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UMTRA WATER SAMPLING AND ANALYSIS PLAN

LAKEVIEW, OREGON

September 1993

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**UMTRA WATER SAMPLING AND ANALYSIS PLAN
LAKEVIEW, OREGON**

September 1993

**Prepared for
U.S. Department of Energy
UMTRA Project Office
Albuquerque, New Mexico**

**Prepared by
Jacobs Engineering Group Inc.
Albuquerque, New Mexico**

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LIST OF ACRONYMS AND ABBREVIATIONS

<u>Acronym</u>	<u>Definition</u>
ac	acres
bls	below land surface
cm/sec	centimeters per second
DOE	U.S. Department of Energy
EA	Environmental Assessment
EPA	U.S. Environmental Protection Agency
ft	feet
ft/day	feet per day
ft/yr	feet per year
ha	hectares
KGRA	Known Geothermal Resource Area
km	kilometers
LTSP	long-term surveillance plan
MCLs	maximum concentration limits
m	meters
mg/L	milligrams per liter
mi	miles
ORP	oxidation-reduction potential
POC	point of compliance
PSCR	Processing Site Characterization Report
QAP	quality assurance program
Ra-226	radium-226
Ra-228	radium-228
RAP	Remedial Action Plan
SOP	standard operating procedure
TAC	Technical Assistance Contractor
TDS	Total dissolved solids
UMTRA	Uranium Mill Tailings Remedial Action
WSAWO	groundwater sampling and analysis work orders

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this document is to provide background, guidance, and justification for water sampling activities for the Lakeview, Oregon, Uranium Mill Tailings Remedial Action (UMTRA) processing and disposal sites. This water sampling and analysis plan will form the basis for groundwater sampling and analysis work orders (WSAWO) to be implemented during 1993.

1.2 SITE LOCATION

The Lakeview UMTRA Remedial Action Project site is located in Lake County, in the south central portion of Oregon, approximately 100 miles (mi) [160 kilometers (km)] east of Klamath Falls. The Lakeview processing site is located approximately 1.5 mi (2.4 km) northwest of the town of Lakeview, Oregon. The disposal site is located approximately 7 mi (11 km) north-northwest of the Lakeview processing site (Figure 1.1).

1.3 SITE HISTORY

The Lakeview mill was active from February 1958 until November 1960. Chemicals used in processing included sulfuric acid, sodium chlorate, amine solvent, and kerosene. Remedial action at Lakeview consisted of cleanup of contaminated buildings, excavation of all contaminated soils, and transport to the disposal site. Approximately 940,000 cubic yards (720,000 cubic meters) of tailings and contaminated materials were moved to the Collins Ranch disposal site. Seismic and geothermal activity in the area prevented stabilization of the tailings at the Lakeview processing site. Soils were disposed of in a single embankment consisting of a geochemical/flow barrier liner constructed of compacted clay and a radon barrier cover to limit infiltration of precipitation and emission of radon, respectively. The radon barrier on the disposal cell was completed in the fall of 1988. Remedial action was completed at Lakeview in the fall of 1989.

1.4 SITE STATUS

Beginning in 1982 and continuing to the present time, groundwater monitoring activities have been carried out at the processing site by the following contractors: Oak Ridge National Laboratories (ORNL, 1980); Ford, Bacon, and Davis, Inc. (FBDU, 1981); Geochemistry and Environmental Chemistry, Inc.; and the current U. S. Department of Energy (DOE) Technical Assistance Contractor (TAC).

The Remedial Action Plan and Site Design for Stabilization of the Inactive Uranium Mill Tailings Site at Lakeview, Oregon (DOE, 1992) (hereafter referred to as the RAP) indicates that the Collins Ranch disposal site will comply with

FIGURE 1.1
LOCATIONS OF FORMER PROCESSING SITE AND TAILINGS DISPOSAL SITE,
LAKEVIEW, OREGON, UMTRA SITE

the proposed U.S. Environmental Protection Agency (EPA) groundwater protection standards by preventing exceedances of the maximum concentration limits (MCL) for designated hazardous constituents in the uppermost aquifer at the point of compliance (POC). The DOE is required to demonstrate through monitoring that the performance of the disposal cell will comply with the EPA groundwater protection standards Title 40 Code of Federal Regulations, Part 192.02 (40 CFR 192.02).

1.5 SAMPLING PLAN SUMMARY

Monitoring at the former Lakeview processing site is for site characterization purposes and in preparation for the risk assessment, scheduled for the fall of 1993. Compliance monitoring was conducted at the disposal site. Details of the sampling plan are discussed in Section 5.0.

Processing site

At the processing site, sampling for arsenic, molybdenum, manganese, nickel, tin, uranium, vanadium, the major cations and anions, and field parameters is recommended at three background wells (501, 523, and 524) and eight downgradient monitor wells (503, 505, 507, 509, 518, 525, 540, and 541). The purpose for sampling at the processing site is to define the nature and extent of the contamination plumes for risk assessment. Approximately 15 to 20 samples have or will be collected from domestic wells upgradient and downgradient of the processing site to screen for the presence of contamination from mill-related activities. Samples were collected from selected DOE monitor wells (501, 503, 505, 507, 509, 518, 540, and 541) and nine private wells during late August and early September. DOE monitor wells 523, 524, and 525 could not be sampled. Geothermal background monitor wells 523 and 524 could not be located and are believed to either have been removed or buried beneath extensive sawdust piles north of the site. Monitor wells 525 and 526 were destroyed since the last sample collection period (September 1992). Corrective actions are being taken to remedy the situations with these four wells. If necessary, additional samples will be collected during the fall of 1993, based on the preliminary results of the August/September analyses.

Surface water and sediment samples will be collected during the fall rainy season (end of October to early November). Sampling during the rainy season is necessary to obtain samples from Hammersley Creek, an intermittent stream that flows during the wet season only. A total of approximately 10 to 12 surface water samples will be collected from Hammersley Creek, Hunters Hot Springs, Hunter Creek, Thomas Creek, vicinity ponds, and drainage ditches. A sediment sample will be collected adjacent to each surface water sampling location.

Disposal site

At the disposal site, annual sampling for arsenic, radium-226 (Ra-226), radium-228 (Ra-228), net gross alpha, uranium, the major constituents and the field parameters is recommended for the POC monitor wells (602 through 609) and one upgradient monitor well (515). All of these wells were sampled during late August and early September.

1.6 SUMMARY OF CHANGES TO LAST YEAR'S SAMPLING PLAN

During 1992, monitoring wells at the processing and disposal sites were sampled semiannually. In 1993, wells at the processing and disposal sites were sampled on an annual basis. This is justifiable as sufficient semiannual historical groundwater quality data have been gathered to meet this year's data collection objectives. Based on average linear groundwater velocities, sampling once this year is sufficient for both the processing and disposal sites.

Samples collected from the processing site will not be analyzed for several analytes that have been routinely analyzed in the past (ammonium, nitrate, phosphate, aluminum, antimony, barium, cadmium, chromium, lead, mercury, selenium, silver, strontium, Ra-226/Ra-228, thorium, and gross alpha/beta), based on a review of historical information of nondetects. Manganese, nickel, and tin were added to the list of analytes for risk assessment purposes in 1993. At the disposal site, the following analytes were omitted in 1993: ammonium, phosphate, aluminum, antimony, barium, lead, mercury, selenium, silver, strontium, vanadium, zinc, thorium, and gross alpha/beta. Manganese was the only additional constituent analyzed in 1993 at the disposal site. A complete list of constituents selected for analysis in 1993 is presented in Section 5.2.

2.0 SITE CHARACTERISTICS

2.1 PHYSIOGRAPHIC SETTING

Both the former Lakeview processing site and the Collins Ranch disposal site are located within the Goose Lake graben, a geologic structure typical of the Basin and Range Physiographic Province. The Goose Lake graben is bounded by the Fremont and Warner mountain ranges. Elevations in the Lakeview area range from about 4700 feet (ft) [1400 meters (m)] at Goose Lake to nearly 8500 ft (2600 m) in the Warner Mountains. The present topography is the result of block faulting that elevated the ranges in relation to the basins. Erosion of the ranges resulted in the deposition of volcanoclastic sediments, primarily by fluvial and lacustrine processes (DOE, 1985a). The present drainage in the Lakeview Basin is to Goose Lake.

Processing site

The areas to the north and west of the processing site are generally swampy during much of the year due to the high water table. To the east of the site, the land is swampy during the spring and early summer and remains dry until fall and winter.

Disposal site

The Collins Ranch disposal site has been constructed on the sideslopes of Augur Hill. The embankment sideslopes of the disposal cell blend into the natural slopes south of Augur Hill (DOE, 1985a). Runoff from the embankment flows to the apron, to natural materials that have been modified by grading to inhibit formation of gullies, and then to the natural drainage patterns southeast of the site.

2.2 GEOLOGY

Processing site

The processing site is underlain by more than 2000 ft (600 m) of heterogeneous alluvial and lacustrine deposits. Unconsolidated alluvial deposits, consisting of silt and sandy clay, extend from the ground surface to an approximate depth of 20 ft (6 m). Underlying the alluvial deposits are discontinuous lenses of unconsolidated to consolidated water-bearing gravels, sands, and silts derived from recent fluvial and ancient lacustrine processes. Consolidated bedrock has not been identified in any DOE boreholes drilled in the area. However, bedrock was encountered at a depth of 5420 ft (1650 m) in a geothermal test well drilled about 1.5 mi (2.4 km) southwest of the former mill site (Hughes, 1976). A Known Geothermal Resource Area (KGRA) (DOE, 1985b) is located 2000 ft (600 m) upgradient of the former mill site, within the Goose Lake graben.

Disposal site

The geology of the disposal site is similar to that of the processing site. The Collins Ranch disposal site is underlain by up to 1000 ft (300 m) of unconsolidated to consolidated sands, silts, and high-plasticity clays of lacustrine origin. Finer-grained materials predominate in the upper 150 ft (46 m), and coarsen with depth. The depth to bedrock is undetermined, but is estimated to be greater than 1000 ft (300 m) (DOE, 1985a).

2.3 HYDROLOGY

The hydrology of the Lakeview processing site and vicinity is described in detail in the draft *Processing Site Characterization Report* (PSCR) for the Lakeview site, Section 5.0 (DOE, 1985b). Additional data and analyses collected by the TAC were incorporated into Appendix D of the *Environmental Assessment* (EA) (DOE, 1985a) and the RAP for the Lakeview site (DOE, 1992). A summary of the hydrology of the processing and disposal sites is presented in the following sections. Monitor well information for the processing and disposal sites is summarized in Tables 2.1 and 2.2, respectively. Lithologic logs and detailed monitor well construction information are provided in Appendixes A and B.

2.3.1 Groundwater

Processing site

Two alluvial/lacustrine groundwater zones have been characterized (DOE, 1985a) at the former processing site. Monitor wells are screened and filter-packed in a "shallow zone" from about 16 to 30 ft (5 to 9 m) deep and a "deeper zone" between depths of 60 to 75 ft (18 to 23 m). DOE monitor well locations at the processing site are displayed in Figure 2.1. Off-site water-quality sampling locations are shown in Figure 2.2.

A September 1992 water table contour map of the "shallow" groundwater zone at the processing site is shown on Figure 2.3. Groundwater beneath the site moves from the northeast to southwest under a hydraulic gradient that ranges from 0.003 to 0.01 in the shallow monitor wells.

The water table beneath the Lakeview processing site generally occurs at a depth of 5 to 15 ft (1.5 to 4.6 m). Water level fluctuations are expected to occur due to a combination of natural recharge and discharge, and localized pumpage in private wells. As shown in Figure 2.4, numerous private wells are located within the vicinity of the former processing site.

Historical groundwater level elevations for the "shallow" and "deep" monitor wells are shown respectively in Figures 2.5 and 2.6. The background well cluster (wells 501 and 502), shows head variations between the "shallow" (501) and "deep" (502) wells that range from 13 to 17 ft (4 to 5 m), indicating a downward vertical gradient. Water-level elevations are approximately equal

TABLE 2.1. MONITOR WELL INFORMATION FOR THE LAKEVIEW PROCESSING SITE
 SITE: LK001 LAKEVIEW
 REPORT DATE: 09/02/93

LOCATION ID	NORTH COORDINATE (FT)	EAST COORDINATE (FT)	GROUND ELEVATION (FT MSL)	BOREHOLE DEPTH (FT)	BOREHOLE DIAMETER (INCHES)	CASING ELEVATION (FT MSL)	CASING DEPTH (FT)	CASING DIAMETER (INCHES)	SCREEN BEGINNING DEPTH (FT)	SCREEN LENGTH (FT)	FLOW CODE	FORMATION OF COMPLETION
0501	8523.5	7525.3	4769.32	25.25	6.500	4771.05	27.00	2.000	20.00	5.0	U	SP
0502	8523.0	7521.5	4769.27	84.70	6.500	4771.36	87.00	2.000	79.70	5.0	U	SP
0503	7931.9	3921.1	4745.89	25.04	6.500	4747.73	27.00	2.000	20.00	5.0	D	SP
0504	7935.0	3921.3	4745.94	79.50	6.500	4747.63	79.92	2.000	72.92	5.0	D	SP
0505	7476.2	3342.9	4742.74	29.50	6.500	4744.64	30.00	2.000	23.00	5.0	D	SP
0506	7478.8	3340.7	4742.91	84.50	6.500	4744.72	84.00	2.000	77.00	5.0	D	SP
0507	6599.3	6102.0	4741.00	24.50	6.500	4742.77	25.00	2.000	18.00	5.0	C	SP
0508	6599.6	6097.7	4740.92	79.50	-	4743.25	79.00	2.000	72.00	5.0	C	SP
0509	6897.1	4762.6	4740.06	34.50	6.500	4742.14	36.00	2.000	29.00	5.0	D	SP
0510	6901.1	4761.6	4739.87	74.50	6.500	4742.30	77.00	2.000	70.00	5.0	D	SP
0511	7998.3	4024.0	4746.63	34.50	6.500	4748.39	34.00	2.000	27.00	5.0	D	SP
0512	8002.8	4023.3	4746.35	124.50	6.500	4748.34	89.00	2.000	82.00	5.0	D	SP
0513	8812.5	4377.1	4749.48	29.50	6.500	4751.47	24.00	2.000	17.00	5.0	O	SP
0514	8812.3	4381.0	4749.55	79.50	6.500	4751.63	77.00	2.000	70.00	5.0	O	SP
0515	9465.8	4601.3	4750.97	24.50	6.500	4753.02	27.00	2.000	20.00	5.0	O	SP
0516	9466.1	4597.4	4750.95	81.00	6.500	4752.94	79.00	2.000	72.00	5.0	O	SP
0517	8070.4	6106.1	4753.57	79.50	6.500	4755.41	77.00	2.000	70.00	75.0	O	SP
0518	5914.7	2231.0	4737.55	29.50	6.500	4739.79	31.00	2.000	24.00	5.0	D	SP
0519	8006.3	4044.4	4746.57	34.50	10.000	4748.78	42.00	6.000	30.00	10.0	D	SP
0520	8001.6	4044.2	4746.66	89.50	10.000	4746.93	87.00	6.000	70.00	15.0	D	SP
0521	7993.8	4024.1	4746.52	24.50	6.500	4748.16	23.00	2.000	16.00	5.0	D	SP
0522	8006.5	4022.6	4746.49	59.50	6.500	4748.45	59.00	2.000	52.00	5.0	D	SP
0523	10412.4	5088.5	4758.07	24.50	6.500	4759.62	27.00	2.000	20.00	5.0	N	SP
0524	10412.1	5092.9	4758.12	74.50	6.500	4759.90	77.00	2.000	70.00	5.0	N	SP
0525	6489.7	4069.7	4738.09	29.50	6.500	4739.96	31.00	2.000	24.00	5.0	D	SP
0526	6486.2	4069.4	4737.82	79.50	6.500	4739.57	70.00	2.000	63.00	5.0	D	SP
0527	8075.0	6100.0	4754.80	26.50	8.000	4756.36	25.00	4.000	25.00	12.0	O	SP
0528	7300.0	6050.0	4737.00	28.00	8.000	4739.10	23.00	4.000	23.00	6.0	D	SP
0529	8950.0	5100.0	4749.50	26.00	8.000	4751.36	23.00	4.000	23.00	14.0	O	SP
0530	8700.0	7075.0	4765.50	31.00	8.000	4767.84	16.00	4.000	16.00	9.0	N	SP
0531	7675.0	4775.0	4743.20	43.00	8.000	4744.92	38.00	4.000	38.00	13.0	D	SP
0532	7300.0	5500.0	4742.90	28.00	8.000	4743.75	25.00	4.000	22.00	13.0	D	SP
0540	7340.20	5486.57	4745.93	30.0	8.0	4747.89	29.0	4.0	27.0	5.0	D	AL
0541	7938.71	4223.85	4745.55	30.0	8.0	4747.56	30.0	4.0	28.0	5.0	D	AL
0801	8070.4	6106.3	-	-	-	-	-	-	-	-	N	AL
0802	8100.0	4150.0	-	-	-	-	-	-	-	-	N	AL
0803	8100.1	4150.1	-	-	-	-	-	-	-	-	N	AL
0804	8100.2	4150.2	-	-	-	-	-	-	-	-	N	AL
0805	8070.4	6106.4	-	-	-	-	-	-	-	-	N	AL
0806	8100.3	4150.3	-	-	-	-	-	-	-	-	N	AL

FORMATION OF COMPLETION CODE:

SP - SAND OR GRAVELLY SAND, POORLY GRADED
 AL - ALLUVIUM

FLOW RELATIONSHIP CODE:

U - UPGRADIENT
 D - DOWN GRADIENT
 C - CROSS GRADIENT
 O - ON-SITE
 N - UNKNOWN

TABLE 2-1. MONITOR WELL INFORMATION FOR THE LAKEVIEW PROCESSING SITE
 SITE: LKV01 LAKEVIEW
 REPORT DATE: 09/02/93

LOCATION ID	NORTH COORDINATE (FT)	EAST COORDINATE (FT)	GROUND ELEVATION (FT MSL)	BOREHOLE DEPTH (FT)	BOREHOLE DIAMETER (INCHES)	CASING ELEVATION (FT MSL)	CASING DEPTH (FT)	CASING DIAMETER (INCHES)	SCREEN BEGINNING DEPTH (FT)	SCREEN LENGTH (FT)	FLOW CODE	FORMATION OF COMPLETION
0807	8070.5	6106.5	-	-	-	-	-	-	-	-	N	AL

FORMATION OF COMPLETION CODE:
 AL - ALLUVIUM

FLOW RELATIONSHIP CODE:
 N - UNKNOWN

DATA FILE: M:\DART\LV01\MM10003.DAT

FIELDS DISPLAYED WITH A DASH INDICATE THE DATA IS UNAVAILABLE

TABLE 2.2. MONITOR WELL INFORMATION FOR THE COLLINS RANCH DISPOSAL SITE
 SITE: LKY02 COLLINS RANCH
 REPORT DATE: 09/02/93

LOCATION ID	NORTH COORDINATE (FT)	EAST COORDINATE (FT)	GROUND ELEVATION (FT MSL)	BOREHOLE DEPTH (FT)	BOREHOLE DIAMETER (INCHES)	CASING ELEVATION (FT MSL)	CASING DEPTH (FT)	CASING DIAMETER (INCHES)	SCREEN BEGINNING DEPTH (FT)	SCREEN LENGTH (FT)	FLOW CODE	FORMATION OF COMPLETION
0501	26662.6	17998.0	4953.82	49.50	6.500	4956.09	48.00	2.000	42.00	5.0	O	SP
0503	25970.1	18002.1	4905.86	49.50	6.500	4907.54	47.00	2.000	36.00	5.0	O	SP
0507	26033.6	18405.9	4929.32	74.50	6.500	4931.72	78.00	2.000	71.00	5.0	O	SP
0508	25644.6	18339.5	4922.71	89.50	6.500	4924.81	91.00	2.000	84.00	5.0	O	SP
0510	26435.3	18761.9	4984.63	124.50	6.500	4986.30	127.00	2.000	120.00	5.0	O	SP
0513	26631.5	17425.2	4890.35	29.50	6.500	4891.97	27.00	2.000	20.00	5.0	N	SP
0514	26211.0	16981.3	4886.46	24.00	6.500	4888.08	22.00	2.000	15.50	5.0	N	SP
0515	25650.6	17575.0	4874.28	29.50	6.500	4875.81	27.00	2.000	20.00	5.0	N	SP
0516	26676.8	16829.7	4892.69	24.50	6.500	4894.37	22.00	2.000	15.50	5.0	N	SP
0517	26016.0	18224.7	4918.75	250.00	6.000	4919.48	84.60	2.000	75.80	5.0	O	SP
0520	26200.65	19410.56	4939.75	151.50	8.000	4942.03	153.50	2.000	142.50	10.0	C	AL
0521	25449.67	19640.73	4929.64	148.00	8.000	4931.85	141.50	2.000	130.50	10.0	D	AL
0522	24700.57	19449.69	4908.09	125.00	8.000	4910.04	125.50	2.000	114.50	10.0	D	AL
0523	25172.97	20147.73	4891.49	111.00	8.000	4893.73	110.00	2.000	99.00	10.0	D	AL
0602	26005.07	18747.11	4963.21	100.0	8.0	4965.02	101.2	4.0	99.2	10.0	D	AL
0603	25639.30	18704.53	4966.66	130.0	8.0	4968.90	112.0	4.0	110.0	10.0	D	AL
0604	25397.45	18513.60	4960.71	100.0	8.0	4962.82	102.0	4.0	100.0	10.0	D	AL
0605	25246.85	18267.20	4953.89	102.0	8.0	4955.58	102.0	4.0	100.0	10.0	D	AL
0606	25236.64	18260.19	4953.56	150.0	8.0	4955.56	150.0	4.0	138.0	10.0	D	CL
0607	25405.67	18502.27	4961.20	150.0	4.0	4963.20	152.0	4.0	150.0	10.0	D	AL
0608	25643.35	18693.88	4966.91	160.0	8.0	4968.70	162.0	4.0	160.	10.0	D	AL
0609	26007.66	18762.21	4963.21	150.0	8.0	4965.56	149.0	4.0	147.0	10.0	D	CL

FORMATION OF COMPLETION CODE:

SP - SAND OR GRAVELLY SAND, POORLY GRADED
 AL - ALLUVIUM
 CL - LEAN CLAYS, SANDY CLAYS, OR GRAVELLY CLAYS

FLOW RELATIONSHIP CODE:

O - ON-SITE
 N - UNKNOWN
 C - CROSS GRADIENT
 D - DOWN GRADIENT

DATA FILE: M:\DART\LKY02\MMJ10001.DAT

FIGURE 2.1
DOE MONITOR WELL LOCATION MAP
OF THE FORMER LAKEVIEW PROCESSING SITE

MAC: SITE/LKV/WSAP/MON/LOC

FIGURE 2.4
PRIVATE WELL LOCATIONS IN THE VICINITY OF THE
FORMER LAKEVIEW PROCESSING SITE

FROM: LKV EA (DOE, 1985)

FIGURE 2.5
WATER TABLE HYDROGRAPH OF SHALLOW DOE MONITOR WELLS,
FORMER LAKEVIEW PROCESSING SITE

FIGURE 2.6
WATER TABLE HYDROGRAPH OF DEEP DOE MONITOR WELLS,
FORMER LAKEVIEW PROCESSING SITE

and remain relatively constant over time in geothermal monitor well cluster 523 and 524. Static water level elevations in the downgradient monitor well clusters range from approximately equal elevations [within ± 1 ft (0.3 m)] to downward gradients with static head differences of greater than 1 ft (0.3 m) to approximately 12 ft (4 m).

Aquifer performance tests conducted in both screened zones indicate that the two zones are hydraulically connected. Slug tests and aquifer performance tests were used to calculate hydraulic properties at and in the vicinity of the former processing site (DOE, 1985a). Slug tests were used to estimate hydraulic conductivity values. However, these values provide limited information for a small radial area immediately surrounding the well. Two 48-hour aquifer performance tests (24-hours of continuous pumping followed by 24-hours of recovery) were run to determine the hydraulic properties of the "shallow" and "deep" lacustrine zones. In one test, a "shallow" monitor well (519) was pumped and water levels were measured in three shallow observation wells (503, 511, and 521); and in the other, a "deep" monitor well (520) was pumped and the water levels in three "deep" (504, 506, and 512) and one "shallow" (522) observation well were measured. The results of the test are summarized in Table 2.3 (from the Lakeview EA).

The average linear groundwater velocities sited in the Lakeview EA range from 50 feet per year (ft/yr) [8×10^{-5} centimeters per second (cm/sec)] in the "shallow zone" to 160 ft/yr (2.5×10^{-4} cm/sec) in the "deep zone." These values were determined using the average hydraulic conductivities cited in Table 2.3 [ranging from 1.4 to 4.4 feet per day (ft/day) (4.9×10^{-4} to 1.6×10^{-3} cm/sec) for the "shallow" and "deep" zones, respectively], and assuming that the average hydraulic gradient is 0.01 and effective porosity is 0.15 for both the "shallow" and "deep" zones. These linear groundwater velocities are considered to be rough estimates due to the level of uncertainty involved in determining the hydraulic conductivities and the assumed effective porosity.

Disposal site

Background monitor wells, downgradient site characterization monitor wells, and eight POC monitor wells have been sampled routinely at the Collins Ranch disposal site. As shown in Figure 2.7, the eight POC monitor wells have been placed in four two-well monitor well clusters; a shallow well screened at approximately 100 ft (30 m) below land surface (bls) and a deeper well screened at approximately 150 ft (46 m) bls. The shallow wells in each cluster have been dry at various times, and at others, water levels are about 10 to 15 ft (3 to 5 m) shallower than the water levels in the deeper wells.

Depths to groundwater beneath the disposal site range from 10 ft (3 m) bls upgradient of the disposal cell to 125 ft (38 m) bls downgradient of the disposal cell. Groundwater levels in the POC wells range from 96 to 120 ft (27 to 36 m) bls. Groundwater is expected to be unconfined to semi-confined within the fine silty sands and clayey silts. The Lakeview RAP (DOE, 1992) reports that an

Table 2.3 Aquifer test summary for the Lakeview processing site (from the Lakeview EA) (DOE, 1985a)

Deep Test/pumped well: LKV-520 screen 70-85 feet						Q = 12.4 gpm s = 23.0 ft	
Well ID	Screened interval (dfg) (ft)	Radial distance from pump well (ft)	Method of analysis	Transmissivity (ft ² /day)	Hydraulic conductivity, K (ft/day) ^b	Storage coefficient S	
LKV-522	52-57	25	Jacob-Cooper	250	5.7	2.8 x 10 ⁻²	
LKV-522	52-57	25	Boulton	264	6.0	5.0 x 10 ⁻²	
LKV-512 ^a	82-87	25	Jacob-Cooper	93 <	5.8 <	6.8 x 10 ⁻⁴	
LKV-512 ^a	82-87	25	Boulton	91 <	5.7 <	8.4 x 10 ⁻⁴	
LKV-504 ^a	73-78	140	Jacob-Cooper	98 <	5.4 <	2.6 x 10 ⁻⁴	
LKV-504 ^a	73-78	140	Hantush	14 <	0.78 <	4.0 x 10 ⁻⁶	
LKV-506 ^a	77-82	460	Jacob-Cooper	624	8.9	1.2 x 10 ⁻³	
$\bar{S} = 4.5 \times 10^{-4}$						$\bar{K}_{Test} = 4.4$ ft/day	
Shallow Test/pumped well: LKV-519 screen 30-40 feet						Q = 0.60 gpm s = 9.6 ft	
LKV-511 ^a	27-32	25	Jacob-Cooper	6.3 <	1.26 <	1.7 x 10 ⁻⁴	
LKV-511 ^a	27-32	25	Theis	4.6 <	0.92 <	3.1 x 10 ⁻⁴	
LKV-521	16-21	30	Jacob-Cooper	175	10.9	4.9 x 10 ⁻³	
LKV-521	16-21	30	Boulton	46	2.8	2.8 x 10 ⁻³	
LKV-503	20-25	140	Jacob-Cooper	118	7.4	8.9 x 10 ⁻⁶	
LKV-503	20-25	140	Boulton	30 <	1.9 <	1.2 x 10 ⁻⁴	
$\bar{S} = 2.0 \times 10^{-4}$						$\bar{K}_{Test} = 1.36$ ft/day	

^aScreened over interval of pumping well.

^bCalculated by dividing transmissivity by the estimated saturated thickness of the aquifer.

< - Indicates value was used in determining average value.

gpm - Gallons per meter.

dfg - Distance from ground.

ft²/day - cubic feet per day.

LEGEND

- ◆ MONITOR WELL, I.D. = 5 cm
- ▲ MONITOR WELL PAIR, I.D. = 10 cm (P.O.C. MONITORING WELLS)

FIGURE 2.7
DOE MONITOR WELL LOCATION MAP OF THE COLLINS RANCH DISPOSAL SITE

average hydraulic conductivity of approximately 0.4 ft/day (1×10^{-4} cm/sec) was calculated from five slug tests for sediments at depths less than 87 ft (26 m) below the Collins Ranch disposal site. As previously discussed, slug tests can only provide estimates of hydraulic conductivities for a very small radial area around the well bore. Transmissivity values estimated from slug tests are considered to be rough estimates because the wells did not fully penetrate the aquifer.

Figure 2.8 shows a September 1992 water table contour map at the Collins Ranch disposal site. The average linear groundwater velocity beneath the disposal site was estimated to range from 10 to 20 ft/yr (2×10^{-5} to 3×10^{-5} cm/sec), assuming an average hydraulic conductivity of 0.4 ft/day (1×10^{-4} cm/sec), a hydraulic gradient of 0.01, and an effective porosity of 0.15. The primary direction of groundwater flow is to the southeast.

2.3.2 Surface water

Processing site

Surface water features at and adjacent to the former processing site include three creeks that drain the processing site area, ponds, and drainage ditches. An unnamed intermittent stream issuing from Hammersley Canyon, northeast of the site, flows across the site adjacent to the north side of the tailings pile. This creek is referred to as Hammersley Creek (Figure 2.2). Thomas Creek flows approximately 1 mi (1 km) west of the site. Warner Creek flows approximately 1000 ft (300 m) west of the site, where it joins the East Branch of Thomas Creek. The confluence of the East Branch of Thomas Creek with Hammersley Creek is approximately 1800 ft (550 m) southwest of the site, as shown in Figure 2.2. Subsequent drainage is southward into Goose Lake (Figure 1.1). An area of approximately 30 square miles (80 square kilometers) is drained by Thomas Creek north of the former Lakeview processing site.

The existence of Hunters Hot Springs, approximately 0.5 mi (0.8 km) north of the former processing site (Figure 2.2), is an important aspect of the surface water hydrology. These springs feed thermal water into Warner Creek and recharge the hydrogeologic units beneath the site. All drainage across the site flows northeast to southwest.

Disposal site

The Collins Ranch disposal site is located adjacent to a drainage divide along the southwestern slopes of Augur Hill (Figure 2.9). There is an area of approximately 15 acres (ac) [6 hectares (ha)] above the disposal cell which drains toward Camp Creek. Located approximately 3000 ft (900 m) to the southwest and 50 ft (15 m) below the site, Camp Creek has a drainage area of approximately 8300 ac (3400 ha). Camp Creek drains into the East Branch of Thomas Creek approximately 6.5 mi (10 km) southeast of the site.

FIGURE 2.9
COLLINS RANCH DISPOSAL SITE - DRAINAGE CHARACTERISTICS

2.4 WATER QUALITY

Processing site

The locations of DOE monitor wells used for water sampling at the processing site are shown in Figure 2.1. Table 2.1 lists information on all monitor wells that have been used at the processing site. Table 2.4 contains the sampling history for the processing site wells. Of the wells listed on these tables, monitor wells 511 through 517 and 519 through 522 have been sealed and are therefore no longer in use.

Disposal site

The locations of monitor wells used for water sampling at the disposal site are shown in Figure 2.7. Table 2.2 lists information on all the monitor wells that have been used for water sampling at the disposal site. Table 2.5 contains the sampling history for these wells. Of the wells listed on these tables, the following monitor wells have been sealed, and are therefore no longer in use: 501, 503, 507, 508, 510, and 517.

2.4.1 Background groundwater quality

Processing site

There are fundamentally two types of background groundwaters in the "shallow zone" at the processing site. These are 1) low-temperature calcium bicarbonate water; and 2) geothermal water, as shown in the trilinear diagram of groundwater chemistry for the former Lakeview processing site (Figure 2.10).

The calcium bicarbonate water is found in shallow monitor wells (501 and 530) upgradient (east) of the tailings pile. It originates as recharge from the Warner Mountains to the east and as local recharge from precipitation. Total dissolved solids (TDS) in these waters range from 98 to 216 milligrams per liter (mg/L). The pH ranges from 6.0 to 7.1 and the Eh is generally oxidizing.

High temperature ($> 20^{\circ}\text{C}$) geothermal water occurs in domestic wells north of a diagonal line cutting approximately northeast to southwest through the southernmost evaporation ponds. Geothermal water is present in TAC wells 523 and 524 directly north of the evaporation ponds, at the Hunters Hot Springs and in Hunter and Warner creeks. This water is related to the Lakeview KGRA (DOE, 1985b). TDS in geothermal water range from 640 to 714 mg/L. The pH ranges from 8.0 to 8.5 and the Eh is generally oxidizing.

TABLE 2.4. WATER QUALITY SAMPLING HISTORY FOR THE LAKEVIEW PROCESSING SITE
 SITE: LKV01 LAKEVIEW
 LOG DATES: 07/01/82 TO 09/19/92
 REPORT DATE: 09/17/93
 PAGE 1a

LOCATION		SAMPLING PERIOD																				
ID	TYPE	08/84	09/84	10/84	03/85	07/85	09/86	10/86	01/87	04/87	08/87	12/87	03/88	06/88	09/88	11/88	12/88	03/89	08/89	12/89	06/90	
0501	WL	0501	.	.	0501	0501	0501	.	0501	0501	0501	0501	0501	0501	0501	0501	0501	.	0501	0501	.	0501
0502	WL	0502	0503	.	0503	0502	0502	0503	0502	0502	0502	0502	0502	0502	0502	0502	0502	0503	0502	0502	.	0502
0503	WL	.	0503	.	0503	.	.	0503	0503	0503	0503	0503	0503	0503	0503	0503	0503	0503	0503	0503	0503	0503
0504	WL	0504	.	.	0504	0504	0505	0504	0504	0504	0504	0504	0504	0504	0504	0504	0504	0504	0504	0504	0504	0504
0505	WL	0505	.	.	0505	0505	0505	.	0505	0505	0505	0505	0505	0505	0505	0505	0505	0505	0505	0505	0505	0505
0506	WL	0506	0506	.	0506	0506	0506	0507	0506	0506	0506	0506	0506	0506	0506	0506	0506	0506	0506	0506	0506	0506
0507	WL	0507	.	.	0507	0507	.	0507	0507	0507	0507	0507	0507	0507	0507	0507	0507	0507	0507	0507	0507	0507
0508	WL	0508	.	.	0508	0509	0508	.	0508	0508	0508	0508	0508	0508	0508	0508	0508	0508	0508	0508	0508	0508
0509	WL	0509	.	.	0509	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
0510	WL	0510	.	.	0510	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
0511	WL	.	0511	.	0511	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
0512	WL	.	0512	.	0512	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
0513	WL	.	0513	.	0513	0513	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
0514	WL	.	0514	.	0514	0514	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
0515	WL	.	0515	.	0515	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
0516	WL	.	0516	.	0516	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
0517	WL	.	0517	.	0517	0517	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
0518	WL	.	0518	0518	0518	0518	0518	.	0518	0518	0518	0518	0518	0518	0518	0518	0518	0518	0518	0518	0518	
0519	WL	0519	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
0520	WL	0520	.	.	0521	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
0521	WL	.	0521	.	0521	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
0522	WL	.	0522	.	0522	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
0523	WL	0523	.	.	0523	0523	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
0524	WL	0524	.	.	0524	0524	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
0525	WL	0525	0525	.	0525	0525	0525	.	0525	0525	0525	0525	0525	0525	0525	0525	0525	0525	0525	0525	0525	
0526	WL	0526	0526	.	0526	0526	0526	.	0526	0526	0526	0526	0526	0526	0526	0526	0526	0526	0526	0526	0526	
0527	WL	0527	0527	.	0527	0527	0527	.	0527	0527	0527	0527	0527	0527	0527	0527	0527	0527	0527	0527	0527	
0528	WL	0528	0528	.	0528	0528	0528	.	0528	0528	0528	0528	0528	0528	0528	0528	0528	0528	0528	0528	0528	
0529	WL	0529	0529	.	0529	0529	0529	.	0529	0529	0529	0529	0529	0529	0529	0529	0529	0529	0529	0529	0529	
0530	WL	0530	.	.	0530	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
0531	WL	0531	0531	.	0531	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
0532	WL	0532	0532	.	0532	0532	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
0533	SL	0533	0533	.	0533	0532	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
0540	WL	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
0541	WL	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
0801	LY	0801	.	0801	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
0802	LY	0802	.	0802	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
0803	LY	0803	.	0803	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
0804	LY	0804	.	0804	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
0805	LY	0805	.	0805	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
0806	LY	0806	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
0807	LY	0807	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

LEGEND

WL - WELL
 LY - LYSIMETER
 SL - SURFACE LOCATION

TABLE 2.4. WATER QUALITY SAMPLING HISTORY FOR THE LAKEVIEW PROCESSING SITE
 SITE: LKV01 LAKEVIEW
 LOG DATES: 07/01/82 TO 09/19/92
 REPORT DATE: 09/17/93
 PAGE 1b

LOCATION		SAMPLING PERIOD											
ID	TYPE	02/91	08/91	01/92	02/92	08/92	09/92						
0501	WL	0501	0501	.	0501	.	0501						
0502	WL	0502	0502	.	0502	.	0502						
0503	WL	0503	0503	0503	.	0503	.						
0504	WL	0504	0504	0504	.	0504	.						
0505	WL	0505	0505	.	0505	.	0505						
0506	WL	0506	0506	.	0506	0506	.						
0507	WL	0507	0507	.	0507	0507	.						
0508	WL	0508	0508	.	0508	0508	.						
0509	WL	.	.	.	.	.	.						
0510	WL	.	.	.	.	.	.						
0511	WL	.	.	.	.	.	.						
0512	WL	.	.	.	.	.	.						
0513	WL	.	0514	.	.	.	.						
0514	WL	.	.	.	.	.	.						
0515	WL	.	.	.	.	.	.						
0516	WL	.	.	.	.	.	.						
0517	WL	.	0518	.	.	.	.						
0518	WL	.	.	.	.	.	.						
0519	WL	.	.	.	.	.	.						
0520	WL	.	.	.	.	.	.						
0521	WL	.	.	.	.	.	.						
0522	WL	.	.	.	.	.	.						
0523	WL	.	.	.	.	.	.						
0524	WL	0525	0525	0525	.	0525	.						
0525	WL	0526	0526	0526	.	0526	.						
0526	WL	.	.	.	.	.	.						
0527	WL	.	.	.	.	.	.						
0528	WL	.	.	.	.	.	.						
0529	WL	.	.	.	.	.	.						
0530	WL	.	.	.	.	.	.						
0531	WL	.	.	.	.	.	.						
0532	WL	.	.	.	.	.	.						
0533	SL	.	.	.	.	.	.						
0540	WL	0540	0540	0540	0540	.	0540						
0541	WL	0541	0541	0541	.	.	0541						
0801	LY	.	.	.	.	.	.						
0802	LY	.	.	.	.	.	.						
0803	LY	.	.	.	.	.	.						
0804	LY	.	.	.	.	.	.						
0805	LY	.	.	.	.	.	.						
0806	LY	.	.	.	.	.	.						
0807	LY	.	.	.	.	.	.						

DATA FILE NAME: M:\DART\LV01\LOT10004.DAT

LEGEND

WL - WELL
 LY - LYSIMETER
 SL - SURFACE LOCATION

TABLE 2.5. WATER QUALITY SAMPLING HISTORY FOR THE COLLINS RANCH
DISPOSAL SITE
SITE: LKV02 COLLINS RANCH
LOG DATES: 09/13/84 TO 09/19/92
REPORT DATE: 09/17/93
PAGE 1a

LOCATION		SAMPLING PERIOD																		
ID	TYPE	09/86	10/86	01/87	02/87	04/87	08/87	12/87	03/88	06/88	09/88	11/88	08/89	12/89	06/90	09/90	02/91	08/91	02/92	09/92
0501	WL	.	.	.	.	.	.	.	.	.	.	.	.	0501	.	.	.	.	.	.
0502	SL	.	.	.	.	.	.	.	.	.	.	.	.	0502	.	.	.	.	.	.
0513	WL	.	.	.	.	.	.	.	.	.	.	.	.	.	0513	.	.	.	.	.
0514	WL	0514	0514	0514	.	0514	0514	0514	0514	0514	0514	0514	0514	0514	0514	.	0514	0514	0513	0513
0515	WL	.	0514	0514	.	0514	0514	0514	0514	0514	0514	0514	0514	0514	0515	.	0515	0515	0515	0515
0516	WL	.	0516	0516	.	0516	0516	0516	0516	0516	0516	0516	0516	0516	0516	.	0516	0516	0516	0516
0520	WL	.	0516	0516	.	0516	0516	0516	0516	0516	0516	0516	0516	0520	0520	.	0520	0520	0520	0520
0521	WL	0521	.	.	0521	0521	0521	0521	0521	0521	0521	0521	0521	0521	0521	.	0521	0521	0521	0521
0522	WL	0522	.	.	0522	0522	0522	0522	0522	0522	0522	0522	0522	0522	0522	.	0522	0522	0522	0522
0523	WL	0523	.	.	0523	0523	0523	0523	0523	0523	0523	0523	0523	0523	0523	.	0523	0523	0523	0523
0606	WL	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0606	0606	0606	0606	0606
0607	WL	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0607	0607	0607	0607	0608
0608	WL	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0608	0608	0608	0608	0608
0609	WL	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0609	0609	0609	.	0609

DATA FILE NAME: M:\DART\LV02\LOT10002.DAT

LEGEND

WL - WELL
SL - SURFACE LOCATION

FIGURE 2.10
TRILINEAR DIAGRAM OF MAJOR ION CHEMISTRIES FOR GROUNDWATER
IN AREA OF FORMER LAKEVIEW PROCESSING SITE, LAKEVIEW, OREGON

Samples of geothermal water from monitor well 524 have exceeded the MCLs for arsenic and molybdenum at least once. Other constituents with MCLs did not show exceedances. Potentially hazardous inorganic constituents without MCLs (52 *Federal Register* (FR) 36000) were generally below detection limits of the laboratory methods used in the analyses. A more extensive tabulation of the available water composition data for the processing site is presented in Attachment A to Appendix F of the Lakeview RAP (DOE, 1992).

Disposal site

At the disposal site, the background groundwaters are predominantly calcium-bicarbonate. The range in TDS in the uppermost aquifer is from 92 to 252 mg/L. The pH of these waters ranges from 5.83 to 8.24 and the Eh is generally oxidizing.

Table 2.6 (DOE, 1992) shows the background concentrations of those constituents at Collins Ranch that have MCLs. The maximum concentrations measured for all but one constituent were below the proposed MCLs; cadmium exceeded the MCL in one sample. Potentially hazardous constituents without MCLs were below the limit of detection of the laboratory methods used in analysis in essentially all cases. A more extensive tabulation of the available water composition data for the processing site is presented in Attachment B to Appendix F of the Lakeview RAP (DOE, 1992).

2.4.2 Baseline groundwater quality

Processing site

An estimate of the contaminant source term composition at the processing site was developed using chemical analyses of 26 tailings and raffinate pore water samples (DOE, 1985b). Column 2 of Table 2.6 summarizes these analyses for key hazardous constituents, while column 4 summarizes the EPA-proposed MCLs for these constituents. Contaminant concentrations were higher in the tailings pore waters compared to the raffinate pond waters. However, the contaminant plume originating beneath the location of the former raffinate ponds is larger, presumably because more water was available for infiltration beneath the ponds compared to the tailings pile.

Disposal site

The DOE has demonstrated in the RAP that the Collins Ranch disposal site will comply with Subpart A (40 CFR 192) of the proposed EPA groundwater protection standards by preventing exceedances of the MCLs for designated hazardous constituents in the lacustrine aquifer at the POC (DOE, 1992). Concentrations or activities of all hazardous constituents measured have been below the MCLs in the POC wells with one exception. An anomalously high nitrate measurement was reported on one occasion (September 1990) for one POC monitor well. This anomalously high occurrence of nitrate was an outlier

Table 2.6 Summary of hazardous constituents of concern at the Collins Ranch disposal site

Constituent ^a	Maximum observed background ^c	Tailings pore fluid average concentration ^d	POC wells average concentration ^e	Proposed EPA MCL ^f
Arsenic	0.01	0.147	0.008	0.050
Barium	<0.1	<0.10	<0.01	1.00
Cadmium	0.002	0.03	<0.001	0.010
Chromium	<0.01	0.01	<0.01	0.050
Lead	<0.005	<0.01	0.002	0.050
Mercury	0.0001	Not measured	<0.0002	0.002
Molybdenum	<0.005	0.04	<0.01	0.100
Nitrate, as NO ³	2	17	3	44
Selenium	0.003	<0.005	0.0025	0.010
Silver	<0.005	<0.01	<0.01	0.050
Uranium-234/238 ^b	0.0011	0.048	0.001	30.0
Radium-226/228 ^b	1.1	Not measured	0.6	5.0
Net gross alpha ^b	11.47	Not measured	0.52	15.0

^aConstituent values are reported as mg/L unless otherwise noted.

^bValues are reported as picocuries per liter.

^cValues are from Lakeview RAP (DOE, 1992), Vol. II, Table F.4.5.

^dValues are from Lakeview RAP (DOE, 1992), Vol. II, Table F.4.1.

^eStatistical average values (mean or median) are calculated from the Data Analysis and Retrieval Tools (DART) data base for the POC monitor wells (September 1990 to September 1992).

^f52 FR 36000.

when compared to 1) the historical data from the respective monitor wells where the samples were collected, and 2) other indicator constituents measured in the same samples. As a result, this nitrate measurement is considered to be suspect.

2.4.3 Plume delineation

Processing site

A geophysical survey was conducted at the Lakeview processing site in June 1984 in order to identify anomalous subsurface electrical conductivity which might define the extent of any contaminant plume associated with the site. Electrical conductivity in the subsurface is related to TDS in the pore water. A contour plot of conductivity data provides a means to indirectly detect highly conductive areas of contaminated water and, under ideal conditions, to define the areal extent of a contaminant plume. The conductivity data are contoured in Figure 2.11 (from the Lakeview EA). Also contoured in this figure are the TDS concentrations in samples obtained from monitor wells in 1984-85. TDS concentrations in groundwater provide a first-order approximation of contamination at the Lakeview processing site. The two methods of plume delineation produce approximately the same result. The direct water sampling provides better resolution.

The two constituents that appear to best define the contaminant plume are sulfate and manganese. Manganese could be a good plume indicator because it has very low concentrations in background waters relative to the site groundwaters. However, it is subject to adsorption reactions and to precipitation reactions wherever sufficiently oxidizing groundwaters are encountered and, therefore, may not always be a conservative tracer.

Sulfate concentrations in site groundwaters are elevated above background but percentage-wise not as much as manganese. Sulfate ions are potentially subject to reduction reactions wherever sufficiently reducing groundwaters are encountered. However, such reducing conditions are unlikely to be encountered in the shallow groundwater downgradient from the site and even if they were encountered locally, the sulfate reduction reactions are known to be very slow kinetically. Whenever groundwaters are oversaturated with gypsum, sulfate concentrations will also be affected by precipitation reactions. However, because waters in well 503 have been significantly oversaturated with gypsum for at least 8 years, gypsum precipitation reactions must also be kinetically inhibited in this environment.

Contouring of the sulfate concentration data suggests there are separate plumes associated with the location of the former tailings pile and the location of the former evaporation ponds (Figure 2.12). These plumes appear to merge in the southwestern portion of the site.

FIGURE 2.12
SULFATE PLUME IN THE SHALLOW GROUNDWATER ZONE
AT THE FORMER PROCESSING SITE, LAKEVIEW, OREGON

Time-series plots of sulfate concentrations in shallow downgradient wells (Figure 2.13) suggest sulfate concentrations are nearly constant with time in wells downgradient from the site (i.e., 503, 505, and 518). The concentrations are highest in downgradient wells closest to the site (e.g., 503) and are progressively lower in wells progressively further from the site (e.g., 505 and 518). This trend probably reflects hydrodynamic dispersion and possibly retardation reactions. Downgradient wells in the "deeper zone" do not appear to show significant sulfate contamination. Sulfate concentrations in the deeper wells have remained relatively constant over time and appear to be generally within the range of the geothermal background waters, as discussed in Section 2.5.

Exceedances of MCLs for arsenic, cadmium, chromium, molybdenum, Ra-226 plus Ra-228, and selenium have been observed in the "shallow zone." The exceedances for cadmium, chromium, Ra-226 plus Ra-228, and selenium represent single occurrences in various wells at concentrations of two (chromium, Ra-226 plus Ra-228, and selenium) to four (cadmium) times the respective MCLs. These exceedances are not statistically significant given the associated allowable contract analytical errors (± 50 percent for chromium, selenium, and cadmium and ± 25 percent for Ra-226 plus Ra-228) and the lack of exceedances in additional sampling events from the same or closely adjacent wells. For arsenic and molybdenum, the exceedances are significant statistically. However, as noted above, the geothermal background waters have naturally elevated arsenic and molybdenum concentrations. Time-series plots of molybdenum and arsenic concentrations in downgradient wells 503, 505, and 518, and in geothermal well 524 are shown in Figures 2.14 and 2.15, respectively.

For potentially hazardous constituents without MCLs, concentrations exceeding background values have been observed for nickel, antimony, tin, vanadium, and zinc in wells screened within the "shallow zone." In the case of antimony, the exceedances all occurred in one sampling round taken in 1984. As subsequent rounds did not show exceedances in the same wells, those detected earlier may have been the result of contamination related to well construction or some other artifact. For nickel, tin, vanadium, and zinc, the exceedances involve more than one sampling round. The exceedances for tin are very inconsistent in those wells in which they have been detected, suggesting they may also be artifacts. The exceedances for nickel, vanadium, and zinc appear to be real although they are all less than four times the detection limit or maximum observed background value.

Groundwater samples from the "deeper zone" beneath the ponds and downgradient from the site show only a one-time MCL exceedance for Ra-226 plus Ra-228 in two wells (506 and 526). One of these exceedances (well 506) has a large analytical error associated with it and is less than the maximum value observed in background water samples from the "deeper zone." The other exceedance (well 526) was not corroborated in 16 additional sampling events and is therefore not statistically significant.

FIGURE 2.13
TIME SERIES PLOT OF SULFATE IN SELECTED SHALLOW GROUNDWATER ZONE
MONITOR WELLS AT THE FORMER PROCESSING SITE, LAKEVIEW, OREGON

FIGURE 2.14
TIME SERIES PLOT OF MOLYBDENUM IN SELECTED SHALLOW GROUNDWATER ZONE
MONITOR WELLS AT THE FORMER PROCESSING SITE, LAKEVIEW, OREGON

FIGURE 2.15
TIME SERIES PLOT OF ARSENIC IN SELECTED SHALLOW GROUNDWATER ZONE
MONITOR WELLS AT THE FORMER PROCESSING SITE, LAKEVIEW, OREGON

Disposal site

As discussed in Section 2.4.2, the disposal cell complies with the EPA-proposed groundwater protection standards (52 FR 36000). Eight POC wells have been installed for compliance monitoring at the disposal site. Historical water-quality data collected from the POC wells demonstrate that the initial performance of the disposal cell is in accordance with the design requirements.

2.4.4 Surface water quality

Processing site

Surface water samples were collected and analyzed at the locations shown in Figure 2.2. Surface water in the area is of two chemical types: sodium-bicarbonate and sodium-sulfate (DOE, 1985a). Water flowing in the East Branch of Thomas Creek is dominated by sodium and bicarbonate ions, with a TDS concentration of 220 to 260 mg/L. Water flowing out of the Hunters Hot Spring area (Hunter Creek) is dominated by sodium and sulfate ions, with significant amounts of chloride also present. TDS concentrations of Hunter Creek ranged from 800 to 850 mg/L. Hunter Creek also had elevated arsenic concentrations relative to the East Branch of Thomas Creek. No water was present in Hammersley Creek during the sampling effort.

Differences in the chemistry of the two streams are due to the presence of Hunters Hot Spring immediately upstream from the Hunter Creek samples. The discharge from Hunters Hot Spring is rich in sodium, sulfate, and chloride, with TDS similar to that found in Hunter Creek. Arsenic concentrations are also high in the geothermal source area relative to the East Branch of Thomas Creek. The lower concentrations of constituents in the East Branch of Thomas Creek compared to Hunter Creek result from dilution by water flowing from the east Branch of Thomas Creek upstream from the confluence with Hunter Creek. No significant differences in constituent concentrations occurred in either stream between samples from locations upstream of the processing site versus downstream locations.

Disposal site

Surface water features in the disposal site vicinity are limited to a minor creek, Augur Creek, and a stock pond. A surface sample was collected from the stock pond, located approximately 1200 ft (370 m) northwest of the designated disposal site boundary, during the initial site characterization effort in 1985 (DOE, 1985c). The surface water sample was analyzed for selected inorganics and radionuclides, and was used in a tritium water-dating investigation discussed in the Lakeview RAP (DOE, 1992). No other surface water samples have been collected from the disposal site area. Historic groundwater quality sampling has indicated that the disposal cell is performing adequately. As a result, surface water monitoring is unnecessary.

2.5 CONCEPTUAL MODEL OF THE SITE

Processing site

A conceptual hydrogeologic model for the former processing site has been developed to properly evaluate the hydrogeology and geochemistry of the processing site area. This model is based on groundwater and surface water interactions, relative contributions of different background waters and site-related waters, and the extent of groundwater contamination.

The former processing site is underlain by more than 2000 ft (600 m) of heterogeneous alluvial and lacustrine deposits. Shallow unconsolidated silt and sandy clay [from the ground surface to approximately 20 ft (6 m) deep] is underlain by discontinuous lenses of unconsolidated to consolidated water-bearing gravels, sands, and silts as shown in Figure 2.16. The water table generally occurs at a depth of 5 to 15 ft (1.5 to 4.6 m) b/s under unconfined to semiconfined conditions. Groundwater movement is to the southwest, under estimated linear flow velocities of 50 ft/yr (8×10^{-5} cm/sec) in the "shallow" zone to 160 ft/yr (2.5×10^{-4} cm/sec) in the "deep" zone. The "shallow" and "deep" zones are hydraulically connected. Water level fluctuations have been noted in both the "shallow" and "deep" zones and are expected to occur due to a combination of natural recharge and discharge, and localized pumping in private wells.

Surface water features include Hunters Hot Springs, three creeks, several ponds, and drainage ditches. The existence of Hunters Hot Springs, approximately 0.5 mi (0.8 km) north of the former processing site, is an important aspect of the surface water hydrology. These springs feed thermal water into other surface water sources and recharge the hydrogeologic units beneath the site.

Bivariant element-element diagrams and sulfur isotopic data have been used to decipher the origins of the various waters at the site. In the sodium versus calcium diagram (Figure 2.17), geothermal waters are shown to have high sodium/calcium ratios (near 30) relative to evaporation pond waters (between 5 and 20), tailings waters (< 1.0), and low temperature background waters (< 1.0). Tailings-related waters and low-temperature background waters can be distinguished on the basis of calcium concentrations. Analyses of waters from each of the groups are shown separately in Figures 2.18 through 2.21. From the perspective of the bivariant plots, the groundwaters in the "deeper zone" beneath the site appear to be dominantly geothermal in origin with high sodium/calcium ratios (Figure 2.20). These conclusions are consistent with those derived on the basis of sulfur isotope data (DOE, 1985b).

The increases in TDS and sulfate in the "deeper zone" downgradient from the processing site, noted in the Lakeview EA and RAP, appear to reflect the evolution of the near-surface geothermal waters. These waters are subject to evaporative concentration of solutes leading to higher TDS and sulfate

FIGURE 2.16
GEOLOGIC CROSS SECTION OF THE FORMER LAKEVIEW PROCESSING SITE

FIGURE 2.17
BIVARIANT ELEMENT DIAGRAM OF SODIUM VS CALCIUM FOR
FORMER LAKEVIEW PROCESSING SITE GROUNDWATERS

FIGURE 2.18
BIVARIANT ELEMENT DIAGRAM OF SODIUM VS CALCIUM FOR
EVAPORATION POND GROUNDWATERS

FIGURE 2.19
BIVARIANT ELEMENT DIAGRAM OF SODIUM VS CALCIUM FOR
TAILINGS PILE PORE FLUIDS

FIGURE 2.20
BIVARIANT ELEMENT DIAGRAM OF SODIUM VS CALCIUM FOR
GEOTHERMAL AND DEEP WATERS

FIGURE 2.21
BIVARIANT ELEMENT DIAGRAM OF SODIUM VS CALCIUM FOR
LOW TEMPERATURE BACKGROUND GROUNDWATER

concentrations. The surface geothermal waters apparently recharge the "deeper zone" along and beneath Hunters Creek and Warner Creek causing the higher TDS and sulfate concentrations found in these waters.

Disposal site

The conceptual hydrogeologic model for the Collins Ranch disposal site is based on the hydrogeology and geochemistry of the subsurface lacustrine materials. Historical water-quality monitoring has indicated that the surface remedial action has not impacted the water quality of the disposal site. The conceptual model is not expected to change from background conditions.

The Collins Ranch disposal site is underlain by up to 1000 ft (300 m) of unconsolidated to consolidated sands, silts, and high-plasticity clays of lacustrine origin. Finer-grained materials predominate in the upper 150 ft (46 m), and coarsen with depth, as shown in Figure 2.22. Depths to groundwater beneath the disposal site range from 10 ft (3 m) bls upgradient of the disposal cell to 125 ft (38 m) bls downgradient of the disposal cell. Groundwater is expected to be unconfined to semiconfined within the fine silty sands and clayey silts. The primary direction of groundwater flow is to the southeast, with an approximate linear groundwater velocity ranging from 10 to 20 ft/yr (2×10^{-5} to 3×10^{-5} cm/sec). A surface drainage divide is adjacent to the Collins Ranch disposal site, along the southwestern slopes of Augur Hill.

Background groundwaters are predominantly calcium-bicarbonate. The range in TDS in the uppermost aquifer is from 92 to 252 mg/L. The pH of these waters ranges from 5.83 to 8.24 and the Eh is generally oxidizing. Concentrations or activities of all hazardous constituents measured have been below the MCLs in the POC wells with the exception of one anomalously high nitrate measurement that is considered suspect for the reasons discussed in Section 2.4.2. Historical water-quality data collected from the POC wells demonstrate that the initial performance of the disposal cell is in accordance with the design requirements.

A'

FIGURE 2.22
GEOLOGIC CROSS SECTION OF THE COLLINS RANCH DISPOSAL SITE

3.0 DATA COLLECTION OBJECTIVES

The data collection objectives addressed in this sampling plan are 1) regulatory requirements and related applicable compliance monitoring, 2) site characterization, and 3) risk assessment. Each of these data collection objectives is discussed in the following sections.

Samples taken for the UMTRA Project groundwater program are collected at and in the vicinity of the processing site. Samples taken for the UMTRA Project surface remediation program are collected at the Collins Ranch disposal site.

3.1 REGULATORY REQUIREMENTS

Processing site

The DOE is responsible for demonstrating that cleanup or control of existing processing-related groundwater contamination at the Lakeview processing site will comply with the proposed EPA groundwater protection standards in Subpart B of 40 CFR 192. However, the DOE has decided that aquifer restoration and groundwater monitoring will be addressed under a separate DOE program and will be part of a separate *National Environmental Policy Act* process.

Disposal site

To achieve compliance with the proposed EPA groundwater protection standards (Subpart A of 40 CFR 192), the DOE has proposed to meet background concentrations or the MCLs for hazardous constituents in groundwater in the uppermost aquifer at the POC at the Lakeview Collins Ranch disposal site. The criteria for establishing a groundwater monitoring program are set forth in 40 CFR 192.02(a)(c). The DOE is required to satisfy the EPA-proposed groundwater standards (52 FR 36000) issued in 1987. The DOE will comply with the published proposed standards until the final standards are in effect.

Data collection objectives focus on the early detection of contaminant leakage from the disposal cell through a screening-monitoring program. This program consists of regular sampling at POC wells and a background well for contaminants of concern. The selection of monitor well locations, analytes, and monitoring frequency for cell performance assessment is discussed in detail in Section 4.0.

A long-term surveillance plan (LTSP) is being prepared for the Lakeview Collins Ranch disposal site. Compliance monitoring will be addressed further in that report.

The groundwater monitoring program will be implemented and carried out over a specified period of time adequate to demonstrate that the performance of the disposal cell is in accordance with the design requirements.

3.2 SITE CHARACTERIZATION

Processing site

Groundwater monitoring will continue at the processing site. The primary data collection objectives are to 1) characterize background water quality, 2) monitor contaminant plume migration, and 3) distinguish site-related activities from the naturally occurring geothermal activities upgradient of the site.

Disposal site

Site characterization at the disposal site has been completed.

3.3 RISK ASSESSMENT

Processing site

Water-quality data will be collected in preparation for a risk assessment to be conducted at, and in the vicinity of, the former Lakeview processing site in the fall of 1993.

Data collection objectives for health protection monitoring at the processing site are based on an evaluation of hazardous constituents present at the site, the maximum concentrations of these constituents, the rate of groundwater movement, and the presence of potential receptors downgradient from the site. Based on the discussion in Section 2.4, the hazardous constituents of concern are arsenic, molybdenum, nickel, vanadium, and zinc in the "shallow zone." Nickel and zinc have been detected above background levels only in on-site wells close to the former tailings pile or the evaporation ponds. Because these metals adsorb strongly on aquifer minerals, they do not pose an immediate off-site hazard, but will be considered for the 1993 risk assessment. Arsenic, molybdenum, and vanadium were detected in off-site wells 503 and 505. Vanadium was detected at concentrations up to two times background levels. These low vanadium levels do not pose an immediate health threat. Arsenic and molybdenum concentrations in off-site wells are similar to concentrations observed in geothermal background well 524. This suggests that even if these constituents originated from site activities, they do not pose a threat over and above that posed by the naturally occurring geothermal waters. These considerations suggest that the data collection objectives for health protection monitoring can be met with a limited monitoring program as discussed in Section 5.0.

Surface water and sediment samples will be collected specifically for the risk assessment. No surface water samples have been collected in the past during the rainy season. As a result, the intermittent stream that transects the former processing site, Hammersley Creek, has never been sampled.

Disposal site

The disposal cell has been designed to be protective of human health and the environment. As a result, risk assessment is not an applicable data quality objective.

3.4 OTHER CONSIDERATIONS

Aside from the data collection objectives discussed in Sections 3.1 through 3.3, there are no additional data collection objectives for the Lakeview processing and disposal sites in 1993.

4.0 DATA QUALITY OBJECTIVES

4.1 ANALYTICAL METHODS, HOLDING TIMES, AND DETECTION LIMITS

For most of the purposes of the UMTRA Project, the data quality objectives will be defined by the analytical support levels required to meet the data collection objectives. Three analytical support levels have been defined (DOE, 1990) as follows:

- Levels A and B for field analyses.
- Level C for laboratory analyses.

Data meeting Level A criteria are nonquantitative or semiquantitative in nature and are used as indicator parameters. Quantitative analyses conducted in the field are defined as Level B analyses. Level C analyses are analyses conducted in qualified laboratories. These laboratories use EPA-approved procedures, participate in the Contract Laboratory Program involving performance evaluation samples, and are regularly audited under a qualified quality assurance program. A more detailed discussion of analytical support levels and other analytical criteria of significance to the UMTRA Project are provided in the *Standard Operating Procedure for Data Management* (UMTRA-SOP 16.3.3) (JEG, n.d.).

In the event that more stringent precision, accuracy, representativeness, completeness, and comparability parameters and/or lower detection limits are required, specific requests must be included with the WSAWO. Similarly, if some locations are regarded as being particularly critical in terms of sampling and analysis, they must be identified as such in the WSAWO.

4.2 SAMPLE FILTRATION

Processing site

Filtered and unfiltered groundwater samples will be collected from the DOE monitor wells at the former processing site in response to the risk assessment data collection objectives. Unfiltered samples are collected from private domestic/industrial wells in the vicinity of the former Lakeview processing site. Samples collected from private wells are collected downgradient of any private filtering system.

Filtered and unfiltered samples are collected from all surface water sampling locations.

Disposal site

Groundwater samples will be filtered. No surface water samples will be collected.

4.3 SAMPLE PRESERVATION AND SHIPMENT

Standard operating procedures (SOPs) have been developed for water sampling, preservation, and transport (SOP 16.2.1) (JEG, n.d.) and various field procedures (SOPs 16.1.3 through 16.2.4) (JEG, n.d.). These SOPs are on file at the UMTRA Albuquerque Project Office.

4.4 CHAIN-OF-CUSTODY PROCEDURES

All sampling will be performed by qualified personnel trained in data collection, preservation and shipping, and chain-of-custody documentation. All field forms, records, and chain-of-custody forms will be included in the permanent site file.

4.5 SAMPLE COLLECTION METHODS AND SEQUENCE

The order in which water-quality samples will be collected has been prioritized so that the least contaminated samples are collected first and the most contaminated samples are collected last. Sampling locations are discussed in Section 5.1. Tables 5.1 and 5.2 in Section 5.0 list the order of prioritization for sample collection from the processing and disposal sites, respectively.

5.0 SAMPLING PLAN

Details regarding water-quality monitoring at the Lakeview processing site and Collins Ranch disposal site are provided below.

5.1 SAMPLING LOCATIONS

Groundwater samples are collected at and in the vicinity of the former processing site and at the disposal site. The rationale for the selection of groundwater sampling locations is presented below.

Processing site

The following locations are selected for water quality monitoring at the Lakeview processing site:

- **DOE Monitor Wells.** 501, 503, 505, 507, 509, 518, 540, 523, 524, 525, 540, and 541.

Wells 501, 523, and 524 are background wells for the low-temperature (501) and geothermal background waters (523 and 524). The remainder are downgradient from the evaporation ponds area and/or the former tailings pile, as illustrated in Figure 2.1. Additional information for these monitor wells is presented in Table 5.1.

Samples were collected from most of the recommended DOE monitor well sampling locations (501, 503, 505, 507, 509, 518, 540, and 541) during late August and early September. However, DOE monitor wells 523, 524, and 525 could not be sampled. Geothermal background monitor wells 523 and 524 could not be located and are believed to either have been removed or buried beneath extensive sawdust piles north of the site. Monitor well cluster 525 and 526 was destroyed since the last sample collection period (September 1992). Corrective actions are being taken to remedy the situations with these four wells.

- **Private wells.** Approximately 15 to 20 private wells, including the 8 private wells shown on Figure 2.2 that have been sampled previously, have or will be sampled in the former processing site vicinity. The selection of private well sampling locations is made in the field. A determination as to which wells are sampled is based on proximity to the site boundary, private residence location relative to the plume (i.e., upgradient, downgradient, crossgradient), and ease of access and consent. Nine private wells were sampled during late August and early September. If necessary, additional samples will be collected during the risk assessment field activities (scheduled for the end of October to early November), based on the preliminary results of the August/September analyses.

Table 5.1 DOE groundwater monitor well sampling locations at the former Lakeview processing site¹

Well Ids.	Location	Screened interval (ft, bls)	Filter-pack interval (ft, bls)	Rationale for Sampling
501	Background	8.0-13.0	16.0-25.2	Characterize background water quality.
509	Downgradient	29.0-34.0	24.5-34.0	Plume delineation and risk assessment.
523	Background	20.0-25.0	16.0-26.0	Characterize background water quality in geothermal area.
524	Background	70.0-75.0	65.6-75.0	Characterize background water quality in geothermal area.
525	Downgradient	24.0-29.0	20.0-29.0	Delineate horizontal extent of the plume and concentration trends.
518	Downgradient	24.0-29.0	17.0-29.0	Delineate horizontal extent of the plume and concentration trends.
507	Downgradient	18.0-23.0	13.0-23.0	Delineate horizontal extent of the plume and concentration trends.
505	Downgradient	23.0-28.0	19.0-28.0	Delineate horizontal extent of the plume and concentration trends.
541	Downgradient	28.0-33.0	13.0-27.0	Delineate horizontal extent of the plume and concentration trends.
540	Downgradient	27.0-32.0	11.0-27.0	Delineate horizontal extent of the plume and concentration trends.
503	Downgradient	20.0-25.0	15.0-25.0	Delineate horizontal extent of the plume and concentration trends.

¹Prioritized from cleanest samples to most contaminated.

- **Surface water.** A total of approximately 10 to 12 surface water samples will be collected during the fall rainy season. Five surface water samples will be collected at the approximate locations shown in Figure 2.2. Two additional samples will be collected from Hammersley Creek (one upstream and the other downstream of the former tailings source area). Surface water samples will also be collected from vicinity ponds and drainage ditches.
- **Sediment.** A sediment sample will be collected adjacent to each surface water sampling location.

Disposal site

Groundwater monitoring at the Collins Ranch disposal site was conducted during late August and early September at the following locations:

- **DOE Monitor wells:** 515 and 602 through 609.

One DOE background monitor well (515) was sampled. This well is the closest upgradient monitor well to the disposal cell.

Wells 602 through 609 are DOE POC monitor wells. The eight POC monitor wells have been placed in four monitor well clusters; each cluster consists of two wells, a shallow well screened at approximately 100 ft bls (wells 602 through 605) and a deeper well screened at approximately 150 ft bls (wells 606 to 609). The shallow wells in each cluster have been reported to be dry at various times in the past, as discussed in Section 2.3.1.

Groundwater monitoring will continue at all of the POC wells to comply with the disposal cell performance evaluation presented in the RAP (DOE, 1992).

Monitor well locations are shown in Figure 2.7. Information regarding monitor well construction and the priority of sample collection is summarized in Table 5.2. The number of monitor wells sampled in 1993 (9 monitor wells) has been scaled back from the number of monitor wells sampled in the past (16 monitor wells). Those wells that were not sampled in 1993 include 1) three additional background wells that are at a greater distance upgradient from the disposal cell, and 2) four wells downgradient from the POC monitor wells. The additional background wells were not sampled this year because the background historical base has been sufficiently characterized. The four downgradient monitor wells were not sampled because the eight POC wells provide sufficient coverage for compliance monitoring at the POC.

No surface water samples were taken at the Collins Ranch disposal site.

Table 5.2 DOE groundwater monitor well sampling locations at the Collins Ranch disposal site

Well Ids.	Location	Screened interval (ft, bts)	Filter-pack interval (ft, bts)	Rationale for sampling
515	Background	20.0-25.0	16.0-28.5	Monitor for potential changes in background water quality.
602	Downgradient	99.2-101.2	79.2- 99.2	POC well.
609	Downgradient	147.0-157.0	122.0-147.0	POC well.
603	Downgradient	110.0-120.0	80.0-110.0	POC well.
608	Downgradient	160.0-170.0	120.0-160.0	POC well.
604	Downgradient	100.0-110.0	76.5-100.0	POC well.
607	Downgradient	150.0-160.0	110.0-150.0	POC well.
605	Downgradient	100.0-110.0	79.0-100.0	POC well.
606	Downgradient	100.0- 110.0	111.0-148.0	POC well.

5.2 CONSTITUENT SELECTION

Based on the discussion in Section 2.4.2 regarding the magnitude of site groundwater contamination, the following analytes are selected for the Lakeview processing site:

- **Field parameters.** Alkalinity, oxidation-reduction potential (ORP), pH, specific conductivity, and temperature.
- **Laboratory analyses.** Calcium, chloride, iron, potassium, magnesium, sodium, silica, sulfate, arsenic, manganese, nickel, tin, vanadium, zinc, molybdenum, and uranium.

Arsenic and molybdenum are selected because they show a statistically significant pattern of MCL exceedances even though these exceedances may not be related to site-related activities. Manganese is included because it is useful as an indicator parameter for plume migration and as a potential health risk parameter. Vanadium, nickel, tin, and zinc are analyzed as potential health risk parameters. The major cationic and anionic constituents and the field parameters were selected as indicator parameters for plume migration and in the modeling of plume migration.

Disposal site

For the disposal site, the selection of analytes is based on the evaluation of the contaminant concentrations measured in tailings pore fluids and on the constituents detected in the uppermost aquifer at the processing site. In addition to contaminants of concern identified through this analysis, major constituents and field parameters are measured as early warning indicators of contaminant migration from the cell and to allow modeling of the hydrogeochemical environment if the need arises. The following constituents are selected:

- **Field parameters.** Alkalinity, ORP, pH, specific conductivity, and temperature.
- **Laboratory analyses.** Calcium, chloride, iron, potassium, magnesium, manganese, sodium, silica sulfate, arsenic, cadmium, chromium, manganese, molybdenum, nitrate, Ra-226 plus Ra-228, and uranium.

5.3 SAMPLING FREQUENCY

Processing site

The sampling frequency at the Lakeview processing site is on an annual basis. The preferred time of sampling groundwater is late summer to monitor baseflow conditions. Additional sampling is anticipated in the fall of 1993 for the risk assessment.

Disposal site

In 1993, the Collins Ranch disposal site was sampled on an annual basis during late summer to monitor baseflow conditions. The data are being statistically evaluated to determine if less frequent sampling is supportable. The change in sampling interval can only be implemented with the concurrence of the U.S. Nuclear Regulatory Commission. The LTSP is the document which will serve as the concurrence vehicle.

5.4 DATA INTERPRETATION METHODS

Based upon an annual review of 1) the water quality and hydrologic data, 2) water quality data needs and objectives for the upcoming year, and 3) assessment of potential risks to human health and the environment, sampling locations, constituents, and sampling frequency will be modified on an as-needed basis every successive year. Analytes may be excluded from the list if the risk assessment indicates they are of low toxicity. Conversely, selected analytes may be added to the list in any given sampling round if justification is provided. These justifications would derive primarily from 1) risk assessment data needs at the processing site, and 2) the requirements specified in the LTSP for groundwater compliance and/or cell performance monitoring at the disposal site.

5.5 RESPONSE TO ANOMALOUS DATA

If a notable increase in concentration of a contaminant is detected, several activities will be conducted to determine whether the increase indicates a significant change in water quality. Increases in analyte concentrations can occur for various reasons, including 1) as artifacts of sample collection and laboratory analysis procedures, 2) due to changes in background water quality, 3) due to changes in the environment that are unrelated to uranium processing activities, and 4) as a single localized "pulse" in the geochemical environment. Activities to determine the nature and extent of an increase in concentration may include reanalysis, resampling, comparison to other geochemical parameters, and trend analysis. If the increase is significant and perceived to be a "health threat," the TAC and DOE will consult to evaluate potential actions.

6.0 REFERENCES

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- Hughes, P. W., 1976. "Geology and Hydrology, Inactive Uranium Mill Site, Lakeview, Oregon," prepared for Ford, Bacon, and Davis, Utah, Inc., Salt Lake City, Utah.
- JEG (Jacobs Engineering Group Inc.), n.d. *Albuquerque Operations Manual*, standard operating procedures, prepared by Jacobs Engineering Group, Inc., Albuquerque, New Mexico, for the U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.
- ORNL (Oak Ridge National Laboratory), 1980. "Radiological Survey of the Inactive Uranium-Mill Tailings at Lakeview, Oregon," ORNL-5464, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

CODE OF FEDERAL REGULATIONS

40 CFR 192, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings," Title 40, *Code of Federal Regulations*, Part 192, U.S. Environmental Protection Agency, Office of the Federal Register, National Archives and Records Administration, Washington, D.C.

FEDERAL REGULATIONS

52 FR 36000, "EPA's Proposed Standards for Remedial Action at Inactive Uranium Processing Sites with Groundwater Contamination," September 24, 1987, *Federal Register*, Office of the Federal Register National Archives and Records Administration, Washington, D.C.

APPENDIX A

**LITHOLOGIC LOGS AND MONITOR WELL CONSTRUCTION INFORMATION
FOR THE FORMER LAKEVIEW PROCESSING SITE**

PROJECT LAKE VIEW PROCESS SITELOG OF WELL BORING NO. 501JOB NO. LKVO1 DATE 06/29/84SURFACE ELEVATION 4769.32TOTAL DEPTH 29.5 feetRIG TYPE CME-75TOP OF FILTER PACK 16.00BORING TYPE H.S. AUGERWELL CASING TYPE 2.0-IN. SCHED 40 PVCLOCATION N 8523.50 E 7525.30COMPLETION LACUSTRINEDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in. PVC well to 25.2 feet. Placed steel protective casing to 4 feet.		CH	ALLUVIUM: SILTY CLAY, trace fine gravel, high plasticity, black (10YR,2/1). Occasional thin seam of silty sand.
5		Installed grout/bentonite seal to 14 feet. Placed bentonite seal from 14 to 16 feet. Installed filter pack of "concrete sand" from 16 to 25.2 ft.		CL	SANDY CLAY, med. grained sand, med. plasticity, dark brown(10yr,4/3). Note: Saturated 6-in. seam of silty sand encountered at 4.0 feet. Initial water level at 4 feet depth.
10				CH	SILTY CLAY, trace fine gravel, high plasticity, dark brown(10YR-4/3).
15				SM	SILTY SAND, med, nonplastic, dark yellow brown. Some thin seams of silty clay.
20		Placed well screen of .01-in. slot from 18.2 to 23.2 ft. Placed blank sump from 23.2 to 25.2 ft.		GC	LACUSTRINE DEPOSITS: CLAYEY SAND, and gravel, well graded, angular, low plasticity, dark brown (7.5YR-3/3). Note: depth of top of Lacustrine deposits based on high N values. Note: Stopped sampling with spoon at 25.9, drilled to 29.5 to allow for cave-in fill.
25		Cave-in fill from 25.2 to 29.5.			TD AT 29.5 FEET.
30		Hole over-drilled to 29.5 to allow for cave-in interval for positioning of screen.			
35		Standard penetration spoon "N" values as follows: @ 1 ft. = 8; @ 5 ft. = 9; @ 10 ft. = 17; @ 15 ft. = 18; @ 20 & 25 ft. = 50 +.			
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
5.4	10:48	8/14/84
9.4	16:03	9/1/92

JEG TAC TEAM

LOG OF WELL BORING NO. 502

PROJECT LAKE VIEW PROCESS SITE
LAKE VIEW, OR.JOB NO. LKV01 DATE 07/12/84SURFACE ELEVATION 4769.27TOP OF FILTER PACK 70.70WELL CASING TYPE 2.0-IN. SCHED 40 PVCCOMPLETION LACUSTRINETOTAL DEPTH 89.5 feetRIG TYPE CME-75BORING TYPE H.S. AUGERLOCATION N 8523.00 E 7521.50DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55				CH	CLAY, some sand, high plasticity, olive (5Y,4/4). Note: Occasional thin sandy or gravelly seam. LACUSTRINE DEPOSITS, Continued.
60					
65		Placed bentonite seal from 65.7 to 67.7 feet.			
70		Installed filter pack of "concrete sand" from 67.7 to 84.7 ft.			
75				CL	SILTY CLAY, some fine sand, trace-little fine gravel, med. plasticity, olive (5Y,4/3).
80		Placed well screen of .01-in. slot from 77.7 to 82.7 ft.			
85		Placed blank sump from 82.7 to 84.7 ft. Cave-in fill from 84.7 to 89.5.		GP	SAND AND GRAVEL, poorly graded, to 1-in., with thin clay seams, low plasticity, olive brown (10YR,3/3).
90		Hole over-drilled to 89.5 ft. to allow for cave-in interval for positioning of screen.			TD AT 89.5 FEET. SAMPLED WITH SPOON TO 84.6 FEET.
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
18.6	10:47	8/14/84
21.3	13:10	9/1/92

JEG TAC TEAM

PROJECT LAKE VIEW PROCESS SITE
LAKE VIEW, OR.JOB NO. LKV01 DATE 07/06/84SURFACE ELEVATION 4745.94TOP OF FILTER PACK 66.50WELL CASING TYPE 2.0-IN. SCHED 40 PVCCOMPLETION LACUSTRINETOTAL DEPTH 89.5 feetRIG TYPE CME-75BORING TYPE H.S. AUGERLOCATION N 7935.00 E 3921.30DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in. PVC well to 78.0 feet. Placed steel protective casing to 4 feet.		ML	ALLUVIUM: SANDY SILT, nonplastic, very dark grey (10YR,3/1). Note: Saturated seam of sand at 3.5 feet.
5		Installed grout/bentonite seal to 64.0 feet.		ML	CLAYEY SILT, low plasticity, light grey (5Y,7/2).
10		Standard penetration spoon "N" values as indicated: @ 10 ft. = 33; @ 15 ft. = 46; @ 20 ft. = 43; @ 25 ft. = 71 @ 30 ft. = 26; @ 35 ft. = 50+; @ 40 ft. = 50+; @ 45 ft. = 19; @ 50 ft. = 50+; @ 55 ft. = 19; @ 60, 65, 70, 75 & 80 ft. = 50+		GM	SILTY SAND AND GRAVEL, subangular, nonplastic, very dark greyish brown (2.5Y,3/2M).
15				SM	LACUSTRINE DEPOSITS: (Contact ?) SILTY SAND, fine to med., trace fine gravel, nonplastic, dark olive grey (5Y,3/2).
20					Note: Color changing to very dark greyish brown (2.5Y,3/2).
25					
30					
35					Note: No gravel, color changed to black, still nonplastic.
40					
45					
50				SP SM	SAND, fine to med. some silt, trace fine gravel, nonplastic, black (5Y,2.5/2M).

GROUNDWATER

DEPTH	HOUR	DATE
16.7	08:00	8/14/84
16.6	08:15	8/31/92

JEG TAC TEAM

PROJECT LAKE VIEW PROCESS SITE
LAKE VIEW, OR.

Page 1 of 1
 LOG OF WELL BORING NO. 505

JOB NO. LKV01 DATE 07/05/84
 SURFACE ELEVATION 4742.74
 TOP OF FILTER PACK 19.00
 WELL CASING TYPE 2.0-IN. SCHED 40 PVC
 COMPLETION LACUSTRINE

TOTAL DEPTH 34.5 feet
 RIG TYPE CME-75
 BORING TYPE H.S. AUGER
 LOCATION N 7476.20 E 3342.90
 DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in. PVC well to 28.0 feet. Placed steel protective casing to 4 feet.		ML	ALLUVIUM: CLAYEY SILT, low plasticity, moist, black (5Y,2.5/1M).
5		Installed grout/bentonite seal to 17.0 feet. Standard penetration spoon "N" values as follows: @1.5 ft. = 7; @5 ft. = 8; @10 ft. = 28; @15 ft. = 34; @20 ft. = +50; @25 ft. = 53.		CH	SILTY CLAY, high plasticity, dark olive grey (5Y,3/2M).
10				GC	CLAYEY SAND AND GRAVEL, poorly graded, subangular, low plasticity, dark brown (10YR,3/3M).
15				SM	SILTY SAND, fine to med. trace clay, very low plasticity, olive grey (5Y,4/2M).
20		Placed bentonite seal from 17.0 to 19.0 feet. Installed filter pack of "concrete sand" from 19.0 to 28.0 ft. Placed well screen of .01-in. slot from 21.0 to 26.0 ft.		CH CL GM	LACUSTRINE DEPOSITS: SILTY CLAY, high plasticity, dark brown (10YR,3/3). SILTY CLAY, low to med. plasticity, dark olive grey (5Y,3/2). SILTY SAND AND GRAVEL, poorly graded, subrounded, nonplastic, very dark grey (5Y,3/1).
25		Placed blank sump from 26.0 to 28.0 ft. Cave-in fill from 28.0 to 34.5.			
30					
35		Hole over-drilled to 34.5 ft. to allow for cave-in interval for positioning of screen.			TD AT 34.5. (SPOON SAMPLING STOPPED AT 26 FEET).
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
10.8	08:00	8/14/84
12.1	07:39	9/19/92

JEG TAC TEAM

PROJECT LAKE VIEW PROCESS SITELOG OF WELL BORING NO. 506JOB NO. LKV01 LAKE VIEW, ORDATE 07/11/84TOTAL DEPTH 85.4 feetSURFACE ELEVATION 4742.91RIG TYPE CME-75TOP OF FILTER PACK 68.50BORING TYPE H.S. AUGERWELL CASING TYPE 2.0-IN. SCHED 40 PVCLOCATION N 7478.80 E 3340.70COMPLETION LACUSTRINEDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					
60					
65		Placed bentonite seal from 66.0 to 68.5 feet.			
70		Installed filter pack of "concrete sand" from 68.5 to 82.0 ft.			
75		Placed well screen of .01-in. slot from 75.0 to 80.0 ft.			
80		Placed blank sump from 80.0 to 82.0 ft.			
85		Cave-in fill from 82.0 to 85.4.			
90		Hole over-drilled to 85.4 ft. to allow for cave-in interval for positioning of screen.			
95					
100					

SM

SILTY SAND, fine to med., trace fine gravel, nonplastic, dark olive grey (5Y,3/2).

TD AT 84.5 FEET. SPOON SAMPLING ENDED AT 85.4 FEET.

GROUNDWATER

DEPTH	HOUR	DATE
14.5	08:00	8/14/84
14.6	16:09	8/31/92

JEG TAC TEAM

PROJECT LAKE VIEW PROCESS SITE
LAKE VIEW, OR.JOB NO. LKV01 DATE 08/09/84SURFACE ELEVATION 4740.92TOP OF FILTER PACK 66.00WELL CASING TYPE 2.0-IN. SCHED 40 PVCCOMPLETION LACUSTRINETOTAL DEPTH 81.0 feetRIG TYPE CME-75BORING TYPE H.S. AUGERLOCATION N 6599.60 E 6097.70DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in. PVC well to 77.0 feet. Placed steel protective casing to 4 feet.		CH	ALLUVIUM: SANDY CLAY, med. to high plasticity, moist, black (10yr, 2/2M) to dark yellowish brown (10YR, 4/4M).
5		Installed grout/bentonite seal to 63.5 feet. Standard penetration spoon "N" values as follows: @5 ft. = 4; @10 ft. = 64; @15 ft. = 37; @20 ft. = 17; @25 ft. = 47; @30 ft. = 10; @35 ft. = 12; @40 ft. = 37; @45 ft. = 53; @50 ft. = 20+; @55, 60...80 ft. = 50+.		GM	SILTY SAND AND GRAVEL, poorly graded, subangular, moist, very dark greyish brown (10YR, 3/2M). Note: Layer of silty sand from 14 to 15.5 ft.
10				SP	LACUSTRINE DEPOSITS:
15				SM	SAND, fine, trace fine gravel, some silt, nonplastic, dark brown (10YR, 3/3).
20				CH	SILTY CLAY, high plasticity, dark grey (5Y, 4/1M).
25				GM	SILTY SAND AND GRAVEL, poorly graded, some clay, subangular, low plasticity, dark brown (10YR, 3/3M).
30				SM	SILTY SAND, fine, nonplastic, dark brown (10YR, 3/3).
35				CH	SILTY CLAY, high plasticity, dark yellowish brown to dark grey (10YR, 3/4 to 4/1M).
40				SC	CLAYEY SAND, fine to med., some fine gravel, low to med. plasticity, dark brown (10YR, 3/3M).
45				CH	SILTY CLAY, high plasticity, brown (10YR, 4/3M).
50					

GROUNDWATER

DEPTH	HOUR	DATE
11.5	10:38	8/14/84
12.1	13:18	8/31/92

JEG TAC TEAM

PROJECT LAKE VIEW PROCESS SITE
LAKE VIEW, OR.

LOG OF WELL BORING NO. 509

JOB NO. LKV01 DATE 07/30/84
SURFACE ELEVATION 4740.06
TOP OF FILTER PACK 24.50
WELL CASING TYPE 2.0-IN. SCHED 40 PVC
COMPLETION LACUSTRINETOTAL DEPTH 37.5 feet
RIG TYPE CME-75
BORING TYPE H.S. AUGER
LOCATION N 6897.10 E 4762.60
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in. PVC well to 34.0 feet.		ML	ALLUVIUM:
		Placed steel protective casing to 4 feet.		CH	SANDY SILT, fine grained sand, nonplastic, moist, very dark to med. grey (5Y,3/1M to 5Y,5/1M).
5		Installed grout/bentonite seal to 22.5 feet.		GM	SILTY CLAY, high plasticity, black (5Y,2.5/2M).
				SM	SILTY SAND AND GRAVEL, poorly graded, some clay, low plasticity, dark brown (10YR,3/3).
10		Placed bentonite seal from 22.5 to 24.5 feet.			SILTY SAND, fine to med., little fine gravel, nonplastic, dark olive grey (5Y,3/2).
15		Installed filter pack of "concrete sand" from 24.5 to 34.0 ft.			
		Placed well screen of .01-in. slot from 27.0 to 32.0 ft.		CH	LACUSTRINE DEPOSITS:
20		Placed blank sump from 32.0 to 34.0 ft.			SILTY CLAY, high plasticity, moist, dark yellowish brown to dark grey (10YR,3/4M) to 10YR,4/1M).
25		Cave-in fill from 34.0 to 37.5.		GM	SAND AND GRAVEL, poorly graded, some silt, subangular, nonplastic, wet, dark olive grey (5Y,3/2).
30		Hole over-drilled to 37.5 ft. to allow for cave-in interval for positioning of screen.		SP	SAND, fine to medium, some silt, nonplastic, dark olive grey (5Y, 3/2M).
35		Standard penetration spoon "N" values as follows: @10 ft. = 21; @15 ft. = 21; @20 ft. = 13; @25 ft. = 30; @30,35 ft. = 50+.		SM	
40					TD AT 37.5 FEET.
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
6.8	06:18	8/16/84
7.4	15:30	12/14/89

JEG TAC TEAM

PROJECT LAKE VIEW PROCESS SITE
LAKE VIEW, OR.

Page 2 of 2
 LOG OF WELL BORING NO. 510

JOB NO. LKV01 DATE 07/28/84

TOTAL DEPTH 79.5 feet

SURFACE ELEVATION 4739.87

RIG TYPE CME-75

TOP OF FILTER PACK 66.00

BORING TYPE H.S. AUGER

WELL CASING TYPE 2.0-IN. SCHED 40 PVC

LOCATION N 6901.10 E 4761.60

COMPLETION LACUSTRINE

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					
60				ML	SANDY SILT, nonplastic, very dark grey (5Y,3/1).
65				SP	SAND, fine, some silt, nonplastic, dark olive grey (5Y,3/2).
70		Placed bentonite seal from 64.0 to 66.0 feet.			
75		Installed filter pack of "concrete sand" from 66.0 to 75.0 ft.			
80		Placed well screen of .01-in. slot from 68.0 to 73.0 ft.		CH	SILTY CLAY, high plasticity, very dark grey (5Y,3/1).
85		Placed blank sump from 73.0 to 75.0 ft.			
90		Cave-in fill from 75.0 to 79.5.			
95		Hole over-drilled to 79.5 ft. to allow for cave-in interval for positioning of screen.			
100					

GROUNDWATER		
DEPTH	HOUR	DATE
8.1	10:28	8/14/84
9.3	15:35	12/14/89

JEG TAC TEAM

PROJECT LAKE VIEW PROCESS SITE
LAKE VIEW, OR

Page 1 of 3
 LOG OF WELL BORING NO. 512

JOB NO. LKV01 DATE 07/14/84
 SURFACE ELEVATION 4746.35
 TOP OF FILTER PACK 72.00
 WELL CASING TYPE 2.0-IN.SCHED 40 PVC
 COMPLETION LACUSTRINE

TOTAL DEPTH 125.0 feet
 RIG TYPE CME-75
 BORING TYPE H.S.AUGER
 LOCATION N 8002.80 E 4023.30
 DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in.PVC well to 87.0 feet. Placed steel protective casing to 4 feet.		ML	ALLUVIUM: CLAYEY SILT, low plasticity, moist, very dark brown(10YR,2/2).
5		Installed grout/bentonite seal to 70.0 feet.		ML	SILT, some fine sand, nonplastic, moist, dark grey (10YR,4/1).
10		Standard penetration spoon "N" values as follows: @5 ft. = 24; @10 ft. = 48; @15 ft. = 40; @20 ft. = 17; @25 ft. = 61; @30 ft. = 50+;		GM	SAND AND GRAVEL, poorly graded, some silt, nonplastic, olive grey (5Y,4/2M).
15		@35,40....50 ft. = 50+; @55ft. = 16; @60-75ft. = 50+. @55,60...80 ft. = 50+.		SP	LACUSTRINE DEPOSITS: ? SAND, fine to med., some fine gravel, nonplastic, dark olive grey.(5Y,3/2M).
20				CL	SANDY CLAY, little fine gravel, med. plasticity, black (5Y,2.5/2M).
25				SP SM	SAND, fine, some silt, trace fine gravel, nonplastic, dark olive grey (5Y,3/2).
30				CH SM	SILTY CLAY, med. to high plasticity, dark olive grey (5Y,3/2). SILTY SAND, fine, nonplastic, dark olive grey (5Y,3/2).
35				ML	SANDY SILT, nonplastic, dark olive grey (5Y,3/2M).
40				SM	SILTY SAND, trace fine gravel, nonplastic, dark olive grey (5Y,3/2M). Note: Occasional seam of silty clay.
45					Note: Color changes to very dark grey, no gravel from 43 feet.
50				GM	SANDY GRAVEL, poorly graded, some silt, nonplastic, very dark grey (5Y,3/1M).

GROUNDWATER

DEPTH	HOUR	DATE
17.9	18:00	8/14/84
17.0	08:55	8/08/85

JEG TAC TEAM

PROJECT LAKE VIEW PROCESS SITE
LAKE VIEW, OR.

Page 3 of 3
 LOG OF WELL BORING NO. 512

JOB NO. LKV01 DATE 07/14/84
 SURFACE ELEVATION 4746.35
 TOP OF FILTER PACK 72.00
 WELL CASING TYPE 2.0-IN. SCHED 40 PVC
 COMPLETION LACUSTRINE

TOTAL DEPTH 125.0 feet
 RIG TYPE CME-75
 BORING TYPE H.S. AUGER
 LOCATION N 8002.80 E 4023.30
 DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					
110				SM	SILTY SAND, fine, trace clay, very low plasticity, moist, dark olive grey (5Y,3/2).
115				CH	SILTY CLAY, high plasticity, moist, dark olive grey (5Y,3/2).
120				SM	SILTY SAND, fine to med., little clay, trace fine gravel, very low plasticity, dark olive grey (5Y,3/2M).
125					Note: No clay below 122.5 ft.
130					
135					
140					
145					
150					
155					
					TD AT 125 FEET.

GROUNDWATER

DEPTH	HOUR	DATE
17.9	18:00	8/14/84
17.0	08:55	8/08/85

JEG TAC TEAM

PROJECT LAKE VIEW PROCESS SITE
LAKE VIEW, OR.

Page 1 of 2
 LOG OF WELL BORING NO. 514

JOB NO. LKV01 DATE 07/20/84
 SURFACE ELEVATION 4749.55
 TOP OF FILTER PACK 66.00
 WELL CASING TYPE 2.0-IN. SCHED 40 PVC
 COMPLETION LACUSTRINE

TOTAL DEPTH 79.5 feet
 RIG TYPE CME-75
 BORING TYPE H.S. AUGER
 LOCATION N 8812.30 E 4381.00
 DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in. PVC well to 75.0 feet. Placed steel protective casing to 4 feet.		ML	ALLUVIUM: SANDY SILT, nonplastic, dark brown to lt. grey (7.5YR,3/2).
5		Installed grout/bentonite seal to 64.0 feet. Standard penetration spoon "N" values as follows: @10 ft. = 44; @15 ft. = 32; @20 ft. = 28; @25 ft. = 50+; @30 ft. = 11; @35 ft. = 50+; @40 ft. = 37; @45 ft. = 70; @50 ft. = 78; @55 ft. = 14.		GM	SILTY SAND AND GRAVEL, poorly graded, subrounded, nonplastic, wet, dark brown (10YR,3/3M).
10				SP	LACUSTRINE DEPOSITS: SAND, with fine gravel, some-little silt, nonplastic, black (5Y,2.5/2M).
15					
20				SC	CLAYEY SAND, fine, low plasticity, moist, olive grey (5Y,4/2).
25				SM	SILTY SAND, fine, nonplastic, wet, black (5Y,2.5/2M).
30				ML	SANDY SILT, trace clay, very low plasticity, olive (5Y,4/3M).
35				CL	SANDY CLAY, low-med. plasticity, moist, black (5Y,2.5/2M).
40					
45					
50				SP SM	SAND, fine to med., some fine gravel, nonplastic, wet, black (5Y,2.5/2M).

GROUNDWATER

DEPTH	HOUR	DATE
18.1	10:06	8/14/84
17.1	09:44	08/08/85

JEG TAC TEAM

PROJECT LAKE VIEW PROCESS SITE
LAKE VIEW, OR.LOG OF WELL BORING NO. 515JOB NO. LKV01 DATE 07/20/84
SURFACE ELEVATION 4750.97
TOP OF FILTER PACK 18.00
WELL CASING TYPE 2.0-IN. SCHED 40 PVC
COMPLETION LACUSTRINE DEPOSITSTOTAL DEPTH 27.5 feet
RIG TYPE CME-75
BORING TYPE H.S. AUGER
LOCATION N 9465.80 E 4601.30
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in. PVC well to 25.0 feet. Placed steel protective casing to 4 feet.		ML	ALLUVIUM: SANDY SILT, nonplastic, dark brown (10YR,3/3 to light grey (10YR, 7/1M).
5		Installed grout/bentonite seal to 16.0 feet.		GM	SAND AND GRAVEL, poorly graded, subrounded, some silt, nonplastic, wet, dark brown (10YR,3/3M).
10				SM	SILTY SAND, fine to med., nonplastic, dark grey (10YR,4/1).
15		Placed bentonite seal from 16.0 to 18.0 feet.		CH	SILTY CLAY, high plasticity, dark grey (10YR,4/1M).
20		Installed filter pack of "concrete sand" from 18.0 to 25.0 ft. Placed well screen of .01-in. slot from 18.0 to 23.0 ft.		GM	SILTY SAND AND GRAVEL, poorly graded, nonplastic, black (5Y,2.5/2/M).
25		Placed blank sump from 23.0 to 25.0 ft. Cave-in fill from 25.0 to 27.5.		CH	SILTY CLAY, high plasticity, dark grey (5Y,4/1).
30		Hole over-drilled to 27.5 ft. to allow for cave-in interval for positioning of screen. Standard penetration spoon "N" values as follows: @10 ft. = 34; @15 ft. = 14; @20 ft. = 69; @25 ft. = 43;			TD AT 27.5 FEET. SPOON SAMPLES ENDED AT 26 FEET.
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
5.7	10:03	8/14/84
6.0	09:27	08/08/85

JEG TAC TEAM

PROJECT LAKE VIEW PROCESS SITE
LAKE VIEW, OR.LOG OF WELL BORING NO. 516JOB NO. LKV01 DATE 07/19/84
SURFACE ELEVATION 4750.95
TOP OF FILTER PACK 62.00
WELL CASING TYPE 2.0-IN. SCHED 40 PVC
COMPLETION LACUSTRINE DEPOSITSTOTAL DEPTH 81.0 feet
RIG TYPE CME-75
BORING TYPE H.S. AUGER
LOCATION N 9466.10 E 4597.40
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55				SM ML	CLAYEY SILT intercalated with silty fine sand lenses, low plasticity, moist, black (5Y,2.5/2M).
60					
65		Placed bentonite seal from 62.0 to 65.0 feet. Installed filter pack of "concrete sand" from 65.0 to 77.0 ft.		SC	CLAYEY SAND, fine, low plasticity, moist, dark olive grey (5Y,3/2M).
70		Placed well screen of .01-in. slot from 70.0 to 75.0 ft.		SM	SILTY SAND, fine to med., little fine gravel, nonplastic, wet, black (5Y,2.5/2M).
75		Placed blank sump from 75.0 to 77.0 ft. Cave-in fill from 77.0 to 81.0.		ML	CLAYEY SILT, with fine sand, low to med. plasticity, dark olive grey (5Y,3/2).
80		Hole over-drilled to 81.0 ft. to allow for cave-in interval for positioning of screen.			TD AT 81 FEET. SPOON SAMPLES ENDING AT 81 FT.
85					
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
8.8	10:00	8/14/84
6.9	09:25	08/08/85

JEG TAC TEAM

PROJECT LAKE VIEW PROCESS SITE
LAKE VIEW, OR.LOG OF WELL BORING NO. 517JOB NO. LKV01 DATE 07/22/84
SURFACE ELEVATION 4753.57
TOP OF FILTER PACK 66.00
WELL CASING TYPE 2.0-IN. SCHED 40 PVC
COMPLETION LACUSTRINE DEPOSITSTOTAL DEPTH 80.3 feet
RIG TYPE CME-75
BORING TYPE H.S. AUGER
LOCATION N 8070.40 E 6106.10
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					very dark grey (10YR, 3/1M). Note: Several thin gravel seams between 52.5 and 53.5 feet.
60				SM	SILTY SAND, fine, nonplastic, moist, dark greyish brown (2.5Y, 4/2M).
65		Placed bentonite seal from 64.0 to 66.0 feet.			Note: Color change to dark olive grey, and saturated, with occasional thin seam of silty clay from 65 feet.
70		Installed filter pack of "concrete sand" from 66.0 to 75.0 ft.			
75		Placed well screen of .01-in. slot from 68.0 to 73.0 ft.			
		Placed blank sump from 73.0 to 75.0 ft.		GM	SILTY SAND AND GRAVEL, poorly graded, subrounded, some to little clay, low to very low plasticity, moist, dark greyish brown (2.5Y, 4/2M).
		Cave-in fill from 75.0 to 79.5.		SC	CLAYEY SAND, fine, low plasticity, moist, dark yellowish brown (10YR, 4/4M).
80		Hole over-drilled to 79.5 ft. to allow for cave-in interval for positioning of screen.			TD AT 80.3 FEET. SPOON SAMPLING ENDED AT 80.3 FT.
85					
90					
95					
100					

GROUNDWATER		
DEPTH	HOUR	DATE
17.8	11:00	8/14/84
18.3	10:32	08/08/85

JEG TAC TEAM

PROJECT LAKE VIEW PROCESS SITE
LAKE VIEW, OR.LOG OF WELL BORING NO. 519JOB NO. LKV01 DATE 08/03/84TOTAL DEPTH 45.0 feetSURFACE ELEVATION 4746.57RIG TYPE CME-75TOP OF FILTER PACK 27.00BORING TYPE AUGER/ROTARY REAMWELL CASING TYPE 6.0-IN. SCHED 40 PVCLOCATION N 8006.30 E 4044.40COMPLETION LACUSTRINEDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 6-in. PVC well for pumping test to 40.0 feet.		ML	ALLUVIUM: SANDY SILT, fine sand, nonplastic, moist, lt. brownish grey to very dark greyish brown (10YR, 6/1M to 10YR, 3/2M).
5		Placed steel protective casing to 6 feet.			
		Installed grout/bentonite seal to 24.5 feet.			
10		Standard penetration spoon "N" values as follows: @5 ft. = 27; @10 ft. = 36; @15 ft. = 40; @20 ft. = 28; @25, 30 & 35 ft. = 50+.		GM	SILTY SAND SAND GRAVEL, poorly graded, some clay, subangular, low plasticity, very moist, dark brown (10YR, 3/3M). Note: Color change at 10.5 feet to very dark grey, and becoming saturated.
15					
20					
25		Placed bentonite seal from 24.5 to 27.0 feet.		ML	LACUSTRINE DEPOSITS: SANDY SILT, nonplastic, moist, dark olive grey (5Y, 3/2).
30		Installed filter pack of "concrete sand" from 27.0 to 40.0 ft. Placed well screen of .015-in. slot from 28.0 to 38.0 ft.		SM	SILTY SAND, fine to medium, nonplastic, saturated, dark olive grey (5Y, 3/2). Occasional seam of silty clay and clayey silt.
35					
40		Placed blank sump from 38.0 to 40.0 ft.			
		Cave-in fill from 40.0 to 45.0.			
45		After drilling with auger, hole reamed with 10-in. rotary/air.			
		Hole over-drilled to 45.0 ft. to allow for cave-in interval for positioning of screen.			
50					
					Note: Drilled with hollow stem auger to 36 feet, then reamed with 10-in. rotary bit to 45 feet. No lithology log from 36 to 45 ft.
					TD AT 45 FEET.

GROUNDWATER

DEPTH	HOUR	DATE
12.6	08:00	8/14/84
12.6	17:02	8/08/85

JEG TAC TEAM

PROJECT LAKE VIEW PROCESS SITE
LAKE VIEW, OR.JOB NO. LKV01 DATE 07/27/84SURFACE ELEVATION 4746.49TOP OF FILTER PACK 48.00WELL CASING TYPE 2.0-IN. SCHED 40 PVCCOMPLETION LACUSTRINE DEPOSITSTOTAL DEPTH 61.0 feetRIG TYPE CME-75BORING TYPE H.S. AUGERLOCATION N 8006.50 E 4022.60DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in. PVC well to 57.0 feet. Placed steel protective casing to 4 feet.		ML	ALLUVIUM: SANDY SILT, fine sand, nonplastic, moist, black to very dark greyish brown (10YR,2/1M).
5		Installed grout/bentonite seal to 46.0 feet. Standard penetration spoon "N" values as follows: @10 ft. = 61; @15 ft. = 26; @20 ft. = 21; @25 ft. = 60; @30 ft. = 50+; @35 ft. = 50+; @40 ft. = 41; @45 ft. = 50+; @50 ft. = 50+; @55 ft. = 20.		GM	SILTY SAND AND GRAVEL, poorly graded, subangular, nonplastic, wet, dark brown (10YR,3/3).
10				GM	LACUSTRINE DEPOSITS: ? SILTY SAND AND GRAVEL, poorly graded, subangular, nonplastic, wet, dark olive grey (5YR,3/2). Note: Occasional seam of clayey silt.
15				SP	SILTY SAND, fine, nonplastic, wet, dark olive grey (5YR,3/2).
20				SM	Note: Occasional thin seams of sandy silt and silty clay.
25					Note: Color change to very dark grey (5YR,3/1M).
30					Note: Includes some fine gravel from 48 feet.
35					
40					
45		Placed bentonite seal from 46.0 to 48.0 feet.			
50		Installed filter pack of "concrete sand" from 48.0 to 57.0 ft.			

GROUNDWATER

DEPTH	HOUR	DATE
14.9	08:00	8/14/84
13.8	08:58	08/08/85

JEG TAC TEAM

PROJECT LAKE VIEW PROCESS SITE
LAKE VIEW, OR

Page 1 of 1
 LOG OF WELL BORING NO. 523

JOB NO. LKVO1 DATE 08/16/84
 SURFACE ELEVATION 4758.07
 TOP OF FILTER PACK 16.00
 WELL CASING TYPE 2.0-IN. SCHED 40 PVC
 COMPLETION LACUSTRINE

TOTAL DEPTH 27.5 feet
 RIG TYPE CME-75
 BORING TYPE H.S. AUGER
 LOCATION N 10412.40 E 5088.50
 DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in. PVC well to 25.0 feet. Placed steel protective casing to 4 feet.		CH ML	ALLUVIUM: SANDY CLAY, some fine to coarse gravel, occasional cobble, med. to high plasticity, moist, very dark brown (10YR,2/2M).
5		Installed grout/bentonite seal to 14.0 feet.		SM	SANDY SILT, fine sand, nonplastic, moist, greyish brown to light brownish grey (10YR,5/2 to 10YR,6/2M).
10					LACUSTRINE DEPOSITS: ? SILTY SAND, fine, nonplastic, wet, black (5Y,2.5/2M). Note: Occasional seams of silt.
15		Placed bentonite seal from 14.0 to 16.0 feet.			
20		Installed filter pack of "concrete sand" from 16.0 to 26.0 ft. Placed well screen of .01-in. slot from 18.0 to 23.0 ft. Placed blank sump from 23.0 to 25.0 ft.		GP	SAND AND GRAVEL, poorly graded, some silt, subrounded, nonplastic, wet, dark olive grey (5Y,3/2M).
25				CH	SILTY CLAY, high plasticity, moist, dark olive grey (5Y,3/2).
26.4		Cave-in fill from 26.0 to 27.5.			TD AT 26.4 FEET. SPOON SAMPLER ENDED AT 26.4 FEET.
30		Hole over-drilled to 27.5 ft. to allow for cave-in interval for positioning of screen.			
35					
40					
45		Standard penetration spoon "N" values as follows: @5 ft. = 21; @10 ft. = 41; @15 ft. = 20; @20 ft. = 22; @25 ft. = 95; @30 ft. = 50+;			
50					

GROUNDWATER

DEPTH	HOUR	DATE
6.5	14:50	8/26/84
4.9	16:25	12/14/89

JEG TAC TEAM

LOG OF WELL BORING NO. 524

PROJECT LAKE VIEW PROCESS SITE
LAKE VIEW, ORJOB NO. LKV01 DATE 08/15/84SURFACE ELEVATION 4758.12TOP OF FILTER PACK 65.00WELL CASING TYPE 2.0-IN. SCHED 40 PVCCOMPLETION LACUSTRINETOTAL DEPTH 79.5 feetRIG TYPE CME-75BORING TYPE H.S. AUGERLOCATION N 10412.10 E 5092.90DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55				SC	CLAYEY SAND, fine, low plasticity, moist, dark grey (5Y,4/1M).
60					
65		Placed bentonite seal from 63.0 to 65.0 feet.		CH	SILTY CLAY, high plasticity, moist, very dark grey (5T,3/1M). Note: Occasional thin seams of silty sand.
70		Installed filter pack of "concrete sand" from 65.0 to 75.0 ft. Placed well screen of .01-in. slot from 68.0 to 73.0 ft.			
75		Placed blank sump from 73.0 to 75.0 ft.		CL	SANDY CLAY, med. plasticity, moist, very dark grey (5Y,3/1M).
80		Cave-in fill from 75.0 to 79.5 feet.			TD AT 74.7 FEET. SPOON SAMPLING ENDED AT 74.7 FT.
85		Hole over-drilled to compensate for expected cave-in fill.			
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
6.2	10:02	8/27/84
4.5	16:25	12/14/89

JEG TAC TEAM

PROJECT LAKE VIEW PROCESS SITE
LAKE VIEW, ORLOG OF WELL BORING NO. 526JOB NO. LKVO1 DATE 08/13/84
SURFACE ELEVATION 4737.82
TOP OF FILTER PACK 64.00
WELL CASING TYPE 2.0-IN. SCHED 40 PVC
COMPLETION LACUSTRINETOTAL DEPTH 81.0 feet
RIG TYPE CME-75
BORING TYPE H.S. AUGER
LOCATION N 6486.20 E 4069.40
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in. PVC well to 68.0 feet. Placed steel protective casing to 4 feet.		ML	ALLUVIUM: CLAYEY SILT, low plasticity, moist, very dark greyish brown (10YR,3/2M).
5		Installed grout/bentonite seal to 58.0 feet. Standard penetration spoon "N" values as follows: @5 ft. = 14; @10 ft. = 19; @15 ft. = 32; @20 ft. = 21; @25 & 30 ft. = 50+.		CH	SANDY CLAY, high plasticity, moist, dark yellowish brown (10YR,3/4M).
10				GM	SILTY SAND AND GRAVEL, poorly graded, subangular, nonplastic, wet, dark brown (10YT,3/3M).
15				SM	LACUSTRINE DEPOSITS: ? SILTY SAND, fine to medium, nonplastic, wet, dark olive grey (5Y,3/2M).
20				GM	SILTY SAND AND GRAVEL, poorly graded, nonplastic, wet, dark olive grey (5Y,3/2M).
25				CH	SILTY CLAY, high plasticity, moist, dark olive grey (5Y,3/2M).
30				GP	SAND AND GRAVEL, poorly graded, some silt subrounded, nonplastic, wet, black (5Y,2.5/2M).
35				SM	SILTY SAND, very fine, some clay, low plasticity, moist, dark olive grey (5Y,3/2M).
40					Note: Changing to nonplastic sands but with occasional thin seam of silty clay.
45					Note: Color change to very dark greyish brown (2.5Y,3/2M).
50				SC	CLAYEY SAND, fine, low to med. plasticity, moist, brown (10YR,4/3M).
				SM	SILTY SAND, fine, nonplastic, wet,

GROUNDWATER

DEPTH	HOUR	DATE
14.5	07:35	9/06/84
13.6	16:23	08/30/92

JEG TAC TEAM

PROJECT LAKE VIEW PROCESS SITE
LAKE VIEW, OR.

Page 2 of 2
 LOG OF WELL BORING NO. 526

JOB NO. LKV01 DATE 08/13/84 TOTAL DEPTH 81.0 feet
 SURFACE ELEVATION 4737.82 RIG TYPE CME-75
 TOP OF FILTER PACK 64.00 BORING TYPE H.S. AUGER
 WELL CASING TYPE 2.0-IN. SCHED 40 PVC LOCATION N 6486.20 E 4069.40
 COMPLETION LACUSTRINE DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					dark olive grey (5Y,3/2). Note: Grain size changing to fine to medium.
60		Placed bentonite seal from 58.0 to 60.0 feet.			
65		Installed filter pack of "concrete sand" from 60 to 61 ft. with more bentonite seal from 61 to 64 feet, then filter pack from 64 to 68 feet. Placed well screen of .010-in. slot from 61.0 to 66.0 ft.		GM	SILTY SAND AND GRAVEL, poorly graded, nonplastic, moist, olive grey (5Y,4/2M).
70		Note: bentonite seal placed in upper three feet of screen areadue to incorrect measurement.		CH	SILTY CLAY, moist, high plasticity, moist, dark olive grey (5Y,3/2M).
75		Placed blank sump from 66.0 to 68.0 ft.		SM	SILTY SAND, fine, nonplastic, wet, dark olive grey (5Y,3/2M). Occasional seams of silty clay.
80		Cave-in fill from 68.0 to 81.0.			
85		Hole over-drilled to 81.0 ft. to allow for cave-in interval for positioning of screen.			TD AT 81 FEET. SPOON SAMPLING ENDED AT 81 FEET.
90					
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
14.5	07:35	9/06/84
13.6	16:23	08/30/92

JEG TAC TEAM

PROJECT LAKE VIEW PROCESS SITE
LAKE VIEW, OR.

Page 1 of 1
 LOG OF WELL BORING NO. 541

JOB NO. LKVO1 DATE 06/08/90
 SURFACE ELEVATION 4745.55
 TOP OF FILTER PACK 13.00
 WELL CASING TYPE 4-IN. SCHED. 40 PVC
 COMPLETION LACUSTRINE DEPOSITS

TOTAL DEPTH 30.0 feet
 RIG TYPE SCHRAM ROTADRILL
 BORING TYPE ROTARY AIR
 LOCATION N 7938.71 E 4223.85
 DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 4-in. well casing to 28 feet.		CL	SOIL: SANDY CLAY, med. plasticity, brown, some gravel.
5		Steel protective casing placed to 4 feet.			
		Cement grout with bentonite placed to 6 ft.		GM	LACUSTRINE DEPOSITS: SILTY SAND AND GRAVEL, gravel to 1-in., subrounded, nonplastic, dark olive grey.
10		Installed bentonite pellet seal from 6 to 13 feet.			
15		Placed 8-12 filter pack from 13 to 27 feet.			
20					
25		.050-inch slot screen placed from 21 to 26 ft.			
		Installed 2-ft. sump from 26 to 28 feet.			Note: becoming harder at 26 feet.
30		Cave-in fill from 28 to 30 feet.			
30					TD AT 30 FEET.
35					
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
11.5	08:05	6/24/90
14.3	08:48	9/01/92

JEG TAC TEAM

APPENDIX B

**LITHOLOGIC LOGS AND MONITOR WELL CONSTRUCTION INFORMATION
FOR THE COLLINS RANCH DISPOSAL SITE**

PROJECT COLLINS RANCH DISPOSAL SITE
LAKE VIEW, OREGON
 JOB NO. LKV02 DATE 08/22/84
 SURFACE ELEVATION 4953.82
 TOP OF FILTER PACK 38.00
 WELL CASING TYPE 2.0-IN.SCHED. 40 PVC
 COMPLETION QUATERNARY LACUSTRINE

LOG OF WELL BORING NO. 501

TOTAL DEPTH 49.9 feet
 RIG TYPE CME-75
 BORING TYPE HS AUGER
 LOCATION N 26662.60 E 17998.00
 DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in. pvc cased well to 47 ft.		SC	LACUSTRINE:
				CH	CLAYEY SAND, with gravel, subrounded, medium plasticity, moist, dark brown (10YR,3/3M).
5		Placed steel protective casing to 4 feet.		ML	SANDY CLAY, little fine gravel, med. to high plasticity, moist, dk. brown (10YR,3/3M).
		Installed bentonite/ cement grout to 36 feet.			SANDY SILT, fine sand, trace clay, very low plasticity, moist, light yellowish brown (10YR,6/3M).
10					
15					
20				SM	SILTY SAND, very fine, nonplastic, moist, lt. brown (10YR,6/3M). Note: Occasional lenses of sandy silt.
25					
30				ML	SANDY SILT, fine, nonplastic, lt. moist, yellowish brown (10YR,6/4M).
35					
40		Installed bentonite pellet seal from 36 to 38 feet.			
		Placed concrete sand filter pack from 38 to 48 feet.		SM	SILTY SAND, fine, nonplastic, moist, dark yellowish brown (10YR,4/4M).
45		Placed .010-in slot well screen from 40 to 45 feet.			
		Placed two foot sump from 45 to 47 feet.		ML	SANDY SILT, moderately cemented, mod. hard, nonplastic, moist, dark brown (7.5Y, 4/4M).
50		Cave-in fill from 48 to 49.5 ft.			TD AT 49.9 FEET.

GROUNDWATER		
DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT COLLINS RANCH DISPOSAL SITE
LAKE VIEW, OREGON

LOG OF WELL BORING NO. 503

JOB NO. LKV02 DATE 08/21/84

SURFACE ELEVATION 4905.86

TOP OF FILTER PACK 36.00

WELL CASING TYPE 2.0-IN. SCHED. 40 PVC

COMPLETION QUATERNARY LACUSTRINE

TOTAL DEPTH 54.0 feet

RIG TYPE CME-75

BORING TYPE HS AUGER

LOCATION N 25970.10 E 18002.10

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in. pvc cased well to 54 ft.		GC	ALLUVIUM: CLAYEY SAND AND GRAVEL, poorly graded, subrounded, low plasticity, slt. moist, lt. yellowish brown (10YR, 6/4M).
5		Placed steel protective casing to 4 feet.		CH	LACUSTRINE: SANDY CLAY, trace of fine gravel, med. to high laticity, slt. moist, (10YR, 4/4M).
10		Installed bentonite/cement grout to 34 feet.		CL	SANDY CLAY, trace fine gravel, medium plasticity, moist, yellowish brown (10YR, 5/4M).
15					
20				CH	SILTY CLAY, high plasticity, moist, yellowish brown (10YR, 5/4M).
25				CL	SANDY CLAY, medium to high plasticity, moist, dk. yellowish brown (10YR, 4/4M). Note: Occasional seams of clayey sand.
30				ML	SANDY SILT, trace of clay, very low plasticity, moist, olive brown. (2.5Y, 4/4M). Note: Occasional seams of silty sand.
35		Installed bentonite pellet seal from 34 to 36 feet.		SM	SILTY SAND, fine, nonplastic, moist, yellowish brown (10YR, 3/4M). Note: Occasional thin seam of coarse sand with some gravel.
40		Placed concrete sand filter pack from 36 to 53 feet.		SP	SAND, fine to med., little silt, nonplastic, moist, dk. brown (10YR, 3/3M).
45		Placed .010-in slot well screen from 38 to 43 feet.		SM	Note: Occasional thin layer of silt. SILTY SAND, very fine to fine, nonplastic, moist, lt. olive brown (10YR, 4/4M)
50		Placed two foot sump from 43 to 45 feet.		ML	SILT, with fine sand, trace clay, very low plasticity, moist, dark yellowish brown (10YR, 4/4M).
					TD AT 50.8 FEET.

GROUNDWATER		
DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT COLLINS RANCH DISPOSAL SITE
LAKE VIEW, OREGON

Page 1 of 1
 LOG OF TEST BORING NO. 504

JOB NO. LKV02 DATE 08/20/84

LOCATION NE
 RIG TYPE CME-75
 BORING TYPE HS AUGER 6.5-IN
 SURFACE ELEV MSL
 DATUM MSL

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample Type	Sample Type	Blows/foot- 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classifi- cation	REMARKS	VISUAL CLASSIFICATION
5	15/20/25		S	45				CL	samples taken with standard split spoon at intervals indicated.	ALLUVIUM ?: SANDY CLAY, some gravel, med. plasticity, slightly moist, dark brown (10YR,3/3M).
	52/50/3		S	50				CL		LACUSTRINE: SANDY CLAY, low to medium plasticity, slt. moist, lt. yellowish brown (10YR,6/4M)
	34/51		S	50				SC		CLAYEY SAND, fine, with fine gravel, low plasticity, moist, dk. yellowish brown (10YR,4/4M).
	50/4		S	50						SANDY CLAY, medium plasticity, moist, dk. yellowish brown (10YR,3/4M).
	20/28/3		S	50						SANDY CLAY, high plasticity, moist, olive (5Y,5/3M).
10	24/33/35		S	50						SANDY SILT, with little clay, very low plasticity, moist, yellowish brown (10YR,5/4M).
	9/10/11		S	21				CL		
	6/8/15		S	23				CH		
	10/29/30		S	50						
20	10/15/17		S	50				ML		
	19/26		S	50					Borehole decommissioned after completion.	
25	50/4		S	50						
	19/25/41		S	50						TD AT 26.0 FEET.

GROUNDWATER		
DEPTH	HOUR	DATE

SAMPLE TYPE
 RX - Rock Coring - NX or HX
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 3" O.D. thin-walled Shelby tube.
 G - Grab, cuttings sample

JEG TAC TEAM

PROJECT COLLINS RANCH DISPOSAL SITE
LAKE VIEW, OREGON

LOG OF TEST BORING NO. 506

JOB NO. LKV02 DATE 08/20/84

LOCATION NE

RIG TYPE CME-75

BORING TYPE HS AUGER 6.5-IN

SURFACE ELEV

DATUM MSL

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample Type	Blows/ft 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classifi- cation	REMARKS	VISUAL CLASSIFICATION
0			S	39			ML	samples taken with standard split spoon at intervals indicated.	LACUSTRINE: SANDY SILT , little clay, very low plasticity, moist, dk. yellowish brown (10YR,4/4M). SANDY CLAY , med. plasticity, slightly moist, dk. yellowish brown (10YR,3/4M). CLAYEY SILT , low plasticity, moist, lt. brown to lt. yellowish brown (10YR,6/4M). Note: Occasional thin seam of silty clay. Becoming very moist at 24 ft.
13			S	50			ML		
26			S	50					
50/4"			S	50					
50/4"			S	50					
21			S	50					
30			S	50					
42			S	50					
15			S	50					
21			S	50					
32			S	50				Borehole decommissioned after completion.	TD AT 26 FEET.
14			S	50					
22			S	50					
32			S	39					
10			S	29					
28			S	34					
31			S	38					
16			S						
19			S						
20			S						
12			S						
12			S						
25			S						
14									
15									
19									
16									
18									
20									

GROUNDWATER

DEPTH	HOUR	DATE

SAMPLE TYPE

RX - Rock Coring - NX or HX
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 3" O.D. thin-walled Shelby tube.
 G - Grab, cuttings sample

JEG TAC TEAM

PROJECT COLLINS RANCH DISPOSAL SITE
LAKE VIEW, OREGON

LOG OF WELL BORING NO. 507

JOB NO. LKV02 DATE 08/23/84

TOTAL DEPTH 79.5 feet

SURFACE ELEVATION 4929.32

RIG TYPE CME-75

TOP OF FILTER PACK 67.00

BORING TYPE HS AUGER

WELL CASING TYPE 2.0-IN. SCHED. 40 PVC

LOCATION N 26033.60 E 18405.90

COMPLETION QUATERNARY LACUSTRINE

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					
60					
65		Installed bentonite pellet seal from 65 to 67 feet.			Note: Change to dk. yellowish brown at 63.5 feet.
67		Placed concrete sand filter pack from 67 to 78 feet.		ML	SANDY SILT, nonplasticity, moist, yellowish brown (10YR, 5/4M).
70		Placed .010-in slot well screen from 68.5 to 73.5 feet.		SM	SILTY SAND, fine, nonplastic, moist, dk. greyish brown (2.5y, 4/2m).
75		Placed two foot sump from 73.5 to 75.5 feet.			
75.9					TD AT 75.9 FEET.
80		Cave-in fill from 78 to 79.5 ft.			
85					
90					
95					
100					

GROUNDWATER		
DEPTH	HOUR	DATE

JEG TAC TEAM

2 of 2

PROJECT COLLINS RANCH DISPOSAL SITE
LAKE VIEW, OREGONLOG OF WELL BORING NO. 508JOB NO. LKV02 DATE 08/24/84SURFACE ELEVATION 4922.71TOP OF FILTER PACK 65.50WELL CASING TYPE 2.0-IN. SCHED. 40 PVCCOMPLETION QUATERNARY LACUSTRINETOTAL DEPTH 92.0 feetRIG TYPE CME-75BORING TYPE HS AUGERLOCATION N 25644.60 E 18339.50DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55				SM	SILTY SAND, fine, nonplastic, moist, dk. olive brown (5Y,3/2M).
60				ML	SILT, with fine sand, trace clay, very low plasticity, moist, lt. yellowish brown (10YR,6/4M).
65		Installed bentonite pellet seal from 63.5 to 65.5 feet.			Note: Changing to dark grey at 62 feet.
70		Placed concrete sand filter pack from 65.5 to 89.5 feet.			
75					Note: Changing to dark brown at 77.5 feet.
80				SM	SILTY SAND, fine, nonplastic, moist, olive brown (5Y,3/2M).
85		Placed .010-in slot well screen from 82 to 87 feet.			
		Placed two foot sump from 87 to 89 feet.		ML	SANDY SILT, nonplastic, moist, dark olive (5Y,3/2M).
90		Cave-in fill from 89 to 92 ft.			TD AT 90.2 FEET.
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT COLLINS RANCH DISPOSAL SITE
LAKE VIEW, OREGON

LOG OF WELL BORING NO. 510

JOB NO. LKV02 DATE 08/26/84
 SURFACE ELEVATION 4984.63
 TOP OF FILTER PACK 116.00
 WELL CASING TYPE 2.0-IN. SCHED. 40 PVC
 COMPLETION QUATERNARY LACUSTRINE

TOTAL DEPTH 132.5 feet
 RIG TYPE CME-75
 BORING TYPE HS AUGER
 LOCATION N 26435.30 E 18761.90
 DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in. pvc cased well to 125 feet.		SC	ALLUVIUM ?: CLAYEY SAND, fine, with fine gravel, low plasticity, slightly moist, dk. brown (10YR,3/3M).
				SM	
5		Placed steel protective casing to 4 feet.			LACUSTRINE: SILTY SAND, fine to med., trace f. gravel, nonplastic, slightly moist, lt. yellowish brown (10YR,6/4M).
		Installed bentonite/cement grout to 114 feet.		SC	
10				ML	CLAYEY SAND, fine, low plasticity, moist, brownish yellow (10YR,6/6M).
				SM	SILT, with fine sand, trace clay, very low plasticity, moist, brownish yellow (10YR,6/6M).
15					SILTY SAND, fine, nonplastic, moist, yellowish brown (10YR,5/4M). Note Occasional seam of silt.
				ML	
20					SILT, with fine sand, nonplasticity, moist, brownish yellow to lt. brown (10YR7/4M).
25					
				ML	
30					SILT, with fine sand, trace clay, very low plasticity, moist, olive (5Y,5/4M).
					Note: Occasional seam of silty clay.
35					
40					
45					
50					

GROUNDWATER		
DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT COLLINS RANCH DISPOSAL SITE
LAKE VIEW, OREGON

LOG OF WELL BORING NO. 510

JOB NO. LKV02 DATE 08/26/84

TOTAL DEPTH 132.5 feet

SURFACE ELEVATION 4984.63

RIG TYPE CME-75

TOP OF FILTER PACK 116.00

BORING TYPE HS AUGER

WELL CASING TYPE 2.0-IN. SCHED. 40 PVC

LOCATION N 26435.30 E 18761.90

COMPLETION QUATERNARY LACUSTRINE

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					
110					
115		Installed bentonite pellet seal from 114 to 116 feet.		ML	SILT, with fine sand, nonplastic, moist, dk. yellowish brown (10YR,3/4M).
120		Placed concrete sand filter pack from 116 to 129 feet.		SM	SILTY SAND, fine, nonplastic, moist, olive brown (2.5Y,4/4M).
125		Placed .010-in slot well screen from 118 to 123 feet.			Note; Occasional thin lenses of coarse sand, with trace f. gravel.
125		Placed two foot sump from 123 to 125 feet.			TD AT 124.8 FEET.
130		Cave-in fill from 129 to 132.5 ft.			
135					
140					
145					
150					
155					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT COLLINS RANCH DISPOSAL SITE
LAKE VIEW, OREGONLOG OF TEST BORING NO. 512JOB NO. LKV02 DATE 08/21/84LOCATION NERIG TYPE CME-75BORING TYPE HS AUGER 6.5-IN

SURFACE ELEV

DATUM MSL

Depth in Feet	Continuous Penetration Resistance	Graphical Log	Sample	Sample Type	Blows/foot 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classifi- cation	REMARKS	VISUAL CLASSIFICATION
0	5/10/17			S	27			CH	samples taken with standard split spoon at intervals indicated.	LACUSTRINE: SANDY CLAY, fine, med. to high plasticity, moist, brown (10YR,5/3M).
10/14/19				S	33					
5	10/15/51			S	50			SC		CLAYEY SAND, fine, little gravel, low plasticity, slightly moist, lt. brown (10yr,6/3).
								SM		SILTY SAND, fine, nonplastic, moist, med. to dk yellowish brown (10yr,4/4m).
38-50/4*				S	50					
10	25/36/39			S	50					
24/29/35				S	50					
15	21/24/31			S	50					
24/32/33				S	50				Borehole decommissioned after completion.	Note: Considerable fine gravel from 20.2 TO 23.0 ft.
20	24/30/42			S	50					
14/19/35				S	50					
25	16/22/28			S	50					TD AT 26 FEET.

GROUNDWATER

DEPTH	HOUR	DATE

SAMPLE TYPE

RX - Rock Coring - NX or HX
 S - 2" O.D. 1.38" I.D. tube sample.
 U - 3" O.D. 2.42" I.D. tube sample.
 T - 3" O.D. thin-walled Shelby tube.
 G - Grab, cuttings sample

JEG TAC TEAM

PROJECT COLLINS RANCH DISPOSAL SITE
LAKE VIEW, OREGON

LOG OF WELL BORING NO. 514

JOB NO. LKV02 DATE 09/06/84

TOTAL DEPTH 24.5 feet

SURFACE ELEVATION 4886.46

RIG TYPE CME-75

TOP OF FILTER PACK 10.00

BORING TYPE HS AUGER

WELL CASING TYPE 2.0-IN. SCHED. 40 PVC

LOCATION N 26211.00 E 16981.30

COMPLETION QUATERNARY LACUSTRINE

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in. pvc cased well to 20 ft.		GC	LACUSTRINE: CLAYEY SAND AND GRAVEL, occasional cobble, poorly graded, low to med. plasticity, slightly moist, lt. yellowish brown (10YR,6/4).
5		Placed steel protective casing to 4 feet.			
		Installed bentonite/cement grout to 8 feet.			
10		Installed bentonite pellet seal from 8 to 10 feet.		ML	SILT, with fine sand, nonplastic, moist, dk. yellowish brown (10YR,5/4M).
15		Placed concrete sand filter pack from 10 to 22 feet.		ML	SANDY SILT, with fine sand, little clay, low plasticity, moist, dk. yellowish brown (10YR,3/6M). Note: Occasional seams of silty sand.
20		Placed .010-in slot well screen from 13 to 18 feet.			Note: Hole not logged below last spoon sample at 20 feet.
25		Placed two foot sump from 18 to 20 feet.			TD AT 24 FEET.
30		Cave-in fill from 22 to 24.5 ft.			
35					
40					
45					
50					

GROUNDWATER		
DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT COLLINS RANCH DISPOSAL SITE
LAKE VIEW, OREGON

Page 1 of 1

LOG OF WELL BORING NO. 516

JOB NO. LKV02 DATE 09/07/84
 SURFACE ELEVATION 4892.69
 TOP OF FILTER PACK 11.00
 WELL CASING TYPE 2.0-IN. SCHED. 40 PVC
 COMPLETION QUATERNARY LACUSTRINE

TOTAL DEPTH 24.5 feet
 RIG TYPE CME-75
 BORING TYPE HS AUGER
 LOCATION N 26676.80 E 16829.70
 DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in. pvc cased well to 20 ft.		GC	LACUSTRINE: CLAYEY SAND AND GRAVEL, Occasional cobbles, poorly graded, subrounded, low plasticity, slightly moist, yellowish brown (10yr,5/4). Note: Occasional lens of sandy clay.
5		Placed steel protective casing to 4 feet.			
10		Installed bentonite/ cement grout to 9 feet.		ML	SANDY SILT, very fine sand, nonplastic, moist, yellowish brown (10YR,5/6). Note: Occasional seam of sandy clay, and possibly water bearing seam of silty sand.
15		Installed bentonite pellet seal from 9 to 11 feet.			
20		Placed concrete sand filter pack from 11 to 23 feet.		SM	SILTY SAND, fine, nonplastic, wet, dk. yellowish brown (10YR,4/4M).
25		Placed .010-in slot well screen from 13 to 18 feet.		ML	CLAYEY SILT, with fine sand, low plasticity, very moist, dk. yellowish brown (10YR,4/6M).
30		Placed two foot sump from 18 to 20 feet.			Note: borehole not logged after last spoon sample taken at 20.9 feet.
35		Cave-in fill from 23 to 24.5 ft.			TD AT 24.5 FEET.
40					
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
15.0	08:50	9-7-84

JEG TAC TEAM

PROJECT COLLINS RANCH DISPOSAL SITE
LAKE VIEW, OREGON

LOG OF WELL BORING NO. 520

JOB NO. LKV02 DATE 08/23/86

SURFACE ELEVATION 4939.75

TOP OF FILTER PACK 99.00

WELL CASING TYPE 2.0-IN. SCHED. 80 PVC

COMPLETION QUATERNARY LACUSTRINE

TOTAL DEPTH 151.5 feet

RIG TYPE SCHRAM ROTADRILL

BORING TYPE ROTARY MUD

LOCATION N 26200.65 E 19410.56

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					LACUSTRINE, Continued.
60					
65				SP	SAND, poorly graded, medium grained, with little gravel and silt, nonplastic, moist, brown.
70					
75					
80					Note: Increased amounts of gravel, to 1/2 inch size, from 80 ft. depth.
85					
90				ML	CLAYEY SILT, trace fine sand, low plasticity, moist, brown.
95		Installed bentonite pellet seal from 96 to 99 feet.			
100		Placed No.20 sand filter pack from 99 to 151.5 feet.			Note: Moderately cemented zone at 100 ft. depth.

GROUNDWATER

DEPTH	HOUR	DATE
90.0	08:30	8-22-86
90.0	08:20	8-23-86

JEG TAC TEAM

PROJECT COLLINS RANCH DISPOSAL SITE
LAKE VIEW, OREGON

Page 1 of 3
 LOG OF WELL BORING NO. 521

JOB NO. LKV02 DATE 08/20/86
 SURFACE ELEVATION 4929.64
 TOP OF FILTER PACK 99.00
 WELL CASING TYPE 2.0-IN. SCHED. 80 PVC
 COMPLETION QUATERNARY LACUSTRINE

TOTAL DEPTH 148.0 feet
 RIG TYPE SCHRAM ROTADRILL
 BORING TYPE ROTARY MUD
 LOCATION N 25449.67 E 19640.73
 DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in. PVC cased well to 139.5 ft.		SP	LACUSTRINE: GRAVELLY SAND, medium, little to some silt, nonplastic, brown.
5		Placed steel protective casing to 5 feet.		GM	SILTY GRAVEL, fine to medium, nonplastic, brown.
10		Installed bentonite/cement grout to 96 feet.		SP	GRAVELLY SAND, coarse to fine, trace silt, fine gravel, nonplastic, brown.
15				SM	SILTY SAND, fine, nonplastic, with fine gravel, brown.
20				SM	SILTY SAND, fine, nonplastic, moist, brown. Frequent lenses of sandy silt, fine, nonplastic, brown.
25					
30					
35				SM	SILTY SAND, fine, little clay, slightly plastic, moist, brown. Occasional lenses with coarse sand.
40					
45					
50				ML	CLAYEY SILT, with fine sand, low plasticity, moist, yellowish brown to

GROUNDWATER		
DEPTH	HOUR	DATE
96.0	10:26	8-22-86
90.5	17:43	8-22-86

JEG TAC TEAM

PROJECT COLLINS RANCH DISPOSAL SITE
LAKE VIEW, OREGON

LOG OF WELL BORING NO. 521

JOB NO. LKV02 DATE 08/20/86

TOTAL DEPTH 148.0 feet

SURFACE ELEVATION 4929.64

RIG TYPE SCHRAM ROTADRILL

TOP OF FILTER PACK 99.00

BORING TYPE ROTARY MUD

WELL CASING TYPE 2.0-IN. SCHED. 80 PVC

LOCATION N 25449.67 E 19640.73

COMPLETION QUATERNARY LACUSTRINE

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					
110					
115					
120					
125				ML	SANDY SILT, medium, nonplastic, dk. brown.
130		Placed .020-in slot well screen from 128.5 to 138.5 feet.			
135				SM	SILTY SAND, fine, nonplastic, dk greyish brown.
140		Placed one foot sump from 138.5 to 139.5 feet.			
145		Cave-in fill from 139.5 to 148 ft.			
150				ML	SILT, nonplastic, brown.
155					TD AT 148 FEET.

GROUNDWATER

DEPTH	HOUR	DATE
96.0	10:26	8-22-86
90.5	17:43	8-22-86

JEG TAC TEAM

PROJECT COLLINS RANCH DISPOSAL SITE
LAKE VIEW, OREGON

Page 2 of 3
 LOG OF WELL BORING NO. 522

JOB NO. LKV02 DATE 08/20/86

TOTAL DEPTH 125.0 feet

SURFACE ELEVATION 4908.09

RIG TYPE SCHRAM ROTADRILL

TOP OF FILTER PACK 102.00

BORING TYPE ROTARY MUD

WELL CASING TYPE 2.0-IN. SCHED. 80 PVC

LOCATION N 24700.57 E 19449.69

COMPLETION QUATERNARY LACUSTRINE

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					LACUSTRINE, Continued.
				SP	SAND, poorly graded, medium to coarse, nonplastic, moist, brown.
60					Note: With little to some silt below 60 ft.
65					Note: Changing to fine sand below 65 ft.
70				ML	CLAYEY SILT, low plasticity, moist, yellow brown to bluish grey.
75					
80					
85					Note: With little to some sand from 85 to 93 ft.
90					
95					Note: Changing to yellow brown at 93 ft. Note: changing to brown from 95 feet.
100		Installed bentonite pellet seal from 99 to 102 feet.		SM	SILTY SAND, fine to med., nonplastic, moist, brown.

GROUNDWATER		
DEPTH	HOUR	DATE
86.0	19:00	8-18-86
73.0	10:00	8-19-86

JEG TAC TEAM

PROJECT COLLINS RANCH DISPOSAL SITE
LAKE VIEW, OREGON

LOG OF WELL BORING NO. 523

JOB NO. LKV02 DATE 08/26/86

TOTAL DEPTH 111.0 feet

SURFACE ELEVATION 4891.49

RIG TYPE SCHRAM ROTADRILL

TOP OF FILTER PACK 88.00

BORING TYPE ROTARY MUD

WELL CASING TYPE 2.0-IN. SCHED. 80 PVC

LOCATION N 25172.97 E 20147.73

COMPLETION QUATERNARY LACUSTRINE

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 2-in. PVC cased well to 108 ft.		GM	LACUSTRINE: SILTY SAND AND GRAVEL, fine to med. gravel, subrounded, brown.
5		Placed steel protective casing to 5 feet.		ML	GRAVELLY SILT, nonplastic, brown.
10		Installed bentonite/ cement grout to 82 feet.		SM ML	SILTY SAND, very fine, nonplastic, moist, dk. brown; Alternating with SANDY SILT, very fine, little clay, non plastic, brown.
15					
20					
25				ML	SILT, with fine sand, nonplastic, moist, brown.
30				SM	SILTY SAND, very fine, nonplastic, moist, brown.
35				SC	CLAYEY SAND, fine, low plasticity, moist, brown.
40				SM	SILTY SAND, fine, nonplastic, moist, brown.
45					
50					

GROUNDWATER

DEPTH	HOUR	DATE
52.5	15:09	8-25-86
54.5	18:22	8-26-86

JEG TAC TEAM

PROJECT COLLINS RANCH DISPOSAL SITE
LAKE VIEW, OREGON

LOG OF WELL BORING NO. 602

JOB NO. LKV02 DATE 05/18/90
SURFACE ELEVATION 4963.21
TOP OF FILTER PACK 79.20
WELL CASING TYPE 4.0-IN.SCHED. 40 PVC
COMPLETION QUATERNARY LACUSTRINE

TOTAL DEPTH 100.0 feet
RIG TYPE SCHRAM ROTADRILL
BORING TYPE ROTARY AIR
LOCATION N 26005.07 E 18747.11
DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55				SM	SILTY SAND, fine, trace gravel, nonplastic, very moist, tan. LACUSTRINE, continued. Note: No gravel from 57 ft. Possibly thin seams of clayey silt.
60				ML	SILT, with fine sand, trace clay, very low plasticity, very moist, lt. brown.
65				SM	SILTY SAND, fine, nonplastic, moist, lt. brown; intercalated with lenses of CLAYEY SILT, low to med. plasticity, brown.
70				SM	SILTY SAND, fine, trace fine gravel, nonplastic, moist, lt. brown.
75		Installed bentonite pellet seal from 72.2 to 79.2 feet.		ML	SILT, with fine sand, little clay, low plasticity, brown.
80		Placed No. 8-12 filter pack from 79.2 to 99.2 feet.		SM	SILTY SAND, fine, trace fine gravel, nonplastic, moist, lt. brown.
85				CL	SILTY CLAY, med. plasticity, tan.
90		Placed .050-in slot well screen from 87.2 to 97.2 feet.			
95		Placed two foot sump from 97.2 to 99.2 feet.			
100		Cave-in fill fro 99.2 to 100 ft.			TD AT 100 FT.

GROUNDWATER		
DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT COLLINS RANCH DISPOSAL SITE
LAKE VIEW, OREGON

Page 2 of 3
 LOG OF WELL BORING NO. 603

JOB NO. LKV02 DATE 05/22/90
 SURFACE ELEVATION 4966.66
 TOP OF FILTER PACK 80.00
 WELL CASING TYPE 4.0-IN. SCHED. 40 PVC
 COMPLETION QUATERNARY LACUSTRINE

TOTAL DEPTH 130.0 feet
 RIG TYPE SCHRAM ROTADRILL
 BORING TYPE ROTARY AIR
 LOCATION N 25639.30 E 18704.53
 DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					plasticity, moist, brown.
					LACUSTRINE, Continued.
60				ML	CLAYEY SILT, low plasticity, moist, tan.
65					
70					
75				ML	SILT, with fine sand, little clay, low plasticity, very moist, tan.
80		Installed bentonite pellet seal from 76 to 80 feet.			
		Placed No. 8-12 filter pack from 80 to 110 feet.			
85				CL	SANDY CLAY, med. plasticity, moist, tan.
90					
95					
100		Placed .050-in slot well screen from 98 to 108 feet.		SM	SILTY SAND, fine to med., nonplastic, moist, lt. brown.

GROUNDWATER		
DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT COLLINS RANCH DISPOSAL SITE
LAKE VIEW, OREGON

LOG OF WELL BORING NO. 604

JOB NO. LKV02 DATE 05/22/90

TOTAL DEPTH 100.0 feet

SURFACE ELEVATION 4960.71

RIG TYPE SCHRAM ROTADRILL

TOP OF FILTER PACK 76.50

BORING TYPE ROTARY AIR

WELL CASING TYPE 4.0-IN. SCHED. 40 PVC

LOCATION N 25397.45 E 18513.60

COMPLETION QUATERNARY LACUSTRINE

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 4-in. pvc cased well to 100 ft.		CL	ALLUVIUM: SANDY CLAY, with basalt gravel fragments, low to med. plasticity, slightly moist, dk. brown.
5		Placed steel protective casing to 5 feet.		CL	SANDY CLAY, trace fine gravel, low to med. plasticity, moist, tan.
10		Installed bentonite/cement grout to 68 feet.		SM	SILTY SAND, fine, nonplastic, moist, tan.
15					
20					
25				ML	CLAYEY SILT, with fine sand, med. plasticity, moist, lt. brown.
30				CL	SANDY CLAY, low plasticity, moist, brown.
35					
40				SC	CLAYEY SAND, fine to med. , low to med. plasticity, moist, brown.
45				ML	SILT, with fine sand, trace clay, very low plasticity, very moist, tan.
50					

GROUNDWATER

DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT COLLINS RANCH DISPOSAL SITE
LAKE VIEW, OREGON

LOG OF WELL BORING NO. 605

JOB NO. LKV02 DATE 05/23/90

TOTAL DEPTH 100.0 feet

SURFACE ELEVATION 4953.89

RIG TYPE SCHRAM ROTADRILL

TOP OF FILTER PACK 79.00

BORING TYPE ROTARY AIR

WELL CASING TYPE 4.0-IN. SCHED. 40 PVC

LOCATION N 25246.85 E 18263.20

COMPLETION QUATERNARY LACUSTRINE

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 4-in. pvc cased well to 100 ft.		ML SM	LACUSTRINE : SILT, with fine sand, nonplastic, slightly moist, brown.
5		Placed steel protective casing to 5 feet.			SILTY SAND, fine, nonplastic, moist, lt. brown
10		Installed bentonite/ cement grout to 74 feet.			
15					
20				ML	CLAYEY SILT, low to med. plasticity, moist, tan.
25				SM	SILTY SAND, fine, nonplastic, moist, dk. brown.
30				ML	CLAYEY SILT, with fine sand, low plasticity, moist, lt. brown.
35				SM	SILTY SAND, fine, nonplastic, moist, lt. brown.
40				ML	SILT, with fine sand, little clay, low plasticity, moist, tan.
45				SM	SILTY SAND, fine, nonplastic, moist, lt. brown.
50				ML	SILT, with fine sand, little clay, low plasticity, very moist, lt. brown.

GROUNDWATER		
DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT COLLINS RANCH DISPOSAL SITE
LAKE VIEW, OREGONLOG OF WELL BORING NO. 606JOB NO. LKV02 DATE 06/17/90SURFACE ELEVATION 4953.56TOTAL DEPTH 150.0 feetRIG TYPE SCHRAM ROTADRILLTOP OF FILTER PACK 111.00BORING TYPE ROTARY AIRWELL CASING TYPE 4.0-IN. SCHED. 40 PVCLOCATION N 25236.64 E 18260.19COMPLETION QUATERNARY LACUSTRINEDATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 4-in. pvc cased well to 148 ft.		SM	LACUSTRINE: SILTY SAND, fine, nonplastic, slightly moist, brown.
5		Placed steel protective casing to 5 feet.			
10		Installed bentonite/cement grout to 106 feet.			
15					
20					Note: Changing to very fine sand and dk. brown at 18 feet.
25					
30				CL	SANDY CLAY, medium plasticity, moist, brown.
35					
40				SM	SILTY SAND, fine, nonplastic, moist, dk. tan.
45					
50				CL	SILTY CLAY, med. plasticity, moist, tan.

GROUNDWATER

DEPTH	HOUR	DATE
144.0	16:00	6-17-90

JEG TAC TEAM

PROJECT COLLINS RANCH DISPOSAL SITE
LAKE VIEW, OREGON

LOG OF WELL BORING NO. 606

JOB NO. LKV02 DATE 06/17/90

SURFACE ELEVATION 4953.56

TOP OF FILTER PACK 111.00

WELL CASING TYPE 4.0-IN. SCHED. 40 PVC

COMPLETION QUATERNARY LACUSTRINE

TOTAL DEPTH 150.0 feet

RIG TYPE SCHRAM ROTADRILL

BORING TYPE ROTARY AIR

LOCATION N 25236.64 E 18260.19

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105		Installed bentonite pellet seal from 106 to 111 feet.			LACUSTRINE, Continued.
110		Placed No. 8-12 filter pack from 111 to 148 feet.		CL	SANDY CLAY, med. plasticity, moist, lt. brown.
115					
120					
125					
130					
135		Placed .050-in slot well screen from 136 to 146 feet.			
140					
145		Placed two foot sump from 146 to 148 feet.			
		Cave-in fill from 148 to 150 ft.			
150					TD AT 150 FT.
155					

GROUNDWATER		
DEPTH	HOUR	DATE
144.0	16:00	6-17-90

JEG TAC TEAM

PROJECT COLLINS RANCH DISPOSAL SITE
LAKE VIEW, OREGON

LOG OF WELL BORING NO. 607

JOB NO. LKV02 DATE 06/19/90

TOTAL DEPTH 150.0 feet

SURFACE ELEVATION 4961.20

RIG TYPE SCHRAM ROTADRILL

TOP OF FILTER PACK 110.00

BORING TYPE ROTARY AIR

WELL CASING TYPE 4.0-IN. SCHED. 40 PVC

LOCATION N 25405.67 E 18502.27

COMPLETION QUATERNARY LACUSTRINE

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
55					LACUSTRINE, Continued. Note: Approaching saturated condition.
60					Note: slightly less moisture.
65					SILTY CLAY, med. plasticity, moist, brown.
70				CL	SILTY SAND, fine, nonplastic, moist, brown.
75				SM	SANDY CLAY, medium plasticity, moist, brown.
80				CL	SILTY SAND, fine, nonplastic, moist, lt. brown.
85				SM	SANDY CLAY, medium plasticity, moist, brown.
90				CL	
95					
100					

GROUNDWATER

DEPTH	HOUR	DATE
140.0	17:10	6-18-90

JEG TAC TEAM

PROJECT COLLINS RANCH DISPOSAL SITE
LAKE VIEW, OREGON

LOG OF WELL BORING NO. 608

JOB NO. LKV02 DATE 06/20/90

SURFACE ELEVATION 4966.91

TOP OF FILTER PACK 120.00

WELL CASING TYPE 4.0-IN. SCHED. 40 PVC

COMPLETION QUATERNARY LACUSTRINE

TOTAL DEPTH 160.0 feet

RIG TYPE SCHRAM ROTADRILL

BORING TYPE ROTARY AIR

LOCATION N 25643.35 E 18693.88

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 4-in. pvc cased well to 160 ft.		CL	LACUSTRINE: SANDY CLAY, with fine gravel, medium plasticity, slightly moist, dk. brown..
5		Placed steel protective casing to 5 feet.		SM	SILTY SAND, fine, nonplastic, moist, lt. brown.
10		Installed bentonite/cement grout to 114 feet.			Note: Trace fine gravel from 13 ft.
15					
20					
25					Note: Occasional thin seams fo sandy clay from 25 feet.
30					
35				ML	SILT, with fine sand, nonplastic, moist, brown.
40					Note: Slightly plastic from 42 ft.
45					
50				SC	CLAYEY SAND, fine, low to med. plasticity, moist, brown.

GROUNDWATER

DEPTH	HOUR	DATE
153.0	11:11	6-20-90

JEG TAC TEAM

PROJECT COLLINS RANCH DISPOSAL SITE
LAKE VIEW, OREGON

LOG OF WELL BORING NO. 608

JOB NO. LKV02 DATE 06/20/90

TOTAL DEPTH 160.0 feet

SURFACE ELEVATION 4966.91

RIG TYPE SCHRAM ROTADRILL

TOP OF FILTER PACK 120.00

BORING TYPE ROTARY AIR

WELL CASING TYPE 4.0-IN. SCHED. 40 PVC

LOCATION N 25643.35 E 18693.88

COMPLETION QUATERNARY LACUSTRINE

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105				SM	SILTY TO CLAYEY SAND, fine, nonplastic to low plasticity, moist, brown.
110					LACUSTRINE, Continued.
115		Installed bentonite pellet seal from 114 to 120 feet.			
120		Placed No. 8-12 filter pack from 120 to 160 feet.			
125					
130				CL	SANDY CLAY, medium plasticity, moist, tan.
135					
140		Placed .050-in slot well screen from 148 to 158 feet.			
145					
150				SM	SILTY SAND, fine, nonplastic ; No sample recovery, lithology estimated from change in drilling rate.
155					

GROUNDWATER

DEPTH	HOUR	DATE
153.0	11:11	6-20-90

JEG TAC TEAM

PROJECT COLLINS RANCH DISPOSAL SITE
LAKE VIEW, OREGON

LOG OF WELL BORING NO. 609

JOB NO. LKV02 DATE 06/26/90

TOTAL DEPTH 150.0 feet

SURFACE ELEVATION 4963.21

RIG TYPE SCHRAM ROTADRILL

TOP OF FILTER PACK 116.00

BORING TYPE ROTARY AIR

WELL CASING TYPE 4.0-IN. SCHED. 40 PVC

LOCATION N 26007.66 E 18762.21

COMPLETION QUATERNARY LACUSTRINE

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
105					
110					LACUSTRINE, Continued.
115					
120					
125		Installed bentonite pellet seal from 116 to 122 feet.			
130		Placed No. 8-12 filter pack from 122 to 147 ft.			
135					
140		Placed .050-in slot well screen from 135 to 145 feet.			
145					Note: No sample recovery from 110 feet. Lithology based on continuity of drilling rate.
150		Placed two foot sump from 145 to 147 feet.			
155		Cave-in fill from 147 to 150 ft.			TD AT 150 FEET.

GROUNDWATER		
DEPTH	HOUR	DATE

JEG TAC TEAM

PROJECT COLLINS RANCH DISPOSAL SITE
LAKE VIEW, OREGON

Page 1 of 3
 LOG OF WELL BORING NO. 609

JOB NO. LKV02 DATE 06/26/90

SURFACE ELEVATION 4963.21

TOP OF FILTER PACK 116.00

WELL CASING TYPE 4.0-IN. SCHED. 40 PVC

COMPLETION QUATERNARY LACUSTRINE

TOTAL DEPTH 150.0 feet

RIG TYPE SCHRAM ROTADRILL

BORING TYPE ROTARY AIR

LOCATION N 26007.66 E 18762.21

DATUM MSL

Depth	Well Con.	Remarks	Lithology	USCS	Visual Classification
0		Installed 4-in. pvc cased well to 147 ft.		CL	LACUSTRINE: SANDY CLAY, with fine gravel, low to medium plasticity, slightly moist, dk. brown.
5		Placed steel protective casing to 5 feet.		ML	SANDY SILT, very low plasticity, moist, tan.
10		Installed bentonite/cement grout to 116 feet.			
15				CL	SANDY SILT, little clay, low plasticity, moist, brown.
20				CL	SANDY CLAY, medium plasticity, moist, brown.
25				ML	CLAYEY SILT, low plasticity, moist, tan.
30				ML	SANDY SILT, fine, nonplastic, moist, lt. tan.
35					Note: Becoming very moist at 37 feet.
40					
45				CL	SILTY CLAY, med. plasticity, moist, tan.
50					

GROUNDWATER		
DEPTH	HOUR	DATE

JEG TAC TEAM

**DATE
FILMED**

12 / 29 / 93

END