Final Technical Evaluation Report

for DOE's Remedial Action at the

LAKEVIEW UMTRA PROJECT SITE

Oregon

November 1990

Uranium Recovery Field Office
Region IV
Nuclear Regulatory Commisssion

Table of Contents

1.0 INTRODUCTION

The Lakeview, Oregon, mill tailings site is one of 24 abandoned uranium mill tailings piles designated to receive remedial action by the U.S. Department of Energy (DOE) under the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA). UMTRCA requires, in part, that the U.S. Nuclear Regulatory Commission (NRC) concur with DOE's selection of remedial actions, to assure that those remedial actions meet the standards promulgated by the U.S. Environmental Protection Agency (EPA). This final Technical Evaluation Report (fTER) documents the review of DOE's remedial action plan (DOE, 1989) and outlines the conclusions resulting from this review. Information in this fTER is freely cited from DOE submittals. Other sources are cited as appropriate.

1.1 EPA Standards

As required by UMTRCA, remedial action at Lakeview must comply with standards established by the EPA in 40 CFR Part 192, Subparts A-C. To summarize:

(1) The disposal site shall be designed to control tailings and other residual radioactive material for up to 1000 years to the extent reasonably achievable and, in any case, for at least 200 years [40 CFR 192.02(a)].

(2) The disposal site shall be designed to limit releases of radon-222 from residual radioactive materials to the atmosphere to an average of not more than 20 picocuries/square meter/second (pCi/m^2s) and the annual average concentration of radon-222 in air at or above any location outside the disposal site shall not be increased by more than 0.5 picocurie/liter (pCi/l) [40 CFR 192/02(b)].

(3) The remedial action shall provide reasonable assurance that radium-226 concentrations in land that is not part of the disposal site, averaged over any area of 100 square meters, do not exceed the background level by more than 5 picocuries/gram (pCi/g) averaged over the first 15 centimeters of soil below the surface and 15 pCi/g averaged over any 15-centimeter thick layer of soil more than 15 centimeters below the land surface [10 CFR 192.12(a)].

On September 3, 1985, the U.S. Tenth Circuit Court of Appeals remanded the ground-water standards [40 CFR Part 192.(a)(2)-(3)] and stipulated that EPA promulgate new ground-water standards. In September 1987, EPA issued draft revised standards in the form of revisions to Subparts A-C of 40 CFR Part 192. The proposed standards consist of two parts: standards applying to the cleanup of contamination that occurred before the remedial action of the tailings, and standards governing the control of future ground-water contamination that may occur from tailings piles after remedial action. When the EPA repromulgates final ground-water protection standards, the DOE will be required under UMTRCA to take appropriate action to comply with those standards.

1.2 Sites and Remedial Action

The Lakeview uranium mill was built in 1958 by the Lakeview Mining Company. The mill operated until 1961, during which time approximately 130,000 tons of ore were processed and 171 tons of uranium were produced by the acid-leach process.

The mill tailings processing site is located approximately 1 mile north of the Lakeview city limits in Lake County, Oregon (Figure 1). The site covers approximately 258 acres including 30 acres of tailings, 69 acres of evaporation ponds, and 25 acres of windblown tailings (Figure 2).

The remedial action for Lakeview consists of the following major activities.

(1) Excavation of a partially below ground disposal cell at the Collins Ranch site.

(2) Placement of a geochemical/flow barrier on the bottom and sides of the excavated disposal cell to minimize seepage from the relocated tailings into the ground-water system.

(3) Removal and cleanup of all contaminated material at the processing site and relocation to the disposal cell at the Collins Ranch site.

(4) Placement of a soil layer over the relocated tailings to minimize seepage of water into the tailings and to reduce radon emissions to EPA standards.

(5) Placement of a rock layer on the outslopes and a rock-soil matrix on the pile top for erosion protection.

(6) Construction of a ditch to divert flows away from the relocated pile.

(7) Placement of rock protection in the diversion ditch to minimize erosion potential.

After completion of the remedial action, the Collins R[illegible] disposal site will be fenced and posted with appropriate warning signs to [illegible]scourage human intrusion. In addition, the site will be surveyed and monitored periodically by a custodial agency under license from NRC. Once the surface and ground-water cleanup has been completed, the Lakeview processing site will be released for unrestricted use.

1.3 Review Process

The review was performed in accordance with the Standard Review Plan (SRP) for UMTRCA Title I Mill Tailings Remedial Action Plans (NRC, 1985) and consisted of comprehensive assessments of DOE's final design and remedial action plan. The remedial action information assessed during this review was provided primarily in the following documents:

(1) Remedial Action Plan and Site Design for Stabilization of the Inactive Uranium Mill Tailings Site at Lakeview, Oregon. Appendix B of the Cooperative Agreement No. DE-FC04-84AL20534, February 1989 (DOE, 1989).

(2) Uranium Mill Tailings Remedial Action Project (UMTRAP), Lakeview, Oregon, Calculations, Final Design for Construction, Volumes I-V, March 1986 (DOE, 1986a).

(3) Uranium Mill Tailings Remedial Action Project (UMTRAP), Lakeview, Oregon, Main Construction Subcontract Documents, March 1986 (DOE, 1986b).

(4) Standard Format and Content for Documentation of Remedial Action Selection at Title I Uranium Sites, NRC, February 24, 1989 (NRC, 1989a).

1.4 Summary of Open Items

Review of DOE's remedial action plan and site design has identified only one open issue which is addressed in Section 5.5 of this fTER. The issue relates to DOE's deferral of ground-water cleanup until after promulgation of EPA's final ground-water protection standards. This deferral is considered to be acceptable for conditional concurrence. When this issue is addressed, final concurrence will be provided on the remedial action at the site.

2.0 GEOLOGY/SEISMOLOGY

2.1 Geologic Site Characterization

The Lakeview processing site and the Collins Ranch disposal site are both located in the basin and range (BAR) physiographic province. The regional topography is characterized by alternating north to northwest trending ridges (horsts) and valleys (graben) caused by normal faulting. During the Pleistocene, these valleys (grabens) often contained lakes which filled the valleys with sediments to depths greater than 5000 feet. The processing and disposal sites are located in the Goose Lake Graben. The Goose Lake Graben sediments range from silts and clays to conglomerates and are underlain by Miocene and Pliocene volcanic deposits. Specifically, the sediments underlying the processing site are interbedded silts, sands, and clays of lacustrine and alluvial origins, while the disposal site is located on a remnant terrace deposit consisting of interfingered layers of silty sands, sandy silts, and surficial lenses of high plasticity clays.

2.2 Seismotectonic Site Characterization

2.2.1 Regional Tectonic Setting

Regionally, the Lakeview processing site and the Collins Ranch disposal site are located in the extreme northwest portion of the BAR, bounded on the west by the Cascade Mountain Province and on the north by the Columbia Plateau Province. The boundary between the BAR and the Columbia Plateau is delineated by a series of right-lateral strike-slip faults. These northwest trending faults are the result of crustal extensions which created westward transport of the BAR with respect to the Columbia Plateau to the north. The faults bound blocks which were subjected to internal extension on a set of conjugate normal faults trending about N20°E and N40°W. The sites are located in one of these blocks. Present day regional stress in this northwestern portion of the BAR is approximately N70°W to S70°E, and as a result, would cause rotation of the blocks and extension on the northwest and northeast conjugate faults. Previous fault displacements within this system have the typical BAR structure. Displacement on the major normal faults has been estimated to be at least 5000 feet, based on well logs.

Historically, southeastern Oregon is an area characterized by low to moderate seismicity. The region is characterized by moderate-sized earthquakes within seismic zones associated with the right lateral shears and low to moderate seismicity on normal faults within the horst-graben blocks. Earthquakes with a Modified Mercalli Intensity of VII have been recorded in the region.

2.2.2 Local Seismotectonic Setting

Both the Lakeview processing site and the Collins Ranch disposal site lie within the Goose Lake Graben, bounded on the west by the Fremont Mountains and on the east by the Warner Mountains. Large displacement normal faults of Pliocene to Holocene age bound the graben and probably additional fracturing and faulting exist in the down-dropped block underlying the graben. The site is located 0.5 mile west of the fault which separates the graben and the Warner Mountains. The DOE analysis of the hazards due to active (Holocene) faulting indicated that significant hazards could occur from activity on the following faults or fault zones: the Goose Lake Graben fault, the Warner Valley fault, the Abert Rim fault, the Summer Lake fault, the Surprise Valley fault zone, the frontal fault on the east flank of the Fremont Mountains, and unmapped faults in Goose Lake Valley.

DOE characterized regional seismicity by obtaining earthquake data bases provided by the National Oceanographic and Atmospheric Administration (NOAA); by applying accepted techniques to determine earthquake magnitudes; and by employing methods suggested in Section 2.2.4 of the NRC Standard Format and Content (NRC, 1989a) for calculating peak horizontal ground acceleration generated by a design-basis event.

In analyzing seismic risk at the disposal site, DOE used the constrained attenuation relationship of Campbell (Campbell, 1981, 1982). Based on these analyses, DOE concluded that the largest horizontal acceleration value would result from a 7.4 magnitude maximum credible earthquake occurring 6.5 km from the site. This event was recommended as the design earthquake, and the resulting onsite peak horizontal acceleration of 0.50g was recommended as the design acceleration.

The use of Campbell's relationships is considered to be appropriate for analyzing seismic risk and thus acceptable for use as design criteria for the Collins Ranch disposal site.

2.3 Geothermal Conditions

The Lakeview processing site is located in a Known Geothermal Resource Area (KGRA). The BAR is a province of high heat flow generally attributed to the existence of a thin, extending crust. The pattern of known geothermal anomalies in the BAR appears to follow the major north-south normal faults which mark the boundary between the mountain front and basins. In Oregon, there are five major areas, including the Lakeview KGRA.

The Lakeview KGRA is on the east side of the Goose Lake Valley and contains three hot springs and over 40 geothermal wells from 3 to 529 meters in depth. Both north and south of the KGRA and west along the western border of the Goose Lake Graben, additional hot springs and geothermal wells are located. Many of these wells and springs are located within 1.5 miles of the processing site. The closest, Hunters Hot Springs, is located about 250 feet north of the northernmost evaporation pond and 0.4 mile northwest of the processing site. Evidence of geothermal activity at the Lakeview site itself consists of water temperatures in the two monitor wells immediately north of the evaporation ponds which register 60° and 41° C respectively, as well as a 4-inch blowhole which opened through the snow in the south evaporation pond in January 1984.

The Collins Ranch disposal site is not located in the immediate vicinity of any known thermal waters. Antone Springs and other springs and one well located north and east of the site, have recorded temperatures ranging only from 20° to 23° C in contrast to the higher temperatures of 96° to 150° C reported in the town of Lakeview. Elevated water temperatures have not been noted in any of the ground-water monitoring wells advanced on the disposal site. The majority of the elevated temperatures in wells and springs in the Lakeview area are apparently associated with the east flank of the Goose Lake Graben. Migration of thermal waters away from this fault zone toward the Collins Ranch site, a distance of 3 km or more, is not likely during the design life of the proposed facility.

2.4 Conclusion

Based on a review of the Final Remedial Action Plan, the Final Design, and numerous DOE responses to review comments, it is concluded that there is reasonable assurance that regional and site geologic and seismologic conditions have been adequately characterized to meet the requirements of 40 CFR Part 192.

3.0 GEOTECHNICAL STABILITY

3.1 Geotechnical Site Characterization

The subsurface stratigraphy at the Collins Ranch disposal site was determined by drilling 17 borings to depths ranging from 25 to 240 feet and digging 8 test pits. Standard penetration tests were run on a nearly continuous basis over the entire depth of each boring. Both disturbed and undisturbed samples were obtained from the borings and test pits for further testing. The locations of the borings are shown on Figure 3.

The boring logs and subsequent testing show the foundation soils to consist of a complex series of interfingered and discontinuous lenses of silts, clays, sands, and various combinations of these. The complexity of the stratigraphy prevented the development of meaningful cross sections. The material for the radon barrier will be obtained through selective stockpiling of foundation excavation material at the Collins Ranch disposal site.

The complex stratigraphic picture described above is present at great depths underlying the site. The boring logs indicate that the near surface conditions extend to depths in excess of 250 feet. The results of standard penetration tests show the soils to be of a generally dense nature.

Based on a review of the information provided by DOE, it was concluded that the field exploration program was conducted in accordance with standard engineering practice. Further, the extent of the program was adequate to characterize the site.

3.2 Soil Properties

Geotechnical properties of the foundation soils were determined by performing various laboratory tests. The tests included moisture content, gradation, Atterberg Limits, specific gravity, consolidation, triaxial shear, and dispersivity tests. Blow counts obtained using the Standard Penetration Test (SPT) were also used to help determine geotechnical properties.

The foundation soils generally classified as CL (clays), SM (sands), or MH (silt) soils according to the Unified Soil Classification System. Of particular note are the MH soils, due to a potential for undesirable behavior. The MH soils exhibited high SPT (Standard Penetration Test) blow count values and overconsolidation ratios ranging from 11 to 16. In addition, the results of three types of dispersivity tests showed that the soil is nondispersive. The test results indicated that the MH soils do not exhibit any characteristics which could eliminate the proposed site as a disposal alternative.

A similar laboratory testing program was conducted to characterize the tailings and evaporation pond materials to be transported to the disposal site. The tailings consist of sands (SP, SM) and slimes (ML, CH). The evaporation pond material consists of a low density, high moisture content silt (MH). DOE documents often refer to this material as "ash."

All tests were conducted in accordance with applicable ASTM standards. Based on a review of the test results provided by DOE, it is concluded that the extent of soils testing was adequate to characterize the soils and tailings, and support the soil parameters used in the stability and settlement analyses.

3.3 Slope Stability

The DOE performed slope stability analyses to evaluate the stability of the reclaimed pile. Static and dynamic loading conditions were evaluated using the computer program STABL, which utilizes the Janbu Method, and infinite slope stability analyses.

A typical cross section of the reclaimed pile is shown on Figure 4. The cross section consists of the following layers: rock erosion protection, radon barrier, contaminated materials, tailings, geochemical/flow barrier liner, recompacted foundation soils, and natural foundation soils. The top of the pile will be graded to a slope of approximately 3 percent, while the embankment outslope will consist of 20 percent slopes.

Parameters used as input in the stability analyses were determined during the field and laboratory testing programs described previously. Parameters for the period immediately following construction were obtained by performing unconsolidated-undrained triaxial tests, while long-term strengths were obtained from consolidated-drained tests. SPT blow count values were used to estimate soil strengths for the foundation soils.

The results of the static stability analyses showed minimum factors of safety of 4.5 for the end of construction stage and 3.5 for the long-term stability. These values are well in excess of the minimum factors of safety of 1.3 and 1.5, respectively, recommended in Regulatory Guide 3.11 (NRC, 1977).

The pseudo-static stability analysis performed utilized a maximum acceleration coefficient of 0.35g. The acceleration value was based on a postulated maximum credible earthquake (MCE) with a Richter magnitude of 7.4 and an expected onsite peak horizontal acceleration of 0.50g. The pseudo-static analysis resulted in a factor of safety of 1.1. The value recommended in Regulatory Guide 3.11 (NRC, 1977) is 1.0.

The stability analyses conducted by DOE indicate that the proposed design exceeds the minimum factors of safety recommended in Regulatory Guide 3.11 (NRC, 1977). In addition, the stability analyses performed by the DOE are acceptable because appropriate parameters were used together with methodology widely used in engineering practice.

3.4 Settlement

An analysis of the settlement expected during and following construction activities at the disposal site was performed to evaluate the potential for disruption of the radon barrier and erosion protection layers. The settlement analysis was based on estimated compression/consolidation parameters for the granular foundation soils and the foundation clays, and the results of consolidation tests performed on remolded samples of evaporation pond materials and tailings.

The compression values for the granular foundation soils were estimated based on the SPT testing performed during the field exploration program. The consolidation parameters for the foundation clays were based on typical values from the engineering literature. A review indicated that the values used are conservative.

The results of the analysis indicated that the total settlement for the embankment and foundation soils would be approximately 2.25 feet, with 1.71 feet of the settlement expected to occur within the embankment itself. Since the materials comprising the embankment will be placed at water contents significantly less than saturation, the DOE estimated that about 90 percent of the total settlement would occur prior to placement of the cover materials. Further, the DOE concluded that the relatively small settlements occurring after cover placement will result in very small differential settlement with little potential for disruption of the cover. Based on a review of the analysis conducted by the DOE it was concluded that settlement will not affect the stability of the relocated tailings pile.

3.5 Liquefaction

The boring logs for the site showed the foundation soils to consist basically of fine-grained, cohesionless soils. As these are the types of soils considered susceptible to liquefaction, an analysis of the potential for liquefaction was conducted by the DOE.

There are two factors considered necessary for liquefaction of fine-grained, cohesionless soils: (1) saturation of the soils, and (2) a low relative density (soils with a relative density exceeding 70 percent are generally not considered susceptible to liquefaction). A review of data generated during the field program conducted by the DOE indicated that the minimum depth at which saturated soils were encountered was 35 feet. Thus, the soils above 35 feet do not have a potential for liquefaction. The SPT values for soils deeper than 35 feet indicate a relative density of at least 95 percent. These soils therefore do not exhibit a potential for liquefaction.

Based on a review of DOE's liquefaction analysis, it is concluded that the site should not be subject to liquefaction.

3.6 Construction Criteria

Construction specifications contained in the RAP include sections pertaining to disposal site clearing, dewatering, earthwork, and erosion protection. The earthwork section describes the material types, placement requirements, compaction requirements, and field quality control for fill sections. All testing is to be done to the applicable ASTM standard.

The contaminated materials will be placed at a minimum of 90 percent of the maximum dry density as determined by ASTM D698. During compaction, the moisture content of the material shall be uniform and will be maintained to achieve a specified density. All materials shall be moisture conditioned, if necessary, prior to compaction. Type 2 contaminated material, consisting of material excavated from the tailings pile, will be placed in the lower layers of the disposal cell. Type 1 material, consisting of windblown and the excavation of the evaporation ponds, will be placed above the Type 2 materials.

Uncontaminated fill will be comprised of the geochemical/flow barrier liner and the radon barrier. Radon barrier material shall consist of CL, MH, or ML soils with a maximum particle size of 2 inches and a minimum of 50 percent passing the No. 200 sieve. The materials shall have a plasticity index of 10 or greater. Geochemical/flow barrier liner material shall be similar to radon barrier material. Radon barrier material shall be placed at a minimum of 100 percent of the maximum dry density as determined by ASTM D698 and within plus three to minus one percent of the optimum moisture content. The geochemical/flow barrier liner shall be compacted to a minimum of 95 percent of the maximum dry density as determined by ASTM D698 at a moisture content greater than optimum moisture.

As a minimum, the in place density and moisture content of the fill shall be tested at least once for every 500 cubic yards of fill placed. Classification and gradation tests of the uncontaminated fill shall be performed at least once for every 2000 cubic yards placed. The quality control program is better defined by the Remedial Action Inspection Plan (RAIP). The latest version of the RAIP reviewed was Revision 3 dated April 6, 1989.

The review of the earthwork specifications provided in the RAP indicate that adequate construction requirements and controls have been provided to ensure that the disposal site will be constructed as designed. The specifications are complete and are consistent with standard engineering practice.

3.7 Conclusion

The analyses that were performed to demonstrate the stability of the remedial action plan used acceptable methodology and sound engineering judgment. It was concluded that the proposed remedial action will meet the EPA criteria with regard to geotechnical stability.

4.0 SURFACE WATER HYDROLOGY AND EROSION PROTECTION

4.1 Hydrologic Description

The Collins Ranch disposal site is located approximately 7 miles northwest of Lakeview, Oregon (Figure 1). The site is situated in a relatively steep area against the southwest slope of Mt. Auger. Flood runoff in drainage channels is produced by rainfall on very small drainage areas at the site.

The remediated embankment will be constructed at the disposal site by relocation, mixing, and consolidation of the Lakeview processing site tailings. In order to comply with EPA standards, which require stability of the tailings for a 1000-year (or minimum 200-year) period, DOE proposes to stabilize the relocated tailings and contaminated materials in an engineered embankment to protect them from flooding and erosion. Design criteria for protection of this embankment included the Probable Maximum Precipitation (PMP) and the Probable Maximum Flood (PMF) events, both of which are considered to have very low probabilities of occurrence during the 1000-year stabilization period.

The tailings will be consolidated into a single pile, which will be protected by a soil and rock cover. As shown in Figure 4, the cover will have maximum slopes of approximately 3 percent on the top and 20 percent on the sides. Disposal will be partially below grade, and diversion channels will be located on the north and west sides of the pile as shown on Figure 5. A 20-foot wide apron will be constructed at the downstream toe of the embankment, where it meets existing ground.

4.2 Geomorphic Considerations

The geomorphic setting at the site is relatively stable. The slopes in the area are generally well protected by a natural gravel and cobble armoring. There are no nearby water bodies which have a potential to adversely affect the site by meandering or erosion. Design measures have been provided to assure that headcutting or migration of a gully located at the toe of the pile will not affect the stability of the tailings (see 4.5, below).

4.3 Flooding Determinations

In order to determine site impacts from flooding, DOE analyzed flooding in various onsite drainage channels to determine peak flows and velocities and to evaluate the need for erosion protection measures. The DOE estimated the PMF peaks in the channels resulting from an occurrence of the PMP over the limited areas draining into the channels. These design events meet the criteria outlined in the Standard Review Plan (NRC, 1985) and are, therefore, acceptable. The details of the flood computations were analyzed as discussed below.

4.3.1 Probable Maximum Precipitation (PMP)

A PMP rainfall depth of approximately 7.2 inches in 1 hour was used by DOE to compute the PMF for the small drainage areas at the site. This rainfall estimate was developed by DOE using Hydrometeorological Report No. 49 (U.S. Department of Commerce, 1977). Based on a check of the rainfall computations, it was concluded that the PMP was acceptably derived for this site (see 4.3.4, below).

4.3.2 Infiltration Losses

DOE assumed that no infiltration losses would occur. This is a very conservative assumption, and is therefore acceptable.

4.3.3 Time of Concentration

Various times of concentration (tc) for the ditches and embankments were estimated by DOE using procedures discussed by the U.S. Department of the Interior (1977). Based on a review of the information provided by DOE, it was concluded that the procedures used for computing tc are representative of the small steep drainage areas present at the site. For those drainage areas with very short times of concentration, DOE utilized tc's as low as 2.5 minutes, which is generally considered conservative.

4.3.4 PMP Rainfall Distribution

DOE derived rainfall distributions and intensities from HMR-49, (U.S. Department of Commerce, 1977) which is acceptable. In the determination of peak flood flows, where the actual times of concentration were shorter than 5 minutes, rainfall intensities were extrapolated to the appropriate time of concentration (or to a minimum of 2.5 minutes). Based on a review of this aspect of the flooding determination, it was concluded that the rainfall intensities were acceptably derived. It should be noted that the site is actually located in the region covered by HMR-43 (U.S. Department of Commerce, 1966) and the PMP derived using that report is 8.4 inches in 1 hour (see 4.3.1, above). However, the PMP amounts and intensities for durations of less than 20 minutes are greater if HMR-49 is used. Since the drainage areas of interest at the site have times of concentration of less than 20 minutes, HMR-49 was conservatively used.

4.3.5 Computation of PMF

DOE utilized the rational formula (U.S. Department of the Interior, 1977) to compute the peak sheet flows down the slopes and PMF flows in the ditches, given the rainfall intensities discussed above. Based on a review of the calculations presented, it was concluded that this method of computation is acceptable.

4.4 Upstream Dam Failures

There are no upstream dams whose failure could affect the long-term stability of the site.

4.5 Design of Erosion Protection

4.5.1 Diversion Ditch

The remedial action design includes a diversion ditch north of the relocated pile. This ditch will intercept and route flood runoff away from the relocated tailings. The erosion protection for the diversion ditch was designed for an occurrence of a local PMP. This design basis meets the criteria outlined in the Standard Review Plan (NRC, 1985) and is, therefore, acceptable. The erosion protection was designed using the Safety Factors method (Simmons and Sentruk, 1977) which is also considered acceptable. At the outlet end where the ditch transitions to existing ground, the bottom of the ditch will flare out and the rock size will increase to dissipate the energy of the flowing water. In addition, the end of the flared section will have an energy dissipation area (EDA) to further reduce the flow velocities. The riprap protection used in the ditch will be 12 inches thick with a median stone diameter (D_{50}) of about 7 inches. In the flared area, the D_{50} will increase to 18 inches, and the thickness to 36 inches. This large riprap will be underlain by an additional 6-inch thick layer of riprap having a D_{50} of about 3 inches. The riprap in the EDA will have a D_{50} of about 3 inches and a thickness of 12 inches. All riprap will be placed on a 6 inch bedding layer.

4.5.2 Top and Sides of Pile

The rock covers, which will be used to protect the soil cover from wind and water erosion, are designed for an occurrence of the PMP. For the 3 percent slopes on the pile top, DOE proposes a 12-inch layer of rock having a D_{50} of about 1.5 inches. For the 20 percent slopes on the sides of the pile, DOE will place a 12-inch layer of rock having a D_{50} of about 3 inches. Each of the rock layers will be placed on a 6-inch bedding layer.

The Safety Factors Method (Simmons and Senturk, 1977) was used to determine required rock sizes for the top slopes of the pile. The Stephenson Method (Stephenson, 1979) was used for the side slopes.

The rock placed in the apron areas at the toes of the side slopes was designed using the Safety Factors Method (Simmons and Senturk, 1977). This rock will be placed 10 feet up the embankment side slopes and 20 feet downstream of the toe. To protect against undercutting of the toes, the aprons will terminate in a 3-foot wide and 3-foot deep key trench. The rock in the apron and key trench will have a D_{50} of 3 inches. In the apron, the rock will be 12 inches thick.

4.5.3 Rock Durability

During the preconstruction investigations, DOE identified a certain quarry as being an acceptable rock source for riprap. The NRC staff in their preliminary technical evaluation report agreed with DOE's assessment. However, the rock specifications provided by DOE to the remedial action subcontractor did not specify a specific quarry; instead, the contractor was given the option of selecting an alternate rock source as long as it met the durability specifications. The subcontractor elected to use an alternate quarry, identified as the Pepperling Quarry. Initial tests performed on the Pepperling rock indicated that it met the durability requirements. However, during riprap production, a seam of unacceptable rock in the orebody was crushed, processed, and stockpiled along with the acceptable rock. This resulted in riprap that did not meet the durability specifications.

As a result of the problems with the stockpiled Pepperling riprap, an extensive sampling and testing program was conducted. On the basis of the results of this program DOE, NRC, and the State of Oregon agreed that the stockpiled riprap could be used provided that certain modifications were made. These modifications included overthickening and oversizing the riprap where required, and relaxing the durability specifications. These agreements were reached by all parties involved, with the understanding that any new riprap would have to meet the original durability specifications.

The subcontractor attempted to produce additional riprap from the Pepperling Quarry using the original durability specifications. This attempt failed in that neither the original nor the relaxed durability specifications could be met. As a result, DOE conducted an investigation to identify alternative acceptable rock sources. Two potential rock sources were identified. However, DOE contended that the costs of obtaining rock from these two sources would be well above the costs of utilizing rock from the Pepperling Quarry. Furthermore, DOE contended that there was a possibility that the rock from the alternate sources might not meet the specifications after crushing and screening. On the basis of their investigations, DOE requested that they be allowed to determine the acceptability of a rock source by utilizing rock scoring criteria that had been proposed by NRC for rock of marginal quality (Johnson, 1985).

The information and justification provided by DOE were reviewed and it was agreed that the costs of obtaining rock from alternate sources were unreasonably high. It was thus agreed to allow the use of NRC rock scoring criteria in determining the acceptability of a rock source, provided the rock had a numerical score of at least 65.

4.6 Conclusion

Based on a review of the information submitted by DOE, it was concluded that the site design will meet EPA requirements as stated in 40 CFR 192, with regard to flood design measures and erosion protection. It was also concluded that an adequate hydraulic design has been provided to reasonably assure stability of the contaminated material at Collins Ranch disposal site for a period of up to 1000 years.

5.0 WATER RESOURCES PROTECTION

5.1 Introduction

The final Remedial Action Plan and Site Conceptual Design (fRAP) was reviewed for compliance with EPA's proposed ground-water protection standards in 40 CFR Part 192, Subparts A-C (52 FR 36000). The NRC Draft Technical Position on Information Needs (NRC, 1988) was used as guidance for review to demonstrate compliance with EPA's Ground-Water Protection Standards in 40 CFR Part 192 Subparts A-C.

Water resources protection is divided into two areas of concern at the Lakeview site. Residual ground-water contamination is known to exist at the processing site; however, DOE currently has no plan in effect to deal with this situation. In anticipation of future work that will likely take place at the Lakeview processing site, a minimal number of monitor wells have been established adjacent to the site. The data from these monitor wells and other characterization information will be reviewed at a future date to determine the need for remedial action. Therefore, the processing site is not a subject of review in this section.

The DOE ground-water compliance strategy consists of isolating the relocated tailings from contact with the ground water known to occur at the disposal site. This consists of lining the disposal cell with a 2-foot thick geochemical/flow barrier and placing a low permeability cover over the tailings to limit infiltration while promoting runoff (Figure 4). DOE has stated that their analysis of the disposal cell design indicates that maximum concentration limits (MCLs) will be met at the point of compliance (POC) wells. Based on a review of the DOE documentation, it is concluded that DOE has provided adequate information to demonstrate that MCLs can be achieved at the site.

The findings and conclusions documented in the following paragraphs apply only to the Lakeview site and should not be construed as applicable for any other UMTRA site.

5.2 Hydrogeologic Characterization

5.2.1 Hydrostratigraphy and Ground Water Occurrence

DOE has characterized the hydrogeology in the vicinity of the disposal site using acceptable techniques, methods, and approaches, and the assessment of hydrogeologic characteristics is adequate to support DOE's performance assessment to demonstrate compliance with the MCLs.

Based upon its hydrogeologic characterization activities, DOE determined that ground water in the vicinity of the Collins Ranch disposal site is contained in alluvial material at depths ranging from 7 to 90 feet below the land surface. The ground-water surface was characterized with 20 shallow boreholes completed as monitor wells and five deeper wells (Figure 6). Nine of the shallow wells contained water as did all five of the deeper wells. The data from these wells indicated that ground water exists approximately 30 feet below the disposal site.

Ground water is unconfined in the poorly consolidated alluvial unit which consists of interfingered and interbedded silts, sands, and clays. These materials are known to be up to 250 feet thick and represent remnant outwash deposits, of Quaternary age, from the nearby Fremont Mountains.

Based on lithologic logs from borings and monitor wells, the uppermost aquifer at the Collins Ranch disposal site consists of the alluvial materials previously described. Based upon the water levels or absence of water in the 20 monitoring wells, DOE constructed potentiometric surface maps to determine the direction and rate of ground-water flow. Examination of the potentiometric surface indicated that the predominant direction of ground-water flow is to the southeast under an average hydraulic gradient of 0.018. The direction of ground-water flow is opposite the topographic slope, indicating that most of the recharge is from the Fremont Mountains to the west rather than the small drainage basin to the northeast of the disposal site.

DOE aquifer characterization indicated that the alluvial materials, in the vicinity of the disposal site have an average hydraulic conductivity of 0.64 ft/day, an effective porosity of 0.15, a saturated thickness of 60 feet, a hydraulic gradient of 0.018, a longitudinal dispersivity of 50 feet and a transverse dispersivity of 10 feet. These values are typical for alluvial materials that are poorly consolidated.

Ground water in the uppermost aquifer is recharged by ground-water underflow, infiltration, and seepage from intermittent streams, while ground-water discharge occurs as ground-water underflow. DOE indicated that ground-water discharge to the land surface or to nearby surface water bodies is believed to occur west and upgradient of the disposal site. As the ground water continues along it's alluvial flow path it moves deeper into the formation. No ground-water discharge occurs within two miles in a downgradient direction. The lack of evidence of ground-water discharge in the immediate site vicinity supports DOE's contention that there is a low probability that humans or the environment will be exposed to hazardous constituents from the Collins Ranch disposal cell should any be discharged into the alluvial ground water.

5.2.2 Geochemical Conditions and Water Use

Based on results of water quality analyses from up-gradient and down-gradient wells in the alluvial aquifer, DOE has determined the ambient concentrations of selected hazardous constituents. In addition to these constituents, numerous anions, cations, and nonhazardous constituents were assayed to determine ground-water quality. Wells 508, 513, 514, 515, 516, 520, 521, 522, and 523 at the Collins Ranch disposal site were sampled between October 1984 and March 1988. The location of these wells is shown in Figure 6. The data indicate that the ground-water quality varies in time and space. Generally the further along the downgradient flow path, the poorer the water quality becomes. Table 1 shows the background concentrations for selected hazardous constituents.

Table 1

Background Concentrations of Selected Hazardous Constituents at the Collins Ranch Disposal Site*

Constituent	Proposed EPA MCL		Minimum observed	Average observed	Maximum observed	No. of samples
Arsenic	0.05		0.001	0.0048	0.006	28
Barium	1.0		0.005	0.006	0.01	4
Cadmium	0.01		0.0005	0.0011	0.017	24
Chromium	0.05		0.005	0.0077	0.02	20
Lead	0.05		0.005	0.0050	0.005	8
Mercury	0.002		0.0001	0.0001	0.0002	4
Molybdenum	0.10		0.005	0.0050	0.005	4
Nitrate	44.0		2.0	5.0	13.0	28
Selenium	0.01		0.0025	0.0025	0.0025	8
Silver	0.05		0.005	0.0050	0.005	4
Uranium-234 & 238	0.044		0.0001	0.0011	0.0015	16
Radium-226 & 228	5.0	pCi/l	0.05	1.00	1.4	16
Gross alpha	15.0	pCi/l	0.0000	0.9866	2.3	10

* Units in mg/l unless stated otherwise.

No organic analyses of those constituents listed in 40 CFR, Part 264, Appendix IX were run, because organics are not expected to occur in background alluvial ground water. Total dissolved solids (TDS) from 28 water samples averaged 194 milligrams per liter (mg/l) with values ranging from 134 to 380 mg/l. The ground water contains relatively low concentrations of calcium (22 mg/l); magnesium (5 mg/l); sodium (16 mg/l); sulfate (8 mg/l); and organic carbon (2 mg/l). These values are the means of the available sample analyses.

Table 1 shows the background concentrations of those constituents having proposed EPA standards (52 FR 36000). The maximum concentrations measured for all but one constituent were below the proposed MCLs. Cadmium exceeded the MCL in one sample. Nine samples from the same well, taken before and after the sample showing exceedance of the cadmium MCL, showed cadmium concentrations between the analytical detection limit and 0.003 mg/l. The maximum observed cadmium concentration in all other wells at Collins Ranch disposal site was 0.004 mg/l. The single exceedance of the proposed EPA MCL for cadmium was assumed to be erroneous, and was therefore not considered to be representative of background water quality in the alluvial aquifer at the Collins Ranch disposal site.

The Lake County Watermaster has no well records for a three-mile area surrounding the Collins Ranch disposal site. However a water-use survey conducted by the DOE during February 1985 identified two private wells located 1.25 and 1.5 miles from the site. Future ground-water development in the area would be governed by the availability of water rights, by land use restrictions on the Federal land, and by economic factors on nearby private land. There are no indications that ground-water use will change from the current minimal use that takes place.

The value of water in the area will probably parallel the value of agricultural products that can be produced by the water supply. Alternatively, population growth in the area could increase demand for a domestic water supply. On a qualitative or relative basis, it can be concluded that the value of ground-water resources in the area is moderate to high, due in part to its limited supply.

In the unlikely event that ground-water contamination takes place at the disposal site, beyond the point of compliance, several alternative water supplies are available. Surface water could be obtained from neighboring perennial streams, if water rights were available. Similarly, deep bedrock aquifers could be utilized, although at considerable expense.

5.2.3 Extent of Contamination

There is no detected ground-water contamination at the Collins Ranch disposal site. Ground water moving under the site has rather good quality which, based upon the ground-water protection being utilized at the site, is expected to remain.

5.2.4 Tailings Characterization

DOE estimated existing source concentrations in tailings materials from pore fluids obtained from two suction lysimeters installed in the tailings. To augment the data, base ground-water samples were taken from shallow wells completed immediately beneath the processing site. These samples were subject to significant mixing and are not considered ideal indicators of the presence, concentrations, or number of hazardous constituents likely to be present in typical tailings solutions. Table 2 shows observed concentrations of selected hazardous constituents in pore fluid and shallow ground water.

Table 2

Measured Concentrations of Selected Hazardous Constituents in Pore Fluid and Shallow Ground Water*

Constituent	Proposed EPA MCL	Average of lysimeter samples	Maximum observed in shallow ground water
Arsenic	0.05	0.147	0.08
Barium	1.0	<0.10	0.10
Cadmium	0.01	0.03	<0.01
Chromium	0.05	0.01	0.01
Lead	0.05	<0.01	0.01
Mercury	0.002	NM	0.0003
Molybdenum	0.10	0.04	0.07
Nitrate	44.0	17.0	2.0
Selenium	0.01	<0.005	0.03
Silver	0.05	<0.01	<0.01
Uranium-234 & 238	0.044	0.048	0.004
Radium-226 & 228	5.0 pCi/l	NM	<2 pCi/l
Gross alpha	15 pCi/l	NM	NM

NM = Not Measured.
* Units in mg/l unless stated otherwise.

The water quality data in Table 2 indicate that barium, chromium, lead, mercury, molybdenum, nitrate, selenium, silver, and radium-226 and 228 are not hazardous constituents of concern in the tailings solution. They are either found at concentrations less than the MCL's or are altogether absent in the tailings extract. However arsenic, cadmium, and U-234 plus U-238 are hazardous constituents that exceed the proposed EPA MCLs in the tailings pore fluids or shallow ground water.

A review of the tailings pore fluid characterization indicates that sufficient water quality data for appropriate hazardous constituents have been collected. The method of measuring either pore fluid of shallow ground water is a conservative approach to determine which hazardous constituents are present at the site.

5.3 Conceptual Design Features For Water Resources Protection

In accordance with draft 40 CFR Part 192.02(a)(3), DOE has specified the features of the disposal cell design needed for ground-water protection. These include: a) placement of a contoured cover to promote sheet flow off the pile; b) placement of a leachate reduction layer over the pit bottom to enhance retardation of tailings constituents; c) limiting the amount of water used for dust control; and d) placement of a clay cap over tailings having a hydraulic conductivity of 7E-8 cm/sec. DOE has also demonstrated that the design does not rely on active maintenance to assure acceptable performance, as discussed in Section 5.4.2.

5.4 Disposal and Control of Residual Radioactive Material

5.4.1 Ground-Water Protection Standard

Under Title I of the Uranium Mill Tailings Radiation Control Act of 1978, as amended, EPA's proposed ground-water protection standards in 40 CFR, Part 192, Subparts A and C require that disposal units be designed to control residual radioactive material in conformance with site-specific ground-water protection standards. The standards that are applicable at the processing site are either the MCLs or the measured background values, which ever are higher. The previously presented Table 1 indicates the ground-water standards that are applicable to the site.

5.4.1.1 Applicability of Standards

The ground-water standards that have been selected by DOE to determine compliance at the POC wells represent either background concentrations or EPA's proposed ground-water protection standards. A review of the proposed standards indicates that they are applicable to the site. The background characterization of the site was determined to be adequate based on the number of samples as well as the time period over which they were taken. The sampling methodology supplied sufficient data to determine variations in time and space. Taking averages of group data values for the various hazardous constituents or using the EPA MCL's are appropriate methods for determining ground-water protection standards.

5.4.1.2 Compliance Demonstration

Two models were utilized by DOE to simulate post-closure operation of the disposal cell. DOE estimated concentrations of hazardous constituents in ground water for various rates of infiltration through the low permeability layer above the tailings. The method-of-characteristics (MOC) ground-water transport model developed by Konikow and Bredehoeft (1978) was used to estimate the effects of dilution and dispersion on source concentrations leaching from the relocated tailings upon introduction of the leachate into the ground water. The approximate analytical procedure of Domenico and Robbins (1985) was utilized to estimate the mixing that would take place through dispersion.

The MOC model was calibrated to represent the aquifer below and adjacent to the relocated tailings. A uniform gradient of 0.018, which matches the measured potentiometric surface, was configured. The leachate injection rate was determined from the average of the saturated hydraulic conductivity of the cover material and the total surface area. Aquifer thickness was assumed to be 60 feet. The model predicted a sub-pile concentration ratio of 0.21. This implies that if the contribution from the tailings impoundment exceeds this ratio for a selected hazardous constituent, the ground-water standard will be surpassed.

The convective-dispersion equation of Domenico and Robbins (1985) was used to estimate the distance required to achieve adequate mixing. The model requires that the input of the source represent a uniform rectangular plane normal to the direction of ground-water flow. Dispersion beneath the cell was not assumed to occur.

Assuming continual saturation of the clay barrier, leachate was estimated to occupy the upper 11.2 feet of the aquifer at the downgradient edge of the disposal cell. Utilizing this approach the concentrations of arsenic, cadmium, and uranium-234 and 238 were predicted to fall below the EPA MCLs within 50 feet of the edge of the disposal cell. As previously stated, all other hazardous constituents meet their MCLs at the currently measured concentrations. The predicted distance to meet the various MCLs is shown in Table 3.

The model parameters used by DOE as well as the modeling effort are considered to be an accurate representation of the future performance of the remedial action. There are, however, variables that are unpredictable such as climatic changes or simply a series of unusually wet years. To compensate for such possible unknowns, DOE has utilized a conservative approach that may actually overestimate the amount and concentration of leachate production that may actually take place. Accordingly, and because the probability of exposure of contaminated water to humans or the environment is low, these concentrations are acceptable and protective of human health and the environment. Thus DOE's proposed remedial action for ground-water protection was considered to comply with EPA's proposed MCLs.

5.4.2 Closure Performance Standard

In accordance with the closure performance standard of 40 CFR Part 192(a)(4), DOE is required to demonstrate that the proposed disposal design: 1) minimizes the need for further maintenance as required in 40 CFR Part 264.111(a); and 2) controls, minimizes, or eliminates releases of hazardous constituents to ground water as required in 40 CFR Part 264.111(b).

Relative to 40 CFR Part 264.111(a), DOE has adequately demonstrated compliance with the long-term stability standards in 40 CFR Part 192.02(a), as described in sections 2.0, 3.0, and 4.0 of this fTER. Further, DOE has demonstrated that the design features needed to comply with the site-specific ground-water protection standards do not rely on active maintenance to ensure satisfactory performance. The barriers are composed of earthen materials that are likely to remain stable and

Table 3

Ground-Water Travel Distance Required
To Meet The Various MCLs*

Constituent	Proposed EPA MCL	Back-ground level	Distance to meet EPA MCL (ft)	Meets MCL at POC?	Remarks
Arsenic	0.05	0.01	<50	Yes	Dilution beneath and immediately downgradient of the cell to concentration below MCL
Barium	1.0	<0.1	0	Yes	Pore water concentration below MCL
Cadmium	0.01	0.002	<50	Yes	Dilution beneath and immediately downgradient of the cell to concentration below MCL
Chromium	0.05	<0.01	0	Yes	Pore water concentration below MCL
Lead	0.05	<0.005	0	Yes	Pore water concentation below MCL
Mercury	0.002	0.0001	0	Yes	Pore water concentration below MCL
Molybdenum	0.10	<0.005	0	Yes	Pore water concentraion below MCL
Nitrate	44.0	7.0	0	Yes	Pore water concentration below MCL
Selenium	0.01	0.003	0	Yes	Pore water concentration below MCL
Silver	0.05	<0.005	0	Yes	Pore water concentration below MCL
Uranium-234 & 238	0.044	0.0011	<50	Yes	Dilution beneath and immediately downgradient of the cell to concentration below MCL
Radium-226 & 228	5.0 pCi/l	1.1 pCi/l	0	Yes	Pore water concentration below MCL

* Concentrations are in mg/l unless noted otherwise.

maintain their integrity during the 1000-year design life. In addition, if an increase in available infiltration occurs, the potential increase in seepage from the disposal cell would not adversely affect human health or the environment because the probability of human or environmental exposure to ground water is low and because an acceptably conservative approach was utilized. It is therefore concluded that DOE has demonstrated that the need for further maintenance of the disposal site has been minimized.

Since DOE has adequately demonstrated compliance with the proposed EPA MCLs, it was concluded that the proposed design minimizes release of hazardous constituents to ground water to the extent necessary to protect human health and the environment in accordance with the requirements of 40 CFR Part 264.

5.4.3 Ground-Water Monitoring and Corrective Action

DOE is required to describe an integrated monitoring program to be conducted before, during, and after completion of the disposal action to demonstrate that the initial disposal performance complies with the ground-water protection and closure performance standards of 40 CFR Parts 192.02(a)(3) and (4).

The DOE has adequately fulfilled the preoperational monitoring requirements of the proposed EPA ground-water protection standards by collecting adequate data over space and time on selected ground-water constituents. These data indicate that the tailings were placed in a moist condition and, based upon the infiltration barrier as well as the slope of the reclaimed tailings, should remain in a similar moisture regime.

To assure that the tailings reclamation protects the water resources as planned, DOE intends to monitor the ground water in the vicinity of the tailings. The monitoring plan, although not yet finalized, is designed to monitor the ground water during the post-construction period. Presently the number of monitoring wells in the vicinity of the disposal cell are adequate to assure proper ground-water monitoring. DOE has proposed to install 4 to 8 additional wells, to monitor water levels and ground-water quality at the point of compliance and downgradient of the disposal cell.

It is concluded that the DOE proposal to monitor at the point of compliance as well as other downgradient locations is acceptable. When the ground-water monitoring plan becomes available the frequency of monitoring and the proposed parameters comprising the program will be reviewed to determine if they are adequate to determine compliance with 40 CFR, Part 192.020(a)(4)(b).

In the unlikely event that infiltration into the Collins Ranch disposal cell is greater than anticipated, it may be possible that hazardous constituent concentrations could increase at downgradient monitor wells. Because of the design of the cell the likelihood of this occurring is remote. Thus DOE has not proposed a corrective action program. This is considered to be acceptable because ground-water monitoring will determine if such a program is necessary. Also, DOE has committed that if concentrations of hazardous constituents do increase, DOE will within 18 months formulate and implement a corrective action program pursuant to 40 CFR 192.02(a)(4)(c). It is therefore concluded that no corrective actions are necessary at this time. Should conditions at the site change, the need for such action will be evaluated at that time.

5.5 Cleanup and Control of Existing Contamination

Cleanup of contaminated ground water is required under Subpart B of EPA's proposed UMTRA Project standards. The need for and extent of aquifer restoration at the Lakeview processing site will be determined based on the extent of existing contamination, the potential for current or future use of the aquifer for drinking water supplies, and the technical practicability of restoring the aquifer. Studies are currently underway to develop plans, guidance materials, and procedures for aquifer restoration activities. Implementation of those plans, however, will be deferred until after the EPA standards have been finalized. Since DOE has deferred corrective action pending finalization of ground-water standards by EPA, full concurrence of the remedial action plan cannot be provided at this time. Therefore, this will remain as an open item.

5.6 Conclusion

In conclusion, DOE has proposed application of primary standards under the provisions of 40 CFR Part 192 for ground-water protection. The design of the disposal cell and the predicted ground-water quality resulting from the climatic conditions that exist adequately demonstrate that primary standards can be achieved at the point of compliance. The Lakeview site is therefore protective of human health and environment because MCLs will be achieved for those hazardous constituents reasonably expected to be in or derived from the relocated tailings.

6.0 RADON ATTENUATION AND SITE CLEANUP

6.1 Characterization of Tailings and Cover Material

The review of the radon attenuation design encompassed independent evaluation of pertinent design parameters for both the tailings and radon barrier soils. The tailings properties evaluated for acceptability included long-term moisture content, radon diffusion coefficient, radium content, radon emanation coefficient, material thickness, bulk density, specific gravity, and porosity. The cover material properties evaluated for acceptability included: long-term moisture content, radon diffusion coefficient, bulk density, specific gravity, and porosity. The tailings consist of two distinct layers: an upper tailings layer (off-pile contaminated material) and a lower tailings layer (actual tailings).

Characterization values assigned to the lower tailings layer in the modeling process were based on laboratory test results or on appropriate estimates made using accepted methodology. It was determined that all parameters were representative of the lower tailings material and were thus acceptable. The values assigned to the upper layer of materials were also found to be acceptable except for the emanation fraction, diffusion coefficient, and the radium activity. The emanation fraction assigned by DOE to the upper tailings layer was the same as that assigned to the lower tailings layer which was based on laboratory testing. As the two materials have significantly different activities, this value cannot be considered representative of the upper layer, and the model must be adjusted accordingly. Similarly, the diffusion coefficient assigned to the upper layer cannot be considered representative as it was also based on data associated with the lower tailings layer material. The activity of the upper layer was estimated based on average Ra-226 ingrowth from Th-230. It was determined that a more representative value could be estimated by using a volume-weighted average.

The characterization of the cover material in DOE's modeling was not considered conservative. The density and resulting porosity was questioned based on the material presented, and the diffusion coefficient was not in agreement with the long term moisture assigned to the material by DOE. Without further justification in the form of additional testing of the proposed cover materials, DOE's characterization of the material was not considered adequate for design purposes. However, an independent evaluation using conservative parameters showed that the radon cover design is acceptable (see Section 6.2 below).

6.2 Radon Attenuation

DOE's calculation of a cover thickness using the parameters they considered representative indicated that no barrier was required to reduce the radon flux to the 20 picocuries per meter squared per second (pCi/m^2s) standard. Due to other functions of the cover design (such as infiltration), DOE's plan includes a 1.5 foot thick radon barrier. However, due to the numerous parameters that were identified as open items by NRC in the draft Technical Evaluation Report and the status of construction activities at the site, it was determined that the final design of the radon barrier thickness should be based on actual field construction data.

To determine that the proposed design depth of 1.5 foot represented a reasonable thickness for preliminary design, DOE's analysis was independently verified. The RADON computer code (NRC, 1989b) was used to model the DOE three-layer system using acceptable values for the tailings and cover characterization properties. Input parameters for values identified as questionable were conservatively estimated or were assigned NRC "default" values which were programmed into the computer code. Due to the lack of representative testing of the proposed cover soils, average published values (U.S. Department of the Interior, 1987) of maximum density for the soil types listed as acceptable material in the specifications were assigned in the model. The long term moisture content was conservatively estimated by emperical methods (Rogers and others, 1984). The diffusion coefficient of the cover soils was calculated by the computer code based on the assumed physical properties and long term moisture content. A comparison of the input parameters is given in Table 4. The NRC RADON model resulted in an exit flux of approximately 15 pCi/m^2s for a cover thickness of 1.5 feet as proposed by DOE.

6.3 Site Cleanup

Review of pertinent information regarding depth of excavation at the various contaminated areas, based on Ra-226, encompasses the basis for concurrence on the site cleanup portion of the fRAP. The DOE proposes to base the excavation of contaminated soils underneath the main tailings pile at the processing site on arsenic levels. The DOE states that excavation of the main tailings pile will be approximately 1 foot deeper than required to meet the Ra-226 standard, based on arsenic contamination. The excavation of the evaporation ponds will be based on the Th-230 concentration.

It was thus concluded that excavation based on these contaminants is acceptable as long as DOE verifies that the processing site meets the EPA Ra-226 standards.

6.4 Conclusion

Based on the review of the information submitted by DOE as supported by independent verification, it was determined that the remedial action will meet EPA requirements as stated in 40 CFR 192, with regard to site cleanup and the attenuation of radon over the design life of the project. It was concluded that an adequate preliminary design was proposed to provide reasonable assurance that the average release of radon from the disposal site would not exceed the EPA standard.

7.0 SUMMARY

This Final Technical Evaluation Report documents the review of the proposed remedial action for the Lakeview tailings site. Based on this review, conditional concurrence is provided on the Remedial Action Plan and Site Design. Complete concurrence will be provided when DOE has addressed cleanup of existing ground-water contamination in accordance with EPA standards.

Table 4

RADON ATTENUATION MODELING PARAMETERS

	DOE	NRC
Thickness (cm)		
Lower Tailings	1220	1220
Upper Tailings	610	610
Radon Barrier	30	46
Porosity		
Lower Tailings	0.53	0.53
Upper Tailings	0.53	0.53
Radon Barrier	0.53	0.50
Mass Density (g/cm^3)		
Lower Tailings	1.18	1.18
Upper Tailings	1.18	1.18
Radon Barrier	1.19	1.40
Activity (pCi/g)		
Lower Tailings	160	160
Upper Tailings	14	20
Emanation Coefficient		
Lower Tailings	0.27	0.27
Upper Tailings	0.27	0.35
Long Term Moisture (%)		
Lower Tailings	21	21
Upper Tailings	21	21
Radon Barrier	16	13
Diffusion Coefficient (cm^2/sec)		
Lower Tailings	0.016	0.016
Upper Tailings	0.016	0.040
Radon Barrier	0.025	0.023

8.0 REFERENCES

Campbell, K.W., 1981, Near-Source Attenuation of Peak Horizontal Acceleration: Bulletin of the Seismological Society of America, V. 71, p. 2039-2070.

Campbell, K.W., 1982, A preliminary methodology for the regional zonation of peak ground acceleration: Proceedings of the 3rd International Earthquake Microzonation Conference, Seattle, Washington, V. 1, p. 365-376.

DOE, 1985, Processing Site Characterization Report for the Uranium Mill Tailings Site at Lakeview, Oregon, October 1985.

DOE, 1986a, Uranium Mill Tailings, Remedial Action Project (UMTRAP), Lakeview, Oregon, Calculations, Final Design for Construction, Volumes I-V, March 1986.

DOE, 1986b, Uranium Mill Tailings, Remedial Action Project (UMTRAP), Lakeview, Oregon, Main Construction Subcontract Documents, March 1986.

DOE, 1989, Remedial Action Plan and Site Design for Stabilization of the Inactive Uranium Mill Tailings Site at Lakeview, Oregon, Appendix B of the Cooperative Agreement, No. DE-FC04-84AL20534, February 1989.

Domenico, P.A., and Robbins, G.A., 1985, A New Method of Contaminant Plume Analysis, in Ground Water, V. 23, No. 4.

Johnson, T.L., 1985, Design of Rock Covers for Reclaimed Uranium Mill Tailings Impoundments: A Regulatory Perspective, Proceedings of the Seventh Symposium on Management of Uranium Mill Tailings, Low-Level Waste, and Hazardous Waste.

Konikow, L.F., and Bredehoeft, J.D., 1978, Computer Model of Two-Dimensional Solute Transport and Dispersion in Ground Water, in the United States Geological Survey, Techniques of Water-Resources Investigations, Chapter C2, Book 7.

NRC, 1977, Design Construction, and Inspection of Embankment Retention Systems for Uranium Mills, Revision 2: NRC Regulatory Guide 3.11, December 1977.

NRC, 1985, Standard Review Plan for UMTRCA Title I Mill Tailings Remedial Action Plans: Washington, D.C., Division of Low-Level Waste Management and Decommissioning, October 1985.

NRC, 1988, Draft Information Needs to Demonstrate Compliance With EPA's Proposed Groundwater Protection Standards in 40 CFR Part 192, Subparts A-C.

NRC, 1989a, Standard Format and Content for Documentation of Remedial Action Selection at Title I Uranium Mill Sites: Washington, D.C., Division of Low-Level Waste Management and Decommissioning, Feburary 24, 1989.

NRC, 1989b, Calculation of Radon Flux Attenuation by Earthen Uranium Mill Tailings Covers: NRC Regulatory Guide 3.64, June 1989.

Rogers, V.C., Nielsen, K.K., and Kalkwarf, D.R., 1984, Radon Attenuation Handbook for Uranium Mill Tailings Cover Design: Washington, D.C., U.S. Nuclear Regulatory Commission NUREG/CR-3533.

Simons, D.B., and Senturk, R., 1977, Sediment Transport Technology: Fort Collins, Colorado, Water Resources Publications.

Stephenson, D., 1979, Rockfill in Hydraulic Engineering: Developments in Geotechnical Engineering, V. 27.

U.S. Department of Commerce, 1966, U.S. Army Corps of Engineers, Hydrometeorological Report No. 43, Probably Maximum Precipitation, Northwest States, November 1966.

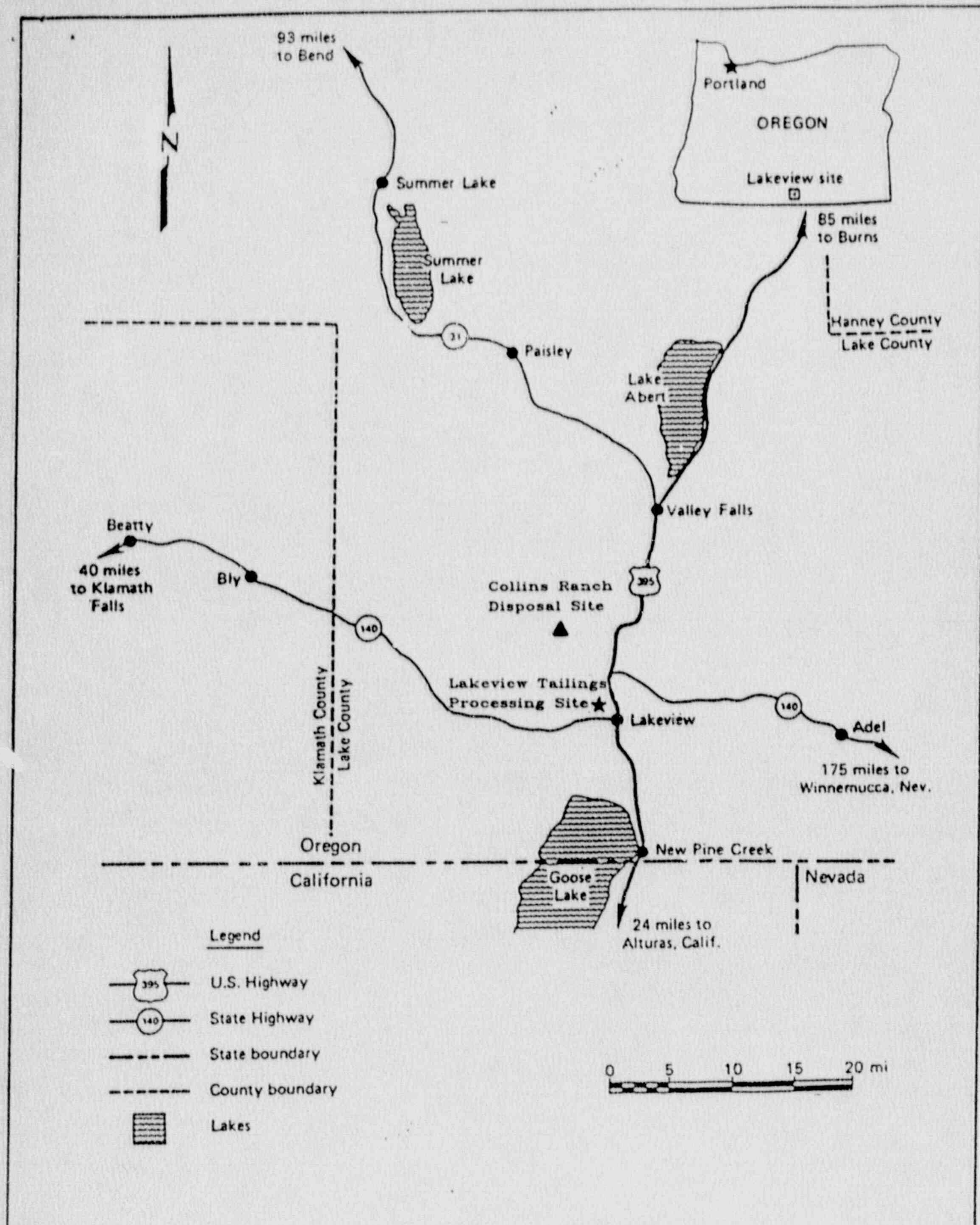
U.S. Department of Commerce, 1977, U.S. Army Corps of Engineers, Hydrometeorological Report No. 49, Probably Maximum Precipitation Estimates, Colorado River and Great Basin Drainages, September 1977.

U.S. Department of the Interior, 1977, Design of Small Dams: Washington, D.C., U.S. Bureau of Reclamation, Water Resources Technical Publications, Revised Reprint 1977.

U.S. Department of the Interior, 1987, Design of Small Dams: Denver, CO. U.S. Bureau of Reclamation, Water Resources Technical Publications, Third Edition, 1987.

APPENDIX

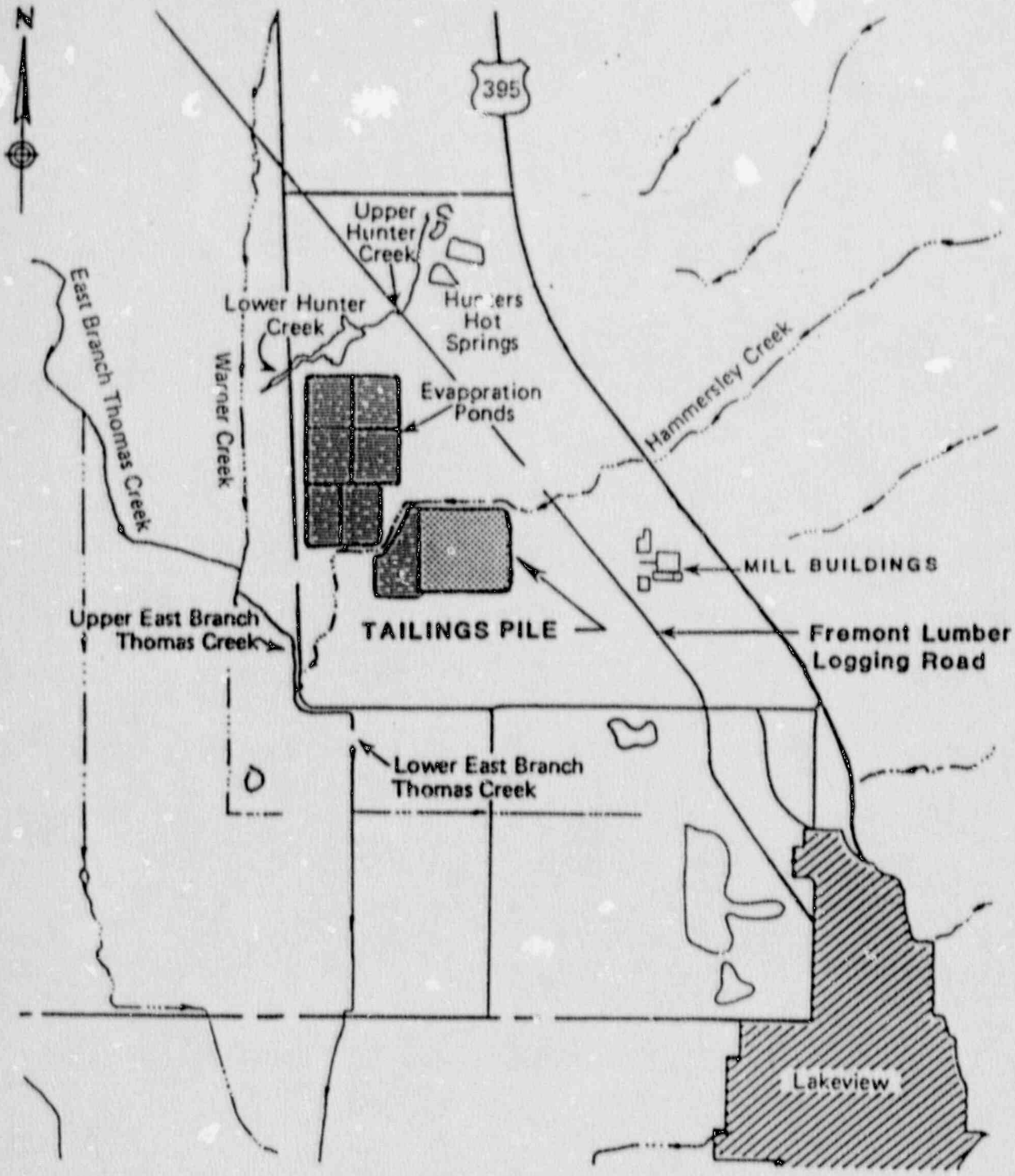
Figures



(From DOE, 1989)

LAKEVIEW SITE LOCATION

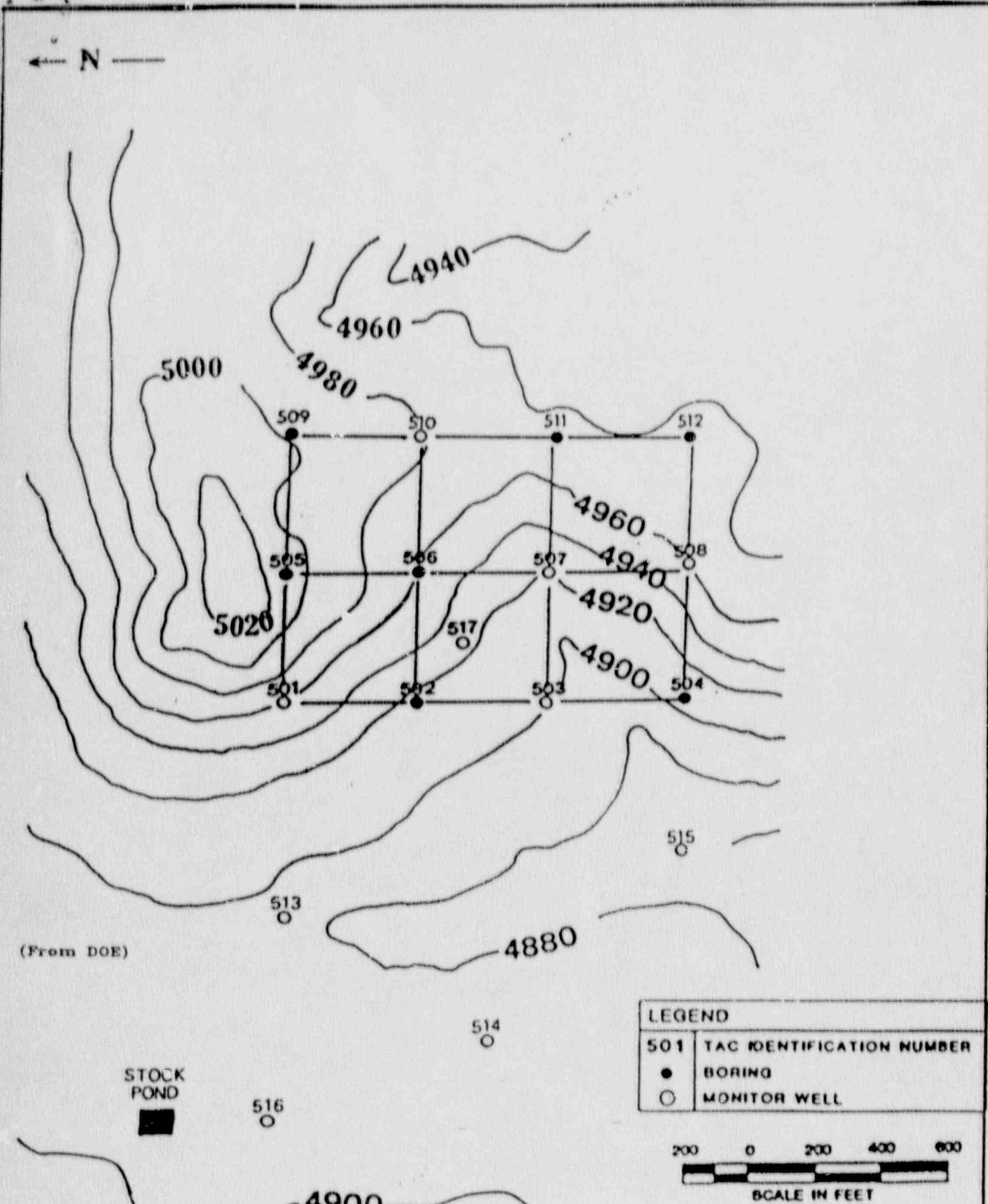
Figure 1



(From DOE, 1989)

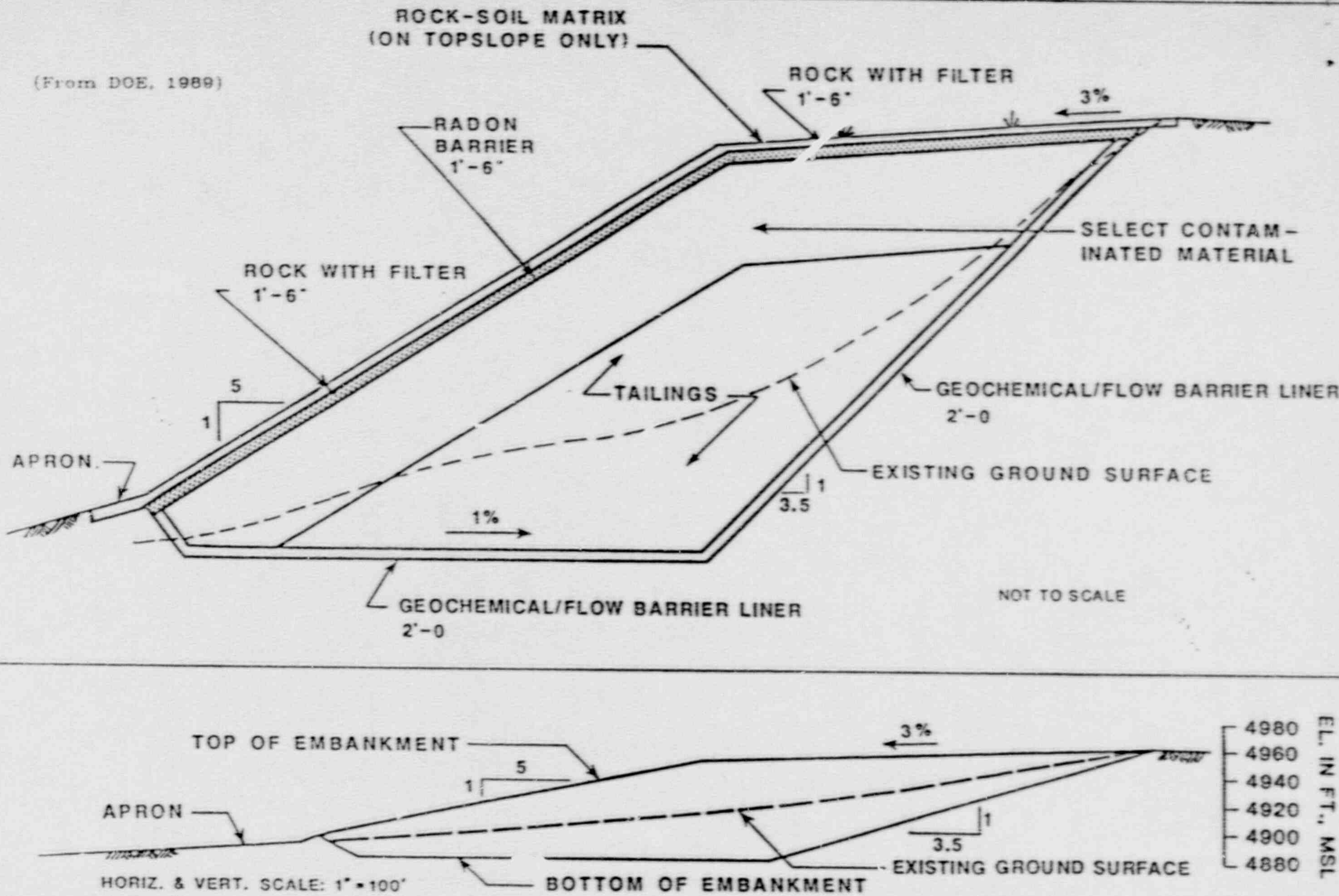
Lakeview Mill Tailings Processing Site

Figure 2



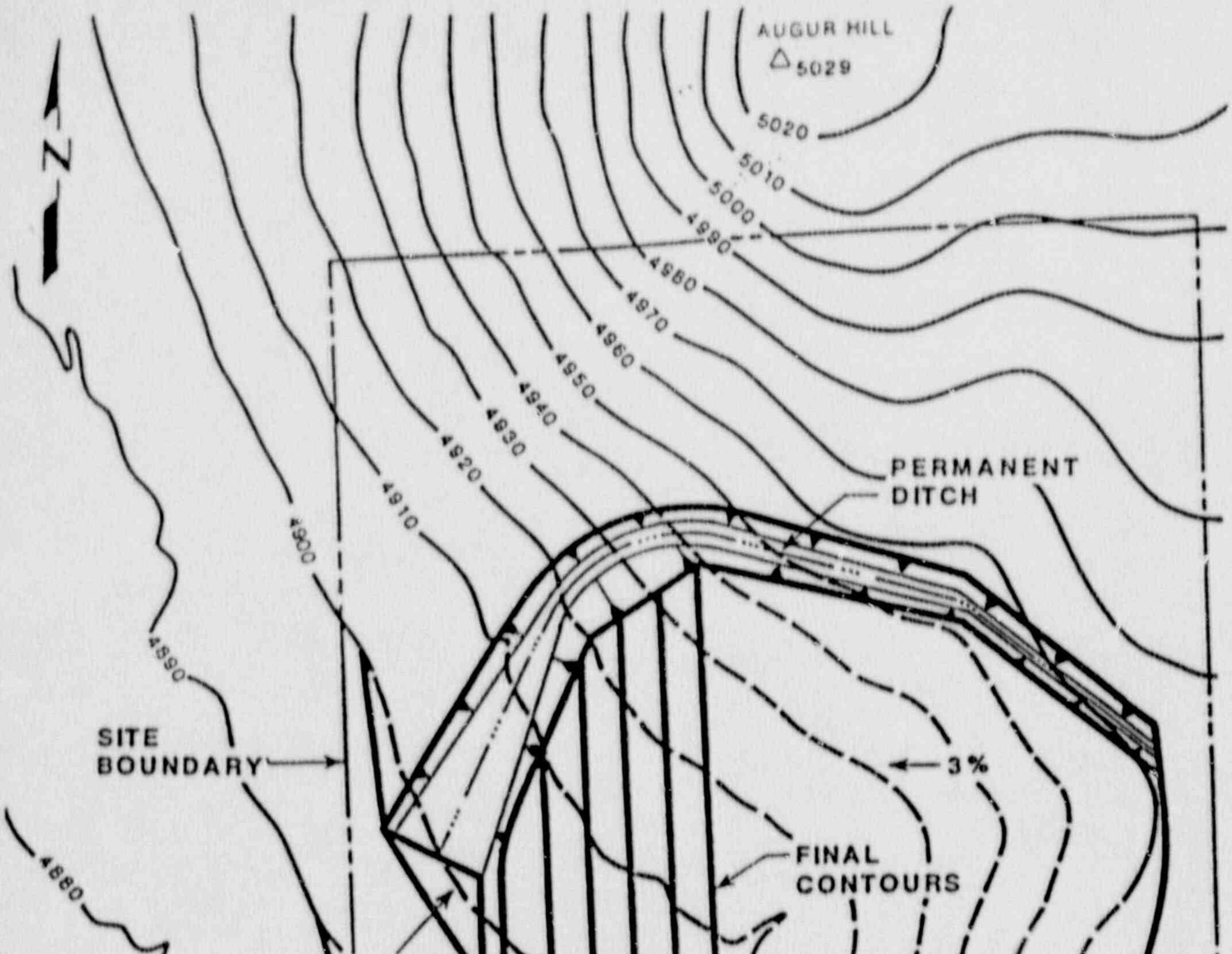
Collins Ranch Disposal Site Borings

Figure 3



COLLINS RANCH DISPOSAL SITE TYPICAL CROSS SECTION

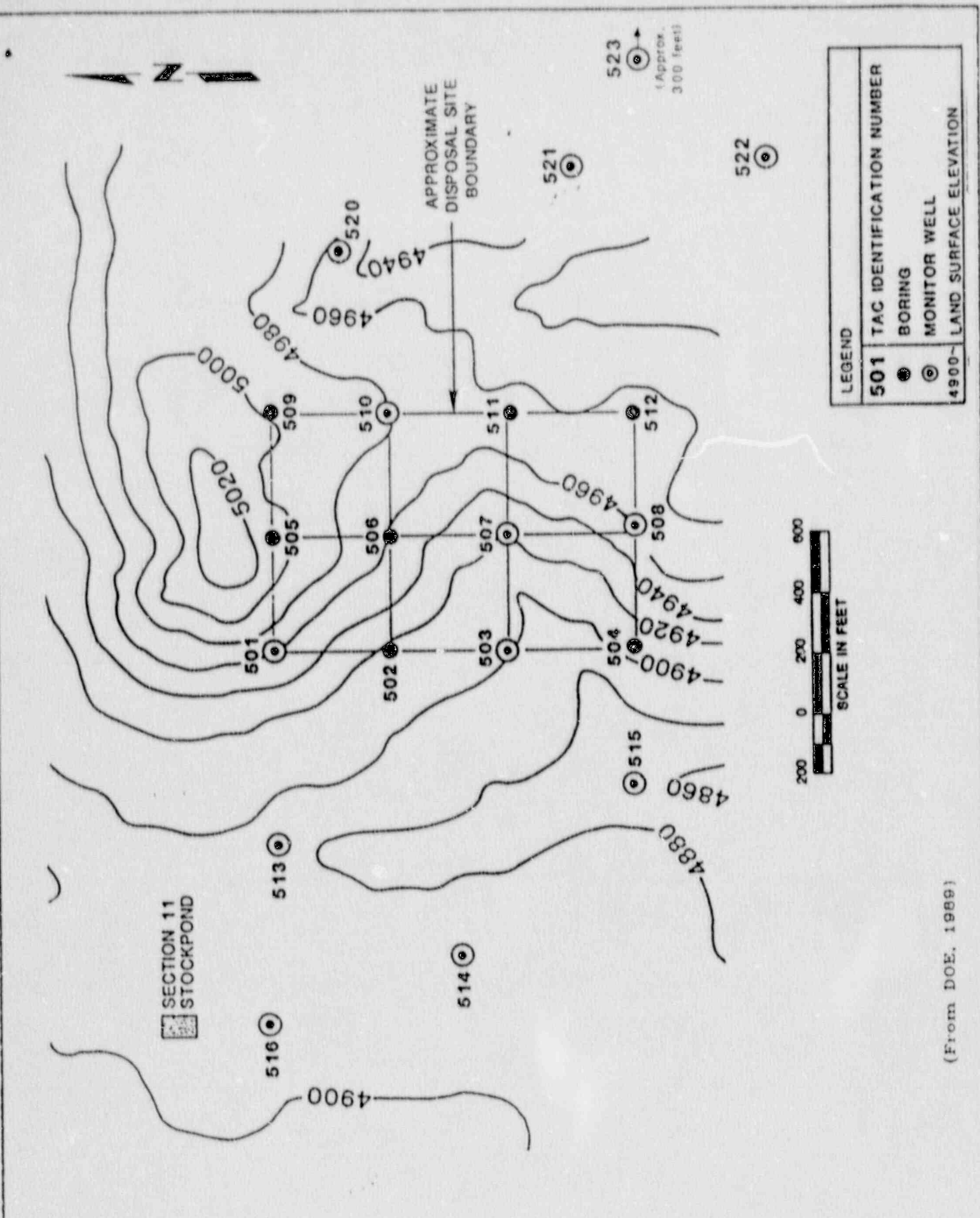
Figure 4



(From PGE, 1989)

FINAL CONDITION - COLLINS RANCH DISPOSAL SITE

Figure 5



Alluvium Monitor Well Locations
at the Collins Ranch Disposal Site

Figure 6