of vadose zone soil will be collected and analyzed for constituents of concern when wells are drilled for other studies (i.e., groundwater investigations) in the vicinity of a waste management unit or unplanned release with reported liquid disposals or spills. Organic vapor (at sites with suspected volatiles) and radiation sampling should also be performed with samples selected by onsite screening.

- Data collected during this investigation will be evaluated to further understand the contribution of contaminants to the vadose zone from specific waste management units and/or unplanned releases and to better define the hydrology and water quality in the vadose zone system through moisture content profiles, tracking of specific contaminants, and soil hydraulic characteristics. However, the issue of contaminant transport through the vadose zone is more appropriate to studies conducted under the direction of the Groundwater AAMSRs.

8.3.3.5 Air Investigation. Air investigations (on an aggregate area scale) should consist of onsite particle sampling as part of the health and safety program. In addition, high-volume air samplers should be placed in appropriate locations on-site based on evaluation of existing meteorological data. The purpose of these samplers will be to determine if any migration of airborne contaminants occurs.

8.3.3.6 Ecological Investigation. Ecological investigation activities, on a site-wide scale, should include a literature search and data review, and a site walkthrough. Data collected during the soils characterization activities are expected to be sufficient to evaluate biota remediation technologies. These activities are intended to identify potential biota concerns which need to be addressed in the site investigation. Particular emphasis should be given to identifying potential exposure pathways to biota that migrate offsite or that introduce contaminants into the food web. Data obtained in this survey will be used to both refine the conceptual model as well as to conduct the ecological risk assessment.

8.3.3.7 Geophysical Stratigraphic Survey. A geophysical survey of subsurface stratigraphy should be conducted across the aggregate area to help characterize the geology and hydrogeology of the vadose zone. Of particular interest are perched water zones and the caliche layer (an important aquitard) in the Plio-Pleistocene Unit.

8.3.3.8 Process Effluent Pipeline Integrity Assessment. An assessment of process effluent pipeline integrity should be conducted early in site investigation activities to look for potential leaks and therefore possible areas of contamination. Initially, as part of this effort, drawings of the process lines and encasements within the aggregate area (Section 2.3.7) should be reviewed and their construction, installation, and operation evaluated. Specific lines will then be selected for integrity assessment with emphasis on lines serving the waste management units that have received large volumes of liquid (e.g., cribs). Investigation of operating high level waste transfer lines will be deferred to their respective programs. Results of the integrity assessments will be evaluated and additional sampling activities may be recommended for subsequent studies.

8.3.3.9 Geodetic Survey. Geodetic surveys will be conducted after the installation and completion of each investigation activity. The survey will be to locate the horizontal locations of surface and near-surface soil samples; corners of geophysics, soil gas, and beta/gamma probe surveys; and surface water and sediment sample locations. Horizontal and vertical locations of all vadose zone soil borings and perched zone wells will be surveyed. The geodetic survey should be conducted by a professional surveyor licensed in the state of Washington and should be referenced to both historic (e.g., Hanford coordinates) and current coordinate datums (e.g., North American Datum of 1983 - NAD-83), both vertical and horizontal.

8.3.3.10 Cultural Resource Investigation. A cultural resource investigation should be conducted for investigation locations outside the 200 West Area to verify the locations of known archaeological sites by reviewing existing data. The focus of the investigation will be to confirm that no archaeological resources are present at proposed drilling sites.

8.3.4 Data Evaluation and Decision Making

Data will be evaluated as soon as results (e.g., soil gas, radiation screening, drilling results) become available for use in restructuring and focusing the investigation activities. Data reports will be developed that summarize and interpret new data. This includes groundwater sampling and RLS borehole logging as part of the AAMS. Data will be used to refine the conceptual model, further assess potential contaminant-specific ARARs, develop the quantitative risk assessment, and assess remedial action alternatives.

The objectives of data evaluation are:

- To reduce and integrate data to ensure that data gaps are identified and that the goals and objectives of the T Plant AAMS are met
- To confirm that data are representative of the media sampled and that QA/QC criteria have been met.

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Table 8-1. Uses of Existing Data for T Plant Aggregate Area Waste Management Units.

	Development of Sampling Plans			Health and Safety	
Waste Management Unit or Unplanned Release	Location	Possible Contamination	Depth of Contamination	Surface Contamination	Expected Max. Level
Tanks and Vaults					
241-T-361 Settling Tank	Y	Y	N	N	Y
Cribs and Drains					
216-T-6 Crib	Y	R,C	R	R	N
216-T-7TF Crib	Y	R,C	R	R	N
216-T-8 Crib	Y	R,C	N	R	N
216-T-18 Crib	Y	R,C	R	N	N
216-T-19TF Crib	Y	R,C	R	R	N
216-T-26 Crib	Y	R,C	R	R	N
216-T-27 Crib	Y	R,C	R	R	N
216-T-28 Crib	Y	R,C	R	R	N
216-T-29 Crib	Y	C	N	N	N
216-T-31 French Drain	Y	R,C	N	N	N
216-T-32 Crib	Y	R,C	R	N	N
216-T-33 Crib	Y	R,C	N	R	N
216-T-34 Crib	Y	R,C	N	R	N
216-T-35 Crib	Y	R,C	R	N	N
216-T-36 Crib	Y	R,C	N	N	N
216-W-LWC Crib	Y	R,C	N	N	N
Reverse Wells					
216-T-2 Reverse Well	Y	R,C	Y	N	N

Table 8-1. Uses of Existing Data for T Plant Aggregate Area Waste Management Units.

	Development of Sampling Plans			Health and Safety	
Waste Management Unit or Unplanned Release	Location	Possible Contamination	Depth of Contamination	Surface Contamination	Expected Max. Level
216-T-3 Reverse Well	Y	R,C	R	–	N
Ponds, Ditches, and Trenches					
216-T-4A Pond	Y	R	N	N	N
216-T-4B Pond	Y	R	N	N	N
216-T-1 Ditch	Y	R,C	N	N	N
216-T-4-1D Ditch	Y	R	N	N	N
216-T-4-2 Ditch	Y	R	N	N	N
200-W Powerhouse Pond	Y	N	N	N	N
216-T-5 Trench	Y	R,C	N	N	N
216-T-9 Trench	Y	N	N	N	N
216-T-10 Trench	Y	N	N	N	N
216-T-11 Trench	Y	N	N	N	N
216-T-12 Trench	Y	R,C	N	R	N
216-T-13 Trench	Y	N	N	N	N
216-T-14 Trench	Y	R,C	N	R	N
216-T-15 Trench	Y	R,C	N	R	N
216-T-16 Trench	Y	R,C	N	R	N
216-T-17 Trench	Y	R,C	N	R	N
216-T-20 Trench	N	R,C	N	N	N
216-T-21 Trench	Y	R,C	R	N	N
216-T-22 Trench	Y	R,C	R	N	N

Table 8-1. Uses of Existing Data for T Plant Aggregate Area Waste Management Units.

	Development of Sampling Plans			Health and Safety	
Waste Management Unit or Unplanned Release	Location	Possible Contamination	Depth of Contamination	Surface Contamination	Expected Max. Level
216-T-23 Trench	Y	R,C	N	N	N
216-T-24 Trench	Y	R,C	R	N	N
216-T-25 Trench	Y	R,C	N	N	N
Septic Tanks and Associated Drain Fields					
2607-W1 Septic Tank	Y	N	N	N	N
2607-W2 Septic Tank	Y	N	N	N	N
2607-W3 Septic Tank	Y	R	N	N	N
2607-W4 Septic Tank	Y	N	N	N	N
Basins					
207-T Retention Basin	Y	R	N	N	Y
Burial Sites					
200-W Ash Disposal Basin	Y	C	N	--	N
200-W Burning Pit	Y	R,C	N	N	N
200-W Powerhouse Ash Pit	Y	N	N	N	N
218-W-8 Burial Ground	Y	R	N	N	N
Unplanned Releases					
UN-200-W-2	N	R,C	N	N	N
UN-200-W-3	N	R,C	N	N	N
UN-200-W-4	N	R,C	N	R	N
UN-200-W-8	N	R,C	N	R	N
UN-200-W-12	Y	R,C	N	N	N

Table 8-1. Uses of Existing Data for T Plant Aggregate Area Waste Management Units.

	Development of Sampling Plans			Health and Safety	
Waste Management Unit or Unplanned Release	Location	Possible Contamination	Depth of Contamination	Surface Contamination	Expected Max. Level
UN-200-W-14	N	R,C	N	N	N
UN-200-W-27	Y	R,C	N	N	N
UN-200-W-29	N	R,C	N	R	N
UN-200-W-58	N	R,C	N	R	N
UN-200-W-63	N	R	N	R	N
UN-200-W-65	Y	R	N	N	N
UN-200-W-67	Y	R,C	N	N	N
UN-200-W-73	N	R,C	N	R	N
UN-200-W-77	N	R,C	N	R	N
UN-200-W-85	Y	R	N	R	N
UN-200-W-88	N	R,C	N	R	N
UN-200-W-98	N	R,C	N	R	N
UN-200-W-99	N	R,C	N	R	N
UN-200-W-102	N	R	N	N	N
UN-200-W-135	Y	R,C	N	N	N

C: Chemical Contamination
N: No
R: Radiological Contamination
Y: Yes

Table 8-2. Data Needs for Preliminary Remedial Action Alternatives for the T Plant Aggregate Area.

Alternative	Physical Attribute	Chemical/Radiochemical Attribute
1. Multimedia Cover (plus possible vertical barriers)	• areal extent • depth of contamination • structural integrity (collapse potential) • run-off/run-on potential • cover properties (permeability)	• surface radiation • biologic transport potential
2. In Situ Grouting/ Stabilization	• areal extent • depth • particle size • hydraulic properties (permeability/porosity) • stratigraphy • borehole spacing • grout/additive mix parameters	• solubility • reactivity • leachability from grout medium
3. Excavation, Soil Treatment, and Disposal	• areal extent[a/] • depth[a/] • particle size • silt-size (dust) content • excavation stability	• toxicity/radioactivity • levels of contaminants • solubility/reactivity • soil chemistry (relative affinity) • concentrations in PM-10 fraction • spent solvent treatment/disposal options
4. In Situ vitrification	• areal extent • depth • soil/waste conductivity • thermal properties • moisture content • voids • air permeability	• volatility • reactivity • leachability/integrity • off-gas treatment waste disposal options
5. Excavation, Above Ground Treatment, and Geologic Disposal	• areal extent[a/] • depth[a/] • mineralogy of soil/waste • particle size • silt-size (dust) content • excavation stability • treatment parameters	• concentrations of TRU • toxicity/radioactivity • levels of contaminants • concentrations in PM-10 fraction • reactivity • leachability/integrity of final waste form
6. In Situ Soil Vapor Extraction	• areal extent • depth • locations/depth of highest concentrations (vapors, adsorbed) • stratigraphy • soil permeability/porosity • voids	• volatility of constituents (Henry's Law Constant) • non-volatile organics • levels • volatile radionuclides (Radon) • treatability (catalytic oxidization)

[a/] May be obtained during remediation using the observational approach recommended by the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a).

Table 8-3. Analytical Levels for the T Plant Aggregate Area.

Level	Description
LEVEL I	Field screening. This level is characterized by the use of portable instruments which can provide real-time data to assist in the optimization of sampling point locations and for health and safety support. Data can be generated regarding the presence or absence of certain contaminants (especially volatiles) at sampling locations.
LEVEL II	Field analysis. This level is characterized by the use of portable analytical instruments which can be used onsite, or in mobile laboratories stationed near a site (close-support laboratories). Depending on the types of contaminants, sample matrix, and personnel skill, qualitative and quantitative data can be obtained.
LEVEL III	Laboratory analysis using methods other than the Contract Laboratory Program (CLP) Routine Analytical Services (RAS). This level is used primarily in support of engineering studies using standard EPA-approved procedures. Some procedures may be equivalent to CLP RAS without the CLP requirements for documentation.
LEVEL IV	Contract Laboratory Program (CLP) Routine Analytical Services (RAS). This level is characterized by rigorous QA/QC protocols and documentation and provides qualitative and quantitative analytical data. Some regions have obtained similar support via their own regional laboratories, university laboratories, or other commercial laboratories.
LEVEL V	Nonstandard methods. Analyses which may require method modification and/or development are considered Level V by CLP Special Analytical Services (SAS).

Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses.

	Soil/Sediment				Water			
	Analysis Method	Practical Quantitation Limit[a] (pCi/g, mg/kg)	Precision (RPD)	Accuracy (%)	Analysis Method	Practical Quantitation Limit[a] (pCi/L, μg/L)	Precision (RPD)	Accuracy (%)
RADIONUCLIDES								
Gross Alpha	900.0 M	TBD	±30	±25	900.0	10	±25	±25
Gross Beta	900.0 M	TBD	±30	±25	900.0	5	±25	±25
Gamma Scan	D3699 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Actinium-225	907.0 M	TBD	±30	±25	907.0	TBD	±25	±25
Actinium-227	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Americium-241	Am-01	TBD	±30	±25	Am-03	TBD	±25	±25
Americium-242	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Americium-242m	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Americium-243	Am-01	TBD	±30	±25	Am-03	TBD	±25	±25
Antinomy-126	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Antimony-126m	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Barium-137m	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Bismuth-210	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Bismuth-211	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Bismuth-213	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Bismuth-214	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Carbon-14	C-01 M	TBD	±30	±25	TBD	TBD	±25	±25
Cesium-134	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Cesium-135	901.0 M	TBD	±30	±25	901.0	TBD	±25	±25

Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses.

	Soil/Sediment				Water			
	Analysis Method	Practical Quantitation Limit[a/] (pCi/g, mg/kg)	Precision (RPD)	Accuracy (%)	Analysis Method	Practical Quantitation Limit[a/] (pCi/L, µg/L)	Precision (RPD)	Accuracy (%)
RADIONUCLIDES (cont.)								
Cesium-137	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Cobalt-60	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Curium-242	907.0 M	TBD	±30	±25	907.0	TBD	±25	±25
Curium-244	907.0 M	TBD	±30	±25	907.0	TBD	±25	±25
Curium-245	907.0 M	TBD	±30	±25	907.0	TBD	±25	±25
Europium-152	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Europium-154	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Europium-155	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Francium-221	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Iodine-129	902.0 M	TBD	±30	±25	902.0	TBD	±25	±25
Lead-209	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Lead-210	Pb-01 M	TBD	±30	±25	Pb-01	TBD	±25	±25
Lead-211	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Lead-212	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Lead-214	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Neptunium-237	907.0 M	TBD	±30	±25	907.0	TBD	±25	±25
Neptunium-239	D35649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Nickel-59	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Nickel-63	TBD	TBD	±30	±25	TBD	TBD	±25	±25

Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses.

	Soil/Sediment				Water			
	Analysis Method	Practical Quantitation Limit[a/] (pCi/g, mg/kg)	Precision (RPD)	Accuracy (%)	Analysis Method	Practical Quantitation Limit[a/] (pCi/L, µg/L)	Precision (RPD)	Accuracy (%)
RADIONUCLIDES (cont.)								
Niobium-93m	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Plutonium	Pu-02	TBD	±30	±25	Pu-10	TBD	±25	±25
Plutonium-238	Pu-02	TBD	±30	±25	Pu-10	TBD	±25	±25
Plutonium-239/240	Pu-02	TBD	±30	±25	Pu-10	TBD	±25	±25
Plutonium-241	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Polonium-214	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Polonium-215	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Polonium-218	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Potassium-40	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Protactinium-231	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Protactinium-234m	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Radium	Ra-04	TBD	±30	±25	Ra-05	TBD	±25	±25
Radium-225	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Radium-226	Ra-04	TBD	±30	±25	Ra-05	TBD	±25	±25
Ruthenium-106	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Samarium-151	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Selenium-79	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Sodium-22	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Strontium-90	Sr-02	TBD	±30	±25	Sr-02	TBD	±25	±25

Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses.

	Soil/Sediment				Water			
	Analysis Method	Practical Quantitation Limit[a/] (pCi/g, mg/kg)	Precision (RPD)	Accuracy (%)	Analysis Method	Practical Quantitation Limit[a/] (pCi/L, µg/L)	Precision (RPD)	Accuracy (%)
RADIONUCLIDES (cont.)								
Technetium-99	Tc-01 M	TBD	±30	±25	Tc-01	TBD	±25	±25
Thallium-207	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Thorium-227	00-06	TBD	±30	±25	00-07	TBD	±25	±25
Thorium-229	00-06	TBD	±30	±25	00-07	TBD	±25	±25
Thorium-230	00-06	TBD	±30	±25	00-07	TBD	±25	±25
Thorium-231	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Tritium	906.0 M	TBD	±30	±25	906.0	300	±25	±25
Uranium	U-04	TBD	±30	±25	U-04	TBD	±25	±25
Uranium-233	U	TBD	±30	±25	908.0	TBD	±25	±25
Uranium-234	U	TBD	±30	±25	908.0	TBD	±25	±25
Uranium-235	U	TBD	±30	±25	908.0	TBD	±25	±25
Uranium-238	U	TBD	±30	±25	908.0	TBD	±25	±25
Yttrium-90	Sr-02	TBD	±30	±25	Sr-02	TBD	±25	±25
Zirconium-93	TBD	TBD	±30	±25	TBD	TBD	±25	±25
INORGANICS								
Ammonia	350.2M	500	±25	±30	350.2	500	±20	±25
Arsenic	7061	0.02	±25	±30	7061	10	±20	±25
Barium	6010	0.02	±25	±30	6010	20	±20	±25
Boron	6010	TBD	±25	±30	6010	TBD	±20	±25

Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses.

	Soil/Sediment				Water			
	Analysis Method	Practical Quantitation Limit[a/] (pCi/g, mg/kg)	Precision (RPD)	Accuracy (%)	Analysis Method	Practical Quantitation Limit[a/] (pCi/L, µg/L)	Precision (RPD)	Accuracy (%)
INORGANICS (cont.)								
Cadmium	6010	0.09	±25	±30	6010	1	±20	±25
Chromium	6010	0.07	±25	±30	6010	10	±20	±25
Copper	6010	0.06	±25	±30	220.2	10	±20	±25
Cyanide	9010	TBD	±25	±30	335.3	50	±20	±25
Fluoride	300 M	TBD	±25	±30	300	50	±20	±25
Iron	6010	20	±25	±30	6010	70	±20	±25
Lead	6010	0.45	±25	±30	6010	450	±20	±25
Manganese	6010	0.02	±25	±30	6010	20	±20	±25
Mercury	7471	0.02	±25	±30	245.2	2	±20	±25
Nickel	6010	1.5	±25	±30	6010	50	±20	±25
Nitrate	300 M	TBD	±25	±30	300	130	±20	±25
Nitrite	300 M	TBD	±25	±30	300	40	±20	±25
Selenium	6010	0.75	±25	±30	270.2	20	±20	±25
Silver	6010	2	±25	±30	272.2	10	±20	±25
Titanium	6010	TBD	±25	±30	6010	TBD	±20	±25
Vanadium	6010	0.08	±25	±30	286.2	40	±20	±25
Zinc	6010	0.02	±25	±30	6010	20	±20	±25

Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses.

	Soil/Sediment				Water			
	Analysis Method	Practical Quantitation Limit[a] (pCi/g, mg/kg)	Precision (RPD)	Accuracy (%)	Analysis Method	Practical Quantitation Limit[a] (pCi/L, μg/L)	Precision (RPD)	Accuracy (%)
ORGANICS								
Acetone	8240	0.1	±25	±30	8240	100	±20	±25
Carbon tetrachloride	8240	0.005	±25	±30	8240	1	±20	±25
Chloroform	8240	0.005	±25	±30	8240	5	±20	±25
Kerosene	8015	20	±35	±30	8015	500	±35	±25
Methylene chloride	8240	0.005	±25	±30	8240	5	±20	±25
MIBK	8015	0.5	±25	±30	8015	5	±20	±25
1,1,1-Trichloroethane	8240	0.005	±25	±30	8240	5	±20	±25
Toluene	8240	0.005	±25	±30	8240	5	±20	±25
Tributyl phosphate	TBD	TBD	±25	±30	TBD	TBD	±30	±25

TBD = To Be Determined
M = method modified to include extraction from the solid medium, extraction method is matrix and laboratory-specific
RPD = Relative Percent Difference
Prescribed Procedures for Measurement of Radioactivity in Drinking Water (EPA 1980a)
Test Methods for Evaluation Solid Waste (SW 846) Third Edition (EPA 1986)
Methods for Chemical Analysis of Water and Waste (EPA 1983)
Radionuclide Method for the Determination of Uranium in Soil and Air (EPA 1980b)
EML Procedures Manual (DOE/EML 1990)
Eastern Environmental Radiation Facility RadioChemistry Procedures Manual (EPA 1984)
High-Resolution Gamma-Ray Spectrometry of Water (ASTM 1985)
Precision and accuracy are goals. Since these parameters are highly matrix dependent they could vary greatly from the goals listed.
[a] pCi/g and pCi/L apply to radionuclides, mg/kg and μg/L apply to organic and inorganic constituents.

Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses.

	Soil/Sediment				Water			
	Analysis Method	Practical Quantitation Limit[a/] (pCi/g, mg/kg)	Precision (RPD)	Accuracy (%)	Analysis Method	Practical Quantitation Limit[a/] (pCi/L, µg/L)	Precision (RPD)	Accuracy (%)
RADIONUCLIDES (cont.)								
Niobium-93m	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Plutonium	Pu-02	TBD	±30	±25	Pu-10	TBD	±25	±25
Plutonium-238	Pu-02	TBD	±30	±25	Pu-10	TBD	±25	±25
Plutonium-239/240	Pu-02	TBD	±30	±25	Pu-10	TBD	±25	±25
Plutonium-241	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Polonium-214	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Polonium-215	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Polonium-218	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Potassium-40	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Protactinium-231	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Protactinium-234m	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Radium	Ra-04	TBD	±30	±25	Ra-05	TBD	±25	±25
Radium-225	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Radium-226	Ra-04	TBD	±30	±25	Ra-05	TBD	±25	±25
Ruthenium-106	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Samarium-151	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Selenium-79	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Sodium-22	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Strontium-90	Sr-02	TBD	±30	±25	Sr-02	TBD	±25	±25

Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses.

	Soil/Sediment				Water			
	Analysis Method	Practical Quantitation Limit[a/] (pCi/g, mg/kg)	Precision (RPD)	Accuracy (%)	Analysis Method	Practical Quantitation Limit[a/] (pCi/L, μg/L)	Precision (RPD)	Accuracy (%)
RADIONUCLIDES (cont.)								
Technetium-99	Tc-01 M	TBD	±30	±25	Tc-01	TBD	±25	±25
Thallium-207	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Thorium-227	00-06	TBD	±30	±25	00-07	TBD	±25	±25
Thorium-229	00-06	TBD	±30	±25	00-07	TBD	±25	±25
Thorium-230	00-06	TBD	±30	±25	00-07	TBD	±25	±25
Thorium-231	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Tritium	906.0 M	TBD	±30	±25	906.0	300	±25	±25
Uranium	U-04	TBD	±30	±25	U-04	TBD	±25	±25
Uranium-233	U	TBD	±30	±25	908.0	TBD	±25	±25
Uranium-234	U	TBD	±30	±25	908.0	TBD	±25	±25
Uranium-235	U	TBD	±30	±25	908.0	TBD	±25	±25
Uranium-238	U	TBD	±30	±25	908.0	TBD	±25	±25
Yttrium-90	Sr-02	TBD	±30	±25	Sr-02	TBD	±25	±25
Zirconium-93	TBD	TBD	±30	±25	TBD	TBD	±25	±25
INORGANICS								
Arsenic	7061	0.02	±25	±30	7061	10	±20	±25
Barium	6010	0.02	±25	±30	6010	20	±20	±25
Boron	6010	TBD	±25	±30	6010	TBD	±20	±25
Cadmium	6010	0.09	±25	±30	6010	1	±20	±25

Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses.

	Soil/Sediment				Water			
	Analysis Method	Practical Quantitation Limit[a] (pCi/g, mg/kg)	Precision (RPD)	Accuracy (%)	Analysis Method	Practical Quantitation Limit[a] (pCi/L, µg/L)	Precision (RPD)	Accuracy (%)
INORGANICS (cont.)								
Chromium	6010	0.07	±25	±30	6010	10	±20	±25
Copper	6010	0.06	±25	±30	220.2	10	±20	±25
Cyanide	9010	TBD	±25	±30	335.3	50	±20	±25
Fluoride	300 M	TBD	±25	±30	300	50	±20	±25
Iron	6010	20	±25	±30	6010	70	±20	±25
Lead	6010	0.45	±25	±30	6010	450	±20	±25
Manganese	6010	0.02	±25	±30	6010	20	±20	±25
Mercury	7471	0.02	±25	±30	245.2	2	±20	±25
Nickel	6010	1.5	±25	±30	6010	50	±20	±25
Nitrate	300 M	TBD	±25	±30	300	130	±20	±25
Nitrite	300 M	TBD	±25	±30	300	40	±20	±25
Selenium	6010	0.75	±25	±30	270.2	20	±20	±25
Silver	6010	2	±25	±30	272.2	10	±20	±25
Titanium	6010	TBD	±25	±30	6010	TBD	±20	±25
Vanadium	6010	0.08	±25	±30	286.2	40	±20	±25
Zinc	6010	0.02	±25	±30	6010	20	±20	±25
ORGANICS								
Acetone	8240	0.1	±25	±30	8240	100	±20	±25
Carbon tetrachloride	8240	0.005	±25	±30	8240	1	±20	±25

Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses.

	Soil/Sediment				Water			
	Analysis Method	Practical Quantitation Limit[a] (pCi/g, mg/kg)	Precision (RPD)	Accuracy (%)	Analysis Method	Practical Quantitation Limit[a] (pCi/L, μg/L)	Precision (RPD)	Accuracy (%)
ORGANICS (cont.)								
Chloroform	8240	0.005	±25	±30	8240	5	±20	±25
Kerosene	8015M	20	±35	±30	8015M	500	±35	±25
Methylene chloride	8240	0.005	±25	±30	8240	5	±20	±25
MIBK	8015	0.5	±25	±30	8015	5	±20	±25
1,1,1-Trichloroethane	8240	0.005	±25	±30	8240	5	±20	±25
Toluene	8240	0.005	±25	±30	8240	5	±20	±25
Tributyl phosphate	TBD	TBD	±25	±30	TBD	TBD	±30	±25

TBD = To Be Determined
M = method modified to include extraction from the solid medium, extraction method is matrix and laboratory-specific
RPD = Relative Percent Difference
Prescribed Procedures for Measurement of Radioactivity in Drinking Water (EPA 1980a)
Test Methods for Evaluation Solid Waste (SW 846) Third Edition (EPA 1986)
Methods for Chemical Analysis of Water and Waste (EPA 1983)
Radionuclide Method for the Determination of Uranium in Soil and Air (EPA 1980b)
EML Procedures Manual (DOE/EML 1990)
Eastern Environmental Radiation Facility RadioChemistry Procedures Manual (EPA 1984)
High-Resolution Gamma-Ray Spectrometry of Water (ASTM 1985)
Precision and accuracy are goals. Since these parameters are highly matrix dependent they could vary greatly from the goals listed.
[a] pCi/g and pCi/L apply to radionuclides, mg/kg and μg/L apply to organic and inorganic constituents.

Table 8-5. Data Gaps by Waste Management Unit Category.

Site Category	Identified Data Gaps
Tanks and Vaults	• Contaminant concentrations in waste management units other than single-shell tanks • Distribution of contaminants in subsurface soils released in leaks • Constituents concentrations in related surface contamination
Cribs and Drains	• Containment concentrations in cribs • Containment concentrations in soils beneath cribs • Specific constituents (especially organic chemicals) • Distribution and vertical/lateral extent of contamination
Reverse Wells	• Containment concentrations in subsurface soils impacted by discharges • Specific constituents (especially organics) • Extent of contamination
Ponds, Ditches, and Trenches	• Distribution/extent of subsurface contamination • Buried contaminant concentrations in stabilized portions/units
Septic Tanks and Associated Drain Fields	• Actual discharge levels • Possible discharge and presence/level of non-sanitary wastes (e.g., laboratory drains)
Transfer Facilities, Diversion Boxes, and Pipelines	• Contamination constituents and concentrations • Direct radiation levels in facilities • Constituents/concentrations in related surface contamination • Integrity of transfer lines
Basins (207-T)	• Constituents and concentrations in sediments • Distribution/extent of subsurface contamination
Unplanned Releases	• Surface soil constituents and concentrations • Buried contamination constituents and concentrations

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Table 8-6. Recommended Characterization Investigation Methods at T Plant Aggregate Area Waste Management Units.

Waste Management Unit or Unplanned Release	Surface Radiation Survey	Subsurface Spectral Geophysics	Surface Geophysics	Soil Gas Survey	Surface Soil Sampling	Surface Water Sediment Sampling	Subsurface Soil Sampling	Perched Zone Monitoring Wells
Tanks and Vaults								
241-T-361 Settling Tank	X	–	–	–	–	–	–	–
Cribs and Drains								
216-T-6 Crib	–	A	–	–	–	–	A	–
216-T-7TF Crib	–	A	–	–	–	–	A	–
216-T-8 Crib	–	A	–	–	–	–	A	–
216-T-18 Crib	–	X	–	X	–	–	X	–
216-T-19TF Crib	X	X	–	X	X	–	X	–
216-T-26 Crib	A	A	–	–	A	–	A	–
216-T-27 Crib	A	A	–	A	A	–	A	–
216-T-28 Crib	A	A	–	A	A	–	A	–
216-T-29 Crib	–	A	–	–	–	–	A	–
216-T-31 French Drain	–	–	–	–	–	–	–	–
216-T-32 Crib	–	A	–	A	–	–	A	–
216-T-33 Crib	A	A	–	–	A	–	A	–
216-T-34 Crib	X	X	–	X	X	–	X	–
216-T-35 Crib	A	A	–	A	–	–	A	–

Table 8-6. Recommended Characterization Investigation Methods at T Plant Aggregate Area Waste Management Units.

Waste Management Unit or Unplanned Release	Surface Radiation Survey	Subsurface Spectral Geophysics	Surface Geophysics	Soil Gas Survey	Surface Soil Sampling	Surface Water Sediment Sampling	Subsurface Soil Sampling	Perched Zone Monitoring Wells
216-T-36 Crib	A	A	–	–	–	–	A	–
216-W-LWC Crib	–	A	–	–	–	–	A	–
Reverse Wells								
216-T-2 Reverse Well	–	X	–	–	–	–	–	–
216-T-3 Reverse Well	–	X	–	–	–	–	–	–
Ponds, Ditches, and Trenches								
216-T-4A Pond	X	X	–	–	–	X	X	–
216-T-4B Pond	X	X	–	–	–	X	X	–
216-T-1 Ditch	–	A	–	–	–	A	A	–
216-T-4-1D Ditch	–	X	–	–	–	X	X	–
216-T-4-2 Ditch	–	A	–	–	–	A	A	–
200-W Powerhouse Pond	X	X	–	–	–	X	X	–
216-T-5 Trench	–	A	–	–	–	–	A	–
216-T-9 Trench	–	A	–	–	–	–	A	–
216-T-10 Trench	–	–	–	–	–	–	X	–
216-T-11 Trench	–	–	–	–	–	–	X	–
216-T-12 Trench	A	A	–	–	A	–	A	–
216-T-13 Trench	–	–	–	–	–	–	X	–

Table 8-6. Recommended Characterization Investigation Methods at T Plant Aggregate Area Waste Management Units.

Waste Management Unit or Unplanned Release	Surface Radiation Survey	Subsurface Spectral Geophysics	Surface Geophysics	Soil Gas Survey	Surface Soil Sampling	Surface Water Sediment Sampling	Subsurface Soil Sampling	Perched Zone Monitoring Wells
216-T-14 Trench	A	A	–	–	A	–	A	–
16-T-15 Trench	A	A	–	–	A	–	A	–
216-T-16 Trench	A	A	–	–	A	–	A	–
216-T-17 Trench	A	A	–	–	A	–	A	–
216-T-20 Trench	–	A	–	–	–	–	A	–
216-T-21 Trench	–	A	–	–	–	–	A	–
216-T-22 Trench	–	X	–	X	–	–	X	–
216-T-23 Trench	–	A	–	–	–	–	A	–
216-T-24 Trench	–	A	–	–	–	–	A	–
216-T-25 Trench	–	X	–	X	–	–	X	–
Septic Tanks and Associated Drain Fields								
2607-W1 Septic Tank	–	–	–	–	–	–	X	–
2607-W2 Septic Tank	–	–	–	–	–	–	X	–
2607-W3 Septic Tank	X	–	–	–	X	–	X	–
2607-W4 Septic Tank	–	–	–	–	–	–	X	–
Basins								
207-T Retention Basin	X	–	–	–	X	X	X	–

Table 8-6. Recommended Characterization Investigation Methods at T Plant Aggregate Area Waste Management Units.

Waste Management Unit or Unplanned Release	Surface Radiation Survey	Subsurface Spectral Geophysics	Surface Geophysics	Soil Gas Survey	Surface Soil Sampling	Surface Water Sediment Sampling	Subsurface Soil Sampling	Perched Zone Monitoring Wells
Burial Sites								
200-W Ash Disposal Basin	X	–	–	–	X	–	X	–
200-W Burning Pit	X	–	X	X	X	–	X	–
200-W Powerhouse Ash Pit	–	–	–	–	–	–	X	–
218-W-8 Burial Ground	–	–	–	–	–	–	X	–
Unplanned Releases								
UN-200-W-2	X	–	–	–	X	–	X	–
UN-200-W-3	X	–	–	–	X	–	X	–
UN-200-W-4	X	–	–	–	X	–	X	–
UN-200-W-8	X	–	–	–	X	–	X	–
UN-200-W-14	X	–	X	–	X	–	X	–
UN-200-W-27	X	–	–	–	X	–	X	–
UN-200-W-29	X	–	X	–	X	–	X	–
UN-200-W-58	X	–	–	–	X	–	X	–
UN-200-W-63	–	–	–	–	–	–	X	–
UN-200-W-65	X	–	–	–	X	–	X	–
UN-200-W-67	X	–	–	–	X	–	X	–
UN-200-W-73	X	–	–	–	X	–	X	–

Table 8-6. Recommended Characterization Investigation Methods at T Plant Aggregate Area Waste Management Units.

Waste Management Unit or Unplanned Release	Surface Radiation Survey	Subsurface Spectral Geophysics	Surface Geophysics	Soil Gas Survey	Surface Soil Sampling	Surface Water Sediment Sampling	Subsurface Soil Sampling	Perched Zone Monitoring Wells
UN-200-W-77	–	–	–	–	–	–	X	–
UN-200-W-85	–	–	–	–	–	–	X	–
UN-200-W-88	–	–	–	–	–	–	X	–
UN-200-W-98	X	–	–	–	X	–	X	–
UN-200-W-99	X	–	–	–	X	–	X	–
UN-200-W-102	X	–	–	–	X	–	X	–
UN-200-W-135	X	–	–	–	X	–	X	–

X = investigation at each individual site.
A = investigation at representative analogous sites.
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9.0 RECOMMENDATIONS

The purpose of the aggregate area management study (AAMS) is to compile and evaluate the existing body of knowledge to support the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a) decision making process. A primary task in achieving this purpose is to assess each waste management unit and unplanned release within the aggregate area to determine the most expeditious path for remediation within the statutory requirements of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA). The existing body of pertinent knowledge regarding T Plant Aggregate Area waste management units and unplanned releases has been summarized and evaluated in the previous sections of this study. A data evaluation process has been established that uses the existing data to develop preliminary recommendations on the appropriate remediation path for each waste management unit. This data evaluation process is a refinement of the *Hanford Site Past-Practice Strategy* (Figure 1-2) and establishes criteria for selecting an appropriate *Hanford Site Past-Practice Strategy* path (expedited response action, ERA; interim remedial measure, IRM; limited field investigation, LFI; and final remedy selection) for individual waste management units and unplanned releases within the 200 Areas. A discussion of the criteria for path selection and the results of the data evaluation process are provided in Section 9.1 and 9.2, respectively. Figure 9-1 provides a flowchart of the data evaluation process that will be discussed. Table 9-1 provides a summary of the results of the data evaluation assessment of each unit. Table 9-2 provides the decisional matrix patterns each unit followed.

This section presents recommended assessment paths for the waste management units and unplanned releases at the T Plant Aggregate Area. These recommendations are only proposed at this time and are subject to adjustment and change. Factors that may affect development of final recommendations include, but are not limited to, comments and advice from the Washington State Department of Ecology (Ecology), U.S. Environmental Protection Agency (EPA), or U.S. Department of Energy (DOE); identification and development of new information; and modification of the criteria used in the assessment path decision-making process. The data evaluation process depicted in Figure 9-1 and discussed in Section 9.1 was developed to facilitate only the technical data evaluation step shown on the *Hanford Site Past-Practice Strategy* (Box A in Figure 1-2). Procedural and administrative requirements for implementation of the recommendations provided in this AAMS will be performed in accordance with the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1990) and the *Hanford Site Past-Practice Strategy*. Changes in recommendations will be addressed, and more detail on recommended assessment paths for waste management units and unplanned releases will be included in work plans as they are developed for the actual investigation and remediation activities.

A number of waste management units and unplanned releases do not have information regarding the nature and extent of contamination necessary for quantitative or qualitative risk

assessment, especially with regard to hazardous constituents, and were recommended for additional investigation (e.g., LFI). Several units and releases assessed within the ERA path were recommended for actions that fall within the scope of existing operational programs. Sites with elevated levels of radionuclide surface contamination are addressed by the Radiation Area Remedial Action (RARA) Program.

Waste management units and unplanned releases which are addressed entirely by other programs were not subjected to the data evaluation process. This includes units and unplanned releases that are within the scope of the Single-Shell Tank Closure Program, Decommissioning and RCRA Closure Program, and Waste Management Program. Table 9-3 provides a list of the units not included in the evaluation.

A majority of facilities not addressed in the data evaluation fall within the scope of the Single-Shell Tank Closure Program. The activities associated with closure of the 200-TP-5 and 200-TP-6 Operable Unit single-shell tank sites have separate Tri-Party Agreement milestones and any recommendations for disposition of these units and associated unplanned releases will be developed as part of the ongoing program addressing the single-shell tanks. The units associated with these operable units include single-shell tanks and associated diversion boxes, vaults, catch tanks, and high-level waste transfer lines.

A discussion of the four decision-making paths shown on Figure 9-1: ERA, IRM, LFI, and final remedy selection, is provided in Section 9.1. Section 9.2 provides a discussion of the waste management units grouped under each of these paths. A discussion of regrouping and prioritization of the waste management units is provided in Section 9.3. Recommendations for redefining operable unit boundaries and prioritizing operable units for work plan development are also provided in Section 9.3. No additional aggregate area-based field characterization activities are recommended to be undertaken as a continuation of the AAMS. All recommendations for future characterization needs (see Section 8.0) will be more fully developed and implemented through work plans. Plan development and submittal will be accomplished in accordance with requirements of the *Hanford Site Past-Practice Strategy* and the Tri-Party Agreement and could include remedial investigation (RI)/feasibility study (FS), RCRA Facility Investigation (RFI)/Corrective Measures Study (CMS), or LFI work plans. Sections 9.4 and 9.5 provide recommendations for focused feasibility and treatability studies, respectively.

9.1 DECISION-MAKING CRITERIA

The criteria used to assess the most expeditious remediation process path are based primarily on urgency for action and whether site data are adequate to proceed along a given path (Figure 9-1). All units and unplanned releases that are not completely addressed under other Hanford Site programs are assessed in the data evaluation process. All of the units and releases that are addressed in the data evaluation process are initially evaluated as candidates

for an ERA. Sites where a release has occurred or is imminent are considered candidates for ERAs. Conditions that might trigger an ERA are the determination of an unacceptable health or environmental risk or a short time frame available to mitigate the problem (DOE/RL 1992a). As a result, candidate ERA units were evaluated against a set of criteria to determine whether potential for exposure to unacceptable health or environmental risks exists. Units and unplanned releases that are recommended for ERAs will undergo a formal evaluation following the selection process outlined in WHC (1991b).

Waste management units and unplanned releases that are not recommended for consideration as an ERA continue through the data evaluation process. Sites continuing through the process that potentially pose a high risk (refer to Section 5.0), become candidates for consideration as an IRM. The criteria used to determine a potential for high risk, thereby indicating a high priority site, were the Hazard Ranking System (HRS) score used for nominating waste management units for CERCLA cleanup (40 CFR 300), the modified Hazard Ranking System (mHRS) scores, surface radiation survey data, and rankings by the Environmental Protection Program (Huckfeldt 1991b). Units and unplanned releases with HRS or mHRS scores greater than 28.5 (the CERCLA cleanup criterion) were designated as candidate sites for IRM consideration. Units and unplanned releases that did not have an HRS score were compared to similar sites to establish an estimated HRS score. Sites with surface contamination greater than 2 mrem/h exposure rate, 100 ct/min beta/gamma above background or alpha greater than 20 dis/min were also designated as candidate IRM sites. The radiation and surface contamination criteria are based on the Westinghouse Hanford Radiation Protection Manual (WHC 1988b) posting requirements. In addition, surface contamination sites which had an Environmental Protection Program ranking of greater than 7 were also designated as candidate IRM sites. A value of 7 was chosen because it represents the approximate midpoint of the scoring range. The candidate IRM sites are listed in Table 5-1, which summarizes the high priority sites. The four risk indicators are based on limited data (refer to Section 8.0) and therefore may not adequately represent the actual risk posed by the site. Technical judgment, including assessment of similarities in site operational histories, was used to include sites not ranked as high priority in the list of sites under consideration for an IRM. Candidate IRM sites were then further evaluated to determine if an IRM is appropriate for the site. Candidate IRM sites that did not meet the IRM criteria were placed into the final remedy selection path. As future data become available the list of units recommended for consideration as IRM sites may be altered.

For certain units and unplanned releases, it was recognized that remedial actions could be undertaken under an existing operational or other Hanford Site program (e.g., Single-Shell Tank Closure, RARA, Waste Management, or Decommissioning and RCRA Closure Programs). As a result, recommendations were made that remedial actions be undertaken (partially or completely) outside the 200 AAMS past practice program. Units or unplanned releases that could be addressed only in part by another program (e.g., surface contamination cleanup under the RARA Program) remained in the 200 AAMS data evaluation process for further consideration. If it cannot be demonstrated that these sites will be addressed under

the operational program within a time frame compatible with the past practice program, they will be readdressed by the 200 AAMS process. Tracking of waste management units included in operational programs will be discussed in the work plans developed for each operable unit/aggregate area.

Units and unplanned releases recommended for complete disposition under another program (e.g., single-shell tanks and associated structures under the Single-Shell Tank Closure Program) were not considered in the 200 AAMS data evaluation process. In addition, potentially new sites that were identified during the AAMS were also not considered. It is recommended that a formal determination be made regarding the regulatory status of all new sites following established procedures before they are considered further under the 200 AAMS data evaluation process.

Specific criteria used to develop initial recommendations for ERAs, LFIs, and IRMs for units and unplanned releases within the aggregate area are provided in Sections 9.1.1 and 9.1.2. Units and unplanned releases not initially addressed under an ERA, LFI or IRM will be evaluated under the final remedy selection path discussed in Section 9.1.3.

9.1.1 Expedited Response Action Path

Candidate ERA sites are evaluated to determine if they pose an unacceptable health or environmental risk and a short time-frame available to mitigate the problem exists. All units and unplanned releases other than those recommended for complete disposition under another Hanford program are assessed against the ERA criteria. The *Hanford Site Past-Practice Strategy* describes conditions that might trigger abatement of a candidate waste management unit or unplanned release under an ERA. Generally, these conditions would rely on a determination of, or suspected, existing or future unacceptable health or environmental risk, and a short time-frame available to mitigate the problem. Conditions include, but are not limited to the following:

- Actual or potential exposure to nearby human populations, biota, or the food chain from hazardous substances and radioactive or mixed waste contaminants
- Actual or potential contamination of drinking water supplies or sensitive ecosystems
- Threats of release of hazardous substances and radioactive or mixed waste contaminants
- High levels of hazardous substances and radioactive or mixed waste contaminants in soils that pose or may pose a threat to human health or the environment, or have the potential for migration

- Weather conditions that may increase the potential for release or migration of hazardous substances and radioactive or mixed waste contaminants
- The availability of other appropriate federal or state response mechanisms to respond to the release
- Time required to develop and implement a final remedy
- Further degradation of the medium which may occur if a response action is not expeditiously initiated
- Risks of fire or explosion or potential for exposure as a result of an accident or failure of a container or handling system
- Other situations or factors that may pose threats to human health or welfare or the environment.

These conditions were used as the initial screening criteria to identify candidate waste management units and unplanned releases for ERAs. Candidate waste management units and releases that did not meet these conditions were not assessed through the ERA evaluation path. Additional criteria for further, detailed screening of ERA candidates were developed based on the conditions outlined in the *Hanford Site Past-Practice Strategy*. Quantification of these criteria for further screening were developed. These screening criteria are shown in Figure 9-1 and are described below.

The next decision point on Figure 9-1 used to assess each ERA candidate is whether a driving force to an exposure pathway exists or is likely to exist. Units or unplanned releases with contamination that is migrating or is likely to significantly migrate to a medium that can result in exposure and harm to humans required additional assessment under the ERA process. Units or unplanned releases where contamination could migrate and, therefore, potentially require significantly more extensive remedial action if left unabated were also assessed in the ERA path.

Waste management units and unplanned releases with a driving force were assessed to determine if unacceptable health or environmental risk and a short time-frame available to mitigate the problem exists from the release. The criteria used to determine unacceptable risks are based on the quantity and concentration of the release. If the release or imminent release is greater than 100 times the CERCLA reportable quantity for any constituent, the unit or unplanned release remains in consideration for an ERA. If the release or imminent release contains hazardous constituents at concentrations that are 100 times the most applicable standard, the unit or unplanned release continues to be considered for an ERA. Application of the criterion of 100 times applicable standards is for quantification of the strategy criteria which addresses "high levels of hazardous substances and radioactive or

mixed waste contaminants...." The factor of 100 is based on engineering judgment of what constitutes a high level of contamination warranting expedited action. In some cases, engineering judgment was used to estimate the quantity and concentration of a postulated release. Standards applied include Model Toxics Control Act (MTCA) standards for industrial sites and DOE and Westinghouse Hanford radiation criteria (refer to Section 6.0). The application of these standards does not signify they are recognized as ARARs.

The ERA screening criteria, in addition to those presented in the *Hanford Site Past-Practice Strategy,* were applied to provide a consistent quantitative basis for making recommendations in the AAMS. The decision to implement the recommendations developed in AAMS will be made collectively between DOE, EPA and Ecology based only on the criteria established in the *Hanford Site Past-Practice Strategy.*

If a release is unacceptable with respect to health or environmental risk, a technology must be readily available to control the release for a unit or unplanned release to be considered for an ERA. An example that would require substantial technology development before implementation of cleanup would be a tritium release since no established treatment technology is available to separate low concentrations of tritium from water.

The next step in the ERA evaluation path involves determining whether implementation of the available technology would have adverse consequences that would offset the benefits of an ERA. Examples of adverse consequences include: (1) use of technologies that result in risks to cleanup personnel that are much greater than the risks of the release; (2) the ERA would foreclose future remedial actions; and (3) the ERA would prevent or greatly hinder future data collection activities. If adverse consequences are not expected, the site remains in consideration for an ERA.

The final criterion is to determine if the candidate ERA is within the scope of an operational program. Maintenance and operation of active waste management facilities are within the scope of activities administered by the Waste Management Program. Active facilities include certain transfer lines, diversion boxes, the 241-TX-302C Catch Tank, the 244-TX Receiver Tank, the 216-W-LWC Crib, and the 216-T-1 and 216-T-4-2 Ditches. Generally, active facilities will not be included in past practice investigations unless operation is discontinued prior to initiation of the investigation. The Decommissioning and RCRA Closures program is responsible for safe and cost-effective surveillance, maintenance, and decommissioning of surplus facilities and RCRA closures at the Hanford Site. The Decommissioning and RCRA Closure Program is also responsible for RARA activities that include surveillance, maintenance, decontamination, and/or stabilization of inactive burial grounds, cribs, ponds, trenches, and unplanned release sites.

If the proposed ERA will not address all the contamination present, the unit or unplanned release continues through the process to be evaluated under a second path. For

example, surface contamination cleanup under the RARA Program may not address subsurface contamination and, therefore, additional investigation may be needed.

Final decisions regarding the conduct of ERAs in the aggregate area will be made among Ecology, EPA, and DOE based, at least in part, on the recommendations provided in this section, and results of the final selection process outlined in WHC (1991b).

9.1.2 Limited Field Investigation and Interim Remedial Measure Paths

High priority waste management units and unplanned release sites were evaluated to determine if sufficient need and information exists such that an IRM could be pursued. An IRM is desired for high priority units and unplanned releases where extensive characterization is not necessary to reach defensible cleanup decisions. Implementation of IRMs at waste management units and unplanned releases with minimal characterization is expected to rely on observational data acquired during remedial activities. Successful execution of this strategy is expected to reduce both time and cost for cleanup of units and unplanned releases without impacting the effectiveness of the implemented action.

The initial step in the IRM evaluation path is to categorize the units. The exposure pathways of interest are similar for each waste management unit in a category; therefore, it is effective to evaluate candidate units as a group. The groupings used in Section 2.3 (e.g., cribs; tanks and vaults; etc.) will continue to be used to group the units for IRM assessment. This grouping approach is especially effective in reducing characterization requirements. As done in the 100 Areas using the observational approach, the LFIs can be used to characterize a representative unit or units in detail to develop a remedial alternative for the group of units. Observational data obtained during implementation of the remedial alternative could be used to meet unit specific needs. Similarities of waste management units may make it possible to remediate them using the observational approach after first characterizing only a few units. It is expected, therefore, that a LFI would provide sufficient information to proceed with an IRM for groups of similar high priority waste management units.

Data adequacy is assessed in the next step. The existing data are evaluated to determine if: (1) existing data are sufficient to develop a conceptual model and qualitative risk assessment; (2) the IRM will work for this pathway; (3) implementing the IRM will have adverse impacts on the environment, future remediation activities or data collection efforts; (4) the benefits of implementing the IRM are greater than the costs. If data are not adequate an assessment was made to determine if an LFI might provide enough data to perform an IRM. If an LFI would not collect sufficient data to perform an IRM, the unit was addressed in the final remedy selection path.

The final step in the IRM evaluation process is to assess if the IRM will work without significant adverse consequences. This includes: will the IRM be successful? will it create

significant adverse environmental impacts (e.g., environmental releases)? will the costs outweigh the benefits? will it preclude future cleanup or data collection efforts? and will the risks of the cleanup be greater than the risks of no action? Units where remediation is considered to be possible without adverse consequences outweighing benefits of the remediation are recommended for IRMs. Low priority unplanned releases at candidate IRM units will be included in the IRM evaluations of the candidate units.

Final decisions will be made among DOE, EPA, and Ecology regarding the conduct of IRMs in the T Plant Aggregate Area based, at least in part, on the recommendation provided in this AAMSR, and the results of a supporting LFI.

9.1.3 Final Remedy Selection Path

Sites recommended for initial consideration in the final remedy selection path are those not recommended for IRMs, LFIs, or ERAs and those considered to be low priority sites. It is recognized that all units and unplanned releases within the operable unit or aggregate area will eventually be addressed collectively under the final remedy path to support a final aggregate area or operable unit Record of Decision (ROD).

The initial step in the final remedy selection process path is to assess whether the combined data from the AAMS, and any completed ERAs, IRMs, and LFIs are adequate for performing a risk assessment (RA) and selecting a final remedy. Whereas the scope of an ERA, IRM, and LFI is limited to individual waste management units or groups of similar waste management units, the final remedy selection path will likely address an entire operable unit or aggregate area.

If the data are collectively sufficient, an operable unit or aggregate area RA will be performed. If sufficient data are not available, additional needs will be identified and collected.

9.2 PATH RECOMMENDATIONS

Initial recommendations for ERA, IRM, and LFI are discussed in Section 9.2.1 through 9.2.3, respectively. Waste management units and unplanned releases proposed for initial consideration under the final remedy selection path are discussed in Section 9.2.4. Table 9-1 provides a summary of the data evaluation process path assessment. A summary of the responses to the decision points on the flowchart that led to the recommendations is provided in Table 9-2. Following approval by Ecology, EPA, and DOE, these recommendations will be further developed and implemented in work plans.

9.2.1 Proposed Sites for Expedited Response Actions

The following eight waste management units meet all the criteria for an ERA prior to determining whether the proposed action was within the scope of an operational program:

- 216-T-6 Crib
- 216-T-7TF Crib and Tile Field
- 216-T-8 Crib
- 216-T-19TF Crib and Tile Field
- 216-T-32 Crib
- 216-W-LWC Crib
- 218-W-8 Vault (Burial Ground or Site)
- 216-T-4-2 Ditch.

The candidate units consist of five cribs and one burial site with collapse potential and one active crib and one active ditch which are potentially mobilizing contaminants. The active units were recommended for disposition under an ongoing Waste Management program to discontinue discharges of liquid effluent to the soil column. A discussion of the recommendations for these waste management units is included in this section. Since the anticipated response actions are not expected to fully remediate the ERA sites, all units will be included for further data evaluation in the assessment paths.

This section will provide a discussion of the perceived threats of these waste managements units and the proposed recommendations. It is anticipated that the proposed response actions will not fully remediate the candidate units, therefore all units will be included for further data evaluation in the assessment paths.

9.2.1.1 Cribs and Burial Vault with Collapse Potential. Five of the older cribs and a burial vault are open wooden structures that could collapse and expose workers. A sudden collapse could result in contaminated dust being released to the surface. Based on crib inventory data, dust derived from the bottom of the cribs or vault would be expected to

contain radionuclides at several orders of magnitude above reportable quantities and concentration standards. Units with potential collapse problems include:

- 216-T-6 Crib
- 216-T-7TF Crib and Tile Field
- 216-T-8 Crib
- 216-T-19TF Crib and Tile Field
- 216-T-32 Crib
- 218-W-8 Vault.

It should be noted the 216-T-7TF Crib and Tile Field and 216-T-32 Crib are located within the boundary of the 241-T Tank Farm and will require interaction with the Single-Shell Tank Closure Program.

Maintenance and contamination control measures for cribs with collapse potential are implemented under the RARA Program. Therefore, actions to mitigate environmental releases from these facilities will be maintained under the RARA Program. An engineering study is planned under the RARA Program for 1993 for the 200 Areas to evaluate the potential for crib collapse.

Response actions such as the addition of clean fill material over the cribs or pressure grouting void areas within the crib to prevent collapse may be considered for these waste management units. Evaluation and recommendation of response actions for these facilities will be performed under the RARA Program.

9.2.1.2 Active Waste Management Units. Two active waste management units within the T Plant Aggregate Area are thought to be potentially discharging contaminated effluent to the soil column. Operation of these units provide a potential migration pathway for movement of radioactive contaminants into the groundwater.

The 216-T-4-2 Ditch receives an average of 71,000 L (19,000 gal) per day from the T Plant facilities via the 207-T Retention Basin (WHC 1992b). This effluent is totally absorbed into the soil within the first 15 m (50 ft) of the ditch. Surface water samples taken from the ditch in 1990 found it contained the highest measured alpha level (111 pCi/L) found in the 200 Areas. It is unknown if this high alpha measurement can be attributed to discharges from T Plant Buildings or from remobilized contaminants in the 216-T-4-2 Ditch but, regardless of its origin, it is still potentially contributing contamination to the underlying aquifers.

The 216-W-LWC Crib is reported to receive an average of 275,000 L (73,000 gal) per day from the 200 West Laundry Facility (WHC 1992b). Approximately two thirds of this volume is from the regulated laundry facility which is responsible for the cleaning of radioactively contaminated clothing and contains a number of contaminants 100 times above the reportable quantities (4% Derived Concentration Guide, DOE Order 5400.5).

9.2.1.3 Non-ERA Sites. The primary reason most waste management units and unplanned releases were not recommended for ERAs was because of the lack of driving force to an exposure pathway. Inactive cribs, ponds, ditches, and trenches are no longer receiving waste and, therefore, no longer have artificial recharge as a driving force to move subsurface contaminants. Natural recharge from local precipitation was not considered a significant short-term driving force. Specifics for each waste management unit or unplanned release are provided in Table 9-2.

A majority of the unplanned release sites either have been addressed by the RARA Program to eliminate the airborne release pathway or had insufficient quantity and concentration of contamination to qualify as an ERA.

9.2.2 Proposed Sites for Interim Remedial Measures

Twenty-six waste management units addressed in the T Plant Aggregate Area data evaluation process were identified as high priority units (refer to Section 5.0) and were assessed as candidates for IRMs. Six of the units were so designated because of high HRS and mHRS scores or assigned scores. Fifteen additional units and unplanned releases were added as high priority because of surface radiation measurements. The Environmental Protection Group rankings added two units to the high priority sites. Three sites received qualitative high scores and were included as high priority sites. Thirteen low priority sites were included in the IRM path because they are sufficiently similar to RI path high priority sites that they warrant evaluation under an IRM path rather than the RI path. It was determined that an LFI could gather sufficient data for an IRM, for 33 of the 39 waste management units and unplanned release sites. The six remaining unplanned release sites were recommended for direct inclusion in the final remedy selection path as discussed in Section 9.2.4. A discussion of the LFIs is provided in Section 9.2.3.

9.2.3 Proposed Sites for Limited Field Investigation Activities

Thirty-three waste management units are recommended to undergo LFIs. The initial decision point in the IRM path is to assess whether data are adequate to conduct an IRM. For each of the 33 units, only screening level field data and inventory estimates are available. No data are available describing the nature and extent of contamination, so LFIs

are required before IRMs may be implemented. The rationale for IRM and LFI will be more completely developed in work plans; however, the following addresses possible considerations during work plan development.

Possible LFI objectives would be to:

- Evaluate the potential for releases from the waste management unit to impact underlying groundwater quality.
- Determine if contamination exists in the soil beneath the waste management unit, and if so, assess the extent.
- Assess the nature and extent of contaminant migration from the waste management unit in support of focused feasibility studies.

Each waste management unit that is recommended for an LFI will be studied as part of an analogous group. The analogous site concept is presented in the *Hanford Site Past-Practice Strategy*.

This concept emphasizes that characterization activities can be reduced by identifying select sites (analogue sites) for characterization that are representative of a group of sites (analogous groups). This concept is particularly applicable to operable units which contain a number of waste management units that are similar in design, disposal history, and geology. Appropriate confirmatory characterization, as necessary to support remedial action, can then be performed at the sites within each analogous group during remediation. Collection of confirmatory data can again be reduced during remediation activities by emphasizing in work plans the use of the observational approach discussed in the *Hanford Site Past-Practice Strategy*.

To facilitate the implementation of these strategies in work plans, individual LFIs are assembled into analogous groups for study. Three primary analogous groups have been identified in the T Plant Aggregate Area: (1) cribs, (2) trenches and low volume cribs, and (3) ditches and basins. Specific waste management units and unplanned releases are then identified that are considered to be representative of the analogous groups. Considerations used to select an analogue site for an analogous group include, but are not limited to, the following:

- Disposal history (including type and quantity of waste received)
- Physical and chemical setting.

Generally the selection process favored as analogue sites are those units or releases that received the most waste and were considered as conservative samples in terms of release mechanisms, media of concern, exposure routes, and receptors.

9.2.3.1 Cribs and 241-T-361 Settling Tank. Twelve waste management units have been assigned to this analogous group based on receiving similar wastes types and volumes. These units are:

- 216-T-6 Crib
- 241-T-361 Settling Tank
- 216-T-7TF Crib and Tile Field
- 216T-18 Crib
- 216-T-19TF Crib and Tile Field
- 216-T-26 Crib
- 216-T-27 Crib
- 216-T-28 Crib
- 216-T-32 Crib
- 216-T-34 Crib
- 216-T-35 Crib
- 216-W-LWC.

The 241-T-361 Settling Tank is included since it is an integral part of the 216-T-6 Crib system. This tank is located adjacent to the crib and was used to remove suspended solids before effluents were sent to the crib.

A comparison of the crib inventories listed in Table 2-2 shows with the exception of the 216-T-19TF and 216-W-LWC Cribs, all cribs received high volumes of plutonium, cesium and strontium. Total plutonium concentration ranged from a low of 59 g (0.13 lb) in 216-T-26 Crib to a high of 1,800 g (4 lb) in the 216-T-18 Crib. Total liquid effluent volumes received by the cribs ranged from a low of 1 x 10^6 L (264,000 gal) for the 216-T-18 Crib to a high of 110 x 10^6 L (29 x 10^6 gal) for the 216-T-7TF Crib.

The 216-T-19TF Crib and the 216-W-LWC received lower levels of radionuclides but higher inflow volumes in comparison to the other cribs. The 216-T-19TF Crib is reported to have received 455 x 10^6 L (120 x 10^6 gal) of inflow and less than 15 g (0.03 lb) of total plutonium. The 216-W-LWC Crib is reported to have received 1.2 x 10^9 L (317 x 10^6 gal) of waste effluent from the 200 West laundry facility. No inventory data has been calculated for this crib but its radionuclide loading is expected to be low based on available water quality information for the regulated radioactive portions of the laundry facility (WHC 1992a).

The physical and chemical settings for the releases from these waste management units are generally similar:

- Relatively large scale liquid releases (greater than 1 x 10^6 L) (264,000 gal) occurred at these waste management units and waste water probably reached the unconfined aquifer beneath the units (Table 4-13).

- The waste management units were completed at about the same depths and in the same stratigraphic horizons. The depth to groundwater is also similar for all of the units (57 to 66 m, 190 to 220 ft).

- The vadose zone stratigraphy is generally uniform beneath the aggregate area and would tend to favor the downward movement of fluid with little lateral spreading. The caliche layer, the primary vadose zone aquitard, occurs beneath each waste management unit.

The 216-T-18, 216-T-34 and 216-T-19TF Cribs are proposed for analog study. The 216-T-18 Crib was selected for study because it is representative of the 216-T-26 and 216-T-7TF Cribs that received first and second cycle supernate waste from the 221-T Building. In addition, it has the highest radionuclide inventory of the cribs.

The 216-T-34 Crib was selected for analog study because it received the largest volume of 300 Area Laboratory waste and is expected to be representative of the 216-T-27, 216-T-28, and 216-T-35 Cribs which also received 300 Area laboratory wastes.

The 216-T-19TF Crib and Tile Field was selected for analog study because it received a variety of waste effluents from 221-T and 224-T Buildings and the 242-T Evaporator. This is expected to be partially representative of the 216-T-6 and 216-T-32 Cribs.

The 216-W-LWC Crib is expected to be somewhat similar to the 216-T-19TF Crib in that is received a high volume of waste effluents but its contamination may be more mobile due to the use of surfactants and detergents in the 200 West laundry facility.

9.2.3.2 Trenches and Low Volume Cribs. A total of seventeen waste management units have been assigned to this analogous group based on receiving similar waste types and volumes. These units are:

- 216-T-5 Trench
- 216-T-9 Trench
- 216-T-12 Trench
- 216-T-14 Trench
- 216-T-15 Trench
- 216-T-16 Trench
- 216-T-17 Trench
- 216-T-20 Trench
- 216-T-21 Trench
- 216-T-22 Trench
- 216-T-23 Trench
- 216-T-24 Trench
- 216-T-25 Trench
- 216-T-8 Crib
- 216-T-29 Crib
- 216-T-33 Crib
- 216-T-36 Crib.

A comparison of the inventory listed in Table 2-2 shows trenches 216-T-14, -15, -16, -17, -21, -22, -23, -24, and -25 all received large volumes of ^{137}Cs ranging from a low of 162 grams (0.4 lbs) in the 216-T-17 Trench to a high of 3,860 grams (8.5 lbs) in the 216-T-25 Trench. The remainder of the trenches and cribs all received two to six orders of magnitude lower quantities of ^{137}Cs.

The physical and chemical settings for the releases from these waste management units are generally similar:

- Relatively large scale liquid releases (77,000 to 2,600,000 L) (20,000 to 690,000 gal) occurred at these waste management units and wastewater probably reached the unconfined aquifer beneath each unit (Table 4-12).

- All of the waste management units were installed near the surface in the upper coarse unit of the Hanford formation with a depth to groundwater of about 70 m (230 ft).

- The vadose zone stratigraphy is uniform beneath each of the waste management units. In particular, the caliche layer, the primary vadose zone aquitard, occurs beneath each of the waste management units.

The 216-T-22 Trench and the 216-T-25 Trench are proposed for analog study. The 216-T-22 Trench was selected for study because it contains a high concentration of ^{137}Cs and is representative of the 216-T-5, -14, -15, -16, -17, -21, -23, and -24 Trenches that received first- and second-cycle supernate from the 221-T Building.

The 216-T-25 Trench was also selected for analog study because it received the highest inventory of radionuclides and is thought to be representative of the worst-case trench.

Although not exact analogs, the remaining waste management units (216-T-9, -12, and -20 Trenches and 216-T-8, -29, -33, and -36 Cribs) are sufficiently similar to be represented by the two chosen analog units. The extent of contaminant migration these remaining facilities is expected to be much less than the analog sites. Therefore, an interim response measure chosen based on data from the analog sites will encompass the conditions anticipated in these units.

9.2.3.3 Ditches and Basin. Four waste management units have been assigned to the analogous group based on receiving similar waste types and volume. These units are:

- 216-T-1 Ditch (following deactivation in June 1995)

- 216-T-4-1D Ditch

- 216-T-4-2 Ditch (following deactivation in June 1995)

- 207-T Retention Basin (following deactivation in June 1995).

The 207-T Retention Basin is included in this analogous group because it is connected to the 216-T-4-2 Ditch and was previously connected to the 216-T-4-1D Ditch.

No waste inventory data is available for the ditches but it is known they all received large volumes of contaminated liquid that potentially flushed contaminants into the unconfined aquifer.

The 216-T-4-1D Ditch is proposed for analog study because it was known to have received high levels of radionuclides based on measured radiation levels of up to 20,000 ct/min in its sediments.

9.2.4 Proposed Sites for Final Remedy Selection

A number of unplanned releases, along with several diverse waste management units which are unique because of design, contaminants received, or operational history, have been proposed for the final remedy selection path. It was determined that sufficient information to directly include one french drain and three unplanned releases in the final remedy selection RA; these are discussed in Section 9.2.4.2. Inclusion in the aggregate area RI is recommended for the remainder of the waste management units and unplanned releases due to the lack of information to perform RAs and select final remedies. These waste management units and unplanned releases are discussed in Section 9.2.4.1.

9.2.4.1 Proposed Sites for Remedial Investigation Activities. A RI has been recommended for the T Plant Aggregate Area which includes several groups of waste management units and unplanned releases. The first group generally contains a mix of unique units which were assessed in the IRM path but had insufficient data to conduct an IRM. The second group consists of low priority ponds and trenches (dry trenches) which generally received one time transfers of waste. The third group contains septic tanks and drain fields which require confirmatory sampling to show that the sites do not contain hazardous or radioactive substances. The fourth group contains burial sites which require confirmatory sampling to show no contamination exists. The fifth group contains low priority unplanned releases which have unique contamination histories.

9.2.4.1.1 Reverse Wells. The two reverse wells within this group were high priority sites assessed in the IRM path. The reverse wells are unique sites for which an LFI is not likely to provide sufficient information to perform an IRM. The units include:

- 216-T-2 Reverse Well
- 216-T-3 Reverse Well.

The 216-T-3 Reverse Well is completed to a depth of 62 m (206 ft), 12 m (46 ft) above the water table. The close proximity to the water table suggests only a relatively small contamination zone may be present at a considerable depth. Confirmatory sampling as part

of the RI may indicate that the soil beneath the reverse well does not pose sufficient risk to require remediation.

The 216-T-2 Reverse Well was completed shallower then the 216-T-3 Reverse Well, but potential contamination is still expected to be a considerable depth, 30 m (75 ft), below the surface. Confirmatory sampling as part of the RI may indicate that the soil beneath this reverse well also does not pose sufficient risk to require remediation.

Insufficient data exists to directly include the reverse wells in the RA. Therefore, inclusion in the RI is recommended to provide data on the nature of contamination in the vadose zone below the reverse wells.

9.2.4.1.2 Ponds and Trenches. A RI is recommended to include the three T Plant Aggregate Area ponds and three trenches:

- 216-T-4A Pond
- 216-T-4B Pond
- 216-T-10 Trench
- 216-T-11 Trench
- 216-T-13 Trench.

These six waste management units all are low priority sites and they are not sufficiently similar to high priority units to warrant evaluation under the IRM path, so they could not be recommended for LFIs.

The 200-W Powerhouse Pond is an active unit and will be included in past practice investigation of the 216-U-14 Ditch, located in the U Plant Aggregate Area. Deactivation of the pond will remain with the on-going program which is the evaluation alternative to replace this unit by June 1995.

The three trenches (216-T-10, -11, and -13) have been exhumed to remove radiological contamination. Inclusion of these trenches in the RI was recommended because confirmatory sampling is likely to be required to verify that no chemical contamination still exists at the units.

Insufficient data exist at these units to conduct a RA. A RI is recommended which would include each of these units to provide nature and extent of contamination information to perform a RA for final remedy selection.

9.2.4.1.3 Septic Tanks and Drain Fields. The RI is recommended to include each of the septic tanks and drain fields:

- 2607-W1
- 2607-W2
- 2607-W3
- 2607-W4.

These four waste management units all have been assigned low HRS scores by comparison with other waste management units and they are not sufficiently similar to high priority units to warrant evaluation under the IRM path, so they could not be recommended for LFIs.

There are no sampling or inventory data for any of these units and so a RA cannot be performed. The purpose of a limited sampling program under a RI would be to confirm that no contamination exists in the septic tanks and sanitary drain fields. If no contamination is found, then no further action would likely be recommended.

9.2.4.1.4 Burial Sites. An aggregate area RI is recommended to include each of four burial sites:

- 200-W Ash Disposal Basin (Active)
- 200-W Powerhouse Ash Pit (Active)
- 200-W Burning Pit
- 218-W-8 Burial Ground.

The active waste management units will only be included in the RI if they are closed prior to initiation of RI activities, otherwise they will be investigated separately when they are deactivated.

The burial sites in this group are low priority units and they are not sufficiently similar to high priority units to warrant evaluation under the IRM path, so they could not be recommended for LFIs. The existing information (i.e., inventory and surface sampling data) on these units is not adequate to conduct a RA. Therefore, a RI is recommended which would include each of these units to provide nature and extent of contamination information to perform a RA for final remedy selection.

9.2.4.1.5 Unplanned Releases. Sixteen unplanned releases are recommended as candidates for inclusion in an aggregate area or operable unit RI. These unplanned releases are:

- UN-200-W-2
- UN-200-W-3
- UN-200-W-4
- UN-200-W-8
- UN-200-W-14
- UN-200-W-27
- UN-200-W-29
- UN-200-W-58
- UN-200-W-63
- UN-200-W-65
- UN-200-W-67
- UN-200-W-73
- UN-200-W-98
- UN-200-W-99
- UN-200-W-102
- UN-200-W-135.

Unplanned Releases UN-200-W-8, UN-200-W-29, UN-200-W-63, UN-200-W-65, UN-200-W-67, UN-200-W-73, UN-200-W-98, UN-200-W-99, UN-200-W-102, and UN-200-W-135 all have HRS scores below 28.5, and do not have sufficient data to conduct a risk assessment. Unplanned Releases UN-200-W-2, UN-200-W-3, UN-200-W-4, UN-200-W-14, UN-200-W-27, UN-200-W-58, and all have insufficient information available for HRS scoring.

A lack of soil sample data and inconsistent survey data prevent RA completion for these sixteen unplanned releases. RI has been recommended to provide enough data for a RA to be performed.

9.2.4.2 Proposed Sites for Risk Assessment. Four candidates have sufficient information for direct inclusion in the final RA under the final remedy selection path, including one french drain, and three unplanned releases:

- 216-T-31 French Drain
- UN-200-W-77
- UN-200-W-85
- UN-200-W-88.

The 216-T-31 French Drain was exhumed in 1959 and was assigned HRS and mHRS scores of 0.0. No organic material was found to have been discharged to this trench.

Unplanned Releases UN-200-W-85, and UN-200-W-88 resulted from contamination spread during transportation of contaminated materials. All detectable contamination associated with UN-200-W-85 and UN-200-W-88 was removed and these releases were assigned "low" HRS scores (less than 28.5) by comparison to other unplanned releases. Unplanned Release UN-200-W-77 resulted from the discovery of radioactive coyote feces. The feces were removed and no further contamination was identified.

It is recommended that a RA be performed encompassing each of these waste management units using available information. If the RA confirms that no contamination warranting remediation remains, it is likely that no further action will be required at these sites.

9.3 SOURCE OPERABLE UNIT REDEFINITION AND PRIORITIZATION

The investigation process can be made more efficient if units with similar histories and waste constituents are studied together. The data needs and remedial actions required for similar waste management units are generally the same. It is much easier to ensure a consistent level of effort and investigation methodology if like units are grouped together. Economies of scale also make the investigation process more cost effective if similar units are studied together.

9.3.1 Units Addressed by Other Aggregate Areas or Programs

One T Plant Aggregate Area waste management unit was recommended for inclusion in the U Plant Aggregate Area. The 200-W Powerhouse Pond has been mistakenly located in the T Plant Aggregate Area based on available information. The appropriate paper work needs to be initiated to have this mistake corrected in the Tri-Party Agreement.

A number of waste management units are associated with the operation of the single-shell tanks and should remain within the scope of the Single-Shell Tank Closure Program. This includes units listed in Table 9-3, which includes units located within the 241-T, -TX, and -TY Tank Farms in addition to three units located outside the tank farms:

- 241-TX-302C Catch Tank
- 241-TX-152 Diversion Box
- 241-TX-154 Diversion Box.

9.3.2 T Plant Operable Unit Redefinition

Redefinition of the 200-TP-1, -2, -3, -4, -5, -6, and -SS-1 Operable Units is suggested based on the data evaluation in this report. In general, it is recommended that:

Groundwater beneath the T Plant Aggregate Area interacts with all surrounding operable units since it is not confined by the geographic boundaries. The carbon tetrachloride plume from the nearby Plutonium Finishing Plant has migrated beneath the T Plant Aggregate Area. Similarly, the contamination originating from the operable units has migrated outside the boundaries of the operable unit. These interactions with other operable units will necessitate the integration of groundwater response actions throughout the 200 West Area. A 200-ZP-1 Groundwater Operable Unit has been recommended which includes the area defined by the hydraulic regime north of the 216-U-10 Pond. The 200-ZP Operable Units would be included with the 200-TP Operable Units in this groundwater operable unit. Perched water investigations would remain within the scope of the source operable units since this is generally a localized phenomena attributed to specific waste management units.

High-level waste transfer facilities and pipelines should remain within the scope of the Waste Management Program and the Decommissioning and RCRA Closure Program. The facilities are also structures with no unplanned releases and can be dealt with more efficiently in these existing Hanford programs. The Tri-Party Agreement does not include these lines within the scope of the past-practices investigations. Effluent transfer lines associated with individual waste management units will be investigated with the respective units.

It is recommended that the 200-TP-3 Operable Unit boundary be redefined to exclude the 218-W-3AE Burial Ground. A small portion of the burial ground falls within the boundary of this operable unit. The 218-W-3AE should be completely addressed under the 200-ZP-3 Operable Unit.

The 200-W Powerhouse Pond was incorrectly assigned to the T Plant Aggregate Area. The pond actually is within the area designated as the 200-UP-2 Operable Unit in the U Plant Aggregate Area. The pond was constructed by enlarging and enclosing the northern end of the 216-U-14 Ditch. The ditch, including the section occupied by the 200-W Powerhouse Pond, is within the U Plant Aggregate Area. Therefore, it is recommended that the 200-W Powerhouse Pond be designated as a U Plant Aggregate Area waste management unit.

9.3.3 Investigation Prioritization

Very little if any data exist to rank the waste management units and unplanned releases within the T Plant Aggregate Area on a risk-related basis. The HRS and surface contamination data which were used to sort the waste management units and unplanned releases into either high or low priority are indicators of potential risk but are not suitable to develop a risk-related ranking. The most useful data for indicating potential risk are probably the waste inventories and facility construction or operation information.

Based on available information about inventories of wastes and contaminants, facility construction, and operational history, it is recommended that investigations be prioritized as follows:

- Based on inventories of contaminants, the cribs and a french drain received the largest quantities of contamination and should be investigated first. The majority of the cribs and the french drain are located in the 200-TP-1, -2, and -4 Operable Units. The 200-TP-3 and 200-SS-2 Operable Units each contain four cribs. This prioritization is consistent with that developed in the Tri-Party Agreement.

- The 241-T, -TX, and -TY Tank Farms, located in the 200-TP-5 and 200-TP-6 Operable Units, are tied to separate milestones in the Tri-Party Agreement and therefore are not subject to prioritization.

- Other facilities which discharged liquid wastes that are not suspected of containing radionuclides and hazardous constituents, such as the septic tanks and associated sanitary drain fields, should be evaluated third.

Specific priorities for each waste management unit will be developed in subsequent work plans.

9.3.4 Resource Conservation and Recovery Act Facility Interface

A total of 45 RCRA facilities are located in the T Plant Aggregate Area as discussed in Section 2.6.1. Forty of these units are associated with the Single-Shell Tank Closure Program at the 241-T, -TX and -TY Tank Farms as listed in Table 9-3. Of the remaining five RCRA units, three are associated with buildings (CSTF, T Plant Treatment Tank, and TRUSAF) and have not resulted in any environmental releases as discussed in Section 2.6.

The remaining two TSD units are the 244-TX Receiving Tank and the 200-W Ash Pit Demolition Site. The active 244-TX Receiving Tank is located within the boundary of the 241-TX Tank Farm and is being addressed by the Waste Management Program. The 200-W Ash Pit Demolition Site is a TSD facility that is scheduled to submit a RCRA closure plan to Ecology and EPA by November 1992. The 200-W Ash Pit Demolition Site is located inside the 200-W Ash Pit Disposal Site which is an active facility. Closure of the 200-W Ash Pit Demolition Site is recommended to be performed under RCRA as tentatively planned but its cleanup levels should not exceed the background levels which exist in the 200-W Ash Disposal Basin which will be closed at a later date. If the concentrations are above all action levels for any compliance constituents, one of the following actions should be taken:

- If contamination is from 200-W Ash Pit Demolition Site activities only, soil should be removed and disposed of in a RCRA approved hazardous waste landfill.

- If the soil is contaminated with hazardous waste constituents from other sources in addition to 200-W Ash Demolition Pit Site activities, the soil should be treated or disposed of, under a RCRA clean up action or in coordination with CERCLA as part of the 200-SS-2 Operable Unit.

- If the soils are contaminated from other sources only, the site should be administratively closed as a RCRA site and remediated under CERCLA as part of the 200-SS-2 Operable Unit.

No unplanned releases are associated with any of the TSD units.

9.4 FEASIBILITY STUDY

Two types of the FS will be conducted to support remediation in the 200 Areas including focused and the final FS. The FFSs are studies in which a limited number of units or remedial alternatives are considered. Final FS will be prepared to provide the data necessary to support the preparation of final ROD. Insufficient data exists to prepare either a FFS or final FS for any units or group of units within the T Plant Aggregate Area. Sufficient data are considered available to prepare a FFS on selected remedial alternatives.

9.4.1 Focused Feasibility Study

Both LFIs and IRMs are planned for the T Plant Aggregate Area for individual waste management units or waste management unit groups. The IRMs will be implemented as they are approved, and the FFS will be prepared to support their implementation. The FFS applied in this manner is intended to examine a limited number of alternatives for a specific site or groups of sites. The FFS supporting IRMs will be based on the technology screening process applied in Section 7.0, engineering judgement, and/or new characterization data such as that generated by an LFI.

Recommendations for the FFS in support of IRMs are not provided in this report because of limited data availability. In most cases, LFIs will be conducted at sites initially identified for IRMs. The information gathered is considered necessary prior to making a final determination whether an IRM is actually necessary or whether a remedy can be selected.

Rather than being driven by an IRM, the FFS will also be prepared to evaluate select remedial alternatives. In this case the FFS focuses on technologies or alternatives that are considered to be viable based on their implementability, cost, and effectiveness and have broad application to a variety of sites. The following recommendations are made for FS that focus on a particular technology or alternative:

- Capping
- Ex situ treatment of contaminated soils
- In situ stabilization.

These recommendations reflect select technologies developed in Section 7.0 of this report.

The FFS is intended to provide a detailed analysis of select remedial alternatives. The results of the detailed analysis provide the basis for identifying preferred alternatives. The detailed analysis for alternatives consists of the following components:

- Further definition of each alternative, if appropriate, with respect to the volumes or areas of contaminated environmental media to be addressed, the technologies to be used, and any performance requirements associated with those technologies. Remedial investigations and treatability studies, if conducted, will also be used to further define applicable alternatives.

- An assessment and summary of each alternative against evaluation criteria specified in EPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA 1988b).

- A comparative analysis of the alternatives that will facilitate the selection of a remedial action.

9.4.2 Final Feasibility Study

To complete the remediation process for an aggregate area, a final or summary FS will be prepared. This study will address those sites not previously evaluated and will summarize the results of preceding evaluations. The overall study and evaluation process for an aggregate area will consist of a number of FFSs, field investigations, and interim RODs. All of this study information will be summarized in one final FS to provide the data necessary for the final ROD. The summary FS will likely be conducted on an aggregate area basis; however, future considerations may indicate that a larger scope is appropriate.

9.5 TREATABILITY STUDIES

A range of technologies which are likely to be considered for remediation of sites within the T Plant Aggregate Area were discussed in Section 7.3. The range of technologies included:

- Engineered multimedia cover
- In situ grouting
- Excavation and soil treatment
- In situ vitrification
- Excavation, treatment, and disposal of transuranic (TRU) radionuclides
- In situ soil vapor extraction of volatile organic compounds (VOCs).

Treatability testing will be required to conduct a detailed analysis for most of the technologies. Relevant EPA guidance will be relied upon to conduct these future treatability studies. A summary of existing programs and of treatability testing needs is as follows:

- Engineered multimedia cover--A number of cover design efforts have taken place in support of Hanford Site waste management, permitting, RARA and RCRA closure activities. Although performance testing is lacking, a number of conceptual cover designs have been developed for various types of waste management units. The feasibility/treatability process can be accelerated by utilizing existing cover design information. Long term performance and

maintenance objectives, and design criteria should be established for various categories of waste management units based on the degree of protection required. The adequacy of existing conceptual designs should be evaluated against these design criteria and modified appropriately. Hydrologic performance and constructibility data needs can then be assessed by pilot-scale testing of preliminary cover designs.

- In situ grouting--Field pilot tests would be required to assess the required injection well spacing and the optimum grout injection methods; bench-scale and pilot-scale tests would be required to demonstrate the effectiveness for stabilizing the contaminants.

- Excavation and soil treatment--Testing will likely be required for several components of an excavation and treatment system. It is anticipated that the waste management units would be excavated with conventional mining and construction equipment. However, some equipment modifications may be required to ensure worker protection. If available, remote excavation equipment could be utilized to protect workers at waste management units containing high exposure potential. Testing of measures to control fugitive dust during retrieval activities will be required.

  The testing required for the treatment process will depend on the type of treatment considered and the site-specific conditions. It is anticipated that most of the treatability information required could be obtained by a combination of literature research, laboratory screening, and bench-scale studies. However, pilot-scale testing may be required for certain treatment processes.

  Physical separation (i.e., soil washing) pilot-scale treatability testing within the 300-FF-I Operable Unit is being planned which will be applicable for the 200 Areas. The soils of the Hanford Site are well suited for treatment with a physical separations process. The soils are predominantly coarse sand and gravel, with less than 10% silts and clay. It is expected that contaminants will be found largely adsorbed on the smaller soil particles and as coatings on larger particles. The physical soil washing process should provide removal of the precipitate coatings from the large particles and separation of large from small particles. This would result in a large volume reduction by separating and concentrating the contaminants.

  The physical separations test in the 300-FF-1 Operable Unit will be conducted in three phases. In Phase I, soils will be characterized to assess physical, chemical, and radioactive properties. Phase II testing will establish baseline operations and capabilities of a system utilizing water as the washing solution. In Phase III, performance of the system will be optimized. Phase III may consist of two parts,

processing with water only, and processing using selected nonhazardous and environmentally acceptable chemical extractants, if necessary to optimize the system. Laboratory bench tests may be performed to determine the primary and secondary chemical extractants to be considered for use in Phase III testing. However, it is anticipated that in the 300 Area, physical separation resulting in a large volume reduction of contaminated soil may be achieved with water only. Chemical extracts maybe required for soil washing to be successful in other areas of the Hanford Site (i.e., 200 and 100 Areas). This will depend to a large extent on the type of contaminant at the adsorption coefficient.

If the pilot-scale test is successful in the 300 Area, then the application of this process to the 200 Areas should be tested.

- In situ vitrification--In situ vitrification has been tested and field demonstrated on soil sites contaminated with radionuclides, heavy metals, and organic wastes. As a result of this testing and demonstration program, established capabilities and limitations of the in situ vitrification technology have been identified, along with technical issues that need to be resolved for successful implementation. The In Situ Vitrification Integrated Program was created by DOE's office of Technology Development to help resolve these issues and promote deployment of the technology in the field. The In Situ Vitrification Integrated Program is currently working to resolve the following key issues for implementation at contaminated soil sites:

  - Develop methods that accurately predict, measure, and achieve significantly greater melt depth and control of the melt shape. Presently, the in situ vitrification process has been demonstrated to a depth of 5 m (16 ft).

  - Improve the understanding of and verify VOC contaminant transport behavior.

  - Determine the potential for transient gas release events while vitrifying contaminated soils under varying conditions. Better define operating parameters and limits to ensure containment and treatment of offgases during processing.

  - Resolve secondary waste generation and handling concerns as they relate to the volatilization of ^{137}Cs from highly concentrated soils.

  Other DOE in situ vitrification related activities include evaluating the cost of in situ vitrification against other technologies (report to be released before fiscal year end) and a field demonstration at the Idaho National Engineering Laboratory (INEL) during fiscal year 1993. Additional field demonstrations will be required

before all issues surrounding implementation of in situ vitrification to contaminated soil sites can be resolved.

There is a large uncertainty whether the In Situ Vitrification Integrated Program will obtain the funding required to resolve these issues. Without resolution of these issues in situ vitrification will have very limited application to remediation at the Hanford Site.

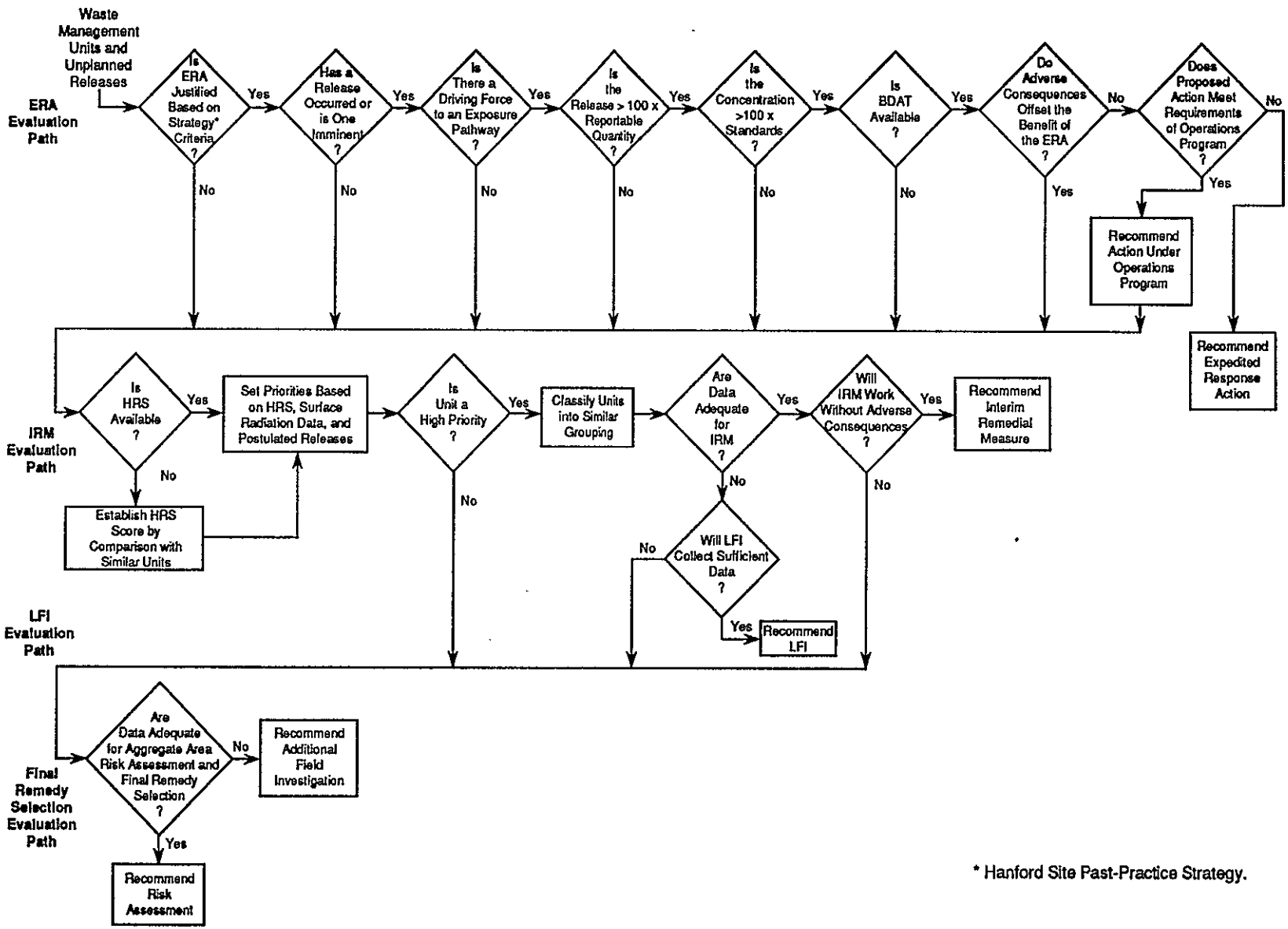
- Excavation, treatment and disposal of transuranic radionuclides--Development and testing of methods to characterize, retrieve, treat, and package waste from TRU contaminated waste management units will be required. The DOE Office of Technology Development has established the Buried Waste Integrated Demonstration (BWID) at INEL to resolve these issues. The BWID is focused on sites containing buried waste; however, it is expected that many of the original containers at INEL degraded significantly, resulting in contamination of the immediately surrounding soil. As a result, the BWID will also be resolving some of the issues surrounding retrieval and treatment of TRU contaminated soil.

  A major concern for retrieval of TRU contaminated materials will be control of fugitive dust. Testing of various types of foams and fixants, that will not interfere with treatment and disposal, will be required. In addition, development of foams and fixants for dust control will be important for non-TRU contaminated waste management units. The use of containment structures (e.g. buildings) to contain fugitive dust during remediation is very expensive and cumbersome (creating problems for both equipment and workers). A significant cost savings could be realized if foams and fixants are used in place of containment structures.

- In situ soil vapor extraction of volatile organic compounds--Development and testing of methods to characterize, retrieve, and treat waste from VOC contaminated soil will be required. The DOE has established the VOC-Arid Integration Demonstration to resolve these issues. The Z Plant Aggregate Area is currently the initial host site for the demonstration and is associated with an active ERA to remove carbon tetrachloride from the vadose zone using vapor extraction. These activities are expected to resolve numerous design and treatability issues associated with in situ soil vapor extraction. However, additional treatability testing may be required to resolve site specific data needs.

As treatability testing of the various alternatives progresses, other parameters are likely to be identified which require further development.

9 3 1 2 9 7 0 1 2 6 4



* Hanford Site Past-Practice Strategy.

Figure 9-1. 200 Aggregate Area Management Study Data Evaluation Process.

Table 9-1. Summary of the Results of Data Evaluation Process Assessment.

Waste Management Unit or Unplanned Release Site	Operable Unit	ERA	IRM	LFI	RA	RI	OPS	Remarks
Tanks and Vaults								
241-T-361 Settling Tank	200-TP-4	--	X	X	--	--	--	
Cribs and Drains								
216-T-6 Crib	200-TP-3	--	X	X	--	--	X	RARA - cave-in potential
216-T-7TF Crib and Tile Field	200-TP-1	--	X	X	--	--	X	RARA - cave-in potential
216-T-8 Crib	200-TP-4	--	X	X	--	--	X	RARA - cave-in potential
216-T-18 Crib	200-TP-4	--	X	X	--	--	--	
216-T-19TF Crib and Tile Field	200-TP-2	--	X	X	--	--	X	RARA - cave-in potential
216-T-26 Crib	200-TP-2	--	X	X	--	--	--	
216-T-27 Crib	200-TP-2	--	X	X	--	--	--	
216-T-28 Crib	200-TP-2	--	X	X	--	--	--	
216-T-29 Crib	200-TP-4	--	X	X	--	--	--	
216-T-31 French Drain	200-TP-2	--	--	--	X	--	--	Exhumed
216-T-32 Crib	200-TP-1	--	X	X	--	--	X	RARA - cave-in potential
216-T-33 Crib	200-TP-4	--	X	X	--	--	--	
216-T-34 Crib	200-TP-4	--	X	X	--	--	--	
216-T-35 Crib	200-TP-4	--	X	X	--	--	--	

Table 9-1. Summary of the Results of Data Evaluation Process Assessment.

Waste Management Unit or Unplanned Release Site	Operable Unit	ERA	IRM	LFI	RA	RI	OPS	Remarks
216-T-36 Crib	200-TP-1	--	X	X	--	--	--	
216-W-LWC Crib	200-SS-2	--	X	X	--	--	X	WMP Active - closed by 6/95
Reverse Wells								
216-T-2 Reverse Well	200-TP-4	--	--	--	--	X	--	
216-T-3 Reverse Well	200-TP-4	--	--	--	--	X	--	
Ponds, Ditches, and Trenches								
216-T-4A Pond	200-TP-3	--	--	--	--	X	--	
216-T-4B Pond	200-TP-3	--	--	--	--	X	--	Active - close by 6/95
216-T-1 Ditch	200-TP-4	--	X	X	--	--	--	Active - close by 6/95
216-T-4-1D Ditch	200-TP-3	--	X	X	--	--	--	
216-T-4-2 Ditch	200-TP-3	--	X	X	--	--	X	WMP Active - close by 6/95
200-W Powerhouse Pond	200-TP-2	--	--	--	--	X	--	Active - close by 6/95
216-T-5 Trench	200-TP-1	--	X	X	--	--	--	
216-T-9 Trench	200-TP-4	--	X	X	--	--	--	
216-T-10 Trench	200-TP-4	--	--	--	--	X	--	Exhumed
216-T-11 Trench	200-TP-4	--	--	--	--	X	--	Exhumed
216-T-12 Trench	200-TP-3	--	X	X	--	--	--	
216-T-13 Trench	200-TP-2	--	--		--	X	--	Exhumed

Table 9-1. Summary of the Results of Data Evaluation Process Assessment.

Waste Management Unit or Unplanned Release Site	Operable Unit	ERA	IRM	LFI	RA	RI	OPS	Remarks
216-T-14 Trench	200-TP-3	--	X	X	--	--	--	
216-T-15 Trench	200-TP-3	--	X	X	--	--	--	
216-T-16 Trench	200-TP-3	--	X	X	--	--	--	
216-T-17 Trench	200-TP-3	--	X	X	--	--	--	
216-T-20 Trench	200-TP-2	--	X	X	--	--	--	
216-T-21 Trench	200-TP-1	--	X	X	--	--	--	
216-T-22 Trench	200-TP-1	--	X	X	--	--	--	
216-T-23 Trench	200-TP-1	--	X	X	--	--	--	
216-T-24 Trench	200-TP-1	--	X	X	--	--	--	
216-T-25 Trench	200-TP-1	--	X	X	--	--	--	
Septic Tanks and Associated Drain Fields								
2607-W1 Septic Tank	200-SS-2	--	--	--	--	X	--	Active
2607-W2 Septic Tank	200-SS-2	--	--	--	--	X	--	Active
2607-W3 Septic Tank	200-TP-4	--	--	--	--	X	--	Active
2607-W4 Septic Tank	200-TP-4	--	--	--	--	X	--	Active
Basins								
207-T Retention Basin	200-TP-3	--	X	X	--	--	--	
Burial Sites								
200-W Ash Disposal Basin	200-SS-2	--	--	--	--	X	--	Active

Table 9-1. Summary of the Results of Data Evaluation Process Assessment.

Waste Management Unit or Unplanned Release Site	Operable Unit	ERA	IRM	LFI	RA	RI	OPS	Remarks
200-W Burning Pit	200-SS-2	--	--	--	--	X	--	
200-W Powerhouse Ash Pit	200-SS-2	--	--	--	--	X	--	Active
218-W-8 Burial Ground	200-TP-4	--	--	--	--	X	X	RARA cave-in potential
Unplanned Releases								
UN-200-W-2	200-TP-4	--	--	--	--	X	--	
UN-200-W-3	200-TP-4	--	--	--	--	X	--	
UN-200-W-4	200-TP-4	--	--	--	--	X	--	
UN-200-W-8	200-TP-4	--	--	--	--	X	--	
UN-200-W-14	200-TP-2	--	--	--	--	X	--	
UN-200-W-27	200-TP-4	--	--	--	--	X	--	
UN-200-W-29	200-TP-2	--	--	--	--	X	--	
UN-200-W-58	200-TP-4	--	--	--	--	X	--	
UN-200-W-63	200-TP-3	--	--	--	--	X	--	Exhumed/covered
UN-200-W-65	200-TP-4	--	--	--	--	X	--	
UN-200-W-67	200-TP-4	--	--	--	--	X	--	
UN-200-W-73	200-TP-4	--	--	--	--	X	--	
UN-200-W-77	200-TP-4	--	--	--	X	--	--	Exhumed
UN-200-W-85	200-TP-4	--	--	--	X	--	--	Exhumed
UN-200-W-88	200-SS-2	--	--	--	X	--	--	Exhumed

Table 9-1. Summary of the Results of Data Evaluation Process Assessment.

Waste Management Unit or Unplanned Release Site	Operable Unit	ERA	IRM	LFI	RA	RI	OPS	Remarks
UN-200-W-98	200-TP-4	--	--	--	--	X	--	
UN-200-W-99	200-TP-2	--	--	--	--	X	--	
UN-200-W-102	200-TP-4	--	--	--	--	X	--	
UN-200-W-135	200-TP-2	--	--	--	--	X	--	

Notes: ERA- Expediated Response Action
IRM- Interim Remedial Measure
LFI- Limited Field Investigation
OPS- Operational Programs
RA- Risk Assessment
RARA- Radiation Area Remedial Action Program
RI- Remedial Investigation/Feasibility Study
WMP- Waste Management Program

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Table 9-2. T Plant Aggregate Area Data Evaluation Decision Matrix.

Waste Management Unit	ERA EVALUATION PATH								IRM EVALUATION PATH			LH PATH	FINAL REMEDY
	Is an ERA Justified?	Release?	Pathway?	Quantity?	Concentration?	Technology Available?	Adverse Consequences?	Operational Programs?	High Priority?	Data Adequate?	No Adverse Consequences?	Collect Data?	Data Adequate?
Tanks and Vaults													
241-T-361 Settling Tank	Y	Y	N	-	-	-	-	-	Y	N	-	Y	-
Cribs and Drains													
216-T-6 Crib	Y	Y	Y	Y	Y	Y	N	Y	N[a]	N	-	Y	-
216-T-7TF Crib and Tile Field	Y	Y	Y	Y	Y	Y	N	Y	Y	N	-	Y	-
216-T-8 Crib	Y	Y	Y	Y	Y	Y	N	Y	Y	N	-	Y	-
216-T-18 Crib	Y	Y	N	-	-	-	-	-	N[a]	N	-	Y	-
216-T-19TF Crib and Tile Field	Y	Y	Y	Y	Y	Y	N	Y	Y	N	-	Y	-
216-T-26 Crib	Y	Y	N	-	-	-	-	-	Y	N	-	Y	-
216-T-27 Crib	Y	Y	N	-	-	-	-	-	Y	N	-	Y	-
216-T-28 Crib	Y	Y	N	-	-	-	-	-	Y	N	-	Y	-
219-T-29 Crib	Y	Y	N	-	-	-	-	-	Y[a]	N	-	-	-
216-T-31 French Drain	N	-	-	-	-	-	-	-	N	-	-	-	Y
216-T-32 Crib	Y	Y	Y	Y	Y	Y	N	Y	N[a]	N	-	Y	-
216-T-33 Crib	Y	Y	N	-	-	-	-	-	Y	N	-	Y	-
216-T-34 Crib	Y	Y	N	-	-	-	-	-	Y	N	-	Y	-
216-T-35 Crib	Y	Y	N	-	-	-	-	-	Y	N	-	Y	-
216-T-36 Crib	Y	Y	N	-	-	-	-	-	Y	N	-	Y	-
216-W-LWC Crib	Y	Y	Y	Y	Y	Y	N	Y	Y	N	-	Y	-

Table 9-2. T Plant Aggregate Area Data Evaluation Decision Matrix.

Waste Management Unit	ERA EVALUATION PATH								IRM EVALUATION PATH			LFI PATH	FINAL REMEDY
	Is an ERA Justified?	Release?	Pathway?	Quantity?	Concentration?	Technology Available?	Adverse Consequences?	Operational Programs?	High Priority?	Data Adequate?	No Adverse Conseq uences?	Collect Data?	Data Adequate?
Reverse Wells													
216-T-2 Reverse Well	Y	Y	N	-	-	-	-	-	Y	N	-	N	N
216-T-3 Reverse Well	Y	Y	N	-	-	-	-	-	Y	N	-	N	N
Ponds, Ditches, and Trenches													
216-T-4A Pond	Y	Y	N	-	-	-	-	-	N	-	-	-	N
216-T-4B Pond	Y	Y	Y	Y	N	-	-	-	N	-	-	-	N
216-T-1 Ditch	Y	Y	Y	Y	N	-	-	-	Y	N	-	Y	-
216-T-4-1D Ditch	Y	Y	N	-	-	-	-	-	N[a]	N	-	Y	-
216-T-4-2 Ditch	Y	Y	Y	Y	Y	Y	N	Y	Y	N	-	Y	-
200-W Powerhouse Pond	N	-	-	-	-	-	-	-	N	-	-	-	N
216-T-5 Trench	Y	Y	N	-	-	-	-	-	N[a]	N	-	Y	-
216-T-9 Trench	Y	Y	N	-	-	-	-	-	N[a]	N	-	Y	-
216-T-10 Trench	N	-	-	-	-	-	-	-	N	-	-	-	N
216-T-11 Trench	N	-	-	-	-	-	-	-	N	-	-	-	N
216-T-12 Trench	Y	Y	N	-	-	-	-	-	Y	N	-	Y	-
216-T-13 Trench	N	-	-	-	-	-	-	-	N	-	-	-	N
216-T-14 Trench	Y	Y	N	-	-	-	-	-	Y	N	-	Y	-
216-T-15 Trench	Y	Y	N	-	-	-	-	-	Y	N	-	Y	-
216-T-16 Trench	Y	Y	N	-	-	-	-	-	Y	N	-	Y	-
216-T-17 Trench	Y	Y	N	-	-	-	-	-	Y	N	-	Y	-

Table 9-2. T Plant Aggregate Area Data Evaluation Decision Matrix.

Waste Management Unit	ERA EVALUATION PATH								IRM EVALUATION PATH			LFI PATH	FINAL REMEDY
	Is an ERA Justified?	Release?	Pathway?	Quantity?	Concentration?	Technology Available?	Adverse Consequences?	Operational Programs?	High Priority?	Data Adequate?	No Adverse Consequences?	Collect Data?	Data Adequate?
216-T-20 Trench	Y	Y	N	-	-	-	-	-	N[2/]	N	-	Y	-
216-T-21 Trench	Y	Y	N	-	-	-	-	-	N[2/]	N	-	Y	-
216-T-22 Trench	Y	Y	N	-	-	-	-	-	N[2/]	N	-	Y	-
216-T-23 Trench	Y	Y	N	-	-	-	-	-	N[2/]	N	-	Y	-
216-T-24 Trench	Y	Y	N	-	-	-	-	-	N[2/]	N	-	Y	-
216-T-25 Trench	Y	Y	N	-	-	-	-	-	N[2/]	N	-	Y	-
Septic Tanks and Associated Drain Fields													
2607-W1 Septic Tank	N	-	-	-	-	-	-	-	N	-	-	-	N
2607-W2 Septic Tank	N	-	-	-	-	-	-	-	N	-	-	-	N
2607-W3 Septic Tank	N	-	-	-	-	-	-	-	N	-	-	-	N
2607-W4 Septic Tank	N	-	-	-	-	-	-	-	N	-	-	-	N
Basins													
207-T Retention Basin	Y	Y	Y	Y	N	-	-	-	Y	N	-	Y	-
Burial Sites													
200-W Ash Disposal Basin	N	-	-	-	-	-	-	-	N	-	-	-	N
200-W Burning Pit	N	-	-	-	-	-	-	-	N	-	-	-	N
200-W Powerhouse Ash Pit	N	-	-	-	-	-	-	-	N	-	-	-	N
218-W-8 Burial Ground	Y	Y	Y	Y	Y	Y	N	Y	N	-	-	-	N
Unplanned Releases													
UN-200-W-2	Y	Y	N	-	-	-	-	-	N	-	-	-	N

Table 9-2. T Plant Aggregate Area Data Evaluation Decision Matrix.

Waste Management Unit	ERA EVALUATION PATH								IRM EVALUATION PATH			LH PATH	FINAL REMEDY
	Is an ERA Justified?	Release?	Pathway?	Quantity?	Concentration?	Technology Available?	Adverse Consequences?	Operational Programs?	High Priority?	Data Adequate?	No Adverse Consequences?	Collect Data?	Data Adequate?
UN-200-W-3	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UN-200-W-4	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UN-200-W-8	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UN-200-W-14	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UN-200-W-27	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UN-200-W-29	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UN-200-W-58	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UN-200-W-63	N	-	-	-	-	-	-	-	N	-	-	-	Y
UN-200-W-65	Y	Y	N	-	-	-	-	-	Y	N	-	N	N
UN-200-W-67	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UN-200-W-73	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UN-200-W-77	N	-	-	-	-	-	-	-	N	-	-	-	Y
UN-200-W-85	N	-	-	-	-	-	-	-	N	-	-	-	Y
UN-200-W-88	N	-	-	-	-	-	-	-	N	-	-	-	Y
UN-200-W-98	Y	Y	N	-	-	-	-	-	Y	N	-	N	N
UN-200-W-99	Y	Y	N	-	-	-	-	-	Y	N	-	N	N
UN-200-W-102	Y	Y	N	-	-	-	-	-	N	-	-	-	N
UN-200-W-135	Y	Y	N	-	-	-	-	-	N	-	-	-	N

[a] Evaluated as high priority unit because of similarities with high priority units.

Table 9-3. Waste Management Units and Unplanned Releases Addressed by Other Programs.

Site Name	Site Type	Program	Active/Inactive	Operable Unit
Tanks and Vaults				
241-T-101	Single-Shell Tank	SSTCP	Inactive	200-TP-6
241-T-102	Single-Shell Tank	SSTCP	Inactive	200-TP-6
241-T-103	Single-Shell Tank	SSTCP	Inactive	200-TP-6
241-T-104	Single-Shell Tank	SSTCP	Inactive	200-TP-6
241-T-105	Single-Shell Tank	SSTCP	Inactive	200-TP-6
241-T-106	Single-Shell Tank	SSTCP	Inactive	200-TP-6
241-T-107	Single-Shell Tank	SSTCP	Inactive	200-TP-6
241-T-108	Single-Shell Tank	SSTCP	Inactive	200-TP-6
241-T-109	Single-Shell Tank	SSTCP	Inactive	200-TP-6
241-T-110	Single-Shell Tank	SSTCP	Inactive	200-TP-6
241-T-111	Single-Shell Tank	SSTCP	Inactive	200-TP-6
241-T-112	Single-Shell Tank	SSTCP	Inactive	200-TP-6
241-T-201	Single-Shell Tank	SSTCP	Inactive	200-TP-6
241-T-202	Single-Shell Tank	SSTCP	Inactive	200-TP-6
241-T-203	Single-Shell Tank	SSTCP	Inactive	200-TP-6
241-T-204	Single-Shell Tank	SSTCP	Inactive	200-TP-6
241-TX-101	Single-Shell Tank	SSTCP	Inactive	200-TP-5
241-TX-102	Single-Shell Tank	SSTCP	Inactive	200-TP-5
241-TX-103	Single-Shell Tank	SSTCP	Inactive	200-TP-5
241-TX-104	Single-Shell Tank	SSTCP	Inactive	200-TP-5
241-TX-105	Single-Shell Tank	SSTCP	Inactive	200-TP-5
241-TX-106	Single-Shell Tank	SSTCP	Inactive	200-TP-5
241-TX-107	Single-Shell Tank	SSTCP	Inactive	200-TP-5
241-TX-108	Single-Shell Tank	SSTCP	Inactive	200-TP-5
241-TX-109	Single-Shell Tank	SSTCP	Inactive	200-TP-5
241-TX-110	Single-Shell Tank	SSTCP	Inactive	200-TP-5
241-TX-111	Single-Shell Tank	SSTCP	Inactive	200-TP-5
241-TX-112	Single-Shell Tank	SSTCP	Inactive	200-TP-5
241-TX-113	Single-Shell Tank	SSTCP	Inactive	200-TP-5
241-TX-114	Single-Shell Tank	SSTCP	Inactive	200-TP-5
241-TX-115	Single-Shell Tank	SSTCP	Inactive	200-TP-5
241-TX-116	Single-Shell Tank	SSTCP	Inactive	200-TP-5
241-TX-117	Single-Shell Tank	SSTCP	Inactive	200-TP-5
241-TX-118	Single-Shell Tank	SSTCP	Inactive	200-TP-5
141-TY-101	Single-Shell Tank	SSTCP	Inactive	200-TP-5
241-TY-102	Single-Shell Tank	SSTCP	Inactive	200-TP-5
241-TY-103	Single-Shell Tank	SSTCP	Inactive	200-TP-5
241-TY-104	Single-Shell Tank	SSTCP	Inactive	200-TP-5
241-TY-105	Single-Shell Tank	SSTCP	Inactive	200-TP-5
241-TY-106	Single-Shell Tank	SSTCP	Inactive	200-TP-5
241-T-301	Catch Tank	SSTCP	Inactive	200-TP-6
241-T-302	Catch Tank	SSTCP	Inactive	200-TP-6

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Table 9-3. Waste Management Units and Unplanned Releases Addressed by Other Programs. Page 2 of 2

Site Name	Site Type	Program	Active/Inactive	Operable Unit
241-TX-302A	Catch Tank	SSTCP	Inactive	200-TP-5
241-TX-302B	Catch Tank	SSTCP	Inactive	200-TP-2
241-TX-302C	Catch Tank	WMP	Active	200-TP-4
241-TY-302A	Catch Tank	SSTCP	Inactive	200-TP-5
241-TY-302B	Catch Tank	SSTCP	Inactive	200-TP-5
244-TX	Receiver Tank	WMP	Active	200-TP-5
244-TXR	Vault	SSTCP	Inactive	200-TP-5
Septic Tanks and Associated Drain Fields				
2607-WT	Septic Tank	SSTCP	Active	200-TP-5
2607-WTX	Septic Tank	SSTCP	Active	200-TP-5
Transfer Facilities, Diversion Boxes, and Pipelines				
241-T-151	Diversion Box	SSTCP	Inactive	200-TP-6
241-T-152	Diversion Box	SSTCP	Inactive	200-TP-6
241-T-153	Diversion Box	SSTCP	Inactive	200-TP-6
241-T-252	Diversion Box	SSTCP	Inactive	200-TP-6
241-TR-152	Diversion Box	SSTCP	Inactive	200-TP-6
241-TR-153	Diversion Box	SSTCP	Inactive	200-TP-6
241-TX-152	Diversion Box	WMP	Active	200-TP-2
241-TX-153	Diversion Box	SSTCP	Inactive	200-TP-5
241-TX-154	Diversion Box	WMP	Active	200-TP-4
241-TX-155	Diversion Box	SSTCP	Inactive	200-TP-2
241-TXR-151	Diversion Box	SSTCP	Inactive	200-TP-2
241-TXR-152	Diversion Box	SSTCP	Inactive	200-TP-5
241-TXR-153	Diversion Box	SSTCP	Inactive	200-TP-5
241-TY-153	Diversion Box	SSTCP	Inactive	200-TP-5
242-T-151	Diversion Box	SSTCP	Inactive	200-TP-5
Burial Site				
200-W	Ash Pit Demolition	RCRA	Active	200-SS-2
Unplanned Releases				
UN-200-W-7	Unplanned Release[a]	SSTCP	Inactive	200-TP-3
UN-200-W-17	Unplanned Release	SSTCP	Inactive	200-TP-5
UN-200-W-38	Unplanned Release[a]	SSTCP	Inactive	200-TP-4
UN-200-W-62	Unplanned Release	SSTCP	Inactive	200-TP-6
UN-200-W-64	Unplanned Release	SSTCP	Inactive	200-TP-6
UN-200-W-76	Unplanned Release	SSTCP	Inactive	200-TP-5
UN-200-W-97	Unplanned Release	SSTCP	Inactive	200-TP-6
UN-200-W-100	Unplanned Release	SSTCP	Inactive	200-TP-5
UN-200-W-113	Unplanned Release[a]	SSTCP	Inactive	200-TP-2

RCRA - RCRA TSD Facility
WMP - Waste Management Program
SSTCP - Single-Shell Tank Closure Program
[a] Associated with a diversion box

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Westinghouse Hanford Company
Aggregate Area Management Studies

T PLANT AGGREGATE AREA
PLATE 1 – Facilities, Sites, & Unplanned Releases

LEGEND

- Aggregate Area Boundary
- Security Systems/Fences
- Perimeter Boundary
- Buildings

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T PLANT AGGREGATE AREA
PLATE 2 - Topography

LEGEND

- Aggregate Area Boundary
- Security Systems/Fences
- Perimeter Boundary
- Buildings

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T PLANT AGGREGATE AREA
PLATE 3 - Monitor Wells & Sample Locations

LEGEND

- Aggregate Area Boundary
- Security Systems/Fences
- Perimeter Boundary
- Buildings

APPENDIX A

SUPPLEMENTAL DATA

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1.0 SUBSURFACE GEOPHYSICAL LOGS

Geophysical well logging has been conducted at the T Plant Aggregate Area since at least as early as 1954, as a surveillance technique to evaluate radionuclide migration in the unsaturated zone underlying or adjacent to waste disposal or storage areas. Vadose-zone monitoring wells ("drywells") and groundwater monitoring wells have been constructed at many of the T Plant Aggregate Area waste management units. Geophysical well logs have been acquired from monitoring wells at the following 23 waste management units, the remaining waste management units did not have monitoring structures in the immediate vicinity:

- 216-T-3 Reverse well
- 216-T-6 Crib
- 216-T-7 Crib
- 216-T-18 Crib
- 216-T-19 Crib
- 216-T-26 Crib
- 216-T-27 Crib
- 216-T-28 Crib
- 216-T-32 Crib
- 216-T-33 Crib
- 216-T-34 Crib
- 216-T-35 Crib
- 216-T-36 Crib
- 216-T-5 Trench
- 216-T-14 Trench
- 216-T-15 Trench
- 216-T-16 Trench
- 216-T-17 Trench
- 216-T-21 Trench
- 216-T-22 Trench
- 216-T-23 Trench
- 216-T-24 Trench
- 216-T-25 Trench.

As part of this Aggregate Area Management Study, select geophysical well logs from these 23 waste management units were examined to provide a preliminary appraisal of migration of radionuclides in the unsaturated zone. RCRA Groundwater monitoring wells and other dry wells listed in Section 4.1 were eliminated from this analysis if they failed to meet screening criteria. Three of the units: the 216-T-18, -19, and -33 Cribs were not included in this review because no additional well logging information was available from the previous evaluation conducted by Fecht et al. (1977). The results of the Fecht analysis for these units are summarized in Section 1.5 of this Appendix.

The objectives of the geophysical well log study were to qualitatively evaluate the extent and rate of vertical and lateral migration of radionuclides. Several previously conducted studies provide important background information. Most notable is a three-volume document by Fecht et al. (1977), in which gross gamma-ray logs were reviewed and evaluated for potential contamination. Several additional published and unpublished documents exist such as gross-gamma logs acquired from the 241-T Tank Farm area (Jensen 1976), periodic reports (Hanlon 1991), and miscellaneous and archived reports in the Tank Farm Surveillance Group files. Pertinent results of previously conducted studies or observations are discussed along with results of this study in sections describing individual waste management units.

The following vadose zone fluid migration pathways have been recognized in the 200 West Area: (1) vertical downward migration, (2) lateral migration at the interface of an underlying coarser-grained zone or low permeability zone, (3) a combination of vertical and lateral migration that may be manifested in adjacent wells as digitate clean and contaminated zones, and (4) vertical downward migration along the well casings in poorly constructed wells. Additional complications in interpreting the migration of contaminants include the natural decay of radionuclides and the different migration rates of various radionuclides.

1.1 AVAILABLE GEOPHYSICAL WELL LOGS

The array of geophysical logs acquired from the T Plant Aggregate Area includes gross gamma-ray logs, gamma-gamma logs, neutron-epithermal-neutron logs, density logs, sonic logs, and temperature logs. To date, no spectral gamma-ray logs have been acquired from T Plant Aggregate Area wells. The gross gamma-ray log was by far the most common log acquired, and, with the exception of the spectral gamma-ray log, is the most useful for evaluating migration of anthropogenic radionuclides in the unsaturated zone. Ancillary logs, such as the neutron and density logs, may also provide useful information. The interpretation of the ancillary logs, however, is complicated by several factors, including: the presence of multiple casing strings, the complications of logging in unsaturated zones, uncertainties in well construction and modifications, and questionable tool geometry and response characteristics. Consequently, the ancillary logs were not evaluated as part of this study.

Nearly all of the available gross gamma-ray logs have been acquired from T Plant Aggregate Area monitoring wells by the Westinghouse Hanford Company (Westinghouse Hanford) Tank Farm Surveillance Group or the Pacific Northwest Laboratory (PNL) under contract by the primary U.S. Department of Defense (DOD) Westinghouse Hanford contractor.

The PNL began recording gross gamma-ray logs from T Plant Aggregate Area monitoring wells in 1958. On the basis of log presentation, three generations of logging equipment have been used in the T Plant Aggregate Area since 1958. However, based on conversations with long-term Westinghouse Hanford and PNL employees, several more subtle equipment modifications were made within generations of logging equipment. In fact,

judging from the normalization factors used by Fecht et al. (1977), procedural or equipment modifications may even have been made annually. Beginning in 1982, procedures were implemented to improve log quality and consistency. Further improvements in logging procedures were implemented in 1989. Since 1976, two probes with similar response characteristics have been used by PNL. Beginning in 1982, the serial number of the probe used has been recorded on the log header. Detailed logging procedures are described in WHC (1991).

The gross gamma-ray logs utilized for this study are listed in Tables 1 through 7. The logs listed in Tables 1 through 7 constitute a comprehensive list of all logs acquired in the T Plant Aggregate Area through 1990.

1.2 LOG QUALITY

An assessment of gross gamma-ray log quality is difficult, particularly for the very early logs, because of a lack of accessible documentation of procedures and results. Evaluation of log quality ultimately encompasses a large number of factors including documentation of design specifications, modifications, and repairs; detailed performance tests of probes and instrumentation; evaluation of the precision and accuracy of the depth measurement system; and probe response; and periodic calibration. Of equal importance to equipment considerations is documentation of monitoring well construction and modifications ("as-built" diagrams) and reference elevations. The PNL has vastly improved their quality control procedures over the last decade. Beginning in 1979, a designated test well (399-5-2) was logged on a quarterly basis, and probe serial numbers were recorded along with basic logging information. "Calibration" logs acquired between 1979 and 1988, when more sophisticated procedures were implemented, are fairly uniform with respect to log intensity and bed resolution. No known quality control information exists for logs acquired by PNL prior to 1979. Since 1988, a significant campaign has been mounted to improve PNL log quality.

Without documentation, the only means to evaluate log quality is to compare logs collected from the same well. There is substantial variability in probe sensitivity both between and within the three generations of equipment, although reproducibility increases significantly after 1980. There also appears to be variability in the linearity of probe response, because peak to background ratios are not consistent. Resolution of marker beds seems to be consistent between generations, but depths typically vary by $\pm$ 0.6 m (2 ft). Both intensity and depth measurements are very difficult to assess on major peaks from the 1958-1959 logs (Esterline-Angus recorder).

1.3 TECHNICAL APPROACH

To facilitate differentiation of peaks resulting from natural and anthropogenic radionuclides, geologic cross-sections of the waste management units were constructed (Figures 1 through 6) using representative gross gamma-ray logs acquired from the main

waste management units. Logs showing obvious or suspected anthropogenic peaks were avoided. Correlations shown on the cross-sections are based on geologic descriptions by Last et al. (1989) and typical gamma-ray log characteristics (Schlumberger 1972, 1979; Dresser Atlas 1982).

In the T Plant Aggregate Area, the upper 12 m to 27 m (40 to 90 ft) consist of coarse sand, gravelly sand, and sandy gravel identified as the Pasco gravel member of the Hanford formation. This horizon typically has a fairly low and uniform natural gamma response. The low gamma response frequently observed in the upper 6 m (20 ft) is probably due to attenuation by conductor casing. Underlying the Pasco gravels member is the basal slack-water sequence of the Hanford formation. The fine-grained nature of this unit produces a slightly higher, but still uniform, gamma-ray response.

One of the most striking features of many logs is the relatively high gamma-ray response resulting from the fine-grained eolian sand and silt (loess) comprising the Early Palouse soil. That unit is typically 6 to 9 m (20 to 30 ft) thick and has one or two peaks yielding the greatest gamma-ray response of the natural radionuclides. The underlying Pliocene-Pleistocene basaltic gravels and caliche-rich paleosal (calcrete) units are not easily recognizable on the logs, although they often display a relatively low gamma-ray response (as low as the Pasco gravels). Zones of especially low response are probably gravel and rich, whereas zones of especially high response may result from the calcrete layers. Underlying the Plio-Pleistocene horizons, is the middle Ringold formation, consisting of sand and gravels and occasional lenses of sand and clay. In the southern portion of the site the upper Ringold formation is present. The discontinuous fine sands and muds of the Upper Ringold produce a fairly high gamma-ray response comparable to the Early Palouse soils.

The "regional" stratigraphic framework described above provides a baseline for more detailed evaluation of logs from an individual waste management unit. For each waste management unit (excluding the 241-T Tank Farm), logs from nearby wells were correlated and compared to the cross-section of the waste management unit to identify log-profile anomalies that might represent anthropogenic radionuclides.

1.4 SITE SPECIFIC RESULTS

The results of the log interpretation for each of the waste management units are presented in the following sections. Some waste management units have been grouped together for discussion because their close proximity makes it difficult to evaluate the units separately.

1.4.1 216-T-3 Reverse Well

Four monitoring wells have been logged with gross gamma-ray probes near the 216-T-3 Reverse Well. Monitoring Well W11-07 is located about 4 m (13 ft) north of the 216-T-3 Reverse Well, in operational unit 200-TP-4 (Table 1). Well W11-07 was completed

in September 1951. It is 20 cm (8 in.) in diameter, has a total depth of 93 m (306 ft) and is perforated from 75 to 88 m (245 to 290 ft). The top of casing for W11-07 is at an elevation of 216 m (709 ft) above sea level. These statistics differ from those used in Price and Fecht (1976). However, the differences still support many of those conclusions.

Profiles of natural gamma radiation measured by scintillation probes plotted against depth were produced on June 8, 1959, February 24, 1970, February 23, 1976, July 2, 1986, and August 12, 1987. These profiles reveal that there are three zones of probable anthropogenic radionuclide contamination between 3 and 37 m (10 and 123 ft) depth. The amplitude and depth of the anomalous gamma readings do not change significantly in time. This implies that there is little or no vertical migration of contaminants and the radionuclides present have long half-lives. The data are inadequate to define any lateral migration trends.

Three other wells, W11-67, W11-1, and W11-64 (in the 216-T-6 area), the closest wells to W11-07 (Figure 1), reveal no significant radionuclide contamination. There is no evidence of significant radioactive contamination of the aquifer in W11-07, which is downgradient from T-3, in the gamma scintillation profiles. However, it is known that radioactive wastes were pumped into the groundwater at this site (Price and Fecht 1976).

Fecht et al. concluded that the radionuclide contamination could not enter the ground above the perforated interval and that the probable source of contamination was either the 216-T-6 Cribs or the 216-T-361 Settling Tank. They discounted the possibility of casing failure because the gamma activity measured is too high.

The contamination in the vadose zone may be correlated with lithologic boundaries mapped and described by Last et al. 1989. The lithologies used for correlation purposes are from well W11-26, located 240 m (800 ft) southeast of W11-07 (Table 1). The contaminated interval from 30 to 38 m (98 to 123 ft) depth corresponds to the Early Palouse soil. The contaminated interval from 13 to 22 m (43 to 71 ft) is above the Basal Slackwater Sequence (fine-grained facies) in the Hanford Formation. The interval from 3 to 7 m (10 to 23 ft) corresponds to an interval of poorly sorted cobbly, silty sandstone in well W11-26. Since the contaminated regions occur in the vadose zone, contaminant migration will be controlled by the southwesterly dipping beds rather than the northward groundwater flow. Therefore it is unlikely that the 216-T-6 Cribs or the 216-T-361 Settling Tank were the source of this contamination. Nor is it likely that gross surface spills are the source since the entire interval would be contaminated. It seems most probable that the 216-T-3 Reverse Well was not properly grouted, and when waste was pumped into it, the radioactive waste backed up the well bore and contaminated more permeable horizons above the perforated interval. Possibility is that the source of the contamination is the T Plant.

1.4.2 216-T-6 Crib

As discussed in Section 2.3.3, the 216-T-6 Crib is composed of two cribs constructed side by side. The 216-T-6 Cribs are monitored by Wells W11-01 and W11-54 through W11-67 (Table 2). These wells, with the exception of W11-60, are located in or near

Crib 1. W11-60 is located in Crib 2. Cross sections were compiled from natural gamma radiation logs (scintillation probe profiles) from these wells (Figure 1). A map of the thickness and extent of probable anthropogenic radionuclides in the subsurface was constructed from these cross sections. Lithologic correlations were based upon the stratigraphy of Well W11-26, located about 160 m (525 ft) southwest of Crib 1 (Price and Fecht 1976).

Analysis of the gamma logs collected from the wells used for monitoring the 216-T-6 Cribs reveals a significant plume of probable anthropogenic radionuclides beneath Crib 1 (Figure 2). This plume is lenticular in shape and elongate towards the south-southeast, the dip direction of the alluvium. It extends from a depth of about 3 m (10 ft) to a depth of about 117 m (54 ft). Elevated gamma activity at the surface was also found in wells W11-54, W11-56, and W11-58; all are located within Crib 1. The amplitude and thickness of the interval of high gamma activity decreases near the edge of the plume. Wells W11-01, W11-60 and W11-65 each have thin, relatively low amplitude peaks approaching background levels. It is uncertain whether the plume beneath Crib 1 continues beneath Crib 2 or if there are separate plumes beneath each crib.

The interpretation of the logs from the T-6 Wells are consistent with the lithologic descriptions from W11-26 and the mapping of Last et al. (1989). The Early Palouse soil has a distinct gamma signature and could be correlated over the entire area. The top of the Basal Slackwater Sequence in the Hanford formation could be correlated across most the area with less certainty. The radionuclide plume occurs in the coarse-grained sequence of the Hanford Formation, well above the water table. The plume appears to coincide with an interval of poorly sorted alluvium found in W11-26 (Figure 2). This layer may be represented by an increase in the gamma response at a depth of about 9 m (30 ft) in wells with background radiation levels (W11-57, -64, -66 and -67). This "step" could be due to increased clay content in the poorly sorted alluvium or it may be due to attenuation of the gamma radiation by concrete or conductor pipe around the well casing at shallow depths.

1.4.3 216-T-14, -15, -16, and -17 Trenches

The 216-T-14, -15, -16 and -17 Trenches are monitored by Wells W11-68, -69, -80, and -81 respectively (Figure 3, Table 3). These wells are 61 to 91 m (200 to 300 ft) apart and are located in a manner which precludes the construction of cross sections using the scintillation probe profiles. Due to the sparseness of data points, it is not possible to evaluate the potential for lateral migration of contaminants. Zones of elevated gamma radiation detected by the scintillation probe profiles from these wells were correlated with lithologic columns constructed for wells W10-1 and W11-26 (Figure 3). Well W10-1 is located about 320 m (1050 ft) east of this area and Well W11-26 is located about 290 m (940 ft) southwest of this area.

Currently, the gamma radiation levels in Wells W11-68, -69 and -80 are at or near background levels. There is no evidence of elevated gamma radiation in wells W11-69 and -80 at any time in the past. Scintillation probe profiles collected between 1963 and 1987

from well W11-68 show that there were once elevated gamma radiation levels in that well. The scintillation probe profiles from well W11-81 indicate that there is currently significant probable anthropogenic radionuclide contamination in the area of that well. There is an appreciable increase in gamma radiation levels at the bottom of W11-81, suggesting that this well does not fully penetrate the zone of potential contamination.

Previous qualitative evaluations of the scintillation probe profiles from these wells by Chamness (1986) and by Brodeur (1988) are consistent with these conclusions. However, Brodeur noted an interval of increased gamma activity at 90 to 100 ft. This interval correlates with the Early Palouse Soil of Last et al. (1989). The amplitude of the scintillation probe profiles in this interval are consistent with normal background levels for that unit.

In both Wells W11-68 and -81, there is evidence of historical or current contamination respectively at a depth of 9 m (30 ft). This interval is located within the coarse-grained sequence of the Hanford formation (Last et al. 1989). In Well W10-1, there is a thin layer of black sand between gravels at 9 m (30 ft). In Well W11-26, the top of a poorly sorted interval is found at 9 m (30 ft) (Figure 4). These observations suggest that although the stratigraphy of the coarse-grained sequence of the Hanford formation is discontinuous, there are significant changes in the permeability of the formation at about 9 m (30 ft) in depth which has caused contaminants to be concentrated at that level.

Scintillation probe profiles collected from 1963 through 1987 in Well W11-68 (which monitors the 216-T-14 Trench) show that gamma radiation levels are currently at or near background levels.

The logs collected after 1976 were not normalized (as per Fecht et al. 1977). The computation of normalization factors for post-1976 scintillation profiles is outside the scope of this project.

1.4.4 216-T-26, -27, and -28 Cribs

Crib 216-T-26 is monitored by Wells W11-70 and -82, Crib 216-T-27 is monitored by wells W11-53 and -62 and Crib 216-T-28 is monitored by wells W14-1, -2, -3 and -4. Scintillation probe profiles collected between 1959 and 1987 (Table 4) were used to construct cross sections of the subsurface beneath these cribs (Figure 4). These cross sections were correlated with the geological units beneath this area as mapped by Last et al. (1989). The stratigraphy of well W11-26 (Last et al. 1989), located 244 m (800 ft) north-northwest of these cribs, was used in the correlation of the cross sections. Maps showing the approximate locations of regions in the subsurface contaminated by probable anthropogenic radionuclides were constructed from the interpreted cross sections (Figure 4).

Most of the lithologic units described by Last et al. (1989) were correlated across the area of the 216-T-26, -27 and -28 Cribs. The maps of the lithologic boundaries and the isopach maps of Last et al. (1989) did not agree within this area. This is probably because

an excess thickness was assigned to the coarse-grained sequence of the Hanford formation. It was not possible to correlate the Upper Ringold unit here because it does not have a distinctive natural gamma radiation signature in the area of the 216-T-26, -27, and -28 Cribs.

Scintillation probe profiles collected after 1976 were not normalized to values consistent with the 1976 profiles (Fecht et al. 1977). It is outside the scope of this project to normalize the newer profiles to the 1976 profiles.

The cross sections constructed from the scintillation probe profiles show that there is insufficient data to fully characterize the extent of elevated gamma radiation levels in the subsurface of the 216-T-26, -27, and -28 Cribs.

There are two main zones in the subsurface in the area of Cribs 216-T-26, -27, and -28 which are or have been potentially contaminated by radionuclides. The shallower of these zones extends from the surface to a depth of 30 to 33.5 m (100 to 110 ft), the top of the Middle Ringold unit (Figure 4). This shallow zone has been significantly contaminated with probable anthropogenic radionuclides. The deeper zone of potential contamination corresponds to the unconfined aquifer beneath these cribs. The water table is approximately 46 m (150 ft) below the surface and dips to the northwest (Last et al. 1989). Although currently there is no evidence of gamma emitters in the groundwater (Figure 4).

It is apparent from the cross sections in Figure 4 that the vertical distribution of elevated gamma radiation in the shallow contamination zone is roughly controlled by the lithology. Gamma radiation levels are generally higher in the sandy Coarse-Grained Sequence of the Hanford formation and the Early Palouse Soil, lower in the silty Basal Slackwater Sequence and the carbonate-cemented sand of the Plio-Pleistocene unit. The gamma radiation levels in the silty interval at the top of the Middle Ringold unit are presently at or near background. This effect is probably due to higher rates of flow (discounting chemical interactions) in the more permeable zones. One of the consequences of this mechanism would be higher levels of activity in more permeable intervals at locations laterally removed from the source of the contamination (Figure 4).

The data are insufficient to accurately evaluate the lateral distribution of radionuclide contaminants in the shallow zone. Preliminary maps of the thickness and the base of the region of elevated gamma radiation were constructed (Figure 5, 6, and 7). From these maps it is apparent that the plume of contaminants is elongate to the south, in the dip direction of the layering (Last et al. 1989).

Based upon the low levels (though significant) of gamma radiation found in Well W14-01 and the profiles in Wells W11-82, W14-4 and W14-62 (Figure 4), the plume probably does not extend much further than shown. This suggests that the plume is relatively thick, with roughly vertical sides and a rounded bottom. These maps also indicate that 216-T-28 Crib was the major source of contaminants, followed by 216-T-26 and -27 Cribs, respectively. This observation is consistent with the waste volumes and inventories for these cribs.

Although 216-T-26, -27, and -28 Cribs are not presently a source of contamination to the groundwater, there is evidence that between 1963 and 1976 the T-28 Crib was a source of groundwater contamination. The scintillation probe profiles from Wells W14-01, -02, -03, and -04 indicate (assuming they were properly normalized) that probable anthropogenic radionuclides migrated from Crib T-28, through the Middle Ringold unit, to the water table during the span of time including 1967 through 1970 (Figures 2, 3, 4 and 5). The profiles from these wells suggest that the migration of radionuclides may have started as early as 1963. By 1976, the radiation levels in the Middle Ringold had returned to near background levels. The unusual mobility (compared with other T Plant areas) of the wastes from the 216-T-28 Crib may be due to their diverse sources and probable diverse chemistry. Another possibility is that the wastes may have traveled to the water table along the pathway provided by a poorly grouted monitoring well. The data are inadequate to evaluate the possibility that 216-T-26 and -27 Cribs were (or are) sources of contamination to the groundwater.

A map of the approximate water table was constructed from the 1976 scintillation probe profiles. This map shows that the direction of groundwater flow was to the northwest, consistent with the current flow direction (Last et al. 1989). (Indications are that although contaminants from the surface impoundments generally migrated downward in a southerly direction, down the dip of the bedding, in the vadose zone, upon reaching the water table, the resulting contaminant plume doubled back and migrated to the northwest. This is supported by the 1976 scintillation probe profiles showing background gamma radiation levels below the water table in Well W14-01, and elevated readings in Wells 14-02, -03, and -04 (Figure 4). Currently, background gamma radiation levels are found in Wells W14-01, -03, and -04.)

1.4.5 216-T-34 and -35 Cribs

Wells W11-15 and W11-16 monitor the 216-T-34 Crib and Wells W11-17, -18, -19, -20, and -21 monitor the 216-T-35 Crib (Table 5). Details of the construction of these wells is provided in Table 2. Cross sections were constructed with available natural gamma radiation logs from these wells (Figure 8). Lithologic correlations were made using the stratigraphic column and natural gamma radiation log from well W6-2, located 427 m (1,400 ft) north of this area (Last et al. 1989). These sections are consistent with the mapping of Last et al. (1989).

The scintillation profiles from the wells in the area of the 216-T-34 and -35 Cribs indicate that there are two zones of probable anthropogenic radionuclide contamination. The shallower zone of contamination is located in the immediate vicinity of 216-T-35, between 6 and 17 m (20 and 55 ft) below the ground surface. There have been no changes in the conditions within this zone, so the conclusions of Price and Fecht (1976) and Brodeur (1989) remain valid and will be summarized here. The deeper zone of potential contamination by anthropogenic radionuclides is located over the entire area below a depth of 76 m (250 ft), at or near the water table. The contamination in the deeper zone was detected between 1967 and 1970 in all the wells in this area, except W11-21. (Reviews of the most recent scintillation profiles indicate there is no evidence of elevated gamma radiation in this zone.)

Monitoring Wells W11-15 and -16 are updip from the 216-T-34 Crib (Last et al. 1989) and their usefulness for monitoring the migration of wastes from that crib has been questioned (Price and Fecht 1976). No contamination has ever been detected above the water table with natural gamma radiation measurements in these wells. Even if the waste inventory for the crib is inaccurate, radioactive waste was dumped there and should be detectable with an effective monitoring system.

Significant levels of gamma radiation from probable anthropogenic radionuclides have been detected between 6 and 17 m (20 and 55 ft) below the surface in Wells W11-18, -20, and -21. Wells W11-17 and -19 have not detected any elevated readings in this shallow zone. An isopach map of the thickness of this plume was constructed using the scintillation profiles from these wells (Figure 9). The plume is lenticular in section and is located in the immediate vicinity of the 216-T-35 Crib. There is no evidence of significant migration of the contaminants. It appears that in Wells W11-20 and -21 the levels of radiation has declined to near background levels over time. However, the radiation levels measured in Well W11-18, near the "head" of the crib, has not changed significantly over the years.

The deeper zone of potential anthropogenic radionuclide contamination extends from near the water table (approximately 76 m [250 ft] below the ground surface) past the bottom of the monitoring wells. Radiation levels in this zone are currently at or near background levels and have been since 1976. However, scintillation profiles run between 1967 and 1970 detected elevated levels of activity in this zone. Assuming that the scintillation probe(s) used in this period were working properly, this suggests that a plume of radioactive material carried by the groundwater passed under the area of the 216-T-34 and -35 Cribs. The earliest profiles available imply that the radioactive contaminants originated from a source northeast of this area because the profiles from wells W11-15, -17, and -18 detected elevated gamma radiation and the profile from W11-16 detected background levels. In 1970, all of the profiles from the wells in this area detected elevated gamma radiation levels in the deep zone. The top of the contaminant plume was mapped using the 1970 data (Figure 10). This map shows that the top of the plume, and presumably the water table, was dipping to the southwest, conflicting with the current northerly dip of the water table (Last et al. 1989). If the groundwater flow was toward the southwest prior to 1976, than a potential source of the radioactive material was northeast of the 216-T-35 Crib. By 1976 the gamma radiation levels had returned to background levels, suggesting that the radioactive material was both very mobile and had a short half-life. The available data from this area is inadequate to determine the present location and level of activity of the contaminant plume.

1.4.6 216-T-21, -22, -23, -24, and -25 Trenches

Wells W15-81, -209, -210, -211, and -212 monitor Trenches 216-T-22, -21, -23, -24, and -25 respectively (Table 6). The scintillation probe profiles from these wells were previously evaluated in a qualitative sense by Chamness (1986). Otherwise, no other evaluations of these wells has been done. A cross section was constructed using the scintillation probe profiles from Wells W15-209, -210, and -211 (Figure 11). This cross section shows that there is significant contamination of the vadose zone by probable

anthropogenic radionuclides. There is no evidence that the contaminants reached the water table in this area. Although these wells are relatively shallow, it was possible to roughly correlate the lithology on this cross section with the mapping of Last et al. (1989) and with the stratigraphy of Wells W15-16 and W11-26. These wells are located about 490 m (1,600 ft) southwest and 610 m (2,000 ft) northeast of these cribs respectively. Profiles for wells W15-81 and -212 were not available at the time of this evaluation.

Chamness (1986) qualitatively evaluated the scintillation probe profiles from wells W15-209, -210, -211, and -212 and found that the radiation levels were declining slowly in these wells. Since these wells were completed in late 1982, only 1984 and 1986 vintage geophysical logs were available for Chamness' evaluation and for the present evaluation (Table 5). Different scintillation probes were used for logging these wells in 1984 than in 1986. The response of these tools is different and the profiles collected have not been normalized to a common datum (such as that used by Fecht et al. 1977). Comparisons between 1984 and 1986 vintage logs collected in other areas indicate that the 1986 profiles are consistently higher than those collected in 1976 and the 1984 profiles are slightly lower. With these qualitative relationships in mind, it is not possible to determine if the levels of radiation measured in these wells declined between 1984 and 1986.

A very rough map of the thickness of the region of elevated gamma radiation in the vadose zone was constructed from the information contained in the cross section and from the mapping of Last et al. (1989) (Figure 12). There is insufficient information available to determine the lateral extent of radionuclide contamination. However, it appears that the plume is thickening toward the south, controlled by the south dipping beds (Last et al. 1989). The base of the plume is interpreted to correspond to the top of the Basal Slackwater sequence in the Hanford formation. The Basal Slackwater sequence pinches out toward the south and east within the area of the 216-T-21, -22, -23, -24, and -25 Trenches (Last et al. 1989). It appears that the base of the plume reaches the Early Palouse soil where the Basal Slackwater sequence is absent. The available data are inadequate to determine if the plume has migrated through the Early Palouse soil.

1.4.7 216-T-7, -32, and -36 Cribs and the 216-T-5 Trench

There are a total of 31 monitoring wells in the area of the 216-T-5 Specific Retention Trench, 216-T-7 Crib and Tile Field, 216-T-32 and -36 Cribs (Table 7). The 216-T-5 Specific Retention Trench is monitored by Well W10-1. The 216-T-7 Crib is monitored by Wells W10-3, -59, -60, -61, -62, -63, -66, -67, -68, and -74 (Table 7). Scintillation probe profiles were not used for Wells W10-60, -62, -66, and -74. Since these wells are in close proximity to the other wells in the 216-T-7 Crib area and they are of similar depths, it is not expected that the scintillation profiles would add to this evaluation. The 216-T-7 Tile Field is monitored by Wells W10-2, -69, -70, -71, -72, -77, -78, -79, -80, and -81. Profiles for Wells W10-78 and -79 were not available at the time of this writing. Wells W10-77 and -81 are too shallow (7.3 and 5.8 m [24 and 19 ft] respectively) to yield information useful to this evaluation. More current logs for many of the wells monitoring the 216-T-7 Crib and Tile Fields (W10-59, -60, -61, -62, -63, -66, -67, -68, -69, -70, -71,

-72, -74, -77, -78, -79, -80, and -81) are not available due to hazardous conditions over the aging wooden structure of the 216-T-7 Crib (Chamness 1986). The 216-T-32 Crib is monitored by Wells W10-52, -56, -57, -58, -64, -65, -73, -75, and -76.

Cross sections were constructed from the scintillation probe profiles from the monitoring wells used in this evaluation (Figures 13 and 14). These cross sections were correlated with the lithologies found in W10-1 and W11-26 (located about 365 m [1200 ft] east-southeast of this area) and with the mapping of Last et al. (1989). An isopach map of the zone of elevated gamma radiation in the subsurface (Figure 15).

The isopach map constructed from the information contained in the correlated cross sections roughly delineates the extent of contamination by probable anthropogenic radionuclides (Figure 15). This map shows that there is a thin 3 m ([10 ft] or less thick) region of elevated gamma radiation beneath the 216-T-32 Crib. The top of this region is 9 to 12 m (30 to 40) ft below the surface. This plume merges with a thick region of contamination beneath the 216-T-7 Crib (more than 30 m [100 ft] thick) and tile field (30 m [100 ft] thick). The top of the plume in the area of the 216-T-7 Crib is 2.4 to 3 m (8 to 10 ft) below the surface beneath the crib and 11 to 12 m (35 to 40 ft) below the surface beyond the crib boundaries. The top of the plume beneath the 216-T-7 Tile Field ranges from 12 to 14 m (40 to 45 ft) below the surface. It is possible that the base of this plume reaches (or reached) the water table (Fecht et al. 1977), but the wells monitoring the 216-T-7 Crib and Tile Field are too shallow to fully penetrate the region of contamination. There is evidence of vertical migration of the plume in the 216-T-7 Crib area (Fecht et al. 1977). Between 1963 and 1987, there has been a 2 m (7 ft) increase in the depth of the top of the contamination measured on the profiles from Well W10-3. The vertical migration of contaminants in the vicinity of this well appears to be confined to the Basal Slackwater Sequence. Changes in the character of the profiles from Wells W10-61 and -80 provide further evidence of vertical migration of contaminants within the Basal Slackwater. There is no evidence of vertical migration of contaminants within deeper lithological units. Scintillation probe profiles from the wells monitoring the 216-T-5 Trench and the 216-T-36 Cribs currently register background levels of gamma radiation. However, the 1963 and 1976 profiles from the W10-4, which monitors 216-T-36 Crib, show low to moderate levels of contamination in the Early Palouse soil and the Plio-Pleistocene unit. The source of these elevated readings was probably effluent from the 216-T-7 Crib and Tile Field (Fecht et al. 1977).

The region of elevated gamma radiation beneath the 216-T-32 Crib is manifested by a sharp peak on the scintillation probe profiles from the monitoring wells (Figure 13). This peak corresponds to a poorly sorted zone at the base of the Coarse Grained Sequence of the Hanford formation (Last et al. 1989) and represents low to near background gamma radiation levels.

1.5 CONCLUSIONS

Scintillation probe profiles collected in monitoring wells in the vicinity of 23 waste disposal units were analyzed. These waste disposal units were divided into 10 areas located in the eastern half of the T Plant area. A discussion of each of these areas is provided below.

1.5.1 216-T-3 Reverse Well

Although the T-3 Reverse Well is in close proximity to the 216-T-6 Cribs, it is updip and the nature of waste disposal activities was different. High levels of gamma radiation is found in the Coarse Grained sequence of the Hanford formation and in the Early Palouse soil. Based upon the nature of waste disposal activities in this area, it appears that the gamma emitting contaminants migrated outwards from the 216-T-3 Reverse Well bore into these units. Since the purpose of this well was to pump wastes into the groundwater, it is certain that wastes reached the ground water. Data are inadequate to determine the lateral extent of contamination.

1.5.2 216-T-6 Crib

High levels of gamma radiation were found beneath Crib 1. It appears this plume is elongate to the south and extends to the east, under Crib 2. The elevated region of gamma radiation is confined to the Coarse Grained sequence of the Hanford formation. Data are inadequate to define the lateral extent of the radionuclides. There is no evidence of vertical migration of radionuclide. There is no evidence that radionuclides reached the groundwater in this area.

1.5.3 216-T-14, -15, -16, and -17 Trenches

The scintillation probe profiles from the well monitoring the 216-T-17 Trench indicate that currently high levels of gamma radiation are found within the Coarse Grained sequence of the Hanford formation. There is no evidence that radionuclides have penetrated to the groundwater. Data are inadequate to delineate the extent of contamination.

The scintillation probe profiles from the well monitoring the 216-T-14 Trench indicate that in the past moderate to low levels of gamma radiation was present in the Coarse Grained sequence of the Hanford formation. Currently levels are at or near background. Based upon regional mapping by Last et al. (1989), this well may not be in an optimal position to monitor the crib.

The scintillation probe profiles from the wells monitoring the 216-T-15 and -16 Trenches have never showed any evidence of gamma emitting radionuclides in the subsurface. However, based upon the regional mapping by Last et al. these wells may not be located in optimal positions for monitoring waste migration from these cribs.

1.5.4 216-T-26, -27, and -28 Cribs

High levels of gamma radiation extending from within the Coarse Grained Sequence of the Hanford formation to the top of the Middle Ringold unit are detected beneath all three of these cribs. Many of the wells in this area do not fully penetrate the plume, but scintillation probe profiles from those that do suggest that this area was a source of groundwater contamination during the late 1960's.

There is evidence from the scintillation probe profiles collected from the monitoring wells in this area that the lateral migration of radionuclides is lithologically controlled. The profiles from wells in close proximity or within the crib boundaries have a "blocky" character, while those further from the cribs have a more "spiky" character. These "spikes" correspond to the Early Palouse soil and Coarse Grained sequence lithologic intervals in this area. This implies that radionuclides traveled further in these intervals than in others. Currently, there is no evidence of vertical migration of radionuclides.

1.5.5 216-T-34 and -35 Cribs

Moderate to high levels of gamma radiation are currently found at the north end of the 216-T-35 Crib. These levels fall off rapidly to the south, along the crib, reaching background levels in the central portion of the crib. The region of elevated gamma radiation once extended from the Coarse Grained sequence of the Hanford formation into the Plio-Pleistocene unit. Currently levels above background are only found in the Coarse Grained sequence. There is no evidence that radionuclides from this crib reached the groundwater. Scintillation probe profiles from wells monitoring the 216-T-34 Crib have never showed any evidence of elevated gamma radiation from that crib. However, regional mapping by Last et al. (1989) suggests these wells may not be located optimally.

In the late 1960's and early 1970's, low to moderate levels of gamma radiation were detected beneath the water table. The temporal and spacial pattern of the contamination suggests that the source was east to northeast of this area.

1.5.6 216-T-21, -22, -23, -24 and -25 Trenches

Although scintillation probe profiles from the wells monitoring Trenches 216-T-22 and -25 were not available, those from 216-T-21, -23 and -24 Trenches indicate that high levels of gamma radiation are found in the Coarse Grained sequence of the Hanford formation. The Basal Slackwater sequence pinches out to the south in this area (Last et al.

1989) and the Coarse Grained sequence thickens. Since the well monitoring the 216-T-21 Trench does not fully penetrate the region of contamination, it cannot be determined if the radionuclides from these cribs have penetrated the Early Palouse soil. The data are inadequate to define the vertical and lateral extent of the plume. However, there is no evidence that radionuclides from these cribs reached the groundwater.

1.5.7 216-T-7, -32, and -36 Cribs and 216-T-5 Trench

A thick region of high levels of gamma radiation were detected beneath the 216-T-7 Crib and Tile Field. This region is found within the Coarse Grained sequence of the Hanford formation, down to the top of the Middle Ringold unit or deeper. There is no evidence that radionuclides reached the groundwater in this area; however, most of the monitoring wells do not penetrate the zone of elevated gamma radiation. There is evidence of downward migration of radionuclides within the Basal Slackwater sequence of the Hanford formation but not in deeper units. There is evidence that radionuclides may have migrated laterally, within the Early Palouse soil and the Plio-Pleistocene unit, as far south as the 216-T-36 Crib. Current conditions around the crib and tile field are uncertain since no scintillation probe profiles were collected after 1963 due to hazardous conditions over the aging wooden structure.

A thin interval of low gamma radiation levels was found beneath the 216-T-32 Crib. These elevated levels are found at the base of the Coarse Grained Sequence of the Hanford formation. There is no evidence of vertical or lateral radionuclide migration. This region of probable anthropogenic radionuclide contamination merges with that found beneath the 216-T-7 Crib and Tile Field to the south.

No elevated gamma radiation levels were detected in the subsurface near the 216-T-5 Specific Retention Trench. Mapping of the top of the Basal Slackwater sequence in this area suggests that the monitoring well for this crib may not be located optimally.

No evidence of elevated gamma radiation in the subsurface from radionuclides placed in the 216-T-36 Crib was found. The low to moderate gamma radiation levels detected within the Early Palouse soil and the Plio-Pleistocene unit during the early 1960's is attributed to lateral migration of contaminants from the 216-T-7 Crib and Tile Field.

1.5.8 216-T-18 Crib

No additional data was available to add to that used by Fecht et al. (1977). Moderate to high levels of gamma radiation were detected in the Coarse Grained sequence of the Hanford formation and moderate to low levels in the Early Palouse soil. There was a large decrease in the amplitude of the gamma radiation levels between 1954 and 1976. Current conditions in this area are unknown.

1.5.9 216-T-19 Crib and Tile Field

No additional data was available to add to that used by Fecht et al. (1977). The four wells monitoring the tile field are of insufficient depth. That monitoring the crib was last logged in 1970 and may not be located optimally per the regional mapping of Last et al. (1989). High levels of gamma radiation were detected in the Coarse Grained sequence of the Hanford formation. Radiation levels declined with depth to the water table. This suggests that this crib was a source of groundwater contamination in the past.

1.5.10 216-T-33 Crib

No evidence of elevated gamma radiation levels has ever been found in this well. Possible regions of elevated gamma radiation referred to by Brodeur (1988) correspond to the Early Palouse soil and Upper Ringold unit intervals. Since the monitoring well for this crib is located to the north, it is probably updip and therefore in a non-optimum position for detecting contaminants from the crib based on the regional mapping by Last et al. (1989).

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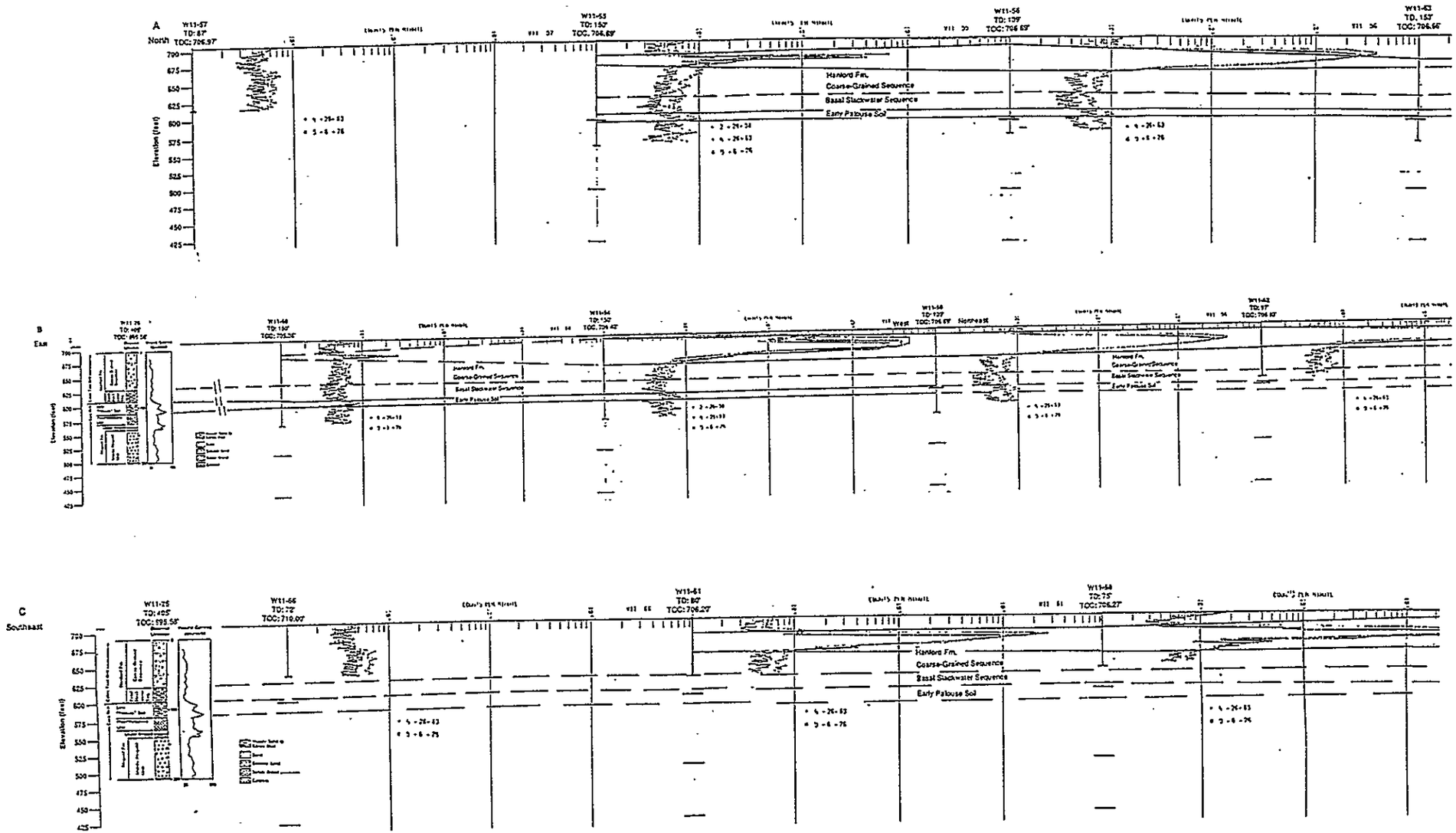


Figure A-1. 216-T-6 Cribs 1 and 2 - Scintillation Probe Profile Cross Sections A-A', B-B', and C-C'. (sheet 1 of 2)

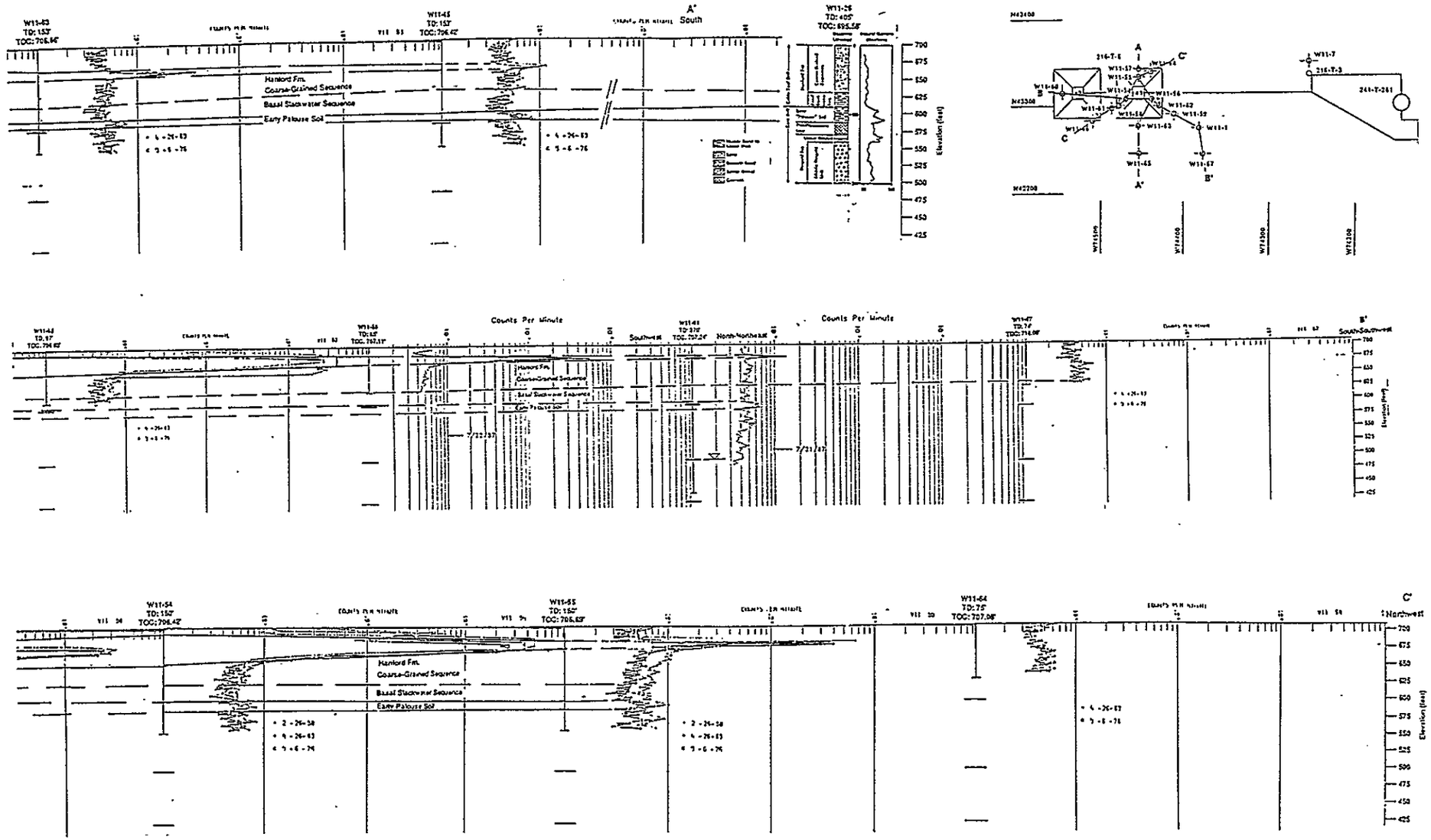
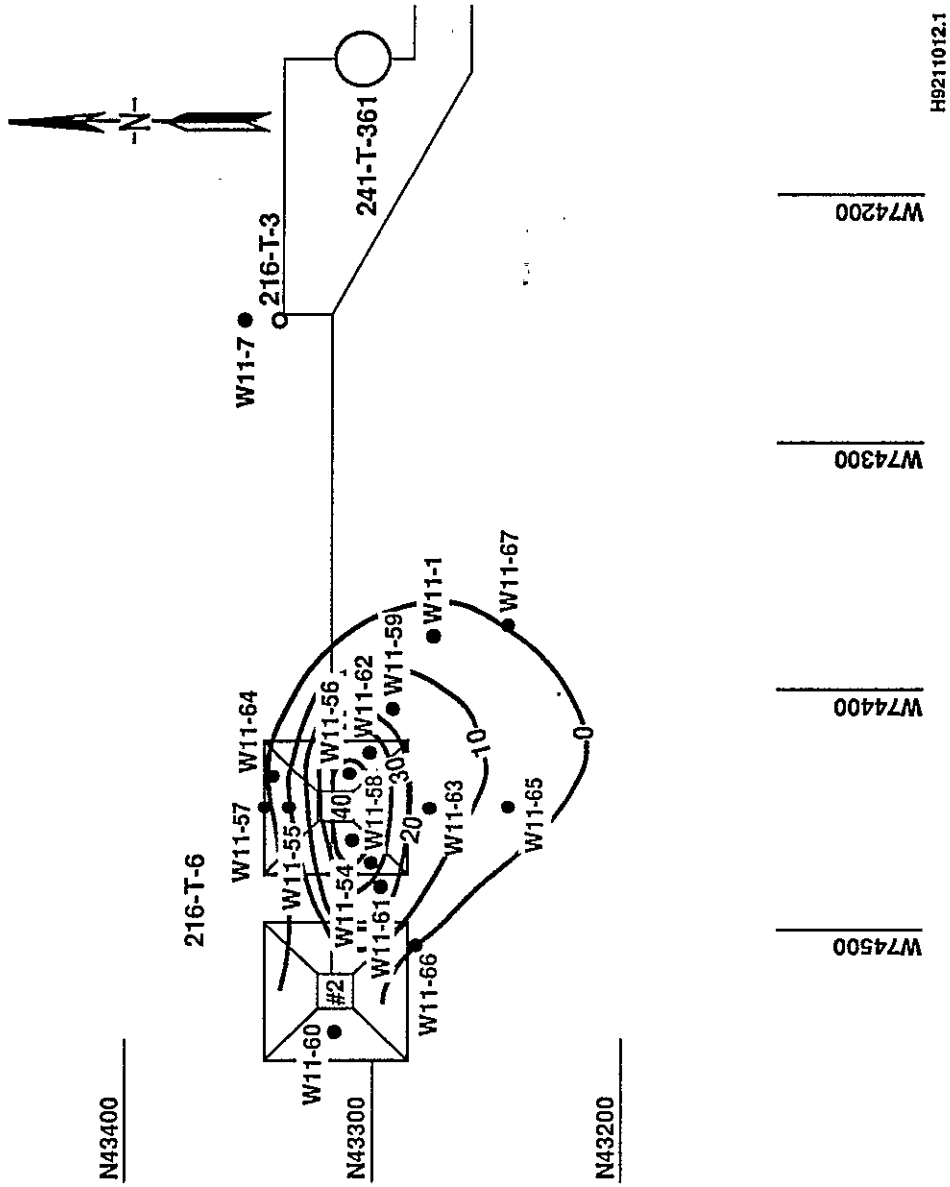


Figure A-1. 216-T-6 Cribs 1 and 2 - Scintillation Probe Profile Cross Sections A-A', B-B', and C-C'. (sheet 2 of 2)

Figure A-2. 216-T-6 Cribs 1 & 2 - Elevated Gamma Radiation Isopach Map.



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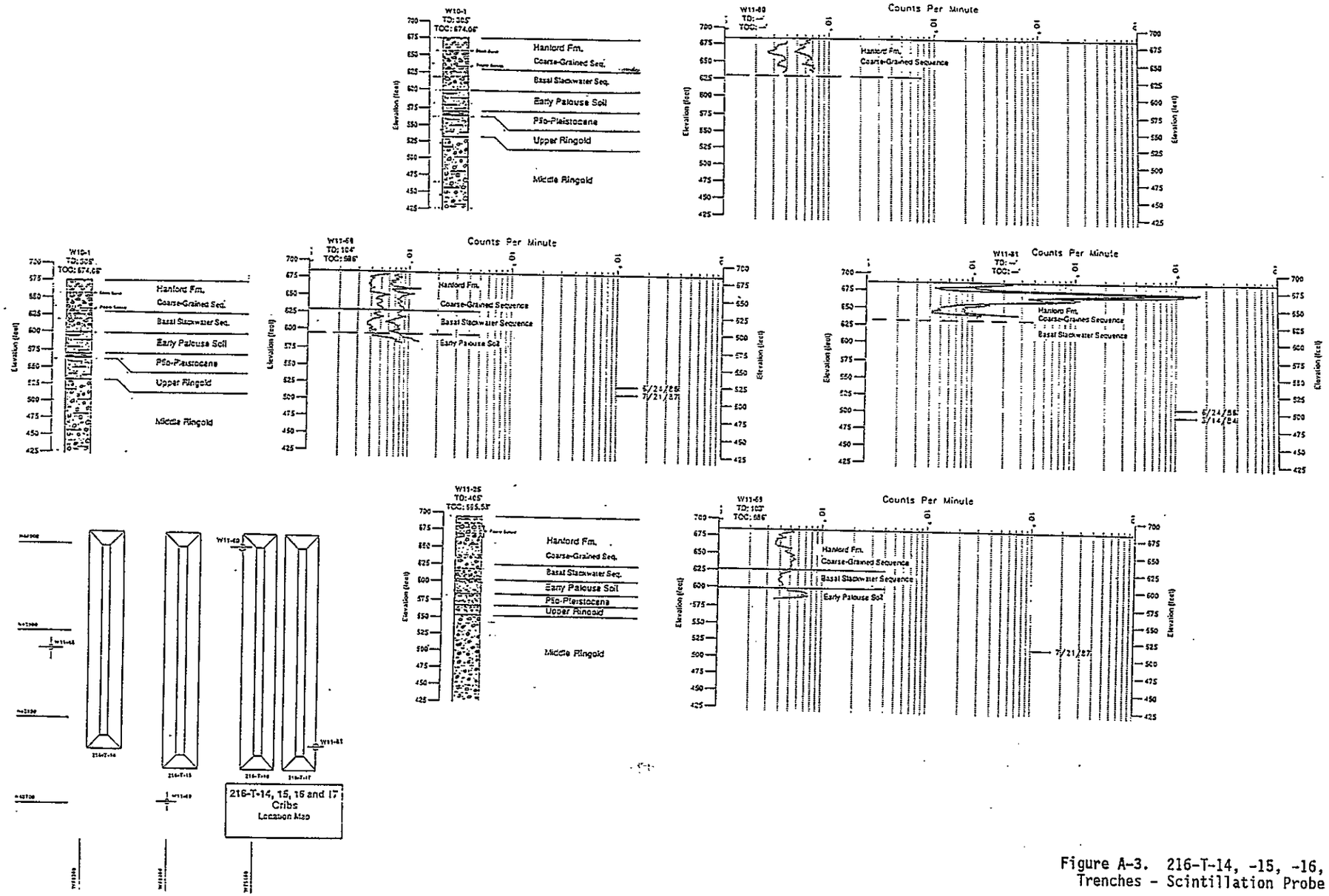
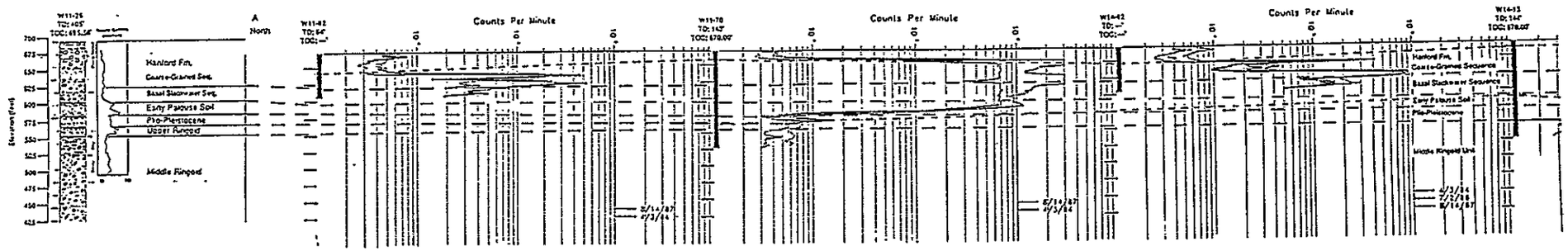


Figure A-3. 216-T-14, -15, -16, and -17 Trenches - Scintillation Probe Profile.



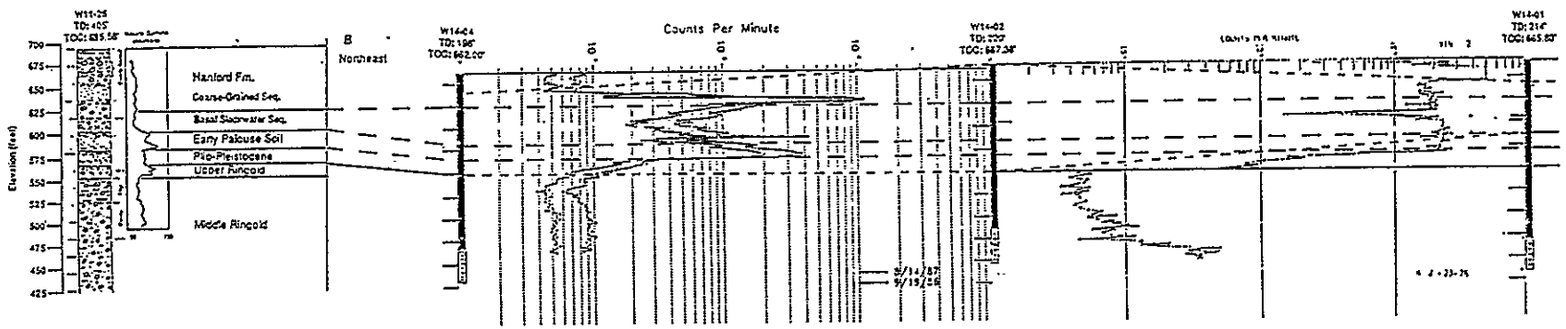


Figure A-4. 216-T-26, 27, and 28 Cribs - Scintillation Probe Profile Cross Sections A-A' and B-B'. (sheet 1 of 2)

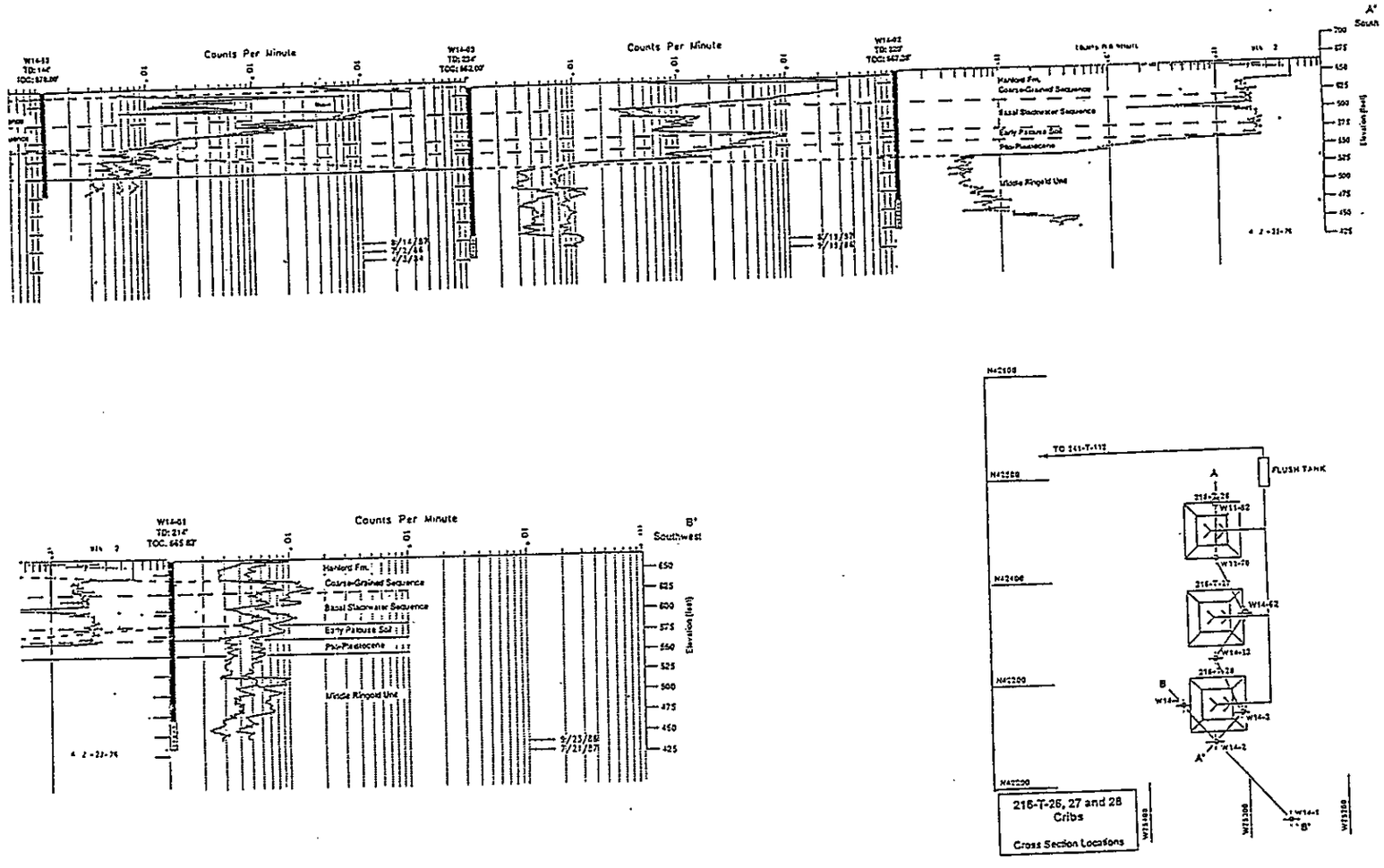


Figure A-4. 216-T-26, 27, and 28 Cribs - Scintillation Probe Profile Cross Sections A-A' and B-B'. (sheet 2 of 2)

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Figure A-5. 216-T-26, 27, and 28 Cribs - Elevated Gamma Radiation Isopach Map.

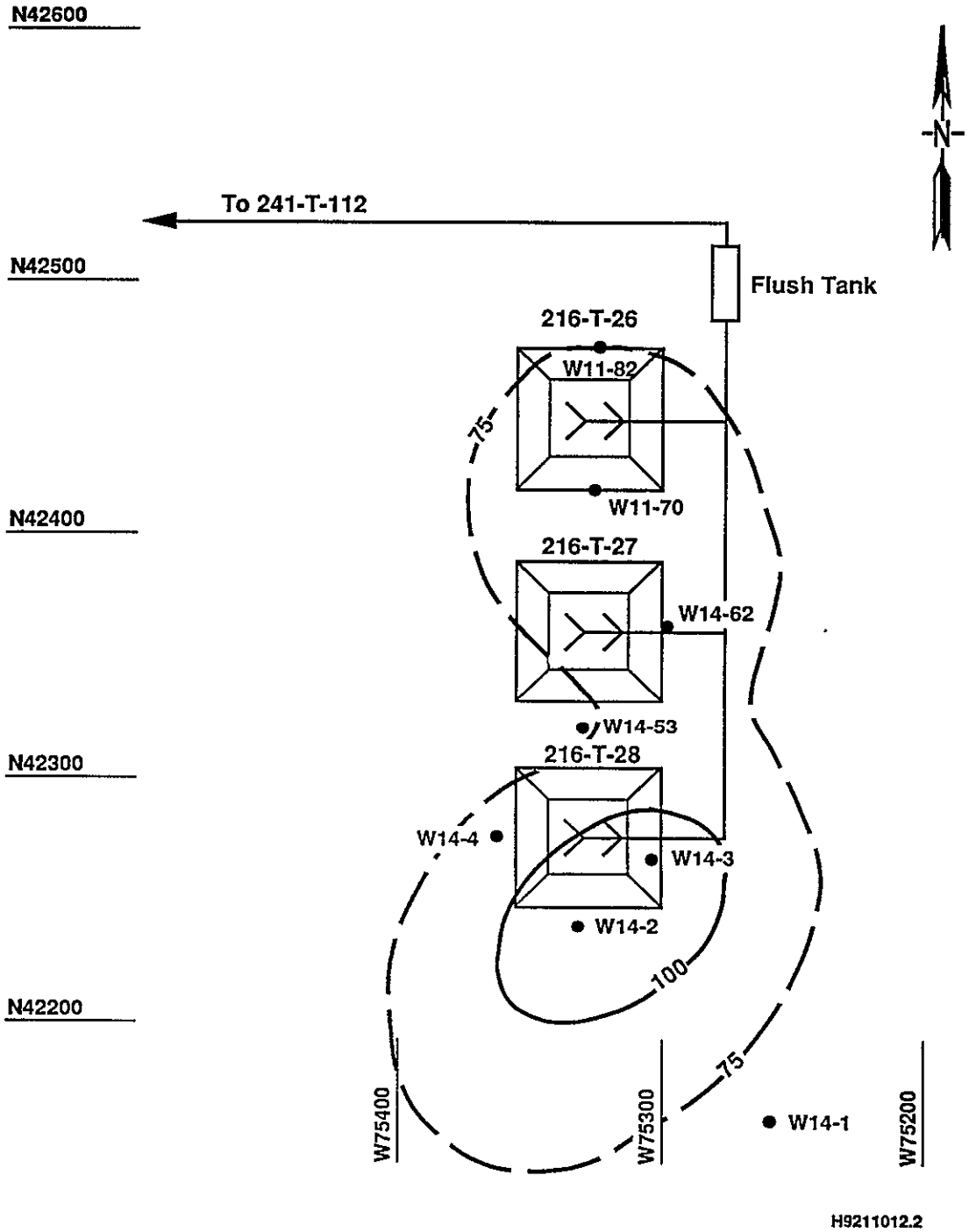


Figure A-6. 216-T-26, 27, and 28 Cribs - Base Contaminated Zone Elevation (ft).

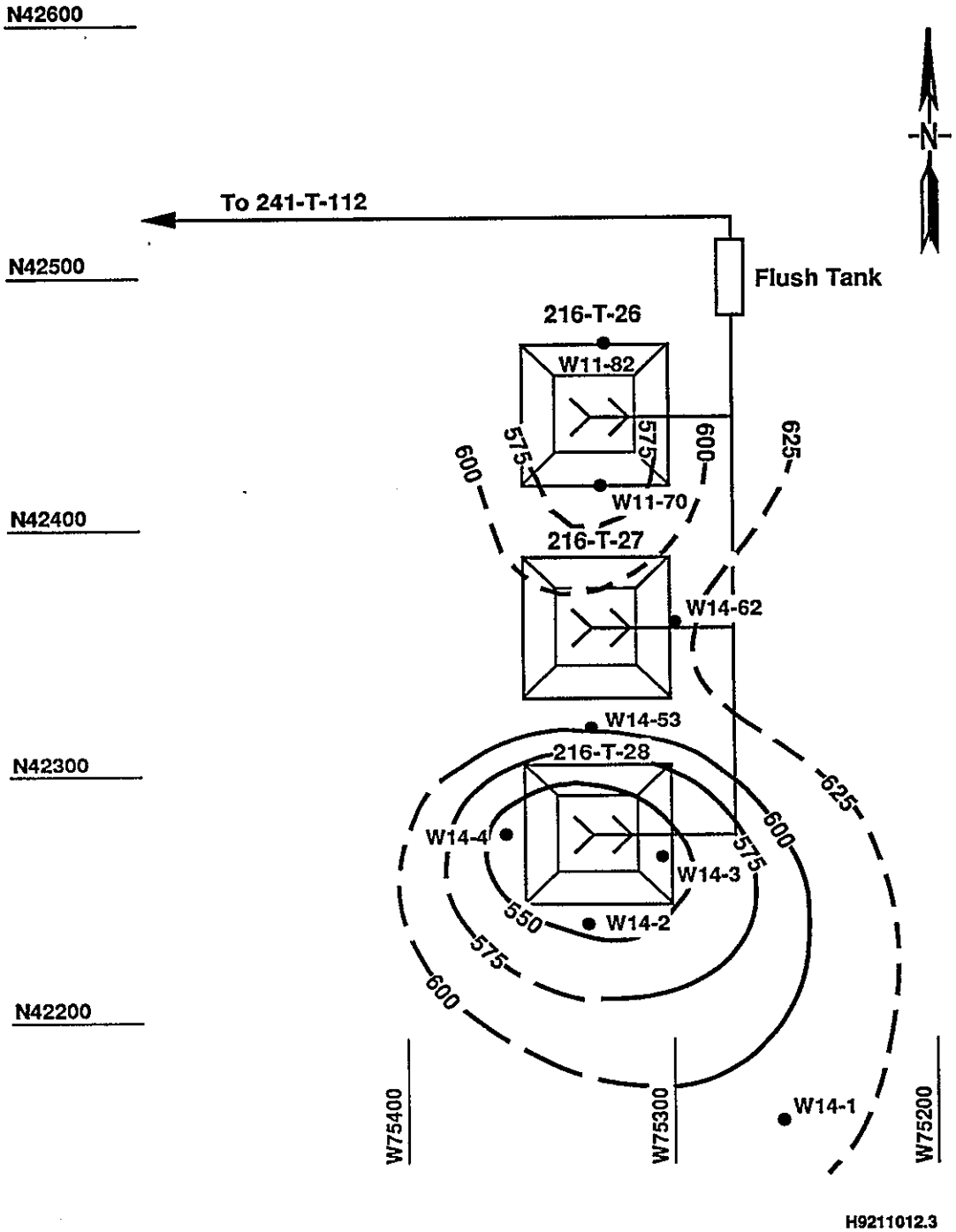
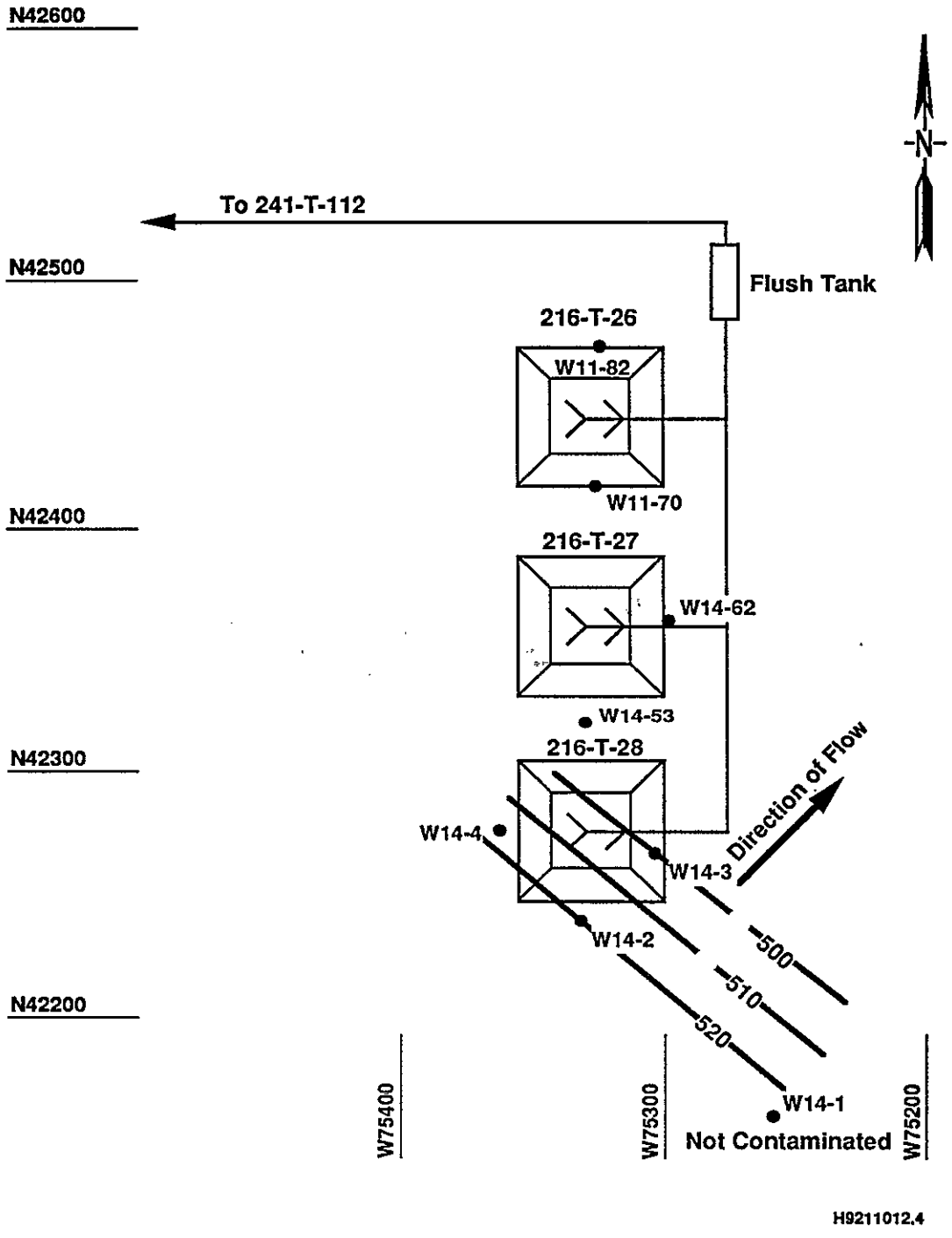


Figure A-7. 216-T-26, 27, and 28 Cribs - Approximate Water Table Elevation (1976).



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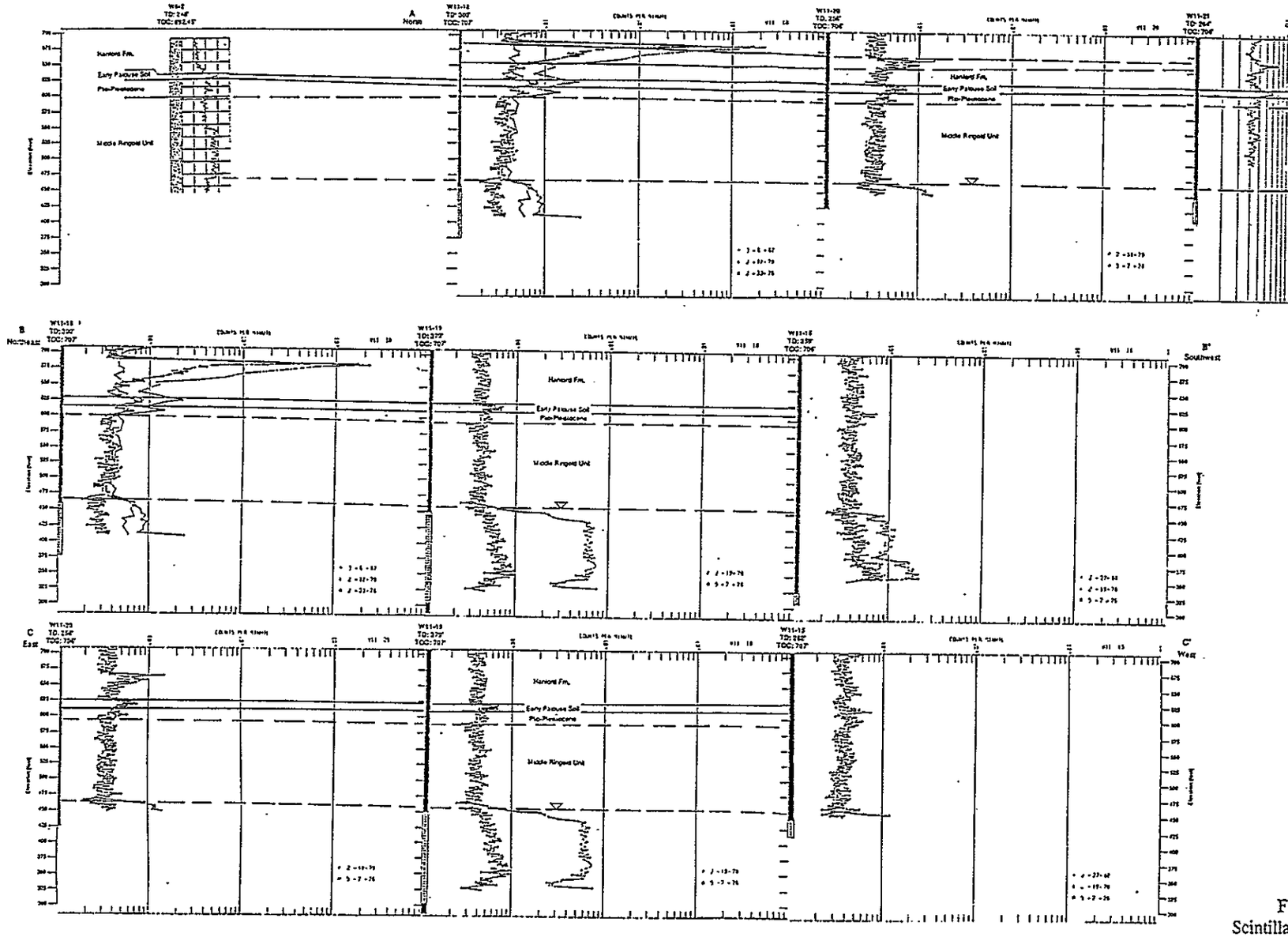

Figure A-8. 216-T-34 and 35 Cribs - Scintillation Probe Profile Cross Sections A-A', B-B', and C-C'. (sheet 1 of 2)

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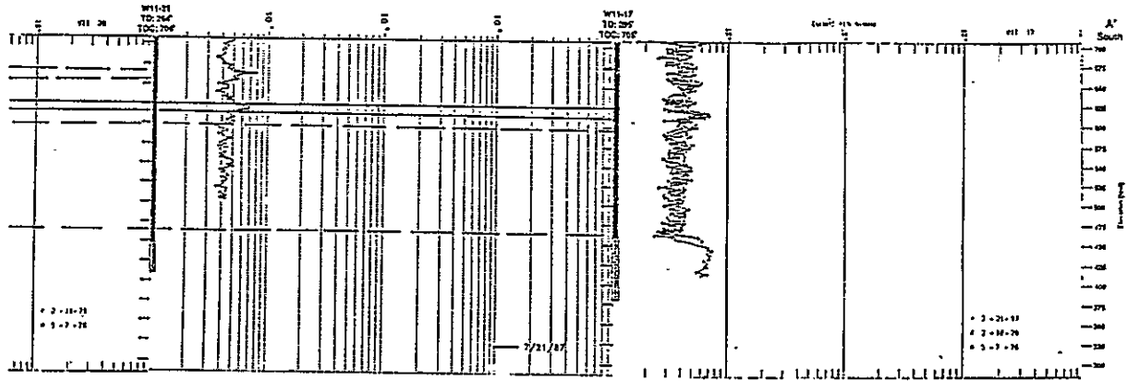


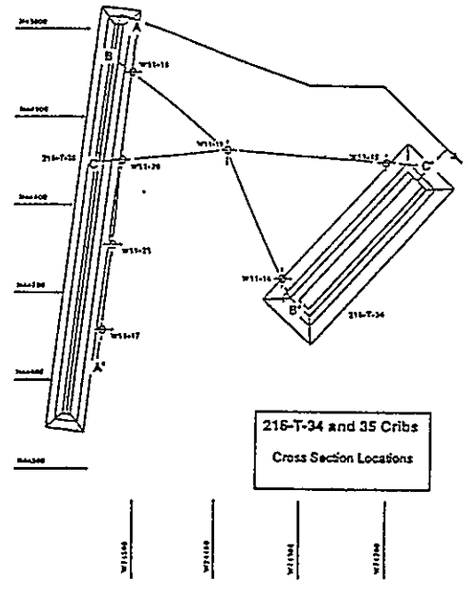


Figure A-8. 216-T-34 and 35 Cribs - Scintillation Probe Profile Cross Sections A-A', B-B', and C-C'. (sheet 2 of 2)

Figure A-9. 216-T-34 and 35 Cribs - Shallow Zone
Elevated Gamma Radiation Isopach Map.

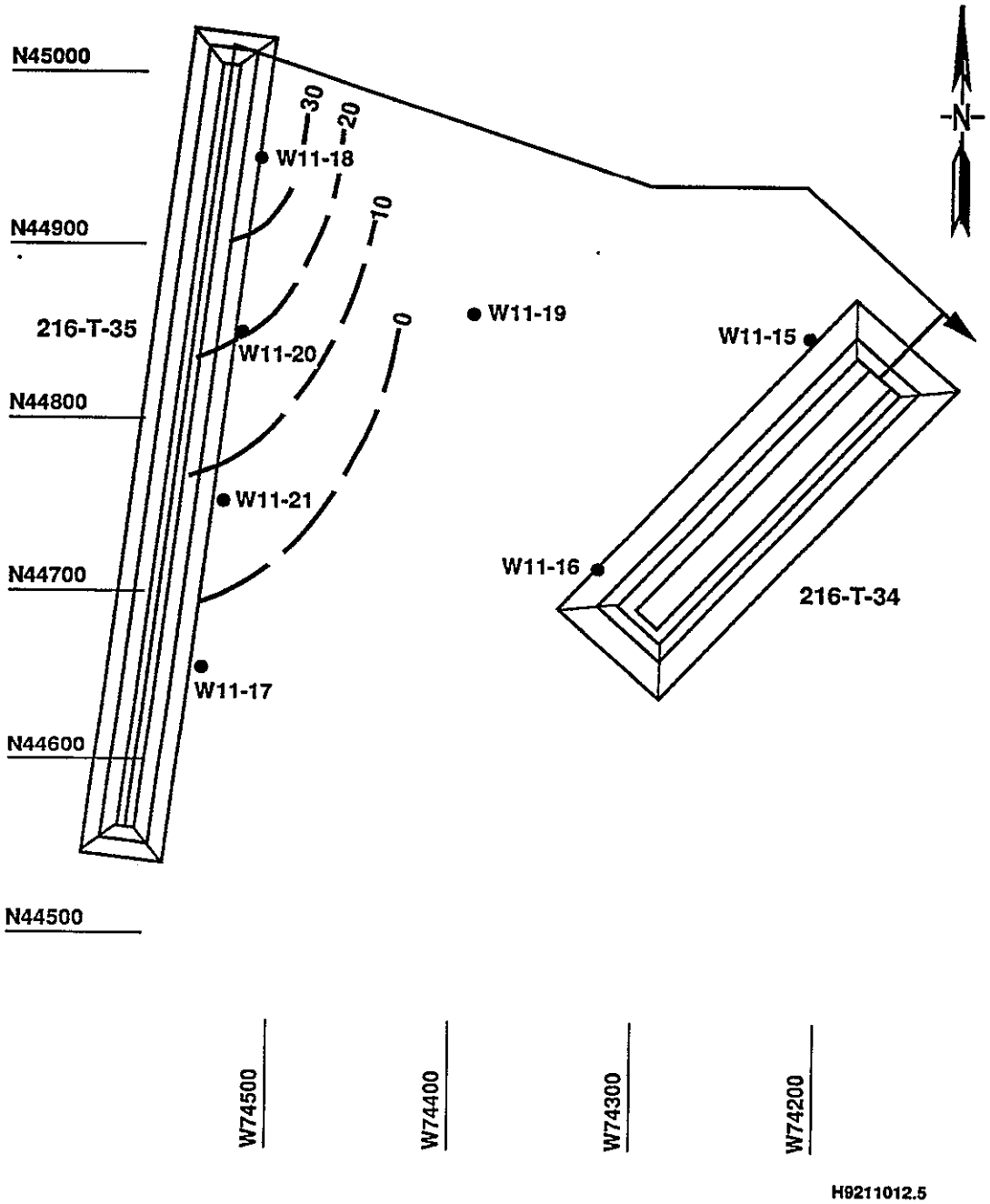
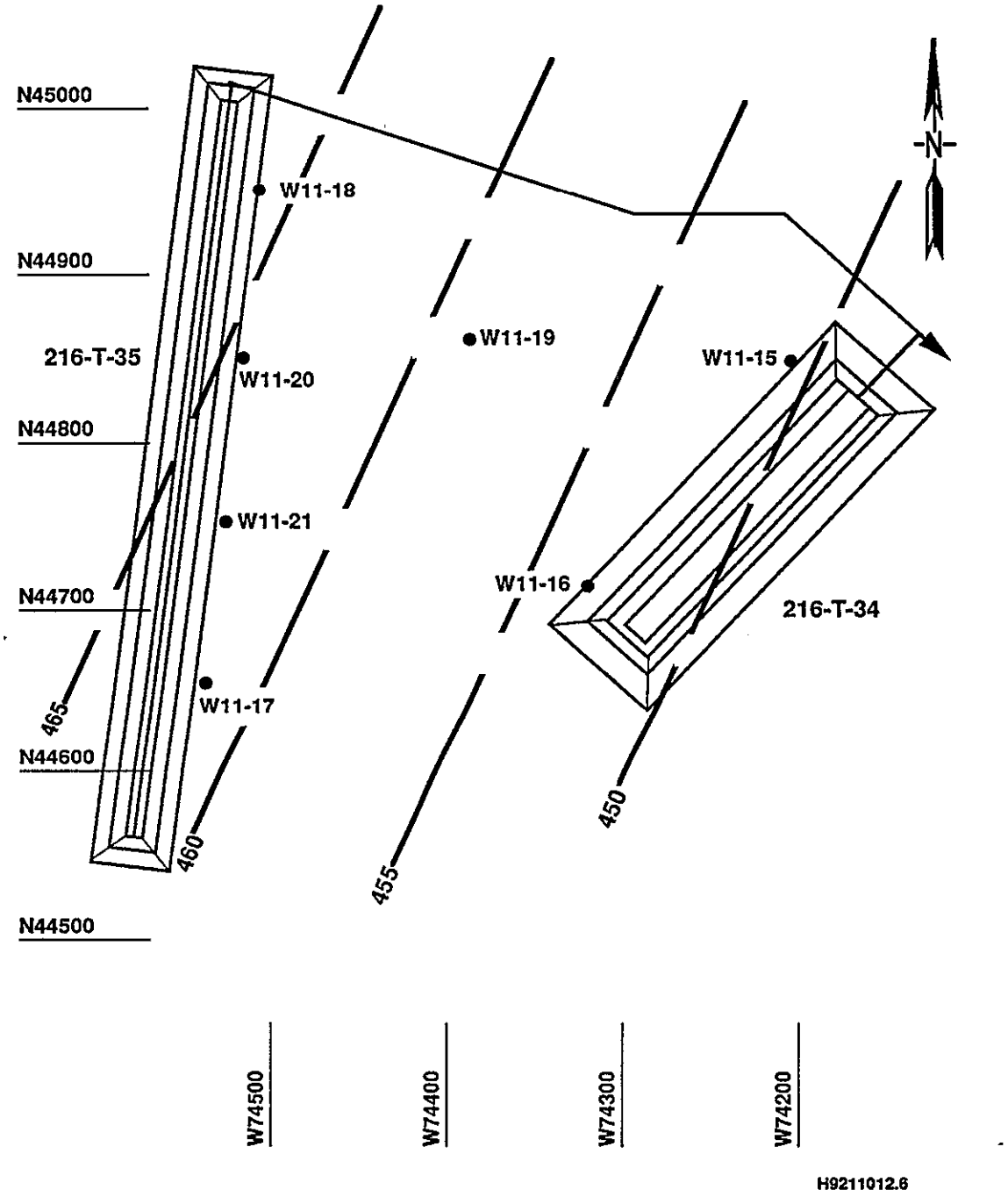


Figure A-10. 216-T-34 and 35 Cribs - Deep Zone Top Elevated Gamma Radiation.



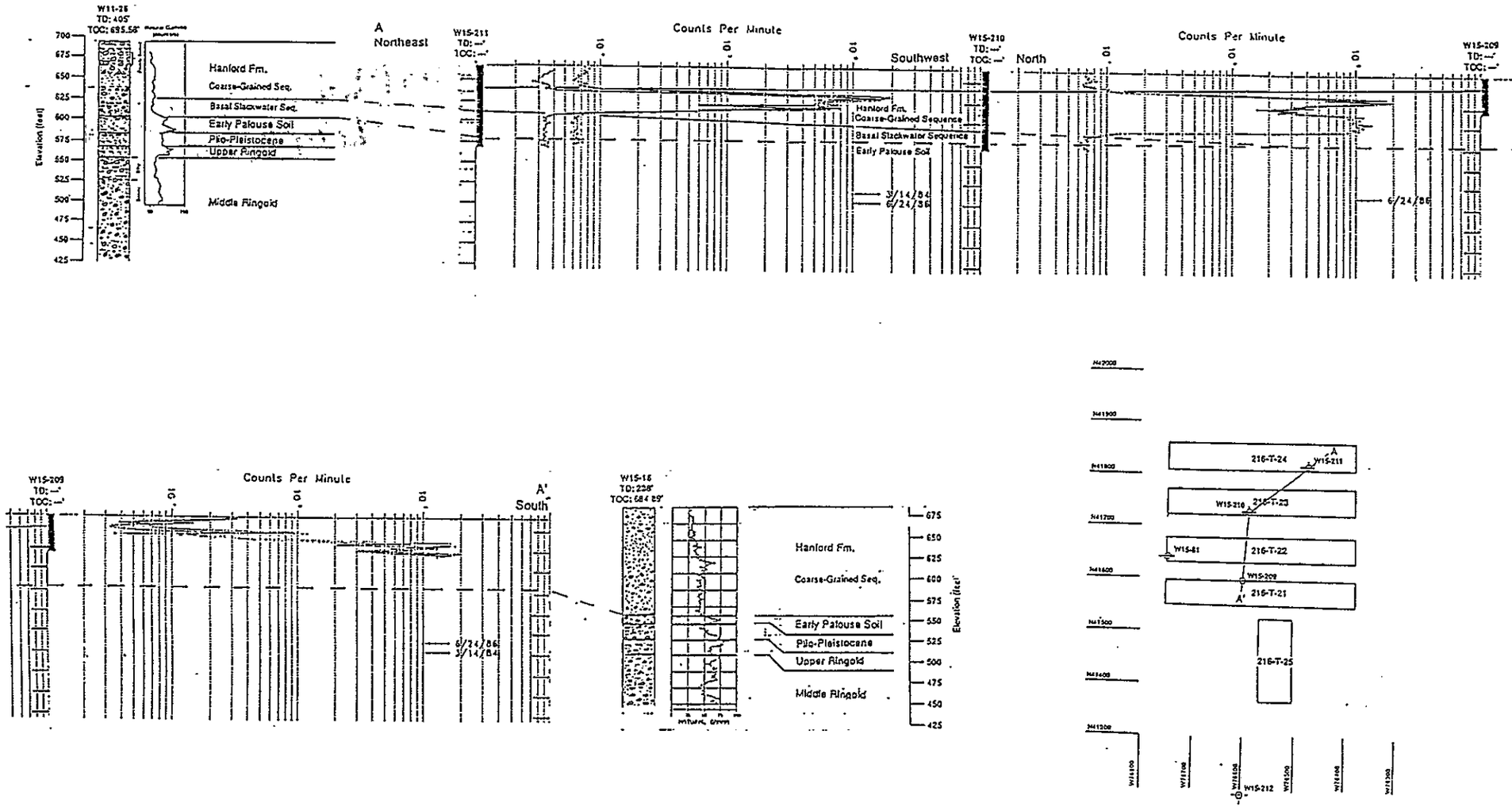


Figure A-11. 216-T-21, 22, 23, 24, and -25 Trenches - Scintillation Probe Profile Cross Section A-A'

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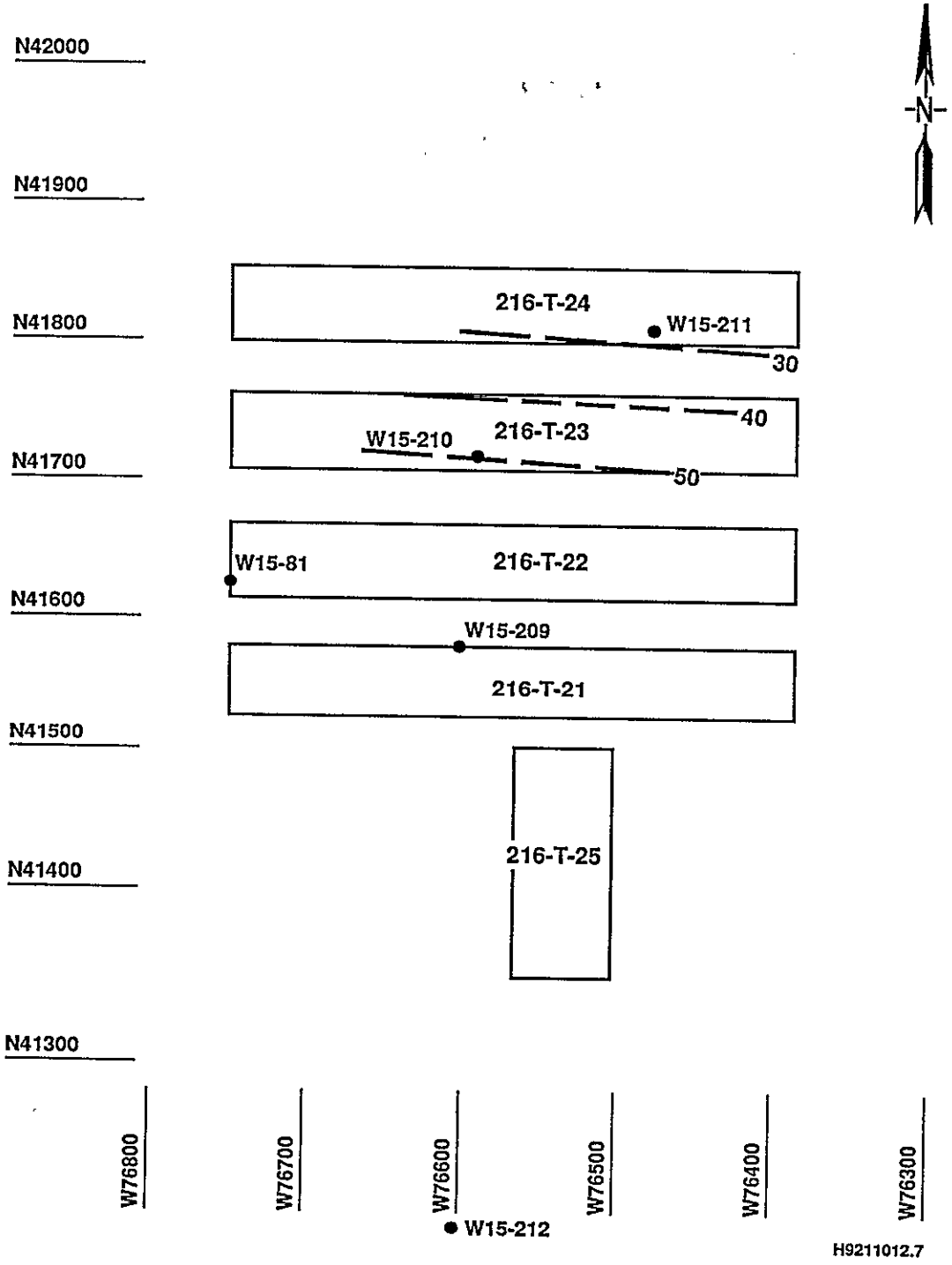
Figure A-12. 216-T-21, 22, 23, 24, and -25 Trenches - Elevated Gamma Radiation Isopach Map



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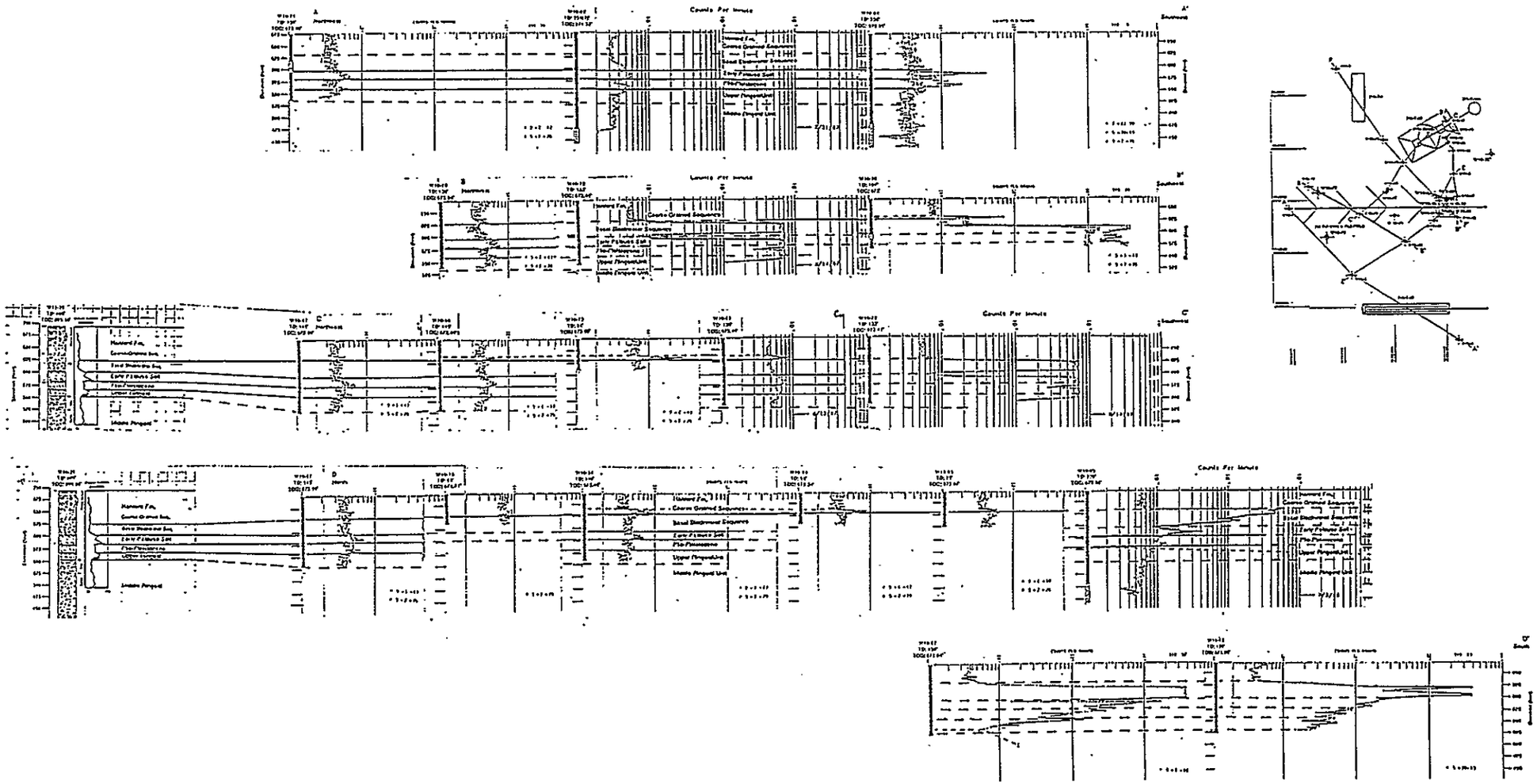

Figure A-13. 216-T-7, -32, and -36 Cribs, and 216-T-5 Trench - Scintillation Probe Profile Cross Sections A-A', B-B', C-C', and D-D'.

9 3 1 2 8 7 0 1 3 2 8

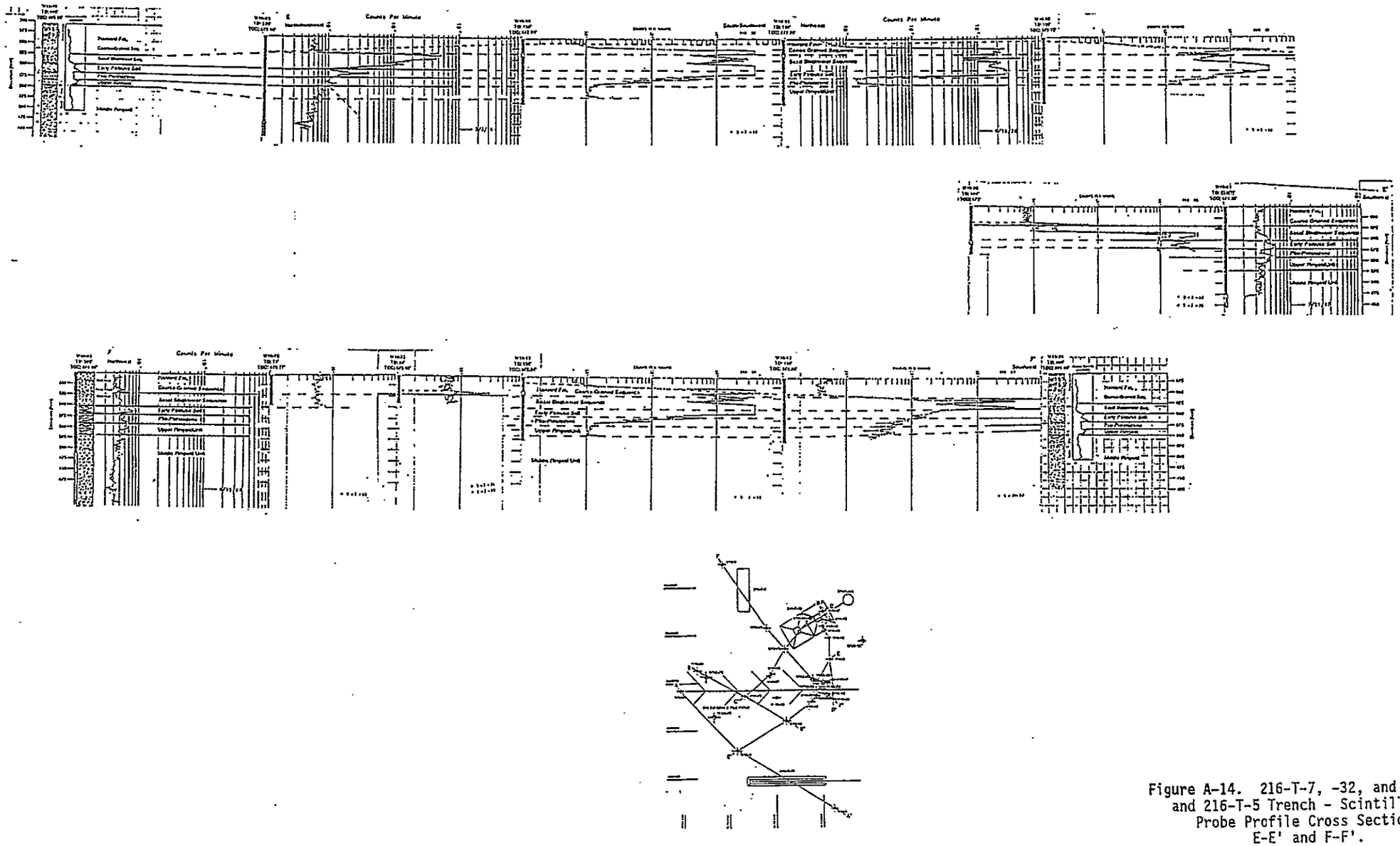

Figure A-14. 216-T-7, -32, and -36 Cribs, and 216-T-5 Trench - Scintillation Probe Profile Cross Sections E-E' and F-F'.

Figure A-15. 216-T-7, -32, and -36 Cribs, and 216-T-5 Trench - Elevated Gamma Radiation Isopach Map

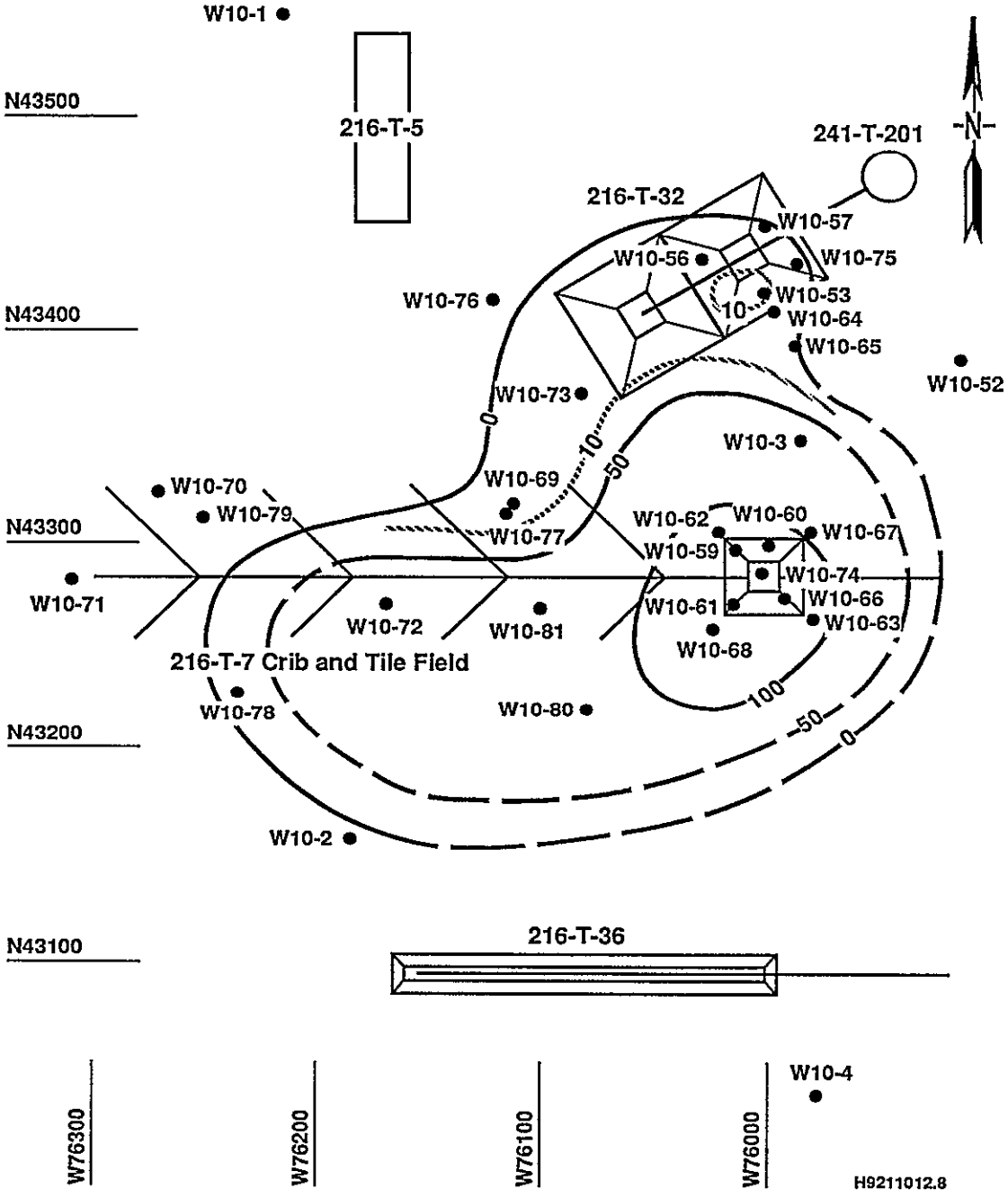

Table A-1. Details of Monitoring Wells for 216-T-3 Reverse Well.

Well Name	O.U.	Completed	T.D.	T.O.C.	Diameter	Gamma Logs
W11-7	200-TP-4	9/51	385	709.11	8	02/58 06/59 04/63 04/68 02/70 02/76

Table A-2. Details of Monitoring Wells for 216-T-6 Cribs. (Sheet 1 of 2)

Well Name	O.U.	Completed	T.D.	T.O.C.	Diameter	Gamma Logs
W11-1	200-TP-4	3/50	270	707.24	8	02/20/58 * 06/08/59 * 04/26/63 * 02/27/68 05/06/76 07/21/87
W11-54	200-TP-3	5/47	150	706.42	8	02/26/58 04/26/63 05/06/76
W11-55	200-TP-3	6/47	150	706.69	8	09/23/53 * 02/26/58 04/26/63 05/06/76
W11-56	200-TP-3	6/47	139	706.69	8	02/26/58 * 04/26/63 05/06/76
W11-57	200-TP-3	3/51	87	706.97	8	02/26/58 * 04/26/63 05/06/76 07/22/87 *
W11-58	200-TP-3	7/47	75	706.27	8	02/26/58 * 04/26/63 05/06/76
W11-59	200-TP-4	7/47	85	707.11	8	02/26/58 * 04/26/63 05/06/76 07/22/87
W11-60	200-TP-3	7/47	150	705.36	8	02/26/58 * 04/26/63 05/06/76
W11-61	200-TP-3	7/47	80	706.20	8	02/26/58 * 04/26/63 05/06/76
W11-62	200-TP-3	8/47	97	706.83	8	02/26/58 * 04/26/63 05/06/76

Table A-2. Details of Monitoring Wells for 216-T-6 Cribs. (Sheet 2 of 2)

Well Name	O.U.	Completed	T.D.	T.O.C.	Diameter	Gamma Logs
W11-63	200-TP-3	9/47	153	706.66	8	02/26/58 * 04/26/63 05/06/76 07/22/87 *
W11-64	200-TP-4	9/47	75	707.08	8	02/26/58 * 04/26/63 05/06/76
W11-65	200-TP-3	10/47	153	706.42	8	02/26/58 * 04/26/63 05/06/76 07/22/87 *
W11-66	200-TP-3	8/51	72	710.00	8	02/26/58 * 04/26/63 05/06/76 07/22/87 *
W11-67	200-TP-4	8/51	74	710.00	8	02/26/58 * 04/26/63 05/06/76 07/22/87 *

* Log Not Used in Interpretation

Table A-3. Details of Monitoring Wells for 216-T-14, -15, -16, and -17 Cribs.

Well Name	O.U.	Completed	T.D.	T.O.C.	Diameter	Gamma Logs
W11-68	200-TP-6	10/53	104	686	8	05/02/58 * 04/29/63 05/07/76 06/24/86
W11-69	200-TP-3	09/53	103	686	8	05/02/58 * 04/29/63 05/07/76 07/21/87
W11-80	200-TP-3	10/82	---	----	8	03/14/84 06/24/86
W11-81	200-TP-3	10/82	---	----	8	03/14/84 06/24/86

* Log Not Used in Interpretation

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Table A-4. Details of Monitoring Wells for 216-T-26, -27, and -28 Cribs. (Sheet 1 of 2)

Well Name	O.U.	Completed	T.D.	Perf.	T.O.C	Diameter	Gamma Logs
W11-70	200-TP-2	05/55	143	----	670	8	07/15/59 *
							08/29/60 *
							04/29/63
							09/02/65
							05/07/76
							04/03/84
							07/03/86 *
							08/14/87
W11-82	200-TP-2	01/83	64	----	----	8	04/03/84
							07/03/86 *
							08/14/87
W14-1	200-TP-2	01/54	214	195-230	665.83	8	04/15/58 *
							06/09/59 *
							08/29/60 *
							04/29/63
							02/23/68
							05/07/76
							09/23/86
							07/21/87
W14-2	200-TP-2	05/55	220	181-222	667.38	8	04/15/58 *
							06/09/59
							08/29/60 *
							04/29/63
							02/23/68 *
							04/09/70
							02/23/76
W14-3	200-TP-2	12/61	234	234-208	662	8	04/29/63
							05/07/76
							09/19/86
							08/19/87
W14-4	200-TP-2	07/66	198	----	662	8	02/07/67
							05/07/76
							09/19/86
							08/14/87

Table A-4. Details of Monitoring Wells for 216-T-26, -27, and -28 Cribs. (Sheet 2 of 2)

Well Name	O.U.	Completed	T.D.	Perf.	T.O.C	Diameter	Gamma Logs
W14-53	200-TP-2	05/55	144	208-268	670	8	07/15/59 *
							08/29/60 *
							04/29/63
							09/02/65 *
							04/09/70
							05/07/76
							04/03/84
							07/02/86
							08/14/87
W14-62	200-TP-2	02/83	----	----	----	8	04/03/84
							07/02/86
							08/14/87

* Log Not Used in Interpretation

Table A-5. Details of Monitoring Wells for 216-T-34 and 216-T-35 Cribs.

Well Name	O.U.	Completed	T.D.	Perf.	T.O.C	Diameter	Gamma Logs
W11-15	200-TP-4	12/65	262	240-263	707	6	02/27/68 02/19/70 05/06/76
W11-16	200-TP-4	12/65	359	343-357	706	6	02/27/68 02/19/70 05/07/76 07/21/87 *
W11-17	200-TP-4	02/67	295	223-295	705	6	02/21/67 02/27/68 * 02/18/70 05/07/76 07/21/87 *
W11-18	200-TP-4	03/67	300	227-295	707	6	03/06/67 02/27/68 * 02/18/70 02/23/76
W11-19	200-TP-4	4/69	379	234-365	707	6	02/19/70 05/07/76 07/21/87 *
W11-20	200-TP-4	06/69	256	----	706	6	02/18/70 05/07/76 07/21/87 *
W11-21	200-TP-4	3/69	264	235-267	706	6	02/18/70 * 05/07/76 07/21/87

* Log Not Used in Interpretation

Table A-6. Details of Monitoring Wells for 216-T-21, -22, -23, -24, and -25 Trenches.

Well Name	O.U.	Completed	T.D.	Perf.	T.O.C	Diameter	Gamma Logs
W15-81	200-TP-1	10/53	115	----	670	8	05/02/63 * 12/02/76 *
W15-209	200-TP-1	11/82	----	----	----	8	03/14/84 06/24/86
W15-210	200-TP-1	10/82	----	----	----	8	03/14/84 * 06/24/86
W15-211	200-TP-1	10/82	----	----	----	8	03/14/84 06/24/86
W15-212	200-TP-1	10/82	----	----	----	8	Unknown

* Log Not Used in Interpretation

Table A-7. Details of Monitoring Wells for 216-T-7, -32, and -36 Cribs and 216-T-5 Trench. (Sheet 1 of 2)

Well Name	O.U.	Completed	T.D.	Perf.	T.O.C	Diameter	Gamma Logs
W10-1	200-TP-1	08/47	305	190-270	674.06	8	06/09/59 05/01/63 04/12/68 * 04/09/70 * 02/23/76 08/13/87
W10-2	200-TP-1	12/51	213	201-229	674.33	4	05/07/76 07/21/87
W10-3	200-TP-6	11/51	228	194-230	672.66	8	06/09/59 05/01/63 * 04/09/70 02/23/76 07/03/86
W10-4	200-TP-2	11/52	236	190-245	670.95	8	04/15/58 * 07/23/59 04/29/63 02/24/70 * 05/07/76
W10-52	200-TP-6	10/44	149	50-150	672.11	6	04/30/63
W10-56	200-TP-6	06/47	145	—	672.86	8	05/01/63 05/07/76
W10-57	200-TP-6	06/47	145	—	673.99	8	05/01/63 05/07/76
W10-58	200-TP-6	07/47	140	—	672.46	8	05/01/63 05/07/76
W10-59	200-TP-6	07/47	150	33-38	672.24	8	05/01/63 12/06/76 *
W10-60	200-TP-6	07/47	150	31-36	671.74	8	05/01/63 * 12/06/76 *
W10-61	200-TP-6	07/47	150	32-37	672.29	8	05/01/63 09/15/76
W10-62	200-TP-6	07/47	150	—	672.37	8	05/01/63 * 12/06/76
W10-63	200-TP-6	07/47	150	—	671.92	8	04/30/63 12/06/76 *
W10-64	200-TP-6	07/47	68	—	672.34	8	05/01/63 05/07/76
W10-65	200-TP-6	08/47	75	—	673.07	8	05/01/63 05/07/76
W10-66	200-TP-6	09/47	125	31-36	671.80	8	04/30/63 * 12/06/76 *
W10-67	200-TP-6	08/47	150	—	672.04	8	05/01/63 12/06/76 *

Table A-7. Details of Monitoring Wells for 216-T-7, -32, and -36 Cribs and 216-T-5 Trench. (Sheet 2 of 2)

Well Name	O.U.	Completed	T.D.	Perf.	T.O.C	Diameter	Gamma Logs
W10-68	200-TP-6	08/47	150	—	672.13	8	05/01/63 12/06/76 *
W10-69	200-TP-6	08/47	138	—	673.44	8	05/01/63 05/07/76 08/13/87
W10-70	200-TP-1	08/47	138	—	673.84	8	05/02/63 05/07/76 08/13/87 *
W10-71	200-TP-1	08/47	138	60-80	673.98	8	05/02/63 05/07/76 08/13/87 *
W-10-72	200-TP-1	08/47	133	—	673.41	8	05/02/63 05/07/76 08/14/87
W-10-73	200-TP-6	09/47	64	—	673.03	8	05/02/63 05/07/76
W10-74	200-TP-6	10/47	49	—	672.01	8	04/30/63 * 12/06/76 *
W10-75	200-TP-6	10/47	65	—	674.71	8	05/01/63 * 05/07/76
W10-76	200-TP-1	10/47	71	—	673.77	8	05/02/63 08/13/87 *
W10-77	200-TP-6	12/48	24	—	672	8	05/01/63 * 05/07/76 * 08/13/87 *
W10-78	200-TP-1	12/48	20	—	672	8	05/02/63 * 05/07/76 * 08/14/87 *
W10-79	200-TP-1	12/48	22	—	672	8	05/02/63 * 05/07/76 * 08/13/87 *
W10-80	200-TP-6	09/51	104	77-83	672	8	05/01/63 05/07/76
W10-81	200-TP-6	11/51	19	—	672	8	05/02/83 05/07/76

* Log Not Used in Interpretation

APPENDIX B

HEALTH AND SAFETY PLAN

9 3 1 2 0 7 0 1 3 3 1

ACRONYMS AND ABBREVIATIONS

AAMS	aggregate area management study
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
EII	Environmental Investigations Instructions
HEHF	Hanford Environmental Health Foundation
HSP	Health and Safety Plan
HWOP	Hazardous Waste Operations Permit
JSA	Job Safety Analysis
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
RCRA	Resource Conservation and Recovery Act
RWP	radiation work permit
SCBA	self-contained breathing apparatus
WHC	Westinghouse Hanford Company
WISHA	Washington Industrial Safety and Health Act

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1.0 GENERAL CONSIDERATIONS AND REQUIREMENTS

1.1 INTRODUCTION

The purpose of this Health and Safety Plan (HSP) is to outline standard health and safety procedures for Westinghouse Hanford Company (Westinghouse Hanford) employees and contractors engaged in investigation activities in the T Plant Source Aggregate Area Management Study (T Plant AAMS). These activities will include surface investigation, drilling and sampling boreholes, and environmental sampling in areas of known chemical and radiological contamination. Appropriate site-specific safety documents (e.g., Hazardous Waste Operations Permit [HWOP] or Job Safety Analysis [JSA]) will be written for each task or group of tasks. A more complete discussion of Westinghouse Hanford environmental safety procedures is presented in the Westinghouse Hanford manual *Health and Safety for Hazardous Waste Field Operations*, WHC-CM-4-3 Vol. 4 (WHC 1992).

All employees of Westinghouse Hanford or any other contractors who are participating in onsite activities in the T Plant AAMS shall read the site-specific safety document and attend a pre-job safety or tailgate meeting to review and discuss the task.

1.2 DESIGNATED SAFETY PERSONNEL

The field team leader and site safety officer are responsible for site safety and health. Specific individuals will be assigned on a task-by-task basis by project management, and their names will be properly recorded before the task is initiated.

All activities onsite must be cleared through the field team leader. The field team leader has responsibility for the following:

- Allocating and administering resources to successfully comply with all technical and health and safety requirements
- Verifying that all permits, supporting documentation, and clearances are in place (e.g., electrical outage requests, welding permits, excavation permits, HWOP or JSA, sampling plan, radiation work permits [RWP], and onsite/offsite radiation shipping records)
- Providing technical advice during routine operations and emergencies
- Informing the appropriate site management and safety personnel of the activities to be performed each day
- Coordinating resolution of any conflicts that may arise between RWPs and the implementation of the HWOP or JSA with health physics

- Handling emergency response situations as may be required
- Conducting pre-job and daily tailgate safety meetings
- Interacting with adjacent building occupants and/or inquisitive public.

The site safety officer is responsible for implementing the HWOP at the site. The site safety officer shall do the following.

- Monitor chemical, physical, and (in conjunction with the health physics technician) radiation hazards to assess the degree of hazard present; monitoring shall specifically include organic vapor detection, radiation screening, and confined space evaluation where appropriate.
- Determine protection levels, clothing, and equipment needed to ensure the safety of personnel in conjunction with the health physics department.
- Monitor the performance of all personnel to ensure that the required safety procedures are followed.
- Halt operations immediately, if necessary, due to safety or health concerns.
- Conduct safety briefings as necessary.
- Assist the field team leader in conducting safety briefings as necessary.

The health physics technician is responsible for ensuring that all radiological monitoring and protection procedures are being followed as specified in the Radiation Protection Manual and in the appropriate RWP. Westinghouse Hanford Industrial Safety and Fire Protection personnel will provide safety overview during drilling operations consistent with Westinghouse Hanford policy and, as requested, will provide technical advice. Also, downwind sampling for hazardous materials and radiological contaminants and other analyses may be requested from appropriate contractor personnel as required.

The ultimate responsibility and authority for employee's health and safety lies with the employee and the employee's colleagues. Each employee is responsible for exercising the utmost care and good judgment in protecting his or her personal health and safety and that of fellow employees. Should any employee observe a potentially unsafe condition or situation, it is the responsibility of that employee to immediately bring the observed condition to the attention of the appropriate health and safety personnel, as designated previously. In the event of an immediately dangerous or life-threatening situation, the employee automatically has temporary "stop work" authority and the responsibility to immediately notify the field team leader or site safety officer. When work is temporarily halted because of a safety or

health concern, personnel will exit the exclusion zone and meet at a predetermined place in the support zone. The field team leader, site safety officer, and health physics technician will determine the next course of action.

1.3 MEDICAL SURVEILLANCE

All field team members engaged in operable unit activities at sites governed by an HWOP must have baseline physical examinations and be participants in Westinghouse Hanford (or an equivalent) hazardous waste worker medical surveillance program.

Medical examinations will be designed to identify any pre-existing conditions that may place an employee at high risk, and will verify that each worker is physically able to perform the work required by this plan without undue risk to personal health. The physician shall determine the existence of conditions that may reduce the effectiveness or prevent the employee's use of respiratory protection. The physician shall also determine the presence of conditions that may pose undue risk to the employee while performing the physical tasks of this work plan using level B personal protection equipment. This would include any condition that increases the employee's susceptibility to heat stress.

The examining physician's report will not include any nonoccupational diagnoses unless directly applicable to the employee's fitness for the work required.

1.4 TRAINING

Before engaging in any onsite activities, each team member is required to have received 40 hours of health and safety training related to hazardous waste site operations and at least 8 hours of refresher training each year thereafter as specified in 29 Code of Federal Regulations (CFR) 1910.120. In addition, each inexperienced employee (never having performed site characterization) will be directly supervised by a trained/experienced person for a minimum of 24 hours of field experience.

The field team leader and the site safety officer shall receive an additional 8 hours of training (in addition to the refresher training previously discussed).

1.5 TRAINING FOR VISITORS

For the purposes of this plan, a visitor is defined as any person visiting the Hanford Site, who is not a Westinghouse Hanford employee or a Westinghouse Hanford contractor directly involved in the Resource Conservation and Recovery Act (RCRA)/Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) facility investigation activities, including but not limited to those engaged in surveillance, inspection, or observation activities.

Visitors who must, for whatever reason, enter a controlled (either contamination reduction or exclusion) zone, shall be subject to all of the applicable training, respirator fit testing, and medical surveillance requirements discussed in Westinghouse Hanford Environmental Investigations and Site Characterization Manual Environmental Investigations Instructions (EII) 1.1 (WHC 1991).

All visitors shall be informed of potential hazards and emergency procedures by their escorts and shall conform to EII 1.1 (WHC 1991).

1.6 RADIATION DOSIMETRY

All personnel engaged in onsite activities shall be assigned dosimeters according to the requirements of the RWP applicable to that activity. All visitors shall be assigned basic dosimeters, as a minimum, that will be exchanged annually.

1.7 REQUIREMENTS FOR THE USE OF RESPIRATORY PROTECTION

All employees of Westinghouse Hanford and subcontractors who may be required to use air-purifying or air-supplied respirators must be included in the medical surveillance program and be approved for the use of respiratory protection by the Hanford Environmental Health Foundation (HEHF) or other licensed physician. Each team member must be trained in the selection, limitations, and proper use and maintenance of respiratory protection (existing respiratory protection training may be applicable towards the 40-hour training requirement).

Before using a negative pressure respirator, each employee must have been fit-tested (within the previous year) for the specific make, model, and size according to Westinghouse Hanford fit-testing procedures. Beards (including a few days' growth), large sideburns, or moustaches that may interfere with a proper respirator seal are not permitted.

Subcontractors must provide evidence to Westinghouse Hanford that personnel are participants in a medical surveillance and respiratory protection program that complies with 29 CFR 1910.120 and 29 CFR 1910.134, respectively.

2.0 GENERAL PROCEDURES

The following personal hygiene and work practice guidelines are intended to prevent injuries and adverse health effects. A hazardous waste site poses a multitude of health and safety concerns because of the variety and number of hazardous substances present. These guidelines represent the minimum standard procedures for reducing potential risks associated with this project and are to be followed by all job-site employees at all times.

2.1 GENERAL WORK SAFETY PRACTICES

2.1.1 Work Practices

The following work practices must be observed.

- Eating, drinking, smoking, taking certain medications, chewing gum, and similar actions are prohibited within the exclusion zone. All sanitation facilities shall be located outside the exclusion zone; decontamination is required before using such facilities.

- Personnel shall avoid direct contact with contaminated materials unless necessary for sample collecting or required observation. Remote handling of such things as casings and auger flights will be practiced whenever practical.

- While operating in the controlled zone, personnel shall use the "buddy system" where appropriate, or be in visual contact with someone outside of the controlled zone.

- The buddy system will be used where appropriate for manual lifting.

- Requirements of Westinghouse Hanford radiation protection and RWP manuals shall be followed for all work involving radioactive materials or conducted within a radiologically controlled area.

- Onsite work operations shall only be carried out during daylight hours, unless the entire control zone is adequately illuminated with artificial lighting. A new tour (shift) will operate the drilling rig after completion of each shift.

- Do not handle soil, waste samples, or any other potentially contaminated items unless wearing the protective equipment specified in the HWOP or JSA.

- Whenever possible, stand upwind of excavations, boreholes, well casings, drilling spoils, and the like, as indicated by an onsite windsock.

- Stand clear of trenches during excavation. Always approach an excavation from upwind.

- Be alert to potentially changing exposure conditions as evidenced by such indications as perceptible odors, unusual appearance of excavated soils, or oily sheen on water.

- Do not enter any test pit or trench deeper than 1 m (4 ft) unless in accordance with procedures specified in the HWOP.

- Do not under any circumstances enter or ride in or on any backhoe bucket, materials hoist, or any other similar device not specifically designed for carrying passengers.

- All drilling team members must make a conscientious effort to remain aware of their own and others' positions in regards to rotating equipment, cat heads, or u-joints. Drilling operations members must be extremely careful when assembling, lifting, and carrying flights or pipe to avoid pinch-point injuries and collisions.

- Tools and equipment will be kept off the ground whenever possible to avoid tripping hazards and the spread of contamination.

- Personnel not involved in operation of the drill rig or monitoring activities shall remain a safe distance from the rig as indicated by the field team leader.

- Follow all provisions of each site-specific hazardous work permit as addressed in the HWOP, including cutting and welding, confined space entry, and excavation.

- Catalytic converters on the underside of vehicles are sufficiently hot to ignite dry prairie grass. Team members should not drive over dry grass that is higher than the ground clearance of the vehicle and should be aware of the potential fire hazard posed by catalytic converters at all times. Never allow a running or hot vehicle to sit in a stationary location over dry grass or other combustible materials.

- Follow all provisions of each site-specific RWP.

- Team members will attempt to minimize truck tire disturbance of all stabilized sites.

2.1.2 Personal Protective Equipment

- Personal protective equipment will be selected specifically for the hazards identified in the HWOP. The site safety officer in conjunction with Westinghouse Hanford Health Physics and Industrial Hygiene and Safety is responsible for choosing the appropriate type and level of protection required for different activities at the job site.

- Levels of protection shall be appropriate to the hazard to avoid either excessive exposure or additional hazards imposed by excessive levels of protection. The HWOP will contain provisions for adjusting the level of protection as necessary. These personal protective equipment specifications must be followed at all times, as directed by the field team leader, health physics technician, and site safety officer.

- Each employee must have a hard hat, safety glasses, and substantial protective footwear available to wear as specified in the HWOP or JSA.

- The exclusion zone around drilling or other noisy operations will be posted "Hearing Protection Required" and team members will have had noise control training.

- Personnel should maintain a high level of awareness of the limitations in mobility, dexterity, and visual impairment inherent in the use of level B and level C personal protective equipment.

- Personnel should be alert to the symptoms of fatigue, heat stress, and cold stress and their effects on the normal caution and judgment of personnel.

- Rescue equipment as required by Occupational Safety and Health Administration (OSHA), Washington Industrial Safety and Health Act (WISHA), or standards for working over water will be available and used.

2.1.3 Personal Decontamination

- The HWOP will describe in detail methods of personnel decontamination, including the use of contamination control corridors and step-off pads when appropriate.

- Thoroughly wash hands and face before eating or putting anything in the mouth to avoid hand-to-mouth contamination.

- At the end of each work day or each job, disposable clothing shall be removed and placed in (chemical contamination) drums, plastic-lined boxes or other containers as appropriate. Clothing that can be cleaned may be sent to the Hanford Site laundry.

- Individuals are expected to thoroughly shower before leaving the work site or Hanford Site if directed to do so by the health physics technician, site safety officer, or field team leader.

2.1.4 Emergency Preparation

- A multipurpose dry chemical fire extinguisher, a fire shovel, a complete field first-aid kit, and a portable pressurized spray wash unit shall be available at every site where there is potential for personnel contamination.

- Prearranged hand signals or other means of emergency communication will be established when respiratory protection equipment is to be worn, because this equipment seriously impairs speech.

- The Hanford Fire Department shall be initially notified before the start of the site investigation project. This notification shall include the location and nature of the various types of field work activities as described in the work plan. A site location map shall be included in this notification.

2.2 CONFINED SPACE/TEST PIT ENTRY PROCEDURES

The following procedures apply to the entry of any confined space, which for the purpose of this document shall be defined as any space having limited egress (access to an exit) and the potential for the presence or accumulation of a toxic or explosive atmosphere. This includes manholes, certain trenches (particularly those through waste disposal areas), and all test pits greater than 1 m (4 ft) deep. If confined spaces are to be entered as part of the work operations, a hazardous work permit (filled out for confined space entry) must be obtained from Industrial Safety and Fire Protection.

The identified remedial investigation activities on the T Plant AAMS should not require confined space entry. Nevertheless, the hazards associated with confined spaces are of such severity that all employees should be familiar with the safe work discussed in the following paragraphs.

No employee shall enter any test pit or trench deeper than 1 m (4 ft) unless the sides are shored or laid back to a stable slope as specified in OSHA 29 CFR 1926.652 or equivalent state occupational health and safety regulations.

When an employee is required to enter a pit or trench 1 m (4 ft) deep or more, an adequate means of access and egress, such as a slope of at least 2:1 to the bottom of the pit or a secure ladder or steps shall be provided.

Before entering any confined space, including any test pit, the atmosphere will be tested for flammable gases, oxygen deficiency, and organic vapors. If other specific contamination, such as radioactive materials or other gases and vapors may be present, additional testing for those substances shall be conducted. Depending on the situation, the space may require ventilation and retesting before entry.

An employee entering a confined or partially confined space must be equipped with an appropriate level of respiratory protection in keeping with the monitoring procedures discussed previously and the action levels for airborne contaminants (see "Warnings and Action Levels" in HWOP).

No employee shall enter any test pit requiring the use of level B protection, unless a backup person also equipped with a pressure-demand self-contained breathing apparatus (SCBA) is present. No backup person shall attempt any emergency rescue unless a second backup person equipped with an SCBA is present, or the appropriate emergency response authorities have been notified and additional help is on the way.

3.0 SITE BACKGROUND

Specific details on the T Plant AAMS background and known and suspected contamination are described in Chapters 2.0 through 10.0 of the plan. The T Plant Aggregate Area is situated within the 200 West Area of the DOE's Hanford Site, in the south-central portion of the state of Washington. The 200 West Area is located in Benton County in the central portion of the Hanford Site. It is adjacent to the 200 East Area, located roughly 5 km to the west.

The T-Plant Area at the Hanford Site was used by the U.S. Government as a chemical separations area in the process to produce plutonium for nuclear weapons. These operations resulted in the release of chemical and radioactive wastes into the soil, air, and water of the area. Each waste site in the aggregate area is described separately in this document. Close relationships between waste units, such as overflow from one to another, are also discussed.

4.0 SCOPE OF WORK AND POTENTIAL HAZARDS

While the information presented in Chapters 2.0 through 10.0 of the plan are believed to be representative of the constituents and quantities of wastes at the time of discharge, the present chemical nature, location, extent, and ultimate fate of these wastes in and around the liquid disposal facilities are largely unknown. The emphasis of the investigation in the T Plant AAMS will be to characterize the nature and extent of contamination in the vadose (unsaturated subsurface soil) zone.

4.1 WORK TASKS

Work tasks are described in Chapter 5.0 of the plan.

4.2 POTENTIAL HAZARDS

Onsite tasks will involve noninvasive surface sampling procedures and invasive soil sampling either directly in or immediately adjacent to areas known or suspected to contain potentially hazardous chemical substances, toxic metals, and radioactive materials.

Surface radiological contamination and fugitive dust will be the potential hazards of primary concern during noninvasive mapping and sampling activities.

Existing data indicate that hazardous substances may be encountered during invasive sampling; these include radionuclides, heavy metals, and corrosives. In addition, volatile organics may also be associated with certain facilities such as the solvent storage buildings or underground storage tanks.

Potential hazards include the following:

- External radiation (gamma and to a lesser extract, beta) from radioactive materials in the soil
- Internal radiation resulting from radionuclides present in contaminated soil entering the body by ingestion or through open cuts and scratches
- Internal radiation resulting from inhalation of particulate (dust) contaminated with radioactive materials
- Inhalation of toxic vapors or gases such as volatile organics or ammonia
- Inhalation or ingestion of particulate (dust) contaminated with inorganic or organic chemicals, and toxic metals

- Dermal exposure to soil or groundwater contaminated with radionuclides
- Dermal exposure to soil or groundwater contaminated with inorganic or organic chemicals, and toxic metals
- Physical hazards such as noise, heat stress, and cold stress
- Slips, trips, falls, bumps, cuts, pinch points, falling objects, other overhead hazards, crushing injuries, and other hazards typical of a construction-related job site
- Unknown or unexpected underground utilities
- Biological hazards; snakes, spiders, etc.

4.3 ASSESSMENT AND MITIGATION OF POTENTIAL HAZARDS

The likelihood of significant exposure (100 mR/h or greater) to external radiation is remote and can be readily monitored and controlled by limiting exposure time, increasing distance, and employing shielding as required.

Internal radiation by inhalation or inadvertent ingestion of contaminated dust is a realistic concern and must be continuously evaluated by the health physics technician. Appropriate respiratory protection, protective clothing, and decontamination procedures will be implemented as necessary to reduce potential inhalation, ingestion, and dermal exposure to acceptable levels.

Dermal exposure to toxic chemical substances is not expected to pose a significant problem for the identified tasks given the use of the designated protective clothing. The appropriate level of personal protective clothing and respiratory protection will vary from work site to work site.

5.0 ENVIRONMENTAL AND PERSONAL MONITORING

The site safety officer or authorized delegate shall be present at all times during work activities which require an HWOP, and shall be in charge of all environmental/personal monitoring equipment. Industrial Hygiene and Safety shall review all activities involving or potentially involving radiological exposure or contamination control and shall prescribe the appropriate level of technical support and/or monitoring requirements. Other equipment deemed necessary by the site safety officer or Industrial Hygiene and Safety shall be obtained

at their direction; work will be initiated or continued until such equipment is in place. These instruments are to be used only by persons who are trained in their usage and who understand their limitations. No work shall be done unless instrumentation is available and in proper working order.

Air sampling may be required downwind of the referenced waste sites to monitor particulates and vapors before job startup. Siting of such sampling devices will be determined by Health Physics, the site safety officer, and HEHF, if appropriate. Any time personnel exposure monitoring, other than radiological, is required to determine exposure levels, it must be done by HEHF. Discrete sampling of ambient air within the work zone and breathing zones will be conducted using a direct-reading instrument, as specified in the site-specific safety document, and other methods as deemed appropriate (e.g., pumps with tubes, O_2 meters). The following standards will be used in determining critical levels:

- "Radionuclide Concentrations in Air," in Chapter XI, DOE Order 5480.1B (DOE 1986)
- "Air Contaminants - Permissible Exposure Limits," in 29 CFR 1910.1000
- *Threshold Limit Values and Biological Exposure Indices for 1990-1991* (ACGIH 1991)
- *Occupational Safety and Health Standards*, 29 CFR 1910.1000
- *Pocket Guide to Chemical Hazards* (NIOSH 1991), which provides National Institute for Occupational Safety and Health (NIOSH)-recommended exposure limits for substances that do not have either a threshold limit value or a permissible exposure limit.

5.1 AIRBORNE RADIOACTIVE AND RADIATION MONITORING

An onsite health physics technician will monitor airborne radioactive contamination levels and external radiation levels. Action levels will be consistent with derived air concentrations and applicable guidelines as specified in the radiation protection manual WHC-CM-4-10 (WHC 1988).

Appropriate respiratory protection shall be required when conditions are such that the airborne contamination levels may exceed an 8-hour derived air concentration (e.g., the presence of high levels of uncontained, loose contamination on exposed surfaces or operations that may raise excessive levels of dust contaminated with airborne radioactive materials, such as excavation or drilling under extremely dry conditions).

Specific conditions requiring the use of respiratory protection because of radioactive materials in air will be incorporated into the RWP. If, in the judgement of the health physics technician, any of these conditions arise, work shall cease until appropriate respiratory protection is provided.

6.0 PERSONAL PROTECTIVE EQUIPMENT

The level of personal protective equipment required initially at a site will be specified in the site-specific safety document for each task or group of tasks. Personal protective clothing and respiratory protection shall be selected to limit exposure to anticipated chemical and radiological hazards. Work practices and engineering controls may be used to control exposure.

7.0 SITE CONTROL

The field team leader, site safety officer, and health physics technician are designated to coordinate access control and security on the site. Special site control measures will be necessary to restrict public access. The zones will be clearly marked with rope and/or appropriate signs. The size and shape of the control zone will be dictated by the types of hazards expected, the climatic conditions, and specific operations required.

Control zone boundaries may be increased or decreased based on results of field monitoring, environmental changes, or work technique changes. The site RWP and the contractor's standard operating procedures for radiation protection may also dictate the boundary size and shape. All team members must be surveyed for radioactive contamination when leaving the controlled zone if in a radiation zone.

The onsite command post and staging area will be established near the upwind side of the control zone as determined by an onsite windsock. Exact location for the command post is to be determined just before start of work. Vehicle access, availability of utilities (power and telephone), wind direction, and proximity to sample locations should be considered in establishing a command post location.

8.0 DECONTAMINATION PROCEDURES

Remedial investigation activities will require entry into areas of known chemical and radiological contamination. Consequently, it is possible that personnel and equipment could be contaminated with hazardous chemical and radiological substances.

During site activities, potential sources of contamination may include airborne vapors, gases, dust, mists, and aerosols; splashes and spills; walking through contaminated areas; and handling contaminated equipment. Personnel who enter the exclusion zone will be required to go through the appropriate decontamination procedures on leaving the zone. Decontamination procedures shall be consistent with EII 5.4, "Field Decontamination of Drilling, Well Development, and Sampling Equipment," and EII 5.5, "1706 KE Laboratory Decontamination of Equipment for RCRA/CERCLA Sampling" (WHC 1991), or other approved decontamination procedures.

9.0 CONTINGENCY AND EMERGENCY RESPONSE PLANS

As a general rule, in the event of an unanticipated, potentially hazardous situation indicated by instrument readings, visible contamination, unusual or excessive odors, or other indications, team members shall temporarily cease operations and move upwind to a predesignated safe area as specified in the site-specific safety documentation.

10.0 REFERENCES

ACGIH, 1991, *Threshold Limit Values and Biological Exposure Indices for 1990-1991*, American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio.

DOE, 1986, *Environment, Safety & Health Program for DOE Operations*, DOE Order 5480.1B, U.S. Department of Energy, Washington, D.C.

NIOSH, 1991, *Pocket Guide to Chemical Hazards, National Institute for Occupational Safety and Health*, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, Washington, D.C.

WHC, 1988, *Radiation Protection*, WHC-CM-4-10, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991, *Environmental Investigations and Site Characterization Manual*, WHC-CM-7-7, Westinghouse Hanford Company, Richland, Washington.

WHC, 1992, *Health and Safety for Hazardous Waste Field Operations*, WHC-CM-4-3 Vol. 4, Westinghouse Hanford Company, Richland, Washington.

APPENDIX C

PROJECT MANAGEMENT PLAN

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ACRONYMS AND ABBREVIATIONS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FS	feasibility study
MCS	Management Control System
PMP	Project Management Plan
PNL	Pacific Northwest Laboratory
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
Tri-Party Agreement	Hanford Federal Facility Agreement and Consent Order

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1.0 INTRODUCTION

This Project Management Plan (PMP) defines the administrative and institutional tasks necessary to support the T Plant Aggregate Area investigations at the Hanford Site. Also, this PMP defines the responsibilities of the various participants, the organizational structure, and the project tracking and reporting procedures. This PMP is in accordance with the provisions of the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) dated August 1990 (Ecology et al. 1990). Any revisions to the Tri-Party Agreement that would result in changes to the project management requirements would supersede the provisions of this chapter.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

2.1 INTERFACE OF REGULATORY AUTHORITIES AND THE U.S. DEPARTMENT OF ENERGY

The T Plant Aggregate Area consists of active and inactive waste management units to be remedied under either the Resource Conservation and Recovery Act (RCRA) or the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). The U.S. Environmental Protection Agency (EPA) has been designated as the lead regulatory agency, as defined in the Tri-Party Agreement. Accordingly, EPA is responsible for overseeing remedial action activity at this aggregate area and ensuring that the applicable authorities of both the U.S. Department of Ecology (Ecology) and the U.S. Department of Energy (DOE) are applied. The specific responsibilities of EPA, Ecology, and DOE are detailed in the Tri-Party Agreement.

2.2 PROJECT ORGANIZATION AND RESPONSIBILITIES

The project organization for implementing remedial activities at the T Plant Aggregate Area is shown in Figure C-1. The following sections describe the responsibilities of the individuals shown in Figure C-1.

2.2.1 Project Managers

The EPA, DOE, and Ecology have each designated one individual as project manager for remedial activities at the Hanford Site. These project managers will serve as the primary point of contact for all activities to be carried out under the Tri-Party Agreement. The responsibilities of the project managers are given in Section 4.1 of the Tri-Party Agreement.

2.2.2 Unit Managers

As shown in Figure C-1, EPA, DOE, and Ecology will each designate an individual as a unit manager for the T Plant Aggregate Area.

The unit manager from EPA will serve as the lead unit manager. The EPA unit manager will be responsible for regulatory oversight of all activities required for the T Plant Aggregate Area.

The unit manager from Ecology will be responsible for making decisions related to issues for which the supporting regulatory agency maintains authority. All such decisions will be made in consideration of recommendations made by the EPA unit manager.

The unit manager from DOE will be responsible for maintaining and controlling the schedule and budget and keeping the EPA and Ecology unit managers informed as to the status of the activities at the T Plant Aggregate Area, particularly the status of agreements and commitments.

2.2.3 Quality Assurance Lead

The quality assurance lead will be a designated person within the Westinghouse Hanford Quality Assurance Organization. This designated person will be responsible for monitoring overall environmental restoration activities for this project. The designated personnel shall have the necessary organizational independence and authority to identify conditions adverse to quality and to systematically seek corrective action.

This individual is responsible for the preplanned survellance and audit activities for this project. A quality assurance report shall be provided to the technical lead, annually as a minimum, for inclusion in the project final report generated by the technical organization. The quality assurance report shall summarize the surveillance and audit activities as well as associated corrective actions that may have been taken during the interval.

2.2.4 Quality Coordinator

The quality coordinator is responsible for coordinating and monitoring performance of the Quality Assurance Project Plan (QAPP) requirements by means of internal surveillance techniques and by auditing, as directed by the quality assurance officer. The quality coordinator retains the necessary organizational independence and authority to identify conditions adverse to quality, and to inform the technical lead of needed corrective action.

2.2.5 Health and Safety Officer (Environmental Division/Environmental Field Services)

The health and safety officer is responsible for monitoring all potential health and safety hazards, including those associated with radioactive, volatile, and/or toxic compounds during sample handling and sampling decontamination activities. The health and safety officer has the responsibility and authority to halt field activities resulting from unacceptable health and safety hazards.

2.2.6 Technical Lead

The technical lead will be a designated person within the Westinghouse Hanford Environmental Engineering Group. The responsibilities of the technical lead will be to plan, authorize, and control work so that it can be completed on schedule and within budget, and to ensure that all planning and work performance activities are technically sound.

2.2.7 Remedial Investigation/Feasibility Study Coordinators

The remedial investigation (RI) and feasibility study (FS) coordinators will be responsible for coordinating all activities related to the RI and FS, respectively, including data collection, analysis, and reporting. The RI and FS coordinators will be responsible for keeping the technical lead informed as to the RI and FS work status and any problems that may arise.

2.2.8 Resource Conservation and Recovery Act Facility Investigation/Corrective Measures Study Contractor

Figure C-1 shows the organizational relationship of an offsite contractor. Assuming a contractor is used to perform the RI/FS for the T Plant Aggregate Area, the contractor would assume responsibilities of the RI and FS coordinators, as described above. In this instance, the contractor will be directly responsible for planning data collection activities and for analyzing and reporting the results of the data-gathering in the RI and FS reports. However, the Westinghouse Hanford coordinator would retain the responsibility for securing and managing the field sampling efforts of the Hanford Site technical resource teams, described below. Figure C-2 shows a sample organizational structure for an RI/FS contractor team.

2.2.9 Hanford Site Technical Resources

The various technical resources available on the Hanford Site for performing the field studies are shown in Table C-1. These resources will be responsible for performing data collection activities and analyses, and for reporting the results of specific technical activities. Figures C-3 through C-6 show the detailed organizational structure of specific technical

teams. Internal and external work orders and subcontractor task orders will be written by the Westinghouse Hanford technical lead to use these technical resources, which are under the control of the technical lead. Statements of work will be provided to the technical teams and will include a discussion of authority and responsibility, a schedule with clearly defined milestones, and a task description including specific requirements. Each technical team will keep the coordinator informed of the work status performed by that group and any problems that may arise.

3.0 DOCUMENTATION AND RECORDS

All plans and reports will be categorized as either primary or secondary documents as described by Section 9.1 of the Tri-Party Agreement. The process for document review and comment will be as described in Section 9.2 of the Tri-Party Agreement. Revisions, should they become necessary after finalization of any document, will be in accordance with Section 9.3 of the Tri-Party Agreement. Changes in the work schedule, as well as minor field changes, can be made without having to process a formal revision. The process for making these changes will be as stated in Section 12.0 of the Tri-Party Agreement. Administrative records, which must be maintained to support the Hanford Site activities, will be in accordance with Section 9.4 of the Tri-Party Agreement.

4.0 FINANCIAL AND PROJECT TRACKING REQUIREMENTS

4.1 MANAGEMENT CONTROL

Westinghouse Hanford will have the overall responsibility for planning and controlling the investigation activities, and providing effective technical, cost, and schedule baseline management. If a contractor is used, the contractor will assume the direct day-to-day responsibilities for these management functions. The management control system used for this project must meet the requirements of DOE Order 4700.1, Project Management System and DOE Order 2250.1C, Cost and Schedule Control Systems Criteria. The Westinghouse Hanford Management Control System (MCS) meets these requirements. The primary goals of the Westinghouse Hanford MCS are to provide methods for planning, authorizing, and controlling work so that it can be completed on schedule and within budget, and to ensure that all planning and work performance activities are technically sound and in conformance with management and quality requirements.

The schedule developed for the T Plant Aggregate Area will be updated at least annually, to expand the new current fiscal year and the follow-on year. In addition, any approved schedule changes (see Section 12.0 of the Tri-Party Agreement for the formal change control system) would be incorporated at this time, if not previously incorporated.

This update will be performed in the fourth quarter of the previous fiscal year (e.g., July to September) for the upcoming current fiscal year. The work schedule can be revised at any time during the year if the need arises, but the changes would be restricted to major changes that would not be suitable for the change control process.

4.2 MEETINGS AND PROGRESS REPORTS

Both project and unit managers must meet periodically to discuss progress, review plans, and address any issues that have arisen. The project managers' meeting will take place at least quarterly, and is discussed in Section 8.1 of the Tri-Party Agreement.

Unit managers shall meet monthly to discuss progress, address issues, and review near-term plans pertaining to their respective operable units and/or treatment, storage, and disposal groups/units. The meetings shall be technical in nature, with emphasis on technical issues and work progress. The assigned DOE unit manager for the T Plant Aggregate Area will be responsible for preparing revisions to the aggregate area schedule prior to the meeting. The schedule shall address all ongoing activities associated with the T Plant Aggregate Area, including actions on specific source units (e.g., sampling). This schedule will be provided to all parties and reviewed at the meeting. Any agreements and commitments (within the unit manager's level of authority) resulting from the meeting will be prepared and signed by all parties as soon as possible after the meeting. Meeting minutes will be issued by the DOE unit manager and will summarize the discussion at the meeting, with information copies given to the project managers. The minutes will be issued within five working days following the meeting. The minutes will include, at a minimum, the following information:

- Status of previous agreements and commitments
- Any new agreements and commitments
- Schedules (with current status noted)
- Any approved changes signed off at the meeting in accordance with Section 12.1 of the Tri-Party Agreement.

Project coordinators for each operable unit also will meet on a monthly basis to share information and to discuss progress and problems.

The DOE shall issue a quarterly progress report for the Hanford Site within 45 days following the end of each quarter. Quarters end on March 31, June 30, September 30, and December 31. The quarterly progress reports will be placed in the public information

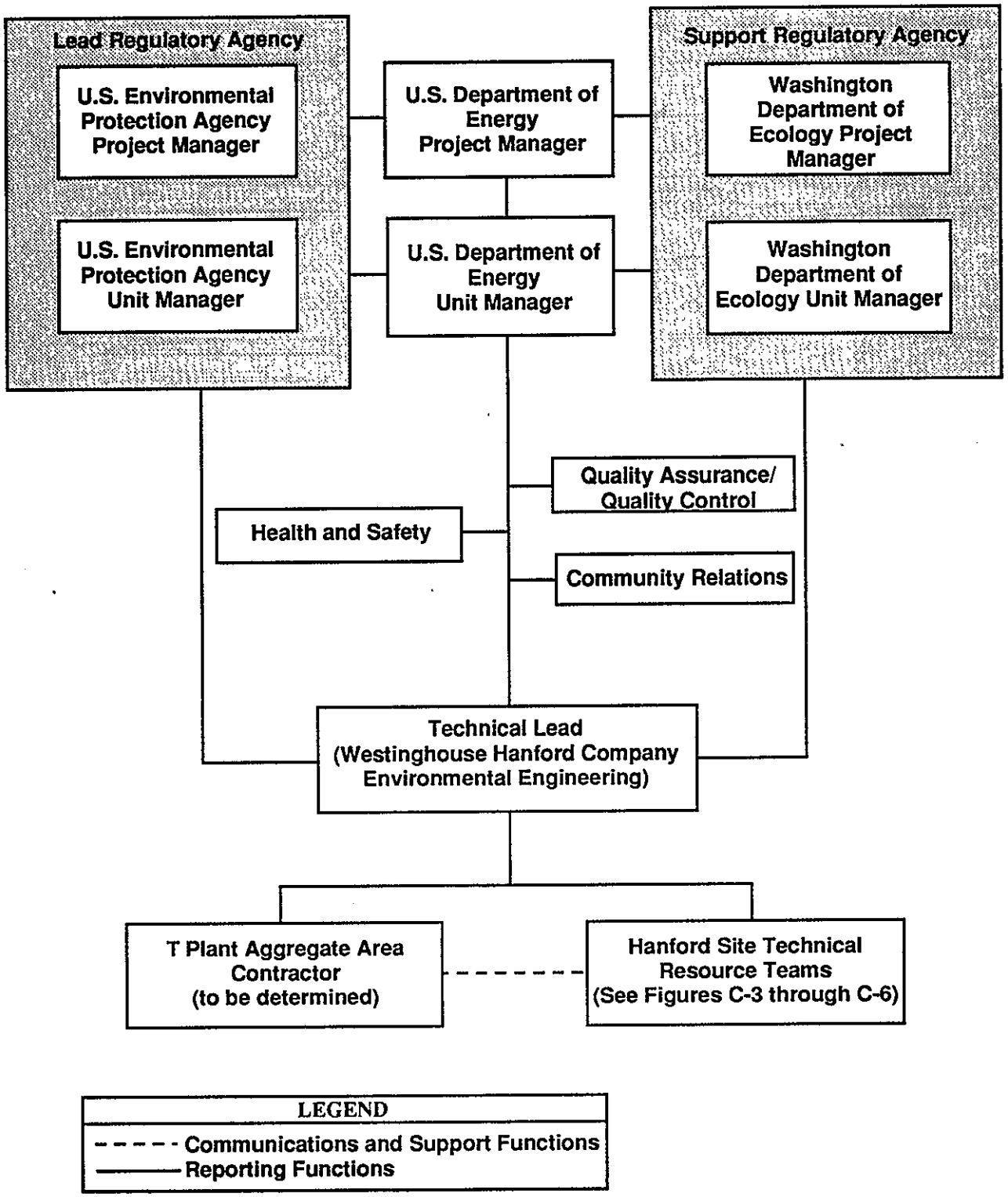
repositories as discussed in Section 10.2 of the Tri-Party Agreement. The report shall include the following:

- Highlights of significant progress and problems.
- Technical progress with supporting information, as appropriate.
- Problem areas with recommended solutions. This will include any anticipated delays in meeting schedules, the reason(s) for the potential delay, and actions to prevent or minimize the delay.
- Significant activities planned for the next quarter.
- Work schedules (with current status noted).

5.0 REFERENCES

Ecology, EPA, and DOE, 1990, *Hanford Federal Facility Agreement and Consent Order*, (First Amendment), 89-10, Rev.1, Olympia, Washington.

Figure C-1. Project Organization for the T Plant Aggregate Area Project.



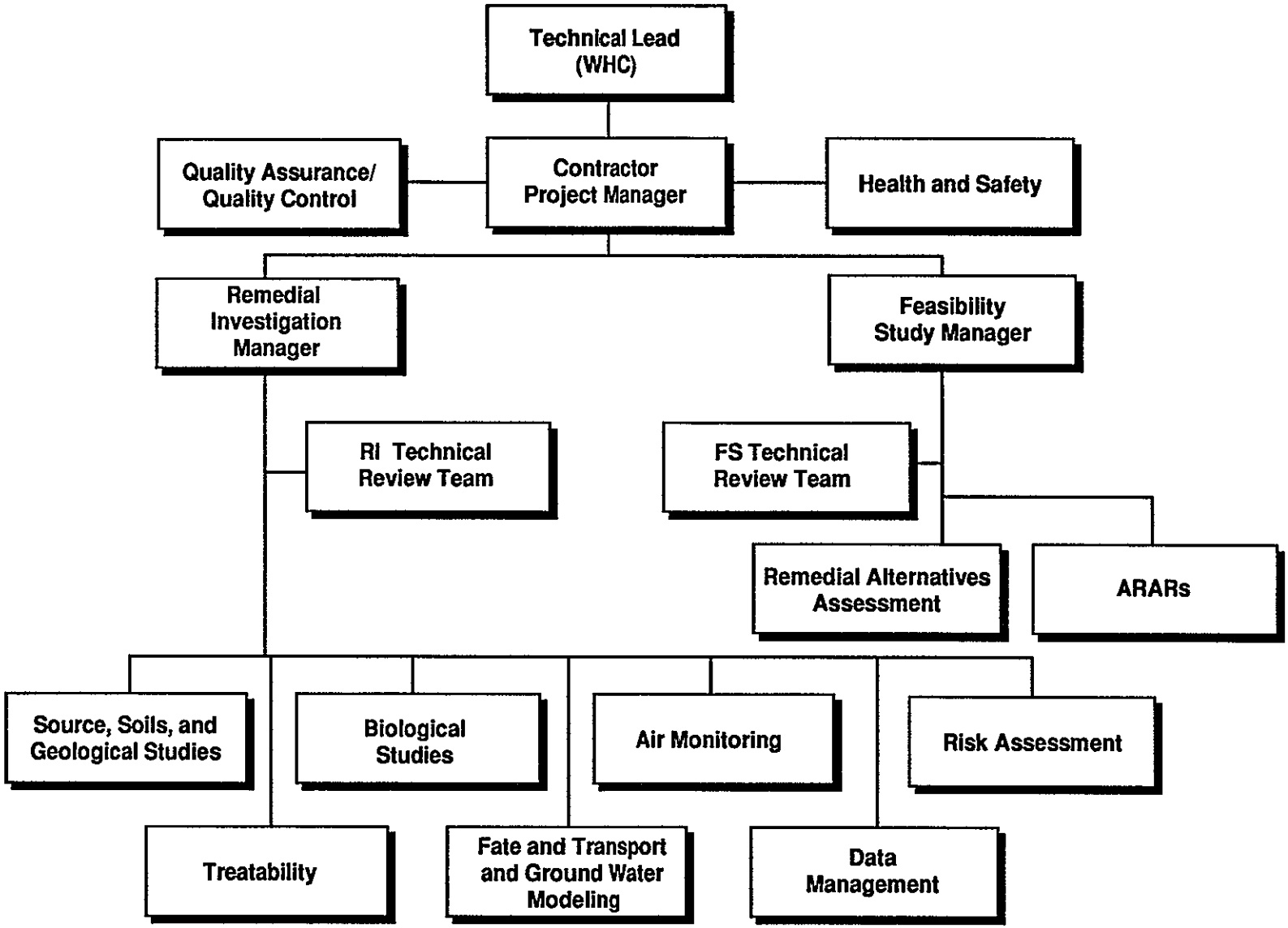


Figure C-2. Example Project Organization for the T Plant Aggregate Area.

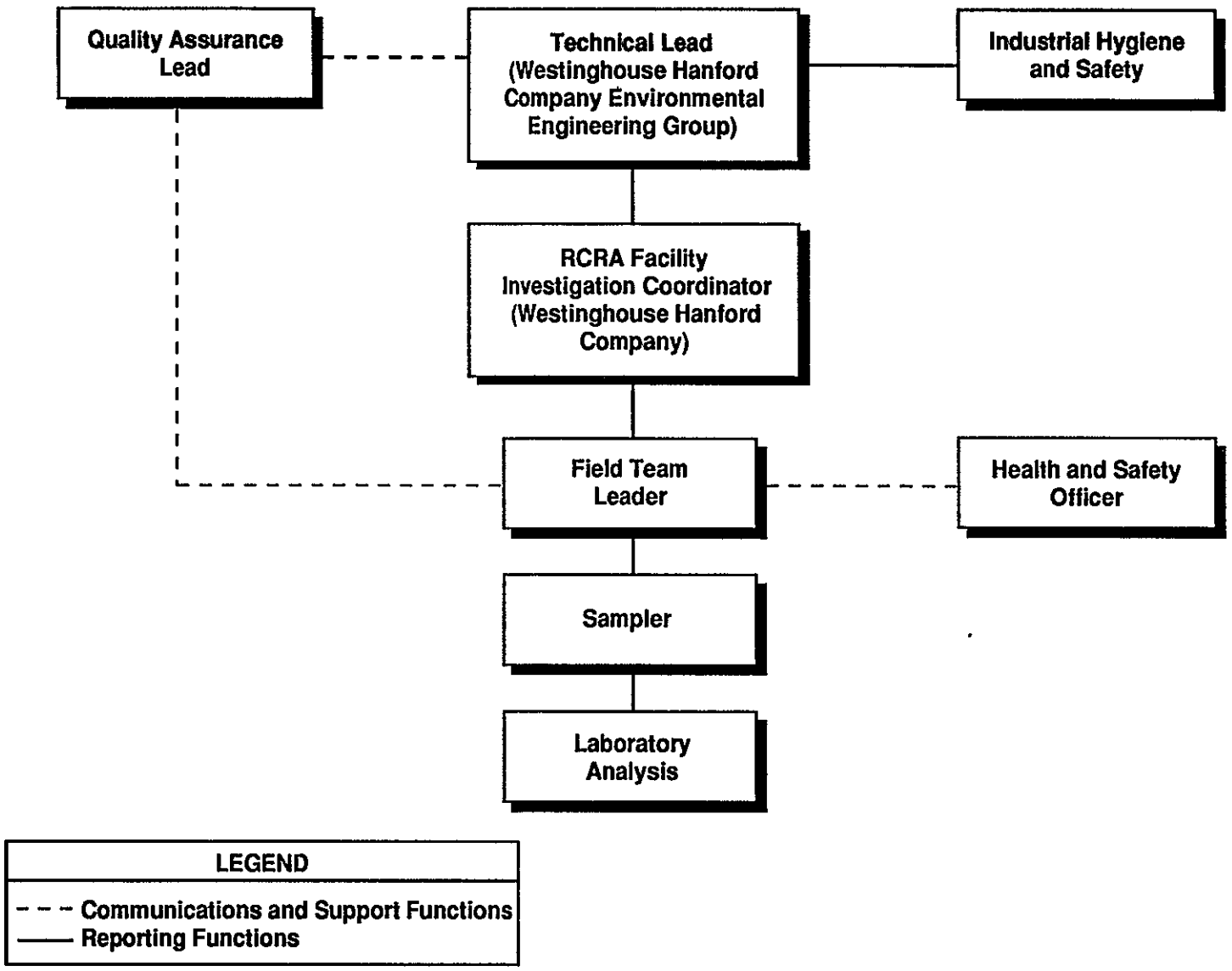


Figure C-3. The Hanford Site Soil Sampling Team.

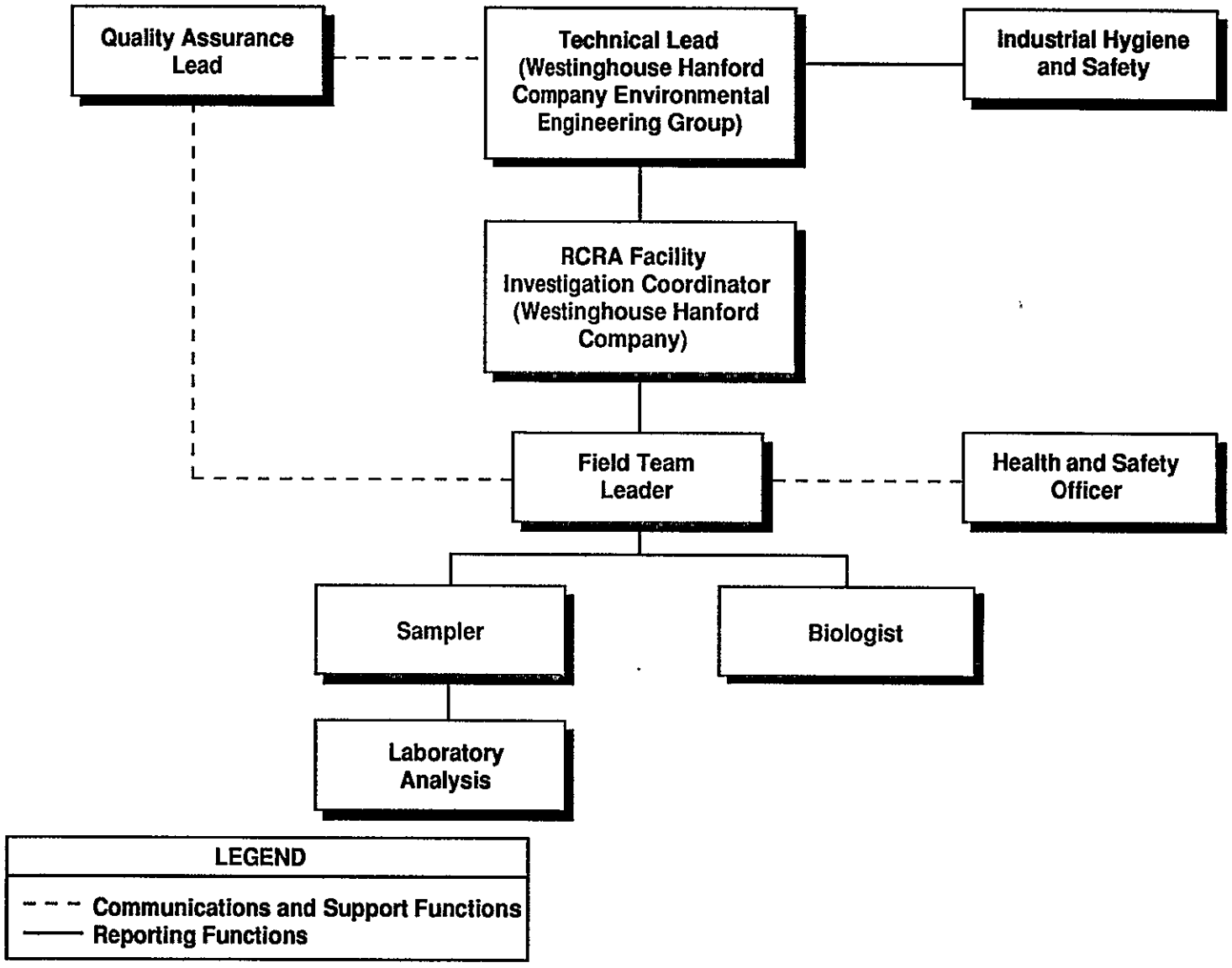


Figure C-4. The Hanford Site Biological Sampling Team.

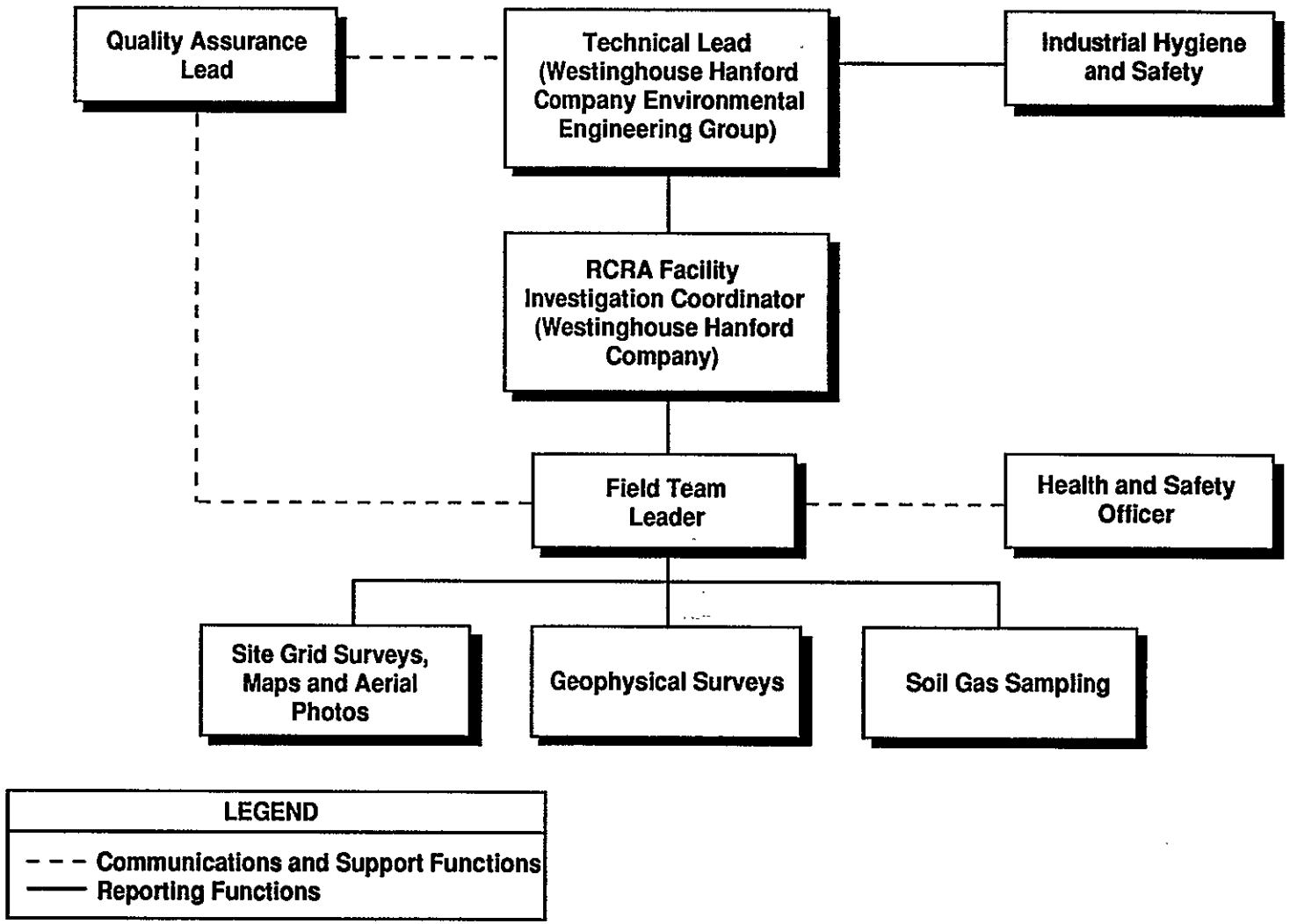


Figure C-5. The Hanford Site Physical and Geophysical Survey Team.

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Table C-1. Hanford Site RI/FS Technical Resources. Page 1 of 2

Subject/Activity	Technical Resources	
	RI	FS
Hydrology and geology	Westinghouse Hanford/Geosciences PNL/Earth and Environmental Sciences Center	Westinghouse Hanford/Geosciences
Toxicology and risk/endangerment assessment	Westinghouse Hanford/Environmental Technology PNL/Earth and Environmental Sciences Center PNL/Life Sciences Center	Westinghouse Hanford/ Environmental Technology
Environmental chemistry	Westinghouse Hanford/Geosciences PNL/Earth and Environmental Sciences Center	Westinghouse Hanford/Geosciences
Geotechnical and civil engineering	Westinghouse Hanford/Geosciences (Planning) Environmental Field Services	NA
Geotechnical and civil engineering	NA	Westinghouse Hanford/ Environmental Engineering PNL/Waste Technology Center
Groundwater treatment engineering	NA	Westinghouse Hanford/ Environmental Engineering PNL/Waste Technology Center
Waste stabilization and treatment	NA	Westinghouse Hanford/ Environmental Engineering PNL/Waste Technology Center
Surveying	Kaiser Engineers Hanford	NA

Table C-1. Hanford Site RI/FS Technical Resources.

	Technical Resources	
Subject/Activity	RI	FS
Soil and water sampling and analysis	Westinghouse Hanford/Environmental Engineering Westinghouse Office of Sampling Management PNL/Earth and Environmental Sciences Center PNL/Materials and Chemical Sciences Center	NA
Drilling and well installation	Westinghouse Hanford/Geosciences Environmental Field Services Kaiser Engineers	NA
Radiation monitoring	Westinghouse Hanford/Operational Health Physics	NA

NA = Not applicable.

APPENDIX D

INFORMATION MANAGEMENT OVERVIEW

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ACRONYMS AND ABBREVIATIONS

AR	administrative record
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CMS	Corrective Measures Study
DOE	U.S. Department of Energy
DOE/RL	U.S. Department of Energy, Richland Operations Office
Ecology	Washington Department of Ecology
EDMC	Environmental Data Management Center
EHPSS	Environmental Health and Pesticide Services Section
EII	Environmental Investigations Instructions
EIMP	Environmental Information Management Plan
EPA	U.S. Environmental Protection Agency
ER	environmental restoration
ERRA	Environmental Restoration Remedial Action
FOMP	Field Office Management Plan
FS	feasibility study
GIS	geographic information system
HEHF	Hanford Environmental Health Foundation
HEIS	Hanford Environmental Information System
HLAN	Hanford Local Area Network
HMS	Hanford Meteorological Station
IMO	Information Management Overview
KEH	Kaiser Engineers Hanford
OSM	Office of Sample Management
PNL	Pacific Northwest Laboratory
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RFI	RCRA Facility Investigation
RI	remedial investigation
ROD	record of decision
TR	training records
Tri-Party Agreement	Hanford Federal Facility Agreement and Consent Order
TSD	treatment, storage, and disposal
Westinghouse Hanford	Westinghouse Hanford Company

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DEFINITIONS OF TERMS

Action Plan. Action plan for implementation of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1990). A negotiation between the U.S. Environmental Protection (EPA), the U.S. Department of Energy (DOE), and the State of Washington Department of Ecology (Ecology). The Action Plan defines the methods and processes by which hazardous waste permits will be obtained, and by which closure and post-closure actions under the Resource Conservation and Recovery Act of 1976 (RCRA) and by which remedial actions under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) will be conducted on the Hanford Site.

Administrative Record (AR). In CERCLA, the official file that contains all information that was considered or relied on by the regulatory agency in arriving at a final remedial action decision, as well as all documentation of public participation throughout the process. In RCRA, the official file that contains all documents to support a final RCRA permit determination.

Administrative Record File. The assemblage of documents compiled and maintained by an agency pertaining to a proposed project of administrative action and designated as AR or that are candidates for inclusion in the AR once a record of decision (ROD) is attained.

Data Management. The planning and control of activities affecting data.

Data Quality. The totality of features and characteristics of data that bears on its ability to satisfy a given purpose. The characteristics of major importance are accuracy, precision, completeness, representativeness, and comparability.

Data Validation. The process whereby data are accepted or rejected based on a set of criteria. This aspect of quality assurance involves establishing specified criteria for data validation. The quality assurance project plan (QAPP) must indicate the specified criteria that will be used for data validation.

ENCORE. The name given to the combination of hardware, software, and administrative subsystems that serve to integrate the management of the Hanford Site environmental data.

Environmental Data Management Center (EDMC). The central facility and services that provide a files management system for processing environmental information.

Environmental Information. Data related to the protection or improvement of the Hanford Site environment, including data required to satisfy environmental statutes, applicable DOE orders, or the Tri-Party Agreement.

Field File Custodian. An individual who is responsible for receipt, validation, storage, maintenance, control, and disposition of information or other records generated in support of Environmental Division activities.

Hanford Environmental Information System (HEIS). A computer-based information system under development as a resource for the storage, analysis, and display of investigative data collected for use in site characterization and remediation activities. Subject areas currently being developed include geophysics/soil gas, vadose zone soil (geologic), atmospherics, and biota.

Information System. Collection of components relate to the management of data and reporting of information. Information systems typically include computer hardware, computer software, operating systems, utilities, procedures, and data.

Lead Agency. The regulatory agency (EPA or Ecology) that is assigned the primary administrative and technical responsibility with respect to actions at a particular operable unit.

Nonrecord Material. Copies of material that are maintained for information, reference, and operating convenience and for which another office has primary responsibility.

Operable Unit. An operable unit at the Hanford Site is a group of land disposal and groundwater sites placed together for the purposes of doing a remedial investigation/ feasibility study. The primary criteria for placement of a site into an operable unit are geographic proximity, similarity of waste characteristics and site types, and the possibility for economies of scale.

Primary Document. A document that contains information on which key decisions are made with respect to the remedial action or permitting process. Primary documents are subject to dispute resolution and are part of the administrative record file.

Project Manager. The individual responsible for implementing the terms and conditions of the Action Plan on behalf of his respective party. The EPA, DOE, and Ecology will each designate one project manager.

Quality Affecting Record. Information contained on any media, including but not limited to, hard copy, sample material, photo copy, and electronic systems, that is complete in terms of appropriate content and that furnishes evidence of the quality of items and/or activities affecting quality.

Quality Assurance. The systematic actions necessary to provide adequate confidence that a material, component, system, process, or facility performs satisfactorily or as planned in service.

Quality Assured Data. Data developed under an integrated program for assurance of the reliability of data.

Raw Data. Unprocessed or unanalyzed information.

Record Validation. A review to determine that records are complete, legible, and meet records requirements. Documents are considered valid records only after the validation process has been completed.

Retention Period. The length of time records must be held before they can be disposed of. The time is usually expressed in years from the date of the record, but may also be expressed as contingent on the occurrence of an event.

Secondary Document. A document providing information that does not, in itself, reflect or support key decisions. A secondary document is subject to review by the regulatory agencies and may be part of the administrative record field. It is not subject to dispute resolution.

Validated Data. Data that meet criteria contained in an approved company procedure.

Verified Data. Data that have been checked for accuracy and consistency following a transfer action (e.g., from manual log to computer, or from distributed database to centralized data repository).

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1.0 INTRODUCTION AND OBJECTIVES

1.1 INTRODUCTION

An extensive amount of data will be generated over the next several years in connection with the activities planned for the T Plant Aggregate Area. The quality of these data are extremely important to the full remediation of the aggregate area as agreed on by the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA) the Washington Department of Ecology (Ecology), and interested parties.

The Information Management Overview (IMO) provides an overview of the data management activities at the operable unit level. It identifies the type and quantity of data to be collected and references the procedures which control the collection and handling of data. It provides guidance for the data collector, aggregate area investigator, project manager, and reviewer to fulfill their respective roles.

This IMO addresses handling of data generated from activities associated with the aggregate area activities. All data collected will be in accordance with the Environmental Investigations Instructions (EII) contained in the Westinghouse Hanford Company's (Westinghouse Hanford) *Environmental Investigations and Site Characterization Manual* (WHC 1991a).

Development of a comprehensive plan for the management of all environmental data generated at the Hanford Site is under way. The *Environmental Information Management Plan* (EIMP) (Steward et al. 1989), released in March 1989, described activities in the Environmental Data Management Center (EDMC) and long-range goals for management of scientific and technical data. The scientific and technical data part of the EIMP was reviewed, revised, and expanded in fiscal year 1990 (Michael et al. 1990). An *Environmental Restoration Remedial Action Program Records Management Plan* (WHC 1991b) issued in July 1991, enables the program office to identify, control, and maintain the quality assurance (QA), decisional, or regulatory prescribed records generated and used in support of the Environmental Restoration Remedial Action (ERRA) Program.

1.2 OBJECTIVES

This IMO describes the process for the collection and control procedures for validated data, records, documents, correspondence, and other information associated with this aggregate area. This IMO addresses the following:

- Types of data to be collected
- Plans for managing data
- Organizations controlling data

- Databases used to store the data
- EIMP
- Hanford Environmental Information System (HEIS).

2.0 TYPES OF DATA

2.1 TYPES OF DATA

The general types of technical data to be collected and the associated controlling procedures are as follows:

Type of data	Procedure
Historical reports	EII 1.6
Aerial photos	EII 1.6
Chart recordings	EII 1.6
Technical memos	EII 1.6
Validated samples analyses	EII 1.6
Reports	EII 1.6
Logbooks	EII 1.5
Chain-of-custody forms	EII 5.1
Sample quality assurance/ quality control (QA/QC)	Office of Sample Management (OSM)

All such data are submitted to the EDMC for entry into the administrative record (AR).

General types of related administrative data is shown in Table D-1, which is organized in terms of general types of personnel and compliance/regulatory data. Table D-1 references the appropriate procedures and the record custodians. Data associated with aggregate area investigations will be submitted to the EDMC for entry into the AR, as appropriate.

2.2 DATA COLLECTION

Data will be collected according to the aggregate area sampling and analysis plans and the Quality Assurance Project Plan (QAPP). Section 2.1 listed the controlling procedures for data collection and handling before turnover to the organization responsible for data storage. All procedures for data collection shall be approved in compliance with the Westinghouse Hanford *Environmental Investigations and Site Characterization Manual* (WHC 1991a).

2.3 DATA STORAGE AND ACCESS

Data will be handled and stored according to procedures approved in compliance with applicable Westinghouse Hanford procedures (WHC 1988). The EDMC is the central files manager and process facility. All data entering the EDMC will be indexed, recorded, and placed into safe and secure storage. Data designated for placement into the AR will be copied, placed into the Hanford Site AR file, and distributed by the EDMC to the user community. The hard copy files are the primary sources of information; the various electronic data bases are secondary sources.

Normal access to data is through EDMC which is responsible for the AR. The Administrative Record Public Access Room is located in the 345 Hills Street Facility in Richland, Washington. This facility includes AR file documents (including identified guidance documents and technical literature).

Project participants may access data that are not in the AR by requesting it at the monthly unit managers' meeting for the operable unit of concern. As the project moves to completion, it is expected that all of the relevant data will be contained in the AR and the need to access data will be minimal.

The following types of data will be accessed from and reside in locations other than the EDMC:

Data Type	Data location
• QA/QC laboratory data	OSM (Westinghouse Hanford)
• Sample status	OSM (Westinghouse Hanford)
• Archived samples	Laboratory performing analyses
• Training records	Technical Training Support Section (Westinghouse Hanford)
• Meteorological data	Hanford Meteorological Station (HMS) (Pacific Northwest Laboratory [PNL])
• Health and safety records	Hanford Environmental Health Foundation (HEHF)
• Personal protective fitting	Environmental Health and Pesticide Services Section (Westinghouse Hanford)
• Radiological exposure	Pacific Northwest Laboratory.

2.4 DATA QUANTITY

Data quantities for the investigative activities will be estimated based on the sampling and analysis plans developed for investigation of sites within the aggregate area.

3.0 DATA MANAGEMENT

3.1 OBJECTIVE

A considerable amount of data will be generated through the implementation of the aggregate area sampling and analysis plans. The QAPP will provide the specific procedural direction and control for obtaining and analyzing samples in conformance with requirements to ensure quality data results. The sampling and analysis plans will provide the basis for selecting the location, depth, frequency of collection, etc., of media to be sampled and methods to be employed to obtain samples of selected media for cataloging, shipment, and analysis. Figure D-1 displays the general data management model for data generated through work plan activities.

3.2 ORGANIZATIONS CONTROLLING DATA

This section addresses the organizations that will receive data generated from aggregate area activities.

3.2.1 Environmental Engineering Group

The Westinghouse Hanford Environmental Engineering Group provides the operable unit technical coordinator. The technical coordinator is responsible for maintaining and transmitting data to the designated storage facility.

3.2.2 Office of Sample Management

The Westinghouse Hanford OSM will validate all analytical data packages received from the laboratory. Validated summary data (sample results and copies of chain-of-custody forms) will be forwarded to the technical coordinator. Nonvalidated data will be forwarded to the technical coordinator on request. Preliminary data will be clearly labeled as such. The OSM will maintain raw sample data, QA/QC laboratory data, and the archived sample index.

3.2.3 Environmental Data Management Center

The EDMC is the Westinghouse Hanford Environmental Division's central facility and service that provides a file management system for processing environmental information. The EDMC manages and controls the AR and Administrative Record Public Access Room at the Hanford Site. Part 1 of the EIMP (Michael et al. 1990) describes the central file system and services provided by the EDMC. The following procedures address data transmittal to the EDMC:

- EII 1.6, Records Management (WHC 1991a)
- EII 1.11, Technical Data Management (WHC 1991a)
- TPA-MP-02, Information Transmittals and Receipt Controls (DOE/RL 1990)
- TPA-MP-07, Administrative Record Collection and Management (DOE/RL 1990)

3.2.4 Information Resource Management

Information Resource Management is the designated records custodian (permanent storage) for Westinghouse Hanford. The procedural link from the EDMC to the Information Resource Management is currently under development.

3.2.5 Hanford Environmental Health Foundation

The HEHF performs the analyses on the nonradiological health and exposure data (Section 3.3.2) and forwards summary reports to the Fire and Protection Group and the Environmental Health and Pesticide Services Section within the Westinghouse Hanford Environmental Division. Nonradiological and health exposure data are maintained also for other Hanford Site contractors (PNL and Kaiser Engineers Hanford [KEH]) associated with aggregate area activities. The HEHF provides summary data to the appropriate site contractor. EII 2.1, Preparation of Hazardous Waste Operations Permits, and EII 2.2, Occupational Health Monitoring (WHC 1991a) address the preparation of health and safety plans and occupational health monitoring, respectively.

3.2.6 Environmental Health and Pesticide Services Section

The Westinghouse Hanford Environmental Health and Pesticide Services Section maintains personal protective equipment fitting records and maintains nonradiological health field exposure and exposure summary reports provided by HEHF for Westinghouse Hanford Environmental Division and subcontractor personnel.

3.2.7 Technical Training Records and Scheduling Section

The Westinghouse Hanford Technical Training Records and Scheduling Section provides training and maintains training records (Section 3.3.4).

3.2.8 Pacific Northwest Laboratory

The PNL operates the HMS and collects and maintains meteorological data (Section 3.3.1). Data management is discussed in Andrews (1988).

The PNL collects and maintains radiation exposure data (Section 3.3.3).

3.3 DATABASES

This section addresses databases that will receive data generated from the aggregate area activities. These and other databases are described in the EIMP (Michael et al. 1990). All of these databases exist independently of this aggregate area and serve other site functions. Data pertinent to the operable unit, housed in these databases, will be submitted to the AR.

3.3.1 Meteorological Data

The HMS collects and maintains meteorological data. Their database contains meteorological data from 1943 to the present, and Andrews (1988) is the document containing meteorological data management information.

3.3.2 Nonradiological Exposure and Medical Records

The HEHF collects and maintains data for all nonradiological exposure records and medical records.

3.3.3 Radiological Exposure Records

The PNL collects and maintains data on occupational radiation exposure. This database contains respiratory personal protective equipment fitting records, work restrictions, and radiation exposure information.

3.3.4 Training Records

Training records for Westinghouse Hanford and subcontractor personnel are managed by the Westinghouse Hanford Technical Training Support Section. Other Hanford Site contractors (PNL and KEH) maintain their own personnel training records. Training records for non-Westinghouse personnel are entered into the Westinghouse (soft reporting) database to document compliance.

Training records include:

- Initial 40-h hazardous waste worker training
- Annual 8-h hazardous waste worker training update
- Hazardous waste generator training
- Hazardous waste site specific training
- Radiation safety training
- Cardiopulmonary resuscitation
- Scott air pack
- Fire extinguisher
- Noise control
- Mask fit.

3.3.5 Environmental Information/Administrative Record

Environmental information and the AR are managed by Westinghouse Hanford EDMC personnel. They provide an index and key information on all data transmitted to the EDMC. This database is used to assist in data retrieval and to produce index lists as required.

3.3.6 Sample Status Tracking

The OSM maintains the sample status tracking database. This database contains information about each sample. Information maintained includes sample number, ship date, receipt date, and laboratory identification.

4.0 ENVIRONMENTAL INFORMATION AND RECORDS MANAGEMENT PLAN

This section briefly discusses the EIMP (Michael et al. 1990) that was developed to provide an overview of an integrated approach to managing Hanford Site environmental data, and the *Environmental Restoration Remedial Action Program Records Management Plan* (WHC 1991b).

4.1 ENVIRONMENTAL INFORMATION MANAGEMENT PLAN

The EIMP provides an overview of how information is managed throughout the lifetime of Hanford Site environmental programs.

The Environmental Division of Westinghouse Hanford is responsible for the protection and improvement of the Hanford Site environment. To fulfill responsibility, the Environmental Division has assumed a management role with respect to Hanford Site environmental information. This management role includes (1) establishing standards for how data are validated and controlled, (2) developing and maintaining a supporting computer-based environment, and (3) sustaining a centralized file management system.

Hanford Site environmental information is defined as data related to the protection or improvement of the Hanford Site environment, including data required to satisfy environmental statutes, applicable DOE orders, or the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1990), (Tri-Party Agreement).

Environmental information falls into several overlapping categories, such as administrative versus technical and electronic versus manual or hard copy. A considerable amount of data are recorded in documents, which are governed by company-wide document and records control practices. Other data are collected or generated by computer and, therefore, exist in electronic form. The name ENCORE has been given to the combination of administrative, hardware, and software systems that serve to integrate the management of this electronic data.

Administrative information (e.g.; budgets and schedules) is subject to accounting and other standard business practices. Scientific and technical data are subject to a different set of legal, classification, release, and engineering requirements.

Superimposed over these categories is the files management system for environmental information. This management system, has been developed to meet a number of Environmental Division needs, including requirements for compilation of AR files. The AR files are compilations of all material related to environmental restoration and remedial action records of decision (ROD) for each operable unit and treatment, storage, and disposal (TSD) group described in the Tri-Party Agreement.

Data in electronic form flows from information systems in the ENCORE realm to both scientific/technical and administrative documents. Environmental documents distributed within the Hanford Site and from regulatory agencies are received by the EDMC for storage and future processing.

Part I of the EIMP describes the overall Westinghouse Hanford systems that are generally applied to documents and records. Part I also describes, in greater detail, the files management system developed to manage the AR file information. The EDMC compiles the AR files and provides controlled distribution of specified information to the AR files held by DOE, Ecology, and the EPA. The EDMC also provides controlled distribution of specified community relations information to regional information repositories.

Part II addresses computer-based information, with an emphasis on scientific and technical data. The long-term nature of environmental programs and the complex interrelationships of environmental data require that the data be preserved, retrievable, traceable, and sufficient for future use. To ensure data availability for response to regulatory and agency requirements, the plan is directed toward optimizing the use of automated techniques for managing data. The current processing environment and the proposed ENCORE realm are described, and the plans for implementation of ENCORE are addressed.

4.2 ENVIRONMENTAL RESTORATION REMEDIAL ACTION PROGRAM RECORDS MANAGEMENT PLAN

The ERRA Program records management plan was developed to fulfill the requirements of the U.S. Department of Energy, Richland Operations Office (DOE/RL) *Environmental Restoration Field Office Management Plan* (FOMP) (DOE/RL 1989). The FOMP describes the plans, organization, and control systems to be used for management of the Hanford Site ERRA Program. The Westinghouse Hanford ERRA Program Office has developed this ERRA Program records management plan to fulfill the requirements of the FOMP. This records management plan will enable the program office to identify, control, and maintain the quality assurance, decisional, or regulatory prescribed records generated and used in support of the ERRA Program.

The ERRA Program records management plan describes how the applicable records management requirements will be implemented for the ERRA Program. The plan also develops the criteria for identifying the appropriate requirements for each individual piece of information related to ERRA work activities.

This records management plan applies to all ERRA Program records and documents generated, used, or maintained in support of ERRA-funded work activities on the Hanford Site. The terms, information, documents, nonrecord material, records, record material, and QA records used throughout the ERRA records management plan are interpreted as ERRA information, ERRA documents, ERRA nonrecord material, ERRA records, ERRA record material, and ERRA QA records.

5.0 HANFORD ENVIRONMENTAL INFORMATION SYSTEM

5.1 OBJECTIVE

The Hanford Environmental Information System (HEIS) has been developed by PNL for Westinghouse Hanford as a primary resource for computerized storage, retrieval, and analysis of quality-assured technical data associated with Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) remedial investigation/ feasibility study (RI/FS) activities and RCRA Facility Investigation/Corrective Measures Study (RFI/CMS) activities being undertaken at the Hanford Site. The HEIS will provide a means of interactive access to data sets extracted from other databases relevant to implementation of the Tri-Party Agreement (Ecology et al. 1990). The HEIS will support graphics analysis, including a geographic information system. Implementation of HEIS will serve to ensure that data consistency, quality, traceability, and security are achieved through incorporation of all environmental data within a single controlled database.

The following is a list of data subjects proposed to be entered into HEIS:

- Geologic
- Geophysics
- Atmospheric
- Biotic
- Site characterization
- Soil gas
- Waste site information
- Surface monitoring
- Groundwater.

5.2 STATUS OF THE HANFORD ENVIRONMENTAL INFORMATION SYSTEM

The HEIS, a computerized database containing technical data and information used to support the Hanford environmental restoration (ER) activities, is operational. The data for the Hanford groundwater wells and groundwater samples is currently accessible via the Hanford Local Area Network (HLAN) to local users and to offsite users via a modem link to the HEIS database computer. Additional data, including geologic, biota, and other pertinent environmental sample results, are being entered into the HEIS database.

The *Hanford Environmental Information System (HEIS) User's Manual* (WHC 1990) was issued in October 1990. An operator manual is being prepared and is expected to be issued in 1992.

The HEIS geographic information system (GIS) will display detailed maps for the Hanford restoration sites including data from the HEIS database. Such spatially related data will be used to support analysis of waste site technical issues and restoration options. The combination of the HEIS for data and the GIS spatial displays offers some powerful tools for many users to analyze and collectively evaluate the environmental data from the ER and site-wide monitoring programs.

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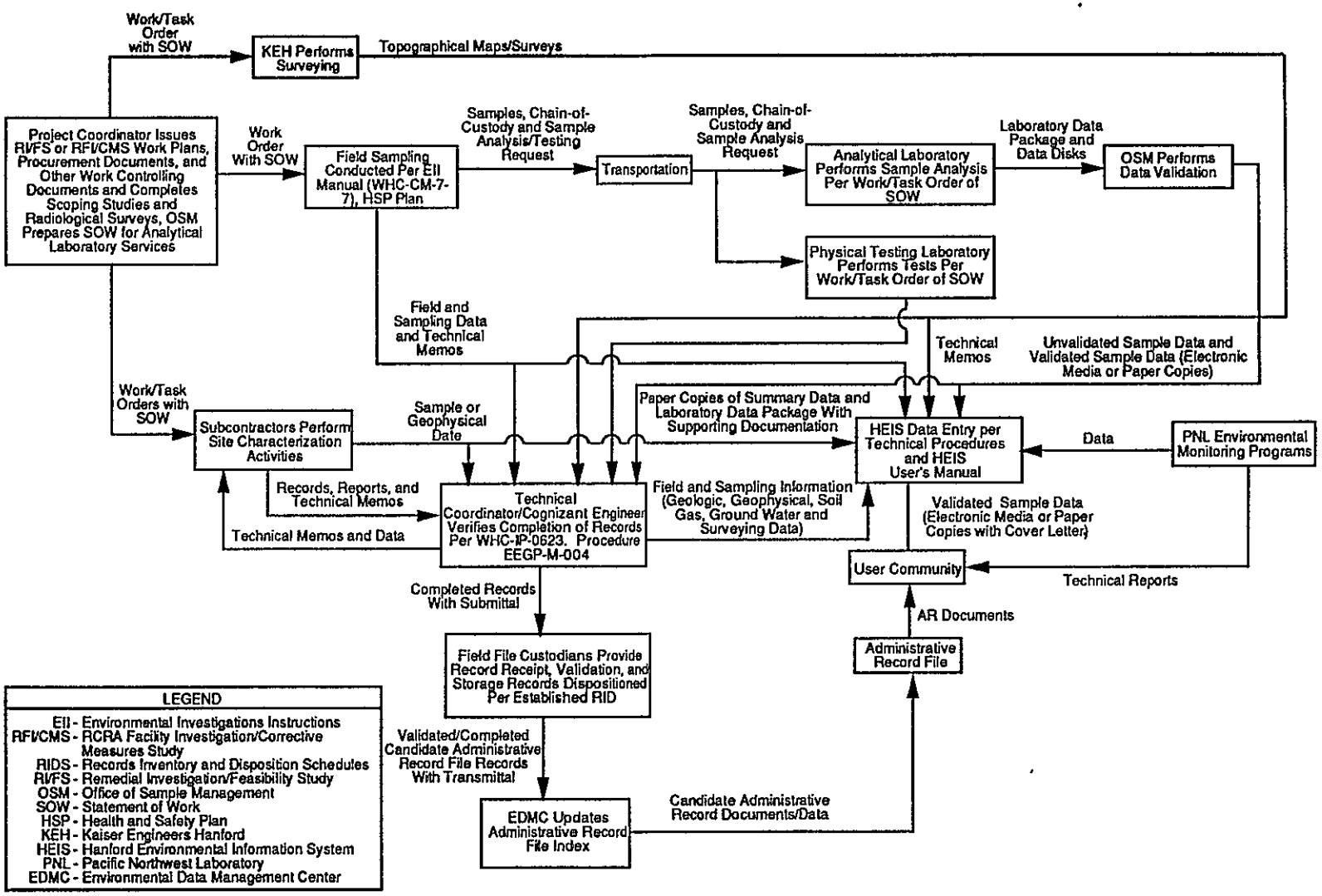

Figure D-1. Environmental Engineering, Technology, and Permitting Data Management Model.

Table D-1. Types of Related Administrative Data.

Type of Data	Controlling document/procedure	Record Custodians				
		TR	HEHF	PNL	EDMC	EHPSS
Personnel						
Personnel training and qualifications	EII 1.7[a/]	X				
Occupational exposure records (nonradiological)	EII 2.2[a/]		X			X
Radiological exposure records				X		
Respiratory protection fitting						X
Personnel health and safety records	EII 2.1[a/]		X			X
Compliance/regulatory						
Action-specific requirements/screening levels	EII 1.6[a/]				X	
Guidance document tracking	EII 1.6[a/]				X	
Compliance issues	EII 1.6[a/]				X	
Problem resolution	EII 1.6[a/]				X	
Administrative record	TPA-MP-11[b/]				X	

[a/] WHC 1991a, *Environmental Investigations and Site Characterization Manual.*
[b/] DOE/RL 1990, *Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Handbook.*
EDMC = Environmental Data Management Center (Westinghouse Hanford Company).
EHPSS = Environmental Health and Pesticide Services Section (Westinghouse Hanford Company).
EII = Environmental Investigations Instructions.
HEHF = Hanford Environmental Health Foundation.
TR = training records (Westinghouse Hanford Company, Pacific Northwest Laboratory [PNL], Kaiser Engineers Hanford [KEH]).

APPENDIX E

SUPPORTING DOCUMENTATION

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CONTENTS

11/18/66	Battelle Low-Level Waste Disposal, by S.J. Beard
10/13/77	Contaminated Rabbit Fecal Pellets Near the 155-TX Diversion Box, Unusual Occurrence #77-180
09/30/86	Fiscal Year 1986 Scintillation Logging Status, by M.A. Chamness
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BEST AVAILABLE COPY

November 15, 1966

R. E. Tomlinson, Manager
Research and Engineering

Subject: BATTELLE LOW-LEVEL WASTE DISPOSAL

INTRODUCTION

For many years it has been the practice to truck low-level liquid waste from the 300 Area to the 200 Areas for crib disposal. In recent years the volume of this waste has been relatively constant at 3 to 4 million gallons per year but the radionuclide content has markedly increased. Activity concentrations are now so high that crib breakthrough is occurring after only a few months of use. Tanker discharges to the 231-Z Building's Z-7 Crib caused strontium breakthrough in October, 1966, and for the last month the 231-Z Building has been discharging waste to the failed crib since no spare is available. Tanker waste is now being discharged to Battelle's new crib, T-34, and after 5 months' use activity has been detected in the ground water. Around the end of December, 1966, this crib is also expected to fail.

The purpose of this letter is to discuss Battelle waste disposal requirements and recommend action to permit Isochem to continue to offer waste disposal service to Battelle. Prompt cooperation and funding from Battelle and the AEC will be necessary to minimize ground water contamination and to avoid curtailment of laboratory activities.

SUMMARY AND RECOMMENDATIONS

New Isochem waste disposal facilities are needed to permit continued acceptance of low-level aqueous waste from the 231-Z Building and tanker waste from the 300 Area 340 Building. The 231-Z Building disposal requirements can be met by making some minor piping changes and constructing a crib to replace the failed Z-7 Crib. Tanker waste is no longer suitable for ground disposal and should be treated as high-level waste after volume reduction by evaporation. An interim crib will be required for emergency disposal of tanker waste while evaporation facilities are being constructed. Charges for disposal of tanker waste will increase sharply since annual evaporation energy alone will cost about $40,000.

The recommended facility modifications and additions with their associated capital costs can be summarized as follows:

1. Temporarily route 231-Z Building waste to Z-5 Crib with provision for overflow to Z-7 Crib. Preliminary cost

2. Construct a new crib by January 1, 1967, to receive 231-Z Building waste. Preliminary cost estimate - $25,000 - $40,000.

3. Build a crib by January 1, 1967, to temporarily receive tanker waste from Battelle. Preliminary cost estimate - $45,000 - $60,000.

4. Provide evaporation facilities for continued tanker waste disposal by June 1, 1967. Preliminary cost estimate - $45,000 - $60,000.

DISCUSSION

Low-level 300 Area laboratory waste has been trucked to the 200 Areas for crib disposal since the early fifties. Figures 1 and 2 show the average monthly volume and curie disposal rates from 1953 to the present time and Table I summarizes pertinent crib statistics for the same period of time. This information shows that the amount of activity in the waste has been steadily increasing since 1958 and large increases occurred in 1965 and 1966. The rapid failure of Cribs T-28, T-27, Z-7 and T-34 in 1965 and 1966 can be attributed directly to the sudden increase in the curie content of the waste. Soil column studies made with a composite waste sample collected during May and June of 1966 show that the waste does not react favorably with the soil and in its present form should not be considered for ground disposal.

There are two problems that must receive immediate attention:

1) 231-Z Building is discharging waste to a failed crib (Z-7); and

2) T-34 Crib is expected to break through around the end of December, 1966, and all alternate sites have already been expended.

The first problem appears to be the easier to solve. Waste from the 231-Z Building is known to be satisfactory for cribbing. A possible way to immediately reduce the contamination entering the ground water is to repipe 231-Z Building to the Z-5 Crib and provide a Z-5 Crib overflow to Z-7 Crib. This action is suggested only as an emergency measure since the Z-5 Crib is not expected to handle the total flow. Z-5 Crib was abandoned in 1947 when pluggage reduced the crib percolation rate below 13,000 gallons per day. Overflow to Z-7 will avoid flooding of Z-5 but sustained overflow to the failed Z-7 cannot be tolerated since water below this crib has a strontium concentration 20-fold above the ground water limit. Recommended action is to immediately design and build a replacement crib for Z-7 and use

Z-5 on an emergency basis. If piping changes or changes in the 231-Z Building operation permit reduction in water discharge rates so that adequate Z-5 capacity is assured, Z-5 can be considered for interim use while a new crib is provided on a normal construction schedule. Preliminary cost estimates indicate piping changes will cost $2000 - $2500 and a new crib will cost $25,000 - $40,000.

The 340 Building waste problem is more difficult to solve. This waste is no longer suitable for ground disposal and timing requires prompt action to minimize further contamination of the ground water. It is recommended that a new temporary crib be provided on an accelerated construction schedule targeted for use January 1, 1967. This crib would be located about 400 feet from T-34 but piped so that the existing unloading station could be used. Preliminary cost estimates indicate this crib would cost $45,000 - $60,000. Enough time should be gained during the life of this crib to permit construction of evaporation facilities within the West Area tank farms for continuing disposal of this waste. Evaporation facilities are estimated to cost $45,000 to $60,000. During the construction period Battelle could undertake a program to try and render the waste suitable for ground disposal by waste treatment or waste segregation. Continued use of the crib could be considered if this program were successful and would be economically desirable since just the cost of energy for waste evaporation will amount to $40,000 per year.

Battelle management at the supervisor and subsection levels has been informally apprised of these waste disposal problems and Isochem Facilities Engineering Section is proceeding with preparation of project proposals for a new 231-Z Building crib and a temporary replacement crib for T-34. Formal correspondence with higher Battelle management should proceed to ensure prompt support of Isochem requirements. Full cooperation and funding from Battelle and the AEC are necessary to avoid further contamination of the ground water beneath the 200 Area.

Original Signed by
S. J. Beard
Manager
Fission Products Process Engineering
Research and Engineering

SJ Beard:jas

Attach: Figs. 1, 2
Table I
References

cc: JB Fecht
HK Harmon
GC Oberg
HP Shaw
RE Smith
JH Warren
LB
File

CONTRACTOR	FACILITY	
ROCKWELL HANFORD OPERATIONS	155-TX Diversion Box	200-W

REPORT NO.		DATE AND TIME OF OCCURRENCE
77-180	☐ PRELIM 10/13/77 11/23/77 02/10/78 03/10/78 4/13/78	August 24, 1977

DOE/RL-91-61, Rev. 0

CONTRACT SUBJECT

CONTAMINATED RABBIT FECAL PELLETS NEAR THE 155-TX DIVERSION BOX

1. DESCRIPTION OF OCCURRENCE AND DESIGNATION OF APPARENT CAUSE

☐ DESIGN ☐ MATERIAL ☐ PERSONNEL [x] PROCEDURE ☐ OTHER

While performing a nonroutine survey on August 24, 1977, a Radiation Monitor found rabbit fecal pellets contaminated with radioactivity in the immediate vicinity of the 155-TX Diversion box excavation. A more extensive survey revealed an area approximate 50 yards by 100 yards around the diversion box scattered with contaminated pellets wit as high as 100 mRad/hr readings.

Radioisotopic analyses on two individual pellets revealed:

18.6	μCi	^{137}Cs/gram of sample
0.044	μCi	^{134}Cs/gram of sample
0.033	μCi	^{106}Ru/gram of sample
0.026	μCi	^{144}Ce/gram of sample
2.63	μCi	^{90}Sr/gram of sample

Subsequent surveys of the area revealed additional contamination reading 500 to 100,00 in small spots within a 500-foot radius of the 155-TX Diversion box.

The source of the radioactivity was traced to contamination leaks from the 155-TX Dive box.

cc:
J. C. [illegible] - [illegible]
O. J. Elgert - [illegible]
T. G. Harris - DOE-RL
J. H. Straub - DOE-RL
M. W. Tiernan - [illegible]

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D. J. Washe
R. E. Wheele
R. A. Zinsl
Central File

2. OPERATING CONDITIONS OF THE FACILITY AT TIME OF OCCURRENCE (IF APPLICABLE)

The 155-TX Diversion box was partially exposed due to excavation that was started in [illegible] and left open for more than a year. The excavation on the east side of the diversion box exposed high radiation fields due to solutions which had leaked from the diversion box. The radioactivity was thought to be held in place by an application of plastic spray.

, indicates change

POOR COPY RECEIVED

...DIATE EVALUATION, CORRECTIVE ACTION TAKEN AND RESULTS

Rockwell Environmental Protection and BHWL Ecosystems Department collected samples for evaluations.

The 50-yard by 100-yard area around the box was cleaned up and the contaminated pellets and soil were taken to dry waste burial.

Contaminated soil was removed from the excavation hole to the extent possible and buri Clean soil was used to replace the removed soil and covered the remaining contaminatic

A. RECOMMENDATIONS

(A) TEMPORARY CORRECTIVE ACTION

A routine survey schedule was set up to monitor the zone for the next several months. There was no additional contamination found.

(B) PERMANENT CORRECTIVE ACTION

See Attachment 1.

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CORRECTIVE ACTION TO BE INITIATED:	R. E. Wheeler	DATE 7/05/78

REFERENCE: REPORT NUMBER AND OCCURRENCE SUMMARY

78-21	Uncontrolled Release of Water in 241-TX-155 Diversion Box.
78-22	Liquid Level Increase in 105-TX Exceeding Increase Criteria (water overflowed into 155-TX).
78-23	Liquid Level Decrease of Diversion Box 155-TX and Catch Tank TX-302-B.

			DATE
R. E. Wheeler		Environmental Engineer	5/31/
J. H. Garbrick		Mgr. Tank Farm Operations	6-1-
W. F. Heine		Dir. Health, Safety & Environment	6-2-
R. A. Zinsli		Program Mgr., Waste Concentration	6-1-
G. C. Owens		Mgr. Environ. & Occupational Safety	5/31/
J. H. Reecke		Program Mgr., Waste Management	6-5-7

Occurrence Report No. 77-180

4b.

Permanent corrective actions are:

1. Project B-208 was initiated to provide the 152-TX Diversion Box as replacement for the 155-TX Diversion Box.

2. The excavated hole at 155-TX was backfilled with soil and the potential for contamination spread was eliminated.

3. Quarterly surveys of the 155-TX Diversion Box area will be conducted as part of the Environmental Surveillance Program. Responsible person: R. E. Wheeler, Engineer, Environmental Protection.

4. A standard has been developed which establishes control measures for excavations and other work in radiation zones that require the removal of protective cover from contamination. Responsible person: R. E. Whee Engineer, Environmental Protection. The standard is to be distributed t July 5, 1978.

Rockwell International

September 30,1986

65633-86-107

V.W. Hall
Waste Management Program Office
2750E/D100/200 East

M.A. Chamness
Geotechnical Engineering
222U/2/200 West

Fiscal Year 1986 Scintillation Logging Status

Ref: RHO-RE-PL-23, September 1984, G.V. Last, K.R. Fecht, M.A. Chamness, "Scintillation Logging Plan for Monitoring Inactive Cribs"

In 1984, the "Scintillation Logging Plan for Monitoring Inactive Cribs" was written to provide a plan and schedule to monitor gamma-emitting radionuclides in the vadose zone (the zone between the surface and the ground water) around inactive cribs (Reference). Scintillation logs provide the means for determining changes in radionuclide intensity due to decay or movement. The plan schedules monitoring at a frequency sufficient for discovering changes in the concentrations or location to permit timely implementation of remedial action before a problem develops.

The scintillation logging plan indicates that a year-end status report will be written covering each year's logging efforts, with a document to be issued once every five years covering the entire scintillation logging network for the past five years. This letter meets the requirement for a year-end status report for Fiscal Year (FY) 1986.

Over 160 wells were to be logged during FY 1986, in an effort to catch up to the schedule given in the scintillation logging plan (Reference). Of these, 122 wells were logged. An appendix is available with digitized logs for each of these wells and copies of the original logs are kept in the Geotechnical Engineering Unit files. The remaining wells could not be logged this year, either because they have been destroyed, were inaccessible, or safety concerns around old wooden cribs prohibited access. When safety measures have been taken around the wooden cribs, those wells still accessible will be logged. Table 1 provides a list of the wells which could not be logged and the reason why.

Table 2 gives a list of the wells logged and the cribs they monitor, along with the results of a qualitative comparison with previous logs. This list contains only those wells logged this year, and not necessarily all of the wells monitoring the crib. Wells with the comment "no change" have always been, and still are, at background levels. Cribs which were used to dispose of waste with long half-lives have logs indicating the radionuclides are "decaying slowly", while those with short half-life waste are "decaying" or have "decayed to background".

Rockwell International

V.W. Hall
Page 2
September 30,1986

There are no indications of movement or increases in intensity of gamma-emitting radionuclides in any of the wells, except for well 299-E28-7, which monitors the 216-B-5 reverse well. It shows background levels of contamination for the vadose zone, as before, but an increase in the ground water from 200 counts per second (cps) in 1976 to 9000 cps this year. Arrangements are being made to log other nearby ground-water monitoring wells, and to have the water in those wells sampled in an effort to determine the reason for the increase in contamination. Another type of problem was encountered when wells around the 216-Z-1 and Z-2 cribs were found to have corroded casing, allowing contaminated sediments to fall into the well. These wells (299-W18-60, W18-61, W18-62, W18-63, and W18-64) will be filled in with grout and destroyed, while W18-65 will have a liner grouted into place so that there will be one well to log immediately adjacent to the Z-1 and Z-2 cribs.

Scintillation logging probes with different backgrounds and sensitivities have been used over the past 10 years, making interpretation of the intensities of the logs difficult. In the future, one probe will be specified for use in scintillation logging of wells, making the logs directly comparable.

If you have any questions, please contact me on 373-2119.

Mickie Chamness

M.A. Chamness, Advanced Geologist
Geotechnical Engineering Unit

MAC/mac

cc: M.A. Adams
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G.L. Wagenaar
R.E. Wheeler

TABLE 1. LIST OF WELLS THAT COULD NOT BE LOGGED

CRIB	WELL NUMBER	COMMENTS
A-2	E24-65	Inside security fence at PUREX
A-4	E24-54	" " " " "
A-5	E24-55	" " " " "
	E24-56	" " " " "
	E24-57	" " " " "
	E24-58	" " " " "
A-31	E24-9	" " " " "
B-8	E33-81	Wooden crib
	E33-82	" "
S-7	W22-13	Wooden crib
	W22-14	" "
	W22-32	" "
	W22-33	" "
S-20	W22-74	" "
T-7	W10-59	" "
	W10-60	" "
	W10-61	" "
	W10-62	" "
	W10-63	" "
	W10-66	" "
	W10-67	" "
	W10-68	" "
	W10-69	" "
	W10-70	" "
	W10-71	" "
	W10-72	" "
	W10-74	" "
	W10-77	" "
	W10-78	" "
	W10-79	" "
	W10-80	" "
	W10-81	" "
U-1 & -2	W19-72	" " 74247W 37859N
U-8	W19-69	" "
	W19-70	" "
	W19-71	" "
Z-1A	W18-77	Well cap welded on
	W18-79	" " " "
	W18-80	" " " "
	W18-149	" " " "
Z-3	W18-67	Cannot locate
	W18-68	" "

TABLE 1 Continued

CRIB	WELL NUMBER	COMMENTS
Z-5	W15-52	Well cap locked, wooden crib
	W15-53	" " " " "
	W15-54	" " " " "
	W15-55	" " " " "
	W15-56	" " " " "
	W15-57	" " " " "
	W15-58	" " " " "
Z-6	W15-60	Wooden crib
Z-10	W15-59	Well cap locked
	W15-60	" " "
Z-12	W18-70	Contaminated tools in well
	W18-156	Well under fence

TABLE 2. LIST OF WELLS LOGGED AND RESULTS

CRIB	WELL NUMBER	DATE LOGGED	COMMENTS
A-6	E25-53	9/86	no change
A-7	E25-54	9/86	decaying
A-9	E24-63	9/86	no change
A-24	E26-2	2/86	decayed to background
	E26-3	2/86	decayed to background
	E26-4	2/86	decayed to background
	E26-5	2/86	decayed to background
A-27	E17-3	7/86	decaying
A-36A	E17-4	7/86	decaying slowly
	E17-10	9/86	no change
B-5	E28-7	7/86	increased from 200 cps to 9000 cps in the ground water
	E28-24	9/86	never logged before
	E28-73	9/86	never logged before
	E28-74	9/86	never logged before
B-44	E33-2	9/86	decaying
	E33-22	9/86	decaying slowly
B-45	E33-22	9/86	decaying slowly
B-46	E33-4	9/86	decaying slowly
	E33-23	9/86	decaying slowly
S-1	W22-6	2/86	no change except for spike at 46'
	W22-11	2/86	decaying
	W22-15	2/86	decaying
	W22-29	2/86	decaying slowly
	W22-31	2/86	decaying slowly
	W22-36	2/86	decaying slowly
	W22-67	2/86	decaying slowly
S-2	W22-5	2/86	decayed to background
	W22-10	2/86	decayed to background
	W22-16	2/86	decayed to background
	W22-17	2/86	decayed to background
	W22-18	2/86	decaying
	W22-29	2/86	decaying slowly
S-9	W22-25	9/86	decaying
	W22-34	9/86	decaying
	W22-35	9/86	decaying
T-3	W11-7	7/86	decaying slowly
	W11-79	7/86	decaying slowly
T-7	W10-3	7/86	decaying
T-14	W11-68	6/86	decayed to background
T-16	W11-80	6/86	no change
T-17	W11-81	6/86	decaying slowly

TABLE 2 Continued

CRIB	WELL NUMBER	DATE LOGGED	COMMENTS
T-19	W14-51	7/86	no change
	W14-52	7/86	no change
	W15-65	7/86	no change
	W15-66	7/86	no change
T-21	W15-80	6/86	no change
T-22	W15-209	6/86	decaying slowly
T-23	W15-210	6/86	decaying slowly
T-24	W15-211	6/86	decaying slowly
T-25	W15-212	6/86	decaying slowly
T-26	W11-70	7/86	decaying slowly
	W11-82	7/86	decaying slowly
T-27	W14-53	7/86	decaying slowly
	W14-62	7/86	decaying slowly
T-28	W14-1	9/86	decaying
	W14-3	9/86	decaying slowly
	W14-4	9/86	decaying slowly
	W14-53	7/86	decaying slowly
Z-1	W18-65	7/86	never logged before
Z-1A	W18-7	9/86	no change
	W18-66	7/86	never logged before
	W18-150	7/86	never logged before
	W18-158	7/86	never logged before
	W18-159	7/86	never logged before
	W18-163	7/86	never logged before
	W18-164	7/86	never logged before
	W18-165	7/86	never logged before
	W18-166	7/86	never logged before
	W18-167	7/86	never logged before
	W18-168	7/86	never logged before
	W18-169	7/86	never logged before
	W18-170	7/86	never logged before
	W18-171	7/86	never logged before
	W18-173	7/86	never logged before
	W18-174	7/86	never logged before
	W18-175	7/85	never logged before
Z-2	W18-60	7/86	never logged before
	W18-61	7/86	never logged before
	W18-62	7/86	never logged before
	W18-63	7/86	never logged before
	W18-172	7/86	never logged before
Z-3	W18-88	9/86	no change

TABLE 2 Continued

CRIB	WELL NUMBER	DATE LOGGED	COMMENTS
Z-7	W15-62	7/86	decaying
	W15-63	7/86	decaying
	W15-64	7/86	no change
	W15-76	7/86	decaying
	W15-77	7/86	no change
	W15-78	7/86	decaying
Z-12	W18-72	7/86	never logged before
	W18-75	7/86	never logged before
	W18-151	7/86	never logged before
	W18-152	7/86	never logged before
	W18-153	7/86	never logged before
	W18-154	7/86	never logged before
	W18-155	7/86	never logged before
	W18-157	7/86	never logged before
Z-18	W18-9	7/86	decaying
	W18-11	7/86	decaying
	W18-82	6/86	no change
	W18-93	7/86	decaying
	W18-94	7/86	no change
	W18-95	7/86	no change
	W18-96	7/86	decaying
	W18-97	7/86	decaying
	W18-98	7/86	no change
Z-19	W18-15	9/86	never logged before
	W18-177	9/86	never logged before

From: Geosciences Group 80230-88-004
Phone: 3-2119 S0-04
Date: May 10, 1988
Subject: FISCAL YEAR 1987 INACTIVE CRIB MONITORING REPORT

To: V. W. Hall R1-15

cc: M. R. Adams R2-78 K. A. Gasper R1-15
T. A. Curran R2-84 JRB File/LB

This is a letter report discussing the fiscal year 1987 inactive crib monitoring work.

The crib monitoring program is specified by a program plan provided in Last (et al., 1984). This current program does not satisfy the objectives specified in the program plan because it has not been fully implmented. New equipment, calibration facilities and more personnel would be required to fully implement such a program.

For 1987, the scope of the monitoring effort was redirected from that specified in the plan. The scope was directed at determining qualitative change in the characteristics of the gross gamma logs from vadose zone monitoring wells at inactive cribs. This includes qualitative assessments of the distribution of gamma emitting radionuclides along the boreholes and an indication of significant changes evidenced by changes in the shapes of the gamma-ray curves.

An attempt was made by the logging contractor (Pacific Northwest Laboratory) to standardize the gross gamma-ray logging tool by repeated logging of a borehole dubbed to be a site "standard". Although this is not a "calibration", it provides an indication that the tool is working and may allow a qualitative comparison of the logs from year to year. This limited standardization does not allow the quantitative comparison of gamma activity levels nor does it necessarily allow a precise determination of the location of gamma emitting radionuclides.

In 1987, approximately 140 wells were logged with a gross gamma-ray geophysical logging tool. Those wells are associated with 39 of the inactive crib sites. Table 1 provides a listing of cribs at which vadose zone wells were logged along with some comments on the sites. Those comments are limited to a qualitative assessment of any changes in the gamma-ray curves compared to previous logs. If the data indicate that radionuclides are migrating to the groundwater, this is also identified in the comment section of Table 1.

All gross gamma-ray geophysical logs are on file and available in Geotechnical Engineering Unit files.

Twenty-three of the 39 cribs that were monitored in 1987, show no significant changes in the gross gamma logs from previous logs, based on a comparison of the curve shapes and amplitudes relative to an assumed background.

For cribs 216-A-2, 216-A-27, 216-B-9, 216-C-9 and 216-S-20, comparison with previous logs was not possible because no previous logs exist, because the data were not recorded in the same manner, or because the instrumentation was not working properly, resulting in bad data.

In the past, several cribs show elevated gamma activity in the groundwater as evidenced by previous reports or old gross gamma logs. These include 216-A-6, 216-A-36A and B, 216-B-5, the entire BC crib area, the BY cribs, 216-S-1 and 2, 216-T-3 and 216-U-17. In each of these cribs or crib areas, no significant changes can be seen in the logs. This suggests that the radionuclides deposited below and around the cribs are not migrating. However, more data would be required to make that determination. The groundwater beneath cribs 216-A-36 and 216-U-17 is currently being monitored and some remedial investigations are being conducted at these sites.

Two problem areas are identified in Table 1. The T trenches (216-T-14, 15, 16 and 17) and the 216-T-26, 27 and 28 cribs show significant changes in the gross gamma log signatures (changes in the shapes of the curves) as compared to previous years. It is not known if the radionuclides are migrating or being redistributed. To make that assessment, quantitative radionuclide monitoring data are needed as well as water content data from a compensated neutron porosity geophysical log. Additional definition of the geology would also be required.

J. R. Brodeur, Senior Engineer
Geotechnical Engineering Unit

dyl

Attachment

Table I CRIB MONITORING SUMMARY

CRIBS	BOREHOLES	DATE LOGGED	PAST LOGS	Comments
A- 2	299-E24- 53 299-E24- 65	-- 9-87	8-82 --	Activity from 30 to 45 ft; Comparison with previous logs not possible, no previous data
A- 4	299-E24- 54	9-87	8-82	Activity from 20 ft to TD; No change in logs
A- 5	299-E24- 1 299-E24- 56 299-E24- 57 299-E24- 58	9-87 9-87 9-87 9-87	6-84,8-82,2-76,4-70,5-63 6-84,8-82,4-76,5-63,5-59 6-84,8-82,4-76,5-63,5-59 6-84,8-82,4-76,5-63,5-59	Two activity peaks (60 and 90 ft); Some activity is seen at water table; Previous logs show relatively high gamma activity in groundwater, Gamma radionuclides have migrated to groundwater in the past, No recent change in gamma logs
A- 6	299-E25- 3 299-E25- 53	7-87 8-87	7-84,6-84,2-76,4-68,5-63 8-84,5-76	Activity at 35 feet; No change in gamma logs
A-24	299-E26- 2 299-E26- 3 299-E26- 4 299-E26- 5 299-E26- 7	8-87 8-87 8-87 8-87 --	2-86,6-84 2-86,6-84 2-86,6-84 2-86,6-84 6-84	Activity between 200 and 240 ft in well E26-3, E26-4 and E26-5; Gamma emitting radionuclides have migrated to groundwater; Currently, little activity is seen in the vadose zone
A-27	299-E17- 2 299-E17- 3	7-87 --	6-84 7-76,4-70,5-63	High gamma at water table in E17-3; No activity at is seen at the water table in E17-2; Contaminated groundwater, source unknown. Comparison with previous logs not possible due to different tool response.
A-31	299-E24- 9	9-87	2-76,4-70,5-63	No activity evident; No change in log
A-36 A&B	299-E17- 4 299-E17- 5 299-E17- 7	7-87 -- 7-87	7-86,6-84,8-82,2-76,4-70 9-82,2-76,4-70,4-68,10-65 6-84,4-76,4-70,3-67	Activity from 60 to 140 ft and in groundwater; Groundwater contamination has occurred, probably from 36A crib; GW monitoring in progress.
A-30	299-E17- 8 299-E24- 11	-- 7-87	4-76.4-70,4-60 2-76,4-70,4-68	Crib was never used; Activity evident only in groundwater; No change in logs.
B- 5	299-E28- 3 299-E28- 7 299-E28- 24 299-E28- 73 299-E28- 74	-- 7-87 7-87 -- --	7-86,5-765,5-63,8-59 9-86	Activity evident in the groundwater; Groundwater contamination is caused by this injection well; Little change is seen in the gamma logs.

Table I 9 CONTINUED

CRIBS	BOREHOLES	DATE LOGGED	PAST LOGS	Comments
U- 9	299-E20- 53	--	5-76,5-69	Only one monitoring well logged; no gamma activity is evident; Additional data are needed.
	299-E20- 54	--	5-76,5-69	
	299-E20- 55	--	5-76,5-69	
	299-E20- 56	--	5-76	
	299-E20- 57	--	--	
	299-E20- 58	--	5-76,5-69	
	299-E20- 59	8-87	5-76,5-69	
	299-E20- 60	--	5-76	
	299-E20- 61	--	5-76,5-69	
B-12	299-E20- 9	8-87	5-76	Gamma activity in well E20-76; Little change in this well
	299-E20- 12	--	3-84,6-83,8-82	
	299-E20- 16	--	5-76	
	299-E20- 64	--	5-76,9-67	
	299-E20- 65	--	5-76,9-60	
	299-E20- 66	--	5-76,9-60	
	299-E20- 76	8-87	3-84	
216-DC Cribs	299-E13- 1	7-87	3-85,4-76,4-60	Three of the logs show gamma activity from the surface down to and into the groundwater; Lateral migration of radionuclides may also have occurred; 1977 report indicates breakthrough; Current logs support this conclusion.
B-14	299-E13- 2	7-87	3-85,4-76,4-60	
B-15	299-E13- 3	7-87	4-85,3-85,4-76,4-68	
B-16	299-E13- 4	7-87	3-85,5-59	
B-17	299-E13- 5	--	5-85,3-85	
B-18	299-E13- 6	7-87	4-85,1-854	
B-19	299-E13- 20	7-87	3-85	
	299-E13- 21	7-87	3-85,4-76,4-60	
DC Area Cribs	299-E13- 7	7-87	3-84,4-76,4-60	Elevated gamma activity is seen in the groundwater near wells E13-12 and E13-10; Well E13-7 is the only groundwater well showing near surface gamma activity (20-40 ft). All nearby shallow vadose wells show gamma activity from the surface to about 40 ft. This suggests that the gross gamma monitoring equipment is not adequately sensitive for monitoring through groundwater wells. Contamination of the groundwater has occurred in the past. Little change is seen from previous logs.
B-20	299-E13- 8	7-87	4-84,2-76,4-60	
B-21	299-E13- 9	7-87	3-84,4-76,4-60	
B-22	299-E13- 10	7-87	3-84,4-76,4-60	
B-23	299-E13- 11	7-87	3-84,4-76	
B-24	299-E13- 12	7-87	3-84,4-76	
B-25	299-E13- 13	--	4-60,5-69	
B-26	299-E13- 14	--	3-84,5-76,4-60	
B-27	299-E13- 15	7-87	3-84,5-76,4-60	
B-28	299-E13- 16	7-87	3-84,4-76,4-60	
B-29	299-E13- 17	7-87	3-84,5-76	
B-30	299-E13- 18	7-87	3-84,5-76,5-69	
B-31	299-E13- 19	7-87	4-84	
B-32	299-E13- 54	7-87	3-84	
B-33	299-E13- 55	7-87	3-84	

Table I CONTINUED

CRIBS	BOREHOLES	DATE LOGGED	PAST LOGS	Comments
DC AREA CRIBS				
B-34	299-E13- 56	7-87	3-84	
B-52	299-E13- 57	7-87	3-84	
B-53A	299-E13- 58	7-87	3-84	
B-53B	299-E13- 59	7-87	3-84	
B-54	299-E13- 60	7-87	3-84	
B-58	299-E13- 61	7-87	3-84	
216-B Trenches	299-E33- 8	--	2-76,5-59	The data available for this group of cribs show stratified gamma activity from 20 to 50 ft. No data are available at depths greater than 50 feet. Little change in gamma logs
B-35	299-E33- 10	--	--	
B-36	299-E33- 21	--	5-76,4-70,5-63,5-59	
B-37	299-E33- 28	--	--	
B-38	299-E33- 29	--	--	
B-39	299-E33-206	7-87	3-84	
B-40	299-E33-207	7-87	3-84	
B-41	299-E33-208	7-87	3-84	
B-42	299-E33-209	7-87	3-84	
	299-E33-290	7-87	3-84	
216-BY Cribs	299-E33- 1	--	4-76,4-68,5-63	All groundwater wells show gamma activity throughout the vadose zone and into the groundwater. Little change in gamma logs.
B-43	299-E33- 2	7-87	9-86,5-76,4-70,5-63	
B-44	299-E33- 3	--	5-76,4-70,5-63	
B-45	299-E33- 4	7-87	9-86,7-76,4-70,5-63	
B-46	299-E33- 5	--	5-76,4-70,5-63	
B-47	299-E33- 6	7-87	5-76,4-70,5-63	
B-48	299-E33- 7	7-87	2-76,4-68,1-59	
B-49	299-E33- 13	7-87	5-76	
B-50	299-E33- 22	7-87	9-86,5-76,9-65	
	299-E33- 23	7-87	9-86,5-76,4-70,9-65	
B-56	299-E28- 14	5-87	5-76	Gamma activity is evident 15 ft below the water table. No gamma activity is seen on the log in the vadose zone. No change
C- 9	299-E27- 1	7-87	--	No gamma activity is seen in the vadose zone in this well. Elevated activity occurs in the bottom of this well. No previous logs to allow comparison.

Table I CONTINUED

CRIBS	BOREHOLES	DATE LOGGED	PAST LOGS	Comments
S- 1	299-W22- 1			Some wells show elevated gamma activity
S- 2	299-W22- 2		5-76,4-70,2-60	throughout the vadose zone.
	299-W22- 5	8-87	5-76,2-60,5-63	Gamma activity may have decreased in some
	299-W22- 6	8-87	2-86,5-76,2-60	wells. Cribs have broken through to ground-
	299-W22- 10	9-87	2-86,5-76,2-60,5-63	water sometime in the past as evidence by
	299-W22- 11	8-87	2-86	gamma logs.
	299-W22- 15	8-87	2-86,5-76,5-63,4-66	
	299-W22- 16	8-87	2-86,5-76,4-70,5-63	
	299-W22- 17	8-87	2-86,5-76,2-60	
	299-W22- 18	8-87	2-86,5-76,2-60,5-63	
	299-W22- 29	--	2-86,5-76,2-60	
	299-W22- 30	--	6-80,5-76,2-60	
	299-W22- 31	--	2-86,5-76,2-60	
	299-W22- 36	--	5-76,2-60	
	299-W22- 67	8-87	2-86,5-76,2-60	
S- 7	299-W22- 12	--	2-76,2-60,2-50	Older logs suggest radionuclides have
	299-W22- 13	8-87	5-76,2-60,5-63	reached the groundwater. Current logs show
	299-W22- 14	--	2-87,5-76,5-63,2-58	slightly elevated gamma activity which may
	299-W22- 32	--	5-76,2-60	or may not be due to contaminants. Most
	299-W22- 33	8-87	5-76,2-60	activity is confined to the vadose zone.
S- 9	299-W22- 25	8-87	9-86,2-76,9-70,2-60	There appears to be elevated gamma activity
	299-W22- 26	--	5-76,9-70,9-66	at the top of the groundwater table.
	299-W22- 34	8-87	9-86,5-76	The level appears to be low however, and may
	299-W22- 35	8-87	9-86,5-76	be due to natural activity. No change
S-20	299-W22- 19	--	9-84,2-76,2-60,7-63	Gamma activity is evident in vadose zone in
	299-W22- 20	--	5-76,2-60,5-63	well W22-74. Gamma log is not comparable
	299-W22- 74	2-87	9-84	with previous log because of poor recording
T- 3	299-W11- 1	7-87	--	Gamma activity is only seen above the water
	299-W11- 7	8-87	7-86,2-76,2-70,6-59	table. Well W11-79 shows gamma activity
	299-W11- 79	--	7-86,4-84	along length and into GW. Minimal change.
T- 5	299-W10- 1	8-87	2-76,5-63,6-59	Low level activity. No change

Table I CONTINUED

CRIBS	BOREHOLES	DATE LOGGED	PAST LOGS	Comments
T- 6	299-W11- 1	7-87	5-76,2-60	Some of the current logs show high activity between 30 and 40 ft. No change in logs.
	299-W11- 54	--	5-76,4-69,2-50	
	299-W11- 55	--	5-76,4-69,2-50	
	299-W11- 56	--	5-76,4-69	
	299-W11- 57	7-87	5-76,4-69	
	299-W11- 58	--	5-76,4-69	
	299-W11- 59	7-87	5-76,4-69	
	299-W11- 60	--	5-76,4-69	
	299-W11- 61	--	5-76,4-69	
	299-W11- 62	--	5-76,4-69	
	299-W11- 63	7-87	5-76,4-69	
	299-W11- 64	--	5-76,4-69	
	299-W11- 65	7-87	5-76,4-69	
	299-W11- 66	--	5-76,4-69	
	299-W11- 67	7-87	5-76,4-69	
T- 7	299-W10- 2	7-87	--	The gamma log from well W10-72 shows several high gamma activity zones. All other current logs do not show significantly high gamma activity. Decrease from previous logs is due to migration or decay of radionuclides.
	299-W10- 3	--	7-86,2-76,4-70,6-59	
	299-W10- 59	--	5-63	
	299-W10- 60	--	--	
	299-W10- 61	--	5-63	
	299-W10- 62	--	--	
	299-W10- 63	--	4-63	
	299-W10- 66	--	--	
	299-W10- 67	--	5-63	
	299-W10- 68	--	5-63	
	299-W10- 69	8-87	5-76,5-63	
	299-W10- 70	8-87	5-76,5-63	
	299-W10- 71	8-87	5-76,5-63	
	299-W10- 72	8-87	5-76,5-63	
	299-W10- 74	8-87	--	
	299-W10- 77	8-87	5-76	
	299-W10- 78	8-87	--	
	299-W10- 79	8-87	--	
	299-W10- 80	--	5-76,5-63	
	299-W10- 81	8-87	5-76	
216-T Trenches				Current well logs show a zone of gamma activity between 90 and 100 ft. Changes in shapes of gamma curves are significant. Quantitative data are required to assess changes.
T-14	299-W11- 68	7-87	6-86,5-76,4-69	
T-15	299-W11- 69	7-87	5-76,4-69	
T-16				
T-17				

Table I CONTINUED 2 2 7 0 1 1 1 8

CRIDS	BOREHOLES	DATE LOGGED	PAST LOGS	Comments
T-26 T-27 T-20	299-W11- 11 299-W11- 70 299-W11- 82 299-W14- 1 299-W14- 2 299-W14- 3 299-W14- 4 299-W14- 53 299-W14- 62	-- 8-87 8-87 7-87 -- 8-87 8-87 8-87 8-87	-- 3-86,4-84 3-86,4-84 9-86 -- 9-86 9-86 7-86,4-84 7-86,4-84	Two zones of gamma activity are seen. One centered near 25 ft; one at 95 ft. Changes in gamma logs are evident. Quantitative data are required to assess changes.
T-33	299-W11- 14	7-87		Two possible contamination zones; 100 ft and 170 ft. Levels are low relative to an assumed background. Little change from previous logs.
T-34	299-W11- 15 299-W11- 16	-- 7-87	5-76,2-70,2-60 5-76,2-70,2-60	No high activity is seen in W11-16. Little change from previous logs.
T-35	299-W11- 17 299-W11- 18 299-W11- 19 299-W11- 20 299-W11- 21	7-87 -- 7-87 7-87 7-87	5-76,2-70,2-67 2-76,2-70,3-67 5-76,2-70 5-76,2-70 5-76	No high activity is seen in the gamma logs. Previously recorded gamma activity has decayed or migrated.
T-36	299-W10- 2 299-W10- 4	7-87 --	5-76 5-76,4-63,7-59	No high activity is seen in W10-2. Little change from previous logs.
U- 9	299-W19- 1	5-87	--	No high gamma activity is seen in this well
U-17	299-W19- 19 299-W19- 20 299-W19- 23 299-W19- 24 299-W19- 25 299-W19- 26	1-87 -- 3-87 -- 4-87 4-87	-- 6-86 -- -- -- --	Gamma activity is evident throughout wells W19-19, W19-20, W19-23, and W19-24. Gamma emitting radionuclides have migrated recently and they have migrated to ground-water. Ground-water minitoring is occurring. Significant changes from previous logs.

Table I CONTINUED

CRIBS	BOREHOLES	DATE LOGGED	PAST LOGS	Comments
Z- 9	299-W15- 6	9-87	5-76,2-60,5-69	Data from this crib show several strata with gamma emitting radionuclides in the unsaturated zone. No gamma activity is seen in the saturated zone. Minimal changes from previous logs.
	299-W15- 8	9-87	4-79,2-70,10-60	
	299-W15- 9	9-87	5-76,4-79,2-67	
	299-W15- 82	9-87	5-76,5-69	
	299-W15- 84	9-87	5-76,4-79,5-69	
	299-W15- 85	9-87	5-76,4-79,5-69	
	299-W15- 86	9-87	5-76,4-79	
	299-W15- 95	9-87	5-76,4-79,5-69	
	299-W15-101	--		
Z-12	299-W10- 2	--	5-76,2-60,5-69	No gamma activity is seen in the groundwater in these wells. Little activity is seen in the unsaturated zone. Little change in the well logs.
	299-W10- 4	8-87	--	
	299-W10- 5	--	5-79,2-60,2-67	
	299-W10- 8	--	--	
	299-W10- 69	--	2-60,2-67	
	299-W10- 70	--	--	
	299-W10- 71	8-87	5-79,2-70	
	299-W10- 72	8-87	7-86	
	299-W10- 73	8-87	5-79	
	299-W10- 74	8-87	5-79	
	299-W10- 75	--	7-86	
	299-W10-151	--	7-86	
	299-W10-152	--	7-86	
	299-W10-153	--	7-86	
	299-W10-154	--	7-86	
	299-W10-155	--	7-86	
	299-W10-156	--	--	
	299-W10-157	--	7-86	
Z-18	299-W18- 9	7-87	7-86	Several high gamma activity peaks are found between 20 and 70 ft. One zone of high gamma activity may occur between 124 and 146 ft. The three groundwater wells in this area do not indicate any gamma activity in the groundwater. Little change from previous logs.
	299-W18- 10	--	--	
	299-W18- 11	7-87	7-86	
	299-W18- 12	--	--	
	299-W18- 13	--	--	
	299-W18- 82	7-87	6-86	
	299-W18- 93	7-87	7-86	
	299-W18- 94	7-87	7-86	
	299-W18- 95	7-87	7-86	
	299-W18- 96	7-87	7-86	
	299-W18- 97	7-87	7-86	
	299-W18- 98	7-87	7-86	
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