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WHC-SA-2287-VA

Groundwater Impact Assessment Plans for 216-T-1 Ditch, 216-T-4-2 Ditch, and 216-B-3 Pond

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Prepared for the U.S. Department of Energy
Office of Environmental Restoration
and Waste Management

Westinghouse
Hanford Company Richland, Washington

Hanford Operations and Engineering Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

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Groundwater Impact Assessment Plans for 216-T-1 Ditch, 216-T-4-2 Ditch, and 216-B-3 Pond

D. K. Tyler
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S. J. Trent

Date Published
January 1994

To be presented at
TPA Meeting to Present Groundwater
Impact Assessment Plans
Richland, Washington
February 22, 1994

Prepared for the U.S. Department of Energy
Office of Environmental Restoration
and Waste Management

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Introduction and Overview of Groundwater Impact Assessment Plan Presentations

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Presentation Outline

Introduction

- Purpose
- Background
  - Relevent milestones
  - Liquid effluent consent order
  - Overlapping regulatory programs and orders

Groundwater Impact Assessment Methodology

- Overview

Assessment Plans

- Objectives
- Format
- General Content
- Implementation Schedule

Site-specific Summary of Major Issues

Presentation of Assessment Plans

Purpose

Present Assessment Plans to Ensure:

- Impact assessments are consistent with methodology and technically credible
- Approach to performing impact assessments consistent with regulators' expectations
- Satisfaction of Tri-Party Agreement (TPA) Milestone M-17-13A Implementation Schedule Target Dates
- Objectives and content elaborated in Assessment Plans section

Milestone M-17-00A

Complete Liquid Effluent Treatment Facilities/Upgrades for All Phase I Streams

Milestone M-17-00B

Complete Implementation of "Best Available Treatment Technology/All Known, Available, and Reasonable Methods of Prevention, Control, and Treatment" (BAT/AKART) for All Phase II Liquid Effluent Streams at the Hanford Site

M-17-00A and -00B Interim Milestones for Phase I and Phase II Streams

Develop and Implement

- Impact Assessment Methodology (M-17-13 and M-17-13A)
- Sampling and Analysis Plans (SAP) for liquid effluent streams
- Treatment System Design and Construction Commitments
- Interim Flow Restrictions
- Cease Discharge Dates

Relevant TPA Milestones

M-17-00A and -00B
Liquid Effluent Series of Milestones

- **M-17-13** Groundwater impact assessment methodology and implementation schedule; Completed October 1991
- **M-17-13A** Groundwater impact assessment implementation schedule 30 days after methodology approval; completed on time; Currently implementing schedule

Relevant TPA Milestones

- **M-17-10** Cease all liquid discharges to hazardous land disposal units unless such units have been clean closed in accordance with RCRA. June 1995

Other Relevent TPA Milestones
Future Discharge of 200 Areas Liquid Effluents

- M-17-08 Initiate full-scale hot operations for "200 Area Liquid Effluent Treatment Disposal Facility" (Project W-049H) June 1995

- M-17-14 Initiate full-scale hot operations for "242-A Evaporator/PUREX Plant Condensate Treatment Facility" with permitted discharge of treated effluent to soil column (Project C-018H) June 1995

Liquid Effluent Consent Order -

Signed December 1991

- Ecology and DOE - consent order No. DE 91NM-177
- Relates to the practice of discharging liquid effluents to the ground
- Separate and legally distinct from the TPA
- Reinforces TPA
- Intended to maintain consistency with TPA Milestone M-17-00

Two Key Provisions:

- The DOE agrees to abide by all applicable state water quality criteria (Chapters 173-200 and 173-201)
- The DOE agrees to secure permits for effluent streams that will continue to discharge to the ground

Groundwater Impact Assessment Methodology

Effluent Discharged to 13 Receiving Sites After June 1992

Objectives - Determine for Each Receiving Site:

- Local impacts to groundwater system (contaminant and hydrologic)
- Extent of contamination in vadose zone
- Contaminant breakthrough to groundwater
- Incremental impacts from continued use
- Adequacy of monitoring system

Groundwater Impact Assessment Methodology (cont.)

A Two-Stage Approach

- Stage 1. Categorize Sites - scoping for Stage 2
- Stage 2. Receiving Site Impact Assessments

Groundwater Impact Assessment Methodology (cont.)

Stage 1. Categorization

Impact Assessment Categories Correspond to Data Collection Effort:

- Level 1 - Use Existing Data
- Level 2 - Limited Field Data Collection (sampling, surveys)
- Level 3 - Extensive Field Data Collection (drilling)

Categorization of Receiving Sites Based on Evaluation of Factors

- Potential for Impact - effluent constituents and volume, hydrogeology
- Schedule for Cessation of Effluent Discharges
- Adequacy of Existing Information

Groundwater Impact Assessment Methodology (cont.)

Stage 2. Impact Assessment of Receiving Sites

General Tasks:

- Task 1 - Develop and present Assessment Plan to regulators
  - for each receiving site
  - information review
  - scoping
- Task 2 - Characterize effluent
  - using existing data
- Task 3 - Develop preliminary conceptual model
  - hydrogeologic framework
  - hydrologic responses
  - contaminant migration processes
- Task 4 - Identify additional information needs

Groundwater Impact Assessment Methodology (cont.)

Stage 2. Impact Assessment of Receiving Sites

General Tasks:

- Task 5 - Perform data collection activities
  - according to category and impact assessment plan
- Task 6 - Analyze and interpret data to refine conceptual model

Groundwater Impact Assessment Methodology (cont.)

Stage 2 - Impact Assessment of Receiving Sites

General Tasks:

- Task 7 - Perform Impact Analysis to satisfy objectives:
  - hydrologic effects
  - predict contaminant breakthrough
  - extent of contamination
  - impacts from continued use

  - Analysis techniques appropriate for data available - analytical solutions, numerical modeling

  - Assessment criteria used as relative measure of impact (WAC 173-200 Groundwater Quality Criteria or DOE Derived Concentration Guidelines for other constituents)

  - Identify additional information needs

  - Evaluate adequacy of existing monitoring network

- Task 8 - Prepare and submit Groundwater Impact Assessment Report

Assessment Plans

Objectives:

- Overview site-specific information
- Define technical issues
- Refine scope of proposed work
- Ensure consistency of proposed impact analysis techniques with groundwater impact assessment methodology
- Ensure approach is technically credible and meets expectations of EPA and Ecology
- Facilitate expedient and effective execution of work

Assessment Plans (cont.)

Format:

- Presented as oral briefings with visuals and handouts
- After presentation for each facility, discuss questions and resolve issues
- Develop consensus on approach
- Meeting minutes to document resolution of issues and action items

Assessment Plans (cont.)

General Content

- Information sufficient to detail the scope of work for implementing assessment activities
- Same topics are fully developed in the impact assessment report

Assessment Plans (cont.)

General Content

- Receiving Site Function and History
  - Receiving site location
  - Dimensions of receiving site
  - Effluent origin - facilities and contributing processes
  - History of operation

Assessment Plans (cont.)

General Content

- Effluent Characteristics and Constituents of Interest
  - Chemical constituent inventory
  - Radioactive constituent inventory
  - Constituents of interest - known and suspected
  - Effluent volume and flow regime
  - Schedule to implement effluent monitoring

Assessment Plans (cont.)

General Content

- Facility Operations and Regulatory Considerations
  - Past and present practices of nearby facilities affecting impact assessment
  - Future operations
  - Regulatory requirements and status

Assessment Plans (cont.)

General Content

- Preliminary Conceptual Model - A Working Hypothesis
  - Hydrogeologic framework
  - Groundwater movement and effluent recharge
  - Geochemical and hydraulic factors affecting contaminant transport

Assessment Plans (cont.)

General Content

- Technical Issues Summarized
- Data Needs and Modeling Techniques Identified
- Project Organization and Schedule

M-17-13A Groundwater Impact Assessment Implementation Schedule

Receiving Site	Contributing Waste Streams	Level Effort	AP Date	GIA Date	Permit Date
216-U-14 Ditch	UO3/U-Plant Wastewater, 242-S Evaporator Steam Condensate, Surface Contamination Control Water	3	1/93	1/94	NA
1325-N LWDF	N Reactor Effluent	1	4/93	9/93	NA
216-W-LC Crib	2724-W Laundry Wastewater	2	4/93	2/94	NA
216-Z-20 Crib	Plutonium Finishing Plant Wastewater	2	12/92	10/93	NA
216-U-17 Crib	UO3 Plant Process Condensate	1	1/93	6/93	NA
216-S-26 Crib	222-S Laboratory Wastewater	1	6/93	11/93	NA
216-T-1 Ditch	T-Plant Laboratory Wastewater	3	1/94	2/95	NA
216-T-4-2 Ditch	T-Plant Wastewater	3	1/94	2/95	NA
284-W Powerhouse Pond	284-W Powerplant Wastewater	1	4/93	9/93	NA
2101-M Pond	2101-M Laboratory Wastewater	1	4/93	9/93	NA
400 Area Ponds	400 Area Secondary Cooling Water	1	8/92	10/92	12/92
100-D Ponds	183-D Filter Backwash Wastewater	3	1/93	7/93	12/93
216-B-3 Pond System	242-A Evaporator Cooling Water, 242-A Evaporator Steam Condensate, B Plant Cooling Water, 241-A Tank Farm Cooling Water, 284-E Powerplant Wastewater, 244-AR Vault Cooling Water	3*	1/94	1/95	12/93

AP = Assessment Plan Presentation
GIA = Groundwater Impact Assessment Report
Permit = WAC-173-216 State Waste Discharge Permit

Shaded lines show receiving sites for which groundwater impact assessment activities are completed.

* Down-graded to level 1.

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Groundwater Impact Assessment Plan for the 216-T-1 Ditch

K.M. Singleton, S.D. Evelo, and S.P. Reidel

Geohydrologic Engineering Function
Westinghouse Hanford Company

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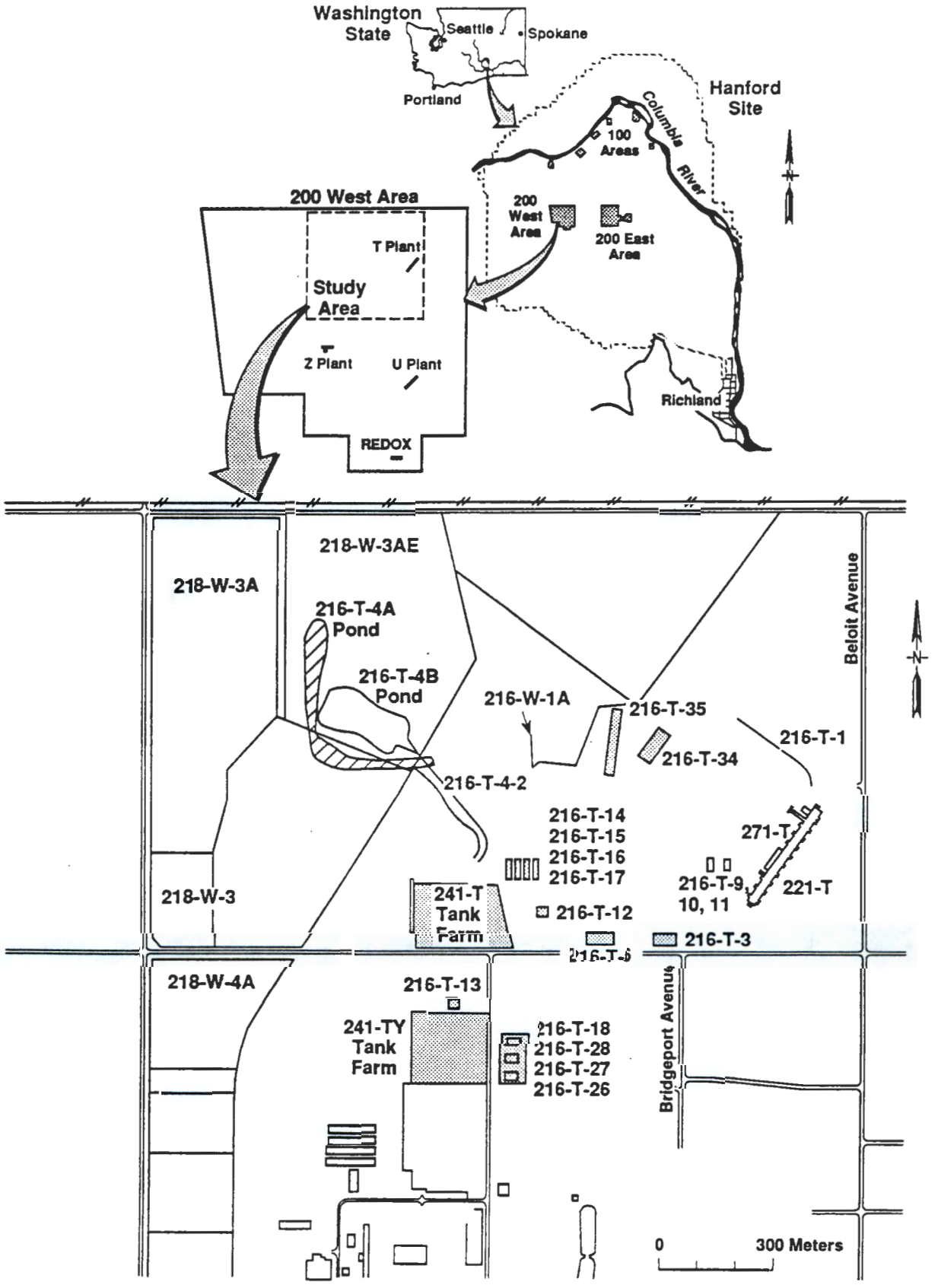
Outline

Groundwater Impact Assessment Plan 216-T-1

- Receiving Site Function and History
- Effluent Characteristics and Constituents of Interest
- Adjacent Facilities
- Preliminary Conceptual Model
- Technical Issues and Data Needs Summary
- Data Collection Plan
  - Highlight key elements

Receiving Site Function and History

- Located in the north central portion of the 200 West Area
  - 1,000 feet long
  - 30 feet wide at top
  - 6 feet wide at base
  - 4 feet deep
- In service since November 1944
- Ditch is fed by 6-inch-diameter underground header pipe that is 90 feet long extending from 221-T Building


Washington State
Seattle
Spokane
Portland
Hanford Site
Columbia River
100 Areas
200 West Area
200 East Area
200 West Area
T Plant
Study Area
Z Plant
U Plant
REDOX
Richland
218-W-3AE
218-W-3A
216-T-4A Pond
216-T-4B Pond
216-W-1A
216-T-35
216-T-34
216-T-1
Beloit Avenue
216-T-4-2
216-T-14
216-T-15
216-T-16
216-T-17
271-T
216-T-9, 10, 11
221-T
218-W-3
241-T Tank Farm
216-T-12
216-T-6
216-T-3
218-W-4A
216-T-13
241-TY Tank Farm
216-T-18
216-T-28
216-T-27
216-T-26
Bridgeport Avenue
0
300 Meters
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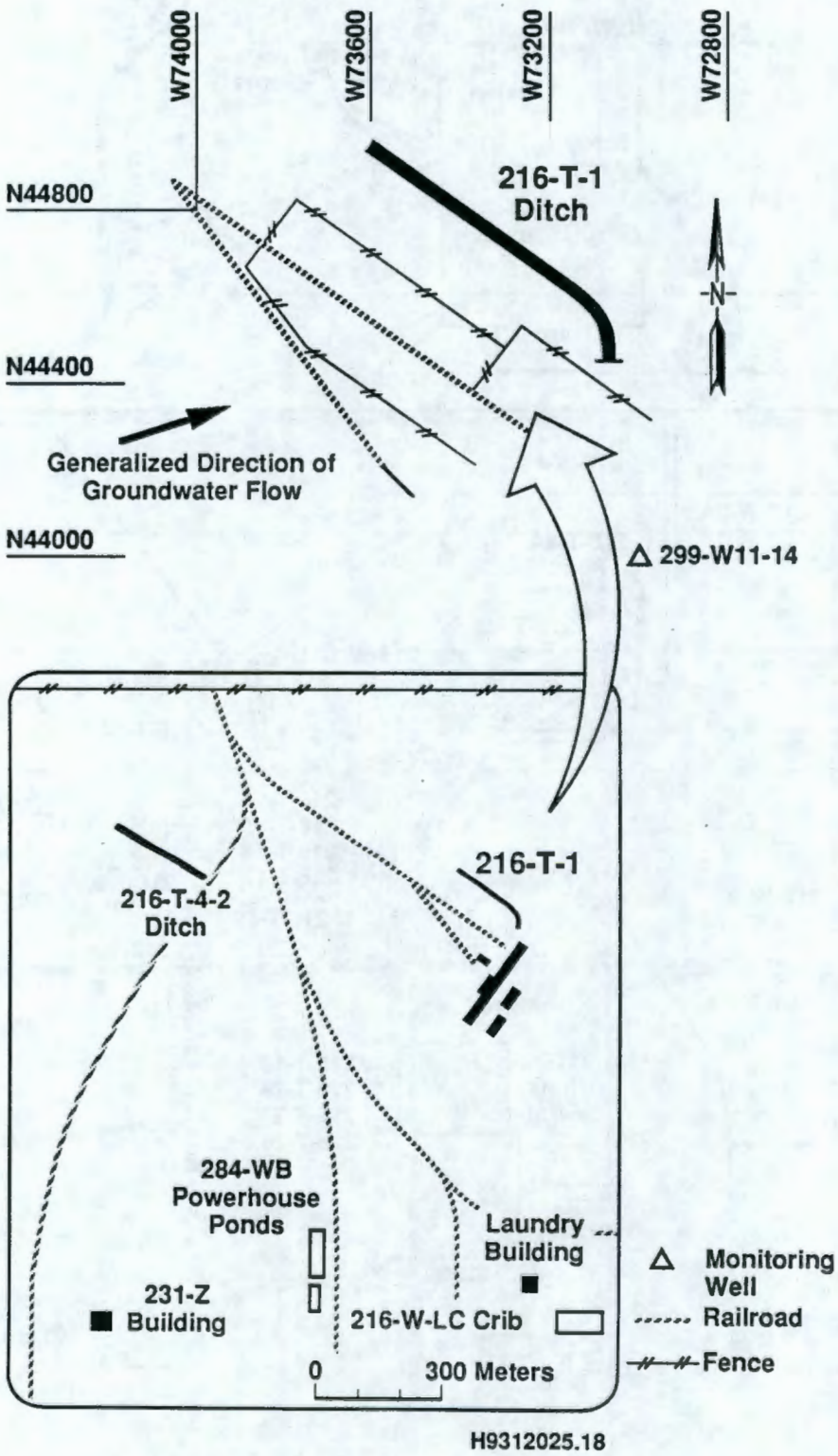
Site Map for 216-T-1 Ditch



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Receiving Site Function and History (cont.)

- T Plant is the primary decontamination facility for the Hanford Site
- T Plant consists of two principal buildings, 221-T and 2706-T
- Effluents from 221-T Building head-end activities flow to 216-T-1 Ditch. Ditch does not receive 2706-T Building effluent

Receiving Site Function and History (cont.)

- 221-T Building constructed in 1943 and 1944
- Provided services in radioactive decontamination, reclamation, and decommissioning of contaminated process equipment
- Head-end and canyon of 221-T originally used to chemically extract plutonium from irradiated fuel by the bismuth phosphate process - ended in 1956
- Head-end of 221-T had served as site of experimental operations and testing

Receiving Site Function and History (cont.)

- Head-end Process History
  - 1945-1956 Process spent fuel
  - 1956-1964 Inactive
  - 1964-1969 Containment system test facility (PNL)
  - 1972-1976 Vacuum fractionator (ARHCO)
  - 1976-1985 Liquid metal reactor safety tests (WHC)
  - 1985-1990 Lightwater reactor tests and fusion program (WHC)
  - No tests since 1990

Receiving Site Function and History (cont.)

- Potential radioactive contamination in waste stream exists
  - Based on process knowledge of testing programs and presence of systems and components in radiological controlled area
  - Based on effluent monitoring results

Receiving Site Function and History (cont.)

- Future use of ditch
  - No new discharges are planned for 216-T-1 Ditch
  - Discontinue use of 216-T-1 Ditch by June 1995

Effluent Characteristics

Chemicals Potentially Introduced into the Effluent - Based on Process Knowledge and Facility Inventory

- **Past chemical usage in Hanford Bismuth Phosphate Process**

  Hanford Technical Exchange Program Process Chemistry at Hanford, September 15,1993

Chemical	Usage, mass/mass U
HNO_3	3.000
H_2SO_4	0.397
$NaNO_2$	0.091
$BiONO_3$	0.063
H_3PO_4	0.985
$NaBiO_3$	0.016
$Na_2Cr_2O_7$	0.0073
$(NH_4)_2Ce(NO_3)_6$	0.0015

- **Past chemical usage in Hanford Bismuth Phosphate Process (cont.)**

Hanford Technical Exchange Program Process Chemistry at Hanford, September 15,1993

Chemical	Usage, mass/mass U
H_2O_2	0.014
$(NH_4)_2SiF_6$	0.116
$FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$	0.210
$La(NO_3)_3 \cdot 2NH_4NO_3 \cdot 2H_20$	0.0112
$H_2C_2O_4 \cdot 2H_2O$	0.0041
HF	0.0052
KOH	0.122
$KMnO_4$	0.0087
$(NH_4)_2SO_3$	0.0005
$(NH_4)_2SO_3$	0.0001
$ZrO(NO_3)_2$	0.0015
For Waste Neutralization	
NaOH	2.95
Na_2CO_3	1.94

Effluent Characteristics (cont.)

- Current chemicals listed for use in the 221-T Building with potential for release to the 216-T-1 Ditch

Nitric acid
Sodium hydroxide
Potassium permanganate
Sodium nitrate
Phosphoric acid
Citric acid
Acetone
Acetic acid

Hydrochloric acid
Oxalic acid
Methylene chloride
Turco solvents
1,1,1, Trichlorethane
Xylene
Soaps

Reference: WHC-EP-0481 "Facility Effluent Monitoring Plan for T Plant" (FEMP)
These are being phased out of use and the FEMP will be revised accordingly.

Effluent Characteristics (cont.)

- Known past disposal of chemicals to the 216-T-1 Ditch

Nonradioactive Liquid-Metal Reactor Safety Tests (between 1978 and 1985)	Nonradioactive Light Water Reactor tests (between 1985 and 1990)
*reacted sodium	cesium
*reacted lithium	manganese
sodium iodide	lithium sulfate
other alkali metals	iodine
	hydrogen

Reference: WHC-EP-0481 "Facility Effluent Monitoring Plan for T Plant" (FEMP)

* Liquid sodium and lithium were "reacted" and dissolved in water prior to disposal.

Effluent Characteristics (cont.)

- Known past disposal of radionuclides to the 216-T-1 Ditch

*Radionuclides	
Cesium-137	< 50 Ci
Strontium-90	< 50 Ci
Plutonium	< 1mg
Gross Alpha	< 10 mCi
Gross Beta	< 0.2 Ci

Reference: WIDS December 14, 1993

* Based on effluent monitoring data

Effluent Characteristics (cont.)

- Chemical constituents detected in wastewater

Acetone
Aluminum
Ammonia
Barium
Boron
Cadmium
Calcium
Chloride
Chromium
Copper
Dichloromethane
Fluoride
Iron
Lead
Magnesium
Manganese
Mercury
Nickel
Nitrate
Potassium
Silicon
Sodium
Strontium
Sulfate
Trichloromethane
Uranium
Zinc
2-Chloronapthalene

Effluent Characteristics (cont.)

- Radiological constituents detected in wastewater

  Gross Alpha
  Gross Beta
  Cobalt-60
  Cesium-137
  Total Radium

Constituents of Interest

Soil		Groundwater/perched
Sodium	Cesium-137	ICP Metals
Lithium	Strontium-90	Anions
Barium	Plutonium-239/240	VOA's
Calcium	Uranium	Gross Alpha
Lead	Cobalt-60	Gross Beta
Zinc	Mercury	TRU's
Chromium	Cadmium	Cobalt-60
Cesium	Phosphate	Uranium (chemical)
Strontium	Bismuth	Alkalinity
Cerium		TDS
Lanthanum		Mercury

Effluent Volume and Flow Rate

Period	Volume (L)	Flow Rate (L/min)
1944 - 1975	1.8E + 08	11
1976 - 1984	N/A	N/A
1985 - 1990	6.5E + 07	25
1991 - present	N/A	N/A

N/A = not available

Nearby Facilities

Facility	Years of Service	Description	Volume Received
Uranium Burial Trench	Inactive	Unirradiated uranium waste is buried in a trench	Unknown
216-T-35 Crib	1967 to 1968 Inactive	Received 300 Area laboratory waste from the 340 Building	5.27E + 6L
216-T-33 Crib	1963 Inactive	Received decontamination waste from 2706-T Building	1.9E + 6L
216-T-9, 10, and 11 Trench	1951 to 1954 Inactive	Received heavy equipment and vehicle decontamination waste	Unknown

Future Operations

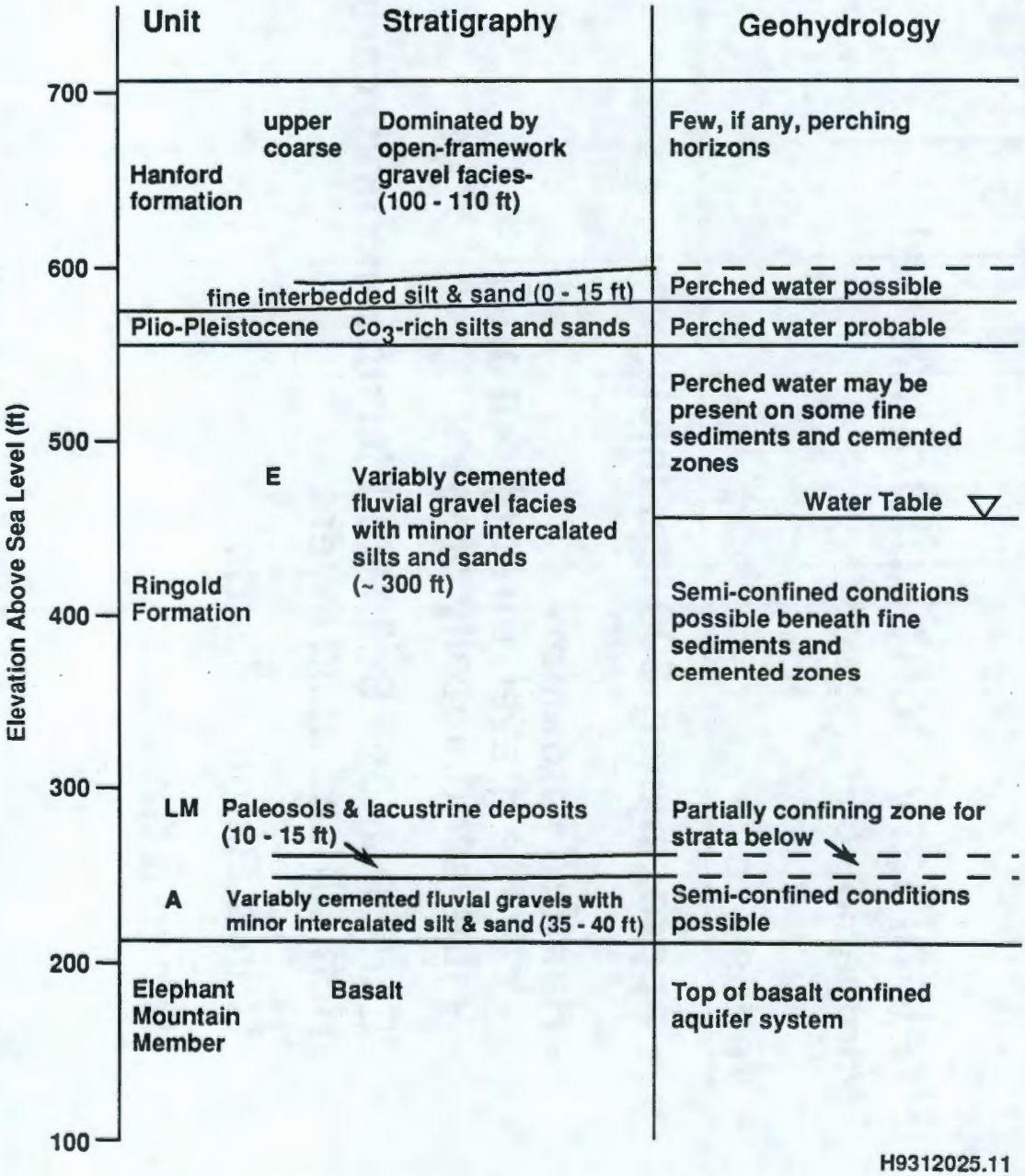
- Laboratory activities are suspended, and the 221-T Building head-end was used as office space, but is not currently in use.
- Steam condensate, cooling water, and floor wash water are the only regular liquid effluents expected to be discharged to the 216-T-1 Ditch. The sources are nonradioactive and nonhazardous.

Preliminary Conceptual Model

Hydrogeologic Framework

- Vadose zone
  - Approximately 200 feet thick
  - Hanford formation
    - coarse gravel, throughout area
    - fine sand, locally present
  - Early Palouse Soil/Plio-Pleistocene unit, carbonate rich silt and sand layers
  - Upper Ringold Sands
  - Ringold Gravels

Generalized Stratigraphy and Hydrology Beneath Southern End of 216-T-1 Ditch



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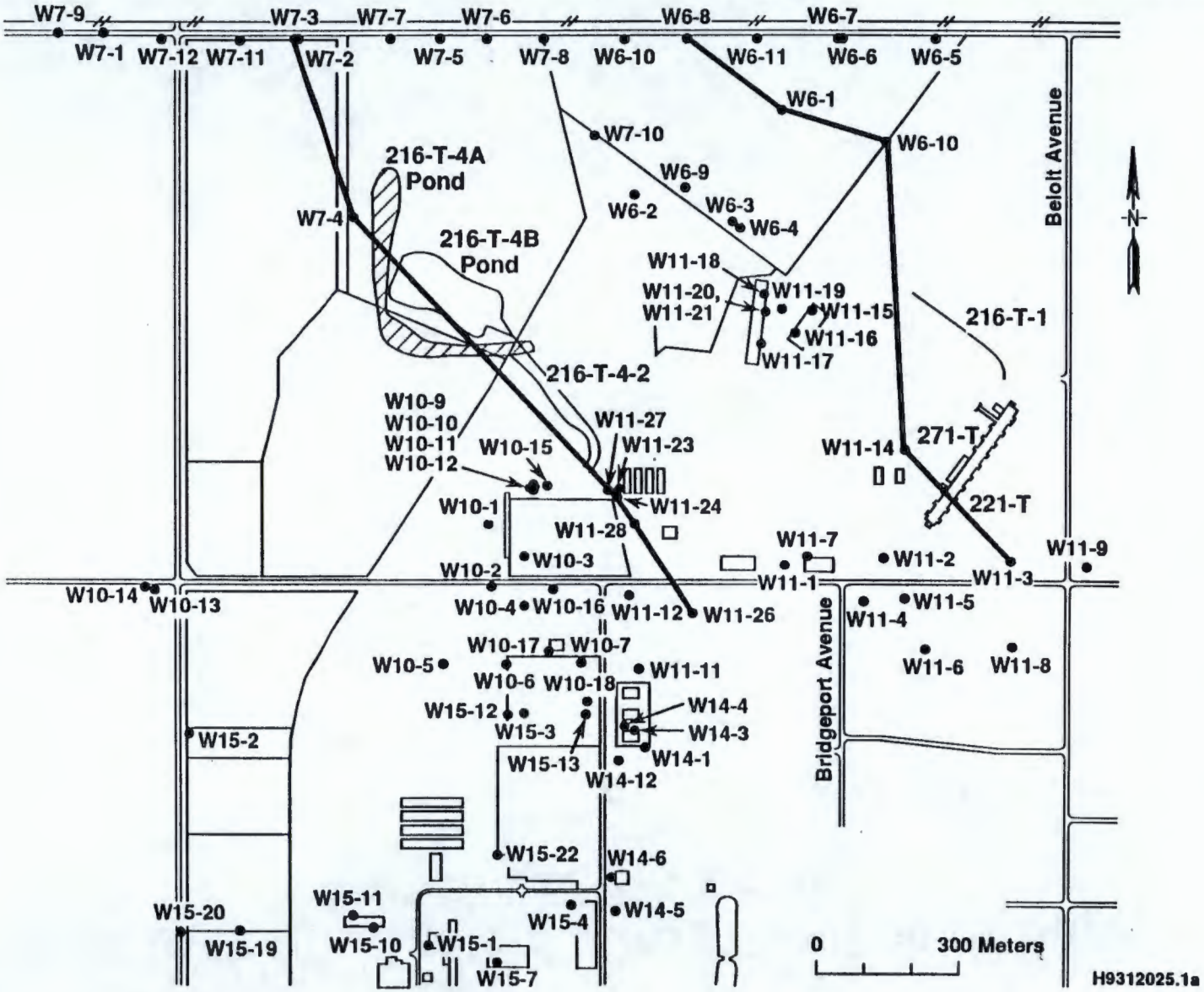
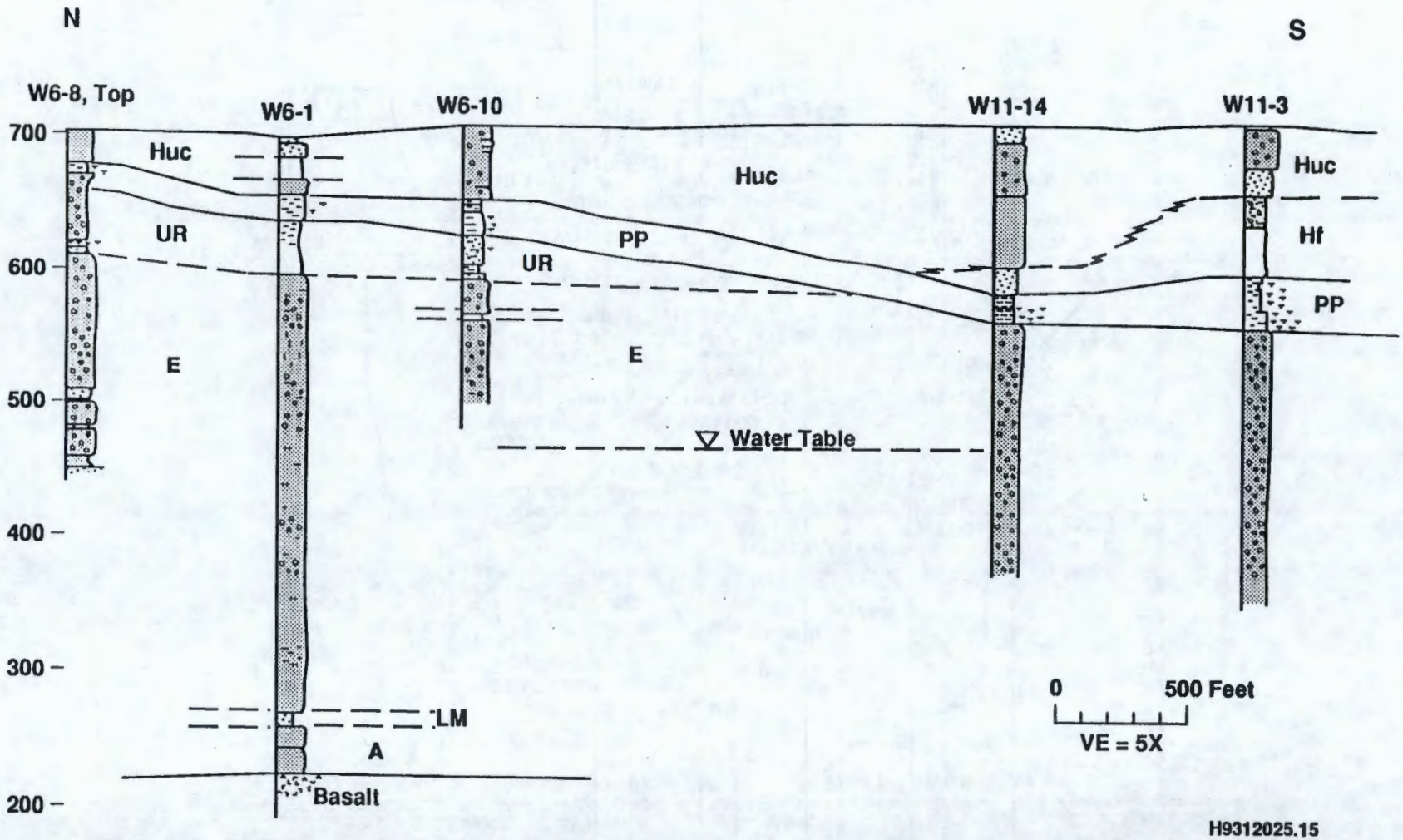
Location Map of Sites and Geologic Cross-sections



North to South Geologic Cross-section through Area of 216-T-1 Ditch



Preliminary Conceptual Model (cont.)

Hydrogeologic Framework

- Vadose zone (cont.)
  - Ditch sediment fines - impede downward flow of water
  - Upper coarse sediment - Hanford formation - highly transmissive
  - Lower fine sediment - Hanford formation - anisotropic
  - Early Palouse Soil/Plio-Pleistocene unit
    - less permeable
    - anisotropic

Ringold Formation - water table

Preliminary Conceptual Model

Contaminant Pathways

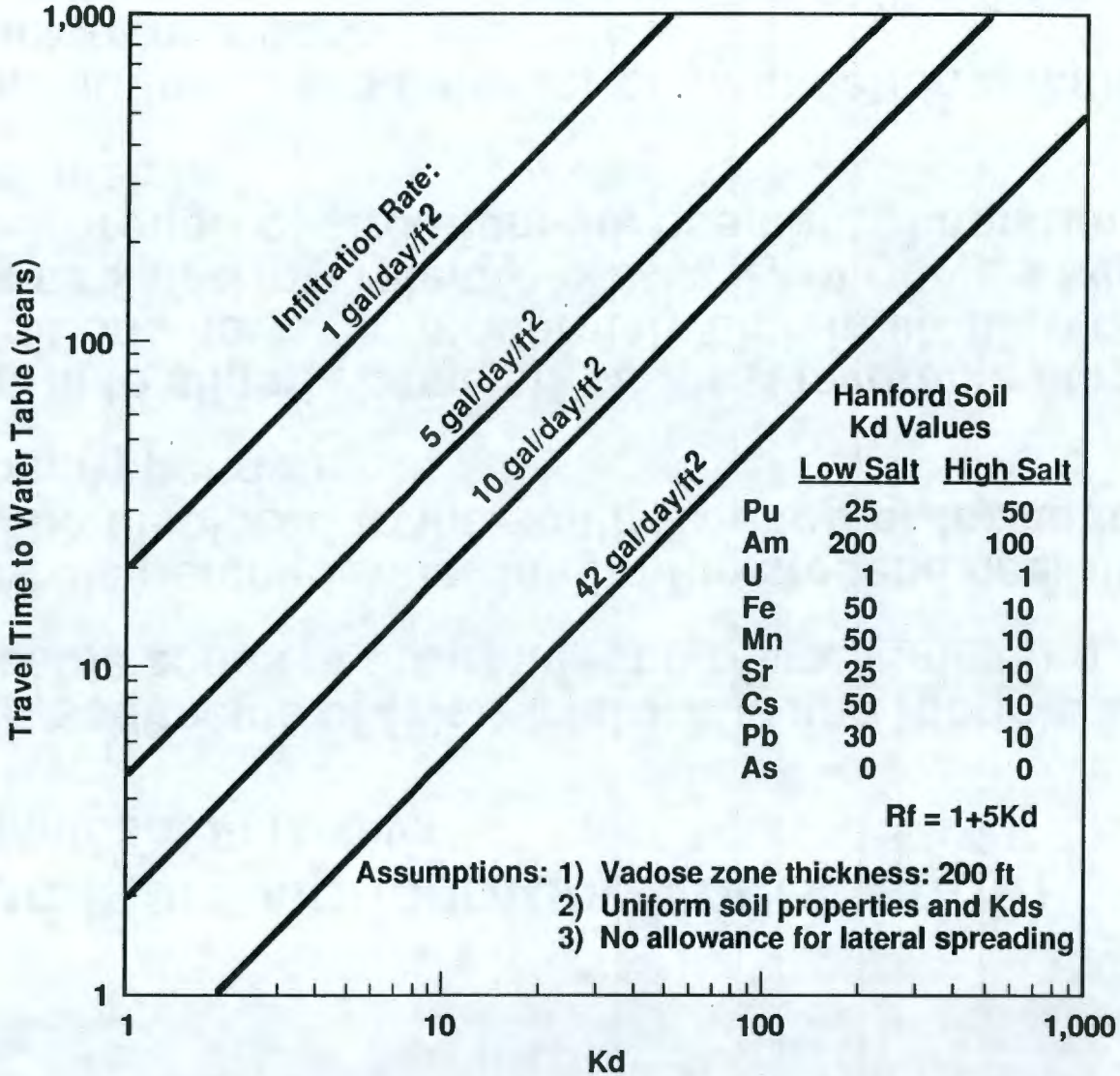
- Potential contaminants include mixed fission products and associated process chemicals
- Low discharge rates suggest contamination is near inlet
- Infiltration rates could range from 3 to 60 gal/day/ft^2
  - 3 gal/day/ft^2 over 150 ft of trench (assuming 1gpm)
  - 60 gal/day/ft^2 at inlet (assuming 2 gpm)(15 ft)
- Open framework gravels have limited contaminant retention capacity

Preliminary Conceptual Model (cont.)

Contaminant Pathways

- Finer sediments of Plio-Pleistocene and Ringold are most probable zones of accumulation of contaminants
- Possible perched water in Plio-Pleistocene near inlet; may be displaced to the south (see top-of-formation maps, Appendix)
- Neutral to slightly basic pH suggest favorable sorption conditions however, moderately high infiltration rates, long use, and low retention capacity of gravels suggest breakthrough of strontium-90, possibly plutonium and other metals
- Contribution to groundwater contamination unknown due to lack of monitoring wells

Estimated Contaminant Travel Time Through Vadose Zone versus Infiltration Rate and Kd, 200 West Area



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$$\text{Travel Time} = \frac{Z\ (\text{ft})}{Vc\ (\text{ft/day})}$$

where:

Z = vadose zone thickness, ft
Vc = estimated contaminant velocity, which is

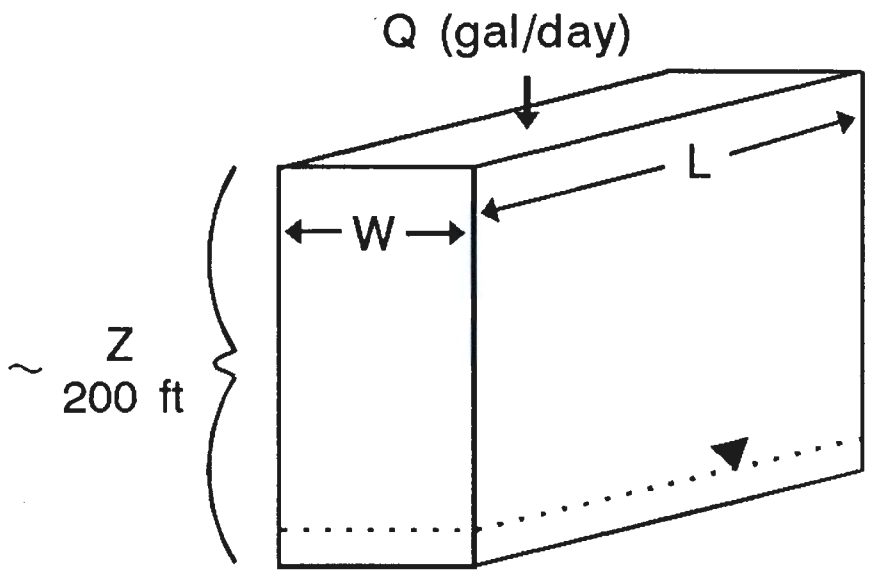
$$\simeq \left(\frac{Vw}{Rf}\right)$$

and water velocity is:

$$Vw = \frac{Q\ (\text{gal/day})}{L\ (\text{ft}) \times W\ (\text{ft})}$$

To convert Vw (gal/day/ft^2) to Vw (ft/day):

$$Vw\ (\text{ft/day}) = [0.13 \times (\text{gal/day/ft}^2)]$$



where: W = width (ft)
L = length (ft)
▼ = water table

The following equation is an approximation of Rf (retardation factor) for Hanford Site soils.

$$Rf \sim (1 + 5Kd) = \left(\frac{Vw}{Vc}\right)$$

Technical Issues

- Determine the fate of known or suspected contaminants released to the 216-T-1 Ditch
- Establish the association between contaminants in the subsurface and 216-T-1 Ditch and differentiate from adjacent sources
- Lack of site specific data
  - Soil properties - no data
  - Essentially no chemistry/rad data for soils and groundwater beneath ditch

Data Needs Summary

- Hydrogeologic Needs
  - Investigate contamination - soil, perched water, groundwater
  - Better delineate geologic and hydrogeologic units
  - Determine soil properties - no site specific data
  - Determine/estimate aquifer properties

Data Collection Plan

- Propose one new boring to water table
  - Immediately east of ditch (downgradient)
- Purpose of new boring
  - Test for extent of contamination
  - Test for zones of perched water

Schedule

- Assessment Plan Presentation - 1/94
- Field Activities/Data Collection/Analysis - 3/94 - 8/94
- GIA Report - 2/95

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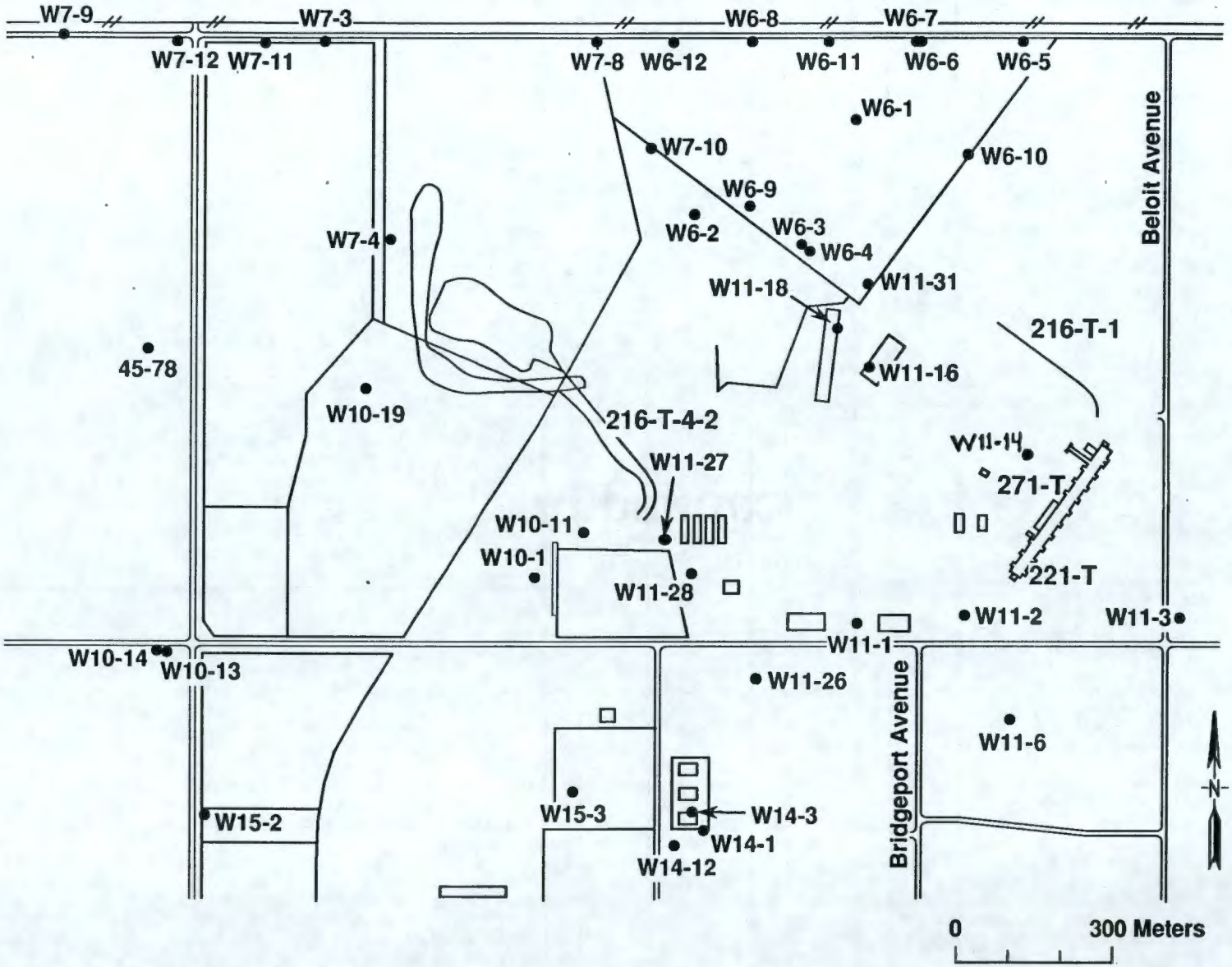
Appendix

Boreholes Used in Construction of Subsurface Maps



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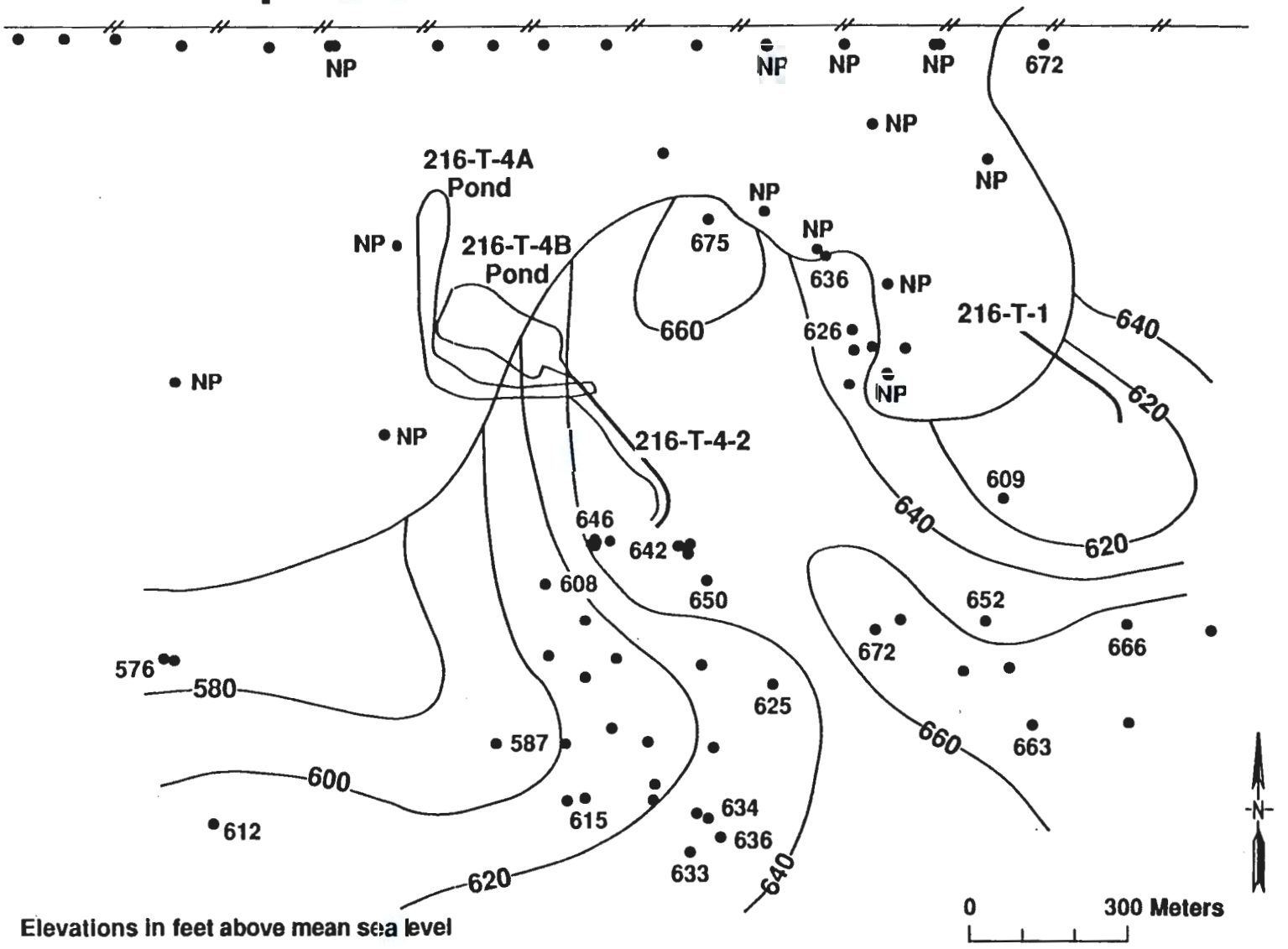
Top of Hanford Formation, Fine Unit



Elevations in feet above mean sea level

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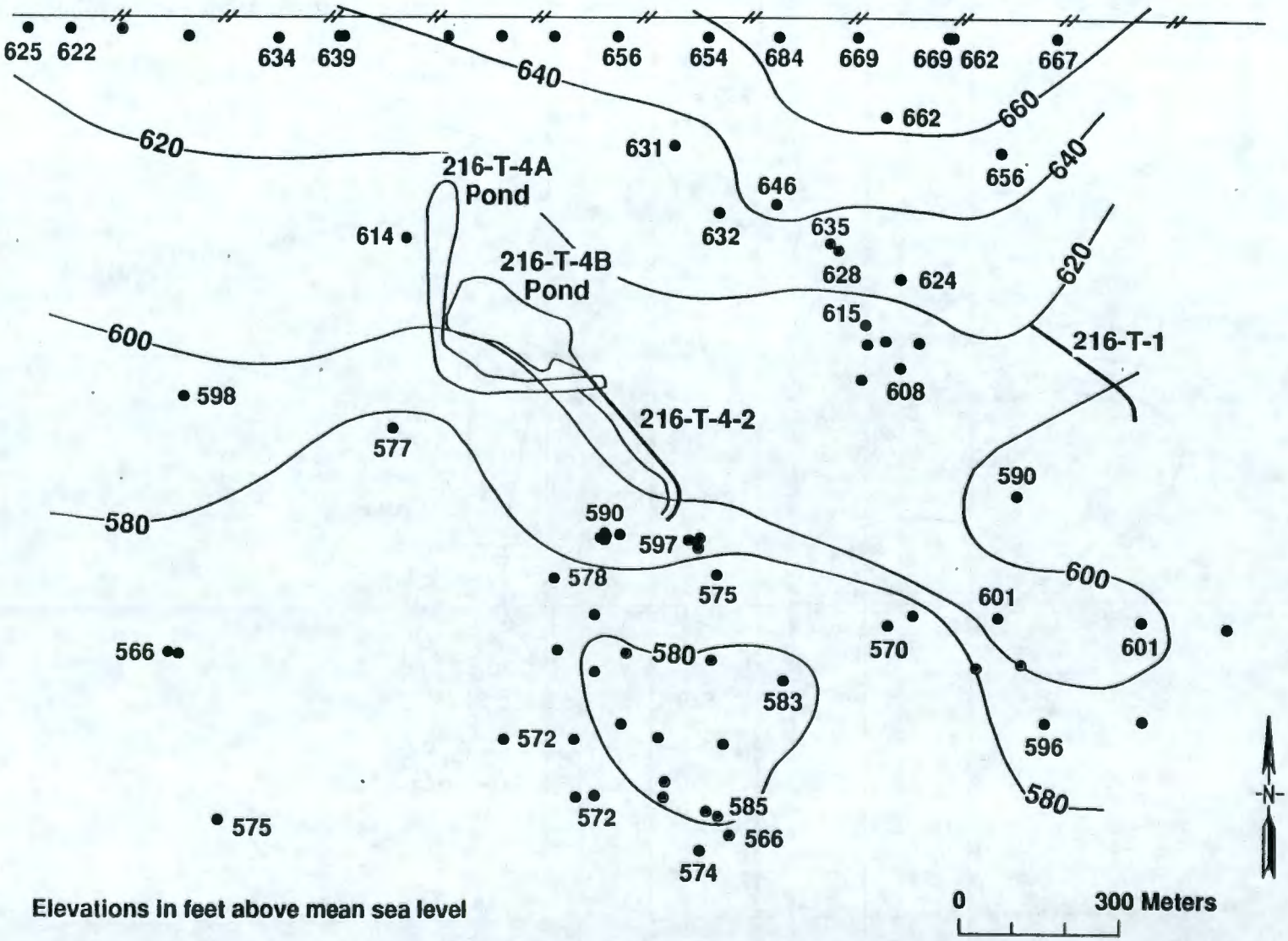
Top of Early Palouse/Plio-Pleistocene Interval



Elevations in feet above mean sea level

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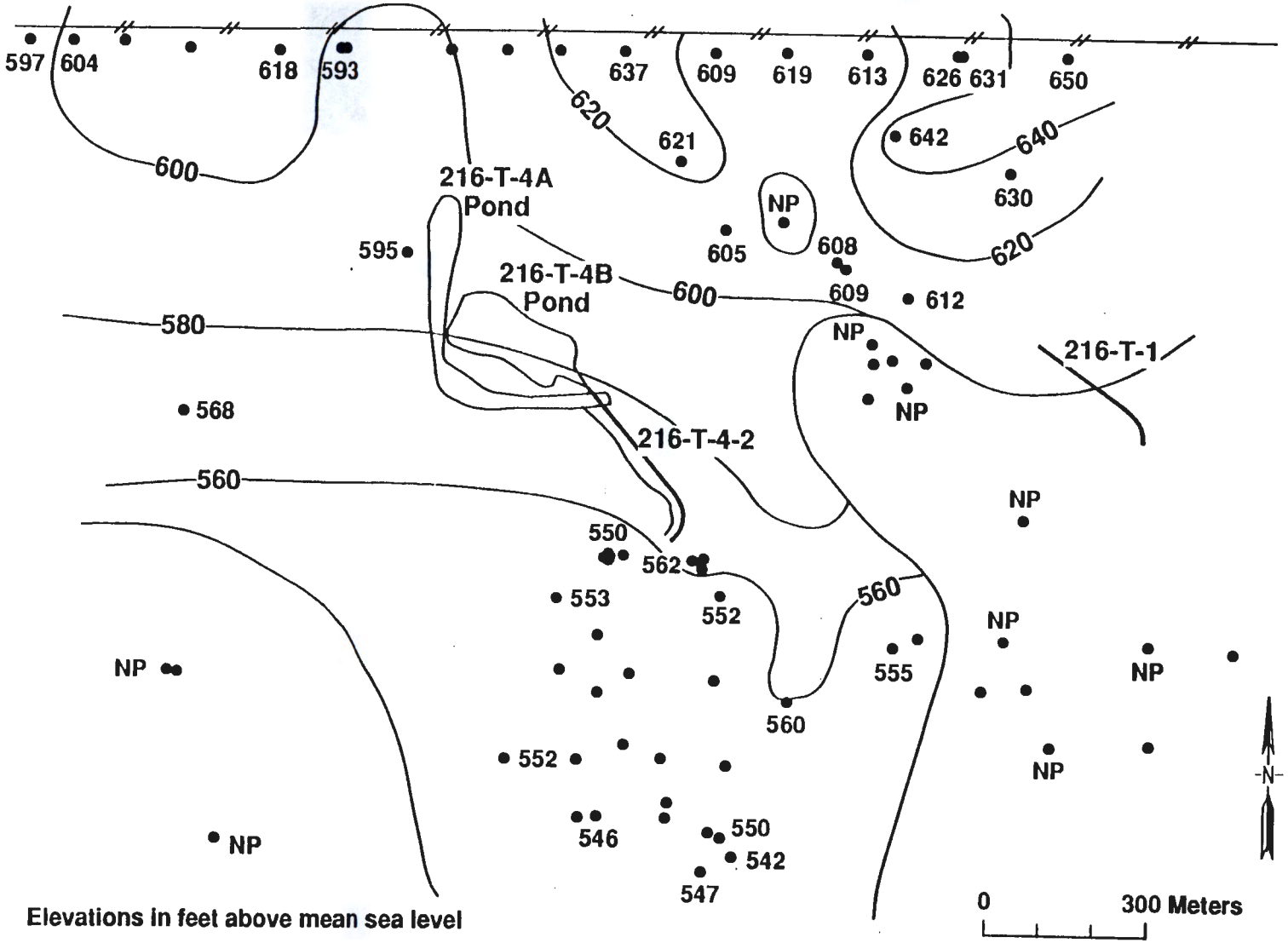
Top of Ringold Formation, Upper Unit



Elevations in feet above mean sea level

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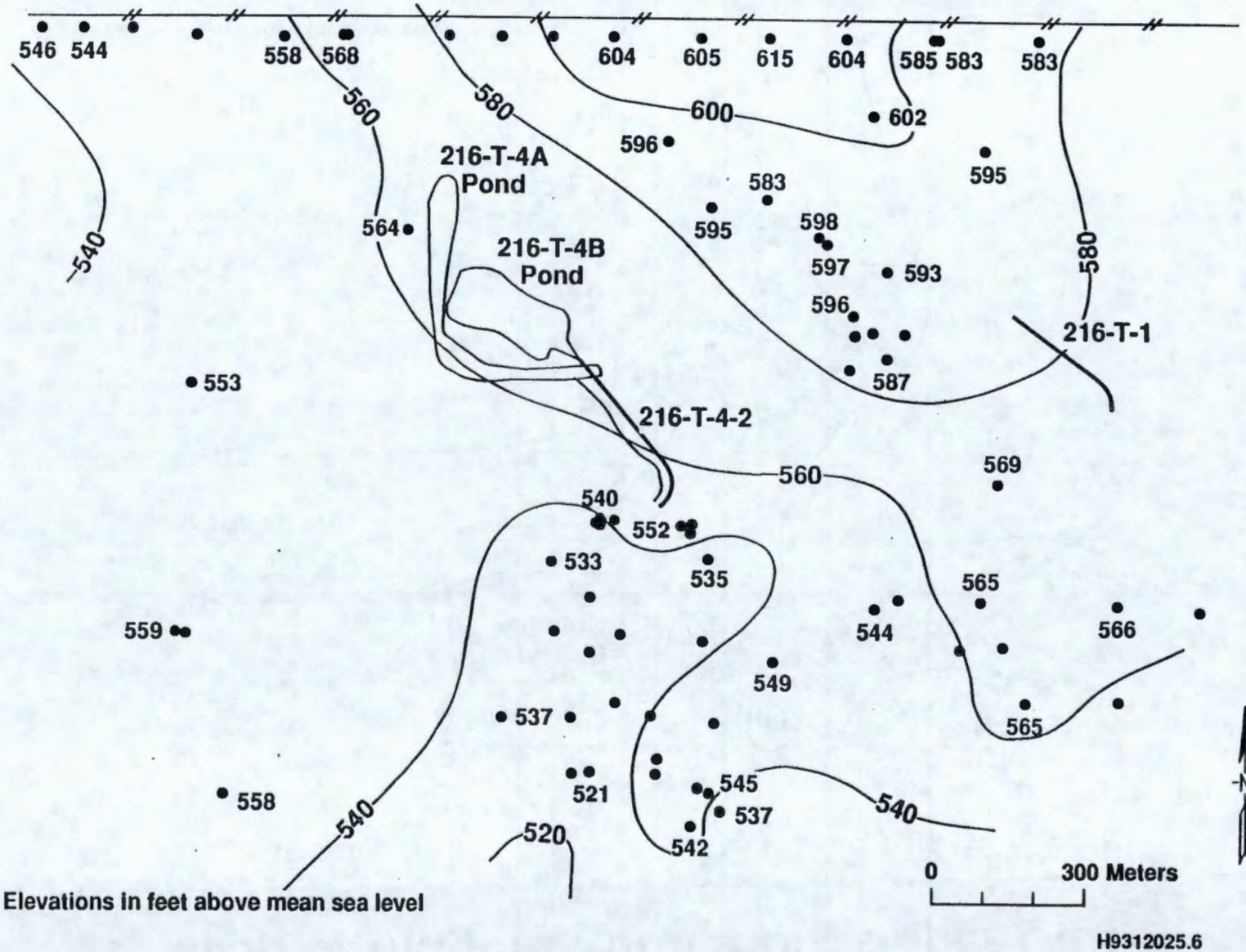
Top of Ringold Formation, Unit E



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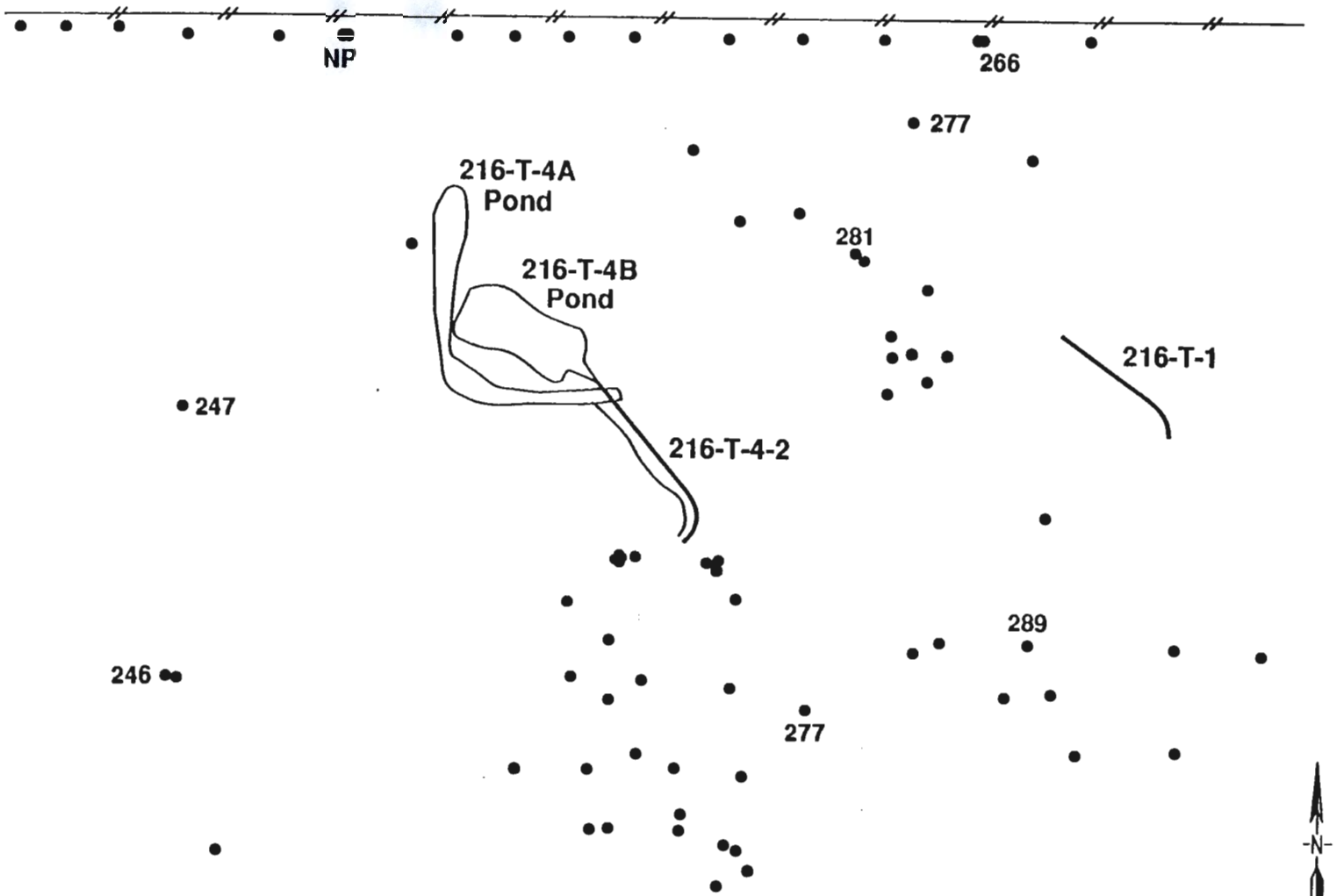
Top of Ringold Formation Lower Mud Unit



Elevations in feet above mean sea level

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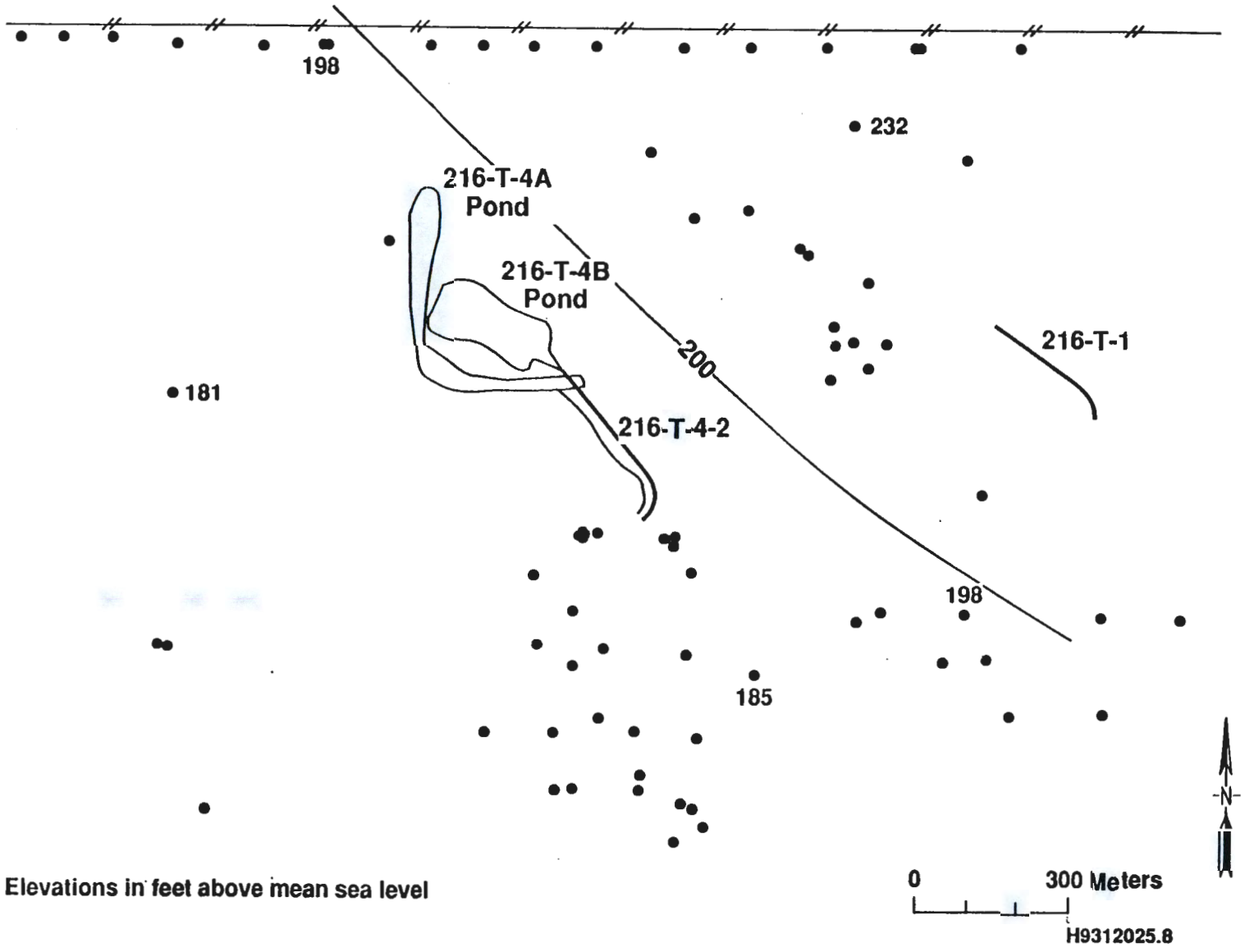
Top of Basalt



Elevations in feet above mean sea level

9413207.0291

Groundwater Impact Assessment Plan for the 216-T-4-2 Ditch

D.J. Alexander, S.D. Evelo, and S. P. Reidel

Geohydrologic Engineering Function
Westinghouse Hanford Company

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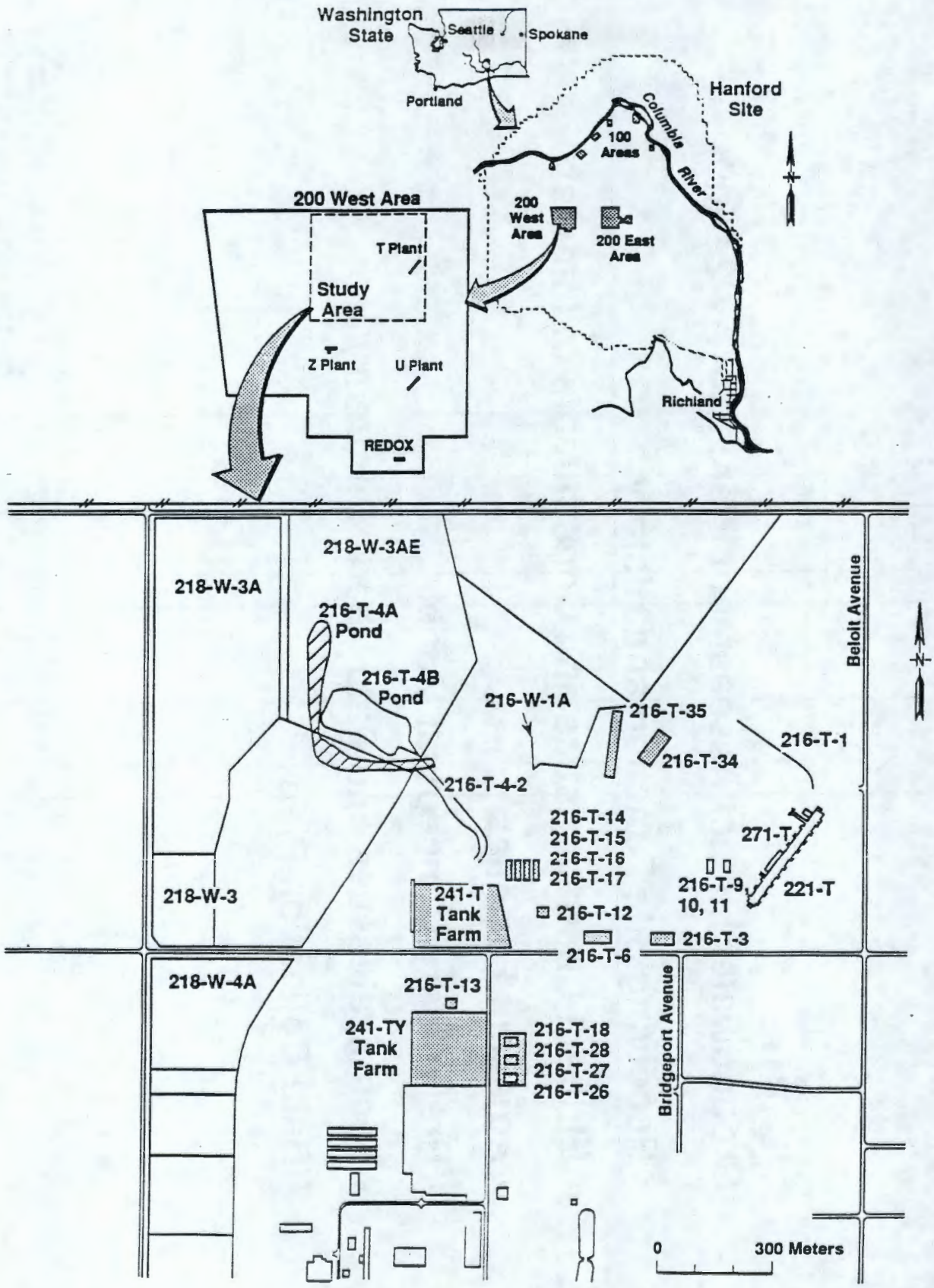
Outline

Groundwater Impact Assessment Plan: 216-T-4-2 Ditch

- Receiving Site Function and History
- Effluent Characteristics and Constituents of Interest
- Adjacent Facilities
- Preliminary Conceptual Model
- Technical Issues and Data Needs Summary
- Data Collection Plan



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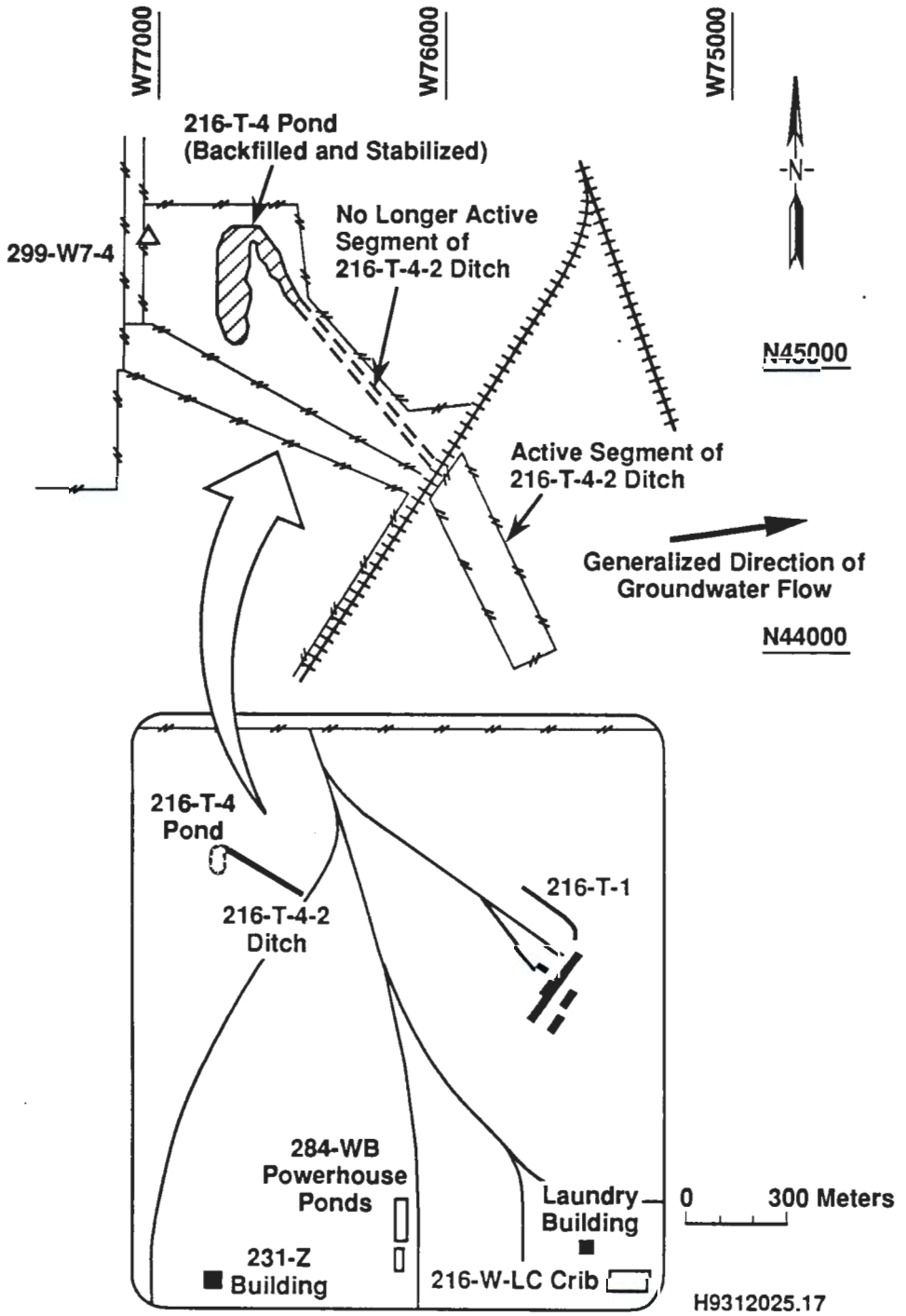
Site Map for 216-T-4-2 Ditch



Receiving Site Function and History

- Located in the north central portion of the 200 West Area
  - 1,750 feet long
  - 6 feet wide at bottom
  - 4 feet deep
- Covers 14,000 square feet
- Receives effluent from the 216-T-4 waste stream
- This is the second ditch to receive effluent from 216-T-4 waste stream

Receiving Site Function and History (cont.)

- Original ditch was labeled 216-T-4-ID Ditch
- Located north and parallel to the original 216-T-4-ID Ditch
- First 50 feet of the old 216-T-4-ID Ditch is in common with the 216-T-4-2 Ditch
- 216-T-4-2 Ditch was dug in 1972 when 216-T-4-ID Ditch had become contaminated to a maximum level of 20,000 cpm

Effluent Characteristics and Constituents of Interest

- 216-T-4-2 Waste Stream (present)
  - Consists of greater than 99% steam condensate, compressor cooling water and chiller cooling water
  - Administrative barrier and engineering barrier provide adequate safeguards to insure no hazardous waste enters 216-T-4-2 waste stream

Effluent Characteristics and Constituents of Interest (cont.)

- 216-T-4-2 waste stream receives liquid effluents from 211-T, 211-T Area, 224-T, 221-T, 271-T and 2715-T
- Average discharge is 8,600 gal/day or 6 gpm

Building	Date Built	Past and Current Use
211-T (Area)	1967	Bulk liquid chemical receiving and storage, hazardous and mixed waste storage
221-T	1943-44	Radioactive decontamination, repair, and decommissioning of process equipment (nothing from canyon, only from pipe and operations gallery)
224-T	1944	Storage and non-destructive assay of drums containing transuranic waste
221-TA	1943-44	Houses supply ventilation fans for 221-T Building canyon
271-T	1943-44	Offices and aqueous makeup units
2715-T	~1960	Previously paint shop, now equipment storage

Effluent Characteristics and Constituents of Interest (cont.)

Contributors to 216-T-4 Waste Stream

- Three groups of contributors
  - Discharged directly to 216-T-4-2 Ditch
  - Monitored by chemical neutralization system prior to discharge (not currently in use)
  - Routed to 207-T Retention Basin (can be discharged to 216-T-4-2 Ditch as necessary)

Effluent Characteristics and Constituents of Interest (cont.)

Group 1 - Direct Discharge to 216-T-4-2 Ditch

- 221-T Building spent fuel storage secondary cooling system water
- 221-T Building steam condensate
- 271-T Building steam condensate
- 271-T Building compressor cooling water
- Liquid to the floor drain in 2715 -T Building (old paint shop, drain is shut off now)

Effluent Characteristics and Constituents of Interest (cont.)

Group 2 - Contribution Monitored by Chemical Neutralization System Prior to Discharge (not currently in use)

- Liquid effluent from 211-T chemical storage area
- Storm water runoff from concrete pit loading area
- Liquid collected in 221-T Building electrical gallery
- 271-T Building swamp cooler effluent
- Liquid from floor drains in 271-T Building
- Liquid from floor drains on first and third floors of 271-T Building
- Liquid from floor drain in 221-T Building operating and pipe gallery
- Liquid from a sink to floor sump in 221-T Building

Effluent Characteristics and Constituents of Interest (cont.)

Group 3 - Contribution Routed to 207-T Retention Basin

- From 1944 to 1976 basin received process or evaporator cooling water from 221-T, 224-T and 242-T Buildings
- Since 1976 basin receives steam condensate from 221-TA Building and steam condensate cooling water from 224-T Building

Summary of Wastewater Stream Contributors to the 216-T-4-2 Ditch

Source	Rate of Discharge/Composition	Potential Contaminants	Stream Handling
221-T Building Spent Fuel Storage Secondary Cooling Water System	• 8,600 gal/day • Raw water supplied to secondary cooling system	Potentially contaminated with radioactive materials	Discharged directly to 216-T-4-2 Ditch through header in Section 3 of 221-T Building. Scheduled to be eliminated.
221-T Building Steam Condensate	• 0 to 100 gal/day • Steam condensate	None	Discharged directly to 216-T-4-2 Ditch through header in Section 15 of 221-T Building.
271-T Building Steam Condensate	• 0 to 500 gal/day • Steam condensate	None	Discharged directly to 216-T-4-2 Ditch.
271-T Building Compressor Cooling Water	• 8,600 gal/day • Sanitary water used as compressor cooling water	None	Discharged directly to 216-T-4-2 Ditch through header at southwest corner 271-T Building. Scheduled to be eliminated.
Liquid to the Floor Drain in the 2715-T Building	• 0 gal/day expected	None	Floor drain has been capped thus eliminating any possibility of effluent discharges to 216-T-4-2 Ditch.
211-T Chemical Storage Area Liquid Effluents	• 0 to 2 gal/day • Variable flow • Collected storm water	None. If a spill of hazardous nonradioactive chemicals were to occur, liquid would be cleaned up as a hazardous spill.	Liquid manually transferred to the 271-T Building basin sump, the chemical neutralization system, and then to the 216-T-4-2 Ditch through the header in Section 13 of the 221-T Building.
Storm Water from the Concrete Loading Area Next to the Door 13 Entrance to 271-T Building	• Variable flow • Storm water	None	Effluents flow to the 216-T-4-2 Ditch via 271-T Building basin sump and chemical neutralization system.

Summary of Wastewater Stream Contributors to the 216-T-4-2 Ditch (cont.)

Source	Rate of Discharge/Composition	Potential Contaminants	Stream Handling
Liquid Collected in the 221-T Building Electrical Gallery Sumps	• 0 to 20 gal/day • Housekeeping and maintenance liquids	Potentially contaminated with radioactive materials	When full, sumps located in each of the 18 sections of the 221-T Building electrical gallery are sampled for radioactive material and manually pumped to the 271-T Building basin sump if no radioactive material is present.
271-T Building Swamp Coolers Effluent	• 0 to 100 gal/day • Sanitary water	None	Effluents flow to the 216-T-4-2 Ditch via 271-T Building basin sump and chemical neutralization system.
Liquid from Floor Drains in the 271-T Building	• 0 to 10 gal/day • Housekeeping and maintenance liquids	Potentially contaminated with radioactive materials	Routed directly to chemical neutralization system catch tank.
Liquid from Floor Drains Located Beneath the AMU System Product Storage Tanks in the 271-T Building	• 0 gal/day expected	Caustic, permanganate, potentially contaminated with radioactive materials. Third floor AMU storage tanks are empty and scheduled to be removed	Currently routed directly to chemical neutralization system catch tank. Drains scheduled to be capped; contributor to be eliminated.
Liquid from Floor Drains in the 221-T Building Operating and Pipe Galleries	• 0 to1 gal/day • Housekeeping and maintenance liquids, primarily sanitary water from testing showers	Potentially contaminated with radioactive materials.	Routed directly to chemical neutralization system catch tank.
221-T Building Electrical Gallery Sink and Floor Sump	• Variable flow • Housekeeping and maintenance liquids	Potentially contaminated with radioactive materials.	Sump pump transfers sump contents to the chemical neutralization system catch tank.
221-TA Building Steam Condensate	• 0 to 20 gal/day • Steam condensate	None	Effluent is routed to the 207-T Retention Basin.
224-T Building Steam Condensate and Cooling Water	• 0 to 50 gal/day • Steam condensate and cooling water	None	Effluent is routed to the 207-T Retention Basin.

Effluent Characteristics and Constituents of Interest (cont.)

- 216-T-4 waste stream is scheduled to be eliminated by June 1995

Effluent Volume and Flow Regime

Potential for Past Migration of Liquid Discharges to the Unconfined Aquifer

Waste Management Unit	Range of Soil Column Pore Volumes (m^3)	Liquid Effluent Volume Received in (m^3)	Potential Migration to Unconfined Aquifer
216-T-4A Pond	4,556 to 13,668	42,500,000	Yes

Reference: DOE/RL-91-61 Rev. 0, "T Plant Source Aggregate Area Management Study Report"

Chemicals Potentially Introduced into the Effluent - Based on Process Knowledge and Facility Inventory

Chemical Usage in Hanford Bismuth Phosphate Process

Hanford Technical Exchange Program Process Chemistry at Hanford, September 15,1993

Chemical	Usage, mass/mass U
HNO_3	3.00
H_2SO_4	0.397
$NaNO_2$	0.091
$BiONO_3$	0.063
H_3PO_4	0.985
$NaBiO_3$	0.016
$Na_2Cr_2O_7$	0.0073
$(NH_4)_2Ce(NO_3)_6$	0.0015

Chemicals Potentially Introduced into the Effluent - Based on Process Knowledge and Facility Inventory (cont.)

Chemical Usage in Hanford Bismuth Phosphate Process

Hanford Technical Exchange Program Process Chemistry at Hanford, September 15,1993

Chemical	Usage, mass/mass U
H_2O_2	0.014
$(NH_4)_2SiF_6$	0.116
$FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$	0.210
$La(NO_3)_3 \cdot 2NH_4NO_3 \cdot 2H_2O$	0.0112
$H_2C_2O_4 \cdot 2H_2O$	0.0041
HF	0.0052
KOH	0.122
$KMnO_4$	0.0087
$(NH_4)_2SO_4$	0.0005
$(NH_4)_2SO_3$	0.0001
$ZrO(NO_3)_2$	0.0015

Chemicals Potentially Introduced into the Effluent - Based on Process Knowledge and Facility Inventory (cont.)

Chemical Usage in Hanford Bismuth Phosphate Process

Hanford Technical Exchange Program Process Chemistry at Hanford, September 15,1993

Chemical	Usage, mass/mass U
For Waste Neutralization	
NaOH	2.95
Na_2CO_3	1.94

Chemicals Potentially Introduced into the Effluent - Based on Facility Inventory

- Only 1% of the wastestream will contain any of the chemicals stored in T Plant

Acetone
Acetic acid
Ammonium citrate
Ammonium hydroxide
Mercury
Methanol
Nitric acid
Phosphoric acid
Potassium permanganate
Sodium
Sodium hydroxide
Sodium nitrite
Zinc

Reference: Facility Effluent Monitoring Plan for the T Plant (FEMP) WHC-EP-0481

These are being phased out of use and the FEMP will be revised accordingly.

Effluent Characteristics (cont.)

- Present chemical constituents detected in T Plant Wastewater

Aluminum*	Iron*	Strontium
Barium	Magnesium	Sulfate
Boron	Manganese	Uranium
Calcium	Nitrate	Zinc
Chloride	Potassium	Ammonia
Copper	Silicon	1-Butanol
Fluoride	Sodium	

* Indicates constituent that exceeds WAC 173-200-040, Washington Groundwater Quality Standards List (WWQS)

Reference: WHC-EP-0342 Addendum 10, "T Plant Wastewater"

Effluent Characteristics (cont.)

- Present radiological constituents detected in T Plant wastewater

  Gross Alpha
  Gross Beta*
  Cesium-137
  Radium

  * Indicates constituent that exceeds the 1/25 Derived Concentration Guideline (1/25 DCG)

Reference: WHC-EP-0342 Addendum 10, "T Plant Wastewater"

Radiological Inventory

- Radiological Results for Liquid Samples from Surface Water (standing water in ditch) for the 216-T-4-2 Ditch (pCi/L)

Constituent	Mean	Max	Min
Total Beta	3.4E+1	8.9E+1	3.1E+1
Total Alpha	5.8E-1	2.6E+0	3.1E-2
Cesium-137	4.6E+1	7.5E+1	3.5E+1
Strontium-90	1.1E+1	2.8E+1	4.7E+0
Tritium	<DL	<DL	<DL

Reference: WHC-EP-0573-1, "Westinghouse Hanford Company Operational Environmental Monitoring Annual Report, CY 1992"

Radiological Inventory (cont.)

- Radiological Results for Aquatic Vegetation from Surface Water for the 216-T-4-2 Ditch (pCi/g)

Constituent	Result
Cesium-137	<4.9
Strontium-90	1.2
Plutonium-239/240	13.0
U total (g/g)	5.2E-8

- Radiological Results for Sediment Samples from Surface Water Disposal Unit for the 216-T-4-2 Ditch (pCi/g)

Constituent	Result
Cesium-137	34.0
Strontium-90	0.55
Plutonium-239/240	1.2
U total (g/g)	2.9E-7

Radiological Inventory (cont.)

- Radionuclide Waste Inventory Summary for the 216-T-4-2 Ditch Summarized in 216-T-4B Pond

Constituent	Result
Total Plutonium (grams)	3.71
Uranium-238 (Ci)	0.232
Cesium-137 (Ci)	6.23
Ruthenium-106 (Ci)	8.67E-7
Strontium-90 (Ci)	3.37

Reference: DOE/RL-91-61 Rev 0, "T Plant Source Aggregate Area Management Study Report"

Constituents of Interest

Soil		Groundwater/perched
Sodium	Cesium-127	ICP Metals
Lithium	Strontium-90	Anions
Barium	Plutonium-239/240	VOA's
Calcium	Uranium	Gross Alpha
Lead	Cobalt-60	Gross Beta
Zinc	Mercury	TRU's
Chromium	Cadmium	Cobalt-60
Cesium	Phosphate	Uranium (chemical)
Strontium	Bismuth	Alkalinity
Cerium		TDS
Lanthanum		Mercury

Nearby Facilities

Facility	Years of Service	Description	Volume Received
241-T Tank Farms	1943 - present active	Received waste generated by uranium and plutonium processing activities	
216-T-7	1948 - 1955 inactive	Received second cycle supernatant and cell drainage for the 221-T Building and from 1952 - 1955 received waste from the 224-T Building	1.1E + 8L
216-T-32	1946 - 1952 inactive	Received TRU contaminated liquid waste from the 224-T Building via the 241-T-201 Single Shell Tank	2.9E + 7L
216-T-5	1955 inactive	Received second cycle supernatant water for the 221-T via the 241-T-112 Single Shell Tank	2.6E + 6L
216-T-4A Pond	1944 - 1972 inactive	Received a number of leaks from the 221-T Building and liquid from 216-T-1D Ditch	4.25E + 10L
216-T-1D Ditch	1944 - 1972 inactive	Received process cooling water and steam condensate from 221-T Building and 242-T Evaporator	4.25E + 10L

Preliminary Conceptual Model

Hydrogeologic Framework

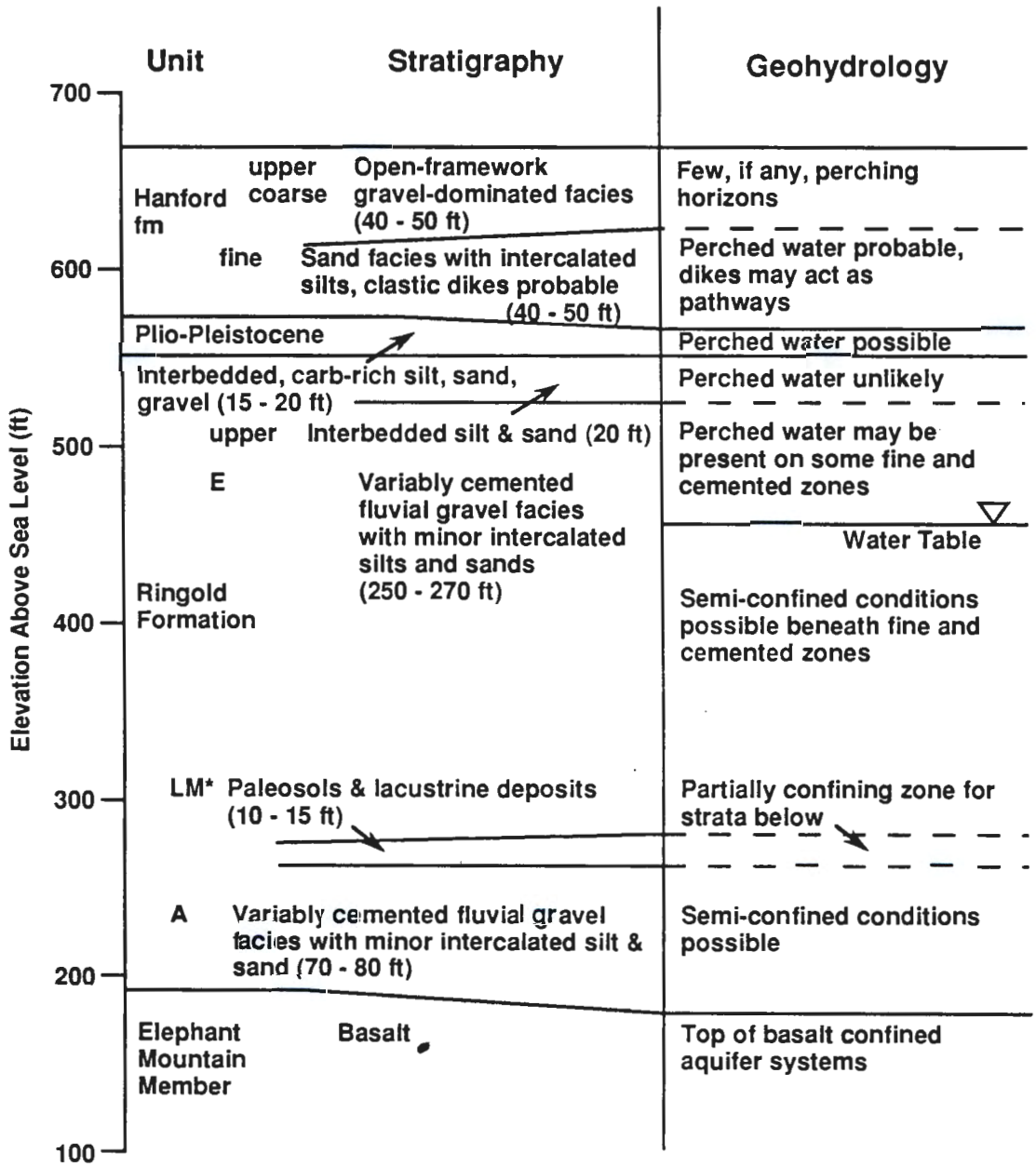
- Vadose zone
  - Approximately 200 feet thick
  - Hanford formation
    - coarse gravels, throughout area
    - fine sand and silt, locally present
  - Early Palouse Soil/Plio-Pleistocene unit carbonate rich silt and sand
  - Upper Ringold Sands
  - Ringold Gravels

Preliminary Conceptual Model (cont.)

Hydrogeologic Framework

- Vadose zone (cont.)
  - Fine sediments in ditch impede downward flow of water
  - Upper coarse sediment - Hanford formation - highly transmissive
  - Lower fine sediment - Hanford formation - anisotropic
  - Early Palouse Soil/Plio-Pleistocene unit
    - less permeable
    - anisotropic
  - Ringold Formation - Water table

Generalized Stratigraphy and Hydrology Beneath Southern End of 216-T-4-2 Ditch



* Unit LM may pinch out beneath vicinity of T-4-2 Ditch

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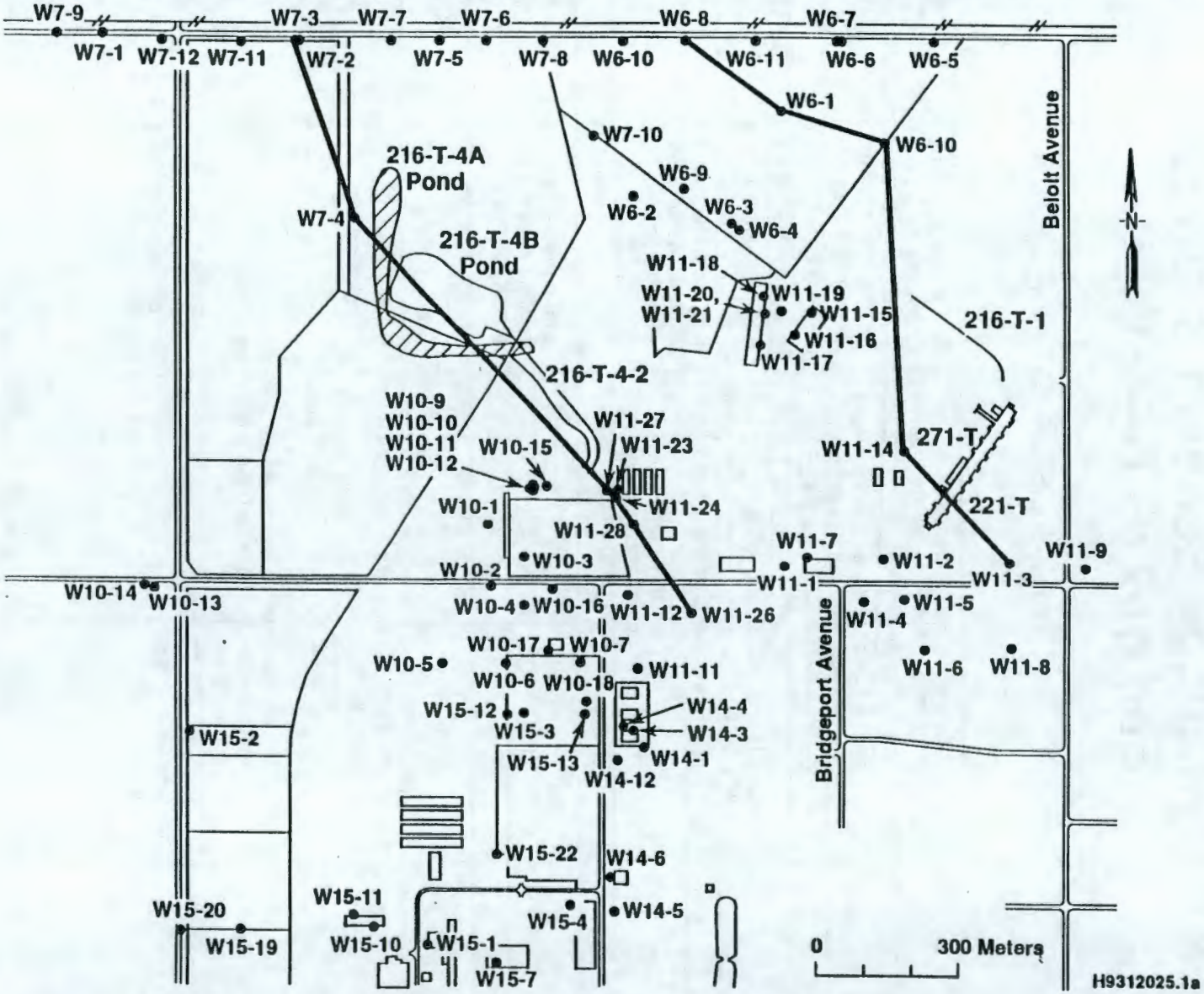
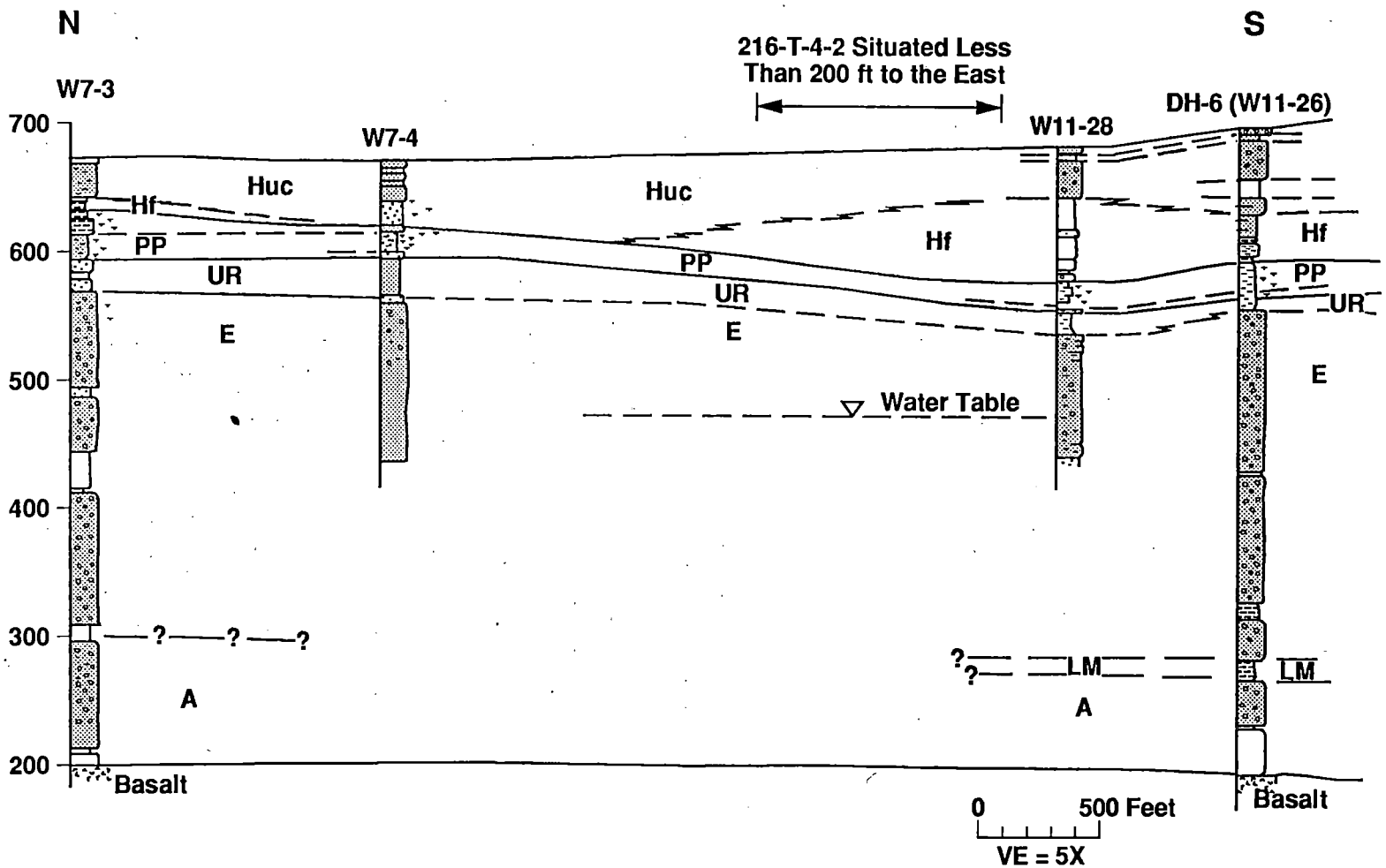
Location Map of Sites and Geologic Cross-sections



North to South Geologic Cross-section through Area of 216-T-4-2 Ditch



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Preliminary Conceptual Model (cont.)

Contaminant Pathways

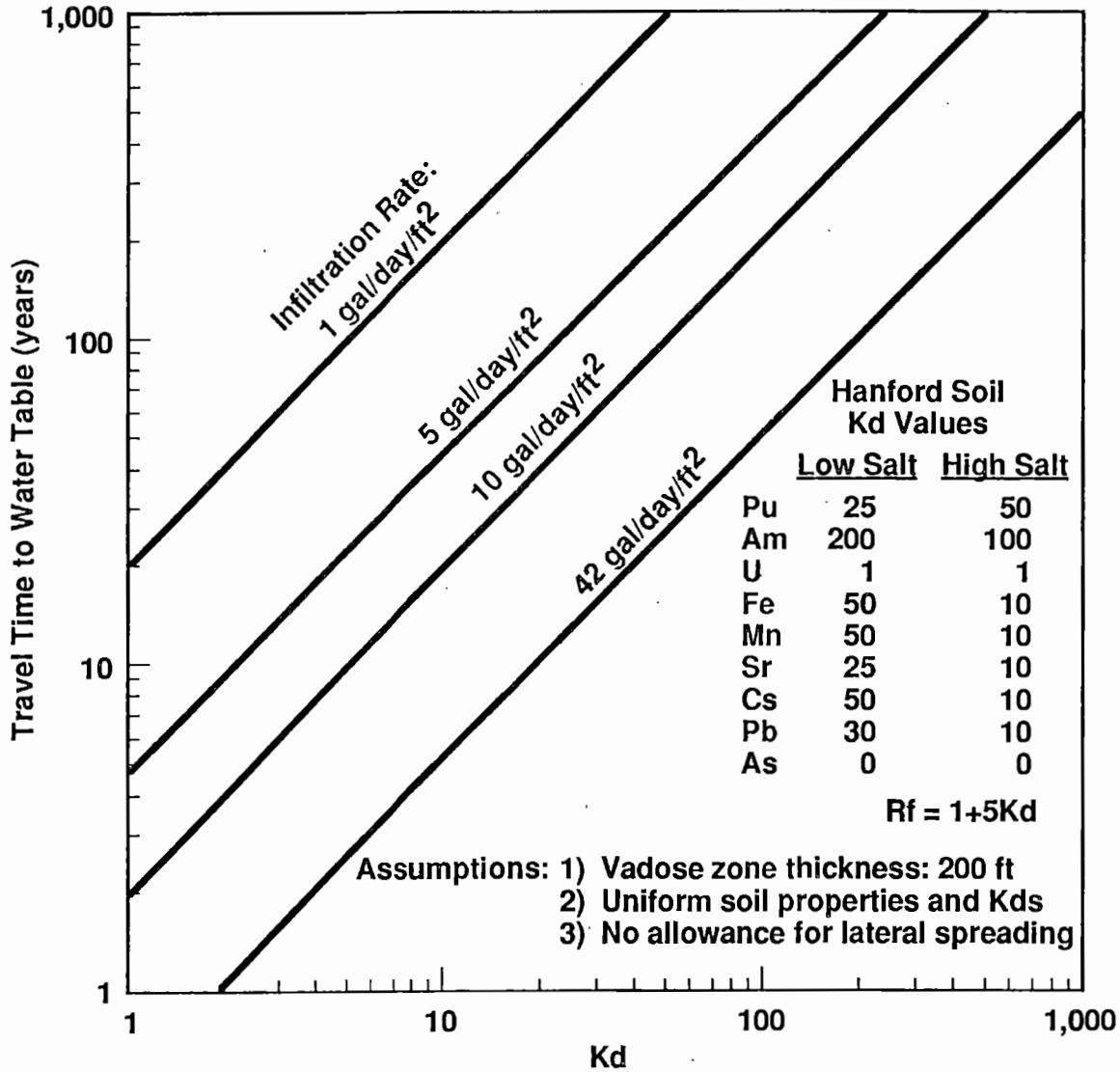
- Potential contaminants include mixed fission products and chemicals
- Possible continued vertical migration of contaminants beneath first 50 feet of ditch
- Infiltration rate may be 4 gal/day/ft^2 or higher near inlet
- Thick (50 ft) of open framework gravel and sands have limited contaminant retention

Preliminary Conceptual Model (cont.)

Contaminant Pathways

- Finer sediments underlying the sands and open framework gravels are the most likely zones of accumulation of contaminants
- Favorable sorption conditions in finer sediments
- Localized zone of perched water may exist in Plio-Pleistocene near inlet; may be displaced to the south (see top of formation maps, Appendix)
- Long term use and low retention capacity of upper soil column suggests possible contaminant accumulation in the Plio-Pleistocene
- Contribution to groundwater contamination unknown due to lack of monitoring wells

Estimated Contaminant Travel Time Through Vadose Zone versus Infiltration Rate and Kd, 200 West Area



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Explanation Page for Previous Table

$$\text{Travel Time} = \frac{Z\ (\text{ft})}{Vc\ (\text{ft/day})}$$

where:

Z = vadose zone thickness, ft
Vc = estimated contaminant velocity, which is

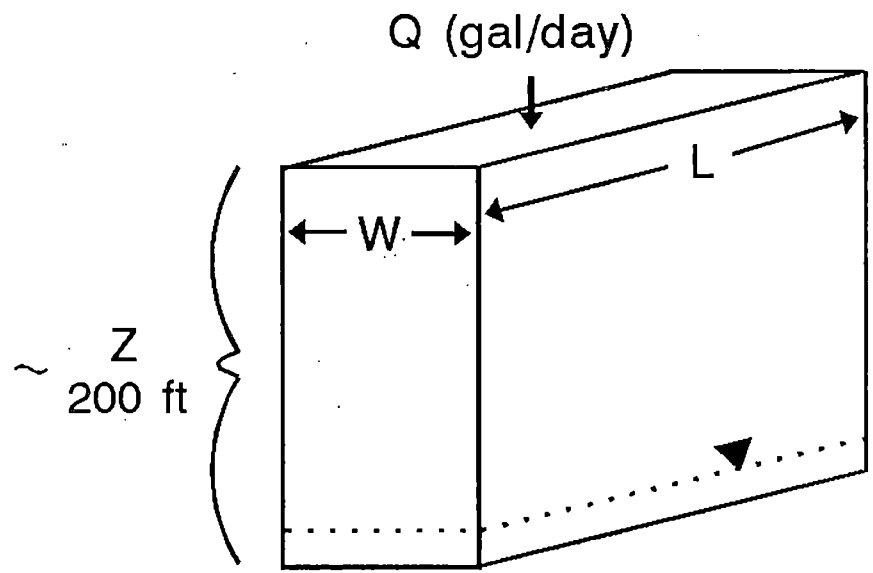
$$\simeq \left(\frac{Vw}{Rf}\right)$$

and water velocity is:

$$Vw = \frac{Q\ (\text{gal/day})}{L\ (\text{ft}) \times W\ (\text{ft})}$$

To convert Vw (gal/day/ft^2) to Vw (ft/day):

$$Vw\ (\text{ft/day}) = [0.13 \times (\text{gal/day/ft}^2)]$$



where: W = width (ft)
L = length (ft)
▼ = water table

The following equation is an approximation of Rf (retardation factor) for Hanford Site soils.

$$Rf \sim (1 + 5Kd) = \left(\frac{Vw}{Vc}\right)$$

Technical Issues

- Determine the fate of known contaminants released to the 216-T-4-2 Ditch
- Establish the association between contaminants in the subsurface and 216-T-4-2 Ditch
- Lack of Site Specific Data
  - Soil properties (e.g., particle size, permeability, moisture content, etc.)
  - Essentially no chemistry/rad data for soils and groundwater beneath ditch

Data Needs Summary

- Effluent Data Needs
- Hydrogeologic Needs
  - Investigate contamination - soil, perched water, groundwater
  - Better delineate geologic and hydrogeologic units
  - Determine soil properties - no site specific data
  - Determine/estimate aquifer properties

Data Collection Plan

- Phase I - Data Compilation - existing data
- Phase II - Field Investigation
  - Vadose
    - Test pit excavations
    - Borehole tests
- Phase III - Data interpretation and report preparation

Data Collection Plan (cont.)

Vadose Investigation

- Three test pit excavations - backhoe
- Purpose: vertical and lateral extent of contamination beneath the ditch
  - Sample schedule
  - Rad isotopes 2', 4', 6', 10'
    - Gamma energy scan
    - Total alpha and beta
  - Chemical constituents of interest 2', 6', 10'

Data Collection Plan (cont.)

- Propose one new boring to water table
  - Immediately east of ditch (downgradient)
- Purpose of new boring
  - Test for extent of contamination
  - Test for zones of perched water

Tentative Schedule of Field Activities

- Existing Data Search - ongoing
- Borehole Drilling/Construction - March/May
- Test Pit Excavations - March/April

Schedule

- Milestones

  17-13 Groundwater Impact Assessment Plan - Jan. 1994

  17-13A Groundwater Impact Assessment Report - Feb 1995

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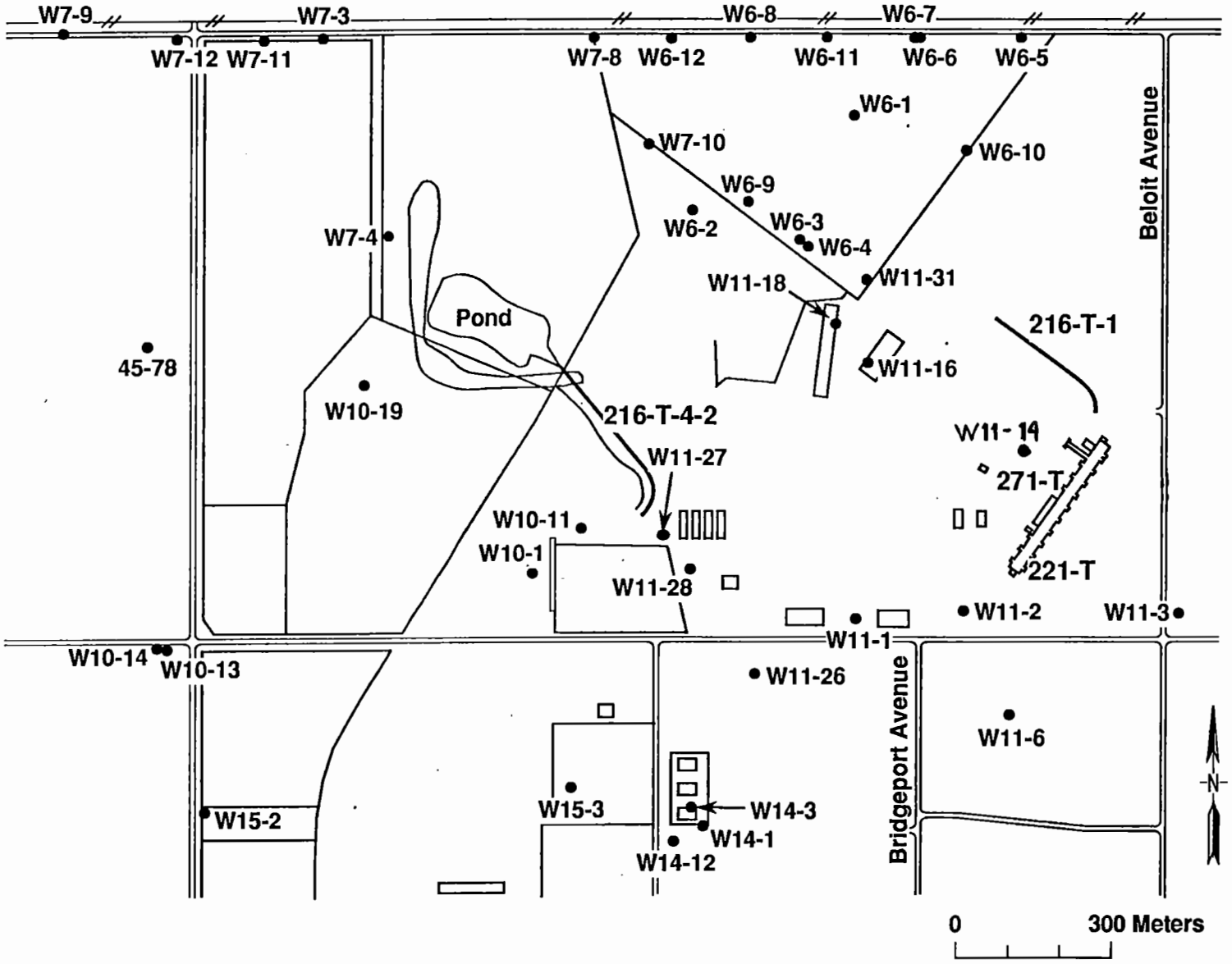
Appendix

Boreholes Used in Construction of Subsurface Maps



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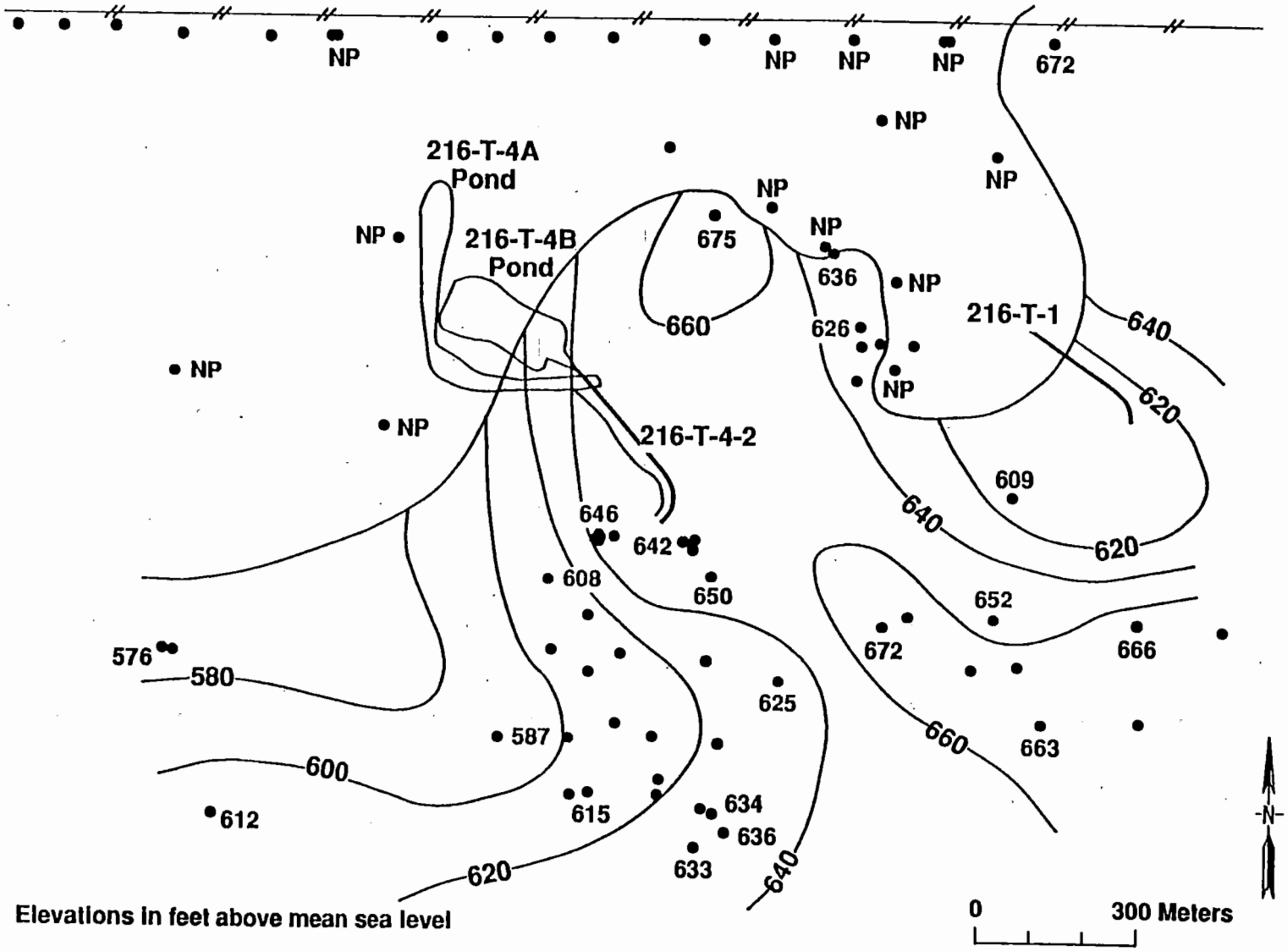
Top of Hanford Formation, Fine Unit



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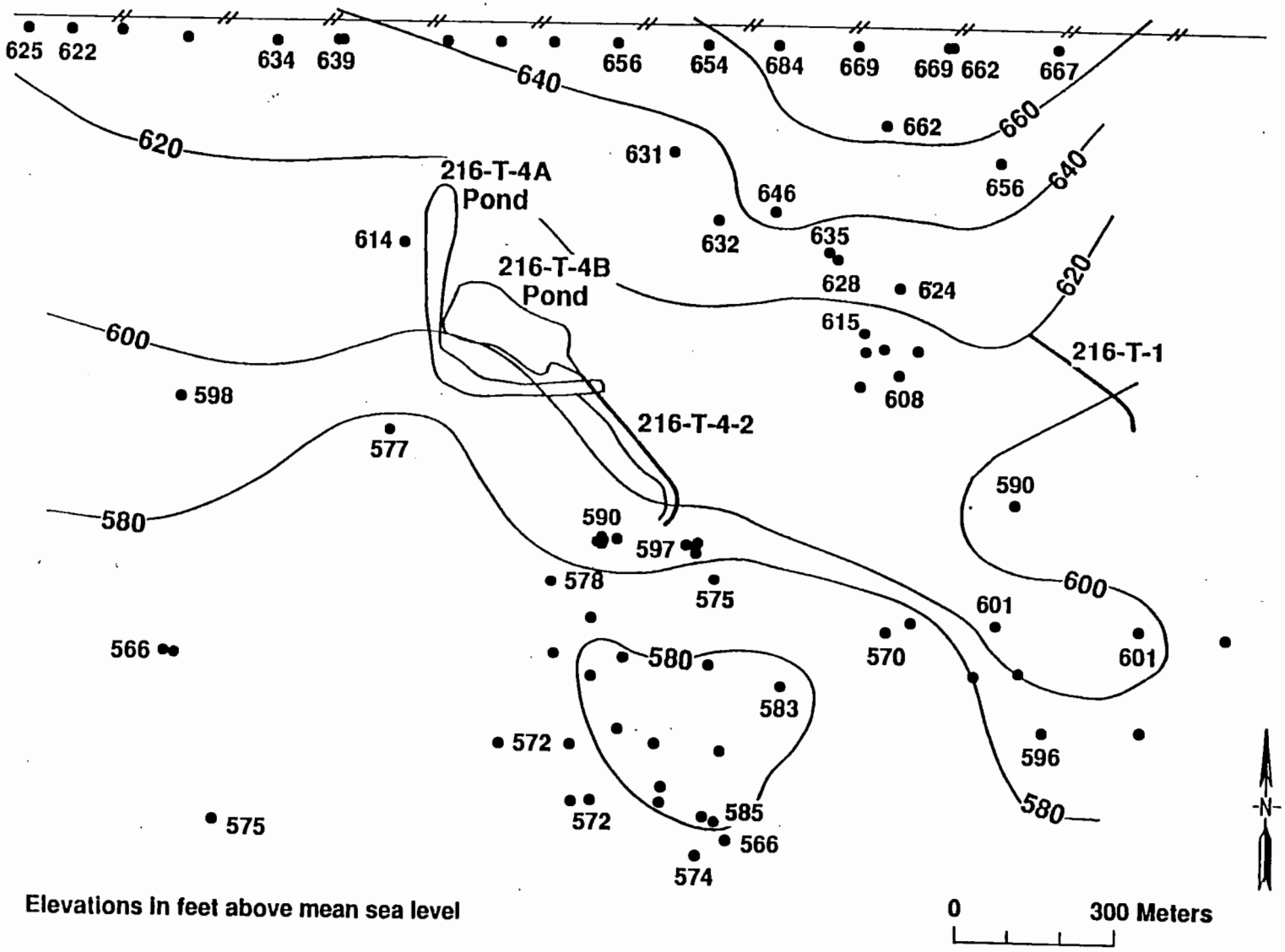
Top of Early Palouse/Plio-Pleistocene Interval



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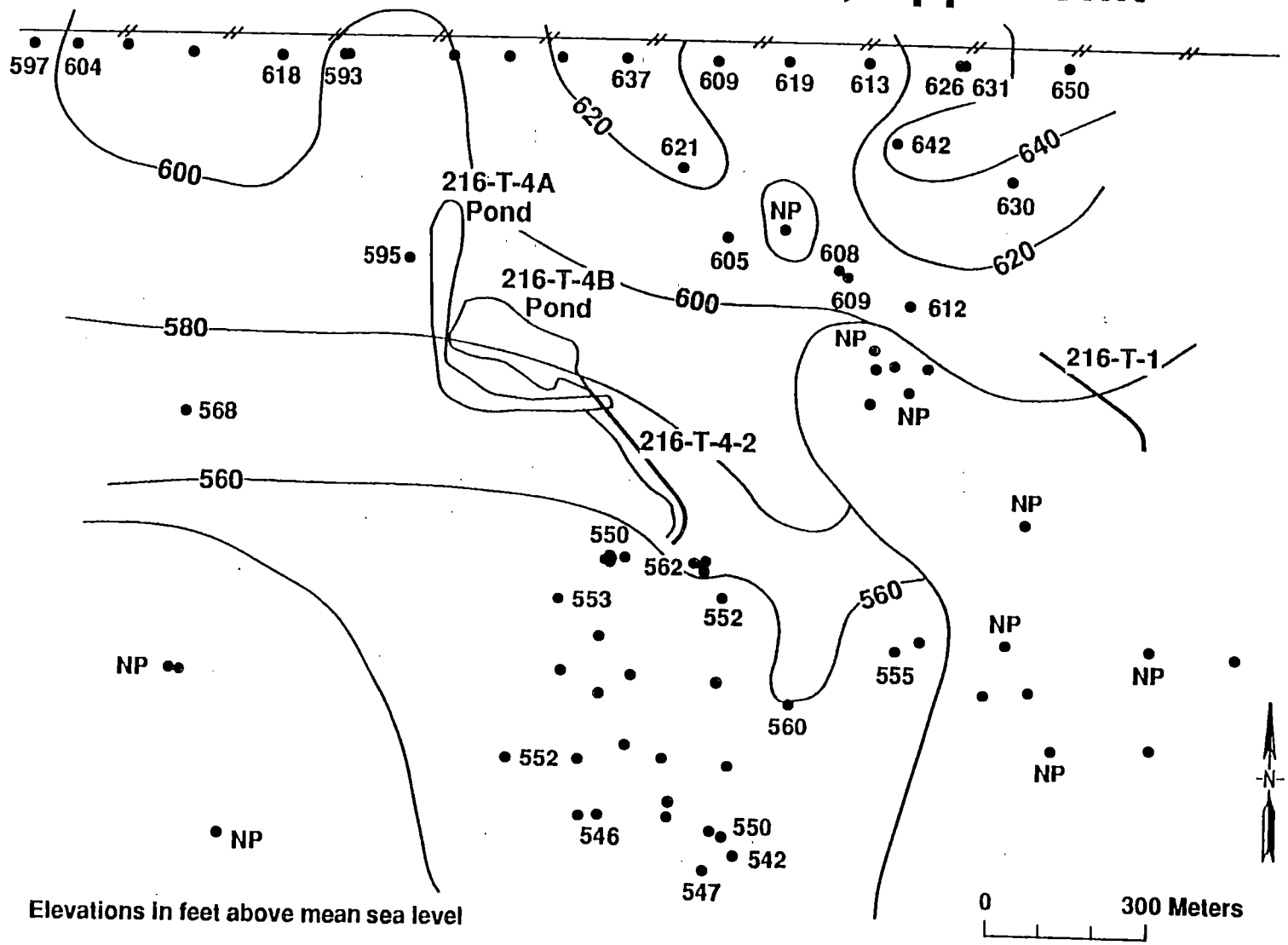
Top of Ringold Formation, Upper Unit



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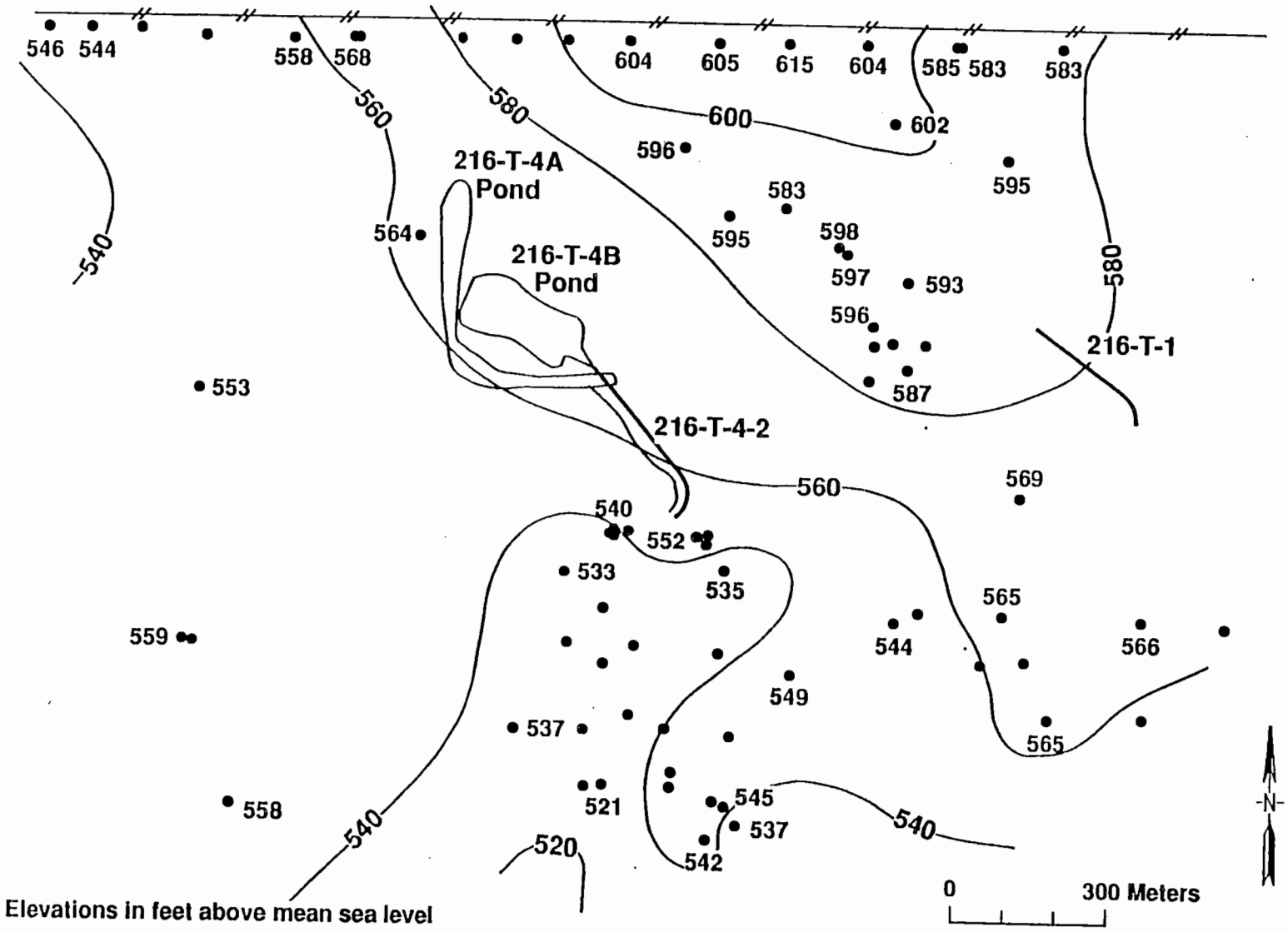
Top of Ringold Formation, Unit E



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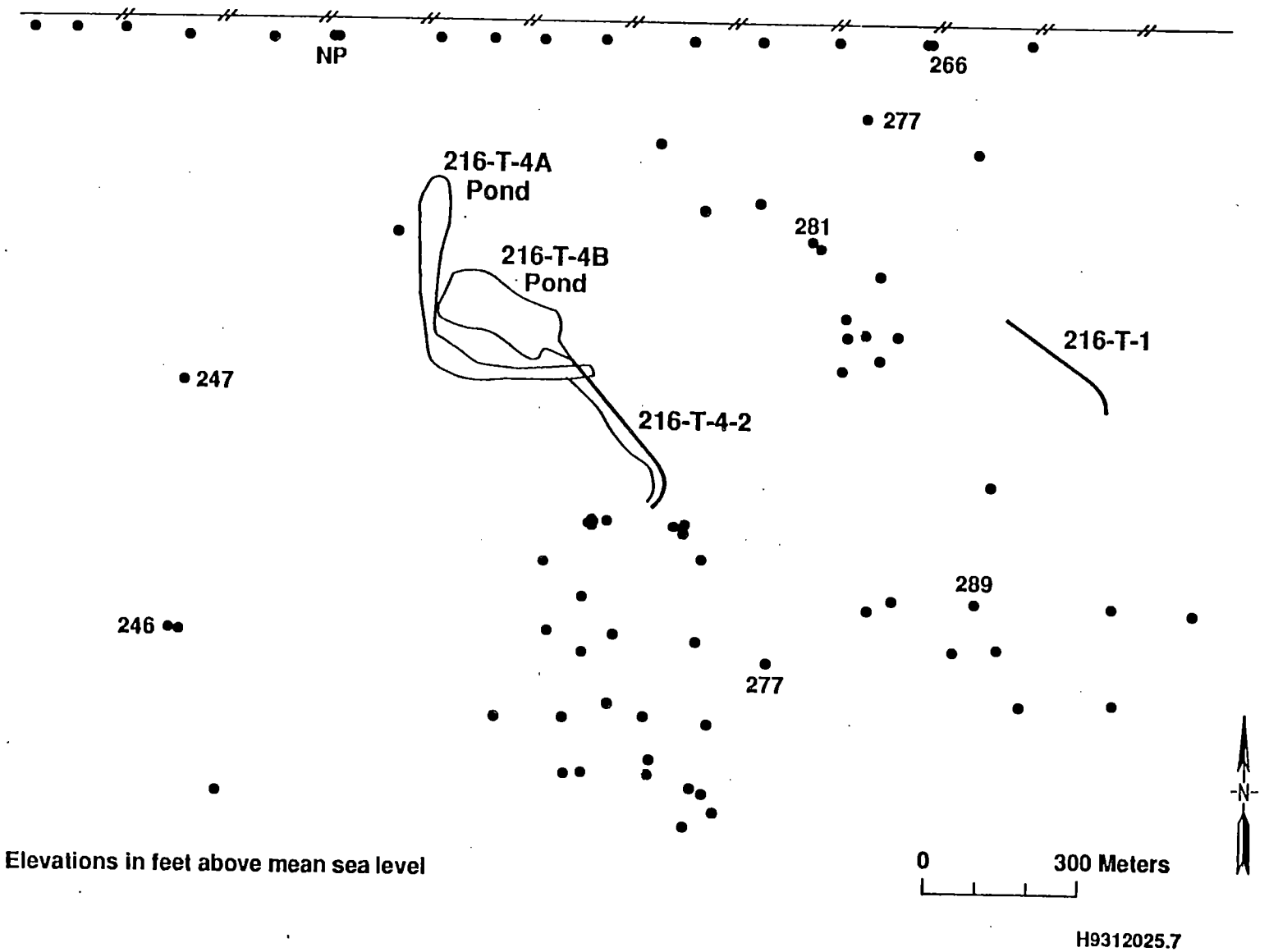
Top of Ringold Formation Lower Mud Unit



Elevations in feet above mean sea level

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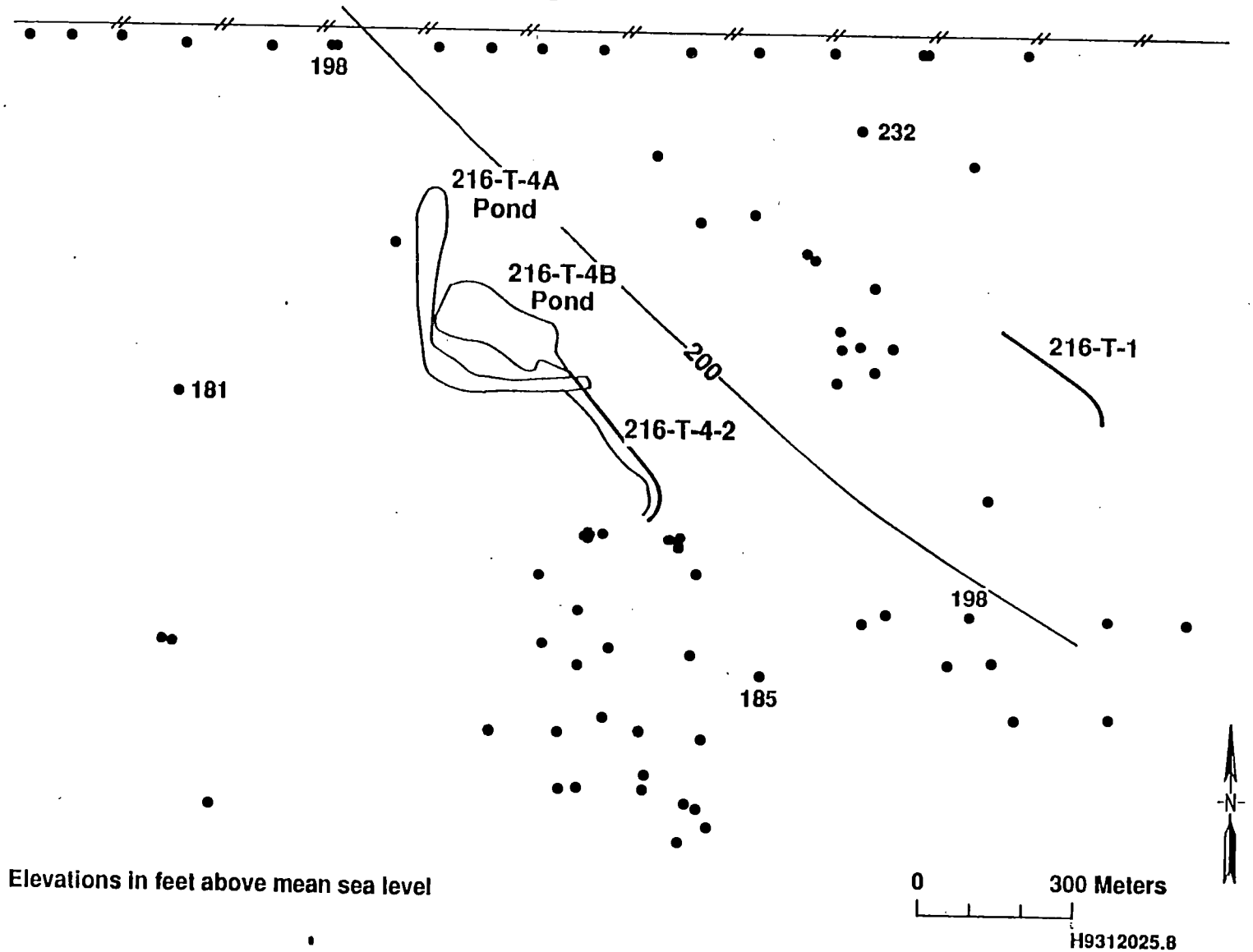
Top of Basalt



Elevations in feet above mean sea level

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Groundwater Impact Assessment Plan for the 216-B-3 Pond System

S.J. Trent

Geohydrologic Engineering Function
Westinghouse Hanford Company

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Outline

Groundwater Impact Assessment Plan for the 216-B-3 Pond System

- Receiving Site Description and History
- Regulatory Strategy
- Effluent Characteristics and Constituents of Interest
- Adjacent Facilities
- Groundwater Quality
- Preliminary Conceptual Model
- Hydraulic Impacts and Assessment Approach

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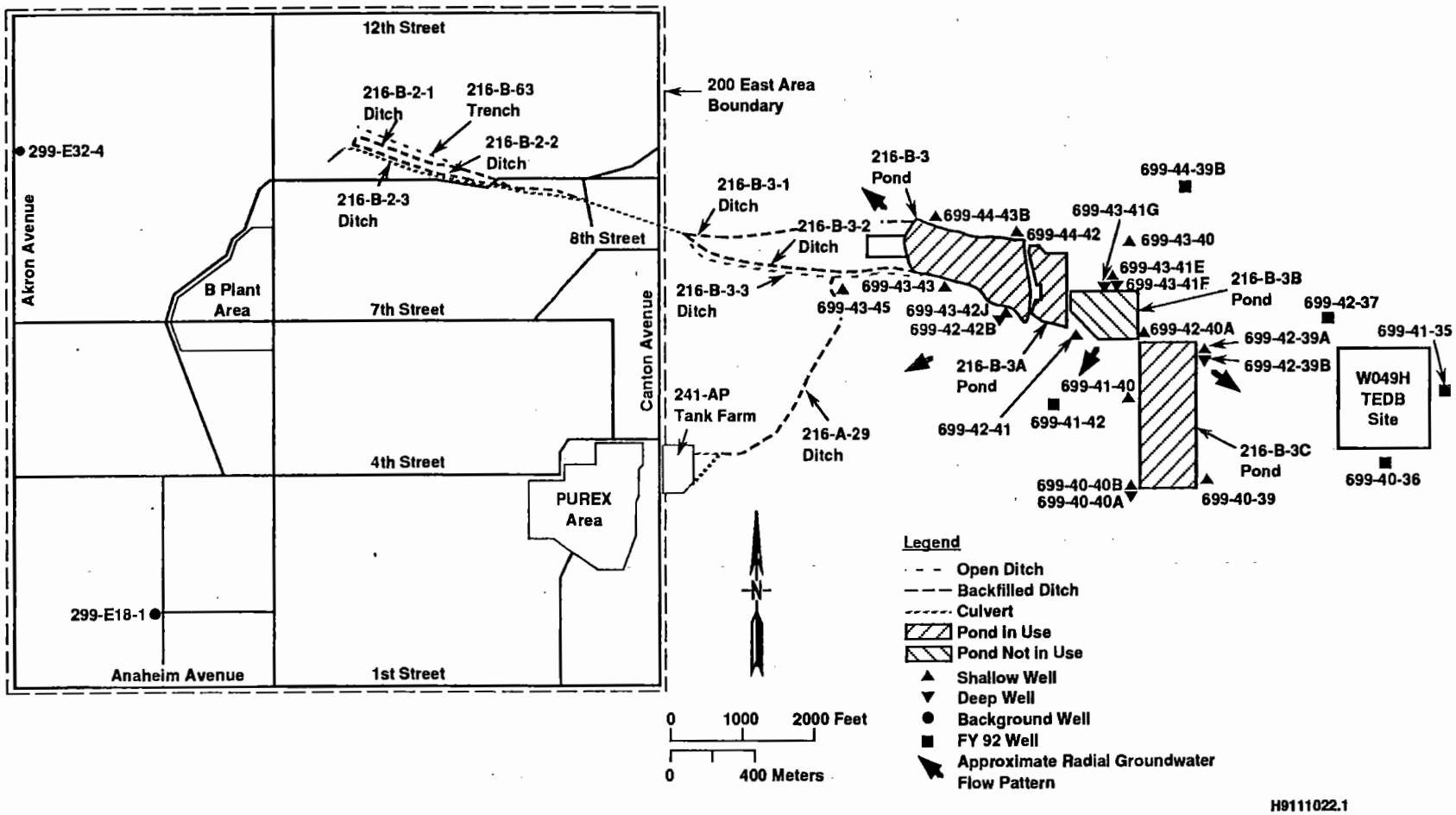


Receiving Site Description and History

- 216-B-3 Pond System - operational from 1945 to present
- 216-B-3 Pond System composed of several receiving units:

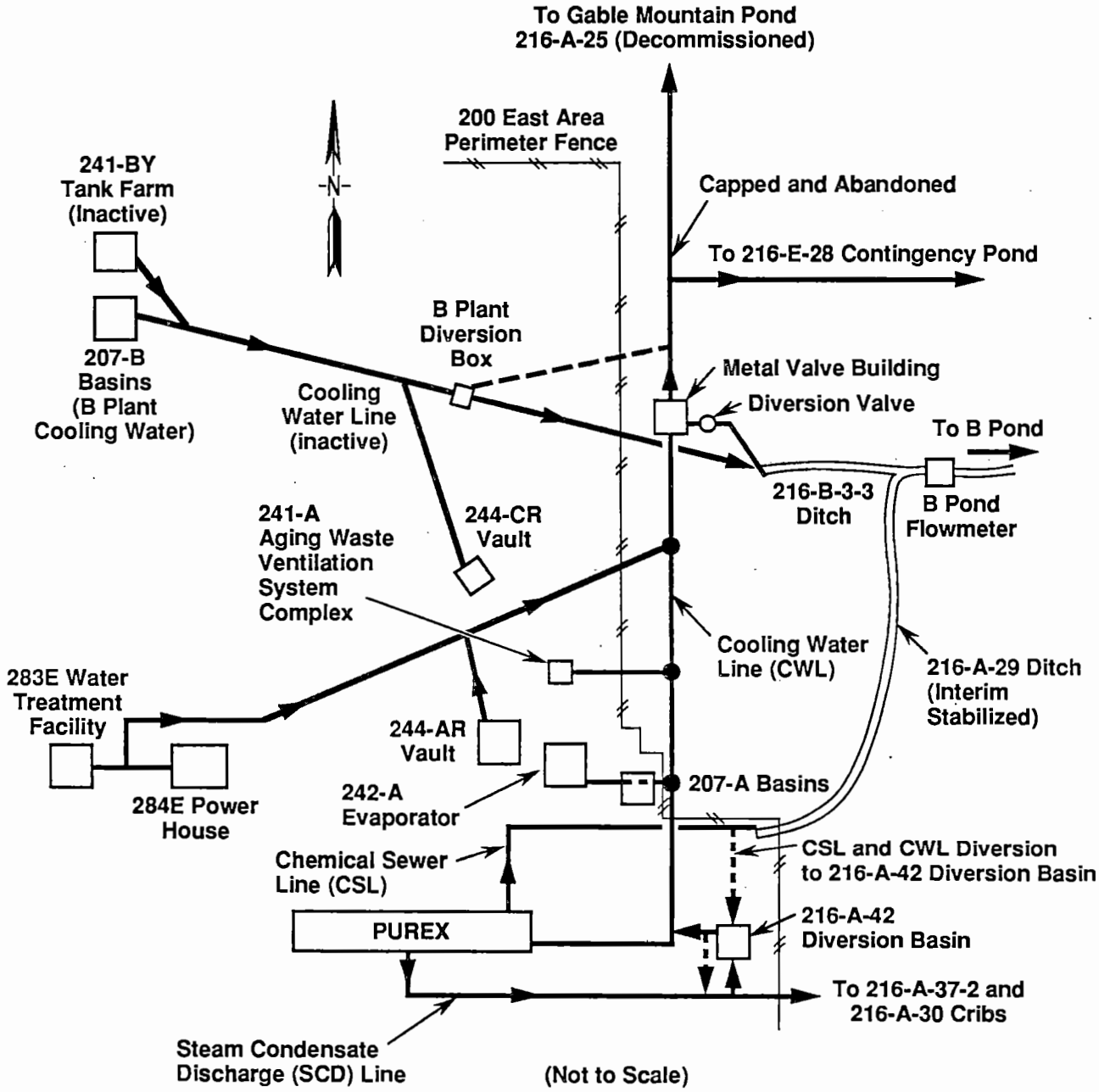
Unit	Period of Service	Function	Size/Dimensions
216-B-3 Main Pond	1945 to present	Primary waste water disposal site for 200 East Area streams	35 acres
216-B-3A Expansion Pond	1983 to present	Overflow pond for the 216-B-3 Main Pond	11 acres
216-B-3B Expansion Pond	1984 to 1985	Overflow pond for the 216-B-3A Expansion Pond	11 acres
216-B-3C Expansion Pond	1985 to present	Overflow pond for the 216-B-3A Expansion Pond	41 acres
216-B-3-3 Ditch	1970 to present	Primary waste water sluice for 200 East Area streams disposed to the 216-B-3 Main Pond	3,700 ft. long 30 ft. wide 4 to 8 ft. deep

Receiving Site Description and History (cont.)

• Waste Stream Description

Waste Water Source	Effluent Stream Type	Dates of Activity	Currently Active
B Plant	Process cooling water Steam condensate Chemical sewer WESF	4/45 to present 4/45 to 9/67 4/45 to 5/70; 2/92 to present 1974 to 1978	X X
284-E Powerhouse	Liquid effluent	4/45 to present	X
283-E Water Treatment Facility	Filter backwash	4/45 to present	X
242-B Evaporator	Cooling water	12/51 to 10/54	
244-CR Vault	Cooling water	3/52 to late 1983	
PUREX Plant	Chemical sewer Acid fractionator condensate Process cooling water	11/55 to present 2/58 to 9/86 11/55 to 6/92	X
244-BXR Vault	Cooling water	7/52 to 7/57	
241-BY Tank Farm	ITS Unit 1 cooling water ITS Unit 2 cooling water	1/65 to 7/73 2/68 to 7/73	
244-AR Vault	Liquid effluent	1/69 to present	X
241-A Aging Waste Ventilation System Complex	Cooling water	1/71 to present	X
242-A Evaporator	Cooling water	3/77 to present 3/77 to present	X X

Flow Routes to B Pond



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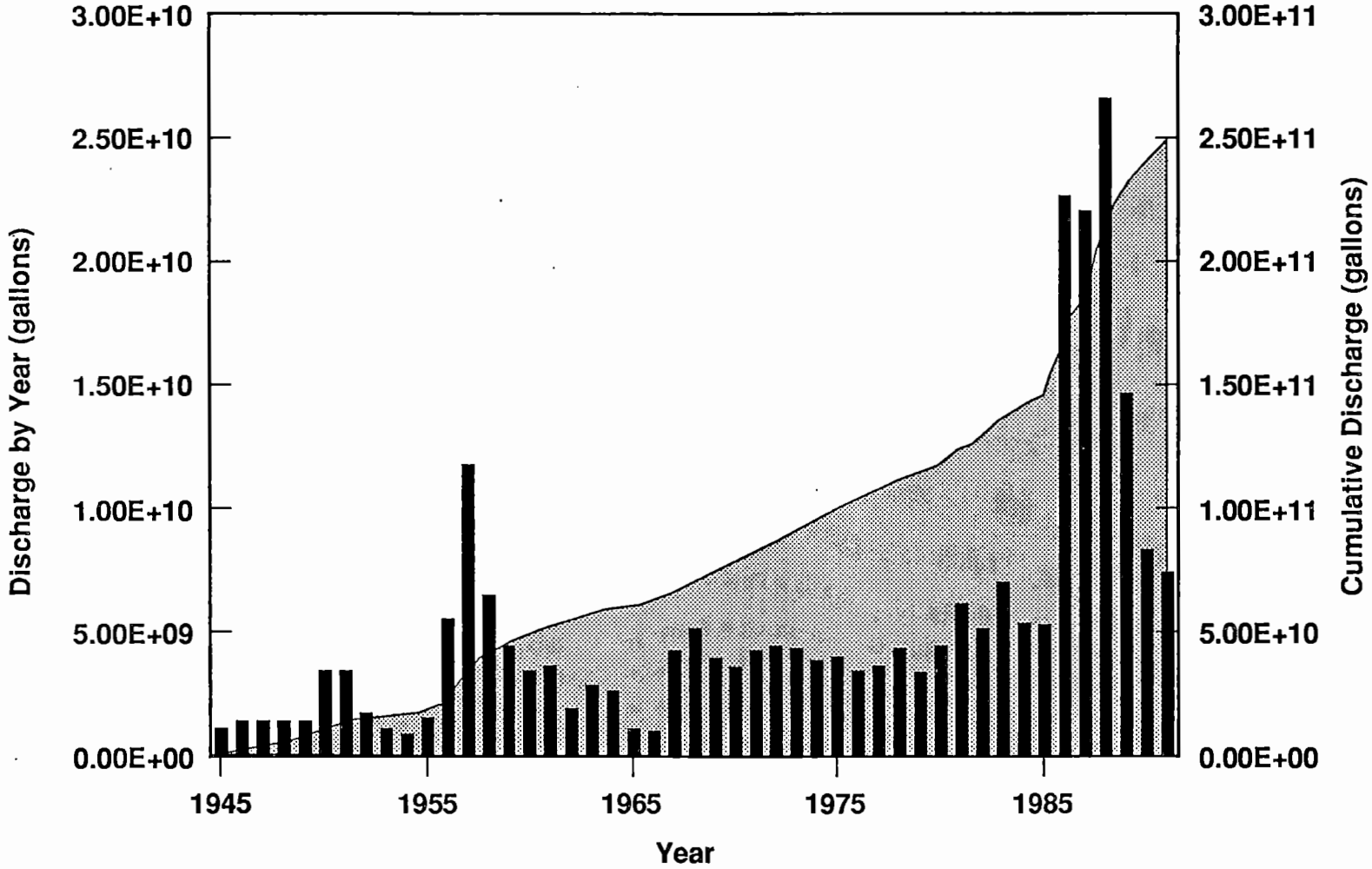
Regulatory Strategy

- 216-B-3 Pond System currently regulated under the RCRA program
  - RCRA groundwater monitoring (assessment-level)
  - RCRA clean closure of 216-B-3A, -3B, and -3C expansion ponds
- Also addressed under 200 East AAMS Groundwater Operable Units
  - 200-BP-5
  - 200-PO-5
- Main pond and 216-B-3-3 Ditch addressed under CERCLA (200-BP-11 Operable Unit)

Effluent Characteristics and Constituents of Interest

- Effluents originate primarily from B Plant and PUREX:
  - Atmospheric condensate
  - Steam condensate
  - Cooling water
  - Chemical sewers
- Cumulative liquid effluent disposed to 216-B-3 Pond System greater than 2.5×10^{11} gallons
- Chemical sewers primary source of nonradiological contamination (past practice)
- Cooling water and condensate streams typically not contaminated

216-B-3 Pond System Discharge History



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Nonradiological Constituents

Known	Potential	
Aluminum nitrate nonahydrate Ammonium fluoride Ammonium nitrate Cadmium nitrate Ferrous sulfamate Hydrazine Hydroxylamine nitrate Nitric acid Potassium permanganate Potassium hydroxide Sodium carbonate Sodium nitrate Sodium hydroxide Sodium nitrite Sulfamic acid Sulfuric acid	Acetic acid Acetone Aluminum Aluminum nitrate (mono basic) Ammonia Ammonium carbonate Ammonium sulfite Ammonium silicofluoride Boric acid Calcium chloride Ceric nitrate Cesium chloride Chromate Citric acid Dibutyl butyl phosphonate DOW Anti-Foam B* (silicon emulsion) Di(2-ethylhexyl)phosphoric acid Ethylenediaminetetraacetic acid Ferric nitrate Ferrous sulfate Formaldehyde Hydrochloric acid Hydrogen fluoride Hydrogen peroxide Hydroxyacetic acid Hydroxyethyl ethylenediaminetetraacetic acid Hyflo-super-cel* (contains silica) Kerosene Lanthanum nitrate Lanthanum-neodymium nitrate Lead nitrate	Mercuric nitrate Nickel ferrocyanide Nickel nitrate Periodic acid Phosphoric acid Potassium fluoride Oxalic acid Phosphotungstic acid Shell E-2342* (Naphthalene/paraffins) Silver Nitrate Sodium bisulfate Tartaric acid Tributyl phosphate Sodium acetate Sodium bismuthate Sodium dichromate Sodium ferrocyanide Sodium persulfate Sodium gluconate Sodium fluoride Sodium thiosulfate Soltrol-170* (paraffins) Sugar Tri-n-dodecylamine Trichloroethane Trisodium nitrilo triacetate Strontium fluoride Tetrasodium ethylenediaminetetraacetic acid Trisodium hydroxyethylenthylene-diaminetriacetic acid Zirconyl nitrate

Decayed (through 1987) Radionuclide Inventory

Radionuclide	Inventory (curies)
Total alpha	$< 1.6 \times 10^{1}$
Total beta	$< 3.93 \times 10^{2}$
Tritium	8.29×10^{2}
Ruthenium-106	$< 1.34 \times 10^{-4}$
Promethium-147	< 1.03
Plutonium-239	$< 5.52 \times 10^{-1}$
Strontium-90	1.03×10^{2}
Cesium-137	9.49×10^{1}
Uranium	< 2.07
Americium-241	< 3.52

Adjacent Facilities

- No active waste water disposal facilities within 2500 feet of the 216-B-3 Pond System
  - 216-A-29 Ditch located to the southwest; interim stabilized (backfilled) in 1991
  - TEDB (WO49H) site to the east; currently not active
  - Grout facility to the west; no liquid discharges

Groundwater Quality

216-B-3 Pond System RCRA Groundwater Monitoring Network

Well	Aquifer	Sampling Frequency	Water Levels	Well Standards	Other Networks
299-E18-1[88]	Top of unconfined	SA	M	RCRA	2101-M
299-E32-4[87]	Top of unconfined	SA	M	RCRA	LLWMA-2
699-40-36[92]	Top of confined	Q	M	RCRA	W-049H
699-40-39[89]	Top of semiconfined	Q	M	RCRA	--
699-40-40A[91]	Lower semiconfined	Q	M	RCRA	--
699-40-40B[91]	Top of semiconfined	Q	M	RCRA	--
699-41-35[92]	Top of confined	Q	M	RCRA	W-049H
699-41-40[89]	Top of semiconfined	Q	M	RCRA	--
699-41-42[92]	Top of unconfined	Q	M	RCRA	--
699-42-37[92]	Top of confined	Q	M	RCRA	W-049H
699-42-39A[91]	Top of semiconfined	Q	M	RCRA	--
699-42-39B[91]	Lower semiconfined	Q	M	RCRA	--
699-42-40A[81]	Top of semiconfined	SA	M	PRE	--
699-42-41[91]	Top of unconfined	Q	M	RCRA	--
699-42-42B[88]	Top of unconfined	SA	M	RCRA	--
699-43-40[91]	Top of unconfined	Q	M	RCRA	--
699-43-41E[89]	Top of semiconfined	Q	M	RCRA	--
699-43-41F[89]	Lower semiconfined	Q	M	RCRA	--
699-43-41G[91]	Top of lower semiconfined	Q	M	RCRA	--
699-43-42J[88]	Lower confined	SA	M	RCRA	--
699-43-43[88]	Top of unconfined	Q	M	RCRA	A-29
699-43-45[89]	Top of unconfined	Q	M	RCRA	A-29
699-44-39B[92]	Top of semiconfined	Q	M	RCRA	--
699-44-42[88]	Top of unconfined	SA	M	RCRA	--
699-44-43B[89]	Top of unconfined	Q	M	RCRA	--

Notes: Shading denotes upgradient wells. Superscript following well number denotes the year of installation.

M = Frequency on a monthly basis.
PRE = Well was constructed before RCRA-specified standards.
Q = Frequency on a quarterly basis.
RCRA = Well is constructed to RCRA-specified standards.
SA = Frequency on a semiannual basis.

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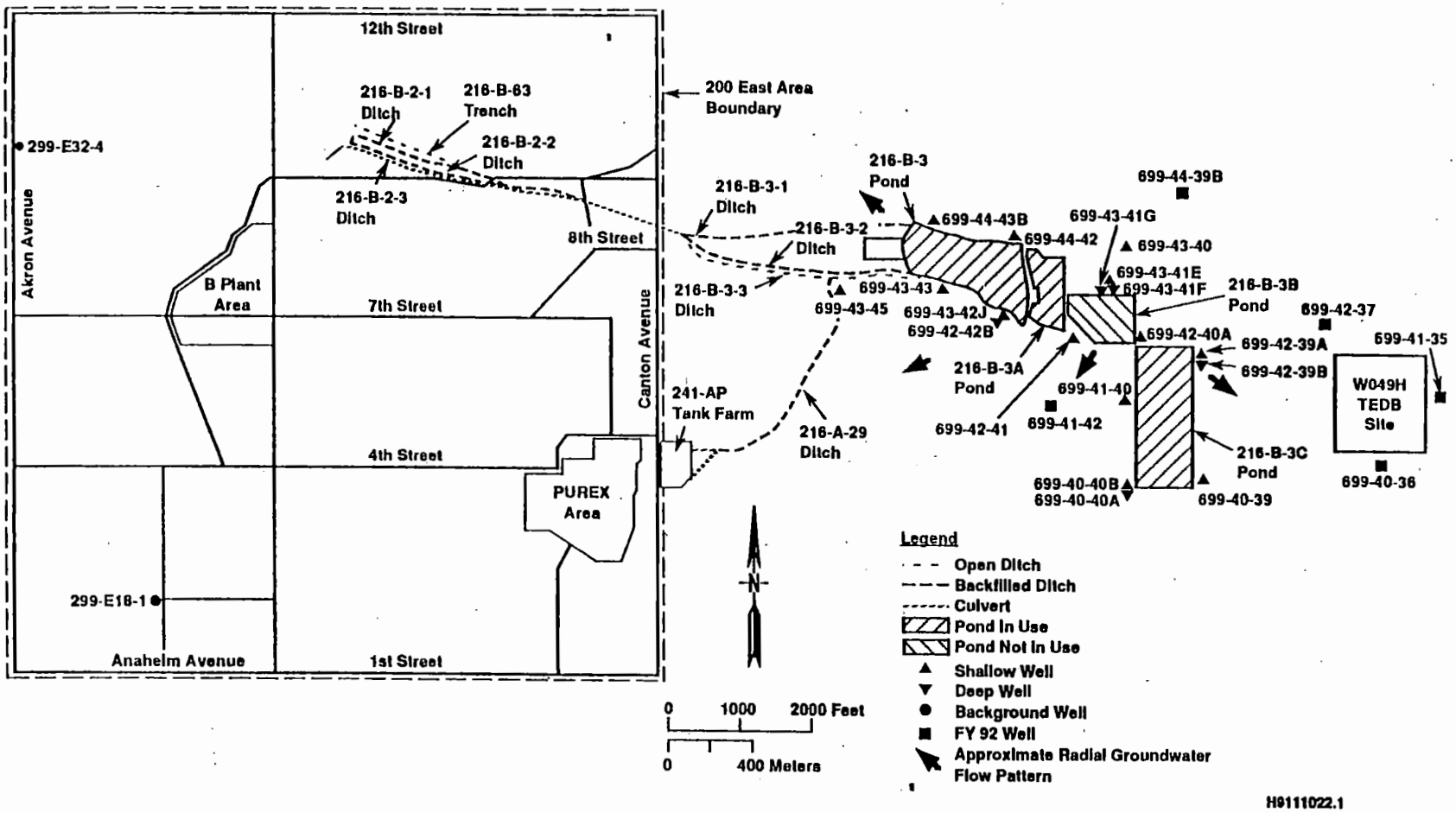


Groundwater Quality

1993 RCRA Groundwater Monitoring Results:

- Several constituents observed above critical means or MCLs

TOX	Unknown; in assessment monitoring
Chromium (630 ppb)	Related to well construction
Iron (64,000 ppb; 4,600 ppb)	Under investigation
Magnesium (1,900 ppb; 390 ppb)	Under investigation
Coliform (200)	Under investigation (three wells)
Nitrate (61,000 ppb)	Under investigation (one well)
Tritium (1.69×10^5 pCi/L)	Past practice disposal activities
tris-2-chloroethyl phosphate (25 ppb)	Unknown; (five wells)
pH (6.10 to 8.78)	Within critical range

Preliminary Conceptual Model
Hydrogeologic Framework

- Stratigraphic units of significance:
  1) Elephant Mountain Member
  2) Rattlesnake Ridge Interbed
  3) Ringold Formation including fluvial gravel unit A and the lower mud sequence
  4) Hanford formation

Preliminary Conceptual Model (cont.)

Hydrogeologic Framework

- Hydrostratigraphic units of significance:

1) Vadose Zone --
   124 to 160 ft. thickness
   Hanford formation

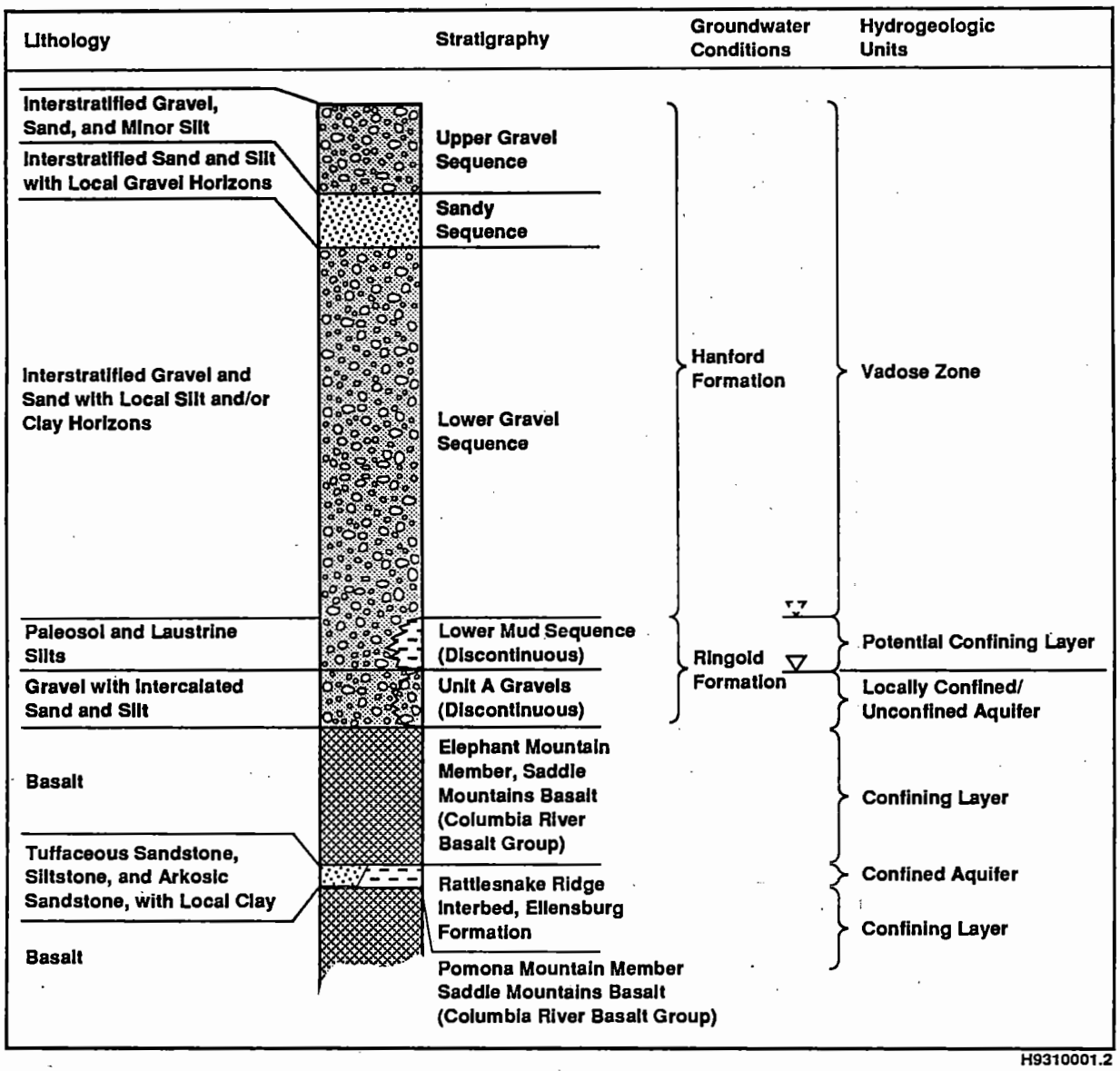
   Perched water zones present

2) Uppermost Aquifer --
   Hanford formation, Ringold Formation
   Elephant Mountain Member

   "Unconfined to northwest grading to confined to semi-confined beneath the lower mud sequence to the east and southeast"

3) Basalt Aquifer System --
   Interflow zone between Basalt of Ward Gap and Basalt of Elephant Mountain
   Rattlesnake Ridge Aquifer

Column from NW Corner of B Pond Area



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Basalt

Sand

Silt/Clay

Gravel

Groundwater Table

Potential Perching Layers (localized, potential perched groundwater may also be associated with fine-grained sediments of Hanford formation and Upper Ringold Unit)

Lithology, stratigraphy, and groundwater conditions based on data from Lindsey et al. (1991), and Delaney et al. (1991).

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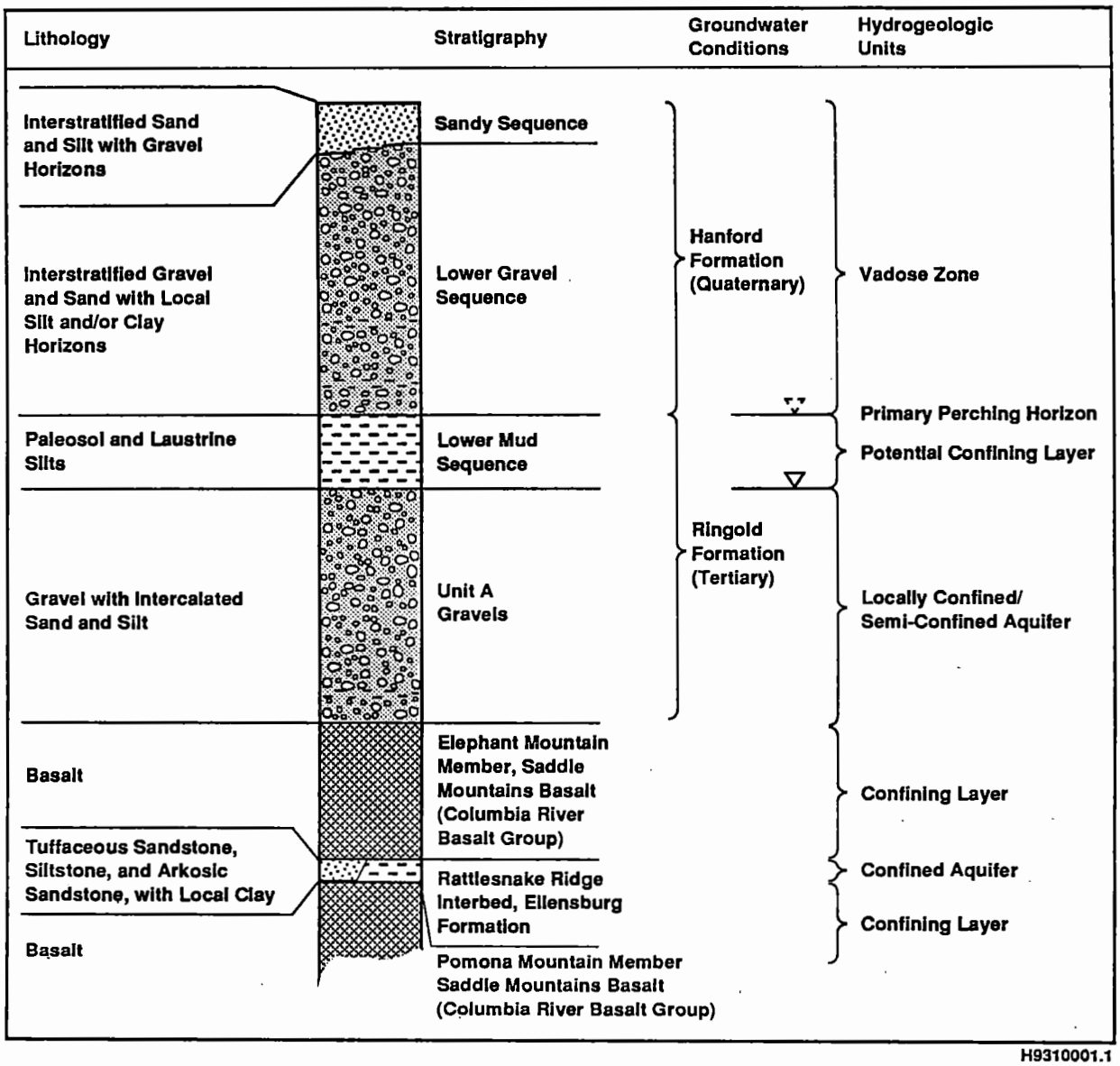
Column from E/SE Corner of B Pond Area



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Basalt

Sand

Silt/Clay

Gravel

Groundwater Table

Potential Perching Layers (localized, potential perched groundwater may also be associated with fine-grained sediments of Hanford formation)

Lithology, stratigraphy, and groundwater conditions based on data from Lindsey et al. (1991), and Delaney et al. (1991).

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Preliminary Conceptual Model (cont.)

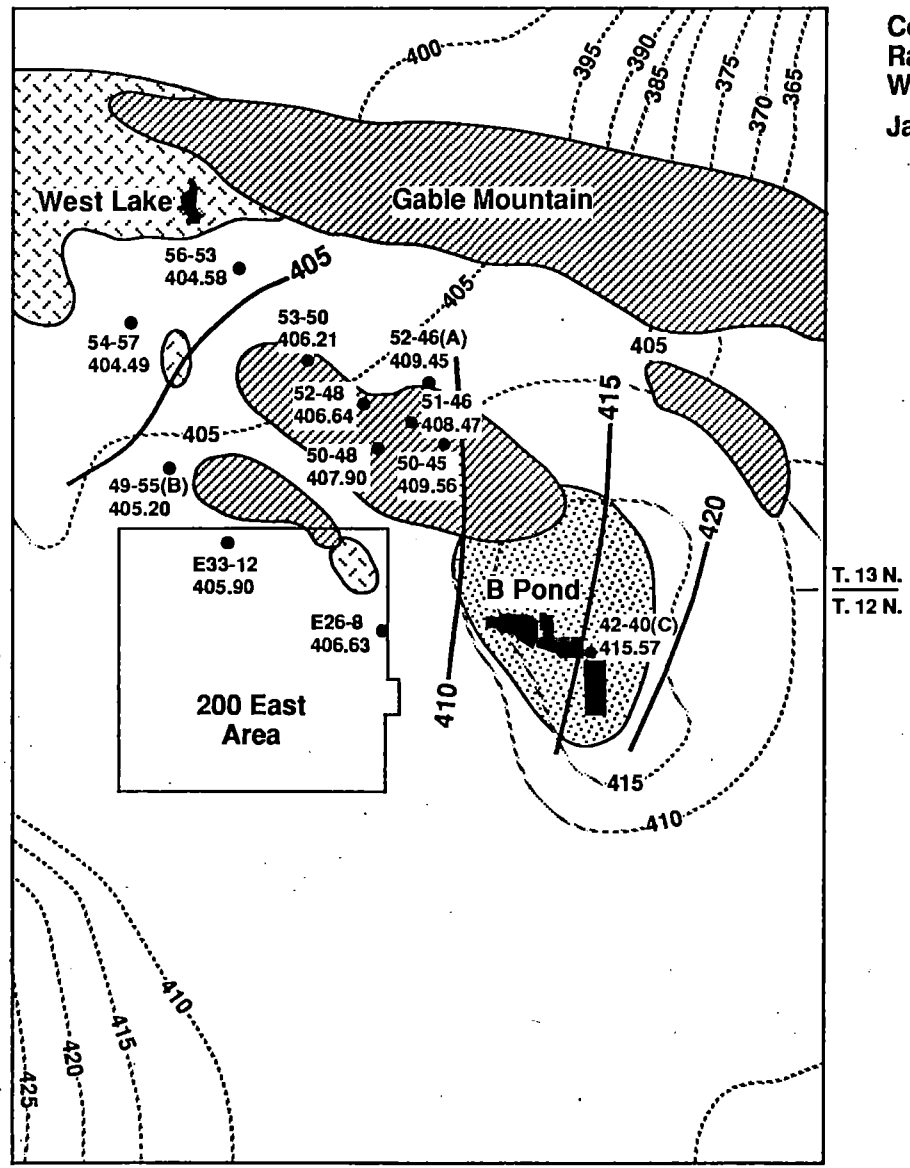
Factors Affecting Contaminant Transport

- Vadose zone beneath the 216-B-3 Pond System is initial receiving medium
  - Hydraulic characteristics of the vadose zone
  - Reactivity of contaminants with the vadose zone
  - Continued hydraulic driving force
- Drainage of effluent into the uppermost aquifer beneath the 216-B-3 Pond System
  - Non-sorbing contaminants
  - Increase/decreases in effluents discharges
  - Continued long-term drainage
  - Mobilization of contaminants in the vadose zone

Preliminary Conceptual Model (cont.)

Groundwater Movement and Recharge

- Extensive groundwater mound beneath 216-B-3 Pond System - vertical and horizontal hydraulic gradients
- Groundwater mound impacts flow direction and gradients throughout eastern portion of 200 East Area
- Mound will dissipate as discharges are terminated.
- Interaction of groundwater mound and the TEDB facility recharge has been modeled.



Comparison of Potentiometric Surface of the Rattlesnake Ridge Confined Aquifer with the Water Table of the Unconfined Aquifer

January 1989

410 — Potentiometric Surface of the Rattlesnake Ridge in Feet Above Mean Sea Level (ft MSL)

Water Table Contours in Feet Above Mean Sea Level (ft MSL)

Areas of Complete Erosion of the Elephant Mountain Basalt (Graham, et al., 1984)

Areas of Downward Hydraulic Gradient

51-46 408.47 — Wells in Confined Aquifer Used in Preparation of Map

Pond

Basalt Above Water Table, as Inferred 6/1984

0 — 1 Mile

0 — 1 Kilometer

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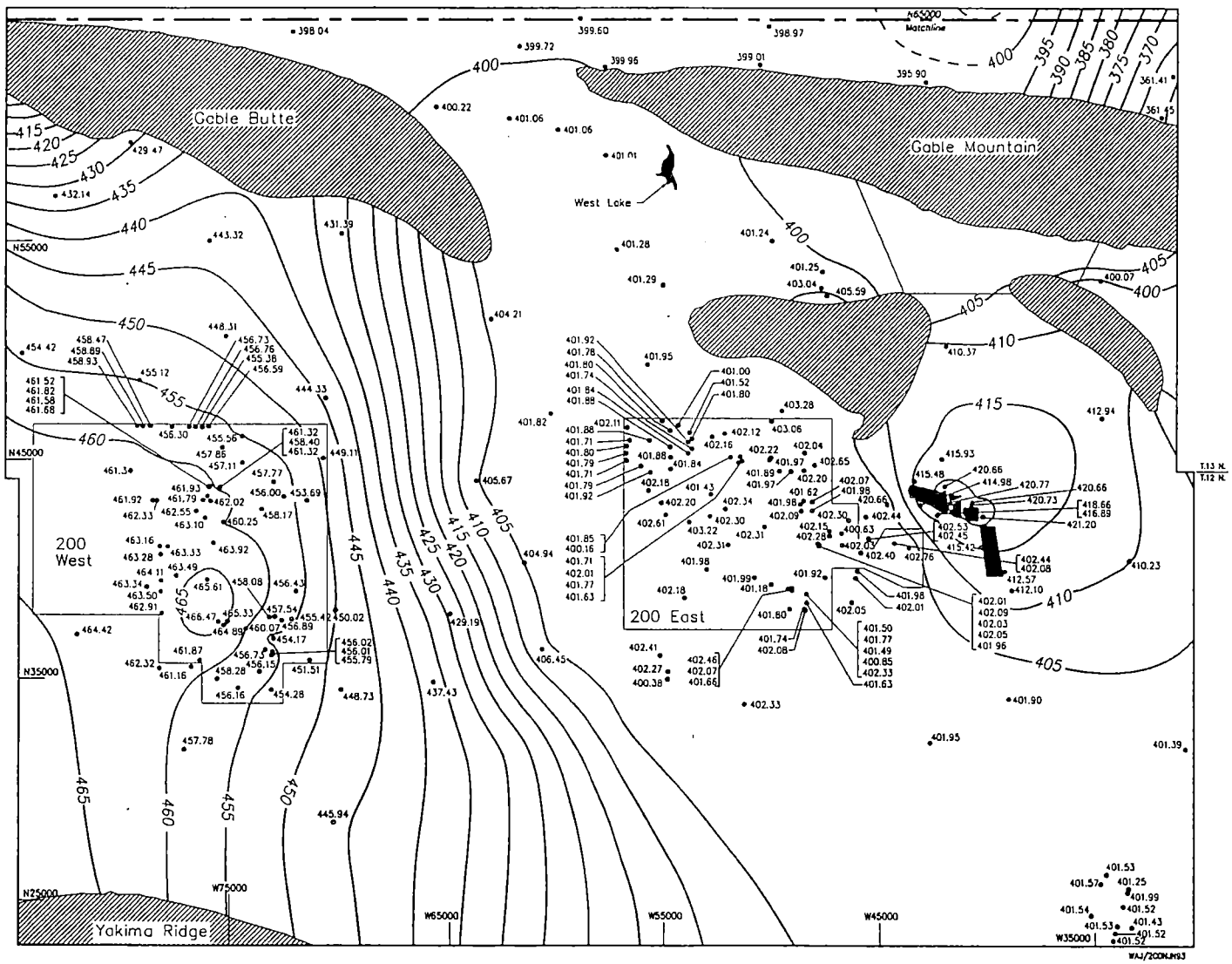


200 Areas Water Table Elevation June 1993

402.49 • Water Table elevation (feet above mean sea level)

405 Water table elevation Contour Interval = 5 ft

Ponds

Areas where the basalt surface is generally above the water table

Area of conflicting data

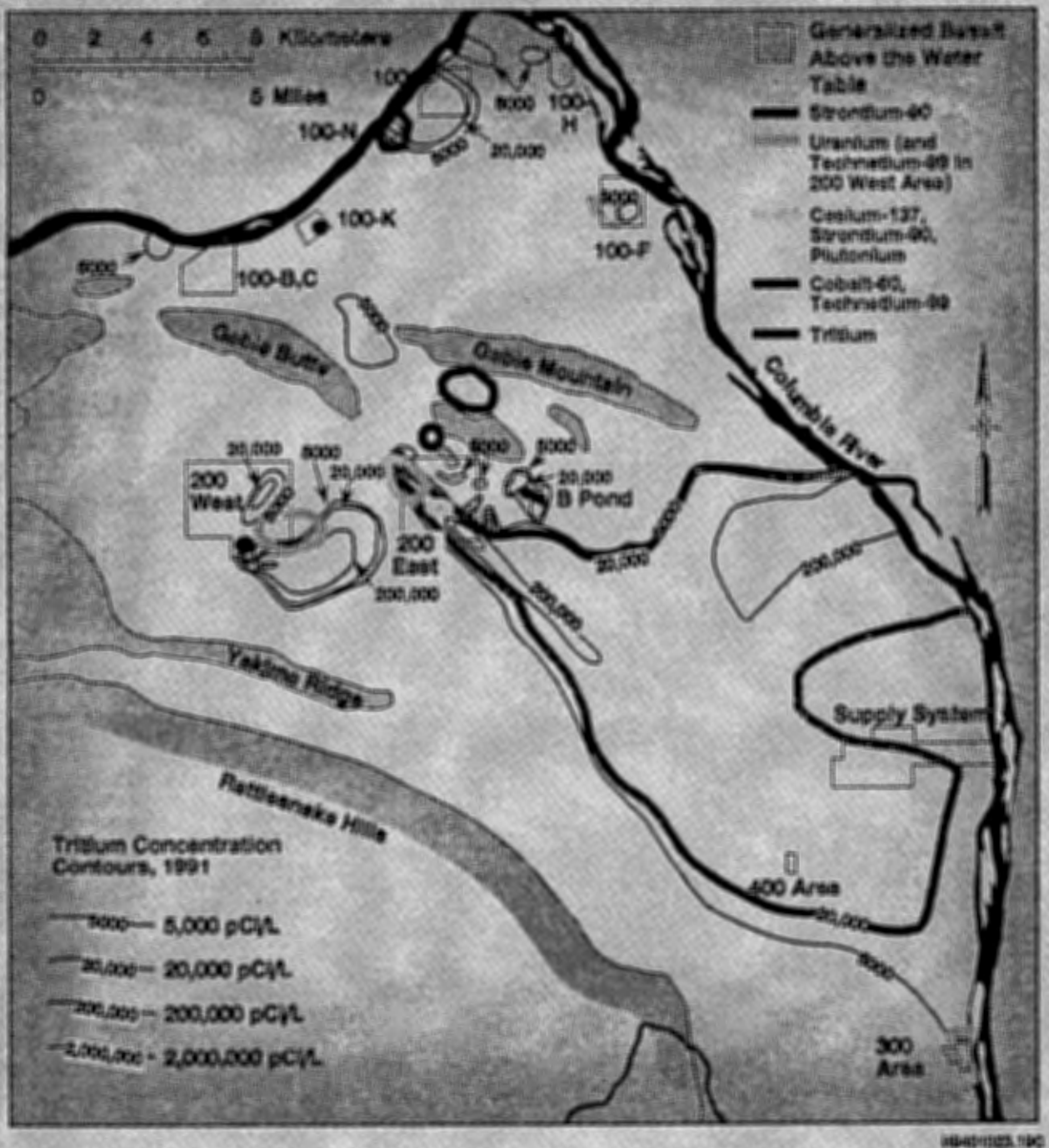
The 200 Areas water table elevation map has been prepared by the Geohydrologic Engineering Function, Westinghouse Hanford Company.

Note: To convert to metric, multiply elevation (ft) by 0.3048 to obtain elevation (m).

0 1 Mile

0 1 Kilometer

N



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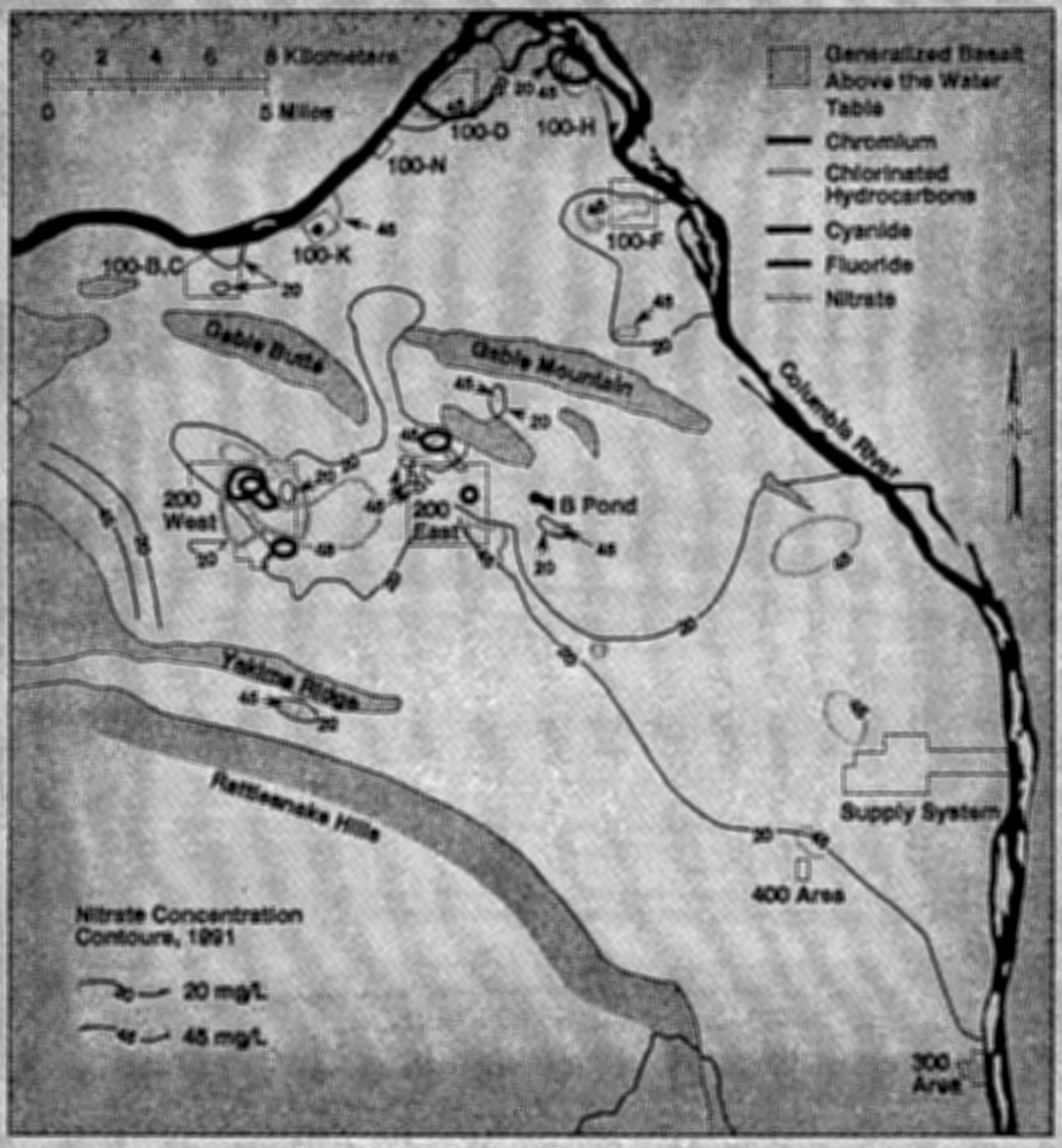
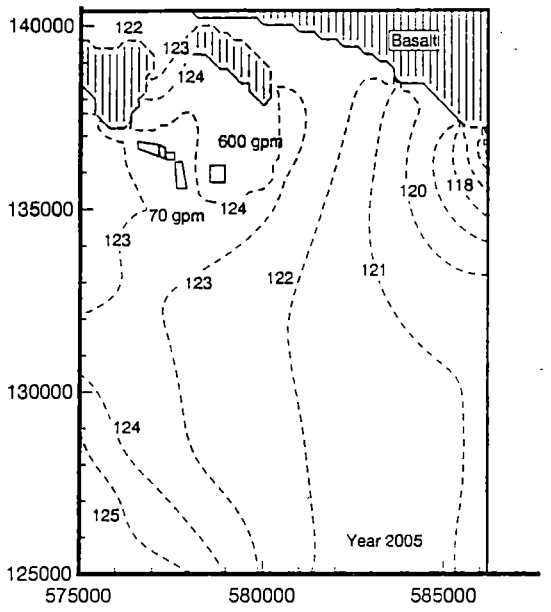

0 2 4 6 8 Kilometers
0 5 Miles
Generalized Basalt Above the Water Table
Chromium
Chlorinated Hydrocarbons
Cyanide
Fluoride
Nitrate
100-D
100-H
100-N
100-K
100-B,C
100-F
Gable Butte
Gable Mountain
Columbia River
200 West
200 East
B Pond
Yakima Ridge
Rattlesnake Hills
Supply System
400 Area
300 Area
Nitrate Concentration Contours, 1991
20 mg/L
45 mg/L

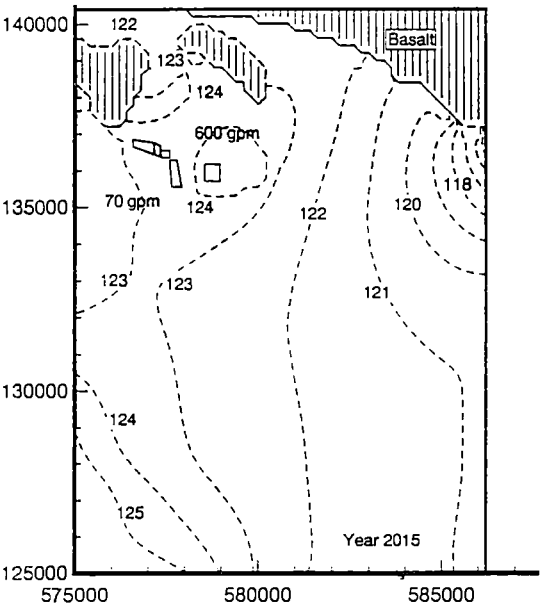
94 3207.0966

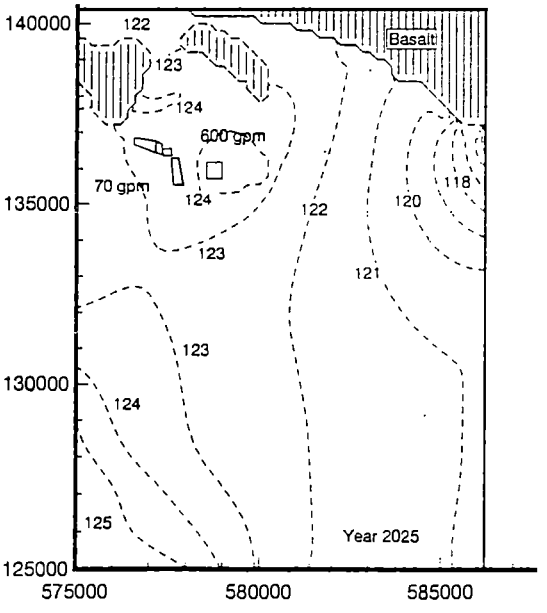
Hydraulic Impacts and Assessment Approach

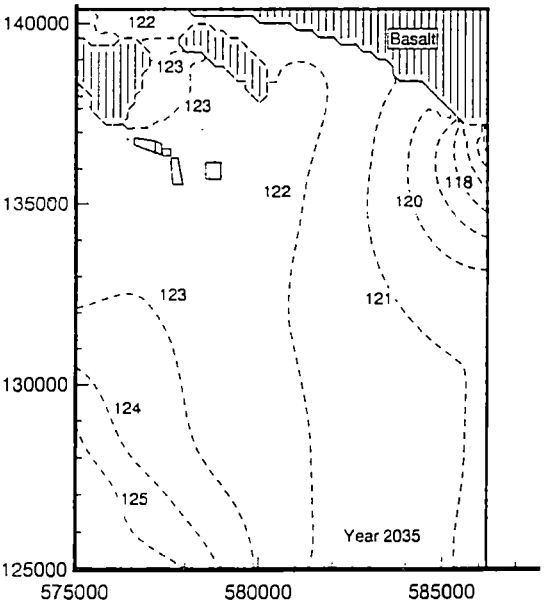
- Hydraulic impact of the 216-B-3 Pond System on the uppermost aquifer and contaminant plume migration is of primary concern
- Assessment methodology will focus on evaluation of future hydraulic impacts and interactions
  - Predict groundwater flow direction and velocity
  - Effects on plume migration
  - Hydraulic interaction with TEBD facility
- Current effort to develop site-wide numerical groundwater flow model will permit evaluation
  - Modeling performed for the TEBD facility provides starting point
  - Geohydrologic data specific to the 216-B-3 Pond System are available to construct model subregion

W-049H Project Modeling









Hydraulic Impacts and Assessment Approach (cont.)

- Site-wide model developed using VAM3DCG code
  - Three-dimensional finite element code
  - Flow and transport modeling under variable saturation conditions
  - Simulate groundwater flow system for entire Hanford Site
  - Includes both natural and artificial sources of recharge
  - Capability to assess contaminant plume migration and hydraulic impacts
- Use of site-wide groundwater model for impact assessment
  - Boundary conditions set
  - Domain for sub-region established
  - Predict hydraulic and contaminant plume impacts:
    - Changes in groundwater flow directions and velocities
    - Changes in plume configuration and migration

Hydraulic Impacts and Assessment Approach (cont.)

- Current status of site-wide groundwater model
  - Domain and boundary conditions established
  - Material properties assigned to grid nodes
  - Calibration to steady-state conditions being performed
  - Flow model to be completed by Spring of 1994
  - Transport model to be completed by Fall of 1994

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